MINUTES

The MOM was written and organized and by Dr. Elarga Hagar.

5th Expert Meeting
SHANGHAI, MAR. 25-27TH 2018

Campus: School of environment and architecture, University of Shanghai for science and technology, China

ATTENDANCE 25 & 26 Mar.-2018, participants present in person:

1. Rojas-Kopeinig Gabriel(GK),PostDoc, Universität Innsbruck, Austria
2. Laverge Jelle (JL), Prof., Ghent University, Belgium
3. Sarah Lima Paralovo (SP),PhD student, Ghent University, Belgium
4. Zhu Jiping (JZU), Prof., Health Canada,Canada.
5. Tariku Fitsum (FT), Prof., British Columbia Institute of Technology, Canada
6. Yang Xudong (XY), Prof., Tsinghua University, China.
7. Sun Chanjuan (CS), Dr., University of Shanghai for Science and Technology, China.
8. Liu Ping, (PL) University of Shanghai for Science and Technology, China.
9. Gao Yao (YG), Prof., Shenzhen Institute of Building Res Co.,Ltd, China.
10. Zou Zhijun (ZZ), University of Shanghai for Science and Technology, China.
11. Wang Xin (XW),Prof., University of Shanghai for Science and Technology, China.
12. Dongmei Sun(DS), Dr., Shenzhen Institute of Building Research Co., China.
13. Haidong Wang(HW),Dr., University of Shanghai for Science and Technology, China.
14. Wang Lihui (LW), Dr., University of Shanghai for Science and Technology, China.
15. Wang Fei (FW), Dr., University of Shanghai for Science and Technology, China.
16. Li Hao (HL), Dr., University of Shanghai for Science and Technology, China.
17. Li Zhao (ZL), Dr., University of Shanghai for Science and Technology, China.
18. Liang Weihui (WL),Prof., Nanjing University, China.
19. Huang Chen (CH), Dr., University of Shanghai for Science and Technology, China.
20. Liu Hongzhi (HL), Dr., University of Shanghai for Science and Technology, China.
21. Jiao Xuemeng (XJ), Dr., University of Shanghai for Science and Technology, China.
22. Su Chunxiao (CS),Dr., University of Shanghai for Science and Technology, China.
23. Rode Carsten (RC)- Operating Agent (OA) Technical University of Denmark, Denmark.
24. Kolarik Jakub(KJ),Prof., Technical University of Denmark, Denmark.
25. Qin Menghao(QM), Prof., Technical University of Denmark, Kgs. Lyngby, Denmark.
26. Elarga Hagar(EH), Dr., Technical University of Denmark, Kgs. Lyngby, Denmark.
27. Palmiste Ülar(PU), PhD Student, Tallinn university of Technology, Estonia.
28. Poussineau Nicole(PN), Dr., Saint-Gobain, France.
29. Kosonen Risto(KR), Prof., Aalto University, Finland.
30. Grunewald John(GJ), Prof., TU Dresden, Germany.
31. Nicolai Andreas(NA), Dr., TU Dresden, Germany.
32. Weiss Dirk(WD), Dr., TU Dresden, Germany.
33. Woo Kyunghun,(WK) Dr., Samsung C&T Corporation, South Korea.
34. Davis Mike(DM), Prof., University College of London, United Kingdom.

35. Burmandir Esfandiar(BE), Prof., University College of London, United Kingdom.
36. Zhang Jensen(ZJ), Prof., Syracuse University, NY, United States of America.

Participants present on skype call

37. Takao Sawachi(TS) Prof., Building Research Institute in Japan, Japan.

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

Sunday, 25 March-2018

1. Start of the meeting and review of agenda

The meeting started on Sep 25th at approx. 8:30 by Prof. Liu Ping, who welcomed everyone in USST and hoped for a fruitful meeting.

Prof Rode Carsten briefly introduced the agenda (ATTACHMENT A) also he has mentioned that the main challenge is to balance between better IAQ and energy efficient residential buildings. Furthermore, a design guidelines have to be prepared. He emphasizes that some present knowledge gaps concerning the indoor chemistry analysis, IAQ modelling, combined influence of heat, moisture on materials will be filled through this annex. Carsten has highlighted the critical time line of Annex 68 where all results have to be reported within 2019. All presentations were given at the meeting can be found at the (Share Point).

Sunday 25th March 2018	
8:00-8:30	Registration
8:30-8:45	Welcome address by the leader of USST, China

	Group Photo
8:45-9:15	Invited Presentation-1
9:15-10:45	Session 1-Subtask 2
11-12:12:30	Session 2-Subtask 3
13:30-14:15	Invited Presentation-2
14:15-15:45	Session 3-Subtask 4
16:00-17:30	Session 4-Subtask 5
Monday 26th March 2018	
8:30-10:00	Left over presentations from Day 1
10:30- 12:00	Plan for final report for all ST leaders
12:00-12:20	Chunxiao Su Presentation
13:30-2:45	General Discussion for all ST´s
3:00-4:30	Managerial issues
4:45-5:30	ST leaders meeting

2. Invited presentations 1

2.1-A Skype presentation from Prof. Sawachi Takao who talked about Annex-68 start in 2014, clarifying the main contents, expected deliverables and ST´s. He emphasise the annex68 wide aspects, *i)* importance of energy reduction beside implementing different typologies of ventilation to improve the IAQ and to reply some questions such as *ii*) how to know the high pollutants materials, emissions form furniture, building materials*, iii)* is the implementation of natural ventilation systems enough for higher IAQ.

2.2- Yang Xudong, China representative of IEA EBC, Indoor Air Quality Simulation and Control

Prof. Yang clarified EBC projects in China, mentioning that Annex68 has a novelty in addressing the IAQ beside ventilation systems energy consumption. He has clarified building requirements, IAQ level, Source of pollutants and how in that accepted pollution levels in China is much higher than the European levels. In addition, he clarified the complexity of pollutants analysis since building materials especially the decoration phase are added subsequently.

3. ST 2 session

For the ST2 time slot, six presentations were scheduled:

3.1 The Progress of ST2 has been presented by Prof. Qin Menghao which included:

-Two setups to measure VOC emissions from different building materials under diverse boundary conditions (temperature and relative humidity) are ongoing.

-Two common exercises have been published, the third one will be completed soon.

-The literature review on the exist database and models has been carried out.

3.2 Prof Zhang, Mechanistic model-based testing and evaluation of material emissions and their impact on IAQ,

He explained the main objectives, current work and future challenges such as lack of detailed database parameters addressing the VOC/SVOC and moisture transport.

3.3 Prof Zhang, Development of a procedure for estimating the VOC transport & storage properties and initial VOC concentrations from the standard emission test data

He clarified the procedures to define the 3 coefficients Dm, Km, Cm through the third common ex. activities by initial guess to identify the BC then by using the ACH a time impact regression analysis could be achieved. He also highlighted the influence of uncertainty and weight factor evaluation.

3.4 Prof. Zhijun Zou, Effects of the gaps height of windows and doors on the calculation for air infiltration

He highlighted the influence of windows and doors gaps on infiltration flow rate. He compared between the estimated by ASHRAE and measured flow rates in China. He found that gaps in china for windows have reached 1.5mm while it is estimated by ASHRAE to be 0.28mm. He claimed that these heights are related to climatic conditions.

3.5 Prof. Yao Gao, Study and application on the design method of indoor decoration pollution control.

He discussed indoor pollution control design methods and claimed that source control is the key of better IAQ. He emphasized that experimental tests should be carried out without the furniture. He advised that standards should be categorized into three levels including with and without furniture.

3.6 Prof. Liang Weihui, Development of a mass transfer model of formaldehyde emission from dry building material.

She clarified a mass transfer model of formaldehyde emission and highlighted the influence of indoor temperature and relative humidity and its necessity to be considered in modelling. She discussed a correlation development to estimate different emission parameters while taking into account the temperature and humidity. Experimental investigation for a test house with 3 parallel sampling was used to validate the models.

4. ST3 session

For the ST3 time slot, five presentations were scheduled (of which one presentation was moved to the following day):

4.1 Prof. Grunewald John, 2D modelling of the PASSYS cell with CHAMPS-BES/DELPHIN5&6

He clarified the current status of the ST3 common exercise. First, the contents of cloud space dedicated for data exchange were introduced. As basis of the common exercise, a model of the PASSYS cell was selected (originally used as a common European outdoor test facility for thermal and solar building research). The PASSYS cell was modelled by using several simulation tools with different modelling capabilities (e.g. 2D hygrothermal building envelope models vs. 3D building energy models). JG presented the results from three numerical models (CHAMPS-BES, DELPHIN5 and DELPHIN6). The modelling complexity is gradually increased in five steps. The simplest test case represents solely a thermal analysis. Hygrothermal analysis without and with airflow follows next. Finally, emission analysis without and with HVAC is built upon the previous test cases. The results of the test cases 1b), 2a), 2b), 3a) and 3b) were presented, which are indicated by bold text in the list below. These cases are considered most relevant and were solved first. The remaining test cases are in preparation. Additional VOC data must be collected before emission analysis can be started.

Test cases to increase the complexity of the exercise:

- Thermal analysis (H)

  a. Free-running building, just heat transfer through walls
  b. External long wave and short wave radiation
  c. Internal heat sources, internal long wave radiation

- Hygrothermal analysis (HM)

  d. Moisture fluctuation in rooms
  e. Rain load, capillary action and moisture buffering in walls
  f. Internal moisture sources

- Hygrothermal analysis with air flows (HAM)

  g. Air exchange with external air in zones
  h. Air permeable construction elements, air flow between zones
  i. Air flow within zones, buoyancy effects

- Emission analysis (HMP)

  j. Internal VOC sources in zones
  k. Absorption and emission of VOC by construction materials
  l. Combination of internal VOC sources, absorption and emission

- Emission analysis with action of HVAC systems (HAMP)

  m. Scheduled ventilation
  n. Demand-controlled ventilation
  o. Influence of heating and cooling, energy optimized HVAC operation

Discussion of results:

Test case 1b): The simulation tools should be capable to capture at least two main effects. First is temperature amplitude damping in the walls from outside to inside and second is the temperature fluctuation in the rooms, which is influenced by the insulation. The temperature field shows clearly the effect of thermal bridges by the H-steel beams. Room and wall temperatures for all tools are in a good agreement.

Test case 2a): Additional conditions (with respect to 1b): Humidity + Rain + Wind. The room air temperatures and relative humidity values should fluctuate inversely in this test case since the construction board consists of steel-covered insulation, which is vapor permeable. The simulation tools should be able to set flux from the humidity and rain boundary conditions to zero. Consequently, the total moisture mass in the construction should remain constant throughout the year, which was correctly calculated by DELPHIN5 and DELPHIN6. While DELPHIN5 and DELPHIN6 results agree very well, CHAMPS-BES shows considerable deviations in relative humidity, which led to convergence problems and stop of the simulation after 1.2 days. This problem was caused by a programming bug, which was fixed in one of the later DELPHIN5 versions. In conclusion, CHAMPS-BES cannot be recommended for hygrothermal simulation problems with air volumes.

Test case 2b): Additional conditions (with respect to 2a): Capillary-active construction (brick masonry) for east wall and partition. Change of the construction from moisture-tight to diffusion-open and capillary-active should increase the moisture content in the east wall by rain water absorption and lead to higher relative humidity values in the test room. This was correctly calculated by DELPHIN5 and DELPHIN6. CHAMPS-BES was excluded from the further analysis. While DELPHIN6 completed the simulation well after approximately two hours, DELPHIN5 must have been stopped at 152nd day because the simulation took longer than two days, which was set as maximum time limit. This shows the advantage of DELPHIN6 over DELPHIN6 in simulation speed. Another remarkable fact is that there are deviations of maximum 15 % between DELPHIN5 and DELPHIN6 in integral moisture contents. DELPHIN5 and DELPHIN6 use different wind driven rain models: DELPHIN5 uses an internal model, and DELPHIN6 uses a model after the European standard (DIN EN ISO 15927-3, 2009).

Test cases 3a) and 3b): Additional conditions (with respect to 2b): Air change rate in zones, air permeable construction. Since DELPHIN5 could not finish the previous case within two days, the original model was replaced with a downscaled version of the PASSYS Cell was used which decreased the number of used volume elements from 23940 to 5670. Air change was modeled in two ways 3a) direct air change with external air at 1 h-1 and 3b) infiltration through air gaps, inlets at the east wall and outlets at the west wall providing air change of 2.5 h-1. The results from DELPHIN5 and DELPHIN6 were almost identical for the room air conditions. However, small deviations could be observed in total moisture mass, even without rain boundary condition. Therefore, further exploration and bug fixing is needed to find the reason for that.

4.2 Prof. Kolarik Jakub, 3D Modelling of the PASSYS cell with IDA-ICE.

He discussed the modeling of the PASSYS cell with IDA-ICE, highlighting some discrepancies between his and the ST3 team results stored in the cloud. The discrepancies could be attributed to the assignment of an incorrect boundary condition in IDA-ICE. Therefore, there was an agreement between ST3 and ST4 members to re-examine the previous results and to unify the simulation constraints and assumptions for more credible outcomes. On the other hand, depending on the well-mixed assumption, significant deviations of the results could also be observed. It was clearly shown that in this case the well-mixed assumption plays a dominant role. In undisturbed air (no air leakage, no ventilation, no windows, no visitors, no equipment) only temperature-related buoyancy effects are assumed, the concrete floor acts as a hot plate at cold outdoor temperatures and as a cold plate at warm temperatures. In the latter case, there is a temperature stratification in which the well-mixed assumption does not apply. It shows that the well-mixed assumption can be used throughout the year by changing the surface transition coefficients of the inner horizontal surfaces accordingly.

4.3 Dr. Weiss Dirk, 3D Modelling of the PASSYS cell with EnergyPlus/NANDRAD.

He has illustrated the 2D and 3D modeling implementing EnergyPlus and NANDRAD to monitor thermal analysis of PASSYS cell. He introduced results with and without consideration of thermal bridges and quantified the importance of other geometrical simplifications like 1D representation of walls in 3D models.

4.4 Prof. Nicolai Andreas, Status VOC model implementation (THERAKLES, DELPHIN6),

He introduced a new implementation of a VOC mass balance equation to DELPHIN6. This effort was taken in order to proceed with the test cases 4) and 5) of the common exercise. He has clarified integrated improvements to DELPHIN6 taking into account the temperature dependence of VOC diffusion by relating the diffusion flux to the partial vapor pressure gradient.

5. Invited presentations 2

5.1 Prof Davies Michael, Homes and cities that are sustainable and healthy.

He presented CUSSH which is an urbanization project funded by Wellcome Trust entitled Complex Urban Systems aims to reach cutting edge scientific evidences for cities sustainable transformation. He clarified that building simulation tools and neural network model application will be implemented in such a project, which so far include 3 pilot sites (Beijing, Nairobi and London). He stressed that one of the objective is to involve and influence policy makers.

5.2 Prof. Huang Chen, Indoor air quality and energy consumption of residential buildings in Shanghai

She mentioned that in current years, more and more attentions were paid to indoor air quality, indoor air pollutants would cause serve health outcomes for people. It had been found that the concentrations of indoor pollutants were closely related to ventilation. In this paper, the associations were analyzed between concentrations of formaldehyde and benzene series and infiltration air volume in 149 bedrooms with doors and windows closed at night. Air change rate were calculated by tracer gas methods. The concentrations of formaldehyde and carbon dioxide were reading from detection instrument. We used gas chromatograph-mass (GC-MS) to obtain the concentrations of different kinds of benzene series and total concentrations were applied in the paper. The infiltration air volume per m2 of night residence in Shanghai ranged from 0.05 ~ 4.32 m*h-1, and concentration of formaldehyde and benzene series at night ranged from 6.8 ~124.7 µg•m-3 and 1.2 ~ 227.7 µg•m-3, respectively. With the increase of infiltration air volume, the emission factors of formaldehyde and benzene series had rising tendency. She also assessed the associations of the emission factor of formaldehyde and benzene series with ventilation during different building characteristics. Lowest infiltration air volume as well as highest effect of ventilation on emission factors of formaldehyde and benzene series was found in children’s bedroom on ground floor. This study provided basic data and scientific basic for development of indoor pollutants concentrations limit standards and risk avoidance of indoor pollutants.

5.3 Prof. Zhu Jiping, Levels of volatile organic compounds in Canadian homes – A national survey, Health Canada

He discussed a comprehensive, population-based national indoor air survey (NIAS) that was conducted between 2009 and 2015 for the presence of volatile organic compounds (VOCs) in indoor air of Canadian homes. The survey was conducted under the framework of cycle 2, cycle 3 and cycle 4 of Canadian Health Measures Survey (CHMS). Cycle lasted two years. 4000 homes were sampled in each of the first two cycles and 2500 homes in the third cycle, to a total of about 10,000 homes. Houses, apartments and other types of homes were included in the survey. Passive sampling tubes were used to collect VOCs in indoor air and the tubes were deployed and terminated by home occupants. Collected indoor air samples were analyzed by thermal desorption GC/MS. Key results included base-line levels of more than 100 VOCs in Canadian residential homes. The study also found that presence of garage and smoking activities in homes increases certain VOC levels. In addition, seasonal variation and differences in levels of certain VOCs between houses and apartments were also observed.

6. ST4 session

For the ST4 time slot, nine presentations were scheduled (of which two presentations were moved to the following day):

6.1 Prof. Kolarik Jakub, General status of Subtask 4.

he presented status for the activity 4.1 and overview of the contributions form particular countries (prepared by Daria Zukowska Tejsen).

6.2 Prof Zukowska Tejsen Daria presented by Prof. Kolarik -Finalization of Task 4.1.

Prof. Kolarik presented the countries indicated in red has not contributed yet. There are countries like Belgium, which contributed to stakeholder survey, but not to review of requirements and review of written guidance. Moreover, there are countries from which no contribution was received. Annex participants are kindly asked to contact Daria Zukowska – Tejsen to submit their contributions, or inform Daria, that no contributions will be delivered. Activity 4.1 is almost finished. Peer reviewed paper will be published on the analysis of contributed data. 4.1 will also produce a chapter for the Annex Guide.

6.3 Dr. Rojas-Kopeinig Gabriel, Studies performed at Univ. of Innsbruck related to ventilation and IAQ in highly energy efficient buildings/passive houses.

He mentioned that these studies could be interesting for the guidebook in ST4. Various projects address improvements, e.g. heat pipes for frost protection, compact HR (fan regenerative energy recovery within fan blades), coaxial ducts, etc. Other projects address potential ventilation concept innovations, like the extended cascade ventilation (living room a pure overflow zone with no additional supply air) or the use of active overflow elements (one central room ventilated with MVHR, other rooms with active overflow elements). These ventilation concepts have been evaluated to a certain extent, but now the modelling and evaluation framework of Annex 68 shall be applied to assess them in more detail.

6.4 Prof. Kosonen Risto, Cost-Effectiveness of Energy Renovation of Apartment Buildings in Cold Climate.

He compared between different renovations technologies for residential buildings built between 60´s and 70´s of the last century. He mentioned that numerical optimization models such as simulation based optimization SBO and multi objective based optimization MOBO are vital tools which support the decision making. He also highlighted that net present value of life cycle assessment and the primary energy PE are fundamental parameters to evaluate the efficiency of the renovation systems. It was concluded that geothermal heat pumps is the optimal solution for the residential heating systems at cold climates and that applying PV on the façade is not a fully efficient system. Furthermore another evaluation is needed to investigate whether envelope renovation investments are more or less beneficial if compared to mechanical systems (heating and ventilation systems).

6.5 Prof. Kosonen Risto, Room Systems as a Service Platform for Smart Buildings

In his second presentation, He talked about smart monitoring of building performance. Smart readiness indicator SRI has been clarified through a project at Aalto University. All sensors are connected to an information cloud (VAV with Fidelix sensor to control the ventilation system, OVERDEG as thermostat, pressure difference is also measured, FOURDEG). A machine learning algorithm implementing user interface and feed-back is used to control the connected sensors. In this project a KINECT camera which is a smart thermal can track the occupancy status was used and connected to the cloud.

6.6 Dr.Palmiste Ülar, Placement criteria for decentralized ventilation air intake and exhaust opening location on building façade.

He discussed the concept of decentralized ventilation and how to combine the fresh and exhaust air from the same opening by controlling the air velocity to avoid shortcut. The control system shall allow for fresh air opening until the outside temperature fall under 0 °C then it will shut down the opening. The idea is still under investigation and it will include CFD modelling for the system.

6.7 Prof. Kolarik Jakub, Performance of MOS VOC sensors tested under activities typical for residences.

He presented a research update regarding testing of Metal Oxide Semiconductor sensors for detection of VOC for use in DCV systems. Experiments are included in Room Vent Solutions project coordinated by DTU. The project involves also another Annex 68 participant a Danish Technological Institute.

7. ST5 session

For the ST5 time slot, four presentations were scheduled <u>(of which one presentation was moved to the following day):</u>

7.1 Prof. Laverge Jelle New experiment

He clarified the current activities through ST5 which mainly addresses the experimental analysis *i)*PASSYS experiment *ii)* Student apartments building and proposed case study in Gylle house in south of France.

7.2 Dr. Paralovo Sara, Dormitory Experiment

She clarified the nature of the Dormitory Experiment, developed in subtask 5 of IEA-EBC-annex 68, comprises a field test carried out in one dormitory suite located in VITO premises (Mol, Belgium) with the goal of testing products emissions by monitoring VOCs room concentration before and after the placement of two sources

(OSB plates and floor coating applied onto aluminum foils). Setup started by 24 hr analysis of background concentration. Influence of temperature (T) and relative humidity (RH) over the products emissions under field conditions were also studied. Several devices were used to monitor T, RH, CO2 and VOCs concentration in 7 different points of the room, before (background characterization) and after the placement of the sources. T, RH, CO2 and total hydrocarbon (THC) from FID data are available; VOCs data from Syft MS and passive samplers are currently being extracted and processed. Because of a leakage in the sampling tube, a part of the Syft MS and FID data has to be discarded. Currently available THC data suggests low influence of T and RH over products emissions.

7.3 Prof. Tariku Fitsum, New experiment

He discussed the control of the indoor humidity in a marine climate and how it is considered a challenge, especially under operating conditions where high indoor humidity is a norm. Outdated mechanical equipment, inefficient ventilation design, and occupants' lifestyles are some of the contributing factors to high indoor humidity. In this field experimental study, the moisture buffering potential of unfinished drywall in reducing daily indoor humidity peaks, coupled with various ventilation strategies are investigated. Two identical test buildings exposed to real climatic conditions in Burnaby, BC are monitored under varying ventilation rates and schemes. The interior of the test building is clad with unfinished drywall, while the control building is covered with polyethylene, which has negligible moisture buffering. In this way, the moisture buffering potential of drywall under four test cases is isolated. Under the test cases, the indoor air quality in terms of CO2 concentration, and ventilation heat loss of the two buildings are also evaluated. The results show that the moisture buffering potential of drywall effectively regulates indoor humidity peaks, and maintains relative humidity levels within acceptable thresholds, when coupled with adequate ventilation as recommended by ASHRAE. When coupled with time-controlled and demand-controlled ventilation schemes, the moisture buffering effect of drywall shows competing benefits when it comes to managing indoor humidity, indoor air quality, and minimizing ventilation heat loss.

<u>Monday, 26 March-2018</u>

8. Left over presentations

The day started 8:45am by the leftover presentation´s from ST3, ST4 and ST5.

- **8.1 ST3-Prof. Grunewald**, presented the idea and status on the similarity approach to get parameters for VOC simulation. For instance: Partition Coefficients (for VOC emission) can be seen in similarity with the slope of the sorption curve (for moisture). The idea is to make use of water vapor adsorption and diffusion values widely measured in building physical laboratories. The DELPHIN5&6 materials database could be used to estimate missing partition and diffusion coefficients for VOC-material combinations. A tool "VOC Data Acquisition Control" is under development which allows to read, edit and write the contents of the VOC database file used by all CHAMPS and DELPHIN software tools. refer to (cloudstore)for more information.
- **8.2 ST4-Prof. Kolarik,** presented for Kevin Smith status of RoomVent project (development of decentral ventilation unit). He discussed the demand based control of innovative decentralized ventilation system installed in renovated apartment building. The study is conducted by Technical University of

Denmark together with several industrial partners in a nationally funded project called Room Vent Solutions. The project includes development of an algorithm for demand-control of a single-room ventilation unit with rotary heat exchanger including method to prevent frost accumulation. The control algorithm, controls rotational speed of the heat exchanger and it have been already implemented and tested during freezing conditions. During spring 2018, testing of the system will start in four apartments of a residential building north of Copenhagen, Denmark.

8.3 ST5-Prof. Fitsum presented measurement performed at BCIT in their two test houses focusing on moisture buffer effects.

8.4 ST5-Prof Burman, presented an overview of the ongoing investigation and interim findings of building performance evaluation of a new-build residential block in East London, UK. Comparison between predicted and actual heating demand of the dwellings in this residential block points to shortcomings in building fabric performance and variation in heating demand as a result of occupant behavior. Despite these issues, the heating energy use of the dwellings is significantly lower than typical benchmarks in the UK. Electricity use is also lower than the median benchmark. Therefore, this case represents a low-energy residential building suitable for Subtask 5 of IEA EBC Annex 68. The presentation reported on the monitoring of Indoor Air Quality (IAQ) in five sample dwellings in this building. Outdoor and indoor concentration levels of PM2.5, NO_2, and TVOC were measured using active environmental monitors. Passive diffuser tubes were also used to measure the concentration levels of VOCs identified as high risk in low-energy buildings in Subtask 1 of the Annex 68 project, namely, benzene, formaldehyde, trichloroethylene, styrene, and alpha-pinene. Initial findings point to high concentration levels of benzene and formaldehyde after 3 years of building operation. The monitoring for the heating season is now completed. This investigation will also be carried out in the summer to establish the annual performance of the dwellings. The followings can be delivered as part of UCL contribution to Subtask 5:

- Active monitoring results for five apartments (weekly blocks in heating season& summer): PM1-10, NO_2, TVOC, CO, CO_2, T, RH
- Passive sampling results (weekly blocks in heating season& summer): concentrations of all critical pollutants identified for low energy dwellings in Subtask 1 of IEA-Annex 68
- PFT measurements (air exchanges in all zones)
- Contextual information: occupancy level & pattern, occupant behaviour (self-reported + site observations).
- Energy performance data.
- Occupant satisfaction surveys (thermal comfort & IAQ)
- Design information.

8.5 ST5-Dr. Rojas-Kopeinig shortly presents an IAQ measurement study conducted at LBNL, which could provide interesting data for Annex 68. In this project the IAQ in 70 gas-fired new Californian homes is monitored in detail. Particularly interesting for A68 could be the continuous measurement of PM, NOx and Formaldehyde. Further details, see https://hengh.lbl.gov/.

9. Final report plans

In 10:00 am, ST3, ST4 and ST5 leaders clarified the prelim vision of final report table of contents (TOC).

9.1 ST2 final report updates was missed.

9.2 **Prof. Grunewald** presented TOC of ST3 final report**.** Prof. Zhang asked if the similarity approach could be added and JG approved. JG mentioned that he applied the same format as ST1 report. **Prof. Grunewald** also has shown his participation in the coming IBPC2018 by an article and promised for more researches.

9.3 - **Prof. Kolarik** presented table of contents TOC of ST4 with assignments for all participants; he clarified how results are going to be shown at the so called Annex Guide. The name "guide" may not be appropriate as the deliverable will rather summarize different case studies from the Annex than provide an organized guide to residential ventilation design. **Dr. Rojas-Kopeinig** suggested to add keywords describing each problem and how it was solved by the annex.

9.4 **Prof. Laverge** discussed the measuring techniques which will be documented at the final report.

Prof Tariku has shown a simplified excel sheet describing the nature, boundary conditions of the case study under examination. It will be available on the share folder.

In 12:00, **Dr. Chunxiao Su** presented a study on the indoor quality and thermal comfort of class rooms at mid-west of USA. He clarified that UV solar radiation is influencing the size of bio aerosol particles.

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10. Discussion

A General discussion between all participants and the speakers from yesterday's and today's presentations.

- **ST2:**

- Prof. Nicolai asked about the model development during ST2 activities, the expected outcome, what is its numerical technique of prediction and if it is enough to be time based. Prof. Qin replied that model is dedicated for formaldehyde. Prof Zhang then interfered and clarified more by saying that model adopted the regression technique as a function of time. The influence of temperature and relative humidity on Cd and CK have been considered. He also mentioned that a chapter at the final report will be dedicated to the model and its results. - Prof. Nicolai has proposed to simulate separately the building energy performance to obtain temperature profiles then link it later to the building emission model.

- **ST3:**

- Prof. Grunewald and Dr. Weiss emphasized to unify and fix the building boundary conditions i.e. orientations, thickness. Dr. Weiss mentioned that PASSYS cell model is oriented with its shorter wall to the south.

- Prof. Kolarik has replaced an insulated wall of the PASYSS cell with other concrete to enforce thermal inertia of the test cell.

- Prof. Grunewald has proposed to obtain the accurate transient values of the ground temperature instead of just assuming a constant value. Prof Rode has insisted to ignore the ground temperature as it won't affect the simulation results. Dr. Weiss has mentioned that it was already done and considered as transient value.

- Prof. Zhang mentioned that solar radiation through window and its influence on the surface temperature change has to be considered. Redistribution solar transmission based on surface areas.

- Prof. Nicolai mentioned that for the air nodes, two options have been considered, the first that assuming that all solar radiation has been absorbed by the air node by convection. The second is that solar radiation is absorbed by the surface ´s then by radiation heat exchange to air node. He found that difference in the estimated temperature didn't exceed 0.5 C.

- Dr.Palmiste mentioned that humidity sensors are not reliable and how to ventilation control is depending on it. JK replied that sensitivity analysis have to be done to avoid such a mistake.

- **ST4**

- Prof. Kolarik presented a research update on the development of control algorithms for decentralized ventilation units with a special focus on frost protections – prepared by Kevin Smith.

- Prof. Kolarik and Prof.Laverge are planning to organize a AIVC webinar about reliability of cheap sensors to control ventilation systems. Probably in May – to be determined together with AIVC. Prof Rode asked if this webinar could be documented and JK replied that it is by itself a disseminating and he depends on audience replies and reactions.

- **ST5**

- Prof. Laverge asked if someone would like to participate in the common excersie and for the reporting. Prof. Nicolai asked if the moisture buffering influence could be monitored and Prof Tariku replied ventilation rate was lower with buffering.

11. Managerial Issues

- Prof Rode discussed again the possibility to have a newsletter, no one has replied.

- Prof Rode emphasize on having a short abstract describing their presentations during the present meeting from each ST leader by 6th Apr.

- Prof Zhang suggested to publish short articles in ASHRAE journal and he will send Prof Rode email with more details about this issue.

- Prof Rode has discussed the possibility to extend the project for another 6 months, everyone have agreed. Hence he asked from participants to send him a well justified report to send it to EBC next mangers meeting. He also proposed to start to think about a new annex and to dedicate some time form the remaining expert meetings to define this new annex.

-Prof. Davis mentioned that it would be a nice idea to engage policy makers to have a robust decision concerning health and energy,

- Dr.Poussineau mentioned that for some companies to consider heath issue is not applicable due to legal impact.

- Prof. Nicolai proposed to have the next CHAMPS EBS workshop in Europe.

- Prof Zhang will send the summer (next Sep) school in SYRCAUSE FLYER to everyone.

- Prof Rode proposed to have a forum on annex 68 at the coming IBPC2018.

The agreed webinar is supposed to be on the 18th May. Prof. Kolarik and Prof Laverge will notify the participants about the exact timeframe.

- Prof Rode has emphasize to complete reporting the annex 68 results regardless of the extension proposal. He asked the participants to do their best to meet the Annex deadlines.

Picture: 1 Participants in the meeting