MINUTES

4th Expert Meeting
NOTTINGHAM, SEP 11-13TH 2017

Campus Nottingham University, Nottingham, England.

ATTENDANCE 11 Sep-2017

	Participants present in person:		**Participants present in person:**
1.	Amar Aganovic(AA) Norwegian University of Science and Technology	2.	Marc Abadie (MA) Université de La Rochelle, F
3.	Carsten Rode (CAR) - Operating Agent (OA) Technical University of Denmark, Kgs. Lyngby, DK	4.	Fitsum Tariku (FT) British Columbia Institute of Technology,CA
5.	Chanjuan Sun, University of Shanghai for science and Technology China	6.	Guillaume Pandraud Saint-Gobain,F
7.	Jensen Zhang (JZ) Syracuse University, NY, USA	8.	Nicole Poussineau(NP) Saint-Gobain,F
9.	Jakub Kolarik (JK) Technical University of Denmark, Kgs. Lyngby, DK	10.	Gabriel Rojas-Kopeinig, (RG) Universität Innsbruck, AS
11.	Daria Zukowska-Tejsen(DZ) Technical University of Denmark, Kgs. Lyngby, DK	12.	Menghao Qin (MQ) Technical University of Denmark, Kgs. Lyngby, DK
13.	John Grunewald (JG) TU Dresden, G	14.	Esfandiar Burmandir(EB) University College London,UK
15.	Maria Del Carmen Bocanegra-Yanez (Carmina) University of Strathclyde,UK	16.	Jelle Laverge(JL) Ghent University,BL
17.	Andreas Nicolai(AN) TU Dresden, G	18.	Hagar Elarga Technical University of Denmark, Kgs. Lyngby, DK
19.	Nadia Lynge Lyng Danish Technical Institute, DK	20.	Dejan Mumovic, University of College London,UK

21. Ular Palmiste Tallinn university of technology	22. Kevin Simth Technical University of Denmark, Kgs. Lyngby, DK
23. Lain Walker, Lawerence Berkely university National Laboratory ,USA	24. Li Wang University of Tokoyo, JP
25. Zhijun ZouUniversity of Shanghai for science and Technology , CN	26. Dzhordzhio Naldzheiev University College London,UK
27. Mike Davis(MD) University College London,UK	28. Chen Huang, University of Shanghai for science and Technology , China
29. Jos van Schijndel, Eindhoven University of Technology	

ATTENDANCE 13 Sep-2017

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21. Mike Davis(MD) University College London,UK	22. Ular Palmiste Tallinn university of technology

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 review of agenda

The meeting started on Sep 11th at approx. 8:45 by MD who has thanked Nottingham University and EB to arrange and invite such an event. He explained the day's arrangement within the campus. Followed by introducing CAR to everyone. CAR then clarified the agenda, subtasks leader's different presentations and also introduced CHAMPS discussion day which was planned to be held in 12th of Sep. He clarified that in Wednesday 13th Sep, another wrap up meeting shall be held at the morning to include some of AIVC activities and highlighting some managerial aspects. CAR showed anxiety about catching up of all addressed items and encourage all participants to participate and to summarize results to industrial participants. 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)

MD introduced Nottingham University team and thanked them for their generous contribution of holding up the annex 4th expert meeting. Later, MD discussed about the days arrangement within the campus.

4. Discussion of ST 1 description

Marc Abadie presented the main results regarding ST1 as this ST is now in a dormant phase. He also presented the already published work "L. Cony Renaud Salis, M. Abadie, P. Wargocki, C. Rode, Towards the definition of indicators for assessment of indoor air quality and energy performance in low-energy residential buildings, Energy and Buildings, 152, 2017, 492-502.". ST1 report is planned to be published as AIVC Contributed Report n°17 in October.

5. Discussion of ST 2 description

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

This subtask has organized a literature survey and made researcher contacts to gather relevant data and existing knowledge on major pollutant sources and loads in residential buildings, including models. 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, databases from Shenzhen IBR and Tsinghua University.

Two experiments are ongoing:

- The first one is a collaborative effort between Nanjing University and Tsinghua University to study the combined effects of temperature and humidity on VOC emissions from different building materials. 6 VOCs are measured for two different materials. The data will also be used to validate the existing models as well as suggesting new models for correlations between emission factors and environmental conditions. So far, 55% of the experimental work has been completed.

- The second is a field measurement in the P+ building in Wujin, Jiangsu, China to study the relationship between IAQ and different ventilation/ air cleaning strategies and building energy consumption. The following indoor atmospheric and energy performance parameters are being measured: T, RH, VOC, particles, ventilation (mechanical + natural), and energy consumption. The tests started in March 2017, and plan to carry out measurements in four seasons. So far, the measurements for spring, rain period and summer have been completed. 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.

Figure 2.1.New small-scale environmental chamber systems at Nanjing University, China. (Source: Student work, Nanjing University)

• 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.

Modelling

A theoretical correlation between the emission rate and indoor temperature and relative humidity has been derived.

- A procedure for the definition of reference buildings for estimating the pollution loads, IAQ and energy analysis for different countries/climates has been 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. The test cases have been used for the common exercise 1.

- 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 have been used for the common exercise 2.
- A procedure to estimate the model parameters of emission source models from the existing emission data accounting for the effect of temperature has been developed and will be used for the common exercise 3.

Subtask 2 has published 2 common exercises based on the following descriptions:

1. A procedure for definition of reference buildings for estimating the pollution loads, IAQ and energy analysis for different countries/climates.

2. 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.

The third common exercise will be published soon.

Figure 2.2. IAQ measurements in the P+ building comprising measurement of VOCs, PM2.5, thermal and humidity conditions as well as energy performance (Source: Student work, Nanjing University)

One journal article and three conference papers on relevant topics have been published with one under preparation.

Active contributors to Subtask 2 are DTU, Syracuse U., Nanjing U., Tsinghua U., University of Shanghai for Science & Technology, Shenzhen IBR, Univ. La Rochelle, and TU Dresden. Recently, the Korea Institute of Civil Engineering and Building has officially joined the Annex and will make contributions to Subtask 2.

JZ *has explained the Ref. blg concept to meet the minimum level of IAQ and energy performances at different countries. A question has been rounded between participants concerning how the occupant behavior is a manipulating parameter among different countries and how to take into consideration.*
So far, two simulations for 2 cities Syracuse and Washington DC have been carried out. JZ has highlighted the importance of exploitation of the idea especially on the energy performance level. From the IAQ JZ mentioned that a realistic ref. of pollutants have to be implemented.
Then JZ explained how to develop a numerical model capable of identify D_m, K_m and C_m. The diffusion model investigated the impacts of diffusion time vs thickness of the material under study. Mass transfer form material to air is included. Uncertainty has been considered with a percentage of 5 to 10%. Basically, the emission factor is estimated as a function of time then later other parameters as Temp and RH could be considered.

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

For the ST3 time slot, three presentations were scheduled:

1) John Grunewald: Introduction of the ST3 CE, based on the PASSYS cells project
2) Jakub Kolarik: Introduction to IDA-ICE modeling
3) Andreas Nicolai: Technologies for Co-Simulation of emission, ventilation control and room models

Summary of Presentations:

1) John Grunewald: With respect to the envisaged Annex 68 CHAMPS modeling platform, the simulation tools need to be complemented by quality-checked reference solutions. The most important aspects of this model verification are:
   - Broad and hierarchically organized modeling scope
     - Most important CHAMPS aspects to be captured
     - Different modeling scopes (walls, rooms, buildings)
     - Different modeling depths (simplified, compact, expert levels)
     - Gradual buildup of model complexity
   - Model-to-model comparison
     - Participation of most commonly used tools (e.g. IDA-ICE, TRNSYS, EnergyPlus)
     - Comparison with measured data not meaningful because of many uncertainties
   - Focus on interoperability and performance
     - Test of different coupling technologies
     - Test of large problems on reasonable execution time

    - Test of numerical robustness
- Towards fully automated quality assurance checks
    - Automatic execution of test cases
    - Automated evaluation of results
    - Automatically generated reports and messaging system

The Annex 68 ST3 CE will deliver reference solutions for model verification, which take into account heat, air, moisture and VOC flows, coupled walls and rooms and a gradual buildup of model complexity by variants. Interoperability, performance and automatization are not yet focused in this exercise but important topics for later analysis.

2) Jakub Kolarik: text By Jakub

3) Andreas Nicolai: The presentation sketched out the individual capabilities of the simulation models DELPHIN, THERAKLES and the ventilation system/equipment model in Modelica. Detailed VOC/pollutant emission from building structures and envelope systems under consideration of temperature and moisture effects can be simulated with DELPHIN.

THERAKLES can model hygrothermal behavior of rooms and construction and the influence of ambient climate and user behavior onto the room air conditions. A ventilation model that takes into account not just temperature and humidity conditions, but also pollutant concentrations within the room air is modeled and solved with Modelica.

The combination of the three distinct simulation software in a Co-Simulation can be achieved in different ways. First, the co-simulation technologies "FMI for Co-Simulation" and Waveform Relaxation method are introduced. An example for a coupled simulation is shown including the setup and execution of the simulation and the result of simulation tests are presented, including a discussion of overall simulation performance and Co-Simulation overhead.

Conclusions, further actions:

In the discussion after the presentations, it was concluded that the common exercise should be put into action as soon as possible. Hereby, the problem definition should be very much idealized in the beginning and become more and more realistic during the exercise. The Annex 68 partners agreed on following steps to increase the complexity:

1 Thermal analysis
2 Hygrothermal analysis
3 Hygrothermal analysis with air flows
4 Emission analysis (repeating Steps 1-3)
5 Emission analysis with action of HVAC systems

In order to ensure comparable results from different participants, we need to provide “human-readable” input files along with detailed project descriptions. Free of charge installers for the CHAMPS family of software programs will be made available to all participants on demand. CHAMPS-Multizone and CHAMPS-

BES are used to provide initial solutions. The CHAMPS programs cannot account for window solar radiation, internal long wave radiation balance, occupancy schedules and detailed HVAC systems. Therefore, IDA-ICE, EnergyPlus and NANDRAD will serve for problems with higher model complexity.

The common exercise will create essential input for the following ST3 deliverables:

1) Classification of available tools (categories: pure research tools, research tools on transition stage, commercial planning tools: sophisticated vs. simplified) on the basis of selection criteria
2) Set of reference cases (problem description, tool+input parameters, solution) with focus on building energy performance under high IAQ conditions
3) List of feature requests from gap analysis of available tools for integrated and coordinated design of low energy and high IAQ buildings.
4) Proposals for improvement of quality assurance standards

Furthermore, the necessity for consolidation of an Annex 68 VOC-Materials DB was discussed. A prototype of this DB is available through the CHAMPS software installers. The data needs to be checked, consolidated and extended:

a) Thermodynamic VOC data: input from ST1
b) Material-VOC data: input from ST2
c) Hygrothermal material data: input from ST3

For the model-independent maintenance of the data, a VOCDataAcquisitionControl.xlsm software will be developed under ST3 and free of charge distributed by the TUD. The VOC Data Acquisition Control will provide Open, Read, Edit and Write functions for the data along with analysis functions for the “Similarity”-approach.

7. Discussion of ST4 description

Following presentations were given at the ST4 session (they can be found in the Share Point):

"Detailed Simulation of the Indoor Environment as a Tool to Design Ventilation Systems in Low Energy Houses“ by Maria del Carmen Bocanegra-Yanez
”A novel algorithm for demand-control of a single-room ventilation unit with a rotary heat exchanger” by Kevin Smith
“Indoor air quality in mechanically ventilated residential dwellings/low-rise buildings: A review of existing information” by Amar Aganovic

Summary of Activity 4.1 (Jakub)

PART 1 – Written knowledge: DTU has written a report that summarizes requirements regarding residential ventilation as stated in national building codes and related standards. The report needs final revisions and updates as well as some editing. This will be coordinated by Daria from DTU during autumn 2017.

Amar has written a review paper on IAQ in mechanically ventilated dwellings. Paper is in the share point. It will be also placed on the webpage. The paper will be considered when output of 4.1 is gathered for the Annex 68 guide.

PART 1 – Review of "guides for practitioners": More action is and effort is needed to collect review at least for those countries which participate also in the "stakeholder" survey. So far, four countries provided input. It would be nice to have all 8 countries. DTU (Daria) will re-distribute the MS Excel table to those who are involved in the stakeholder survey. The data will be collected until the end of the year so that there is some time to process the results before the next expert meeting.

PART 2 – Stakeholder survey: Data collection is still ongoing. 8 countries responded (however not all stakeholders were represented in the answers). First results were summarized in a paper for AIVC conference. Work group was - Daria, Esfandiar, Guangyu, Amar, Gabriel, Carmina and Jakub. Paper is in the sharepoint and will be placed also on the internet.

Next steps – we should write a peer review paper – starting soon, probably the same group as for the conference paper. Paper should include advanced qualitative analysis. Based on all collected data the output for the Annex guide will be generated.

Jakub asked all Annex participants who could be interested to contribute to do so. Jakub will send an email with a limited response time (one month) for all participants to question them if they would like to participate. To plan the future steps, Jakub asked Marc how to implement the IAQ metrics through applied design phases. Also he asked Jelle and Gabriel about the status of their common exercise and Gabriel replied that he will update Jakub when he returns to Austria next March.

Discussion about activities 4.2 and 4.3

Activity 4.2

It was decided in Dresden that the activity 4.2 will be organized in such way that each participant interested in involvement in 4.2 will write down his topic of interest in "list of open questions" in sharepoint. So far DTU, Gent Univ. and UIBK/Gabriel have specified some tasks-projects.

Jakub informed that DTU has started with their project conducting a simulation study (presented briefly in ST3 session), which was focused on ventilation strategies for Danish low energy apartments as well as on implementation of pollution modeling in IDA ICE. The study is still ongoing; Jelle Laverge and Marc Abadie are "reviewers" from the Annex side.

Jelle informed that experiments at U Gent should start soon.

Gabriel informed that his inputs are still in a stage of project ideas and more will be clear after he returns from the USA.

Jakub encouraged other participants to join the 4.2 which should generate a collection of examples for new approaches to design strategies. Jakub also mentioned that it has to be discussed with ST1 to which extend can the results from ST1 be transformed to 4.2/design.

Activity 4.3

Jakub suggested how to proceed in the case of 4.3. The activity will be based on case studies included in ST 5. If there are not enough case studies in ST5, we will need to look around at use other case studies from Annex partners. Tools and methods from STs 1, 2 and 3 will be also applied if necessary to evaluate operation of the systems designed in 4.2. Possibility to use tools & methods from STs 1, 2&3 will be strongly dependent on the particular case studies. Suitability of different control strategies and operational modes will be addressed. However, we need a common method/approach to assess "Suitability".

In the discussion it was decided, that it will be difficult to differentiate between 4.2 and 4.3 in the current situation in the Annex. It was discussed that the approach should be similar to 4.2 meaning that partners, who are interested, will contribute with their examples from operation of innovative ventilation systems. One example will be DTU's project Room Vent Solutions where innovative decentralized ventilation systems are to be tested in practice.

Discussion about Activity 4.4 – The Annex Guide

Jakub reminded what the guide should be about: The guide will summarize results of previous subtask activities. Besides design and operation of residential ventilation, the guide will also address communication to building managers and occupants focused on increasing awareness regarding importance of IAQ for health and comfort.

Jakub presented intended structure of the guide and suggested team of people who could work on the guide – see figures 1 and 2.

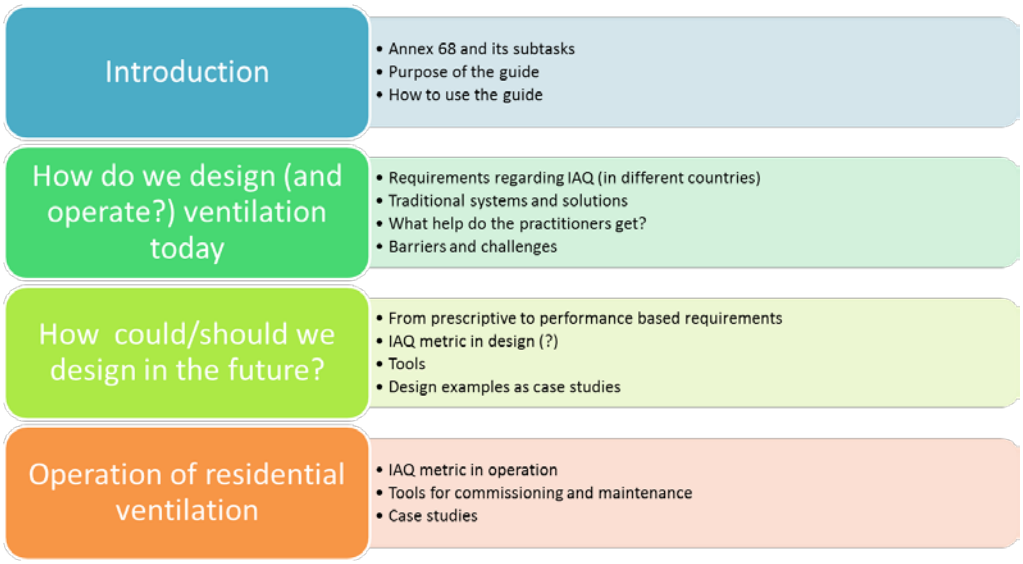


Figure 1 – Intended structure of the Annex Guide

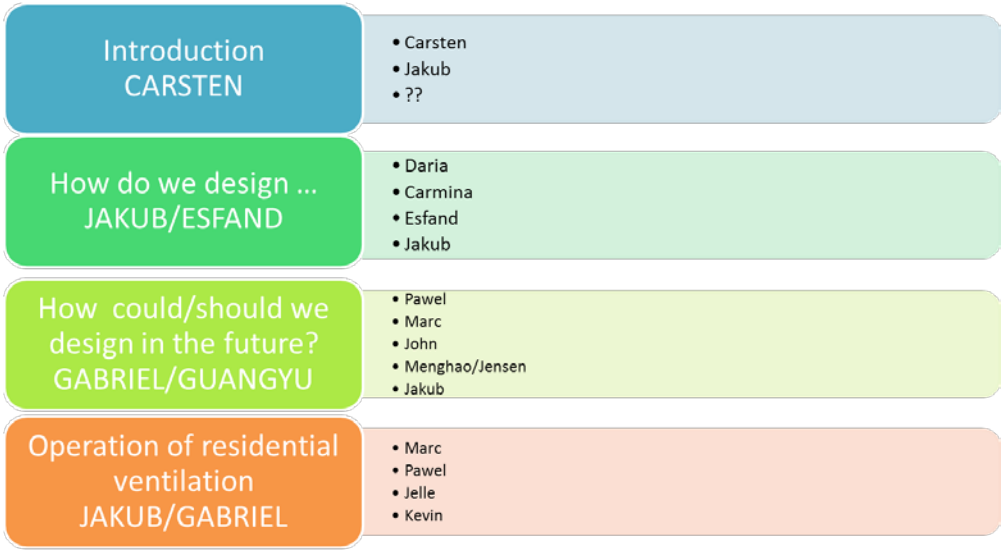


Figure 2 – Suggestion for collaborators on the annex guide

Any other Annex participants are of course welcome to participate on the guide preparation. Jakub will contact the persons mentioned in Figure 2 to discuss details. It was also suggested that the guide should have a form of structured webpage. The page can be hosted by DTU – Jakub will coordinate whit responsible persons at DTU so that the guide is integrated into the Annex 68 webpage.

All presentations from the session can be seen in Sharepoint.

8. Discussion of ST5 description

Jelle clarified the current activities through TS-5 and he suggested the PASSYS test could be repeated by considering solar radiation, regular finishing materials, other pollutants and use cheap sensors. JZ asked about air leakage rate in the PASYYS Cell and Jelle replied that pressurization test, wind speed and direction have to be investigated.

Jelle clarified that through a project of social dwellings for mechanical ventilated system MRHV and for the window opening behaviour on room level at dwellings, and on all windows level on apartment level, a survey has been designed to validate the occupant's behaviour. Jelle concluded that behaviour could be so different.

Fitsum presented an experimental design to measure solar induced pollutant (formaldehyde) emission rate from particleboard samples. Two test samples were prepared from a single sheet of particleboard and palced in identical two test buildings. One of the test samples was exposed to solar radiation inside South Test Building (STB). Whereas, the other test sample was placed inside the North Test Building (NTB) in which the window was fully covered with aluminum foil to block solar radiation reaching the conditioned space. The mass loss from the test samples due to formaldehyde emission was measured using balance scale. The off-gassed formaldehyde concentration in the room was measured using formaldehyde sensor.

(a) South test building (STB) (b) North test building (NTB)

Preliminary observations: The preliminary study indicated that the mass change measurement is very low and need to find material (dry or wet sample) that yields measurable mass change due to emission. Similar to the balance measurement, the formaldehyde concentration reading in the test building was very low. Thus, it is essential to use a test material with high formaldehyde concentration than particleboard or use the same test material but with larger emission surface area. The follow-up task will focus on refining the test methodology, keeping in mind of another experiment constraint: the test sample weight needs to be limited to the maximum capacity of the balance scale. JZ proposed to check surface temperature.

Planned activity:
In the summer, when solar gain into the test buildings spaces increase, solar induced emission rate experiments will continue. In between, during the winter period, Fitsum will conduct field measurement of formaldehyde emission rate from particleboard samples in indoor space with different combinations of indoor temperature and humidity conditions.

9. TO DO LIST:

ST2:

ST3

ST4

ST5

10. Round meeting -11-Sep for only the Task leaders

Jakub and Jelle mentioned that contribution and interaction of participants are very limited. Jelle and JZ proposed to spread the results of the annex through a summer school or training sessions. Jakub mentioned that an arrangement is needed between ST leaders to organize such sessions. A prelim guide or a report including time schedule and deliverable could be also a good idea. John shall construct a prelim DB and generalize this data for CHAMPS and other software's. Scope of this DB shall be defined and it is going to be on TXT file. JZ has confirmed that DB has to be divided to include hygrothermal and building physics materials stds. Jak mentioned that beyond the DB, we have to think how to maintain IT.

CAR discussed the following items:

- *Asked the Task leaders to try again to encourage participants to contribute and to notify him with who is not welling to participate.*
- *Deliverables list of all tasks, and if there some modifications should be considered before mid-year report.*

  ST2: create a new strategy to perform a data base.

  : definition of Ref building.

JZ proposed that Shanghai university could be a participant in pollution load at new and existing buildings.

11. General Conclusions 13th Sep.

(Car) started the meeting by illustrating the agenda of the managerial steps to be taken. The next meeting shall be at Shanghai university-China in 25th to 28th Sep.

Car proposed to have a localized approach to solve open problems. JZ proposed to have an outlines or recommendation in term of energy and IAQ. Jak mentioned that it is important to have a section discussing the learned lessons for each case study in different countries. JZ asked if there is a possibility to develop a generalize tool for ST4 cases.

MQ has illustrated the next steps in calibration procedure and the reference building definition as common exercise. Investigation of the available data and level of accuracy (Km, Dm).

MQ mentioned that a report shall be sent including description of different experiments, uncertainties levels.

JZ proposed to implement regression model on MATLAB, or adopt information/template from the EBC on how to repeat experimental measurements.

MQ will send some surveys results to participants and then contact them individually to enforce the involvement between the annex participants.

JOH mentioned that thermal bridges to be considered either in 2D or 3D in the simulation process. Andres proposed to put some literature review of different ventilation strategies, demand control co2 and humidity sensors. Also Andreas if it is possible to link between these different control strategies to CHAMPS.

JAK defined the kind of material and emissions on IDA ICE and it is presented a structure method. JAK asked if in CHAMPS is it possible to couple different rooms with leaks. JZ replied that no special distribution of ventilation is available at CHAMPS and well mixed condition is a boundary condition. Joh mentioned that if CHAMPS BES is used, the inner zone is represented as 2D with no windows and no solar radiation. While in CHAPMS multi zones version, the solar gain is considered. Andreas will write a report describes the potential of how numerical models could be improved and flows/gaps to be avoided in the future. Joh asked other participants to send him problems or gaps faced by them when using CHAMPS BES and multi zones.

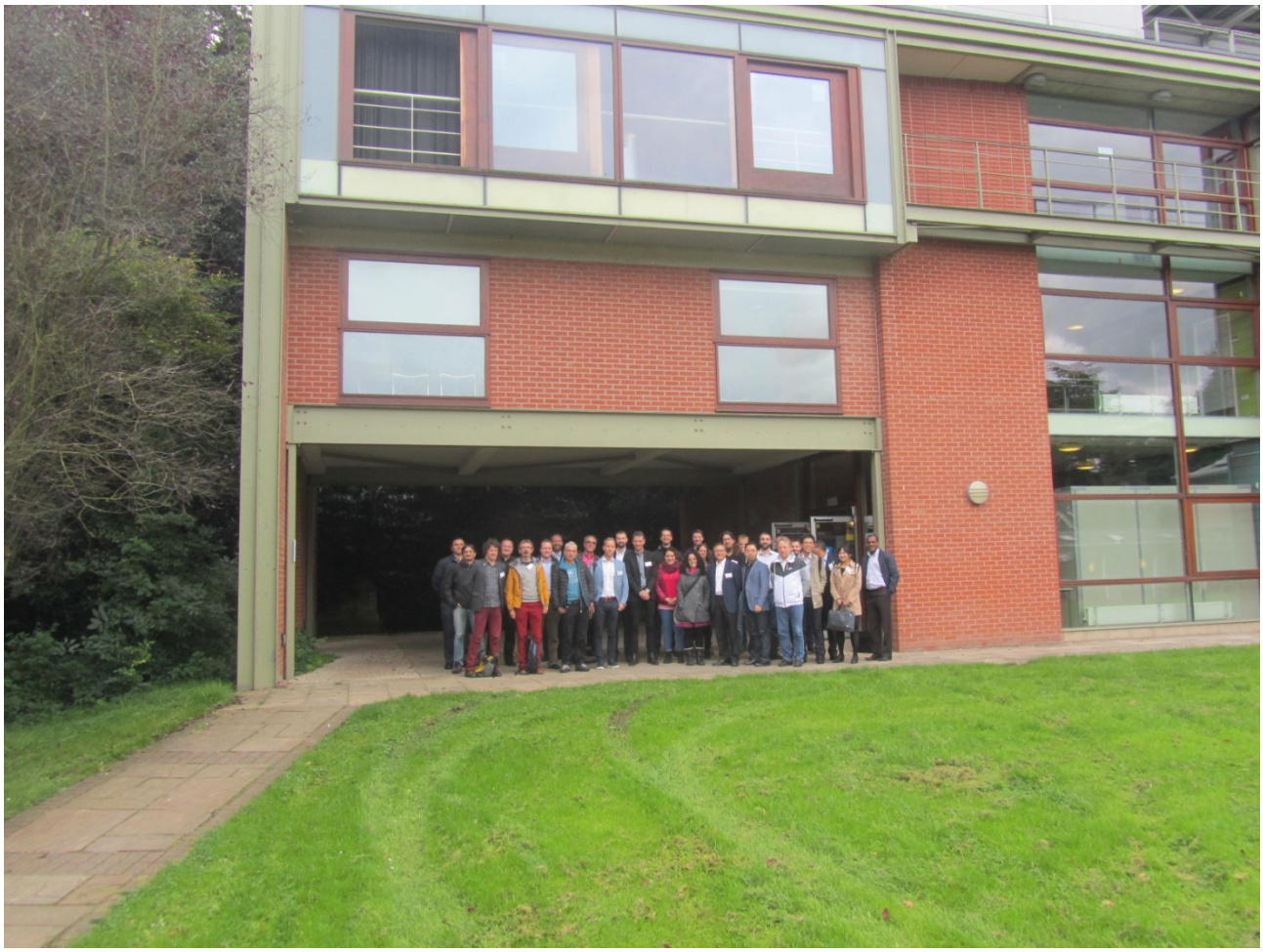
Jelle asked to have the emission rates of the available materials. Jelle clarified that it is very hard to model the occupant behaviour based on just on case study and he proposed to take the NIST case as a reference case.

CAR asked that all presentations, articles and presentations to be uploaded on the share folder. He highlighted the importance of documenting the Annex way of progress.

CAR mentioned that the home page is under progress and count on viewers /Q&A could be integrated. CAR clarified to the attendees that a more vibrant environment in the annex is needed. He mentioned that each participated country is promised to have 3 participants for3 years in meetings and it is about activities, articles and research.

Jak replied that he is facing problems to involve some of the participants, and that there is no obligation on any of the participants but the voluntary motivation.

CAR mentioned that participants list has to be modified based latest countries which have been contacted.



Picture: 1 Participants in the meeting at CSIC, Nottingham

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