IEA EBC Annex 68 – Subtask 3, Modelling

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1 INTRODUCTION AND OBJECTIVES

The objectives of Subtask 3 Modeling are to improve the understanding and develop prediction models on the impacts of outdoor pollutants, thermal environment, building materials and envelope, and indoor furnishing and occupant activities on the indoor air quality, and the energy necessary to achieve the desired IAQ level in residential buildings, considering the IAQ metrics and pollution loads to be developed in Subtask 1 and 2, respectively.

2 SCOPE AND EXPECTED OUTCOMES

Existing knowledge is inadequate for predicting the combined effects of hygrothermal conditions and chemical reactions on the indoor pollution species and concentrations in light of most recent revelation of the importance of secondary emissions such as Ozone-initiated indoor air and surface chemistry in affecting the indoor air quality. The approach of modeling the effects of combined heat, air, moisture and pollutant (CHAMPS) transport and their impact on energy and IEQ is needed. This task is to collect and develop guidelines about 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. The whole building perspective is realized by integral consideration of indoor air and building envelope, building users and the building services systems. Focus, and what can be seen as a new development, will be on methods to predict the emission and absorption of chemical compounds from materials under realistic in-use conditions regarding the CHAMPS-exposure in buildings. Notwithstanding the perspectives in new paradigms for modeling the chemical and atmospheric conditions, it will be a top priority that the methods also facilitate prediction of the energy consumption associated with the operation of buildings, such that the tools can be used to optimize for the minimal energy consumption that satisfies the needs with respect to indoor environmental quality. Activities for the Subtask will include:

- Literature survey and provision of knowledge about contemporary modeling capabilities in thermal   whole building energy and hygrothermal analysis in combination with air flow and emission models. Development of a paradigm for work with these models such that they can be used as optimization tool for good building energy performance under high IEQ conditions. Identification of gaps in current modeling capabilities.
- Development of new procedures, when and if necessary, that will be needed to model the interaction between energy efficient operation and high IEQ. Incorporation of the methods

for analysis in modeling paradigms from other ongoing IEA activities, e.g. within IEA Annex 60.

Apart from partners from academia, it is anticipated that building design companies and companies involved in building design tool development may contribute to the subtask. It is anticipated that a modeling framework (such as CHAMPS) and design tool (such as a Virtual Design Studio) will be developed for evaluating the energy and IAQ performance of residential building design and operation strategies.

3 COLLABORATIVE WORK PLAN

Conceptually, the modelling framework will include a multizone network model (e.g., CHAMPS-MZ) that integrates an envelope model (e.g., CHAMPS-BES), HVAC model (e.g., E+) and space/room model (e.g., TUD's room model, Tokyo U's response factor model, U. of La Rochelle's Proper Orthogonal Decomposition-POD model, Tsinghua U's residential IAQ model) supported by shared databases of pollutant properties, sources and sink models, chemical reaction models, material properties and weather conditions (Figure 1). The CHAMPS modelling framework will be tailored it to residential applications and be improved through the following planned specific new model developments and implementations:

1. Develop and incorporate models to account for the impacts of indoor air chemistry and surface chemistry/physics on the concentrations of pollutants of interests, including O3 initiated gas phase and surface reactions, particle deposition and resuspension, VOCs and SVOCs adsorption and desorption. Tsinghua U (lead), SU, UT Austin, Health Canada, Missouri University of Science and Technology, and others.

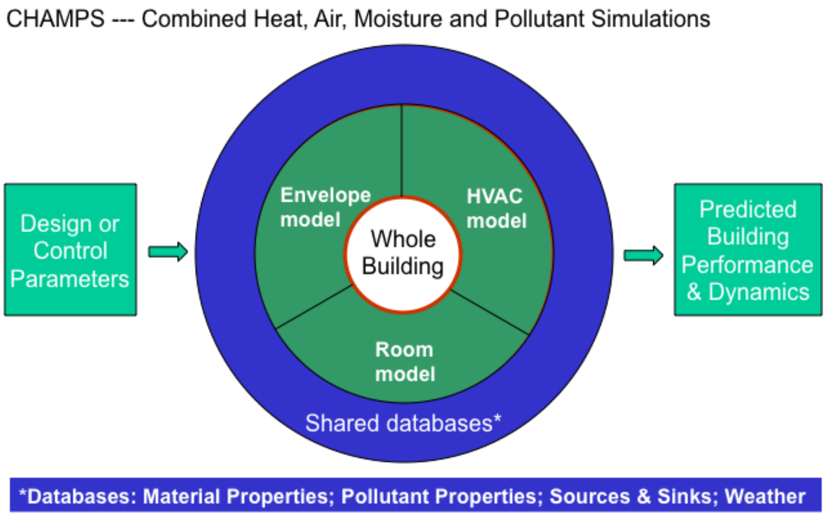

Figure 1 A conceptual CHAMPS model for building systems

2. Develop and incorporate better models for outdoor to indoor pollutant transport, including gas and particle penetration through building envelope, and through outdoor air supply systems. Nanjing University (lead), SU and others.
3. Develop a model for better describing the impacts of temperature and humidity on the transport of VOCs and SVOCs in building materials and envelope systems. Danish Technical University (lead), SU, Tsinghua U and TUe.
4. Develop a fast room simulation model for integration with the multizone network model. TU Dresden and TUe.
5. Develop a response factor-based modelling approach for fast simulation of air and pollutant distribution in rooms for use in the multizone network flow models. University of Tokyo and TUe.
6. Develop a CHAMPS modelling framework that incorporate the above models for residential building applications. SU, TU Dresden and TUe.