RESHYVENT

Cluster Project on Demand Controlled Hybrid Ventilation in Residential Buildings with Specific Emphasis on the Integration of Renewables

Contract No: ENK6 – CT – 2001 – 00533

WP 4: Standards and Regulations support unit

Report Title:

Opportunities, barriers and challenges in relation to the application of standards and regulations on hybrid ventilation systems

General considerations

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Disclaimer

The authors of this report have made their best efforts to get reliable information. The authors are not responsible for the use which might be made of the information contained in this report.

In particular, it must be noticed that this report has been prepared at the very beginning of the RESHYVENT project. Since that, standards and regulations may have changed.

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1. Introduction

During the last decade, there is in general a tendency to pay more attention to indoor climate (thermal comfort, indoor air quality, visual comfort and acoustics) and energy efficiency aspects of buildings and systems. The development of hybrid ventilation systems is clearly linked to this tendency.

As part of the increased interest in indoor climate and energy efficiency, and mainly due to the complex interaction between the various aspects, the quantification of these aspects becomes more important. An increased number of countries have standards and regulations concerning the energy efficiency of buildings and the indoor climate performances.

Standards and regulations are important boundary conditions in the development, optimisation and evaluation of hybrid ventilation systems:

- In case of existing of envisaged regulations which impose certain performances (.e.g. indoor air quality requirements, fire safety,…), it is evident that hybrid ventilation systems have to comply with these specifications.
- In case of standards and regulations focusing on the total energy performance of buildings, it is clear that hybrid ventilation systems may represent opportunities for improved energy performance. As a result, they may be become an attractive alternative for other investments in energy efficiency measurements.

Often, such standards and regulations are to a large extent written on the basis of the experiences with existing systems. As such, it is not always evident to show the compliance of new and innovative systems with the regulations.

In this report, the following issues are discussed:

- The various roles for ventilation and the specific features of hybrid ventilation (§3);
- Classification of standards and regulations (§4);
- Performance oriented versus descriptive standards (§5);
- Challenges for translating customers and societal needs in standards and regulations(§6);
- Accuracy requirements concerning performance predictions in standards and regulations(§7);
- Direct versus indirect performance specifications (§8);
- Energy performance standardisation: an open platform for innovation (§9);
- Information about related projects (§10)
- Overview of standards and working items in CEN TC 156 (§12)

2. Practical information concerning WP 4 ‘Standards and regulations support unit’

WP4 is one of the 5 support units of the RESHYVENT project (Figure 1).

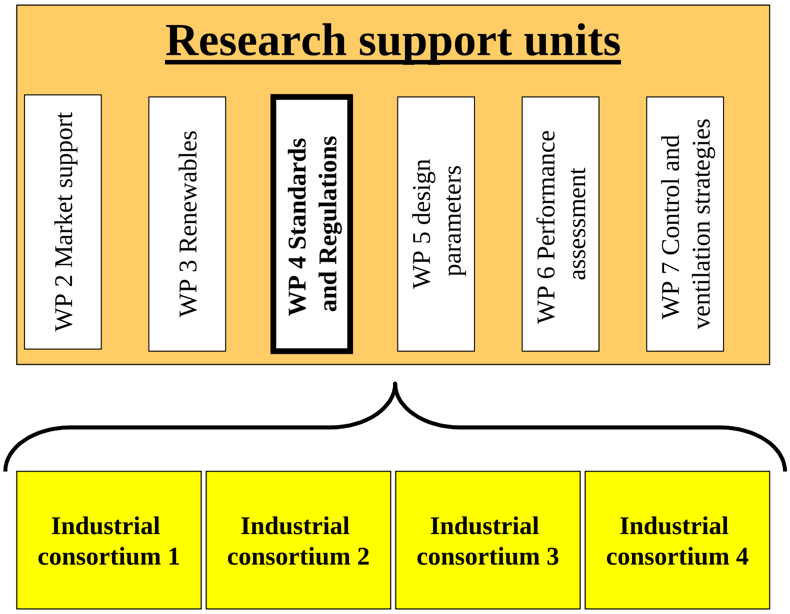

Figure 1: Support units in RESHYVENT project

As is the case with the other support units, there is support at various levels:

- general support to all participants in the RESHYVENT project (Figure 2,❶);
- specific, confidential support to each industrial consortium (Figure 2,❷);
- information which is available for the whole building community (Figure 2,❸).

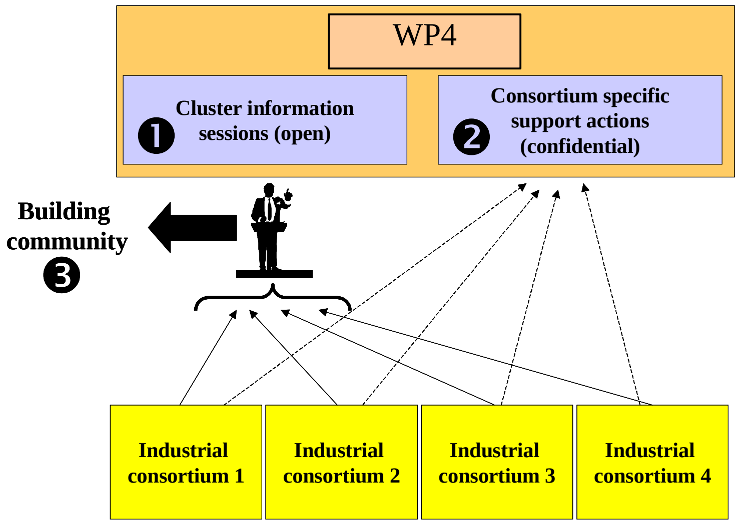

Figure 2: Various kinds of support from WP4

2.1 Objectives of WP4

The objectives are in the RESHYVENT contract described as follows:

- One objective of this task is to identify barriers related to standard and regulations and to make proposals for better standards and regulations.
- The 2nd objective is to develop possible solutions for correctly assessing hybrid ventilation strategies in the framework of energy performance standards and regulations.

2.2 Description of work by WP4

The work is split up in 2 sub-tasks whereby each of them covers one of the 2 objectives of this work.

Task 4.1. Ventilation specifications for IAQ control

- Collection of available overview studies of existing standards and regulations. Useful results are expected from the JOULE-TIPVENT study and of AIVC studies.
- Identification of barriers for the application of hybrid ventilation in the framework of existing standards and regulations.
- Proposal for improving the standards and regulations with respect to the use of hybrid ventilation concepts. Specific attention will be given to a performance-oriented approach (as far as possible). Discussions with (potential) manufacturers of hybrid ventilation systems are part of the work since they probably know very well the problems with existing standards and regulations.
- Checking of proposed concepts for 2..3 innovative hybrid ventilation concepts and, if necessary, improving proposals for standards and regulations

Task 4.2. Energy performance standards and regulations

- Identification of barriers for the application of hybrid ventilation in the framework of existing standards and regulations. Since 4 of the project partners are heavily involved in the development of such national standards and regulations, it is expected that the required expertise is available for carrying out this work.
- Proposal for improving the standards and regulations with respect to the use of hybrid ventilation concepts. A performance-oriented approach is essential.

Checking of proposed concepts for 3 innovative hybrid ventilation concepts and, if necessary, improving proposals for standards and regulations

2.3 Deliverable of WP4

A report which clearly describes standards and regulations with respect to the present situation, the major barriers and possible solutions for the promotion of hybrid ventilation in residential buildings.

2.4 Milestones and expected results

- Milestone 4.1. Completion of draft report ‘inventory of existing approaches and identification of barriers’. This report should be illustrated by examples of hybrid ventilation systems

- Milestone 4.2. Completion of proposal on improving the standards and regulations with respect to the use of hybrid ventilation concepts

WP 4: Standards & Reg.	**2002**												**2003**												**2004**											
4.1. IAQ specifications	■	■	■	■	■	■	■	■	■	■	■	■																			■	■	■			
4.2 EP related activities				■	■	■	■	■	■	■	■	■	■	■	■										■	■	■	■	■	■	■	■	■			
4.3 Seminars	■						■												■						■									■		
4.4 Report																															■	■	■	■	■	■

Table 1: Envisaged timing for WP 4

3. Ventilation: general considerations

3.1 Ventilation in general

Ventilation in buildings is today in most countries considered as an essential aspect in each building project. Whereas in the past, ventilation was automatically linked to indoor air quality control, there is now a growing interest in ventilation as part of an energy efficient strategy for achieving thermal comfort in summer. In order to assess ventilation components and systems, it is therefore essential to explicitly separate ventilation for indoor air quality control and ventilation as part of a thermal comfort strategy in summer (Figure 3).

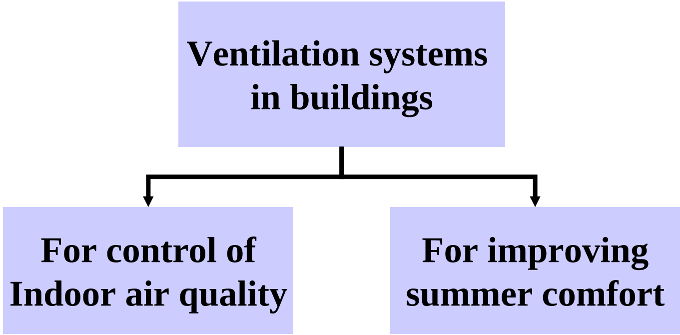

Figure 3: A correct identification of the purpose of ventilation is essential and in practice often not well expressed

As further discussed in the next paragraphs, the devices to be used for IAQ control and summer comfort control are in most cases quite different. The major reason for this difference is the fact that, if compared with ventilation for IAQ control, effective night ventilation requires rather high air flow rates. As an illustration, Figure 4 shows air flow rates (predicted with ESP-r) for the new IVEG office building in Hoboken (Belgium) where intensive natural ventilation is used at night-time (Wouters, 1999). The average air flow rate for IAQ is showed as well. In this project, presence detection is used for IAQ control.

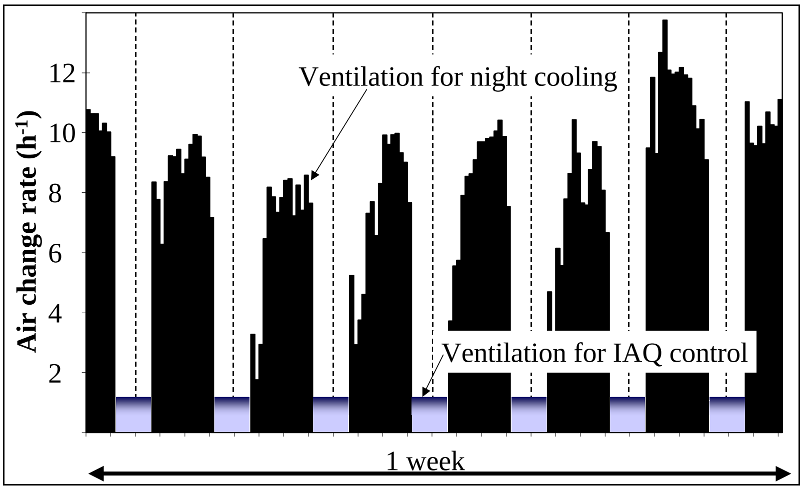

Figure 4: Ventilation rates in IVEG building for IAQ and thermal comfort purposes: various orders of magnitude

Another fundamental difference between both types of ventilation is the optimisation challenge:

- In case of ventilation for IAQ control, the challenge is to achieve during periods of heating and cooling demand an optimal equilibrium between IAQ needs and energy use. Balancing of systems, demand controlled ventilation,… are therefore important issues;
- In case of ventilation as part of a strategy of energy efficient cooling, maximisation of the air flow rates without creating comfort problems (e.g. undercooling in the morning,..) is the challenge and there is in most projects no heavy demand on air flow optimisation.

For both types of ventilation, a successful application will only be achieved if a whole range of potential barriers and problems are solved.

3.2 Hybrid ventilation

As far as innovative ventilation is concerned, the splitting between natural and mechanical ventilation is becoming in many cases rather weak. More fundamentally, one observes that there is a tendency for combining the best of both technologies: intelligent natural ventilation if appropriate, efficient mechanical ventilation if required. This tendency is valid also for ventilation in relation to thermal comfort in summer.

This new tendency is called hybrid ventilation. Hybrid ventilation systems are in the framework of IEA 35 defined as (Heiselberg, 1998):

> *"Hybrid ventilation systems can be described as systems providing a comfortable internal environment using different features of both natural ventilation and mechanical systems at different times of the day or season of the year. It is a ventilation system where mechanical and natural forces are combined in a two-mode system. The main difference between conventional ventilation systems and hybrid systems is the fact that the latter are intelligent systems with control systems that automatically can switch between natural and mechanical mode in order to minimise energy consumption and maintain a satisfactory indoor environment. "*

Hybrid ventilation aims to optimise the indoor air quality and the energy efficiency. A qualitative representation is given in Figure 5:

- poor IAQ conditions should in principle not occur;
- if there is not a high energy penalty for cooling or heating, a better indoor air quality than the minimum level can be achieved.

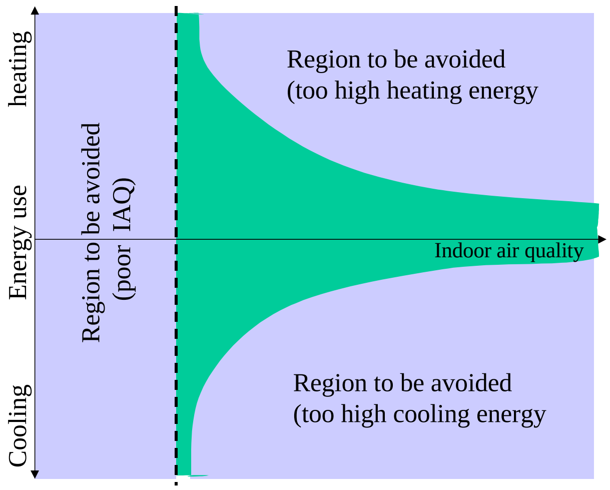

Figure 5: Challenges for hybrid ventilation systems

An energy performance assessment method (as existing in e.g. the Netherlands and France and as under development in e.g. Belgium and Greece) allows in principle to correctly take into account the potential benefits of hybrid ventilation. However, it is not possible to determine the performances with the standard procedure. Therefore, it is necessary to make use of the principle of equivalence. This document aims to create well argued boundary conditions for assessing (hybrid) ventilation systems in the framework of the principle of equivalence.

As far as control is concerned, various control strategies for hybrid ventilation systems may be important, e.g.:

- during certain periods of time, the control of the ventilation system is mainly determined by IAQ concerns,
- during other periods, temperature (indoor or outdoor) related control may be dominant.

4. Classification of standards and regulations

Standards and regulations clearly have an impact on the building process. Standards are often considered as nothing else than calculation or measurement procedures whereas regulations are requirements which are in most cases based on procedures described in standards.

However, there are various types of standards and regulations with rather substantial differences between them. In the framework of this report, the following types of standards and legislation are briefly discussed:

- European legislation (§4.1)
- European standards (§4.2)
- ISO standards (§4.3)
- Private sector voluntary standards (§4.4)
- National standards: example of Belgian standards (§4.5)

4.1 European legislation

4.1.1 Types of decisions

The European Union has, according to the Single European Act and the Maastricht Treaty, the possibility to take certain legislative measures in relation to energy efficiency of buildings. Various possibilities (Santamouris, 1996) exist: directives, mandates, regulations and decisions. See Table 2. Some of these terms are also described in Table 4.

- **Directives**

  They are issued by the EC Commission and the Council of Ministers and they contain instructions to the Governments of all Member States which must comply with them. National laws must be adapted or produced in line with the requirements of the Directive and this before the specified deadline. The Directive allows to harmonise laws on the specified issues, the laws should be identical or at least similar. Public and private bodies must comply with them.

  Since 1985, the "New approach Directives" aim to speed up the process and the major changes are:

  - To adopt weighted majority voting, instead of requiring unanimity in the process of producing and adopting harmonising directives;
  - To replace detailed technical criteria previously contained in annexes to directives, with references to CEN/CENELEC standards.

    The most relevant example of a "New Approach Directive" in relation to this document is the Construction Product Directive (CPD).

- **Mandates**

  They are work orders issued by the European Commission that instruct European standards (CEN/CENELEC) or approval (EOTA) bodies to produce Technical Standards or European Technical Approvals (ETAs) required to enforce Directives.

- **Regulations**

  It is another form of legislation. They are legislative documents issued directly by the Council of Ministers and becomes part of the European law immediately without requiring Member States to bring their own laws into line. Public and private Bodies must comply with them.

- **Decisions**

  They are binding in all respects on their addressees. They can be addressed to Member States as well as to private parties and are the means by which the Community adopts individual administrative acts.

Table 2: Various types of European legislative measures Source: Santamouris (1996)

4.1.2 Construction Product Directive (CPD)

Paragraph 71 of the White Paper on completing the internal market, approved by the European Council in June 1985, states that, within the general policy, particular emphasis will be placed on certain sectors, including construction. The removal of technical barriers in the construction field, to the extent that they cannot be removed by mutual recognition of equivalence among all the Member States, should follow the new approach set out in the Council resolution of 7 May 1985 which calls for the definition of essential requirements on safety and other aspects which are important for the general well-being, without reducing the existing and justified levels of protection in the Member States.

The 6 essential requirements specified in the Construction Product Directive (CPD) provide the basis for the preparation of harmonised standards at European level for construction products:

- The **essential requirements** applicable to works which may influence the technical characteristics of a product are set out in terms of objectives in Annex I of the Directive. These are only very general descriptions and very condensed. The content of annex I is fully included in Table 3.
- **Interpretative documents** have been established in order to give concrete form to the essential requirements at a technical level. They are the technical basis for the harmonised standards and other technical specifications at European level and for the drawing up or granting of European technical approval. To a large extent based on these interpretative documents, the European Commission is given mandates to CEN, CENELEC and EOTA.
- **Harmonised standards** have to be established in order to achieve the greatest possible advantage for a single internal market, to afford access to that market for as many manufacturers as possible, to ensure the greatest possible degree of market transparency and to create the conditions for a harmonised system of general rules in the construction industry.

4.1.3 Energy Performance Directive (EPD)

Within the context of the European Union, a second major driving force and/or boundary condition is the Energy Performance Directive. This directive, which was adopted in January 4 2003, forces all EU member countries to implement energy performance procedures.

The main features of this new directive are described in article 1:

"This Directive lays down requirements as regards:

(a) the general framework for a methodology of calculation of the integrated energy performance of buildings;

(b) the application of minimum requirements[1] *on the energy performance of new buildings;*

(c) the application of minimum requirements on the energy performance of large existing buildings that are subject to major renovation;

[1] It is recalled that under Article 176 Member States may maintain or introduce more stringent protective measures. Such measures must be compatible with this Treaty.

(d) energy certification of building; and

(e) regular inspection of boilers and of air-conditioning systems in buildings and in addition an assessment of the heating installation in which the boilers are more than 15 years old."

In practice, this means that:

- all member states must implement procedures for the determination of the energy performance of buildings, whereby attention must be paid to indoor climate conditions;
- such procedures must be applied to all new and existing buildings;
- minimum energy performance requirements must be imposed for new buildings as well for large existing buildings;
- energy performance certificates must be available for all buildings.

As far as the energy performance calculation is concerned, the directive specifies that the following elements have to be taken into account:

- thermal characteristics of the building (shell and internal partitions, etc.). These characteristics may also include air tightness
- heating installation and hot water supply, including their insulation characteristics
- air-conditioning installation
- ventilation
- built-in lighting installation (mainly the non-residential sector)
- position and orientation of buildings, including outdoor climate
- passive solar systems and solar protection
- natural lighting and natural ventilation
- designed indoor climate.
- elements, products or components with thermal or energetic characteristics certified in accordance with national standards.

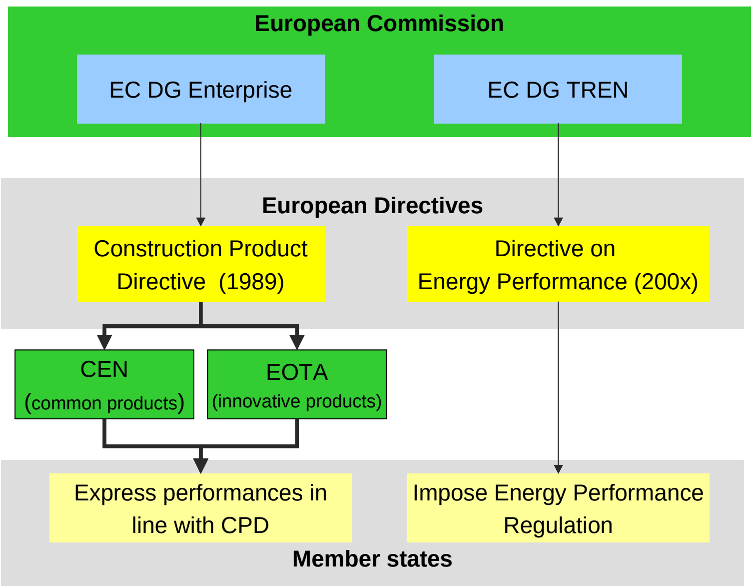

Figure 6: Construction Product Directive and Energy Performance of Buildings Directive

Note:

On February 6 2002, the European Parliament has discussed the proposal for Directive. A first indication of the outcome of these discussions is summarised below (`ENDS Environment Daily - Issue 1153, Thursday 7 February 2002`)

> *"Parliament votes for softer line than energy ministers over EU energy efficiency certificates*
>
> *An EU directive being drafted to combat climate change by improving energy efficiency in buildings was substantially weakened by the European Parliament yesterday when MEPs voted against early introduction of mandatory building energy certificates.*
>
> *As proposed by the European Commission last spring, the directive will introduce a requirement for all building sale and rent transactions to be accompanied by an energy performance certificate allowing prospective occupants to compare future costs. The idea is that this will put pressure on owners to reduce their buildings' energy consumption*
>
> *The Commission recommended that certification should apply from the entry-into-force of the directive at the end of 2003. Under the parliament's new proposals, however, member states would not have to transpose the law until 2005 or apply certification to all existing buildings until 2010.*
>
> *The parliament's position is now less demanding even than that taken by energy ministers last December, who decided to allow member states to delay transposition to 2004 and full certification until 2008 if they lacked resources to carry out energy audits.*
>
> *The significance of delaying widespread implementation until 2008 or 2010 is that it would substantially reduce the directive's ability to help reduce carbon dioxide emissions from buildings by the time of the first commitment period under the UN Kyoto protocol, 2008-12.*
>
> *Criticising the parliament over this today, Andrew Warren of energy-saving product association EuroAce said: "Parliament is saying that the 45m tonnes carbon dioxide saving [predicted under the European climate change programme as the directive's contribution to the EU's Kyoto effort] will not be realised...I haven't seen a coherent argument to justify such delays."*
>
> *The parliament's rapporteur MEP Alejo Vidal-Quadras Roca confirmed to Environment Daily that, following this vote, member states would not be obliged to require energy audits in the sale or rent of existing buildings until towards the end of 2010. "This type of legislation is not so easy to adapt" at national level, he said.*
>
> *Mr Vidal-Quadras said other of the parliament's amendments would focus more attention on cooling systems for buildings in southern EU countries and could reduce the need for air conditioning. Meanwhile, Mr Warren welcomed a change made by the parliament to make the law cover office buildings at industrial sites."*

4.2 European standards

Three bodies are responsible for the planning, development and adoption of European standards:

- CENELEC (European Committee for Electrotechnical Standardisation) for electrotechnical issues;
- ETSI (European Telecommunications Standards Institute) for most of the Information and Communications Technologies;
- CEN (European Committee for Standardisation) for all other sectors.

CEN is a legal association, the members of which are the National Standards Bodies of nineteen European countries and six associates (organisations representing social and economic interests at European level).

The CPD mandates the following organisations for carrying out specific activities:

– CEN and CENELEC for preparing and adopting the standards.

– EOTA (European Organisation for Technical Approval) for preparing the technical approvals.

The procedure for approval of European standards is rather complicated and its description falls outside the objective of this report. However, it is important to mention that the adoption of standards does not require unanimity but that it is based on a weighted voting principle.

The principle deliverable of CEN is the European Standard (EN). Besides European standards, there are other types of deliverables. They are briefly described in Table 3 and important related terms are also included.

The products must be suitable for construction works which (as a whole and in their separate parts) are fit for their intended use, account being taken of economy, and in this connection satisfy the following essential requirements where the works are subject to regulations containing such requirements. Such requirements must, subject to normal maintenance, be satisfied for an economically reasonable working life. The requirements generally concern actions which are foreseeable.

1. Mechanical resistance and stability

The construction works must be designed and built in such a way that the loading that are liable to act on it during its constructions and use will not lead to any of the following:

a) collapse of the whole or part of the work;

b) major deformations to an inadmissible degree;

c) damage to other Parts of the works or to fittings or installed equipment as a result of major deformation of the load-bearing construction;

d) damage by an event to an extent disproportionate to the original cause

2. Safety in case of fire

The construction works must be designed and built in such a way that in the event of an outbreak of fire:

- *the load-bearing capacity of the construction can be assumed for a specific period of time,*
- *the generation and spread of fire and smoke within the works are limited.*
- *the spread of the fire to neighbouring construction works is limited,*
- *occupants can leave the works or be rescued by other means.*
- *the safety of rescue teams is taken into consideration.*

3. Hygiene, health and the environment

The construction work, must be designed and built in such a way that it will not be a threat to the hygiene or health of the occupants or neighbours, in particular as a result of any of the following:

- *the giving-off of toxic gas,*
- *the presence of dangerous particles or gases in the air.*
- *the emission of dangerous radiation*
- *pollution or poisoning of the water or soil,*
- *faulty elimination of waste water, smoke, solid or liquid wastes,*
- *the presence of damp in parts of the works or on surfaces within the works.*

4. Safety in use

The construction work must be designed and built in such a way that it does not present unacceptable risks of accidents in service or in operation such as slipping. falling, collision, burns, electrocution, injury from explosion.

5. Protection against noise

The construction works must be designed and built in such a way that noise perceived by the occupants or people nearby is kept crown to a level that will not threaten their health and will allow them to sleep, rest and work in satisfactory conditions.

6. Energy economy and heat retention

The construction works and its heating, cooling and ventilation installations must be designed and built in such a way that the amount of energy required in use shall be low, having regard to the climatic conditions of the location and the occupants.

Table 3: Complete text of the technical description of the essential requirements in the Construction Product Directive (Annex I) (Source: CEC, 1989)

The following observations are important:

- The Construction Product Directive is part of the European legislation. European standards resulting from the CPD have to be implemented at national level. It is an obligation for the member states to implement these standards at national level.
- The European standards themselves don't automatically have an impact on the building sector and on the individuals in the member states. Only if a standard is used for specifying a certain performance level,(e.g. in the framework of a national legislation, by being part of project specific requirements,…) it becomes part of the requirements for quality.

Term	***Abbreviation***	***Definition***
European Standard	*EN*	*A CEN/CENELEC (and ETSI) standard that carries with it the obligation to be implemented at national level by being given the status of a national standard and by withdrawal of any conflicting national standards*
European Pre-Standard	*ENV*	*Prospective CEN/CENELEC standards for provisional application in technical fields where the innovation rate is high or when there is an urgent need for guidance and primarily where aspects of safety for persons and goods are not involved. If national standards exists that conflict with a pre-standard, it is not obligatory to withdraw them.*
CEN Report	*CR*	*A CEN/CENELEC publication authorised by the Technical Board in order to provide information*
Harmonisation document	*HD*	*A CEN/CENELEC standard that carries with it the obligation to be implemented at national level, at least by public announcement of the HD number and title, and by withdrawal of any conflicting national standards.*
CEN Standstill	-	*An agreement among the CEN members to not take any action, either during the preparation of an EN of HD, or after its approval, which could prejudice the harmonisation intended and in particular, to not publish a new or revised national standard which is not completely in line with the existing EN*
European Directive	*e.g. 89/106/EEC*	*A legislative instrument within the European Union which is binding for Member States with regards to the objective to be achieved but which leaves to the national authorities the choice of form and methods used to attain the objectives which were agreed on at EU level within their domestic legal systems.*
EC/EFTA mandate	*M/xxx*	*A political request regarding a specific area of interest according to which the European Commission and /or EFTA formally invites European Standardisation organisations to develop standards on a voluntary basis within a given time limit by consensus amongst all interested parties involved. In many cases, a mandate is given by the EC and/or EFTA to support Directives, in particular the New Approach Directives (Essential Requirements), or particular industrial policy.*
New Approach Directives	-	*Directives that have been put into force since May 1985 by the Council of the European Communities which define 'legislative harmonisation in those sectors where barriers to trade are created by justified divergent national regulations concerning the health and safety of citizens and consumer and environmental protection, will be confined to laying down the 'essential requirements', conformity with will be entitle a product to free movement within the Community.'*
Essential Requirements	-	*Requirements that represent the core of Union law around which an effective policy has been developed in matters of safety, health and other measures for those areas covered by the 'New Approach Directives'.*
Harmonised standard	-	*A European standard that is developed under a mandate from the EC and/or EFTA and which supports 'essential requirements 'of a New Approach Directive of the European Union. If in addition, its reference is published in the Official Journal of the European Communities, it gives presumption of conformity to the 'essential requirements' of the related Directive.*
Presumption of Conformity		*If a manufacturer attests that a product conforms to a harmonised standard whose reference is published in the Official Journal of the European Communities, the national authorities accept that the product or service fulfils the 'essential requirements' of the Directive concerned.*

Table 4: Glossary of terms and abbreviations in relation to CEN

4.3 ISO standards

The International Organization for Standardisation (ISO) is a world-wide federation of national standards bodies from some 130 countries, one from each country. (ISO, 1999)

ISO is a non-governmental organization established in 1947. The mission of ISO is to promote the development of standardisation and related activities in the world with a view to facilitating the international exchange of goods and services, and to developing co-operation in the spheres of intellectual, scientific, technological and economic activity.

ISO's work results in international agreements which are published as International Standards.

ISO is the world-wide counterpart of CEN and it has a standing protocol (the Vienna agreement) to facilitate technical co-operation.

4.4 Private sector voluntary standardisation

An example of a private sector voluntary standardisation organisation is EUROVENT. As far as the European building sector is concerned, the importance of private sector voluntary standardisation has substantially reduced since the CPD.

Remark:

> The Technical Notes published by the Belgian Building Research Institute (BBRI) can to a certain extent be considered as voluntary standardisation reports of the Belgian building sector. It is the qualified Technical Committee of BBRI who approves the proposed Technical Notes.

However, outside Europe is the situation quite different. In the United States, private sector voluntary standards are very important. ANSI (American National Standards Institute) act as administrator and co-ordinator. The following description (ANSI, 1999) aims to clarify the functioning of the standardisation approach in the United States and also gives a good indication of the economic importance of private sector voluntary standardisation in the USA.

> *‘Founded in 1918 by five engineering societies and three government agencies, ANSI remains a private, non-profit membership organization supported by a diverse constituency of private and public sector organisations.*
>
> *Throughout its history, the ANSI Federation has maintained as its primary goal the enhancement of global competitiveness of U.S. business and the American quality of life by promoting and facilitating voluntary consensus standards and conformity assessment systems and promoting their integrity. The Institute represents the interests of its nearly 1,400 company, organization, government agency, institutional and international members through its headquarters in New York City, and its satellite office in Washington, D.C.*
>
> *ANSI does not itself develop American National Standards (ANSs); rather it facilitates development by establishing consensus among qualified groups. The Institute ensures that its guiding principles -- consensus, due process and openness -- are followed by the more than 175 distinct entities currently accredited under one of the Federation’s three methods of accreditation (organization, committee or canvass). In 1996 alone the number of American National Standards increased by nearly 4% to a new total of 13,056 approved ANS. ANSI-accredited developers are committed to supporting the development of national and, in many cases international standards, addressing the critical trends of technological innovation, marketplace globalisation and regulatory reform.*
>
> *ANSI promotes the use of U.S. standards internationally, advocates U.S. policy and technical positions in international and regional standards organisations, and encourages the adoption of international standards as national standards where these meet the needs of the user community.*
>
> *ANSI is the sole U.S. representative and dues-paying member of the two major non-treaty international standards organisations, the International Organisation for Standardisation (ISO), and, via the U.S. National Committee (USNC), the International Electro-technical Commission (IEC).*
>
> *ANSI was a founding member of the ISO and plays an active role in its governance. ANSI is one of five permanent members to the governing ISO Council, and one of four permanent members of ISO’s*

Technical Management Board. U.S. participation, through the U.S. National Committee, is equally strong in the IEC. The USNC is one of 12 members on the IEC's governing Committee of Action and the current president of the IEC is from the United States.

Through ANSI, the United States has immediate access to the ISO and IEC standards development processes. ANSI participates in almost the entire technical program of both the ISO (78% of all ISO technical committees) and the IEC (91% of all IEC technical committees) and administers many key committees and subgroups (16% in the ISO; 17% in the IEC) . As part of its responsibilities as the U.S. member body to the ISO and the IEC, ANSI accredits U.S. Technical Advisory Groups (U.S. TAGs) or USNC Technical Advisors (TAs). The U.S. TAG's (or TA's) primary purpose is to develop and transmit, via ANSI, U.S. positions on activities and ballots of the international technical committee.

In many instances, U.S. standards are taken forward, through ANSI or its USNC, to the ISO or IEC where they are adopted in whole or in part as international standards. Since the work of international technical committees is carried out by volunteers from industry and government, not ANSI staff, the success of these efforts often is dependent upon the willingness of U.S. industry and the U.S. government to commit the resources required to ensure strong U.S. technical participation in the international standards process.

Conformity Assessment, the term used to describe steps taken by both manufacturers and independent third parties to assess conformance to standards, also remains a high priority for the Institute. ANSI's program for accrediting third-party product certification has experienced significant growth in recent years, and the Institute continues its efforts to obtain world-wide acceptance of product certifications performed in the U.S. and the promotion of reciprocal agreements between U.S. accreditors and certifiers.

One of the best indicators of the strength of the U.S. system is the government's extensive reliance on, and use of, private sector voluntary standards. Pursuant to OMB Circular A119, federal government agencies are required to use voluntary standards for regulatory and procurement purposes when appropriate. State and local governments and agencies have formally adopted thousands of voluntary standards produced by the ANSI Federation, and the process appears to be accelerating.

In summary, the ANSI Federation continues to be fully involved in its support of the goals of U.S. and global standardisation and committed to enhancing of the quality of life for all global citizens'

Organisations as ASHRAE (American Society for Heating, Refrigeration and Air Conditioning Engineers) and ASTM (American Society for Testing and Materials) are themselves active in the development of standards.

These private sector voluntary standards get used in a variety of ways (Sherman, 1999):

- *'One way is through product specifications. A client can specify that a given product (window, air conditioner, etc.) must meet e.g. ASTM XXX,…*
- *Another way is for government, utility or private programs to require the use of certain standards in projects they are doing.*
- *Another way is through the court system. If damage is caused because a professional failed to follow a consensus standard of his profession, he can be held liable.*
- *One typical way that building standards get used is as part of codes. Codes are regulations and do have the force of law, and often incorporate or reference standards. Getting a standard adopted by a particular code body gives it the force of law. Building codes, however, are the province of local jurisdictions. That is, each city or location has its own and there are thousands of jurisdictions in the US.'*

Other types of standardisation from the private sector include for instance the MINERGIE label in Switzerland, which is a quality label for new and refurbished buildings. The trade name MINERGIE is mutually supported by the Swiss Confederation, the Swiss Cantons along with Trade and Industry and has been registered to prevent misuse.

4.5 National standards: example of Belgian standards

Besides CEN and ISO standards and private sector voluntary standards, there are also national standards. The procedure for standardisation is not the same in each country. As an example, the Belgian procedure is described.

4.5.1 Procedure for adopting standards

At Belgian level, there are 2 types of standards: 'ratified standards' and 'registered standards' (BIN-IBN, 1999)

The procedure for adopting 'ratified standards' is as follows:

- The work is initiated by a proposal from an acting member of BIN-IBN, from an existing BIN-IBN technical committee or from an international or foreign standardisation document.
- A commission consisting of representatives from producers, consumers, governments, scientific and commercial associations,.. further develops the document and, after unanimous agreement, adopts it as a proposal for standard.
- After presentation to the Management Committee of BIN-IBN, it will pass a public review;
- The final text will be edited by the commission whereby the comments received from the public review are taken as much as possible into account. After unanimous agreement in the commission, the document is again presented to the Management Committee of BIN-IBN, which might decide to let it ratify by the King. Such ratification has to be announced in the Belgian Official Journal.

The procedure for adopting 'registered standards' is as follows:

- It are standards or publications of foreign or international nature which, after agreement in the qualified commission consisting of representatives of producers, consumers, governments, scientific and commercial associations,.. are submitted to the Management Committee of BIN--IBN.
- The Management Committee can decide to adopt them as Belgian Standard.
- Registered standards have to be announced in the Belgian Official Journal.

In order to comply with the EU rules, the Management Committee of BIN/IBN can register or submit for ratification European standards without a positive advice of the qualified commission. In fact, Belgium is obliged, as all other members of CEN, CENELEC and ETSI, to convert European standards in national standards within a delay of 6 months.

The CPD was adopted in 1989 and has resulted in very important developments in the activities of BIN-IBN (as well as of the other national standardisation institutes). One of the results of the CPD is in most cases the so-called stand-still procedure for national standards, which means that it is not longer allowed (unless a special procedure is followed) to start new standardisation activities at national level if similar standards are prepared at CEN level. As a result, most of the activities in the BIN committees are since 1990 devoted to the follow-up of CEN standardisation.

Besides the follow-up of the proposed CEN standards during their development and voting procedures, an important task for the national standardisation institutes is the implementation of the CEN standards at national level and the streamlining with the national regulations.

4.5.2 Impact of Belgian standards on building process

The Belgian Order of Council of 30.07.76, modified by the Belgian Order of Council of 23.10.86, gives the following specifications with respect to the role of standards (BBRI, 1992):

Article 5:

> *'The State and all statutory persons can impose compliance with by the King ratified standards in their decisions, administrative matters, specifications by simple reference to the indicator of these standards'.*

Article 7:

> *The State and other statutory persons, private persons and other interested parties consider the by the King ratified standards and the by the Belgian Standardisation Institute (BIN-IBN) registered standards as rules of good workmanship.'*

It means in practice that Belgian standards can have an important impact on the building process, even if they are not explicitly imposed in the framework of building regulations or by the technical specifications of a project.

It is important to indicate that there are important differences between Belgian standards. A generic classification is made in Table 5. Standards of type b. and c. have an impact on the building process, even without being part of a legislation or project specific requirements.

a. Many standards include no performance requirements at all. This is e.g. the case with NBN B62-002 (BIN-IBN, 1987) for the calculation of the U-value and with NBN B62-301(BIN-IBN, 1989) for the calculation of the thermal insulation level of a building. It is evident that these standards have no impact at all on the building process unless a performance level is specified:
   - by a regulation applicable to the region where the building is situated;
   - in the technical specifications of a project, in which case the imposed level must be strictly met;
   - in a general available publication from a recognised body. This is the case for Technical Notes of BBRI as well as for articles published in the BBRI revue. In this case, there is not the need for strictly meeting the proposed levels but a performance of similar level is advisable.

b. Some standards describe calculation methods as well as typical design assumptions (e.g. NBN B62-003(1986) for the calculation of the nominal heating power at room level) but it is allowed to use other design values. These standards directly influence the building procedures.

c. Finally, certain standards include nearly all the requirements. An example is NBN D50-001(1991) concerning ventilation requirements for dwellings.

Table 5: Classification of Belgian standards according their impact on the building process

5. Performance oriented versus descriptive standards

5.1 Description of both approaches

In general, the aim of standards and regulations is to contribute to a correct formulation of the requirements for quality. A performance oriented approach is focused on the real (or assumed) user needs whereas a descriptive approach is more focused on describing acceptable solutions.

The differences between the performance and the descriptive approach can be illustrated by the example of specifications in relation to indoor air quality.

→ In a ***performance oriented standard*** for indoor air quality control, one will express the required 'real objectives'. This can be done by defining for a series of pollutants (CO, TVOC, CO_2, NO_X, dust,…) e.g. the maximum concentrations, the acceptable dose,… and the boundary conditions for which the requirements must be met.

In order to guarantee such specifications, one needs in most cases a ventilation system. It is clear that it is not possible to guarantee for all possible situations of outdoor climate and internal pollution sources that the requirements will be met. Therefore, a performance oriented standard must specify the boundary conditions, e.g. what are the maximum outdoor pollution levels.

In ASHRAE 62-1989 (ASHRAE, 1989), the concept of a performance oriented approach is foreseen. However, the use in practice is very limited. This is illustrated by statements made by Steve Taylor, chairman of ASHRAE Standing Standard Project Committee (SSPC) 62 and Dennis Stanke (Trane Company, LaCrosse) in a round table published in the ASHRAE Journal of June 1998 (ASHRAE, 1998):

> *Steve Taylor: 'Nobody really uses the indoor air quality method. You have to have three things. You have to know the contaminants of concern, the source strengths of the contaminants, and the concentration limits to be maintained. We don't know any of those three things. So it's an impossible method. '*
>
> *Dennis Stanke: 'I may not characterise it as impossible so much as speculative, subjective or judgmental. In my view, designers avoid it because it is too risky. It isn't a bad idea to have a performance-based procedure, if we want one. If somebody does, at some point in time, actually know source strengths and contaminant removal rates at the filter and acceptable concentrations, we could actually tell them how to calculate the required outdoor air flow rate at a space. The designers can speak for themselves here, but is seems like to me that most prefer a prescribed rate for a space type. That's a lot easier than going through a bunch of calculations and guessing at a bunch of things.'*

The performance oriented approach assumes that it is possible to explicitly define the requirements to be realised as well as the boundary conditions. In order to prove that the requirements are met, this may require the use of rather complex calculation or testing procedures. This is not evident as illustrated by the previous statements.

→ In the **descriptive approach** for indoor air quality control, one avoids to a large extent the need to specify the boundary conditions and the '*real objectives*' to be achieved. By assuming certain default values, it is then often possible to come to requirements which are less complex and easier to be understood by most designers and installers.

An example is the requirements on air flow rates in the Belgian standard NBN D50-001 (BIN-IBN, 1991), e.g. 1 $dm^3/s.m^2$ of floor area for certain rooms.

In theory, a fully performance oriented approach is preferable. However and as indicated before, practice shows that such approach is often not evident:

– For those in charge of preparing the standards, it is not always possible to express the 'real objectives' and 'boundary conditions' in performance terms. Moreover, a standard may not become a highly academic document and should be more or less readable by the average professional.

- For those who have to apply the standard and who have to meet the requirements, it is important that they are able to understand the procedures described in the standards and the related requirements.
- As is illustrated by the discussions in §4 concerning the evolution in identified needs with respect to indoor air quality, it is not evident to really identify the desired performances and new knowledge may lead to new performance needs.

In practice, several standards and regulations have descriptions which are between fully performance oriented and fully descriptive.

The authors believe that the future developments should focus on an intelligent mixture of various approaches. As an example, the procedure developed in the framework of the Dutch Energy Performance standardisation and which is at present also under consideration for the Flemish EP regulation looks quite attractive. It is schematically presented in Figure 7 and consists of the following elements:

- The basis of the whole concept are (as far as possible) detailed evaluation procedures (❶) for the various aspects: solar gains, lighting, ventilation, pump energy,… These procedures, which should be as much as possible performance based, can not be directly used but they are the basis for the standard and they are available to the public;
- These detailed procedures should give the standard (❷) a scientific basis and should justify the values adopted in the standard. The standard itself is probably a mixture of performance based procedures and more descriptive procedures.
- If a part of the building sector express the need to allow simpler procedures for common design approaches, one can develop so-called practice design rules (❸). These rules are purely descriptive and describe acceptable solutions.
- In general, a standard cannot cover all possible technologies. In order to avoid that the standard becomes a barrier for innovation, the concept of 'equivalent performance' (❹) is foreseen. This procedure allows to proof the performances of such innovative systems based on the calculation of an equivalent energy use. The detailed evaluation procedures have then to be used as reference documents for calculating the equivalent performance level.

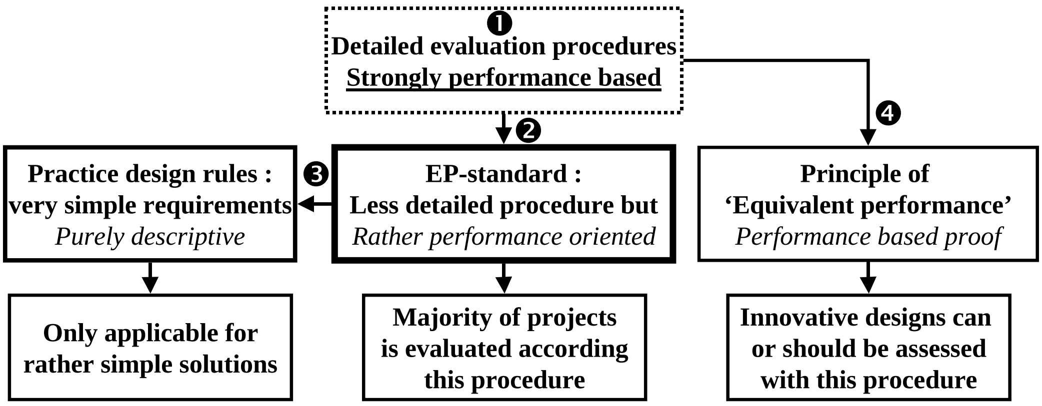

Figure 7: The framework of the Dutch EP approach

6. Challenges for translation of customer (and societal) needs in standards specifications

Standards and regulations are very important boundary conditions for the building sector and they can strongly influence product development. They should correctly reflect the customer and societal needs. Therefore, it is important that standards and regulations:

- cover all key aspects of the component performances (§6.1);
- translate the customer needs in an optimal way in performance requirements (§6.2);
- are as clear as possible and allow verification of specifications (§6.3);
- allow simplified procedures if appropriate whereby these simplified procedures should in the majority of the cases meet the requirements of the standard procedure (§6.4)

At present, there exist major differences with respect to the standards and regulations applicable in various parts of Europe. A discussion about the approaches used in Belgium and the Netherlands is held in §6.5.

6.1 Standards and regulations should preferably cover all key performances

Design, components and execution can strongly influence the performance level.

It is not a problem if certain crucial performance aspects are not considered in a given standard or a specific regulation at the condition that it is treated in another standard or regulation. However, in practice one finds in relation to indoor environment and energy efficiency various situations where essential criteria are not covered at all and which may result in a lack of quality.

This can be illustrated by the following two examples.

- **Requirements on maximum air flow rate of mechanical ventilation systems**

  Many countries have standards or regulations imposing minimum air flow rates. However, it is not common to pay attention to the maximum air flow rates. In such case, there is no strong motivation for carefully balancing a system unless there are very specific requirements at the project level and at the condition that these requirements are verified.

  An interesting example is the French regulation (Visier, 2000) which explicitly takes into account the risk of too high air flow rates.

- **Heat recovery including losses through ductwork in unheated spaces**

  The thermal efficiency of air to air heat recovery systems may substantially drop if there is in unconditioned spaces a long distribution network of non-insulated ductwork between the recovery system and the dwelling. At present, these losses are rarely considered.

6.2 Optimal translation of customer needs in performance specifications

Performance specifications in standards and regulations should be the translation of the customer needs and take into account the requirements of society. In practice, one can find specifications which are not a very logical translation of such needs. A number or examples are given as illustration.

- **Requirements for ductwork airtightness**

  The most common approach is to express the airtightness requirements of ductwork as a maximum air flow rate per m² of ductwork and for a given pressure difference. This may be a pragmatic approach, although a more logical translation of the customer need is to impose a limitation on the leakage flow rate by expressing it as a percentage of the nominal air flow rate of the system.

Example:

Assume 2 systems with both a nominal flow rate of 500 dm³/s. The first system works at a pressure difference of 200 Pa whereas the 2nd system operates at 25 Pa. The surface of the ductwork in the first case is 40 m² whereas in the 2nd case it is 4 m². If the airtightness class A is met, the leakage rate for the 1st system is 9.4% and for the 2nd system 0.3%. An identical airtightness class results in a very different leakage rate.

As far as the system performance is concerned, a better approach would be to express the allowable leakage rate as a percentage of the nominal air flow rate.

In prEN 13779 (CEN,1999), both approaches are recognised.

- **Performance specifications with respect to avoidance of condensation and mould problems**

  The temperature factor approach is much better than imposing a maximum U-value.

6.3 Specifications should be as clear as possible and allow verification

There are standards and regulations, which include performance descriptions that:

- are so vague that they have nearly no impact or;
- can lead to confusion or a misunderstanding.

It is logical that such descriptions have to be avoided. A number of examples can be given as illustration.

Example 1: Belgian standard NBN D50-001 (BIN-IBN, 1991) **concerning ventilation in dwellings**

In this standard, there are a whole range of specifications which are not well defined so that it may lead to confusion.

Examples are:

- NBN D50-001: §3.4:Supply and exhaust provisions

  '… The supply and exhaust openings have in all circumstances a rather small section and are designed in such way that they -–even in open position – don't increase the risk of burglary.'

  It is not precisely defined what has to be understood by 'don't increase the risk of burglary'. The philosophy is clear but there may be technical solutions for which it is not evident to assess if they comply with this requirement.

- NBN D50-001: Table 1 concerning nominal air flow rates

  'bedroom, study, playroom: 1 l/s.m² floor area with a minimum of 7 l/s. One is not obliged to exceed 10 l/s.person'

  The nominal occupancy of bedrooms is not a formal part of the Belgian procedure for a building permit. Therefore, it is not appropriate to refer to air flow rates per person. Moreover, it is in the French version not clear if one is 'not obliged' or 'not allowed' to exceed 10 l/s.person.

- NBN D50-001: §4.3.2.3.: No condensation risk

  'In any case, one has to take care that the supply openings don't increase the risk of surface condensation'.

It is not defined what has to be considered as a reference situation: condensation risk on the glazing, on the window profile or on the adjacent wall? It would be much better to define e.g. a minimum required temperature factor.

- NBN D50-001: §4.3.2.: *Additional general requirements or guidelines*

  It is not evident if this sentence means that it are absolute requirements or just recommendations and suggestions.

- NBN D50-001: §4.3.3.: Values concerning building airtightness

  'In case of a mechanical supply and exhaust ventilation system with heat recovery, it is desirable from an energy point of view to meet an airtightness level which corresponds with an air change rate of not more than 1 h^{-1} for a pressure difference of 50 Pa.'

  In this case, it is clearly stated that it is 'desirable' and not required. However, what will happen if the real airtightness is much worse, e.g. a 10 times higher leakage rate? This latter is not exceptional in Belgium. Can this phrase be used for accusing one of the suppliers of non-quality?

Example 2: Belgian law on ventilation in Horeca (BBRI, 1992)

The Belgian regulation has a very weak and unclear description of the performances with respect to e.g. air cleaning devices. Based on such kind of specifications, no control at all is possible.

Example 3: Belgian standard NBN B62-002 (BIN/IBN,1987) **for calculating heat losses**

In this standard, there are several specifications which are not well defined and which results in confusion.

Examples are:

- NBN B62-002 §5.3.3.: Calculation of thermal bridges

  'The determination by measurement or calculation of 2-dimensional and 3-dimensional thermal bridges has always to be done in the following cases:

  - *Large buildings with a large number or a large length of one or more typical thermal bridges;*
  - *Building parts with a large number of metal fasteners which go across the thermal insulation and of which the thermal bridge effect has a distinct multi-dimensional character.*
  - *All thermal bridges for which a accurate determination of the real heat losses is required.*

  The philosophy of this description is more or less clear but the legal interpretation in case of disputes is far from evident.

- NBN B62-002, §6.3.5.: simplified formulae for the U-value of windows

  'In case of simple constructions, such as private dwellings or apartment buildings with not more than 5 flats, the calculation of the U-value of the window is done – unless one explicitly requires the use of the precise formulae – by means of the following formulae: …'

  This phrase is rather vague by referring to '*simple constructions*' and by giving 2 examples.

Example 4: Regulation in Walloon Region on net heating demand of buildings (Official Journal, 1996)

The Walloon region requires for new dwellings that they reach a certain global insulation level (K55) or a maximum heating demand for given boundary conditions (be_{450}). The requirements for the net heating demand are expressed per m² of floor area. The determination of the floor area is not clearly described and the freedom in interpretation can in several cases result in very different performance levels.

Two practical examples:

- In figure 8, 2 dwellings with identical shape and protected volume are presented. The left one has no attic floor, whereby the room height varies. According to the standard, the net heating demand for the right hand one will be lower because the assumed internal gains are twice as high.

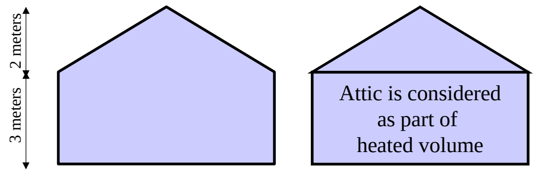

figure 8: How to normalise the energy use as function of floor area: example 1

Therefore, the heating demand per m² floor area is for the right dwelling less than half of the net heating demand of the left dwelling. This is not very logical.

- In figure 9, both dwellings have the same shape and protected volume. However, the left one has a living with double height. Again, the right dwelling has, according to the standard, a lower heating demand and a much lower heating demand per m² of floor area.

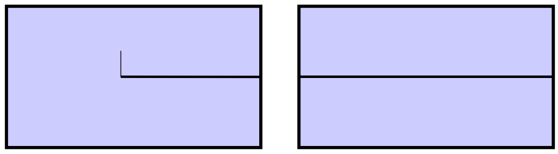

figure 9: How to normalise the energy use as function of floor area: example 2

Both examples show that there is on the one hand lack of clarity in the procedures and on the other hand a lack of logic in the approach. A better approach would be to express the requirement per m³ of dwelling volume.

Example 5: UK Building regulations, part F (Department of the Environment, 1995)

In the UK Building regulations, the requirements for background ventilation are an example of requirements which are not at all performance driven. The requirement in part F for background ventilation for e.g. *a habitable room is a section of 8000 mm²*. This description aims to result in a certain air flow rate performance but it is clear that the determination of the cross section is not evident at all for the more complex devices, e.g. acoustically insulated trickle ventilators. A description as e.g. in Belgium, France and the Netherlands (a certain air flow rate for a given pressure difference) is much more performance based and a much better technical base for product characterisation and improvement.

Example 6: CEN CR1752 (CEN,1998)

The CEN report CR1752 considers the possibility of CO_2 control. Although the approach is surely more performance driven than the concept of fixed air flow rates, the boundary conditions under which the CO_2 requirement has to be met, are not well defined. The full text in the report is as follows:

> *'If sedentary occupants are assumed to be the only source of pollution, the CO2 concentration above the outdoor level corresponding to the three categories is A: 460 ppm, B: 660 ppm and C: 1190 ppm'*

6.4 Simplified procedures should be available but they must in most cases lead to results which meet the requirements of the standard procedure

In many cases, the availability of simplified procedures will be appreciated by a part of the users. Therefore, the availability of simplified procedures can be considered as a possible customer need.

Simplified procedures can be of different nature (figure 10):

- The availability of simpler performance assessment schemes (❶):

  Such simpler procedures are often called 'rules of practice,…'.

- The availability of default values. (❷)

It is important that such simplified procedures should not lead to many solutions which would not be acceptable if the detailed procedure would be used.

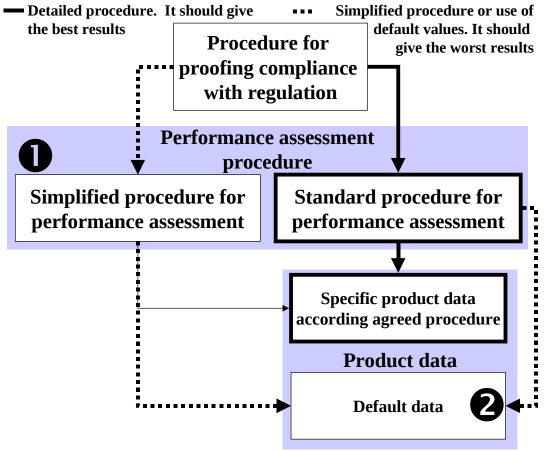

figure 10: Philosophy with respect to simplified procedures

6.5 A global analysis of present approaches for translating user needs into performance specifications in standards and regulations

Good standards and regulations should, among others:

- correctly reflect the societal needs;
- give attention to the design, component and execution performances (figure 11).

In this paragraph, a critical review is made of the approaches used in the Flemish Region, the Walloon Region and the Netherlands.

This is not done for all aspects but by comparing a number of different types of performance specifications. An overview is given in Table 6.

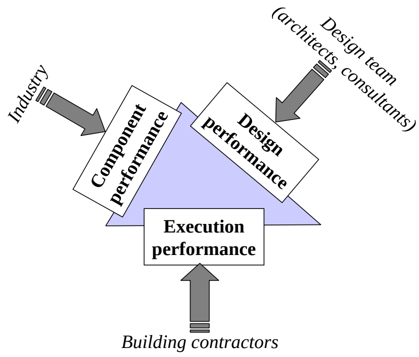

figure 11: Crucial performance aspects

The following comments refer to the numbers in Table 6:

1. The method is in principle general, it may be that the first implementation phase will not cover all building types …
2. Thermal comfort requirements are not included in the Dutch legislation. However, the Dutch agency for public buildings (Rijksgebouwendienst) has comfort criteria which are used in many projects
3. In principle no problem since the Belgian standard NBN D50-001 is considered as part of good workmanship. However no law and in practice often not applied.
4. A maximum U-value requirement is used but this is on itself not a guarantee of good building details
5. There are minimum legal requirements, no stimulation of better performances than minimum requirements
6. No real stimulation of optimal control procedures within a given type of control (e.g. daylight compensation)
7. The airtightness of the building is not checked in reality, for dwellings are 3 classes defined
8. Measurement not necessary. If measurement results not available, default values can be used

9. Handing over should in principle check if minimum air flow rates are possible, no upper limit for air flow rate

From this comparison, it is clear that there are major differences between the present approaches used in the Flemish and Walloon Region on the one hand and the Netherlands on the other hand. The proposed concept for Flemish Energy Performance regulation intends to come in line with the Dutch approach and, if possible, go further in some areas. It is the intention to pay specific attention to the execution performances and it is also planned to vary the allowable energy use as function of certain comfort parameters (e.g. nominal air flow rate, lighting level,…).

Issue of concern	Present Flemish regulation	Walloon regulation	Dutch EP standard	Possible Flemish EP approach
Building type				
Dwellings	✓	✓	✓	✓
Offices and schools		✓	✓	✓
Other buildings			✓	✓[1]
Indoor climate aspects under consideration				
Thermal comfort in winter	✓	✓	✓	✓
Thermal comfort in summer			✓[2]	✓
Ventilation for indoor air quality	✓[3]	✓	✓	✓
Design performance				
Minimising transmission losses	✓	✓	✓	✓
Use solar gains in wintertime		✓	✓	✓
Control solar gains in summer time			✓	✓
Ventilation: minimising heating energy			✓	✓
Ventilation: minimising fan energy			✓	✓
Heating: piping outside conditioned spaces				
VentHeat recovery:ducting outside cond. spaces				
Lighting: Design for daylight			✓	✓
Lighting: energy efficient control			✓	✓
Domestic hot water performances			✓	✓
Use of renewable energy sources			✓	✓
Component performances				
Thermal insulation of building components	✓	✓	✓	✓
Assessment of condensation risk	(✓)[4]	(✓)[4]	✓	✓
Heating boiler efficiency	(✓)[5]	(✓)[5]	✓	✓
Lighting: energy efficient devices and control			✓	✓
Lighting: performances of control components			[6]	?
Execution performances				
Airtightness of building			(✓)[7]	✓[8]
Airtightness of ductwork				✓[8]
Pressure losses in ductwork				
Correct air flow rates		(✓)[9]	(✓)[9]	✓
Lighting levels				
Correct execution of thermal insulation				

Table 6: Comparison of various performance aspects (status June 2000)

(✓) = rather weak specifications ✓= rather strong specifications

(numbers refer to comments on previous page!)

7. Accuracy requirements concerning the predicted performances by standards and regulations

In case a standard predicts a certain performance (e.g. the net heating demand of a building, the normalised energy consumption), a customer of a standard probably expects that the predicted performance (or change in performance due to a modification) has a certain correlation with the performance to be found in practice or, in other words, that the customer and/or societal needs are correctly expressed by the performance specifications in the standard and regulation.

In order to have a good correlation, it is important that:

1. the performances at building level as predicted by the standard is a reasonable indication of the typical performances in practice;
2. the prediction by the standard concerning the impact of certain technological measures is globally in line with the tendency in the reality.

The authors have the impression that the first aspect is receiving by many people a high priority whereas the second aspect is often almost neglected. However, the second aspect is at least as important as the first one.

As an illustration, 3 alternative prediction models for a standard are evaluated in figure 12, figure 13 and figure 14. It could be e.g. 3 different concepts for the prediction of the energy performance of a building.

- The example of figure 12 shows a model for which, on average, the building performance as predicted by the standard is of the same level as the real performance. As such, one can consider that the absolute level of the predicted performance is rather reliable.
- The example of figure 13 clearly performs less good: the standard underestimates systematically the energy performance and such a standard should be improved.
- In the example of figure 14, there is a slight underestimation of the standard and some correction might be useful.

Whereas the example of figure 12 predicts on average the absolute performance globally better than the example of figure 14, this is not at all the case if the predicted impact of certain modifications is evaluated. In the example of figure 14, there is a very good level of agreement between the predicted and real variation in the energy performance. In figure 12, all possible relations are observed.

For the 4 considered cases in figure 12, the following remarks can be made (including in italic a few practical examples):

- **Variation A:**
  - ➚ Predicted variation of a certain technological modification is of the same order of magnitude as the real change in performance
- **Variation B:**
  - ➘ The standard predicts that the technological modification gives a performance reduction whereas in reality there is an improvement

    In case of a poorly designed air-to-air heat exchanger, it is possible that the gain (in primary energy units) due to an improvement in thermal efficiency of the heat exchanger will be completely lost by increased fan energy use (due to higher pressure losses). If a standard only focuses on the thermal performances of the heat exchanger, the predicted performances will be the opposite of the real performances.
- **Variation C:**

➔ The technological modification gives a significant improvement in real performance whereas the standard does not at all consider this as a performance improvement

A standard which automatically considers a fixed energy reduction for daylight compensated luminaires without giving attention to the building and window design is not able to give a benefit for a good daylight design. Also if a fixed benefit is given to presence controlled lighting without considering the technology used, there is no motivation for industry for making use of very energy efficient presence detection systems.

See also Figure 15. In case of a step-function for the cooling penalty, one does not acknowledge measures which improve the thermal comfort.

- **Variation D:**

🡅 The technological modification gives no improvement in real performance whereas the standard predicts a substantial performance improvement

Application of daylight compensated luminaires in offices without windows will in practice give no energy reduction at all. If the standard gives a fixed benefit for daylight compensated lighting, also this benefit will be given to luminaires in rooms without daylight or for luminaires installed at a distance of 6….15 meters from windows.

See also Figure 15.

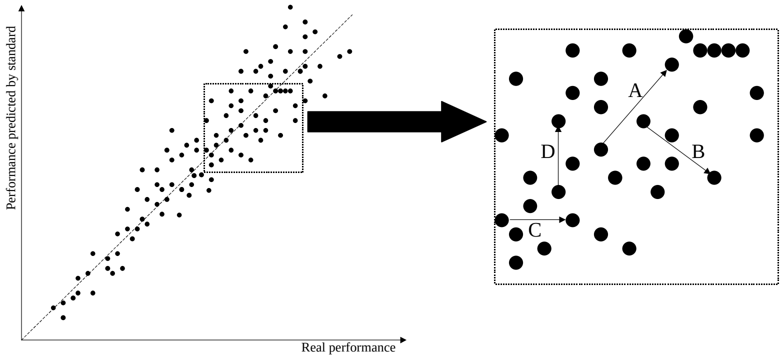

figure 12: Predicted energy performance versus real performance: example of good global correlation but poor prediction of change of performance (explanations in text)

If a preference has to be made among the 3 models, we clearly prefer the model presented in figure 14. Although in absolute terms not very precise, it gives the correct tendency as far as technological modifications are concerned. Such approach will effectively stimulate the use of more energy efficient technology.

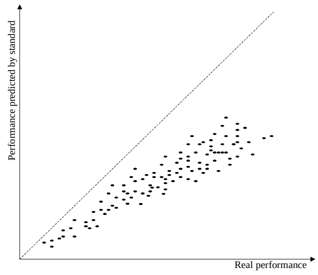

figure 13: Systematic underestimation of the performance by the standard

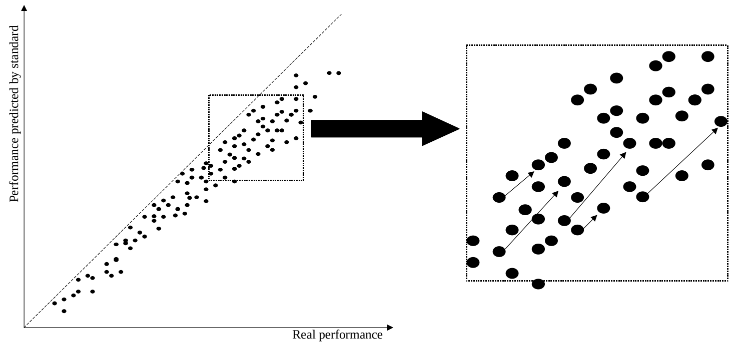

figure 14: predicted energy performance versus real performance: example of moderate global correlation but good prediction of change of performance

This principle can also be applied in the case of summer comfort assessment and energy use for cooling. In the framework of an Energy Performance (EP) Regulation, it is crucial to stimulate buildings with good summer comfort and a limited use of active cooling. An EP procedure can determine a summer comfort index. (Figure 15, ❶). Assuming that such index is suitable, it should be a reasonable indication of the average comfort assessment by the occupants and/or of the probability that active cooling will be installed in the building (Figure 15, ❷). However, there surely exist a substantial uncertainty. In any case, one might expect that there is a reasonable correlation between the EP overheating index and the comfort/active cooling probability: the higher the index, the worse the comfort appreciation and the higher the probability that cooling will be installed. The application of the philosophy presented in figure 14 can be translated in a curve as presented in Figure 15,❸. A curve as presented in Figure 15,❹ is not appropriate: it does not give a sufficiently refined incentive for the optimisation of a given design. The precise form of the curve in Figure 15,❸ has to be determined with great care.

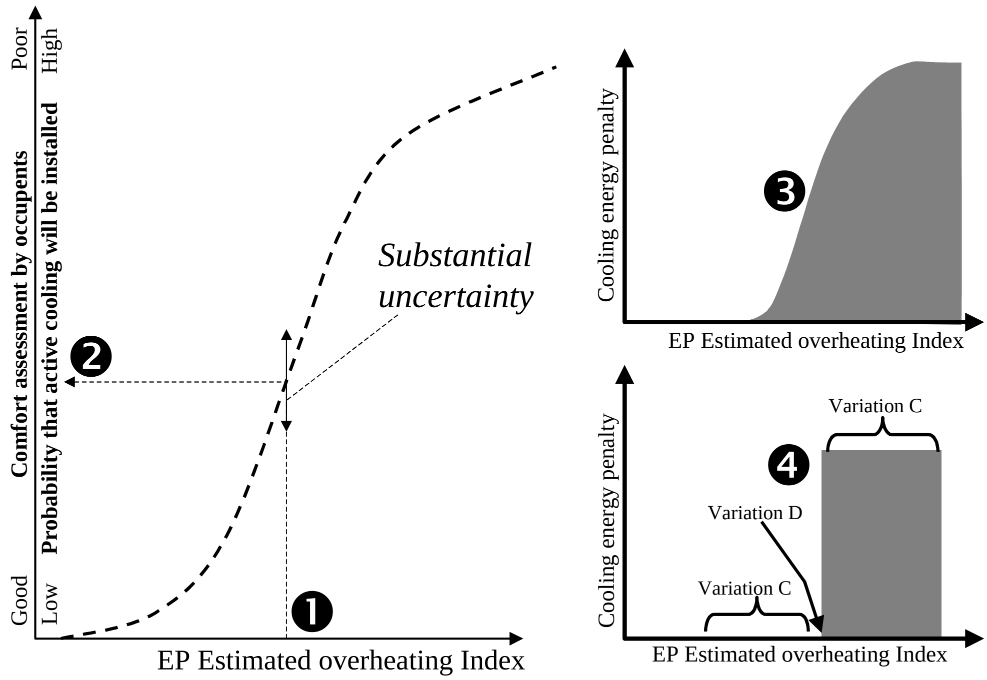

Figure 15: Application of concept presented in figure 14 in case of summer comfort assessment

8. Direct versus indirect performance specifications

Energy performance can be stimulated by explicitly imposing a performance level for certain components, e.g. the U-value, the efficiency of heat exchangers, the airtightness of ductwork.

However, an attractive alternative which allows a greater flexibility and which, if well implemented, may be more cost effective and more market oriented, is to impose an overall performance level whereby the requirement is expressed at the highest possible level (in relation to the issue of concern)

An interesting case is the issue of the airtightness of ductwork (in relation to energy efficiency):

- The most straightforward approach is to impose an airtightness class (A, B, C, D according CEN procedure)(Figure 16, ❶). However, one is not sure that there are no other measures which have a better cost-benefit relation.
- At the condition that a performance control at the end of the works can be part of the proof of conformity with the regulations, one can develop a scheme in which the energy performance of a building depends on the type and quality of the ductwork (Figure 16, ❷):
  - if no performance checks are carried out, one can assume for the EP calculation a default performance value (this can be a fixed value or it may depend on the type of ductwork);
  - if a performance check is applied, one can use the measured result in the EP calculations.

  Such approach has the advantage that there is no need for imposing a whole range of requirements and this may be from a political point of view an important advantage.

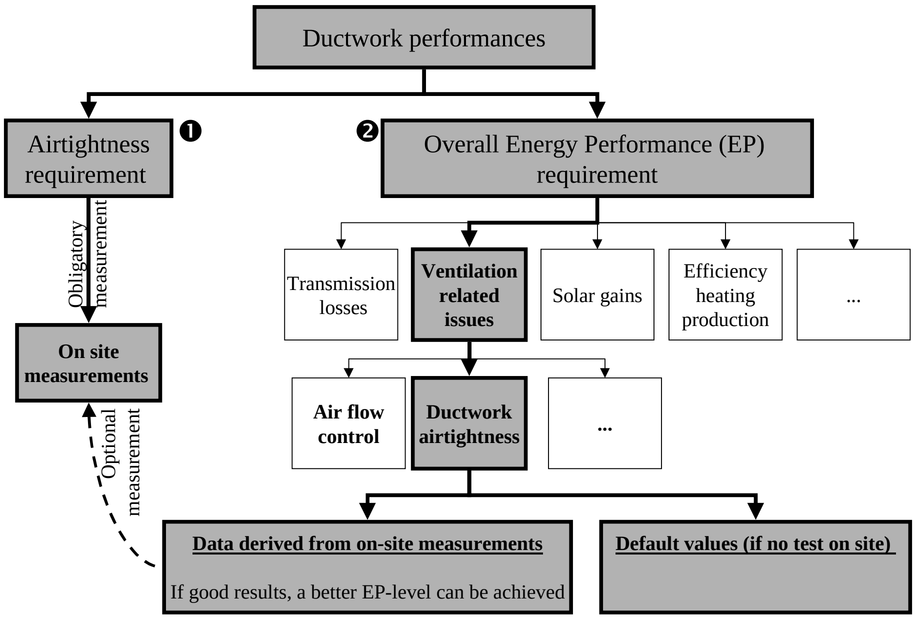

Figure 16: Example of direct requirements or indirect stimulation of performances

Of course, there may be other needs which justify that specific requirements are stated in relation to the ductwork airtightness (e.g. fire regulations, simplicity of control procedures,…).

9. Energy Performance Standardisation: an open platform for innovation and creativity

As has been shown several times in this report, the availability of cost-effective innovation (ductwork, advanced glazing, energy efficient lighting,…) with respect to indoor climate and energy efficiency is not a guarantee of a large scale use by the building sector. Many customers are not able to correctly assess the benefits of certain innovations. Moreover, creative solutions for improving the indoor climate and/or energy efficiency are not always understood by the decision makers. An EP approach has the potential to stimulate innovation and to promote creative solutions.

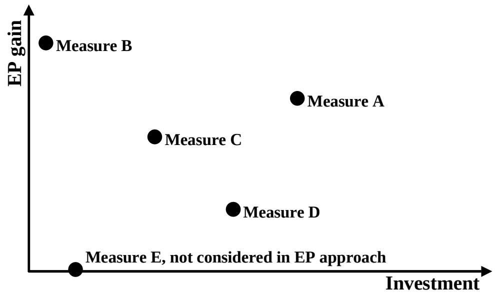

Figure 17: Comparison of various measures

As far as quality is concerned, it can strengthen the requirements for quality. In Figure 17, various possible actions (all aiming to improve the energy efficiency of a building) are compared with respect to their investment and the energy savings (in EP terms). In principle, an EP approach must allow to assess all relevant technological improvements, therefore a situation as presented for 'measure' E should not occur.

As far as the various measures have a similar lifetime and no other advantages, an EP approach will orient the market to those measures with the best 'investment-energy savings'-relation, which corresponds in Figure 18 with those measures with the steepest slope.

A major advantage for governments is that one can focus on a single global requirement and that the market forces can offer the most attractive options.

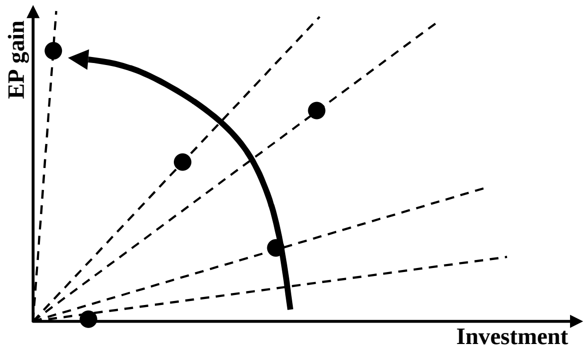

Figure 18: An EP approach stimulates the use of cost-effective measures

10. Information about related projects

10.1 EC TIPVENT project

The major aim of the *TIP-Vent* project was to give a substantial contribution to the creation of better boundary conditions for the application of mechanical ventilation systems with good performances.

The following organisations were involved in the TIPVENT project:

- Belgian Building Research Institute, Belgium
- ALDES Aeraulique S.A. - France:
- Bergschenhoek B.V. - The Netherlands
- Basler & Hofmann AG – Switzerland
- BSRIA Ltd - United Kingdom
- AB Jacobson & Widmark - Sweden
- University of Porto – Portugal
- TNO Building and Construction Research Division of Systems and Buildings, The Netherlands

The *TIP-Vent* project had the following objectives:

1. Achieving a better understanding of the impact of air flow rate requirements found in standards on the energy demand of buildings (residential and non-residential sector) and the existing background for the specifications of ventilation requirements.
2. Evaluating for a selection of buildings (residential and non-residential) equipped with mechanical ventilation the level of agreement between:
   - required, design and real air flow rates;
   - required, design and real noise levels;
   - required, design and real draught performances;
   - the desirable and real fan consumption;
   - desirable and real air quality of the supply air.
3. Analysing in the participating member countries (south, central and north of Europe), as well as in some other countries with interesting approaches, the impact of existing and proposed standards and building regulations on the performances of ventilation systems.
4. Creating a pre-normative framework / platform (performance oriented approach and procedures for on site checking,…) that will stimulate the development and the market entry of smart mechanical ventilation designs, systems and strategies.
5. Applying/testing the developed concept on a representative range of systems.
6. Developing a number of new innovative ‘smart’ designs for improved performances with emphasis on active acoustical insulation, demand control ventilation, low pressure mechanical ventilation and intelligent fan control.

The *TIP-Vent* consortium of industrial companies and research teams has identified actions which can lead to improved performances of mechanical ventilation systems and the introduction and wider use of innovative ventilation designs. The development of performance oriented procedures for designing, commissioning and maintaining mechanical ventilation systems plays a central role in the structure of this project. The following chart shows the different tasks and their links.

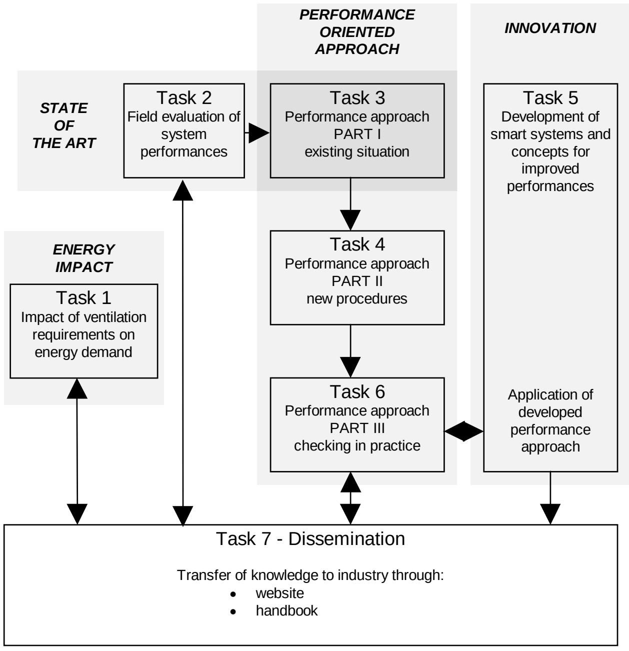

Figure 19: Relation between the different tasks within the TIP-Vent project

Task 1 aim to achieve a good understanding of the exact energy consequences due to ventilation requirements for residential and non-residential buildings. The major findings are in the final report given in chapter 5 'Energy use due to ventilation'.

Tasks 2 and 3 had as objective to evaluate the present situation regarding the real performances of systems (in-situ evaluation) and regarding the impact of existing European standards and regulations on the performances of mechanical ventilation systems and on the market penetration of smart designs. In the final report, the information in chapter 6.1 ('Ventilation performances in daily practice: requirements of ventilation systems') is based on the work of task 3 whereas chapter 6.3 ('Ventilation performances in daily practice: examples of system performances') reports information collected in task 2.

Task 4 was devoted to the development of new procedures/approaches that are performance oriented and which can form a framework/platform for future standardisation or regulations in Europe. Chapter 7 of the final report contains a summary of its conclusions.

Task 5 consisted of developing new smart products aimed at improving the performances of ventilation systems. The outcome of this work is reported in the final report in chapter 9.

Results of task 4 were checked in practice by developing guidelines for practitioners in task 6

The CD-ROM with the final report as well as all the annex reports has been distributed during the kick-off meeting of the RESHYVENT project.

10.2 IEA Annex 35 'HybVent' – WP A2

As part of IEA ECBCS Annex 35 'HybVent', the work package WP A2 is focusing its attention on the issue of the assessment of hybrid ventilation systems in relation to standards and regulations.

A source book entitled 'Performance assessment of advanced ventilation systems in the framework of energy and IAQ regulations: critical issues, challenges and recommendations" is under preparation and should be available before the end of 2002.

The table of content is given in Table 7.

1. Introduction
2. Ventilation
    a. Ventilation in general
    b. Hybrid ventilation
3. Performance assessment in standards and regulations
4. Desirable challenges for energy performance regulations
5. Assessing innovative systems
6. development of an assessment concept based on system competition
7. Suggestions for a generic set of assumptions
8. Legal aspects
9. Interaction with SAVE ENPER-TEBUC project
10. Conclusions
11. References

Table 7: Table of context of source book under development in IEA Hybvent project

10.3 EC SAVE ENPER-TEBUC project

Since April 2001, the European SAVE ENPER-TEBUC project (www.enper.org) has started. It brings organisations from 15 European Union countries together around the topic of energy performance standardisation and regulation.

10.3.1 Project objectives:

This EC SAVE project deals with the issue of harmonisation in European Building Codes integrating the project proposals 'ENPER' and 'TEBUC' into a single clustered project programme.

A first part of the study concerns the investigation of the possibilities to design harmonised building codes at the European level. Therefore the existing European building regulations are compared, extending existing work in that field. Since within the time horizon of the Kyoto protocol (2008 – 2012), the existing building stock will be responsible of most of the energy consumption and CO_2-emissions, possible measures to foster energy efficiency in this field will be particularly scrutinised. On this basis general principles for a model building code for use in new buildings and - where applicable - renovation will be developed. Furthermore the questions of checking the application and building certification will be investigated, so that this code can serve as a reliable and visible tool for ensuring building energy efficiency.

Since the Energy Performance (EP) standardisation and legislation is in many member states considered to be an attractive tool for increasing the energy efficiency of new buildings and existing buildings, the second part of the study is dealing with this issue in detail. Several countries have already an Energy Performance Regulation (EPR) in place (Netherlands, France, Spain, Sweden, etc.) and/or are preparing a new regulation (Belgium, Denmark, France, Germany, Greece, etc.). Whereas a whole range of European standards are prepared and/or adopted that cover several subdomains of an EP standard, there are major differences in the overall approach used in the different countries for determining the EP level of a building. Setting up a platform for information exchange among the prominent national players, to systematically collect and summarise the different approaches and to develop suggestions for a European 'model code' is therefore another main goal of this project.

10.3.2 Project duration:

April 2001 – September 2003

10.3.3 Work programme

The work of the ENPER related activities is organised in 9 tasks:

1. Energy Performance (EP) calculations
2. Approaches for dealing with innovative concepts in EP approaches
3. Legal context for and practical implementation of an EP legislation
4. Applicability on existing buildings: renovation and refurbishment
5. Impact of an EP regulation on the building and technology market
6. Source book for 'best practice concepts' and model building code
7. Website
8. Seminar
9. Identification of priority areas for further actions.

11. Air Infiltration and Ventilation Centre

The AIVC is one of the IEA information centres and is for more than 20 years active in the area of dissemination of information concerning air infiltration and ventilation related issues. As part of its working programme for the period 2001-2004, it is foreseen to produce a database concept which must allow to include all relevant information concerning standards and regulations in the field of ventilation in buildings. As such, the information on standards and regulations coming out of the RESHYVENT project can be integrated in this database allowing a wide-scale distribution of the information.

12. European standards – Technical committee 156 'Ventilation for buildings'

Within the European Union, standards related to ventilation for buildings are prepared by the Technical Committee 156 of the CEN (European Committee for Standardisation).
The status of the different documents is not the same for all of them. Some documents have already been published, some have been ratified, some are under approval and other are still under development.

Updated lists of the documents under development, under approval or already published can be found on the CEN web site (available in English): http://www.cenorm.be/cenorm/index.htm > Standards and drafts > Finding draft standards > select "CEN/TC 156 Ventilation for buildings" > Standard under development > Published standards

13. Conclusions

1. Standards and regulations are expected to be an important boundary condition in the development and optimisation of hybrid ventilation systems.
2. It is clear that the present standards and regulations are not necessarily the best possible approaches for stimulating the use of advanced ventilation systems.
3. The standardisation activities in the framework of CEN are clearly of crucial importance.
4. The Energy Performance of Buildings Directive will be very important for the development of energy efficient ventilation systems in Europe.

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