Demonstration of an innovative room based mechanical ventilation system in a renovated Danish apartment building

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SUMMARY

Ambitious goals regarding CO_2 neutrality put the energy renovations of apartment buildings in the top places on the energy efficiency & sustainability agenda in Denmark. Improved airtightness and maximum primary energy requirements imply utilization of ventilation with heat recovery. The control of ventilation installed during renovations often considers a whole dwelling as one climate zone, which neglects differences among individual rooms. Increased insulation and tightness leads to higher sensitivity to solar and occupancy gains, moisture loads and pollutants. When controlled as a single zone, it is difficult to sense and react to loads. A common consequence is overheating and insufficient bedroom ventilation. The project called RoomVent Solutions had a goal to develop and demonstrate a residential ventilation controlled by demand in particular rooms. Furthermore, the project aimed to develop and demonstrate Cloud connected ventilation and thus enable monitoring of its performance as well as control via Internet. We focused on synergy between monitoring and control of indoor climate to enable "continuous commissioning" that ensures that the systems work as intended throughout their lifetime.

KEYWORDS

Smart ventilation, energy renovation, residential ventilation, IAQ, energy efficiency

1 INTRODUCTION AND OBJECTIVES

Residences represent 60% of Danish building stock and 40% of that are apartment buildings. At the same time, 90% of them were built before 2004 and about 25% are older buildings built in the period 1850-1930 (Odgaard 2019). At the same time, Denmark has a goal to use only sustainable energy sources for heating and electricity in buildings by 2035. It is evident that energy renovation is of outmost importance. Renovation measures notably increase building airtightness while the Danish Building Code- BR18 (BR18 2022) prescribes ventilation rates to keep acceptable indoor environmental quality and humidity conditions. This, together with energy efficiency requirements, mostly results in installation of mechanical ventilation with heat recovery (MVHR). Use of MHVR brings challenges related to installation and commissioning, indoor environmental quality and control. The project focused on addressing these challenges having two main objectives: 1) to develop and demonstrate a residential ventilation controlled by demand in particular rooms, 2) to develop and demonstrate Cloud connected ventilation that enabler performance monitoring and control via Internet.

2 METHODS AND RESULST

Two industrial partners further developed their room-based ventilation systems within the framework of the project. Consequently, we demonstrated both systems in real apartment buildings (see Figure 1). A fan-based air distribution box that enables precise control of airflow to individual rooms. We added a control algorithm, which considered both thermal environment

and indoor air quality in particular rooms. The system connects to a Cloud portal, which serves for control and performance data visualization. We integrated the air distribution box with a decentralized ventilation system in four apartments in Copenhagen. Cloud based controller communicated with the air distribution box via a gsm gateway placed in the apartment. Moreover, data from indoor environmental quality loggers as well as operational data for air handling unit in the apartment fed into the Cloud controller. The second room-based ventilation system in focus were single-room ductless ventilation units providing balanced airflows on a room level, equipped with heat recovery (see Figure 1). We connected then to the Cloud for continuous performance monitoring and demonstrated this solution in three apartments in Birkerød (25 km north of Copenhagen).

The results showed that room-based demand control could save upwards of 60% fan energy compared to standard decentralized ventilation. Online performance monitoring helped to identify installation faults as well as airflow unbalance in several apartments. The system appeared to be more demanding with respect to commissioning and as BR18 prescribes minimum ventilation of 0.3 L/(s·m^2) during occupancy, its full potential cannot yet be fully utilized in practice.

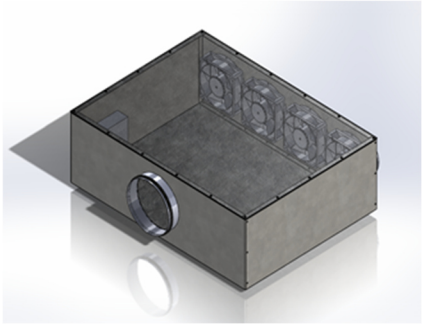
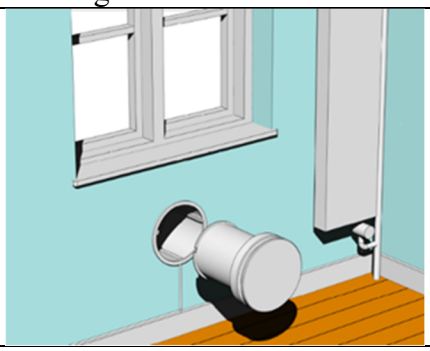
Air distribution box	Demo-building Copenhagen
	
Single-room ductless unit	Demo-building Birkerød
	

Figure 1: Tested room-based ventilation systems and demonstration sites (image credits: Ebm-papst, Dorte Krogh, Sustain Solutions, Anders Jansen)

3 REFERENCES

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