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Barriers to Natural Ventilation Design of Office Buildings

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Synopsis

Perceived barriers restricting the implementation of natural or simple fan assisted ventilation systems in the design of new office type buildings and in the refurbishment of existing such buildings have been identified in seven central and north European countries with moderate or cold climate: United Kingdom, Belgium, The Netherlands, Switzerland, Norway, Sweden and Denmark.

The barriers were identified in an in-depth study with structured interviews based on questionnaires among leading designers and decision makers: architects, consultant engineers, contractors, developers, owners and governmental decision makers. The study is part of the *NatVent™* project being carried out under the EC JOULE programme.

The interviews identified a significant lack of knowledge and experience on special designed natural ventilation in office buildings compared to the knowledge and experience on mechanical ventilation. In addition there is a lack of sources to natural ventilation knowledge in standards, guidelines and building studies and a desire for new design tools on natural ventilation including calculation rules and easy-to-use, simple and advanced computer programmes.

1. Introduction

Mechanical ventilation systems are often installed in office buildings where good natural ventilation would have been sufficient to obtain comfortable indoor climate and good air quality. It is important to identify the barriers seen by designers and decision makers which restrict the implementation of natural ventilation systems and lead to the decision to install mechanical ventilation plants in office buildings where it is not strictly necessary. Knowing the barriers is the first step in providing solutions to overcome them.

2. Interviews

A total number of 107 designers and decision makers were interviewed. In general the interviews in each country were performed with: 5 architects, 3 HVAC consultant engineers, 2 developers, 2 owners, 2 contractors and a governmental decision maker responsible for regulations and standards in the country. The interviewees were selected with the intention of also identifying the variety in opinions and viewpoints on natural ventilation in office buildings among people with the same profession.

The interviews were based on two questionnaires as follows:

- General view on natural ventilation in office buildings.
General knowledge, viewpoints, experience and perceived problems with natural ventilation systems in office type buildings.
- Specific building project.
Decisions actually made during the design or refurbishment of an office type building.

A specific 5 point scale was used where possible. The questionnaires were not too tight and there was ample space for additional comments, remarks and viewpoints not included in the questions. The questionnaires were completed by the interviewee and the interviewer together. In general both parts of the interview were performed with all interviewees. The only exception is the governmental decision makers, where only the general view was relevant.

3 Main results

The main results from the interviews are given in this paper. Details can be found in the references. The results in the figures are given as the average for each group of professions interviewed. *All* is the average of all profession groups except for the governmental decision makers.

3.1 Knowledge on ventilation

Nearly all the interviewees have less knowledge on special designed natural ventilation compared to their knowledge on mechanical ventilation in offices, see figure 1. Especially in Belgium, Denmark, Switzerland and Norway the knowledge on special designed natural ventilation is very low compared to the knowledge on mechanical ventilation, see figure 2.

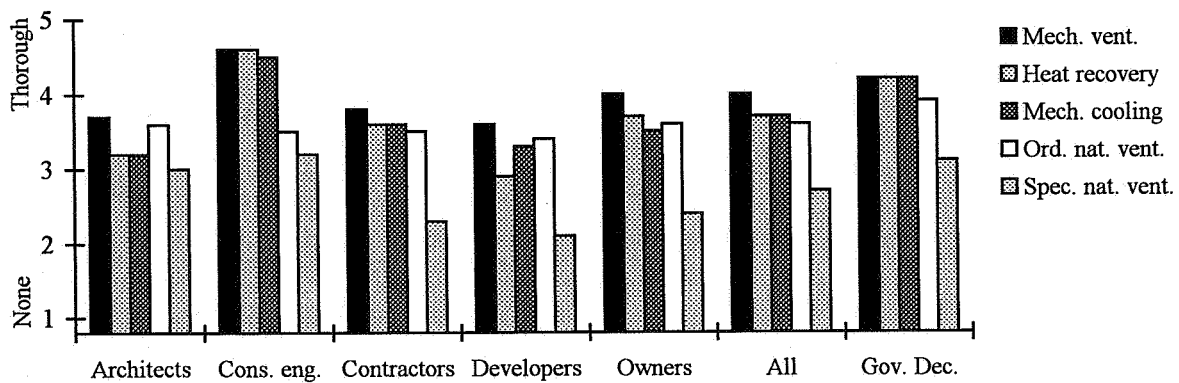


Figure 1. The interviewees perception of own knowledge, by profession.

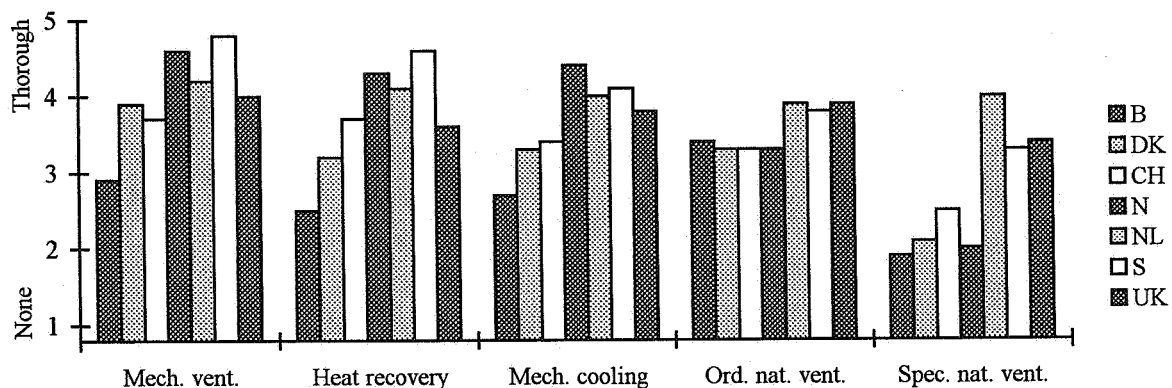


Figure 2. The interviewees perception of own knowledge, by country. B=Belgium, DK=Denmark, CH=Switzerland, N=Norway, NL=The Netherlands, S=Sweden, UK=United Kingdom

On average the interviewees have the same level of knowledge on ordinary natural ventilation as on mechanical ventilation. The exception is the consultant engineers who in general have less knowledge on ordinary natural ventilation compared to their knowledge on mechanical ventilation. The interviewees have indicated their level of knowledge on the five topics based on the knowledge necessary to perform their normal task in the design or decision process and relative to their profession. It is therefore not possible to compare the absolute level of knowledge between the professions based on the results.

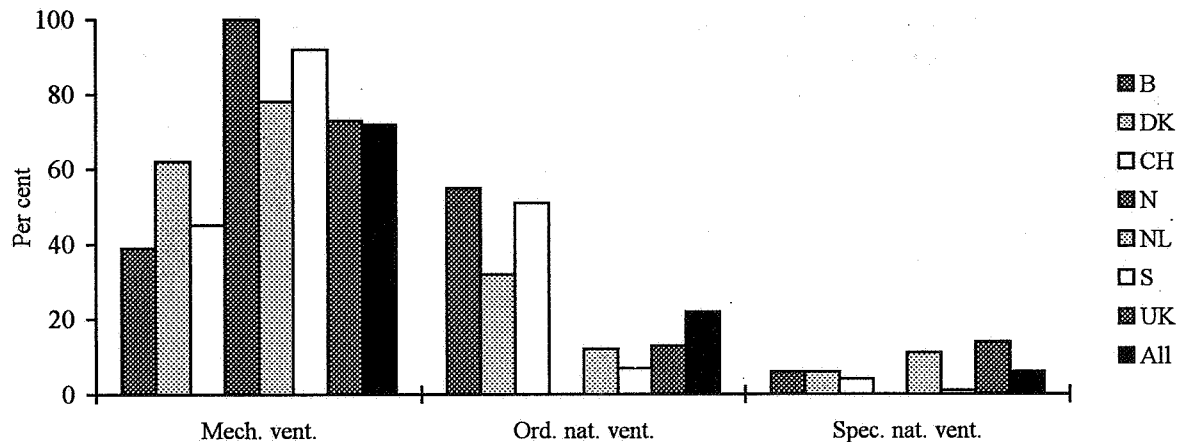


Figure 3. The interviewees relative experience with mechanical, ordinary and special designed natural ventilation in new offices. The scale is the per cent of offices designed, constructed or owned.

3.2 Experience

Most of the interviewees have much experience on mechanical ventilation in offices, whereas the experience with special designed naturally ventilated offices is very limited, see figure 3. Many of the interviewees have worked with ordinary natural ventilation in office buildings, but the actual number of buildings designed, constructed or owned varies significantly. The exception is Norway where none of the interviewees had designed, constructed or owned an office building with natural ventilation. The experience with ventilation in refurbished offices was about the same as in new offices.

3.3 Project fee

In many of the countries most of the interviewed architects and consultant engineers are normally paid according to design fee rules of the national Council of Practising Architects or Counsel of Consultant Engineers, and with the fee for the detailed design fixed based on a percentage of the estimated construction costs.

3.4 Design

In general there is no significant difference in the interviewees perception of the *ease of design* in the four cases: natural ventilation in cellular offices, natural ventilation in open plan offices, mechanical ventilation in cellular offices and mechanical ventilation in open plan offices, see figure 4. Many of the interviewees emphasised that the ease of design also depends on the demands of the indoor climate and on the complexity of the ventilation system.

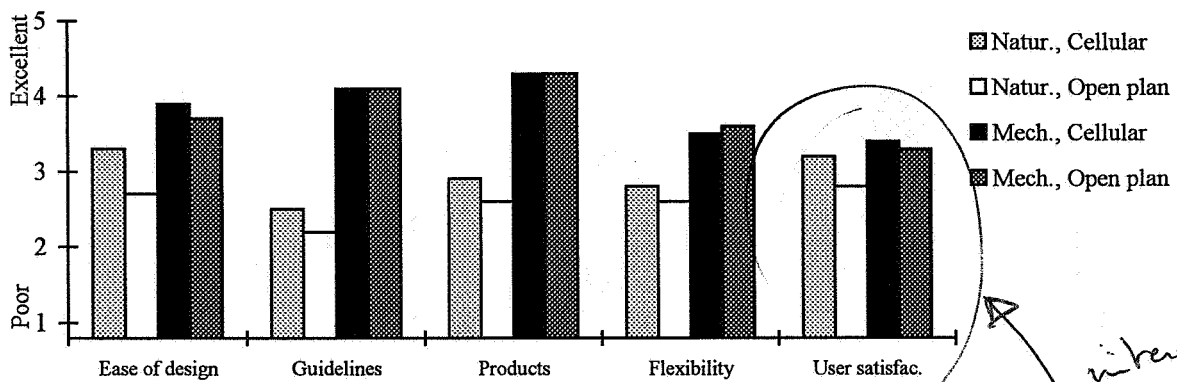


Figure 4. The interviewees perception of the design of ventilation offices.

Nearly all interviewees found that the availability of design *guidelines* and *products* were better on mechanical ventilation systems when compared with natural ventilation systems. The interviewees also expected a higher *flexibility* in mechanical ventilated offices than in natural ventilated offices.

The interviewees expect the same *user satisfaction* in natural and mechanical ventilated cellular offices. They expect higher user satisfaction in natural ventilated cellular than in natural ventilated open plan offices. In mechanical ventilated offices the expected user satisfaction is the same in cellular and in open plan offices. It was mentioned that user satisfaction also depends on the expectations, which are normally higher in mechanical ventilated offices.

3.5 Performance in practice

In general the interviewees expect a better performance of mechanical ventilation systems than of natural ventilation systems regarding cooling effectiveness, draught minimisation, ability to remove odours and pollutants, ability to prevent ingress of odours and pollutants and insulation against external noise, see figure 5. Regarding generation or transmission of internal noise the interviewees on average expect the same performance level by natural and mechanical ventilation. Several of the interviewees emphasised that the performance also depends on how well the system is designed.

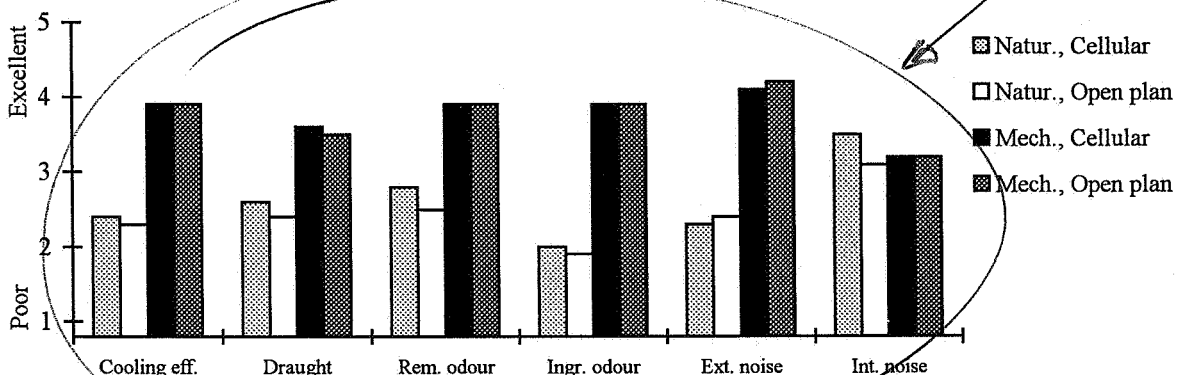


Figure 5. The interviewees perception of the performance in practice of office ventilation.

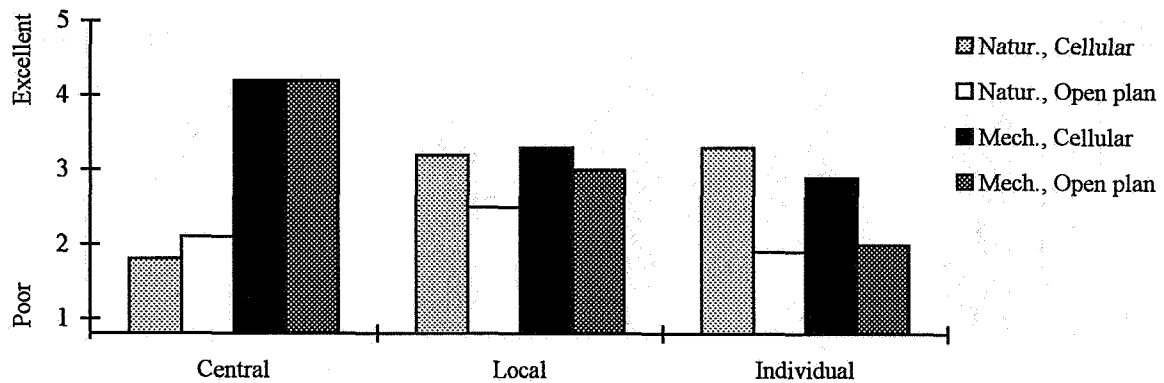


Figure 6. The interviewees perception of the controllability of office ventilation.

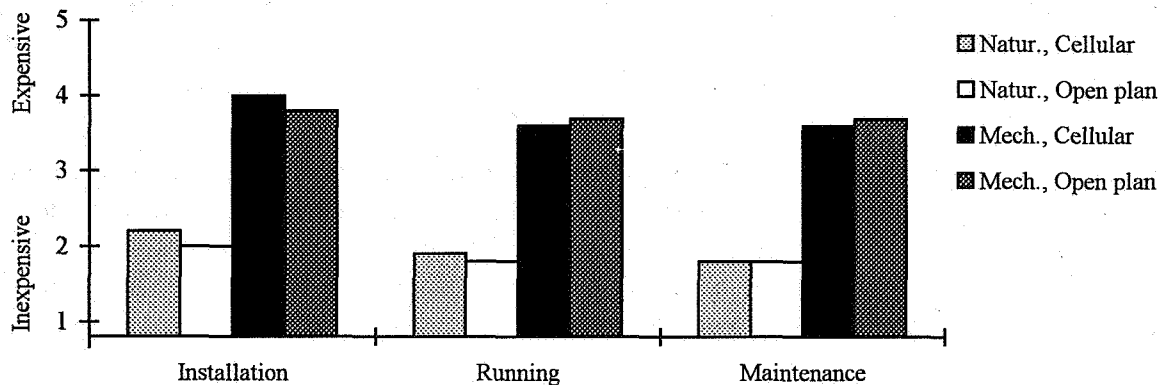


Figure 7. The interviewees perception of the costs for office ventilation.

3.6 Controllability

In general the interviewees expected a high degree of central controllability of mechanical ventilation systems and a low degree of central controllability of natural ventilation systems especially in cellular offices, see figure 6. The expected degree of local and individual controllability of the ventilation is a little higher in cellular offices than in open plan offices.

3.7 Costs

Most interviewees expect higher installation, running and maintenance costs for mechanical ventilation systems than for natural ventilation systems, see figure 7. Several of the interviewees emphasised that if mechanical ventilation is installed in a building a perceptible percentage of the total construction costs would be for the mechanical ventilation systems. It was also mentioned that the installation costs for natural ventilation systems is high if additional floor area or space is required.

3.8 Source to natural ventilation knowledge

The general opinion among the interviewees is that there is huge lack of good sources to natural ventilation knowledge. The mentioned sources are very sporadic and nearly no specific sources were mentioned by more than one or two of the interviewees.

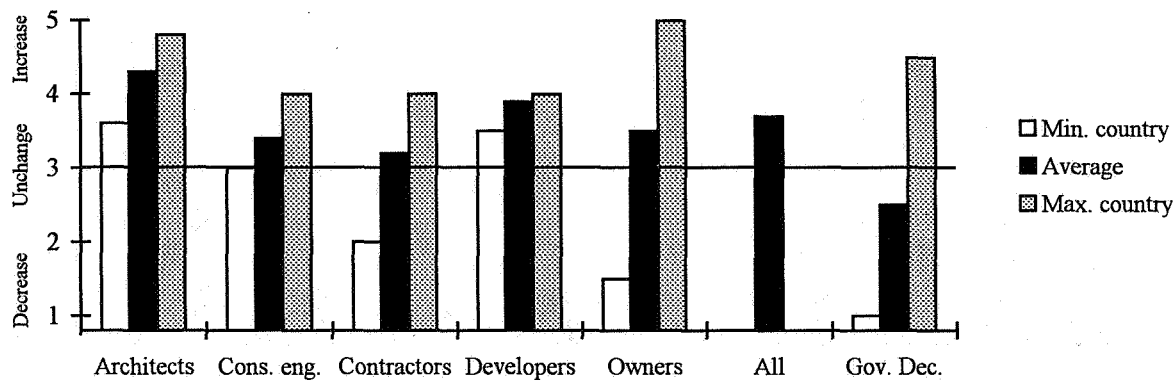


Figure 8. The interviewees expectations on the future use of natural ventilation in offices.

3.9 Expected future use of natural ventilation

The architects in general have the highest expectations of an increase in the use of natural ventilation in offices, see figure 8. On average only the governmental decision makers expect a decrease in the use of natural ventilation. The Swiss and Swedish governmental decision makers expected a significant decrease in the use of natural ventilation in offices. In Norway the interviewed governmental decision maker saw no future for natural ventilation. Also the HVAC consultant engineers and contractors expected natural ventilation to continue to be non-existent in Norwegian office buildings.

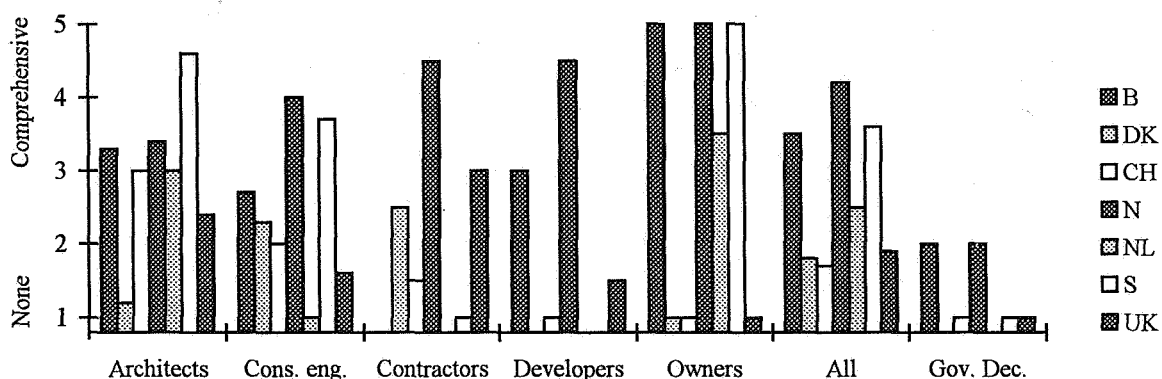


Figure 9. The interviewees perception of restricting requirements in regulations, codes etc.

3.10 Restricting requirements in codes

In Belgium, Norway and Sweden the interviewees perceived significant restrictions in building regulations, codes, norms and standards to the use of natural ventilation, see figure 9. In the other countries restrictions exist but they are perceived to be more limited. In general it is the architects and the owners that see the largest restrictions. The governmental decision makers perceived the restrictions from the requirements in building regulations, codes, norms and standards to be much more limited than the rest of the interviewees in a country.



Figure 10. Critical parameters in the design of the buildings.

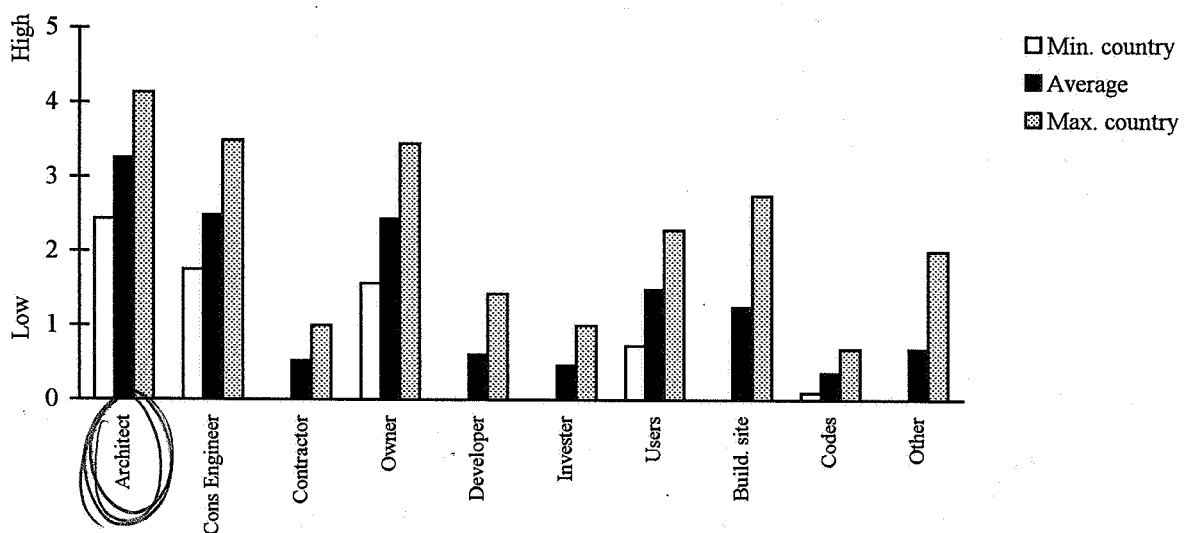


Figure 11. Influence on the design of the buildings.

3.11 Critical parameters

The interviewees perceived summer temperature, construction costs and indoor air quality to be the most critical design parameters in the specific building projects, see figure 10. The projects included buildings with natural ventilation in the offices and buildings with mechanical ventilation in the offices.

3.12 Influence

The architects, the consultant engineers and the owners were the ones with the highest influence on the chosen design in the specific building projects, see figure 11.

4. Conclusions

It is necessary with further improvement of natural ventilation system concepts, components, controls and design tools to encourage the wider uptake of natural ventilation in office buildings and to accelerate natural ventilation as a main design option in new and refurbished office buildings.

Simple, energy efficient, low cost natural ventilation system concepts for new and refurbished office buildings have to be developed and tested so that the use of natural ventilation in the majority of ordinary office buildings is not a technical and architectural challenge but a simple and well approved design solution.

Standards and guidelines have to be improved to be a better technical and legal background for the design of naturally ventilated office buildings. The standards and guidelines should also include generally accepted, simple and easy-to-use calculation rules for the design of natural ventilation.

Simple design tools need to be developed e.g. diagrams or easy-to-use computer programmes, that can be used in the early design process by architects, consultant engineers or design teams for analysis of the advantages and disadvantages of different ventilation systems.

The development of better components and control systems for natural ventilation need to be improved in order to enlarge the number of types of office buildings and geographic locations where natural ventilation would be the best choice.

The general knowledge on natural ventilation has to be improved. Among architects, consultant engineers and possibly also contractors the improved knowledge must come from basic education, post education, source books and building studies. Among developers and owners the improved knowledge must be obtained through simple, easy-to-understand descriptions and examples.

It may also be necessary to adjust the fee structure for the design of office buildings so that the designers are paid for the energy, indoor climate and total cost advantages of their design solutions and not for the amount of equipment installed in the building.

5. Acknowledgements

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6. References

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