

Indoor environment and energy efficiency in schools – Part 1 Principles

summary of the key contents of REHVA
Guidebook no 13

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REHVA



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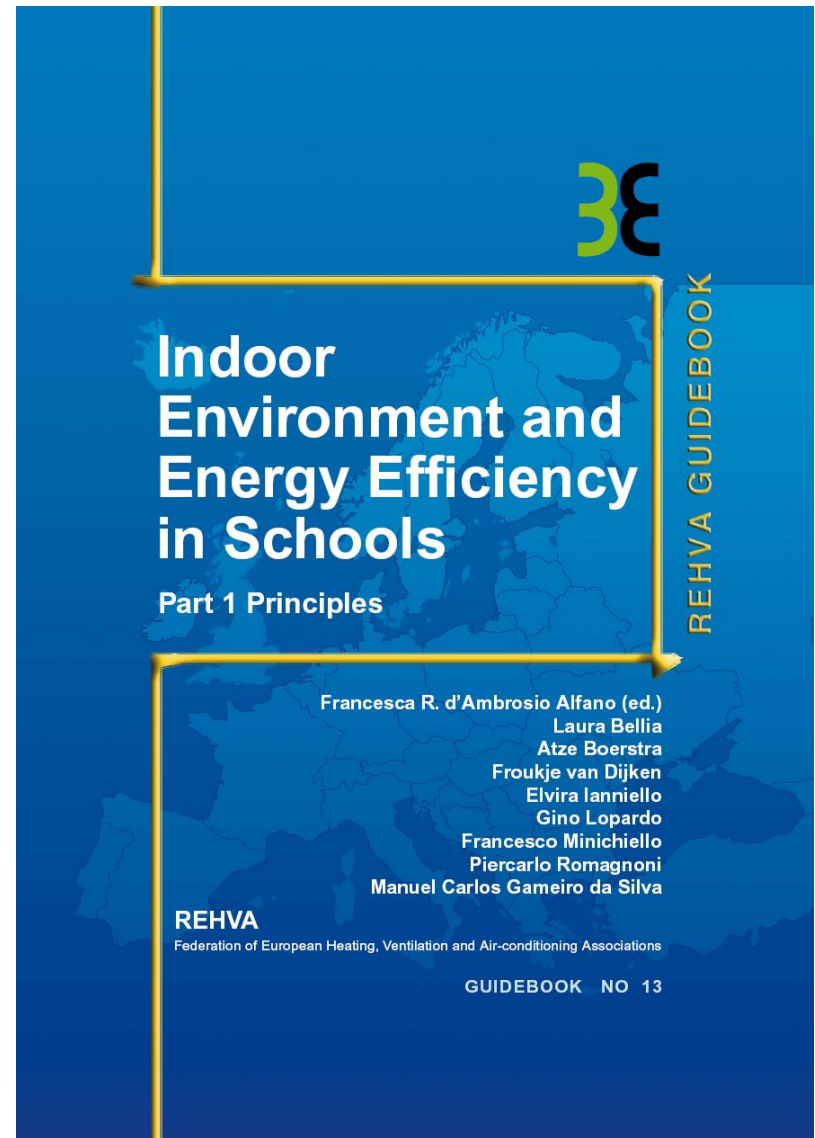
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Indoor environment and school buildings

School is the place where young people stay for the most of the day: a comfortable and healthy environment is necessary for well-being indoor and for productivity.

In the design of school buildings the obtainment of a good environment is often not considered as a priority.

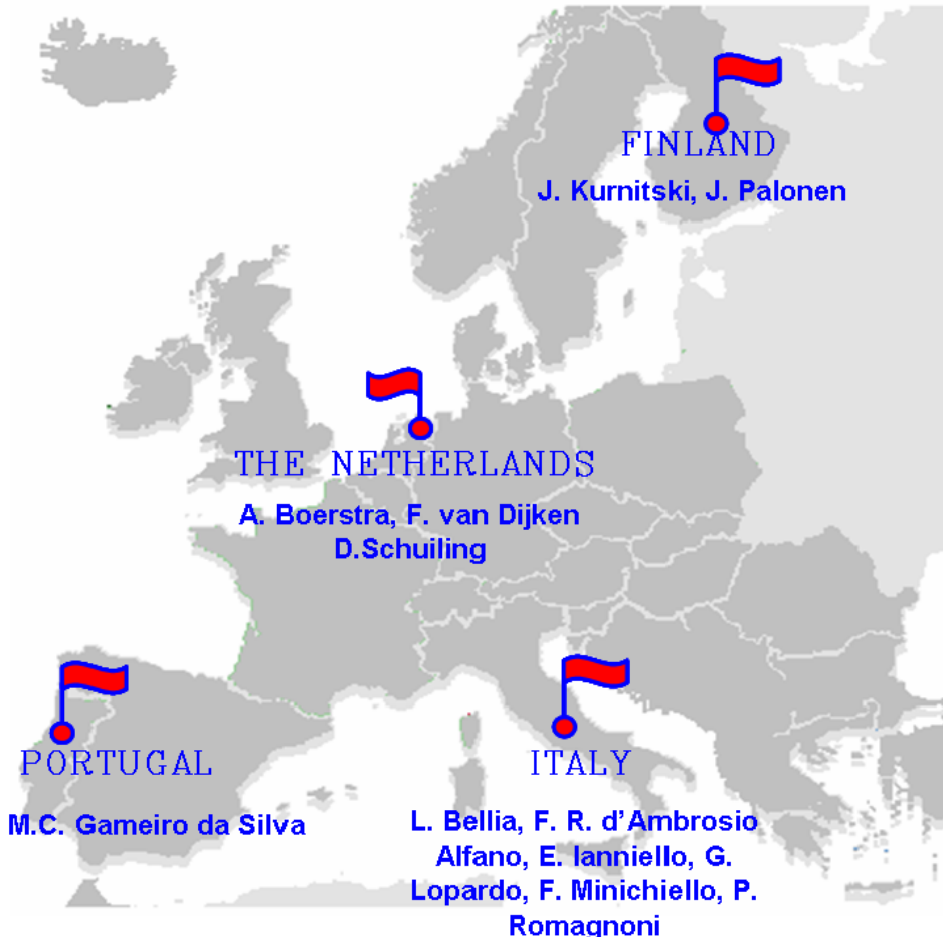
In existing school buildings very often non optimised systems in terms of energy consumption can be found.

Indoor environment and school buildings: aim of the guidebook

The aim of the guidebook is to give an overview on the main aspects and criticises of school buildings envelope and systems design. The aim is to obtain comfortable and energy sustainable environments.

Guidebook n. 13: the experts

The guidebook originates from the work of cooperation of experts coming from several Countries of Europe



Guidebook n.13: main contents and structure

Main contents

principles concerning each aspect of Indoor Environmental Quality, the dimensioning of the HVAC systems and the energy consumption with special attention to the design of school buildings.

The structure

Chapter 1 - Environmental comfort and energy sustainability

Chapter 2 - Indoor environmental comfort aspects

Chapter 3 - Energy saving and global comfort

Chapter 4 - HVAC systems

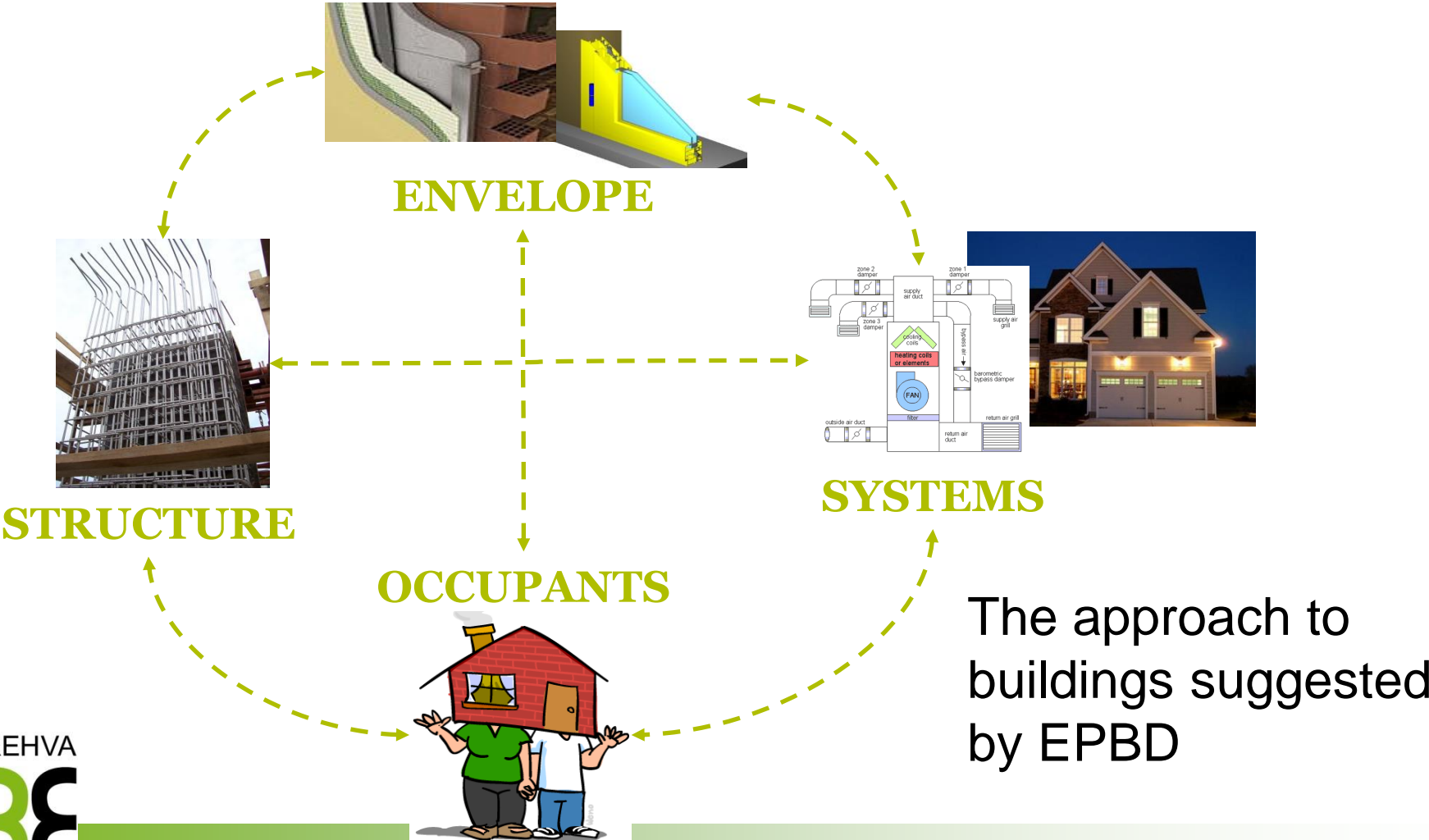
Chapter 5 - Energy Consumption

Chapter 6 - Cases Studies

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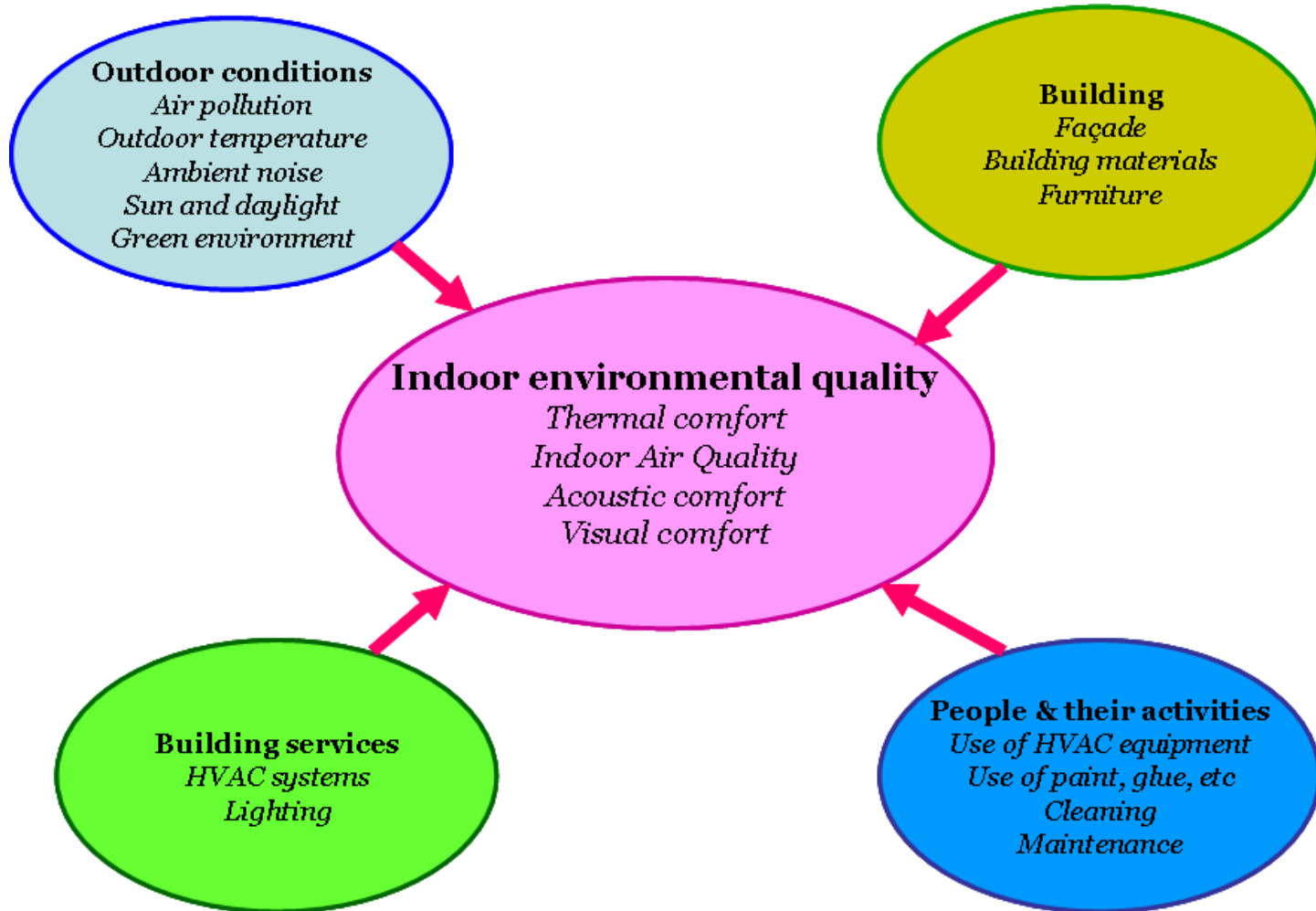


Chapter 1: Environmental comfort and energy sustainability



The approach to buildings suggested by EPBD

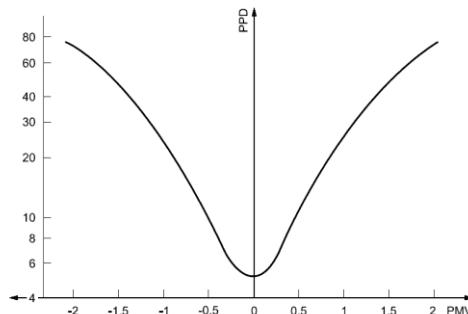
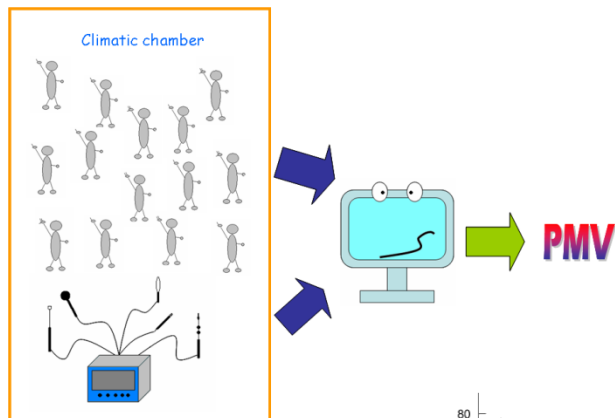
Chapter 2: indoor environmental comfort aspects



Chapter 2: indoor environmental comfort aspects- thermal comfort

Principles of thermal comfort theories are shown and criteria for the classification of the environments are given.

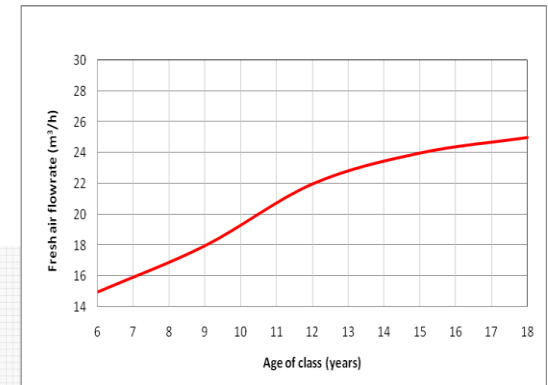
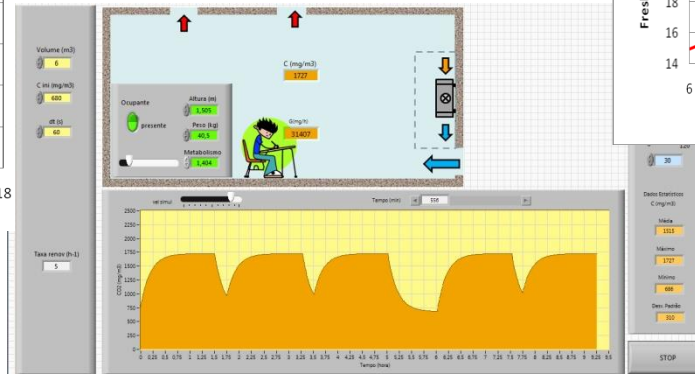
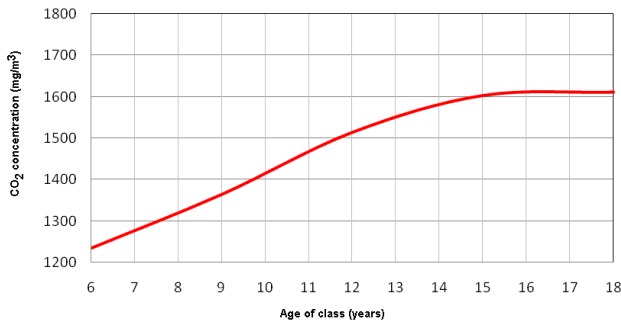
Table 2.2 Categories of thermal environment.



EN 7730							
	category A		category B		category C		
		PPD PD (%)		PPD PD (%)		PPD PD (%)	
PMV	-0,20 ÷ 0,20	≤ 6	-0,50 ÷ 0,50	≤ 10	-0,70 ÷ 0,70	≤ 15	
$t_{11} - t_{01}$	< 2°C	≤ 3	< 3°C	≤ 5	< 4°C	≤ 10	
$\Delta t_{r,0.6h}$	< 10°C	≤ 5	< 10°C	≤ 5	< 13°C	≤ 10	
$\Delta t_{r,0.6h}$	< 5°C	≤ 5	< 5°C	≤ 5	< 7°C	≤ 10	
$v_{e,r}$	DR < 10	≤ 10	DR < 10	≤ 10	DR < 15	≤ 15	
t_a	19 ÷ 29°C	≤ 10	19 ÷ 29°C	≤ 10	17 ÷ 31°C	≤ 15	
EN 15251							
	category I		category II		category III		category IV
		PPD PD (%)		PPD PD (%)		PPD PD (%)	PPD PD (%)
PMV	-0,20 ÷ 0,20	≤ 6	-0,50 ÷ 0,50	≤ 10	-0,70 ÷ 0,70	≤ 15	< -0,70; > 0,70 > 15
$t_{11} - t_{01}$	< 2°C	≤ 3	< 3°C	≤ 5	< 4°C	≤ 10	
$\Delta t_{r,0.6h}$	< 10°C	≤ 5	< 10°C	≤ 5	< 13°C	≤ 10	
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Chapter 2: indoor environmental comfort aspects- IAQ

Indoor air quality principles such as main contaminants, assessment, environments classification are given and a methodology for the calculation of the evolution of carbon dioxide concentration is explained. Then a simulation computational tool is presented.



Chapter 2: indoor environmental **comfort aspects- acoustic comfort**

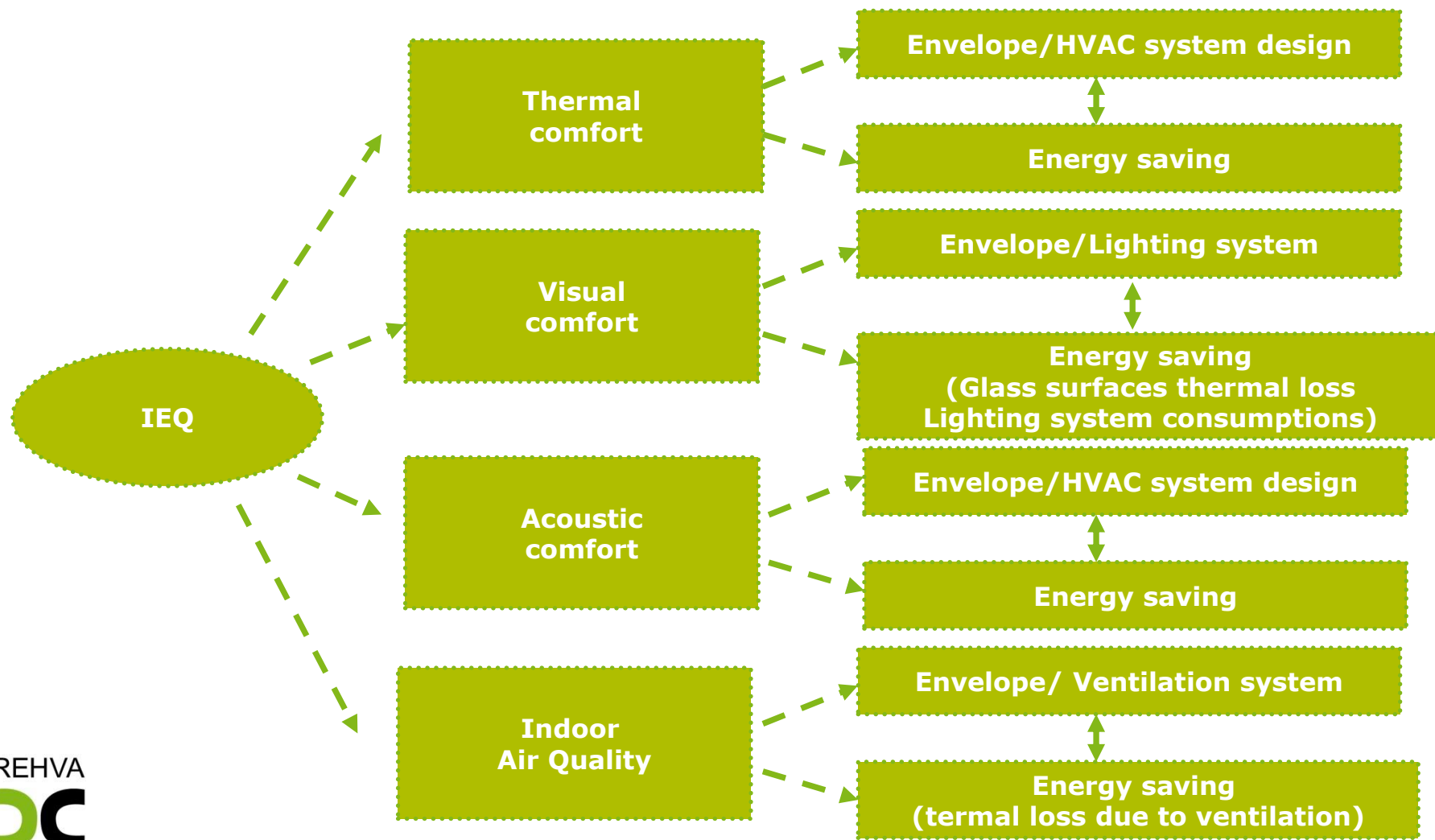
- Main effects related to noise exposure are shown with particular regard to school environments.
- Standard references concerning the characterization of speech intelligibility are presented and the main current guidelines for the design of acoustics in school buildings are reported.
- Acoustic comfort indicators useful and necessary to characterize the acoustic quality of the building envelope and of the indoor environment are presented.

Chapter 2: indoor environmental **comfort aspects- visual comfort**

An overview is given on the effects of lighting on performance and health.

Main visual comfort parameters that should be kept into consideration in the design of lighting systems, in accordance with the current Standards in the field are reported and commented

Chapter 3: Energy saving and global comfort



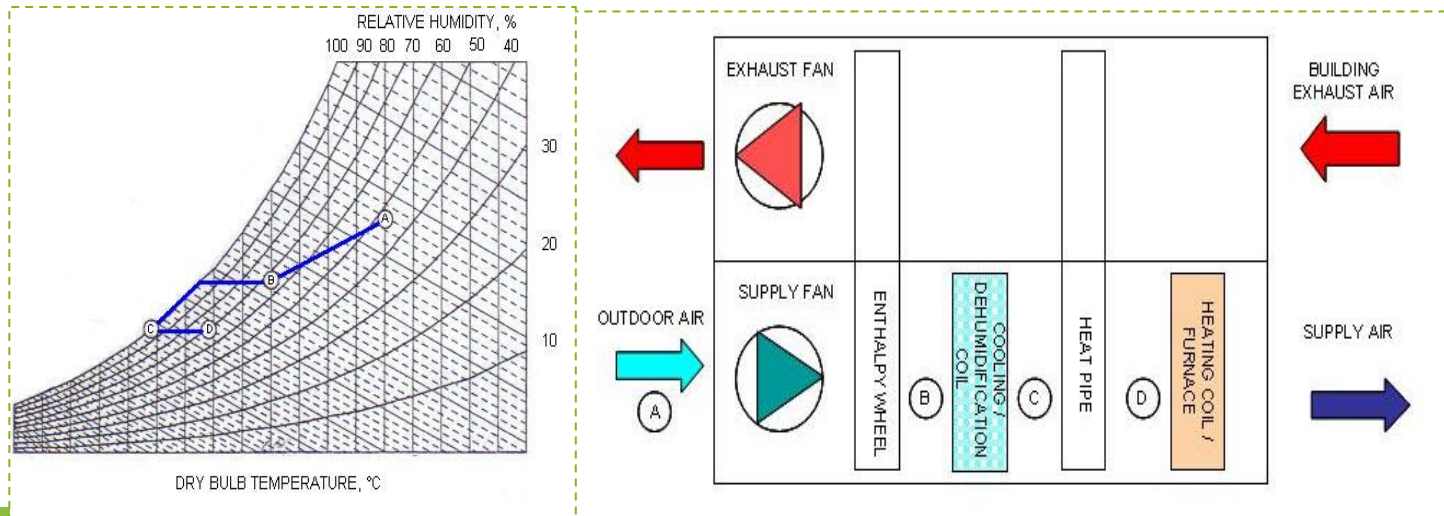
Chapter 3: Energy saving and global comfort

In this chapter the problem of the impact of energy saving choices on global comfort is analysed and the contents of EN15251 Standard are shown with particular regard to the requirements of school buildings.

Methodologies for the categorization of the indoor environments are presented

Chapter 4: HVAC systems

- Design criteria for HVAC systems
- Thermal loads calculation
- Main equipment and systems typologies in school buildings: selection criteria
- Criteria of choice of the most suitable HVAC system for new buildings and existing ones
- Criteria for maintenance



Chapter 5: Energy consumptions

- **Overview on the energy consumption assessment methodologies for new buildings, with a special focus on the methods for primary energy needs estimation**
- **Energy consumptions and energy assessment benchmarking methodologies for existing buildings**
- **Primary energy evaluation criteria**
- **Energy considerations about schools**

Chapter 6: cases studies

Case 1

Concerns the assessment of Indoor Environmental Quality of an Italian high school containing over 1000 students. Globally 20 classrooms were investigated during summer and winter season. The case study contains the main results of the investigation and the remarks given to the director of the school for improving IEQ.

Chapter 6: cases studies

Case 2

This case describes a renovation project of a school in the Dutch city of The Hague. The school used to be a typical Dutch school building with natural ventilation. The school was renovated in 2006 in order to improve the indoor air quality, thermal environment and energy efficiency. The main intervention consisted in a mechanical exhaust ventilation system.

Chapter 6: cases studies

Case 3

Concerns the description of a field study in a classroom of a Dutch primary school building. In this study the natural ventilation system is replaced by a novel balanced displacement ventilation system and consequences of these renovations are analysed in terms of IEQ and energy performance improvement.

Chapter 6: cases studies

Case 4

Concerns the the Poikkilaakso School, a small primary school and day nursery completed in 2001. The Poikkilaakso School was a pilot project having the aim to achieve low heating and electricity consumption by using demand controlled supply ventilation to individual rooms, with air transferred via internal rooms to a single central exhaust and heat recovery between main exhaust and supply ducts. Main design lesson are shown in the case

Conclusion

The guidebook can be an useful help for designers who want to approach to the subject of school building design, because it gives an overview on the main topics related to Indoor Environmental Quality and energy efficiency requirements for this kind of buildings.

Since the topic is really vast and complex the authors, in concordance with REHVA, are willing to continue in the work by publishing the Part two of this guidebook with a further study in depth concerning the operative actions to begin, aiming to meet the requirements described in this text.

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for your
attention

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