Buildings Post Corona

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Buildings Post Corona is a Swedish collaborative research project between Chalmers, KTH Royal Institute of Technology, Lund, and Umeå Universities. The project supports the building sector in designing and maintaining sustainable buildings with a healthy and good indoor environment. The COVID-19 crisis has stressed the importance and urge of this research, which is financially supported by FORMAS*.

Systems approach

Climate change, with increasing periods characterized by extreme cold and extreme heat, place completely new demands on buildings and their systems for indoor climate. Also, the escalating global increase in CO_2 emissions is an aggravating circumstance, calling for a radical reduction of the use of energy within the building sector. At the same time, the COVID-19 pandemic has made it clear that we need to be careful when designing and using buildings in order to reduce disease transmission, hence ensure efficient ventilation performance.

* FORMAS is a governmental research council for sustainable development. https://formas.se

Thus, the building sector faces new challenges when designing, building, and operating buildings that are healthy, use limited resources, and are climate resilient.

The scope of the project is to develop a methodology for the operation and design of buildings with an indoor environment that meets future health and climate challenges. The project's overall goal is to establish an interdisciplinary platform to document existing experiences and knowledge and to gain new knowledge required for good building design and operation.

The project is formed around four sub-goals encompassing networking, methodology development, methodology evaluation and development of guidelines.

A network for collaboration

One of the project's overall goals is to establish an interdisciplinary platform for collaboration that gathers national academic expertise on healthy indoor environments. The idea is that the platform shall support decision-makers and that it will facilitate and promote holistic ways of working with the planning, construction, and maintenance of energy- and resource-efficient buildings with healthy indoor environments. An important task is to identify and open up laboratories and test facilities so that we in the future can do the necessary tests with the most appropriate infrastructures with minimum delays and cost. The idea is also to critically review current guidelines and ways of working related to the indoor climate and suggest updated guidelines and checklists for buildings owners/planners/contractors.

Methodology for design of sustainable buildings

Methodologies are needed to support design of healthy indoor environments and minimize the risk of disease transmission. The work includes demonstrating a combination of models for comprehensive evaluation of indoor climate and airflows to develop and optimize new or existing HVAC systems in terms of relative humidity (RH), temperature, and inlet and outlet specifications. Also introducing a machine learning approach to find optimal combinations of parameters from the perspective of combining the requirements of providing appropriate thermal comfort and reduce the risk of airborne infection and low energy use.

Methodology evaluation

In order to answer the research questions in this study, we will conduct qualitative and quantitative surveys of the effectiveness of solutions implemented to diminish the effects of heatwaves, the spread of airborne diseases, ventilation optimization, and energy minimization. Based on information gathered from the surveys we will choose solutions/scenarios, which according to surveys proved efficient and had positive outcomes. We will develop a test monitoring methodology for assessment of the chosen solutions for indoor air quality, comfort with a minimized spread of airborne diseases. Depending on the solution we will design either a set of measurement tests under controlled laboratory conditions or a methodology that could be applicable for field measurements e.g., in specific indoor environments of interest. A battery of measurement techniques will be used that encompasses measurements of not only the key pollutants of interest e.g., airborne particles (pathogen models), gas pollutants, CO_2 and comfort parameters T, RH, but also environmental parameters such as noise, draught (air velocities), ozone, which may impair the perceived indoor environment quality, but also initiate indoor air chemistry that may have negative health effects. We will perform the measurements of selected solutions and assess their effectiveness from the holistic perspective on indoor environmental quality. Cost and practicality of implementation of assessed solutions will be also evaluated. The outcomes will be

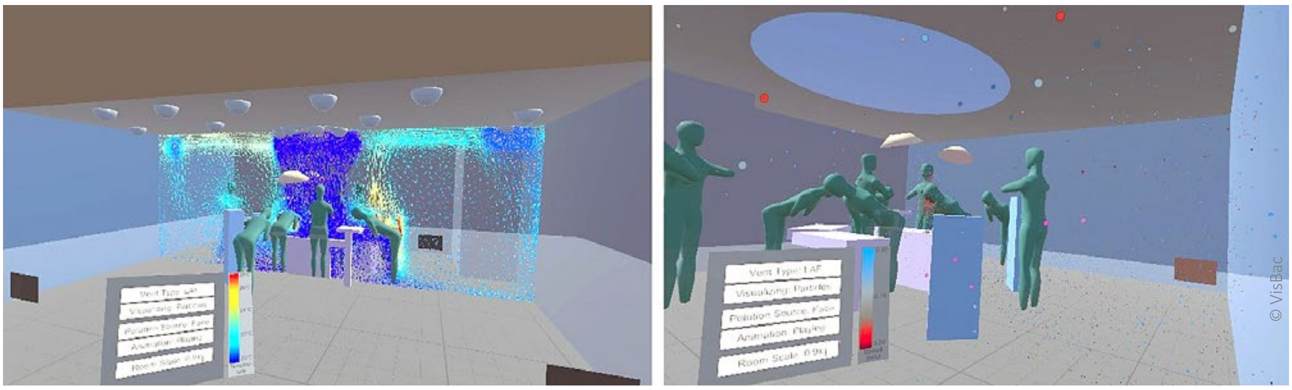

Figure 1. Visualization of airflow field (left) and airborne particle distribution (right) within the enclosed environment.

***Buildings Post Corona* -project participants in brief**

The division of Buildings Services Engineering, Chalmers, Gothenburg. This research team builds knowledge of system solutions for ventilation, heating, cooling, as well as control and regulation technology. The goal is to develop and disseminate knowledge about methods that contribute to good indoor environments in energy and resource-efficient buildings. The research is based on a combination of theoretical modeling, experiments in a controlled laboratory environment and field studies.

KTH Live-In Lab at KTH Royal Institute of Technology. A platform with several test beds in real environments for testing and researching new technologies and new methods. Through collaboration projects with industry, academia and society, KTH Live-In Lab shortens the lead times between research results and introduction to the market. KTH Live-In Lab spreads knowledge about technology, methods and systems that enable the smart and sustainable buildings of the future. KTH Live-In Lab accelerates the pace of innovation in the civil engineering sector.

The fluid and Climate research group at KTH conducts rich, interdisciplinary, and broad research with the aim of indoor air quality improvement and promoting occupants' health and wellbeing. Most of the investigation in the group comprises the use of numerical simulations which are a great compliment to KTH Live-In Lab experimental studies.

The aerosol laboratory at Lund University.has an advanced infrastructure for examining airborne particles in different environments. In addition to a wide range of techniques for measuring the biological, physical and chemical properties of pollutants and contaminants in the air, the laboratory also has rooms for controlled simulation of ventilation, climate and exposure. Researchers at the laboratory work, among other things, in close collaboration with healthcare on how infection is spread and can be counteracted.

The Center for Healthy Indoor Environments (CHIE) adds interdisciplinary expertise that combines technical, psychological and medical aspects to create healthy indoor environments. CHIE promotes methods for a holistic view with a focus on the residents' needs, health and well-being.

The energy efficiency group at Umeå University conducts research focusing on the end-use of energy and the indoor environment in buildings. The aim is to develop more powerful methods and methodologies for evaluation, validation, and control towards a better indoor thermal environment and air quality with increased energy efficiency.

The work is based on laboratory investigations and field measurements as well as on simulations of newly built and refurbished buildings. The research group has experimental equipment for field measurements, but also a laboratory at the university with a climate chamber and technical installations for experimental studies. Simulations are performed with both data-driven and physical models. Often, the research projects are interdisciplinary and often involve several different disciplines in energy and building construction technology, ranging from primary energy conversion (production), distribution, and energy end-use.

compared to model simulations where the gathered data and outcomes will be used for models' validation.

In addition, we will use Computational Fluid Dynamics (CFD) technique to predict, and visualize environmental factors, such as temperature, humidity, air motion and airborne particle distributions.

Guidance for best practice

Finally, we aim at packaging the knowledge and results from earlier stages, presenting the material to the network through a series of workshops and seminars. Also developing guidelines and checklists related to new State-of-the-Art building ventilation/geometry/control/sensing capabilities, as well as development of evaluation plans (technical strategy, identification of key actors) for final implementation. The work also includes consideration of societal impact and scrutinizing existing institutional settings (rules, regulations, law, norms).

The work is ongoing, and the scope is big. The project team invites REHVA and REHVA members to connect in order to sharing ideas and searching for opportunities to collaborate You can read more and find contact details at https://www.buildingspostcorona.se/participants. ■