Draft report for discussion with stakeholders, 30 March 2016
(A final report, including information from other experiences and feedback from stakeholders, is planned to be published in February 2017)

Hans Erhorn, Heike Erhorn-Kluttig (Fraunhofer Institute for Building Physics, Germany), Susanne Geissler (OEGNB, Austria), Peter Wouters (BBRI, Belgium)

With contributions and/or reviews from: Samuel Caillou (BBRI, Belgium), François Rémi Carrié (ICEE/INIVE), François Durier (CETIAT, France), Pär Johansson (Chalmers, Sweden), Clarisse Mees (BBRI, Belgium)

www.qualicheck-platform.eu
Contents

Executive summary ...................................................................................................................... 5
1. Introduction ............................................................................................................................ 6
2. Context of this source book .................................................................................................... 7
   2.1 What is meant by quality of the works? ........................................................................... 7
   2.2 Achieving quality of the works: various conditions to be fulfilled ................................. 7
   2.3 NZEB and quality of the works ......................................................................................... 8
   2.4 Third party and second party control and enforcement frameworks ............................... 8
   2.5 A third party control and enforcement framework is not always necessary ....................... 9
   2.6 Governmental control and enforcement schemes are politically a sensitive issue ............. 9
   2.7 Terminology .................................................................................................................... 10
3. Overall philosophy regarding improved boundary conditions for a better quality of the works .. 12
   3.1 Introduction .................................................................................................................... 12
   3.2 Analysis of the reasons for lack of quality of the works in building construction .............. 12
      3.2.1 Lack of competence for achieving good quality of the works ..................................... 12
      3.2.2 Effective application of the available knowledge .......................................................... 13
      3.2.3 Stepwise approach for combining capacity building with enforcement schemes ........... 14
   3.3 Practical experience with skills requirements and enforcement in relation with energy efficient building .......................................................................................................................... 17
      3.3.1 Market uptake of new energy efficient products without specific challenges for the building workers 17
      3.3.2 Thermal bridges ....................................................................................................... 17
      3.3.3 Renewables ............................................................................................................... 18
      3.3.4 Insulation cavities in existing cavity walls ................................................................. 19
      3.3.5 Building airtightness ................................................................................................. 19
      3.3.6 Ventilation ............................................................................................................... 20
   3.4 Challenges and opportunities for the various actors ......................................................... 20
      3.4.1 The impact of an effective quality framework on the supply industry ......................... 20
      3.4.2 The impact of an effective quality framework on the contractors ............................... 20
      3.4.3 The impact of an effective quality framework on the designers ................................... 21
      3.4.4 The impact of an effective quality framework on the government .............................. 21
   3.5 QUALICHeCK approach for obtaining better enforcement frameworks ......................... 21
4. Critical success factors for effective quality frameworks ...................................................... 22
   4.1 Introduction .................................................................................................................... 22
   4.2 Overall approach ............................................................................................................. 22
   4.3 PART 1: Technical procedures to obtain and prove good quality of the works ................. 22
      4.3.1 Introduction ............................................................................................................. 22
5. Documented set of best practices PART 1: Technical procedures to obtain and prove good quality of the works ................................................................. 36

5.1 Clear description of work specifications ................................................................. 36

5.2 Clear description of the procedures to show evidence of compliance .................. 38

5.3 Tracing procedures ......................................................................................... 39

5.4 Handling of innovative solutions ........................................................................ 40

5.5 Consider simpler on-site compliance procedures for certain systems ............... 42

4.3.2 Clear description of work specifications ................................................................. 23

4.3.3 Clear procedures to show evidence of compliance .............................................. 23

4.3.4 Tracing procedures .......................................................................................... 23

4.3.5 Handling of innovative solutions ......................................................................... 23

4.3.6 Giving benefits to systems that have a high probability to perform well .......... 24

4.3.7 Rewarding good practice .................................................................................. 24

4.3.8 Specific issues for existing buildings .................................................................. 24

4.3.9 Quality management approaches ...................................................................... 24

4.3.10 Market surveillance and integrating lessons learned ......................................... 25

4.3.11 Interrelation with European and national legislations and standards .............. 25

4.3.12 Overview of reasons for good or poor quality of the works ......................... 25

4.4 PART 2: Robust procedures how to decide on compliance and how to respond to non-compliance 26

4.4.1 Introduction ....................................................................................................... 26

4.4.2 Different types of non-compliances ................................................................... 27

4.4.3 Clear procedures to check the quality of the works .......................................... 27

4.4.4 Types of penalties in case of non-compliance .................................................... 27

4.4.5 Clear rules about liabilities and penalties ......................................................... 27

4.4.6 Consequences in terms of qualification, certification, labelling ....................... 28

4.4.7 Specific issues for existing buildings .................................................................. 28

4.4.8 Interrelation with European and national legislations and standards .............. 28

4.4.9 Overview of reasons for good or poor quality of the works ............................... 28

4.5 PART 3: Operational framework for better compliance and effective penalties related to quality of the works ............................................................................. 29

4.5.1 Introduction ....................................................................................................... 29

4.5.2 The willingness to check ................................................................................... 30

4.5.3 The resources to check ..................................................................................... 30

4.5.4 Effective sampling schemes ............................................................................. 30

4.5.5 Effective penalties ........................................................................................... 30

4.5.6 Handling of market complaints ........................................................................ 30

4.5.7 Overview of reasons for good or poor quality of the works ............................... 31

4.6 Examples on transmission characteristics ............................................................. 31

4.7 Examples on ventilation and airtightness ................................................................. 32

4.8 Examples on sustainable summer comfort technologies ...................................... 33

4.9 Examples on renewables in multi-energy systems .................................................. 33

3
5.6 Consider simpler on-site compliance procedures for certain companies ........................................ 43
5.7 Rewarding good practice ........................................................................................................... 44
5.8 Specific issues for existing buildings ...................................................................................... 45
5.9 Quality management approaches ........................................................................................... 46
5.10 Market surveillance and integrating lessons learned .............................................................. 47
5.11 Influence by European and national legislations and standards ............................................. 48

6. Documented set of best practices PART 2: Robust procedures how to decide on compliance and how to respond to non-compliance .................................................. 50
   6.1 Different types of non-compliance ......................................................................................... 50
   6.2 Clear procedures to check the quality of the works ............................................................ 51
   6.3 Types of penalties in case of non-compliance .................................................................. 54
   6.4 Clear rules about liabilities and penalties ........................................................................... 56
   6.5 Consequences in terms of qualification, certification, labelling ........................................... 58
   6.6 Specific issues for (deep) renovations .................................................................................. 60
   6.7 Influence by European and national legislations and standards ........................................... 62

7. Documented set of best practices PART 3: Operational framework for better compliance and effective penalties related to quality of the works ............................................ 64
   7.1 The willingness to check ...................................................................................................... 64
   7.2 The resources to check ....................................................................................................... 65
   7.3 Effective sampling schemes ............................................................................................... 67
   7.4 Effective penalties .............................................................................................................. 69
   7.5 Handling of market complaints ......................................................................................... 70

8. About innovation ......................................................................................................................... 71
   8.1 Introduction ......................................................................................................................... 71
   8.2 Simplified procedures are important but should not be a barrier for innovation................. 71
   8.3 Need of a robust framework for assessing technologies not covered by the classical procedures ... 72
       8.3.1 The problem ................................................................................................................. 72
       8.3.2 Possible solutions ....................................................................................................... 72

9. Importance of societal support for compliance and enforcement .................................................. 73
   9.1 Effective enforcement not evident without strong societal support ................................... 73
   9.2 Raising societal awareness regarding reliability of EPC .................................................... 73
   9.3 Societal support for effective compliance ......................................................................... 74

10. Economics of compliance ........................................................................................................ 74
    10.1 Effective compliance framework on reliable data requires efforts ..................................... 74
    10.2 Who pays for it? ................................................................................................................. 74
    10.3 What are the costs of poor compliance? ........................................................................... 75
    10.4 Lower total cost? ............................................................................................................... 75

11. Conclusions ............................................................................................................................. 76

12. ANNEXES ............................................................................................................................... 77
    12.1 The meaning of ‘quality’ in the technical literature ............................................................. 77
Executive summary

(to be drafted in later phase)
1. Introduction

New buildings as well as the existing building stock must become much more energy efficient to reach the EU climate goals (Emissions from houses and office buildings can be almost completely cut – by around 90% in 2050, compared to 1990). Of course, one should aim for not only a good energy performance but also good quality of the works, as good quality of the works is the precondition for high building energy performance. Various experiences show that there are cases where the quality of the works is a (major) issue of concern. An analysis of the additional costs in the German construction sector caused by faults during the construction process in 2014 identified approx. 10 Billion € or nearly 10% of the turnover of the German construction sector.

This source book aims to act as a guidance and support for persons and organisations interested the evaluation if a better enforcement of the quality of the works is needed and, if it is needed or relevant, what are the possibilities and points for attention to implementing a more effective enforcement framework.

In chapter 2, the context and scope of this source book is developed, with specific attention to various aspects of the quality of the works and its implementation.

Chapter 3 is approaching the challenges related to the quality of the works in a global context, whereby the focus is on assessing a certain context and identifying which kind of measures are needed or appropriate. Often, it is sufficient to focus on better specifications and training for acquiring the required competences. However, in some cases second or third party control systems (e.g. examinations by persons up to on-site inspections) might be justified and or needed.

Chapter 4 is focusing on those cases where probably there must be second or third party control of the delivered works. Hereby, the crucial elements for coming to an effective enforcement are briefly described in 3 parts.

The detailed description of these 3 parts is then discussed in chapters 5, 6 and 7.

As innovation is a key element for progress, it is important that second and third party control and enforcement frameworks are not a barrier for innovation. This is discussed in chapter 8.

For third party control and enforcement schemes, it often is crucial to have societal support, and this is covered in chapter 9.

Control and enforcement schemes introduce always some extra costs, but are there also benefits? This is discussed in chapter 10.

Finally, the conclusions are found in chapter 11.

<table>
<thead>
<tr>
<th>IMPORTANT REMARK</th>
</tr>
</thead>
<tbody>
<tr>
<td>The authors are aware that some work is still needed with respect to finetuning parts of the report. This will be done in the light of the stakeholder consultations outcome in the coming months.</td>
</tr>
</tbody>
</table>
2. Context of this source book

The Energy Performance of Buildings Directive (EPBD) imposes member states to raise the requirements regarding the energy performance of new and existing buildings. In parallel, there are also various voluntary energy performance frameworks related to minimum energy performance of buildings (passive house, others, …). These requirements effects challenges in terms of building and system design as well as products and systems to be used. Moreover, it often also represents specific challenges regarding the quality of the works.

In this source book which focuses on quality of the works, it is important to have a clear understanding of what is meant by quality of the works, the various aspects of attention and key issues of concern. This is discussed in this chapter.

2.1 What is meant by quality of the works?

Work can be defined as a physical or mental effect or activity towards the production or accomplishment of something. In the context of this book work are all the activities directed to produce or refurbish a building.

In the former ISO 8402, quality was defined as “Totality of characteristics of an entity that bear on its ability to satisfy stated and implied needs”. Needs are usually translated into characteristics with specified criteria. Needs may include, for example, aspects of performance, usability, dependability, safety, environment, economics and aesthetics.

More information on quality related terms can be found in §12.1.

What is crucial in the context of this source book is that “quality of the works” for a given activity (e.g. installation of a PV system) has to be clearly defined. As such, one can for the same activity come to a quite different set of specifications (“stated needs”) and, in order to minimise the risk of disputes, one should try to minimise the number of implied needs, as different parties might have a completely different view on the implied needs.¹

2.2 Achieving quality of the works: various conditions to be fulfilled

In order to achieve conditions that all parties involved will agree that in practice quality of the works has been realised, at least 3 conditions have to be met:

1. There must be an agreement about the specifications which have to be met by the works (What is quality)
   → Ideally, it requires a full inventory of the needs to be fulfilled AND clear written statements (in descriptive or performance based terms) of what has to be done.

2. There must be the required knowledge/competence to design and execute the works according the specifications (The competence to deliver the required quality)
   → In case of lack of knowledge and/ or competence among part of the design and workforce, it might be necessary to invest in training activities.

3. There must be the will and resources to carry out the works according the specifications (The will and means to deliver the required quality)
   → In case of concerns about the required will and resources, control and enforcement schemes might be necessary.

¹ Implied needs are needs which are assumed to be evident. Once you identify and define an implied need, it becomes a stated need.
2.3 NZEB and quality of the works

The various conditions to be fulfilled as listed in §2.2 should apply to all kind of works and therefore also to Nearly-Zero Energy Buildings (NZEB).

In practice, there are some specific challenges for NZEB, in several Member States, e.g.:

- The available transition time to come to NZEB requirements is, in terms of the typical transition speed in the building sector, extremely short. In contrast with other industrial sectors, the European building sector is composed of e.g. a few hundred thousand architects and millions of construction workers, often working in SME’s.
- Meeting the NZEB requirements often represents a substantial extra investment cost. The pressure to save costs might result in not meeting the NZEB requirements;

1. **What is the required quality of the works for NZEB?**

The tendency to move to NZEB typically requires for most components energy performances which are much higher than in the past (better U-value, higher efficiencies …). Moreover, there will be in most cases more care needed with respect to the connections between components (the building nodes, e.g. connection between walls and windows …) and interactions between (components of) systems. In parallel of energy requirements, there are other more stringent requirements (e.g. acoustics …).

In the transposition of the EPBD into national legislation, attention is paid to most product and system characteristics but rarely contains specifications dealing with other aspects of the quality of the works. Also, many incentives schemes or voluntary schemes dealing with energy efficiency and/or renewables are mostly focusing on the presence of the required components and systems, whereby very limited attention is given to other specifications, such as indoor climate.

2. **How to guarantee that there is the competence to deliver the required quality for NZEB buildings?**

It is important to evaluate present learning and training programmes with respect to the evolution in specifications due to the NZEB requirements. If needed, one has to invest in training.

The European BUILD UP skills programme has been focusing on these topics. More information can be found on www.buildupskills.eu.

There are also various other EU and national projects specifically focusing on creating better conditions for learning.

3. **How to guarantee that there is the will and means to deliver the required quality**

In quite a lot of cases, designers and builders will apply the specifications if these specifications are clear and if the required competence is available. This is in particular the case if poor performance might introduce high liability costs, including financial risks.

However, there are cases where it not always is enough to have clear specifications and the required competence. Often, the economic pressure is the major factor for not delivering the required specifications. If this kind of non-compliance is a major issue of concern, one should consider to pay more attention to control and enforcement measures.

2.4 Third party and second party control and enforcement frameworks

The focus of this source book is on NZEB related projects whereby control and enforcement has to be considered.

Basically, there are 2 types of control mechanisms:

- **Second party control:**
  - In this type of control, it is the client (or its representatives) which carry out the control and enforcement activities.
  - In case of a building project, control issues can be realised by the owner, the architect, consulting engineers, a quality surveyor, …
- It can also include internal control by e.g. a quality assurance department in the same company?
- The specifications are fully covered by the contract between client and supplier.

- **Third party control:**
  - In this type of control, a legally independent entity is taking care of the control mechanisms.
  - The third party control can be imposed by government, a public body, a social housing company, voluntary schemes … It can also be imposed by a private builder.

In addition, there is the concept of self-control, meaning that companies commit themselves in the framework of voluntary quality assurance schemes. However, this concept is not in the focus of this sourcebook.

Most of the content and points of attention raised in this source book are valid for both types of control mechanisms. In the case of second party control, several points of attention might be less crucial. This is in particular the case for societal support as it is the client who imposes the specifications. The opposite are third party control mechanisms that are imposed by government. In order to be effective and lasting, a wide societal support is crucial and requires much more care in the preparation and implementation phase.

### 2.5 A third party control and enforcement framework is not always necessary

Second party control is in the hands of the client and/or its representative(s), whereby the level of control and related compliance measures have to be decided by them. This source book contains information and suggestions which can make such control and compliance actions more effective and acceptable by all parties involved.

A third party control is not always necessary. In particular in the context of energy legislations, incentive schemes, … it is important to evaluate if such third party control scheme is necessary or if more simple measures can achieve a comparable level of quality. The reason is that third party control and enforcement schemes introduce extra investments for the investor, whereby enforcement and penalties often give a lot of discussions.

In those cases where it appears not evident to come to the required level for the quality of the works, an effective third party compliance and enforcement scheme might be the right option. This source book aims to help the reader in better understanding potential bottlenecks as well as providing suggestions for an effective approach.

This issue is developed in more details in §3.

### 2.6 Governmental control and enforcement schemes are politically a sensitive issue

Third party control and enforcement by governmental organisations (as part of legislation or in the context of incentive programmes), is in most countries politically very sensitive. In general, the building sector is not in favour of third party control schemes with strict enforcement schemes. In particular, some stakeholders organisations might react strongly if the enforcement scheme results in penalties

Therefore, and in order to come to a sustainable control and enforcement schemes, it is crucial to evaluate if such schemes are necessary and, if so, if the development of the scheme is done in close collaboration with the leading stakeholders organisations. By doing so, the stakeholders will probably better understand the reasons for such schemes, can bring in considerations and suggestions for improvement and reflect the concerns by their members.
2.7 Terminology

Compliance - Compliant
Compliance is defined as the fact of according with EPC procedures or with specifications of the works. Compliant is the adjective referring to something which is in accordance with EPC procedures or with specifications of the works.

Quality of the works
"Quality of the works" refers to the potential gap between the works realised and the works expected to meet stated or implied needs. When looking specifically at how quality of the works impacts energy performance certificates, "quality of the works" may be further defined as a measure of the gap between the specifications of the works stated or implied to be consistent with the input values assumed to be used in the energy performance certificate, and the actual execution of the works. It is assumed that the desired level(s) of the corresponding input data is (are) explicitly defined.

Therefore, the quality of the works may be qualified as "good" or "compliant" if, for example:
- a system is installed according to the technical specifications agreed within a given context (e.g. technical prescriptions, a technical approval, rules of a professional association, etc.) ;
- products are installed according to the designer’s and manufacturer’s specifications in another context.

Quality of the works has no absolute meaning, but is always linked to the stated (and implied) needs, i.e. one has to know the needs in order to judge the quality of the works.

Errors in execution of the works
Errors in execution of the works are mistakes (intentional or not) made when realising the works taking as reference stated or implied specifications. The quality of the works depends on the size and nature of these errors.

2.8 Structure of QUALICHeCK deliverables
This report builds on the outcomes of QUALICHeCK, namely:
1. The status on the ground report, which includes the analysis of 31 specific studies addressing specific concerns on performance data from the field, the compliance of input data, the quality of the works, as well as feedback from compliance frameworks.
2. The reports of each of the 10 field studies conducted within QUALICHeCK in the 9 focus countries of the consortium. These studies aimed at enriching the literature on quality and compliance issues with clear data. Each study investigated a sample of at least 25 buildings.
3. The report on documented examples of existing situations regarding quality of works that describes a series of critical situations on the construction site that can result in poor quality, successful initiatives to overcome site implementation issues and examples in the context of regulatory frameworks, quality labels, self control or quality management procedures/guidelines, and training programmes.
4. 55 factsheets produced in total within QUALICHeCK, including xx with a specific focus on EPC input data and compliance aspects.

All of these deliverables are available on the QUALICHeCK website.(www.qualicheck-platform.eu)
3. Overall philosophy regarding improved boundary conditions for a better quality of the works

3.1 Introduction
There can be many reasons for poor quality of the works. Before deciding on any kind of corrective measures, it is important:
- to understand the reasons for the poor quality of the works
- to identify the most effective way for remediation.

Within the context of the QUALICHeCK project, there is a strong focus on compliance frameworks and enforcement, but there might be much lighter and easier to implement approaches, whereby these approaches will also receive a broader societal support. Therefore, it is very important to understand reasons for problems with the quality of the works and possible ways for remediation. The analysis of these issues has already been partly done in the framework of the EPBD Concerted Action 3 and in close collaboration with BUILD UP Skills. This resulted in a report published in 2014\(^2\) (www.hyperlink.eu).

Three of the 4 authors of this report are also participating in the QUALICHeCK project and this work has been further developed in the framework of this project.

Specific emphasis is put on the differences and synergies between capacity building and enforcement schemes. Both can be crucial elements to improve the building quality on site. The following aspects are described in the next chapters:

- Analysis of the reasons for lack of quality of the works in building construction (§ 3.2);
- Practical experience with skills requirements and enforcement in relation with energy efficient building (§ 3.3);
- Challenges and opportunities for the various actors (§ 3.4);
- QUALICHeCK approach for obtaining better enforcement frameworks (§ 3.5).

3.2 Analysis of the reasons for lack of quality of the works in building construction
Assuming that there is a common understanding of what is meant by good quality of the works, the following two requirements have to be met:
1. The appropriate competence for achieving a good quality of the works.
2. Effective application of this competence.

In the next paragraphs, these aspects are dealt with in more detail.

3.2.1 Lack of competence for achieving good quality of the works
There are problems regarding the quality of the works in several types of works related to energy efficiency and renewable energy in buildings. Often, this is due to a lack of competence, either in design, or in the execution of the works (and the latter is explained in the chapters below), or both:

---
3.2.1.1 Lack of competence regarding ‘classical’ works

Experience shows a lack of competence for several, rather well-known technologies, e.g.:

- poor placement of thermal insulation in walls, resulting in high energy losses;
- poor placement of windows, resulting in high air leakage losses, acoustical and other problems;
- poor execution of ventilation systems, resulting in wrong airflow rates, acoustical problems and maintenance issues.

Basic knowledge with good rules of workmanship, along with the appropriate training courses, technical publications, etc., can be very useful and should in principle already be available. Such training can be organised either by neutral training organisations, or by the supply industry or other organisations. In all cases, and in order to increase the credibility of the building workforce, it is important that such training is worked out in close collaboration with the representative professional organisations (for example building associations).

3.2.1.2 Additional challenges for new technologies

To a large extent driven by the more strict energy targets, a whole range of new technologies have recently emerged in the market, e.g., heat pumps, photovoltaic installations, solar collectors, vacuum insulation, multi-functional systems for heating, ventilation and domestic hot water and others. In parallel, for more classical aspects, like ventilation and airtightness, new solutions and components introducing higher complexity with much higher performance requirements are resulting in the need for additional skills in several countries. All in all, in order to improve the quality of the works, there is a need for developing appropriate training and course material. At the same time, and in particular for such new emerging technologies, for which there can be a very quick evolution in the market, the need for regular updating of the course material is crucial.

Also here, close collaboration with the representative professional associations, and in particular with the representative branch organisations/federations of such innovative technologies, is important to guarantee up to date content and credibility of the information.

3.2.1.3 Important to guarantee that the required knowledge is effectively available

Assuming that a sufficient wide offer of appropriate training is provided to the market, it is still not reasonable to expect that all relevant building workers will follow such training and effectively acquire this type of knowledge. In order to guarantee so, there is a need for creating the relevant boundary conditions, e.g. mandatory training requirements and certification of persons who have successfully followed a course.

3.2.2 Effective application of the available knowledge

Is it correct to assume that the acquiring of knowledge will result in better workmanship?

In many cases, such an assumption is valid, also in the building sector. This may typically be the case for works where poor workmanship results in high risks of damage claims and/or security & health problems, e.g.:

- electricity and gas works;
- stability of buildings;
- works which result in (major) aesthetical or functional problems, e.g.:
  - condensation and mould growth problems due to thermal bridges;
  - corrosion of steel in concrete;
  - cracks in plastering;
  - damage to PV panels by heavy winds.
In various other cases, it is not evident to automatically assume that the acquired knowledge will be implemented. This may typically be the case for technologies where:

- good workmanship means extra efforts and/or costs, in terms of design, material and system costs and labour time AND
- whereby less quality works are often not resulting in major claims.

Examples may e.g., be:

- **the installation of ventilation systems**, where controls often highlight problems regarding the air flow rates, the acoustical performances and/or energy efficiency features; however, there often is little risk that poor performance will result in actual damage claims;
- **building airtightness**: unless there are very strict compliance frameworks in place, there is a large probability that requirements will not be met in practice;
- **energy aspects of thermal bridges**: these performances are very difficult to detect and, if detected, often not feasible to legally demonstrate a problem of compliance.

### 3.2.3 Stepwise approach for combining capacity building with enforcement schemes

As illustrated in Figure 1 it is appropriate to have the following logics in order to make sure that capacity building will actually result in an energy efficient building (NZEB) on site:

**STEP 1**: Analyse if there is a sufficient offer of Vocational Education and Training (VET) and if the available VET is in line with the needs for NZEB buildings

- If this is not the case, then there is a need for new VET offers, or for upgrading the existing VET offers to bring them in line with the NZEB needs.

**STEP 2**: Analyse if, despite the offer of appropriate VET, there is a substantial risk that workers are not following these trainings and/or not sufficiently acquiring the assumed competences.

- In case of a substantial such risk, several actions can be taken into consideration, e.g., mandatory courses, examinations, certification of successful training, obligation to have works executed by certified workers, etc.

**STEP 3**: Analyse if there is a risk that competent workers will not carry out the works accordingly, e.g., due to cost considerations, competition, difficulties at work, etc..

- In such case, the following possibilities should be evaluated for a more effective control:
  - **TYPE OF REQUIREMENTS**: These can range from the obligation to make use of certified workers, to random inspection of the works, up to inspection on each individual building site. This is further discussed in § 5.1.3.1.
  - **DIRECT OR INDIRECT CHECKS OF THE QUALITY OF THE WORKS**: Checks may either focus on the competence of the worker, or on the final outcome of the work. This is further discussed in § 5.3.1.2.
  - **FRAMEWORKS FOR IMPOSING QUALITY REQUIREMENTS**: The framework in place for such effective control is crucial and may vary from within a wide range of possibilities; imposed at the level of individual projects, imposed for a specific sector (e.g., social housing), imposed by insurance, imposed by governments (e.g., when applying for incentives), or even mandatory for all cases. This framework may also apply to voluntary schemes, managed by certification bodies for the certification of persons or companies. The topic is further discussed in § 5.3.1.3.
3.2.3.1 Type of requirements

In case there are strong concerns that poor workmanship will occur although there are no major barriers for acquiring the required competence, external drivers for increasing the probability for good workmanship may be considered.

Three common types of external control are briefly described in the next paragraphs and as well in § 2.4.

**Works to be performed by certified persons/companies**

In this approach, the works must be performed by certified persons/companies, but without a direct follow-up action (such as reporting site-related performance features or inspection) of each building project.

**Declaration of performance by a certified person for each building site**

In this case, there is a specific action expected for each building project. This can include reporting of specific, site-related performance features. In some cases it is mandatory that such reporting is done by independent persons (e.g., airtightness reporting in France), whereas in other frameworks the reporting can be done by persons involved in the building project, but certified and controlled by a third party.

**Systematic inspection of a building site by an independent person**

The strictest form of control is inspection, whereby each building site or samples on a random basis is visited by an independent person. This can be quite costly and should therefore only be considered in cases where poor quality may result in major costs (in terms of energy losses, damage, or health & safety issues).

A typical example of such a control, for non-energy related works is the mandatory inspection of new electrical and gas installations prior to connecting to the grid. Major drivers in this example are health and safety risks.
3.2.3.2 Direct and indirect control of the quality of the works

Indirect checks: Focus on the effective competence of the workers

A direct check of the required performances (e.g., whether or not an existing cavity wall is completely filled with the appropriate density), may often be a very costly and resource consuming experience. In such cases, an effective procedure might be to focus on the quality of the design and execution competences, in combination with random checks of the executed works.

Direct checks: Focus on the effective performances in practice

In several cases, a direct determination of key performances can be very effective. This is, e.g., the common approach of quality checks of new electrical and gas installations mentioned earlier. In principle, everyone (including the do-it-your-self) can execute the works, as long as the final requirements are achieved. Such an approach is the case in many countries for, e.g., the mandatory inspection of cars.

In the area of energy efficiency of buildings, there are several examples of such direct performances (e.g., airtightness testing of building envelope and air distribution systems, air flow rates of mechanical ventilation systems, etc.).

Combinations of various types of checks

Often, it is not possible, and/or economically not feasible to perform a comprehensive check of all the direct performances (e.g., the U-value of an insulated wall, the effective output of a PV system, etc.). In practice, it can be very efficient and desirable to have a combination of direct and indirect checks. Such real life examples are the schemes used in Belgium and the UK for the insulation of existing cavity walls, whereby on one hand specific duties have to be carried out by workers that have completed a mandatory training and examination (indirect check), and on the other hand measurements (direct check) are performed on site, e.g., the width of the cavity, the area of insulated walls, etc.

In certain cases, different quality frameworks may co-exist, in parallel. France has since 2012 a mandatory quality framework for building airtightness which comprises of either:

- direct checks: a direct measurement of the building airtightness of each building by certified testers;
- indirect checks: a proven quality framework at the level of the building firm, allowing to have airtightness declarations without testing each building.

3.2.3.3 Frameworks for imposing quality requirements

The basic principle for a quality framework must be ‘voluntary if sufficient, mandatory if needed’. In practice, there is a wide range of frameworks for imposing quality of the works:

- at PROJECT LEVEL: at the building or individual site, the building owner, architect or other can impose that the works are done under a specific quality framework;
- at SECTOR LEVEL: a specific sector (e.g., association of external insulation, PV installers) can impose that all their members respect an agreed quality framework;
- at REAL ESTATE DEVELOPMENT LEVEL: major real estate developers (e.g., in the social housing sector) can decide to impose that all their works respect an agreed quality framework;
- at INSURANCE COMPANY LEVEL: insurance companies can impose compliance with a specific quality framework as a prerequisite for accepting certain works as part of the covered guarantee;
- at GOVERNMENTAL LEVEL: governments can impose compliance with specific quality frameworks as a condition for incentives, or as a general quality requirement for all works.

Practice shows that imposing quality frameworks in not equally easy at all levels:

- at project level it will be difficult to impose if the end user is not sufficiently aware, or better, sufficiently convinced of the added value of the quality framework;
to convince sector associations to respect a given quality framework can be very challenging, in particular if the sector association is not covering the whole sector, e.g., if a part of the sector is applying lower quality standards.

3.3 Practical experience with skills requirements and enforcement in relation with energy efficient building

In this section, a series of examples are given on how to deal with skills requirements and enforcement in relation with energy efficient building. The following aspects are described in the next chapters:

- market uptake of new energy efficient products without specific challenges for the building workers;
- thermal bridges;
- renewables;
- insulation cavities in existing cavity walls;
- building airtightness;
- ventilation.

3.3.1 Market uptake of new energy efficient products without specific challenges for the building workers

Surprisingly, a whole range of sometimes spectacular developments in terms of improvement of the energy performance of buildings often have nearly no impact on the required skills and needs for good workmanship. Such examples are e.g., the replacement of classical double glazing by argon filled, low-e glazing, the replacement of boilers with higher efficiency, etc.

In such cases, the existing training schemes can continue to exist with only marginal updates. Of course, if there are already major quality concerns with the classical systems, there might be a need for better training and/or control, but this is then not linked to the introduction of new technologies.

3.3.2 Thermal bridges

The example of thermal bridges is an interesting one as it illustrates that the challenges regarding compliance and enforcement may differ for different aspects. Thermal bridges present two major issues of concern:

- increased energy losses;
- risk of condensation and/or mould problems.

Both aspects create a need for training (of designers, craftsmen) on how to minimise relevant problems. Improved and/or new training is crucial, in particular within the context of NZEB.

In terms of compliance and enforcement, there are fundamental differences between these 2 aspects:
- Condensation and mould problems will be detected by the users of the buildings. There can be multiple reasons for these problems, e.g. wrong building detail, poor execution of the works, too high humidity production in the building, lack of ventilation, … There are various mechanisms for dealing with non-compliance and enforcement (e.g. agreement for solution between building partners, decision by court case, …). Imposing a requirement (e.g. a minimum temperature factor) would require a lot of work (2D- and 3D- thermal bridge simulations) to assess the building envelope as well as to check the results.

- For energy losses, the situation is very different. It is in practice almost impossible for the building user to identify if there are (major) thermal bridges with high energy losses. It seems therefore useful to have a formal framework in place, allowing checks at building project level.

Example: Belgian approach for thermal bridges

A refined scheme is in place in Belgium for taking the energy aspects of thermal bridges into account in the Energy Performance of Buildings calculations. Five possibilities for compliance check are allowed, the simplest approach being a default value (e.g., the U-value is increased by X W/m²K) and the most complex being a detailed, 2- or 3-dimensional, calculation. The 3 intermediate options are based on the principles of ‘approved building nodes’, whereby a relatively small extra heat quantity has to be taken into account. There is no framework for certified ‘calculators’, but an assessment has to be done for each building. Indirectly, it is a major driver for craftsmen to pay attention to thermal bridges.

With respect to condensation and mould growth, it was an explicit choice not to impose requirements as part of the EPBD implementation.

3.3.3 Renewables

It is clear that technologies which are based on renewable energy sources (thermal solar systems, PV systems, heat pumps, etc.) represent for craftsmen new challenges and there clearly is a need for new forms of training and/or refinement of existing training schemes.

The Renewable Energy Sources Directive (RESD) imposes Member States to develop frameworks for the certification of RES installers (). However, the same Directive (RESD) does not impose that the works have to be done by a certified installer ().

Poor design, system quality and/or poor workmanship may result in major problems in practice. Examples are e.g., major damages to solar systems installed on the roof during storms.

In practice, it is possible to go further than the requirements in the RES directive, e.g.:

- Member States, insurance companies, major builders, etc. can impose that the works have to be done by certified workers ();
- moreover, Member States, insurance companies, major builders, etc. can impose that there is specific reporting for each building, as well as random controls, etc.()
3.3.4 Insulation cavities in existing cavity walls

In specific countries, e.g., the UK, Belgium and The Netherlands, it was in the past quite common to have non-insulated cavity walls. It is clear that such walls represent high heat losses. A potentially attractive technique to reduce heat losses is the post-insulation of the walls, by blowing-in or injecting cavity insulation. However, such works require the use of appropriate insulation systems and competent workers.

In the UK and, more recently also in the Belgian Flemish Region, quality frameworks with wide scale implementation have been set up to ensure that cavity insulation is properly implemented. These schemes require, at least for a certain part of the work, the involvement of certified persons, in conjunction with the use of proven insulation techniques. In addition, there is also a mandatory reporting at building level.

Examples: Quality frameworks for cavity insulation of existing walls in the UK and the Belgian Flemish Region

The quality framework for cavity insulation by CIGA (Cavity Insulation Guarantee Agency - www.ciga.co.uk) is already for many years in operation in the UK. In practice, more than 3 million dwellings have been insulated within the CIGA framework.

A rather similar framework is in operation since the middle of 2012 in the Flemish Region of Belgium. By the end of 2013, more than 20,000 dwellings have been insulated within this quality framework in Belgium.

3.3.5 Building airtightness

Within the move towards NZEB, there is a strongly growing attention to building airtightness. Building airtightness is in many countries a rather new point of attention which clearly results in new training needs for designers and craftsmen. Of specific importance is the fact that nearly all building professionals have an impact on the overall building airtightness; it is of course difficult to impose that all works are done by certified workers. In principle, it is rather easy to measure the overall airtightness result by a pressurisation test and most EPBD related calculation methods allow taking such measured values into account.

There are several issues of concern, in particular:

- Reliability of declared airtightness results: wrong values may be reported as a result of testing without the appropriate competence, or in case of fraud. Several countries put schemes in place that require the use of certified testers in order to minimise such risk. Examples of such governmental schemes are found in France, the UK and Sweden.

- Long term performance: it is not evident to assume that the initial airtightness levels will be kept during the lifetime of the building. The potential risk can be minimised through appropriate building details, good workmanship and high quality procedures at the level of the building companies.

More information can be found on www.tightvent.eu.

Example: French quality framework for building airtightness

In the framework of the French RT2012 regulation, it is mandatory to assess the building airtightness. Two possibilities exist:

- a systematic testing of the airtightness of each building; such tests must be done by certified testers and the assessment also includes leakage detection;

- an overall quality framework at the level of the building companies involved; this approach requires the fulfilment of a series of procedures at company level, in combination with testing of about 5% of all buildings.
3.3.6 Ventilation

In general, and most certainly in the context of improved attention to building airtightness, it is important to have buildings with the appropriate ventilation systems guaranteeing a good indoor air quality. Moreover, in the context of the move towards NZEB, it is important that these ventilation systems are energy efficient.

Practice in many countries often shows problems in the design, execution and/or maintenance of the ventilation systems; the reasons often being a lack of competence and a lack of broader offer of training. In order to increase the possibility for correct execution of the works, several countries therefore created voluntary quality frameworks, including certification of installers of ventilation systems. However, it remains uncertain whether the market will automatically make use of such quality frameworks. This is illustrated by the experience in The Netherlands, where apparently only 2% of the installers are working according to such quality framework. An interesting positive example however is Sweden. Here, and for most building types, it is mandatory to let a certified person perform a check, both at the moment of delivery of the installation, as well as during the lifetime of the building. In the case of the Swedish and the French approaches, there is no need for proven competence of the installers. However, the fact that there is a strict control at the end of the works is a very strong driver for competence.

Examples: Mandatory inspection of ventilation systems in Sweden and France

In Sweden, the testing of ventilation systems is for most building types mandatory since several years. Two types of certified testers exist. A control has to be done at the moment of delivery of the installation and also at regular intervals. These intervals (3, 6 or 9 years) are a function of the type of building.

In France, the Effinergie labelling scheme imposes a quality control of the ventilation system at the moment of delivery of the system.

3.4 Challenges and opportunities for the various actors

It is clear that an effective quality framework may have a substantial impact on the working conditions for the various actors in the building process. In the following paragraphs, some considerations are given for the supply industry, the contractors, the designers and the government.

3.4.1 The impact of an effective quality framework on the supply industry

For the supply industry, an effective quality framework will be a major push for improvement of the quality of the installed products. Moreover, and perhaps even more important, it may be a very strong driver for the development of new products and systems which optimise certain aspects of workmanship and the end result.

E.g., an appropriate quality framework for air distribution systems (with attention for good airtightness, low pressure losses, etc.) may be a strong driver for the supply industry to provide systems that are easy to correctly install and with low pressure drops. On the contrary, the use of high performance products in markets which show only a low quality focus will often be marginal. As a result, there will be limited interest for product development from the supply industry.

In economic terms the total investment cost is not necessarily higher when using better conceived products and systems, as the extra product costs might be compensated by lower installation costs.

3.4.2 The impact of an effective quality framework on the contractors

In the context of an effective quality framework, contractors will have to deliver a good quality of the works. Depending on the original market conditions, this may require a substantial effort for the building contractor sector. At the same time, an effective quality framework might be very positive for those contractors delivering good quality, as there will be a much more fair competition with other contractors who before delivered poor quality.

In areas where there is a wide consensus that quality improvements are important, it is crucial to support these by providing the appropriate services and the relevant timing for raising the quality standards for the sector. If these are not in place, societal support for such changes might get lost.
3.4.3 The impact of an effective quality framework on the designers

In the context of an effective quality framework, several changes might be needed for the design sector, and will affect architects, consulting engineers, etc. in the following ways:

- On the one hand, due to new procedures and requirements they may have to pay more attention to appropriate specifications for achieving good quality of the works, in particular where several types of contractors are involved. As an example, an effective quality framework will stimulate designers to provide sufficient space for technical installations for HVAC.
- On the other hand, an effective quality framework may facilitate acceptance of the delivered works.

3.4.4 The impact of an effective quality framework on the government

Imposing governmental requirements is often not popular. In order to meet the crucial societal support for such requirements (as part of incentives, general requirements, etc.), stakeholders’ concertation is crucial and a pragmatic implementation is important.

If successfully implemented, an effective quality framework will give a better energy performance, reduce the risk of problems and increase the societal support. It will also facilitate the achievements of the 20-20-20 targets according to the EU climate and energy package.

3.5 QUALICHeCK approach for obtaining better enforcement frameworks

In case the implementation of an enforcement framework is considered as an effective approach for a better quality of the works, the QUALICHeCK approach is based on a 3-step approach

PART 1: Technical procedures to obtain and prove good quality of the works

There should be very clear technical procedures describing what is understood by good quality of the works, in order to minimise the risk of differences in interpretation in case of control.

PART 2: Robust procedures how to decide on compliance and how to respond to non-compliance

There should be very clear and enforceable procedures regarding the rules for identifying compliance and sanctions and penalties in case of non-compliance.

PART 3: Operational framework for better compliance and effective penalties related to quality of the works

There should be the appropriate resources for carrying out monitoring and, if necessary, to sanction give an effective penalty.
4. Critical success factors for effective quality frameworks

4.1 Introduction

The challenges regarding quality of the works in NZEB buildings were in a general way discussed in §3. In this chapter we focus on those circumstances whereby second or third party control schemes are considered as appropriate and/or necessary to achieve on a large scale quality of the works.

4.2 Overall approach

In order to achieve good compliance, societal support is important, meaning that stakeholders understand and accept the need for energy efficiency requirements, the need for compliance and the need to check and enforce compliance.

A three-step approach has been identified how to achieve good compliance:

- There should be clear procedures what requirements must be fulfilled in order to achieve good quality of the works (Part 1)
- There should be clear procedures how to decide on compliance and related actions in case of non-compliance (Part 2)
- There should be effective control and penalties mechanisms to be applied in cases of non-compliance (Part 3)

The paragraphs below present the analysis of reasons for good and poor quality of the works allocated to each of the three steps. Each of these 3 steps will be discussed in more detail and in a structured way in §5, §6 and §7.

4.3 PART 1: Technical procedures to obtain and prove good quality of the works

4.3.1 Introduction

The analysis of the construction practice illustrates that there are different ways to specify quality related procedural aspects:

- There can be specifications regarding competence of persons or companies:
  - Need to follow training
  - Need to successfully pass theoretical exams
  - Need to show competence in practice
  - Need to be certified (e.g. linked to RES Directive)
- There can be specifications regarding techniques to be used and execution rules
  - Need to use approved systems and follow the related execution specifications
- There can be specifications regarding checks on site
  - Measurement of air flow rates
- There can be a combined set of requirements
  - PV installations: competence, system choice, checks on site

Sometimes, there can be several paths in parallel and/or progress in time.

This chapter presents an analysis of reasons for good and poor quality of works, taking into account the following aspects with regard to practical procedures:

- Clear description of work specifications
- Clear procedures to show evidence of compliance
- Tracing procedures
- Handling of innovative solutions
- Usability of the specifications in practice
- Giving benefits to systems that have a high probability to perform well
- Rewarding good practice
- Specific issues for existing buildings
- Quality management approaches
Market surveillance and integrating lessons learned
Interrelation with European and national legislation and standards

The chapters below briefly describe these aspects, and an overview of reasons for good and poor quality of the works is highlighted in table 1. Detailed information about these aspects is available in chapter 5.

4.3.2 Clear description of work specifications

In most of the building project tenders there is a comprehensive description of material and technologies to be mounted, but the quality description of the executed work is often not part of the construction contract and depends finally on the experiences and the philosophy of the contractor and its craftsmen. Due to the complex influences of some technologies on the overall performance of the building, it is often not enough just to trust in a comprehensive installation guide of a single component manufacturer. It is necessary to define procedures how to test and to guarantee the expected performance on site and also to ensure the qualification of the craftsmen for installing advanced and innovative technologies.

To ensure an acceptance to meet requirements in practice, the specifications of the expected execution of the work have to be written in a plain way. The craftsmen have to understand clearly, what is expected from them, where possible problems can come up and how to avoid them.

**Critical success factor:** The development of a unique and comprehensive work specification has to be done under consensus of all the relevant players in the building process. Explicitly the interfaces between crafts have to be taken into consideration and the responsibility of each work step has to be mentioned.

Specifications should be written as complete as possible and in a simple language style in just one document instead of using many cross references to other information sources. A simple cross reference, like “Eurocode XYZ has to be considered”, will not help the craftsmen to understand where specific attention has to be taken.

4.3.3 Clear procedures to show evidence of compliance

Beside a description of the work specification, a clear procedure is needed how to show the evidence of compliance, in order to ensure a transparent process which has to be followed to prove the quality of work in practice.

**Critical success factor:** The procedure should be referenced from the beginning of the process, so the contractor and the client have clear rules how to proceed and at which milestones in the construction process or at which deadlines verification has to take place. Special attention must be paid to the implementation of intermediate controls at critical phases.

4.3.4 Tracing procedures

In addition to clear procedures to show evidence of compliance on the building site, it is advisable to establish a documentation system where all the relevant data gathered during the construction process are stored and are easily accessible for verification procedures. This kind of database could also be extended to a documentation of the work progress. In the future BIM (Building Information Modelling), a digital representation of the characteristics of a building and its systems, can significantly help to share information before and during construction, as well as during the use of the building and at the end of its life.

**Critical success factor:** The acceptance of all involved parties to join this procedure has to exist to guarantee a comprehensive procedure.

4.3.5 Handling of innovative solutions

With the progressive movement towards a high energy-efficient building stock more and more innovative technologies enter the market and displace the well-known and mostly easy to handle conventional technologies. The craftsmen are often not trained to handle the new technologies, which can end in a refusal by the contractor or lead to damages at the installed systems.
Critical success factor: A training and qualification course for specialised craftsmen, which has to be periodically refreshed can help to sort out such problems and ensure a high reliability of innovative solutions at the building site. The procedure has to be agreed by the whole trade sector, otherwise the arising costs will prevent the success of this approach on a broad level.

4.3.6 Giving benefits to systems that have a high probability to perform well

The simpler a technology to be applied on the building site is, the smaller the risk of faults in the operation mode is. Plug and play solutions are mostly more fail-safe than others that assembled from pieces at the construction site. Therefore it can be expected with the utmost probability, that an easy to implement technology will perform in practice statistically better than comparable but complicated technologies which need experienced craftsmen for the installation.

Critical success factor: There has to be an effect that has to be beneficial for both parties (investor and contractor). This effect can be accounted in different ways in the process. The implementation of “in use factors” in the calculation method is one of the ways to promote plug and play solutions, simplified test requirements for plug and play solutions is another way is another.

4.3.7 Rewarding good practice

Instead of sanctioning in case of poor quality of the works, one can also consider a more positive approach by explicitly rewarding good quality of the works. A useful instrument to motivate the craftsmen to deliver a good practice is, to offer a gratification scheme. Such schemes could be developed on very different levels and directions, for example:
- Mentioning the company as a good practice craft shop on neutral advertising platforms
- Better result in the context of performance declarations, EPC, …
- Higher incentives
- Better loans from banks

Critical success factor: There has to be an independent system installed, to set and prove the rewarding criteria.

4.3.8 Specific issues for existing buildings

Improving energy efficiency in existing buildings requires specific knowledge regarding the as-built situation of the past construction periods as well as up-to-date technical know-how to assess which energy efficiency measures are suitable in the specific building to be renovated. Sometimes problematic situations are hidden and cannot be detected during the initial survey. Damages have to be eliminated before renovation works can start. Therefore, staff working on-site must be qualified to identify critical situations when they become evident and react accordingly in order to achieve good quality of the works.

Critical success factor: A tailor-made quality check procedure has to be developed to ensure quality of the works with limited additional costs. This procedure should ideally be applicable in the course of a deep renovation as well as in the course of a single renovation measure.

4.3.9 Quality management approaches

ISO 9000 introduces eight quality management principles on which quality management systems can be based on. Concerning the improvement of the quality of work at high performance buildings, mostly the principle 4 (process approach) is applied, but also principles 1 to 3 (customer focus, leadership and involvement of people) have great relevance. The principles are listed in § 5.9.

Critical success factor: Most critical for the acceptance of the implementation of quality management systems are the expected additional costs. The approaches of verifying the defined quality criteria’s are often directed to third party control, but also second party approaches can be found which are mostly more cost-efficient, but have to be organised in a transparent manner to ensure confidence. Some approaches are dynamic over the progress in time.
4.3.10 Market surveillance and integrating lessons learned

In practice, the work specifications (4.3.2) might be in some cases not sufficient to guarantee good quality of the works. It is important that there is some kind of procedures to handle complaints from practice, whereby this knowledge should then be used to improve the procedures (4.3.2).

Complaints can be of different nature, e.g.:
- Too weak requirements resulting in some cases in poor quality of the works
- Too strong or too many requirements resulting in too high and unnecessary costs

**Critical success factor:** If there are complaints about a building without an organisation involved that runs a quality framework, consumers will most probably contact the building owner and also the consumers’ association for assistance. Therefore, consumers’ associations might be valuable partners in assessing market complaints and developing elements of quality assurance frameworks.

4.3.11 Interrelation with European and national legislations and standards

Design of quality frameworks is influenced by European and national legislations and standards. In this respect the Services Directive, the Construction Product Regulation, the Public Procurement Directive, the certification of qualified individuals according to EN ISO/IEC 17024 are important as well as national legislation, for example privacy legislation, building legislation, and national energy efficiency in buildings subsidy schemes.

**Critical success factor:** Design of quality frameworks must respect various legislations

4.3.12 Overview of reasons for good or poor quality of the works

The following table summarises the aspects described above and presents an overview of reasons for good or poor quality of the works related with practical procedures.

<table>
<thead>
<tr>
<th>Aspects which are important for good quality of the works</th>
<th>Reasons for good quality of the works</th>
<th>Reasons for poor quality of the works</th>
</tr>
</thead>
<tbody>
<tr>
<td>Clear description of work specifications</td>
<td>Target groups have clear instructions how to install building and technical elements and what to consider</td>
<td>No consensus between target groups regarding responsibilities</td>
</tr>
<tr>
<td>Clear procedures to show evidence of compliance</td>
<td>From the beginning of the process a clear procedure is defined to show the evidence</td>
<td>Unclear what are the criterias and who checks them</td>
</tr>
<tr>
<td>Tracing procedures</td>
<td>A comprehensive continuous documentation allows an early recognition of faults</td>
<td>All documentation will be checked at the final stage only, which does not allow the craftsmen to react in time</td>
</tr>
<tr>
<td>Handling of innovative solutions</td>
<td>Continually trained and experienced craftsmen</td>
<td>Overstrained craftsmen which have not followed the developments on the market</td>
</tr>
<tr>
<td>Usability of the specifications in practice</td>
<td>The craftsmen understand clearly, what is expected from them and where possible problems are</td>
<td>Uncomplete specifications written in a difficult language style</td>
</tr>
<tr>
<td>Giving benefits to systems that have a high probability to perform well</td>
<td>Ease to implement technology in combination with other beneficial effects for the craftsmen</td>
<td>Technologies which need highly experienced craftsmen for the installation and give no beneficial effects for the craftsmen</td>
</tr>
</tbody>
</table>
Rewarding good practice

<table>
<thead>
<tr>
<th>Specific issues for existing buildings</th>
<th>The specific challenges in existing buildings are taken into account</th>
<th>No sanctioning in case of poor quality of the works</th>
</tr>
</thead>
<tbody>
<tr>
<td>Quality management approaches</td>
<td>Advantage of a reduced effort for daily compliance procedures, if the company uses a collective compliance procedure</td>
<td>Too high costs for the compliance procedures leads to failure to comply</td>
</tr>
<tr>
<td>Market surveillance and integrating lessons learned</td>
<td>An organisation running a quality framework was involved</td>
<td>Reasons can be of different nature: too low requirements or too high and unnecessary costs</td>
</tr>
<tr>
<td>Interrelation with European and national legislations and standards</td>
<td>Possible synergies are investigated and made use of</td>
<td>Limitations are not respected causing an appeal against the procedures, thus hindering implementation</td>
</tr>
</tbody>
</table>

4.4 PART 2: Robust procedures how to decide on compliance and how to respond to non-compliance

4.4.1 Introduction

In order to have a robust framework for deciding on dealing with non-compliances, second and third party quality frameworks related to quality of the works should have specifications regarding the following 3 aspects:

- **Qualification requirements** of persons or companies performing the works;
- **Reporting requirements**: e.g. declaration of performance by a certified person for each building site; reporting of specific, site-related performance features:
  - reporting must be done by independent persons, or
  - reporting can be done by persons involved in the building project, but certified and controlled by a third party;
- **Checking requirements**: e.g. systematic inspection of a building site by an independent person

Quality frameworks can address the whole building quality (e.g. voluntary green building rating schemes) or focus on well-known problematic situations (e.g. voluntary SWIGA Solid Wall Insulation Guarantee Agency scheme).

This chapter presents an analysis of the reasons for good and poor quality of works, taking into account the following aspects with regard to quality frameworks:

- Different types of non-compliance
- Clear procedures to check the quality of the works
- Types of penalties in case of non-compliance
- Clear rules about liabilities and penalties
- Consequences in terms of qualification, certification, labelling
- Specific issues for existing buildings
- Interrelation with European and national legislations and standards

The chapters below briefly describe these aspects, and an overview of reasons for good and poor quality of the works are highlighted in table xx. Detailed information about these aspects is available in Chapter 5.
4.4.2 Different types of non-compliances

Not respecting the above addressed requirements imposed by the quality framework, corresponds with different types of non-compliance:

- Not respecting qualification requirements of persons or companies
- Not respecting reporting requirements
- Not respecting checking requirements

The quality framework will be effective and contribute to achieving good quality of the works if types of non-compliance are clearly defined, can be revealed by cost-efficient procedures and penalties are appropriate and proportionate.

**Critical success factor:** Involved stakeholders (building owner, executing companies, authorised experts and other third-party entities) are aware of possible types of non-compliance and which penalties apply. In this context, awareness creation activities are important, not only regarding non-compliance with requirements imposed by quality frameworks but regarding the need of quality frameworks in general.

4.4.3 Clear procedures to check the quality of the works

Quality frameworks can be voluntary (e.g. SWIGA Solid Wall Insulation Guarantee Agency scheme) or mandatory, e.g. to achieve public funding for proven quality of the works and thus better building performance. Quality frameworks can be governed by public authorities, companies authorised by the government or private organisations running third-party quality schemes. They can cover the entire building or focus on a specific problematic situation.

Clear procedures to check the quality of the works require the following decisions:

- What should be checked, based on which information and reported by whom?
- Who checks and which requirements must these individuals and / or companies meet?
- Are checks systematic or random checks, and how are samples for random checks selected?
- How is information processed and archived?
- What happens in case of detected non-compliances?

**Critical success factor:** Acceptance of quality frameworks will be better, if it is very clear that the quality framework aims to improve a serious weakness. Therefore, a good knowledge of critical situations in buildings caused by poor quality of the works is a precondition for designing problem-oriented and effective quality frameworks.

4.4.4 Types of penalties in case of non-compliance

There are different types of penalties in case of non-compliance, such as warning, obligation to correct the mistakes, attending additional trainings including examination, fines, loss of licence, loss of financial support. First of all, penalties addressing poor quality of the works should not aim at punishing but trying to achieve improvements on-site but also permanent improvements, for instance by imposing additional trainings. In this regard, a step-wise penalty system including at least a step or warning will contribute to constant improvement while securing societal support.

**Critical success factor:** Step-wise penalty schemes will contribute to better quality of the works effectively. In fact, there should be no need to apply penalties like fines, loss of licence, and prison, because the problem should have been solved during earlier steps of the penalties scheme. However, step-wise penalty schemes based on warnings have to be reflected by administrative procedures (e.g. database with the option to put marks).

4.4.5 Clear rules about liabilities and penalties

An effective quality enforcement framework specifies penalties for non-compliance and whom they address. Entities governing quality frameworks should aim at making the rules and related penalties as clear as possible, in order to minimise discussions afterwards and minimise the risk of loss of societal support.
Depending on the specifications of the contract with the third-party control and the defect detected, liability can be with the building owner, the design team, the construction site supervisor, the executing company, and the companies commissioned with external quality assurance.

**Critical success factor:** Commissioning routines taking place at critical moments during the construction process are essential because they help to detect mistakes which will be hidden later on as construction works proceeds (e.g. missing insulation of pipes mounted in the wall). Rules about liabilities should make clear that procedures aim at detecting the source of a quality problem including responsibilities with the objective to correct it.

### 4.4.6 Consequences in terms of qualification, certification, labelling

Qualification certification, labelling schemes and quality seals offered by government or acknowledged and trustworthy organisations, provide support for the implementation of cost-efficient quality frameworks aiming to improve quality of the works. They are an important element to ensure quality of the works delivered by the executing companies but also delivered by the competent persons in charge of self-checks or second/third-party checks.

**Critical success factor:** Running accredited schemes or schemes complying with CEN/ISO standards can be very costly due to the procedures to be followed, and therefore sometimes organisations decide to offer their own quality schemes. If the operator of a quality framework wants to make use of existing certifications, labels and quality seals, it must be sure that organisations awarding them are acknowledged and trustworthy and that the requirements their schemes are based on are in line with the expectations of the manager of the quality framework addressing quality of the works. Rules must be transparent and limitations of certifications, labels and quality seals must be clearly communicated (e.g. company label versus individual certification).

### 4.4.7 Specific issues for existing buildings

Regarding the building stock, there are two aspects to be taken into account:

- Improving energy efficiency in existing buildings requires specific knowledge, for example regarding the identification of hidden critical situations when they become evident during renovation works and reacting accordingly in order to achieve good quality of the works.
- Depending on a country’s building stock, specific standard renovation measures can be defined and tailor-made quality frameworks can be developed to ensure quality of the works. These frameworks can be applied in the course of a deep renovation as well as in the course of a single renovation measure.

**Critical success factor:** Existing buildings can suffer from poor maintenance which adds unexpected cost to the renovation budget and thus increases the total cost of energy-related renovation measures. Financing of energy efficiency in existing buildings is a priority in many countries due to the fact that renovation rates are lacking behind expectations. It will be essential to combine requirements addressing quality of the works with the availability of financing instruments and public funding in order to make a progress in quality of the works in building renovation.

### 4.4.8 Interrelation with European and national legislations and standards

Design of quality frameworks is influenced by European and national legislations and standards. In this respect the Services Directive, the Construction Product Regulation, the Public Procurement Directive, the certification of qualified individuals according to EN ISO/IEC 17024 are important as well as national legislation, for example privacy legislation, building legislation, and national energy efficiency in buildings subsidy schemes.

**Critical success factor:** Design of quality frameworks must respect limitations and should make use of synergies.

### 4.4.9 Overview of reasons for good or poor quality of the works

The following table summarises the aspects presented above and presents an overview of reasons for good or poor quality of the works related with procedures.
Table 2: Overview of analysis of reasons for good or poor quality of the works related with procedures

<table>
<thead>
<tr>
<th>Aspects which are important for good quality of the works</th>
<th>Reasons for good quality of the works</th>
<th>Reasons for poor quality of the works</th>
</tr>
</thead>
<tbody>
<tr>
<td>Different types of non-compliance</td>
<td>Target groups are aware of different types of non-compliance and support the application of quality frameworks</td>
<td>No awareness among target groups</td>
</tr>
<tr>
<td>Clear procedures to check the quality of the works</td>
<td>Basic information about the way to check the quality of the works is available to develop clear procedures suitable to address critical issues</td>
<td>Procedures lack detail; Procedures are not well focused and do not sufficiently address critical issues</td>
</tr>
<tr>
<td>Types of penalties in case of non-compliance</td>
<td>Penalties are proportionate; The full range of possible penalties is used in a step-wise sanctioning scheme with the objective to contribute to constant improvement of the quality of the works</td>
<td>Possibility to bypass penalties; Penalties are pure punishment; No execution of penalties due to missing societal support</td>
</tr>
<tr>
<td>Clear rules about liabilities and penalties</td>
<td>Rules include the definition of the right moments for commissioning and checking to detect the source of a mistake and oblige the responsible person / company to correct the mistake</td>
<td>Rules about liabilities are not sufficient to hold the person / company liable who caused the problem</td>
</tr>
<tr>
<td>Consequences in terms of qualification, certification, labelling</td>
<td>Requirements are clear and certifications, labels and quality seals are operated according to transparent rules</td>
<td>Limitations of certifications, labels and quality seals are not clearly communicated</td>
</tr>
<tr>
<td>Specific issues for existing buildings</td>
<td>The specific challenges in existing buildings are taken into account</td>
<td>Quality frameworks are not sufficiently specific</td>
</tr>
<tr>
<td>Interrelation with European and national legislations and standards</td>
<td>Possible synergies are investigated and made use of</td>
<td>Limitations are not respected causing an appeal against the procedures, thus hindering implementation</td>
</tr>
</tbody>
</table>

4.5 PART 3: Operational framework for better compliance and effective penalties related to quality of the works

4.5.1 Introduction

This chapter presents an analysis of reasons for good and poor quality of works, taking into account the following aspects:

- The willingness to check/control
- The resources to check
- Effective sampling schemes
- Effective penalties
- Handling of market complaints

The chapters below briefly describe these aspects and reasons for good and poor quality of the works are highlighted in table xx. Detailed information about these aspects is available in Chapter 6.
4.5.2 The willingness to check

The main reasons for the willingness to check the quality of the works are financial implications and public interest, depending on who is the manager running the quality framework. The willingness to check depends on the advantages or benefits gained from the checking procedure in relation to the resources and thus cost caused by the checking procedure.

**Critical success factor:** The willingness to check might increase if building owners actively demand for quality checks addressing critical situations, or at least are ready to tolerate or even support them.

4.5.3 The resources to check

The resources needed for checking will decide whether a quality framework will be feasible on the one hand and meaningful and effective on the other hand.

Resources are necessary in terms of:

- Human resources: availability of qualified staff
- Time resources: sufficient time to carry out the work properly according to specifications
- Financial resources: availability of monetary budget to pay for quality checks

**Critical success factor:** Irrespective of the type of control, checking is limited to critical situations and critical moments. Experience shows that the simple fact that a check could take place results in improved workmanship.

4.5.4 Effective sampling schemes

Development of sampling schemes deals with the decision on the sampling type and sampling size (e.g. problematic technology, inconsistencies in reporting of construction site supervisor, ...), the way of choosing samples (e.g. execution companies marked with warnings, ...), how to collect data and administrate results, and whether systematic checks or random check should apply.

**Critical success factor:** The sample size is as big as necessary and as small as possible. There is a clear method of evaluating results and a feedback loop to revise decision making on sampling sizes and choosing samples.

4.5.5 Effective penalties

There are several types of penalties, among others withdrawal of financial support. Financial support is crucial for improving the energy efficiency of new buildings, as well as of existing buildings. Therefore, combining requirements addressing quality of the works with access to financial instruments and public funding schemes has proven to be an effective penalty.

Other effective penalties address the qualification of executing companies directly, namely a warning including the obligation to improve the quality of the works according to the requirements and the obligation to attend a mandatory training including evidence to have passed the examination.

**Critical success factor:** Whether penalties are effective or not, depends on the market where a certain type of penalty is applied. If a penalty is too severe, stakeholders will look for a way how to bypass the system, and acceptance will be low. In poorly developed markets, warnings may be appropriate to make stakeholders aware and get prepared, while infringements related with well-established technologies can be subject to harsher punishment.

4.5.6 Handling of market complaints

In practice, operation of quality frameworks can result in complaints, especially if rules and liabilities are not transparent and not clear. The manager of the quality framework must also run a unit managing complaints. It is necessary to plan resources accordingly, to ensure the effectiveness of this unit.

**Critical success factor:** The complaints handling unit needs sufficient resources and a clear structure for individual complaints resolution. In addition, handling of market complaints should be used to generate input to further develop the quality framework based on the weaknesses revealed through market complaints.
4.5.7 Overview of reasons for good or poor quality of the works

The following table summarises the aspects presented above and presents an overview of reasons for good or poor quality of the works related with aspects relevant for practical implementation.

Table 3: Overview of analysis of reasons for good or poor quality of the works related with operational issues

<table>
<thead>
<tr>
<th>Aspects which are important for good quality of the works</th>
<th>Reasons for good quality of the works</th>
<th>Reasons for poor quality of the works</th>
</tr>
</thead>
<tbody>
<tr>
<td>The willingness to check</td>
<td>Main reasons are financial implications of and public interest in quality of the works</td>
<td>Building owners do not support quality checks addressing critical situations</td>
</tr>
<tr>
<td>The resources to check</td>
<td>Allocation of human resources, time resources and budget for checking is sufficient</td>
<td>Checks are not efficient due to underestimation of effort to check, resulting in insufficient or incomplete information</td>
</tr>
<tr>
<td>Effective sampling schemes</td>
<td>Schemes address critical situations with the appropriate method of choosing and checking samples</td>
<td>Choice of samples is not well motivated and sample sizes are too small to gain the necessary information</td>
</tr>
<tr>
<td>Effective penalties</td>
<td>Choice of penalties reflects the status of market development regarding the technologies subject to the quality framework</td>
<td>Choice of penalties is not tailor-made but transferred based on the experience in other fields and thus might be suboptimal in contributing to improving the quality of the works</td>
</tr>
<tr>
<td>Handling of market complaints</td>
<td>Complaints handling succeeds in resolving individual complaints and in collecting and assessing complaints as a contribution to further developing the quality framework</td>
<td>Complaints handling is not well organised and hinders the effective implementation of the quality framework</td>
</tr>
</tbody>
</table>

4.6 Examples on transmission characteristics

In France, the national programme RAGE (Règles de l’Art Grenelle Environnement 2012) produced several professional recommendations on the implementation of walls, roofs, facades using different construction products, but also on the implementation of different insulation techniques, thermal break systems or windows. These recommendations published in 2014-2015 are reference texts recognised by insurance companies. Fulfilling their requirements helps to improve the quality of the design, installation and maintenance works. These documents are available for free at the website of the new French national programme PACTE (Programme d’Action pour la qualité de la Construction et la Transition Energétique - http://www.programmepacte.fr/catalogue), that will continue to publish such documents intended to improve the quality of the works.

Autumn 2016 workshop on transmission losses should give additional useful inputs
4.7 Examples on ventilation and airtightness

In France, the national programme RAGE (Règles de l’Art Grenelle Environnement 2012) produced 5 professional recommendations on ventilation systems, published in 2014-2015. These recommendations are reference texts for design, dimensioning, implementation and maintenance that are recognised by insurance companies. Fulfilling their requirements helps to improve the quality of the design, installation and maintenance works.

The systems covered include:
- exhaust-only mechanical ventilation systems for renovation of houses,
- exhaust-only mechanical ventilation systems for renovation of apartment buildings,
- balanced ventilation systems for new houses,
- balanced ventilation systems for new apartment buildings,
- room exhaust mechanical ventilation systems for renovation.

Guides were also published for innovative systems such as ground-to-air heat exchangers (covering design and dimensioning, implementation, maintenance) and hybrid ventilation systems.

All these documents are available for free at the website of the new French national programme PACTE (Programme d’Action pour la qualité de la Construction et la Transition Energétique - http://www.programmepacte.fr/catalogue), that will continue to publish such documents intended to improve the quality of the works.

In Sweden, a system is well implemented to ensure the quality of the ventilation work. The system based on:
- A clear description of work specifications: VVS AMA specifications
- A clear procedures to show evidence of compliance: OVK compulsory Ventilation Checks
- A qualification of ventilation testers: KIWA certification for OVK compulsory ventilation checks.

In Belgium, a professional guide has been published in 2015. This document give practical recommendations to the designers and to the workers to build airtight building. It is mainly based on technical details. (Note d’information Technique Etanchéité à l’air des bâtiments - Technische voorlichting Luchtdichtheid van gebouwen)

More details are given in the Lund workshop presentations.
4.8 Examples on sustainable summer comfort technologies

In France, the national programme RAGE (Règles de l’Art Grenelle Environnement 2012) produced 2 professional recommendations on metal solar shading systems for new and renovated buildings, published in 2014. These recommendations are reference texts recognised by insurance companies. Fulfilling their requirements helps to improve the quality of the design, installation and maintenance works. These documents are available for free at the website of the new French national programme PACTE (Programme d’Action pour la qualité de la Construction et la Transition Energétique - http://www.programmepacte.fr/catalogue), that will continue to publish such documents intended to improve the quality of the works.

March 2016 workshop in Athens should give additional useful inputs

4.9 Examples on renewables in multi-energy systems

Setting up new professional recommendations in France

In France, the national programme RAGE (Règles de l’Art Grenelle Environnement 2012) produced 42 professional recommendations on systems using renewable energy sources, published in 2014-2015. These recommendations are reference texts recognised by insurance companies. Fulfilling their requirements helps to improve the quality of the design, installation and maintenance works.

For domestic solar thermal water heaters, solar heating systems, heat pump water heaters, air-to-air heat pumps, air-to-water heat pumps, geothermal heat pumps, and for commercial heat pumps (air-to-water and water-to-water), 5 recommendations for each of these systems cover:

- design and dimensioning of new installations,
- design and dimensioning of installations for renovation,
- implementation and commissioning of new installations,
- implementation and commissioning of installations for renovation,
- maintenance works.

One recommendation deals with all these aspects for heat pump combination heaters.

For solar water heaters in apartment buildings (with a centralised storage or with individual storage tanks), 3 recommendations for each of these systems cover:

- design and dimensioning,
- implementation and commissioning,
- maintenance works.

Guides were also published for innovative systems such as hybrid heat pumps/hybrid boilers (i.e. systems combining a heat pump and a boiler), as well as a practical guide for workers on air-to-water heat pumps.

All these documents are available for free at the website of the new French national programme PACTE (Programme d’Action pour la qualité de la Construction et la Transition Energétique - http://www.programmepacte.fr/catalogue), that will continue to publish such documents intended to improve the quality of the works.

An harmonised organisation of the certification of workers implemented in France

For September 2014, the label RGE (Reconnu Garant de l’Environnement) has been implemented in France for certifying the skills of workers and companies specialized in energy renovation and installation of systems using renewable energies.

From 1 September 2014, only the works done by companies having the RGE label can be funded through zero-interest loans.

From 1 January 2015, this also applies to the tax credit for certain energy renovation works and installation of certain systems using renewable energies.

The display of this voluntary sign of quality allows its holder to strengthen its trust relationship with customers.

RGE holders are referenced on a website dedicated to individuals: www.renovation-info-service.gouv.fr. There are also listed by the advisors in the "Points renovation information service" where individuals can get advice.
Labels are given by several organisations: QUALIBAT, QUALIFELEC, QUALIT'ENR, CERTIBAT, CEQUAMI.

For energy renovation, the labels can be:
RGE Eco-artisan,
RGE Les Pros de la performance énergétique,
RGE Qualibat
RGE Qualifelec
RGE Certibat Rénovation énergétique
RGE NF HABITAT
RGE NF HABITAT HQE

For the installation of systems using renewable energies, the labels can be:
RGE QualiSol
RGE QualiPV
RGE QualiPac
RGE QualiBois

A key module of the guideline is the commissioning protocol in the form of a 3-pages checklist (see picture) which must be signed by both, the planner of the solar thermal system and the installer who mounted the solar thermal system. The name of the company who did the professional adjustment of the solar thermal system must also be provided.

The fact that the checklist also asks for the control number issued for the collectors by the institute carrying out the standard testing reminds the stakeholders of the importance of high quality products.

Thanks to the checklist-oriented structure filling in the commissioning protocol does not take much time. Due to the fact that it is evident what will be checked, planners and installers pay specific attention to critical aspects which correspond with the criteria of the checklist.

The criteria include for example:

- Check for damaged frame and glass, check for tightness
- Check for completeness of insulation, whether insulation is damaged, whether outdoor minimum insulation thickness of 30 cm is present
- Function check of control elements, temperature sensors, pressure reading and heat meter
- Setting of the circulation pump to be documented, is it a high efficiency pump adapted to the system, built-in situation of the circulation pump ok or not, function check
- System connected to existing lightning protection device
- Hydraulic balancing carried out in case of parallel connected collectors or different supply-line lengths
The commissioning checklist asks for the complete documentation of the system consisting of the following elements:

- Short user guideline explaining the operation
- Documentation of changes applied to the setting
- Maintenance plan
- Maintenance contract
- Addresses of service providers
- Addresses of all companies involved in planning and execution including product suppliers
- Documentation of products (type, capacity, size, …)
- Installation diagram
- Electrical circuit diagram
- Building permit or notification

The commissioning checklist requests that the operator of the solar thermal systems must have received an explanation of the documentation described above. In addition, information must be provided about other important aspects such as:

- Functioning principles of the solar thermal system
- Possible reasons for system failures
- How to respond to system failures

The January 2017 workshop in France should give additional useful inputs.
5. Documented set of best practices PART 1: Technical procedures to obtain and prove good quality of the works

5.1 Clear description of work specifications

CONTEXT AND MOTIVATION:
In most of the building project tenders there is a comprehensive description of material and technologies to be mounted, but the quality description of the executed work is often not part of the construction contract and depends finally on the experiences and the philosophy of the contractor and its craftsmen. Often phrases as “acknowledged rules of technologies have to be applied” or “all relevant standards have to be considered” are integrated to fix the competence requirements of the executor but this results in non-uniform requirements to the quality of work in practice.

To enforce the quality of work it is necessary to have a uniform and comprehensive work specification available to reference to in the building tender, which ideally is developed under consensus of the relevant players in the building process. This specification should contain besides the technical specifications also the following quality elements:
- Requirements so that they can be verified;
- Training or competence requirements, if applicable;
- Certification, qualification, labelling requirements of persons, companies or products (if applicable);
- Tracing procedures, types of checks, and checking procedures.

Due to the complex influences of some technologies on the overall performance of the building, it is often not enough just to trust in a comprehensive installation guide of a single building or technical system component manufacturer. It is necessary to ensure procedures how to test and guarantee the expected performance on site and also to ensure the qualification of the craftsmen for installing advanced and innovative technologies.

The specifications (as discussed above) should be clear in order to allow an effective second or third party control. This is a minimum requirement but, in particular for compliance frameworks imposed by third parties as e.g. a government, and given the fact that works are often done by small and medium enterprises or one person companies, it is important that the specifications are sufficiently simple by all potential workers. This can e.g. by done by having various possibilities for meeting the specifications, e.g. performance based specifications (typically more abstract and requiring more knowledge by the parties involved) and descriptive specifications.

EXAMPLES OF PROBLEMATIC SITUATIONS
- **PV systems**: The wind resistance of PV systems is an important aspect. In practice, storm damage has been reported several times. It is not appropriate to use as a requirement a generic description of the type “The PV system should resist to storms”. It is important to describe the requirements in a performance or descriptive criteria which can be verified, e.g. by making use of standards. See also §5.5.
- **Glazing and solar gains**: The installation of the glazing in a window frame causes sometimes problems at the building site, as the craftsmen do not consider which side of the glazing has to be mounted to the inner (room) side and which to the outer side. This is not important for the visibility, the air- and watertightness, the heat losses or the acoustic, but can influence the solar gains, depending on the position of the IR coating. Therefore the installer has to be trained to be sensitive to this issue and how to find out and document which is the right position of the installed glass.
- **Requirements**: The development of different requirements in Eurocodes was an important step to harmonise and standardise procedures all over Europe, but the Eurocodes are mainly written in a more general standardisation language, which will often not allow the reader to apply them directly to the national situation. Therefore a national transposition has to be done, before they can be applied at practical construction work. A simple cross reference, like “Eurocode XYZ has to be considered”, will not help the craftsmen to understand where specific attention has to be taken.
CONSIDERATIONS REGARDING PROCEDURAL ASPECTS:
It is highly desirable, and in particular if there is a governmental imposed third party control scheme, that the development of the work specifications are developed under consensus of all the relevant players in the building process, explicitly the interfaces between crafts have to be taken into consideration and the responsibility of each work step has to be mentioned.

APPROACHES WITH RELEVANCE FOR THIS TOPIC:

- The German STLB-Bau specification system (Standardleistungsbuch für das Bauwesen) is a library of specification texts for standard construction works. It enables the building owner or planner to dynamically build up a specification text out of numerous text passages. The work is organized in one of the three steering committees of the “German Committee for construction contract procedures” under the umbrella of the German Federal Ministry for Environment and Building. Among its members are building departments of the federal government, central organizations of the building and construction technology industries, public building authorities, central municipal organisations, associations of architects and engineers and professional associations. They support the work by sending honorary members to its approximately 100 working groups free of charge. The equal appointment of all committees achieves an acceptable, well-considered arrangement for everyone. Thus, neutrality and the acceptance of the results are guaranteed. The work results are published by DIN (Deutsches Institut für Normung e.V.).

- Another example is from the Swedish building industry. Svensk Byggtjänst (the Swedish Building Centre) is publishing since 1950 the general material and workmanship specification system AMA. AMA is specified in tenders and then has to be applied by the contractor.

- An example based on an industry initiative, is the German Gütegemeinschaft Fenster und Haustüren e.V., an association of manufacturers of windows, front doors, facades and winter gardens, that has obliged themselves to ensure an outstanding product and installation quality. In order to prove this quality the products are subject to a strict quality control. The qualified products receive the RAL-Gütezeichen, a quality certificate. In addition to that, the association publishes a guideline for installation of the high quality products. This guideline includes the accepted rules of technology for installing windows and front doors. Besides treating statics the part ‘Fixation and sealing’ deals mainly with the preparation of the components before the sealing, the different levels of sealing, the sealing functions, where to place the sealing system within the seam, the preferable seam size, different sealing systems, and presents exemplary installation technologies for different types of window systems and situations. Additionally the association developed a quality of work procedure, to which each manufacturer has to collect a standardized checklist of installation details for each window or door that they have produced and have been installed by an installer, which has to be filled in and signed by the installer. ift Rosenheim checks randomly that these checklists are available for each product and each installer that holds the RAL certificate.

REFERENCES
➔ AMA factsheet (under development by Chalmers)
➔ THE GERMAN STLB-BAU SPECIFICATION SYSTEM (http://www.gaeb.de/en/about-us/)
5.2 Clear description of the procedures to show evidence of compliance

CONTEXT AND MOTIVATION:
Beside a clear description of the work specification (§5.1), a clear procedure is needed how to show in the case of second and third party control or in a self-check procedures by the worker or the working company the evidence of compliance. E.g. it has to be defined which kind of verification procedure or measure has to be applied, to what content and complexity, at which construction phase and scale is acknowledged and who is authorised to acknowledge this proof.
The procedure should be referenced from the beginning of the process, so that all parties involved (contractor; client,….) have clear rules how to proceed and at which milestones in the construction process or at which deadlines verification might take place.

EXAMPLES OF PROBLEMATIC SITUATIONS
In particular in case of second and third party control, it is problematic if there is no clarity about what has to be precisely provided as proof for showing compliance with the works specifications (§5.1). If there are no clear rules how e.g. competence must be proven in practice, about the specific materials used, …., it might lead to disputes and/or lack of support for the overall quality approach.

CONSIDERATIONS REGARDING PROCEDURAL ASPECTS:
In general, and in particular in case of third party control schemes, it is highly desirable that the development of comprehensive proof procedures is done under consensus of all relevant players in the building process, explicitly the interfaces between crafts have to be taken into consideration and the responsibility of each work step has to be clarified.

APPROACHES WITH RELEVANCE FOR THIS TOPIC:
- In Belgium, technical specifications for the renovation of existing cavity walls by adding insulation in the cavity are adopted (STS 71.1 and regional legislation in case of subsidy scheme). The quality assurance organisation has set up an IT environment which has to be used at all critical steps of the process.
- In the French RT 2012 regulation, it is mandatory to prove the airtightness on new constructions. An alternative approach to the systematic measurement is foreseen to show evidence of the compliance. Instead of direct measurements on the building site, the construction company can collect good details they usually apply, document that only qualified persons are appointed for the construction work in the company and document a certain sample of realised buildings, to provide evidence that with a high probability the required result will be realised. In this case no measurements on the building site are needed.
- One focus area of the Swedish general material and workmanship specification system AMA is the ductwork airtightness specification and verification. The duct airtightness is specified to meet a certain air tightness class, which means that there is a permissible air leakage to be met, and if required verified according to a given test procedure. The contract is not approved unless the contractor can state, or if required, prove that the requirements are met. The builder can ask for a compliance test for a part of the ventilation duct work and the contractor has to prove the air tightness according to a given test procedure described in AMA (measurements of allowed air leakage at a specified static pressure).

REFERENCES
➔ STS 71.1
➔ RT 2012 air tightness proof procedure alternatives (Remi???)
➔ AMA factsheet (under development by Chalmers)
5.3 Tracing procedures

CONTEXT AND MOTIVATION:
Besides clear procedures to show evidence of compliance on the building site, it is advisable to establish a documentation system where all the relevant data gathered during the construction process are stored, whereby easily accessible for verification procedures but they might also be useful afterwards, e.g. post intervention dossiers, ... This kind of database could also be extended to a documentation of the work progress.

EXAMPLES OF PROBLEMATIC SITUATIONS
In order of quite severe airtightness requirements and/or in order to guarantee very good airtightness results, it might be effective to carry out intermediate airtightness test (at critical phase of the works) and/or identify leakage paths. In case of second and third party control schemes, it is important to avoid very general descriptions (e.g. ‘the airtightness have to be tested at critical phases of the work and leak detection must be done’), but instead have precise specifications regarding such tasks, e.g.:
- At which stages of the work must leak detection be done (e.g. after the installation of the windows, after installation of the ventilation system, …)
- What kind of leakage detection must be done, what has to be reported, …
- Are the specification regarding the persons to carry out these tasks?

CONSIDERATIONS REGARDING PROCEDURAL ASPECTS:
It is clear that modern communication means (tablets, cloud, …) offer new and interesting possibilities for achieving powerful tracing procedures. Examples:
- storage of all relevant data in the cloud
- coupling between applications, e.g. in case of EPC declarations between the EPC tool and the quality framework, in case of incentives schemes direct data exchange with the organisation providing incentives
- long term access to collected data, e.g. by giving owners unique and secure access to data, so that also long after the works the information remains available.

APPROACHES WITH RELEVANCE FOR THIS TOPIC:
The use of a central database for the documentation of compliance results can have the advantage, that specific information, even if anonymised (like airtightness test results) can be linked to a central database system of associations which allow to have a good benchmark for the current practice.
In the future BIM (Building Information Modelling), a digital representation of the characteristics of a building and its systems, can significantly help to share information before and during construction, as well as during the use of the building and at the end of its life.

REFERENCES

➔ A factsheet?
5.4 Handling of innovative solutions

CONTEXT AND MOTIVATION:
As explained in §5.1, a clear description of the work specifications is important, in particular in case of second and third party control afterwards. It is important that all existing technologies of good quality are covered by these procedures. New technologies are regularly introduced, with potential benefits as better performances, lower cost, …
In case such new technologies are not in line with the technical specifications or if already existing technologies are not covered, it might be that the second and third party control will identify non-compliance with the specifications. In practice, it means that an effective control scheme may be a major barrier for innovation.
In order to avoid this, it is necessary to consider appropriate procedures allowing new technologies with a similar quality level to be applied.

EXAMPLES OF PROBLEMATIC SITUATIONS

Renewable energy systems (PV or solar thermal) on flat roofs: if the technical procedures (see §5.1) for wind resistance only foresee mechanical ballast as an acceptable procedure, it is clear that mechanical fixing methods cannot be used. Nor combinations of mechanical ballast and mechanical fixing. Also, if the technical specifications only allow wind analysis at the level of single arrays, innovative concepts might be blocked.

Demand controlled ventilation: in case the technical procedures specify that the air flow rates have to be measured on site under nominal conditions, this might be problematic for e.g. humidity controlled ventilation, unless there is a possibility to by-pass the humidity control. Appropriate procedures for such technologies might be necessary.

CONSIDERATIONS REGARDING PROCEDURAL ASPECTS:
The development of a robust framework for avoiding barriers to innovation has different aspects:
- The use of performance based procedures (instead or in parallel with descriptive procedures) typically give more possibilities for covering systems not thought of when developing the procedures.
- Ideally, there should be from the beginning organisational procedures foreseen to handle systems not covered by the procedures. Aspect to cover include e.g. which formal procedure to be followed, by whom can an alternative procedure be developed and approved, … (to be completed)

APPROACHES WITH RELEVANCE FOR THIS TOPIC:
The examples below are illustrations of quality frameworks which impose regular training and, in that sense, allow to make persons aware of new innovative developments:

A qualification system “QualiSol” for installation companies of solar thermal systems has been applied in France to improve the quality of work. The system is managed by the French association “QualitEnR”.
An audit has to be applied every 3 years to continue the voluntary certification of the installation company. The association established a journal to publish failures found during the audit procedures. More than 12,000 companies have already been certified.
Following the good experiences from the thermal solar initiative, comparable procedures have been implemented for solar PV systems (QualiPV), domestic wood boiler (QualiBois) and heat pump installations (QualiPac).

Another approach is the European wide applied vocational education and training programe “Solarteur”. It is an additional training for engineers, technicians, craftsmen and skilled workers from neighboring trades. The course structure emphasises on practice-orientated training. Solarteur is a certified program across the trades (HVAC and electric) for renewable energy professions according to the EU guideline EG 2008/29.

In France, a national programme called RAGE (Règles de l’Art Grenelle Environnement 2012) led to 42 new professional recommendations on systems using renewable energy sources (often innovative or not
well known solutions), published in 2014-2015. These reference texts include requirements that help to improve the quality of the design, installation and maintenance works. They are recognised by insurance companies.

REFERENCES

➔ A factsheet?
➔ A webinar?
5.5 Consider simpler on-site compliance procedures for certain systems

CONTEXT AND MOTIVATION:
The efforts and costs related to second or third party compliance checks depends strongly on the frequency of controls to be carried out and the type and number of checks to be done for the works. The simplest approach is to have the same procedure for all kind of systems. In practice, there might be systems which have a higher probability for non-compliance than other systems. A differentiation in approach as function of the risk assessment might lower the costs, increase the societal support for the system and it can in some cases even increase the quality of the works.

EXAMPLES OF PROBLEMATIC SITUATIONS
- **Ductwork airtightness**: It is technical possible to meet good airtightness requirements with circular and rectangular ductwork. In the case of circular ductwork, there are systems on the market with specific fittings which don’t require additional actions (taping, ...). In case of a moderate airtightness requirement (e.g. class a according CENxxx), there are systems which systematically will meet the requirement. In such case, it is redundant to carry out systematically an on-site test. Therefore, specific procedures allowing no test or a lower test frequency can be very relevant. But care is needed with such approach. E.g. specifying that no or less tests is allowed for circular ducts is not acceptable as might result in products which are of less quality but without the need for on-site testing.
- **External insulation systems**: there is a whole range of external insulation systems. Several suppliers offer systems which are pre-designed, with specific attention to ease of execution, appropriate accessories and guidelines for installation. In parallel, there are systems which are assembled on a case by case basis. Applying the same set of control procedures can be costly and also counterproductive (further to be worked out).

CONSIDERATIONS REGARDING PROCEDURAL ASPECTS:
- The criteria for allowing simpler compliance procedures for specific types of works have to be carefully selected and have to be robust. Criteria which may play a role are e.g.:
  - the probability that a given system will meet the specifications
  - it is important not to impose system specifications which are in conflict with national and European legislations, e.g. the Construction Product Directive
- (to be completed)

APPROACHES WITH RELEVANCE FOR THIS TOPIC:
- External insulation systems with technical approvals
- Ventilation kits with technical approvals
- Pressure compensated ventilation grills:
- Sweden: Circular ductwork

REFERENCES

➔ A factsheet?
➔ A webinar?
5.6 Consider simpler on-site compliance procedures for certain companies

CONTEXT AND MOTIVATION:
If there is sufficient evidence that the probability of a good quality of the works is higher for companies and persons with proven compliance criteria at company level, it might be appropriate to have simpler compliance checks at the building site and/or a lower frequency for the compliance checks.

EXAMPLES OF PROBLEMATIC SITUATIONS
sub-contracts to companies which do not comply

CONSIDERATIONS REGARDING PROCEDURAL ASPECTS:
No specific example available.

APPROACHES WITH RELEVANCE FOR THIS TOPIC:
In France, there are 2 possible approaches for assessing the building airtightness level in the context of RT2012. One procedure requires to test systematically each building by a certified airtightness tester. In this case, there is no requirement with respect to the companies who did the building works.
There is an alternative procedure (annex F), whereby companies who follow a certain set of rules (building details, trained workers, …) can use a fixed airtightness value with only testing typically 5 or 10% of all buildings.

REFERENCES
➔ A factsheet?
➔ A webinar?
5.7 Rewarding good practice

CONTEXT AND MOTIVATION:

The energy performance level in the European construction sector has strongly increased during the last decades and will continue during the next. This results usually in higher construction costs, which may be compensated by lower operating costs. To ensure these lower operating costs in the long run, the quality of the construction and the realised work is substantial. Instead of sanctioning in case of poor quality of the works, one can also consider a more positive approach by explicitly rewarding good quality of the works.

A useful instrument to motivate the craftsmen to deliver a good practice is to offer a gratification scheme. Such schemes can be developed on very different levels and directions, for example:

- Mentioning the company as a good practice craft shop on neutral advertising platforms
- Better result in the context of performance declarations, EPC, …
- Higher incentives
- Better loans from banks

EXAMPLES OF PROBLEMATIC SITUATIONS

No specific example available.

CONSIDERATIONS REGARDING PROCEDURAL ASPECTS:

In case good quality of the works is rewarded, one has to evaluate if the other works can be accepted. Assume e.g. a PV system whereby good workmanship is rewarded. Is it acceptable that those works which are not according good workmanship principles are allowed? If not, it means that those works should be sanctioned and that, in a certain way, there is no longer a need for a positive rewarding.

There are surely applications where it makes sense to have a ‘minimum’ quality level and a ‘higher’ quality level, whereby a rewarding of this 2nd level could be envisaged.

Transition period, forerunners, ….

APPROACHES WITH RELEVANCE FOR THIS TOPIC:

In the French RT 2012 regulation, it is mandatory to prove the airtightness on new constructions. An alternative approach is foreseen to show evidence of the compliance. Instead of direct measurements on the building site, the construction company can collect good details they usually apply, document that only qualified persons are appointed for the construction work in the company and document a certain sample of realised buildings, to provide evidence that with a high probability the required result will be realised. In this case no measurements on the building site are needed.

REFERENCES

➔ A factsheet? The French RT 2012 regulation concerning this issue (to be discussed)
➔ A webinar?
5.8 Specific issues for existing buildings

CONTEXT AND MOTIVATION:
Various Member States have set financial schemes to stimulate deep energy renovations. This stresses the relevance of qualification and quality control targeting the specific challenges encountered in the major renovation of existing buildings and to secure, that the grants are not used as economic subsidy fraud.
Improving energy efficiency in existing buildings requires specific knowledge regarding the as-built situation in the past construction periods as well as up-to-date technical know-how to assess which energy efficiency measures are suitable in the specific building to be renovated. Sometimes problematic situations are hidden and cannot be detected during the initial survey. Damages have to be eliminated before renovation works can start. Therefore, staff working on-site must be qualified to identify critical situations when they become evident and react accordingly in order to achieve good quality of the works.
Depending on the building stock of a country, specific standard renovation measures can be defined (see example on cavity wall insulation below) and a tailor-made quality framework can be developed to ensure quality of the works. These frameworks can be applied in the course of a deep renovation as well as in the course of a single renovation measure.

EXAMPLES OF PROBLEMATIC SITUATIONS
Special in the course of realisation of a single renovation measure (like replacement of windows) the craftsmen need to have the overview on what other construction issues can be influenced and therefore which damages (e.g. mould) can be the result.

CONSIDERATIONS REGARDING PROCEDURAL ASPECTS:
The contractor should be experienced enough, so that he can address possible subsequent damages.

APPROACHES WITH RELEVANCE FOR THIS TOPIC:
In Germany the city council of Stuttgart established a quality seal to reward good quality for craftsmen specialized in renovation. The contractor who applies for the seal has to agree, that his staff has to participate in a continuous further vocational training and that the city’s independent energy consultant center (Energieberatungszentrum Stuttgart) checks a random sample of construction sites of this contractor. The contractor can use the seal in advertising campaigns and he will additionally be listed as an experienced company on the website of the city’s energy consultant center.

REFERENCES
➔ A factsheet? Factsheet “Stuttgarter Quality Seal” (under preparation)
➔ A webinar?
5.9 Quality management approaches

CONTEXT AND MOTIVATION:

ISO 9000 introduces eight quality management principles on which quality management systems can be based on, which are:

Principle 1 – Customer focus
Principle 2 – Leadership
Principle 3 – Involvement of people
Principle 4 – Process approach
Principle 5 – System approach to management
Principle 6 – Continual improvement
Principle 7 – Factual approach to decision making
Principle 8 – Mutually beneficial supplier relationships

Concerning the improvement of the quality of the work at high performance buildings, mostly the principle 4 is applied, but also principles 1 to 3 have great relevance. Although it is most common to apply sanctions in case of not complying to expected quality criteria, also a few approaches which rewards good practices can be found in the EU Member States. The approaches of verifying the defined quality criteria are often directed to third party control, but also second party approaches can be found which are mostly more cost-efficient, but have to be organised in a transparent manner to ensure confidence. Also some approaches are dynamic over the progress in time.

EXAMPLES OF PROBLEMATIC SITUATIONS

No example available.

CONSIDERATIONS REGARDING PROCEDURAL ASPECTS:

The procedure to apply a quality management system is well described in ISO 9000.

APPROACHES WITH RELEVANCE FOR THIS TOPIC:

In Belgium a three step approach for the proof of the execution of internal insulation systems was developed:

· 2016: subsidies only possible if the design and the monitoring is done by an architect
· 2017: subsidies also possible if the work is done by an approved contractor
· 2019: subsidies only possible if a combination of approved techniques and competence proof for certain activities are available

This dynamic approach, which moves from a third party to a second party approach during a time span of 3 years, was developed to motivate the craftsmen to gather experiences within a year and get an approval on the proven competence and enter then the market in addition to the architects.

The financing scheme of the German KfW Bank on “Energy-efficient construction and home ownership” targets private persons, landlords and housing companies and promotes the construction of particularly energy-efficient homes. Since 2014 the grant can only be claimed, if the owner of the building involves an independent consultant during the design and the construction process. This consultant has to certify that the design was realised under a reasonable care and the implementation complies with all requirements, before the KfW Bank transfers the grant to the client. The cost of the consultant is funded by the bank. Additional to the independent consultant the bank performs an internal quality assurance system to check the quality of the independent consultant using three random sample controls including an on-site inspection. The bank also advises the clients that the detailed specification of expected performances and responsibilities are as important as the quality control and should be carefully contractually fixed before the assignment: Only specifications that have been set out in writing can be claimed at a later stage.
5.10 Market surveillance and integrating lessons learned

CONTEXT AND MOTIVATION:

In practice, the work specifications (5.1) might in some cases not be sufficient to guarantee a good quality of the works. It is important that there is some kind of market surveillance and/or procedures to handle complaints from practice, whereby this knowledge should then be used to improve the procedures (5.1). Complaints can be of different nature, e.g.:

- Too weak requirements resulting in some cases of poor quality of the works
- Too strong or too much requirements resulting in too high and unnecessary costs

If there are complaints about a building where no organisation running a quality framework was involved, consumers will most probably contact the building owner and also the consumers’ association for assistance. Therefore, consumers’ associations might be valuable partners in assessing market complaints and developing elements of quality assurance frameworks.

Specific attention should be given to situations where companies try to blame users for deficiencies, such as mould. Mould in apartments can appear due to wrong user behaviour; however, in a specific case it might not be the user’s fault but lack of quality of the works causing this problem.

EXAMPLES OF PROBLEMATIC SITUATIONS

- A procedure for complaint management is published but not respected in practice, e.g. due to lack of resources

CONSIDERATIONS REGARDING PROCEDURAL ASPECTS:

Not applicable

APPROACHES WITH RELEVANCE FOR THIS TOPIC:

In UK, a voluntary programme operated by CIGA (Cavity Insulation Guarantee Agency) provides 25 years guarantees for insulations fitted by registered installers respecting the organisations’ quality frameworks including qualification and training requirements and control procedures. CIGA runs a transparent consumer complaints scheme which is publicly available: https://www.ciga.co.uk/consumer-complaints/

REFERENCES

➔ Factsheet UK and Belgian quality control schemes for cavity insulation guarantees (to be provided soon by Arnold Jansens)?
➔ A webinar?
5.11 Influence by European and national legislations and standards

CONTEXT AND MOTIVATION:
Although the Services Directive has been implemented by all EU countries by 28 December 2009, the construction business is still dominated by local companies executing the work. Trade regulation takes place at national level and conditions for practising a defined job vary among Member States, strongly influencing the actual knowledge level of skilled trades. The Services Directive aims at creating a legal framework to ensure the freedom of establishment and the free movement of services between the Member States. However, this Directive does not affect the freedom of Member States to define, in conformity with Community law, what they consider to be services of general economic interest, how those services should be organised and financed, in compliance with the State aid rules, and what specific obligations they should be subject to. Freedom of establishment for providers must be guaranteed, but authorisation schemes will be possible if the authorisation scheme does not discriminate against the provider in question. In terms of mandatory qualification requirements and quality frameworks requiring authorisation, this means that authorisation schemes must be non-discriminatory, justified by an overriding reason relating to the public interest; proportionate to that public interest objective; clear and unambiguous; objective; made public in advance; transparent and accessible (Article 10).

The Construction Product Regulation imposes the free circulation of construction products in the EU’s Single Market, meaning that products have to be tested only once according to a harmonised European standard or European Assessment Document. This has to be taken into account when setting rules how to check the quality of the works.

The Public Procurement Directive supports the life-cycle costing approach (Article 68) and thus also employment of qualified workforce. In addition it says: “Furthermore, with a view to the better integration of social and environmental considerations in the procurement procedures, contracting authorities should be allowed to use award criteria or contract performance conditions relating to the works, supplies or services to be provided under the public contract in any respect and at any stage of their life cycles from extraction of raw materials for the product to the stage of disposal of the product, including factors involved in the specific process of production, provision or trading and its conditions of those works, supplies or services or a specific process during a later stage of their life cycle, even where such factors do not form part of their material substance.”

Certification of qualified individuals according to EN ISO/IEC 17024 (e.g. certified heat pump installers, certified solar thermal installers, certified PV installers, certified ventilation installers) can be an option to enhance qualification. However, certification according to EN ISO/IEC 17024 requires the establishment of a body operating the certification and the respective certification scheme. The procedure takes time and is costly.

Besides relations with EU legislation and standards, there are also links with national legislation, for example:
- National privacy legislation: It is not allowed to inspect a building unit in use after building completion, thus limiting the possibilities to check quality of the works during building utilisation.
- National building legislation: There are no obligations regarding commissioning and inspection to ensure the quality of the works although standards and voluntary systems are available.
- National energy efficiency in buildings subsidy scheme: a quality framework is imposed and is a condition to receive financial support.

EXAMPLES OF PROBLEMATIC SITUATIONS
- The effort needed for designing functioning quality frameworks is underestimated: Quality frameworks are designed without thorough discussion of pros and cons with all affected parties and without sufficient legal expertise, resulting in cancellations, and as a consequence, also resulting in a loss of societal support.

CONSIDERATIONS REGARDING PROCEDURAL ASPECTS:
- To be in line with EU-Directives, quality frameworks addressing qualification and quality of the works must be transparent and non-discriminatory.

APPROACHES WITH RELEVANCE FOR THIS TOPIC:
- See examples listed in other sections of this source book.
REFERENCES


→ EN ISO/IEC 17024 Conformity assessment - General requirements for bodies operating certification of persons

QUESTIONS:

● Are you aware of a national legislation with a positive or negative impact on the implementation of quality frameworks addressing qualification and quality of the works in your country?
6. Documented set of best practices PART 2: Robust procedures how to decide on compliance and how to respond to non-compliance

6.1 Different types of non-compliance

CONTEXT AND MOTIVATION:
In practice, there have been multiple examples of poor quality construction works not meeting the standard, or even worse, causing serious damage. The situation is tightened by the transposition of the EPBD into ambitious building legislations leading to regulations being one step ahead of professional skills. This demonstrates the need for further training and qualification of the workforce and the need for the application of the acquired skills in practice to actually meet energy performance requirements.

In this regard third party quality frameworks addressing qualification and quality of the works are essential, specifying requirements regarding:

- Qualification requirements of persons or companies performing the works
- Reporting requirements: e.g. declaration of performance by a certified person for each building site; reporting of specific, site-related performance features:
  - reporting must be done by independent persons, or
  - reporting can be done by persons involved in the building project, but certified and controlled by a third party
- Checking requirements: e.g. systematic inspection of a building site by an independent person

Different types of non-compliance refer to the elements of the third party quality framework in place, irrespectively whether they are mandatory or voluntary:

- Not carrying out the work according the procedures in terms of staffing, e.g. the requirement that works must be performed by certified persons or companies is not respected
- Not following the foreseen procedures in terms of e.g. documentation or reporting, e.g. the requirement of declaring the performance by a certified person for each building site is not respected
- Not following the procedures in terms of systematic inspection, e.g. the requirement of systematic inspection of a building site by an independent person is not respected
- Not carrying out the work according the procedures in terms of technical quality

While the first three types of non-compliance refer to requirements regarding qualification of staff for execution works and quality assurance procedures carried out by qualified staff and subject to third party control, the last type of non-compliance relates to the technical terms of the contract.

However, the pre-condition for consequences in both cases is that there is awareness of possible types of non-compliance. While clients are aware of contractual quality aspects such as window-frame material, there is little awareness that invisible mistakes due to lack of qualification and poor quality of the works cause leakages and thermal bridges and this will result in energy losses during building operation.

Another pre-condition for consequences in both cases is that the non-compliance can be detected. Therefore, clear procedures to check the quality of the works are necessary (more information on clear procedures to check the quality of the works: see next chapter).

EXAMPLES OF PROBLEMATIC SITUATIONS

- In general no awareness of energy-related non-compliance and thus no demand for quality assurance.
- No awareness about the cost implication of energy-related non-compliance during the building life cycle.

CONSIDERATIONS REGARDING PROCEDURAL ASPECTS:

- Not applicable

APPROACHES WITH RELEVANCE FOR THIS TOPIC:

- Not applicable

REFERENCES

6.2 Clear procedures to check the quality of the works

CONTEXT AND MOTIVATION:

Clear procedures for checking the quality of the works are necessary for checking compliance with the requirements, for example related with subsidies and quality labels, and imposed by third party control.

The following aspects are crucial in the context of developing clear procedures to check the quality of the works:

1. To identify the quality problems: focus is on specific problematic issues.
2. To develop effective methods to ensure quality and compliance: quality frameworks impose criteria to be respected and which can be checked.
3. To define appropriate procedures how to check compliance with requirements: procedures define roles, responsibilities, and consequences.
4. To determine who is entitled to check compliance and what are the conditions: check by government administration, authorised company or independent expert, voluntary or mandatory check.

The following table shows a brief overview of examples regarding potential quality problems, methods how to ensure quality, and approaches how to check compliance.

Table 4: Overview of potential quality problems and procedures how to address them

<table>
<thead>
<tr>
<th>Potential quality problems</th>
<th>Examples of how to ensure quality (requirements imposed by qualification frameworks)</th>
<th>Examples of how to check compliance (procedures)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Products / components built in the wrong way</td>
<td>Employ qualified workforce (certified / trained workers) and / or quality coach (BUILD UP Skills); Provide sufficiently clear execution details including the requirement of measured performance</td>
<td>Check the reporting of an independent expert; Check the declaration of performance by a certified person; Systematic inspection by an authorised person</td>
</tr>
<tr>
<td>Information gaps between skilled trades result in worse performance</td>
<td>Employ cross-trade qualified workforce; Commissioning dates including measurements in between trades (time schedule); Construction book for documentation</td>
<td>Check the standardised commissioning checklist forms on product / component level signed by the responsible professional; Check reporting document (e.g. construction book)</td>
</tr>
<tr>
<td>Overall adjustment of building services systems does not take place</td>
<td>Standardised commissioning checklist forms on product / component and performance level (evidence what is actually built in and whether systems are working properly)</td>
<td>Check standardised commissioning checklist forms filled in and signed by qualified person</td>
</tr>
</tbody>
</table>

There are several options regarding the organisation who can carry out control and the control procedures to be applied, the best suitable one to be chosen taking the national conditions into account.

Possible organisations who can carry out control and check quality of the works are:

- The Government and organisations / individuals acting on behalf of the government (mandatory control, e.g. as part of a public subsidy scheme)
  - Government administration, e.g. the local administration in charge of building permits and permits to use the building
  - Public authorities such as a regional energy agency
  - A designated third party: accredited companies (requirements to be specified)
  - A designated third party: certified individuals (requirements to be specified)
  - Specified self-control: authorised professionals (e.g. authorised by professional license), subject to control by an authorised party
- Third party control (voluntary, e.g. as part of a green building rating scheme)
  - Certified companies and individuals (requirements to be specified for e.g. by national Green Building Councils)
● Self-check (voluntary, e.g. as part of a self-declaration building assessment programme; independent commissioning unit within a big company)
  ○ Building assessment programme randomly checks self-declaration by qualified company staff
  ○ Independent commissioning unit in a big company checks quality of the works carried out by qualified company staff

Possible control procedures (archive based or on-site checks, sample checks or full checks depending on the size and complexity of the project) must be effective and preferably low cost. Examples of on-site checks are given below:

- Check of human resource policies of involved companies compared with voluntary and / or mandatory requirements (e.g. regular in-house training for craftsmen to update technical know-how): e.g. by means of on-site interviews with a few workers
- Check of on-site quality assurance procedures compared with voluntary and / or mandatory requirements (e.g. a few hours on-site training for craftsmen prior to a crucial implementation phase, specific tasks to be performed by site supervisor such as filling and signing commissioning checklists, etc.): e.g. by means of on-site interviews with a few workers
- Check of qualification certificates of involved craftsmen on-site: all documentation required according to tender specification and / or mandatory requirements has to be available on-site for random check
- Check of time schedule and execution plan, including visits of construction site during critical periods and check whether execution complies with voluntary and / or mandatory requirements (visual check)
- Check of reporting documents, commissioning checklists and measurement protocols (airtightness) regarding compliance with voluntary and / or mandatory requirements (functional check)

EXAMPLES OF PROBLEMATIC SITUATIONS
- Procedures are not problem-oriented and not specific enough.
- There are no minimum requirements defined which refer to installation rules for building elements and can be easily checked.
- Requirements regarding qualification of workforce are not sufficiently specified, giving opportunity to companies submitting dumping offers and executing with less qualified workforce.
- Certain aspects regarding qualification are not sufficiently covered by the requirements, and therefore it can be problematic to procure based on the cheapest offer.
- Reporting documents needed for checking are not well specified, and standard formats are not available.
- Hand-over procedures do not include verification checks.
- Commissioning is only done at the point of handing-over, there is no commissioning at critical stages, and therefore mistakes cannot be corrected at reasonable costs. Authorised experts entitled to check the quality of the works do actually not have the technical knowledge to perform their work according to expectation.

CONSIDERATIONS REGARDING PROCEDURAL ASPECTS:
- It is not the objective to introduce third party control for as many elements of the construction process as possible, but for those ones which are crucial and pose a serious problem.
- Requirements should be detailed to address also building elements, especially those which are crucial for energy building performance, and should be formulated in a way that they can be checked easily. They become even more important taking into account the development towards nearly zero energy buildings or even plus-energy buildings.
- In many countries it is the usual procedure that there is the supervising engineer (construction site supervisor) who verifies that the building is built in accordance with the plans and specifications and also verifies the quality of the construction. These duties can be extended to also include energy aspects (self-check). In general, self-checks increase the level of quality and thus reduce the necessary number of costly third party checks.
- Timing of on-site check: What are the best moments to control the as-built situation (self-check by construction site supervisor and third-party check of site supervisor)?
- Development of procedures have to carefully deal with the qualification requirements inspectors
and authorised experts allowed to check the quality of the works must fulfil.

- Development of procedures should consider and assess the advantages and disadvantages of the following options in the specific national or regional context:
  - Archive versus on-site checks
  - Mandatory versus voluntary checks
  - Systematic checks versus sample-based checks
  - Self-checks versus third-party checks
  - Visual checks versus functional measurements (performance)

**APPROACHES WITH RELEVANCE FOR THIS TOPIC:**

- **Quality assurance procedure in Ireland:**
  - The owner must appoint an inspector for the construction process.
  - The authority only checks that the prescribed process has been followed not as such compliance with the requirements.
  - The designer must sign that the design complies with the requirements.
  - At completion, the builder must sign that the building is constructed according to the design and in accordance with the requirements and the drawings submitted to the authority. The builder must be competent (legal meaning, i.e. have the necessary education or skills), however is allowed to lean on competent sub-contractors, e.g. plumber, electrician etc.

- **Measurements after completion in France:** Enforcement of airtightness requirements was introduced in the requirements as a first step towards introduction of NZEB requirements. This is seen as a way to ensure better skills of the contractors and increase focus on airtightness. There are two ways to demonstrate compliance with the requirements; 1) measurements in the building after completion; 2) management of a quality assurance procedure in the construction company.

**Commissioning checklists for self-control in Austria:** The klamaaktiv programme is funded by the government and provides a green building self-declaration scheme including supporting material such as detailed checklists for systems commissioning to ensure quality of the works and thus energy efficiency.

**REFERENCES**

- BUILD UP Skills Austria: [http://buildupskills-crosscraft.at/moodle/?lang=en](http://buildupskills-crosscraft.at/moodle/?lang=en)
- Factsheet on Green Building Rating Schemes (under development)
- klamaaktiv quality requirements for building services systems as part of the klamaaktiv green building self-declaration: [http://www.klamaaktiv.at/publikationen/bauen-sanieren/qualitaetslinien.html](http://www.klamaaktiv.at/publikationen/bauen-sanieren/qualitaetslinien.html)
- Factsheet: Building regulations can foster quality management: the French example on building airtightness
6.3 Types of penalties in case of non-compliance

CONTEXT AND MOTIVATION:
Penalties in case of non-compliance with requirements regarding qualification and quality of the works target executing companies, developers, and companies commissioned with quality assurance activities:

- Executing companies violating the requirements of quality frameworks addressing qualification of the workforce
- Executing companies not carrying out the work according to the procedures in terms of technical quality
- Developers not respecting the reporting requirements
- Developers not respecting the inspection requirements
- Quality assurance companies not respecting qualification requirements
- Quality assurance companies making mistakes and delivering defective work

The following types of penalties are possible, depending on the framework applicable to quality frameworks, the conditions regulating the activities, rights and obligations (licence) of professions in the Member States, and the culture prevailing in the Member States:

- Warning and no further consequence
- Warning and publication of companies marked with warnings in terms of quality of the works
- Warning and obligation to correct the mistake within a given period
- Warning and counting the warnings; after a certain number of warnings an administrative fine will apply, and several fines will result in the withdrawal of permit to execute this type of activities
- Requirement for (additional) training/examination of the workforce within a given period of time
- Requirement to carry out additional activities before works can be approved/delivery of attestation
- Administrative fine
- Prison
- Withdrawal of permit to execute this type of activities

Finally, the building owner will be liable for the lack of building performance resulting from poor quality of the works. Aspects regarding EPBD-compliance are dealt with in the Qualicheck Source book for improved compliance of Energy Performance Certificates (EPCs) of buildings, while compliance with other requirements (e.g. imposed by green building certification schemes, financing schemes) is tackled in this report. Penalties addressing the building owner will be for example: obligation to correct the mistake, loss of financial support, loss of green building certificate.

EXAMPLES OF PROBLEMATIC SITUATIONS
- Possibilities to bypass penalties, for example: Green building certification schemes usually offer design certificates and completion certificates for the same building. It happens quite often that building owners only commission the design certificate and use it also for the completed building, although the design certificate does not reflect the (defective) as-built situation. In some cases, the penalty “loss of certificate” would have to apply but cannot take place.

CONSIDERATIONS REGARDING PROCEDURAL ASPECTS:
- First of all, the types of chosen penalties should rather contribute to constantly improving the quality of the works than represent a pure punishment.
- Penalties must be designed in a way that they are proportionate and effective.
- Execution of penalties must be feasible from the administrative point of view.
- A step-wise penalty-system (warning – fine – withdrawal of licence) requires a database to collect and administrate building-related as well as company-related information about quality of the works.

APPROACHES WITH RELEVANCE FOR THIS TOPIC:
- **In Austria (province Lower Austria)**, an effective qualify framework was applied in the course of granting additional financial support for energy efficient buildings exceeding energy performance
minimum requirements. Several on-site visits were carried out and in case of mistakes solutions were suggested and discussed with the responsible executing companies. Companies had to follow the advice because otherwise the building owner would have lost the financial support. In this regard, the penalty “Warning and obligation to correct the mistake within a given period” was used to raise awareness of quality of the works. The penalty “Loss of financial support” addressing the building owner was never applied because detected mistakes were used as an opportunity to train the executing companies and achieve the energy minimum requirements at the same time. The program was very effective but also costly because technically up-to-date experts had to be employed to carry out meaningful inspections and on-site advice for executing companies.

REFERENCES

➔ EPBD Concerted Action http://www.epbd-ca.eu/
6.4 Clear rules about liabilities and penalties

CONTEXT AND MOTIVATION:
Growing awareness of quality of the works is translated in more emphasis on qualification and training of the workforce and also on third party quality frameworks, sometimes focusing on competence of workers and in other cases on the execution quality on the building site, or both. Quality of the works involves liability issues and a potential cost increase, and therefore remains a very sensitive issue requiring a careful approach.

An effective quality enforcement framework specifies penalties in case of non-compliance and whom they address. Entities governing quality frameworks should aim at making the rules and related penalties as clear as possible, in order to minimise discussions afterwards and minimise the risk of loss of societal support.

Depending on the infringements detected during voluntary or mandatory control, e.g. in the framework of financing schemes, liability can be with the building owner, the design team, the construction site supervisor, the executing companies, and the companies commissioned with external quality assurance.

Roles and responsibilities are for example:
- Design team is responsible for breaking down requirements to the level of executing trades (detailed design, execution planning)
- Design team is responsible for marking crucial stages for the construction site supervisor and third party control to pay special attention to (interfaces between trades, e.g. relevant to achieve an airtight building envelope)
- Executing companies are responsible for respecting the requirements regarding qualification of the workforce
- Executing companies are responsible for carrying out the work according to the procedures in terms of technical quality
- Executing companies are responsible for respecting the commissioning and reporting requirements
- Developers representing the client are responsible for respecting the reporting requirements
- Developers representing the client are responsible for respecting the inspection requirements
- Construction site supervisor representing the client is responsible for internal quality control according to requirements (self-checks subject to third party control)
- Third party control (company commissioned with quality assurance or independent commissioning unit in a big company) is responsible for carrying out the agreed checks and measurements according to specification
- Third party control (company commissioned with quality assurance or independent commissioning unit in a big company) is responsible for fulfilling the qualification requirements regarding their own staff

Clear rules and related penalties in case of non-compliance help to set up the contracts between the parties affected by the quality framework in a way that there are clear roles between partners, resulting in clear responsibilities for the quality of the works depending on the type and the complexity of the project.

In case of disputes taking place during a project subject to a quality framework, the entity governing the quality framework can be the first contact point trying to mediate the dispute prior to making use of established procedures according to civil law.

Procedures in case of disputes should be transparent and publicised, including penalties and whom they will address if there is a violation of requirements.

EXAMPLES OF PROBLEMATIC SITUATIONS
- Execution planning does not pay sufficient attention to interfaces between trades in terms of commissioning dates: e.g. installation of heating system with insulated piping flush-mounted fitting (in-wall mounted), and therefore responsibilities are not clear and penalties cannot be applied.
- Specification is not detailed enough regarding qualification of staff in order to justify penalties: some employees of the company hold the required certificate, but staff involved in the project does not.
- Task description of construction site supervisor is not sufficiently detailed, and therefore he or she cannot be held liable.
CONSIDERATIONS REGARDING PROCEDURAL ASPECTS:

- Penalties must be specified by the entity running the respective quality framework.
- Penalties must address the responsible actor who is in the position to correct the mistake at the source of the problem.
- Standardised commissioning checklists and other supporting material for carrying out checks should be provided by the entity governing the quality framework.

APPROACHES WITH RELEVANCE FOR THIS TOPIC:

- **In Belgium / Flemish region**, the “Enforcement framework for cavity wall insulation of existing buildings” allows a quality approach based on the certification by an accredited organisation. This enforcement framework can also serve as an example for similar approaches to be considered for other technologies (internal insulation, external insulation, installation of windows and doors, …), for ventilation systems and heat pumps, as well as for renewable energy technologies (PV, solar hot water, …).

- **In Austria**, the national climate protection programme klimaaktiv (funded by the government) issues quality guidelines for heating systems, heat pumps, solar thermal systems, PV systems, airtight building envelope, ventilation systems, lighting, and district heating systems in the framework of the voluntary green building self-declaration scheme called klimaaktiv. Quality guidelines include execution checklists specifying responsibilities among trades, e.g., what to consider during execution to achieve a building envelope meeting the airtightness requirements, as shown below:
  - Time schedule for accompanying checks and airtightness measurements during construction period is available
  - Visual check of executed connections, intersections and penetrations; check of materials used, steam breaks and foils glued
  - Airtight installation of windows and doors according to ÖNORM B 5320; responsible: window installer (commissioning of the works)
  - Solid construction: airtight interior plaster completed; responsibility: builder (commissioning of the works)
  - Light weight construction: airtightness layer completed; responsibility: carpenter (commissioning of the works)
  - Plastering the chimney; responsibility: builder (commissioning of the works)
  - Plastering of brick walls behind chimneys and built-in components such as sewage systems; responsibility: builder (commissioning of the works)
  - Airtight integration of electrical installations; responsibility: electrician (commissioning of the works)
  - Empty conduits / tubing are sealed to the outside (e.g. for solar thermal system, electric wiring, ...) ; responsible: plumber, electrician (commissioning of the works)
  - Airtightness measurement completed, n50: …

Responsible is the construction site supervisor representing the client who is subject to random control carried out by the klimaaktiv programme management. This programme applies the penalty “loss of certificate”: If the airtightness measurement does not comply, the klimaaktiv label will not be awarded.

REFERENCES

- Factsheet “Enforcement framework for cavity wall insulation of existing buildings in Belgium / Flemish region”
- klimaaktiv quality guidelines including checklists: http://www.klimaaktiv.at/publikationen/bausanieren/qualitaetslinien.html
6.5 Consequences in terms of qualification, certification, labelling

CONTEXT AND MOTIVATION:

Accredited certification schemes for individuals, certification schemes for individuals operated by acknowledged and trustworthy organisations, and seals of quality awarded to companies (related to products, systems, quality of the works) by acknowledged and trustworthy organisations can play an essential role in ensuring quality of the works delivered by executing companies but also delivered by the competent persons in charge of self-checks subject to third-party checks or third-party checks. However, rules must be transparent and limitations of certifications, labels and quality seals must be clearly communicated (e.g. company label versus individual certification).

In terms of staff of executing companies, in-house trainings as well as product specific trainings are often considered an appropriate and cheaper alternative compared with trainings resulting in certificates, in order to ensure qualification and achieve good quality of the works. However, experience shows that fluctuation of staff (promotion of successful workers in the company and better opportunities outside the company) can compromise in-house qualification efforts. Product specific trainings are necessary but not a substitute for trade specific further education, either. Sufficiently qualified craftsmen need to understand the relation of their own trade with the other ones and their position in achieving the objective of an energy efficient or nearly zero energy building.

Therefore, on-site trainings resulting in qualification certificates can be feasible options in terms of coping with the trade-off regarding cost.

EXAMPLES OF PROBLEMATIC SITUATIONS

- Certification schemes exist, but the certification of qualification is not a requirement due to concerns regarding higher cost and thus lack of acceptance.
- Certification schemes exist, but in many countries they are limited to installers dealing with renewable energy technologies because this has been a consequence of implementing the RES-Directive. Similar schemes are necessary for ventilation installers and trades responsible for delivering an airtight building envelope (trades dealing with insulation, windows, facade, roof), but not available yet.
- Unclear information leads to confusion regarding liability and non-compliance, e.g. the company holds a qualification certificate, but regarding the individual workers on-site there is no evidence that requirements are met.

CONSIDERATIONS REGARDING PROCEDURAL ASPECTS:

- Evidence of qualification must be available in a form allowing the translation into requirements imposed by quality frameworks.
- Evidence of qualification must be available in a form allowing for the compliance checks.

APPROACHES WITH RELEVANCE FOR THIS TOPIC:

Examples of trainings and certified qualifications showing the potential to be used in quality frameworks:

- **In Romania**, the BUILD UP Skills QualiShell project (IEE) focusses on the development of qualification schemes for building envelope insulators and insulated window system installers to ensure the execution of high performance building envelopes.
- **In Slovenia**, the Chamber for Crafts and Small Business Slovenia developed this pilot initiative: Because there were no guidelines for the installation of ETICS, companies (manufacturers of ETICS, approximately 18 ETICS companies offering ETICS facade systems on the Slovenian market) have organised their own trainings targeting installers. The number of ETICS façade certified installers was about 800 in the year 2014.
- **In Austria**, accredited certification schemes are available for photovoltaic systems installers, solar thermal systems installers, heat pump installers, and airtightness testers. Other certification schemes (operated by programs, companies, associations or research institutions) are available for ventilation installers, builders, biomass heating systems installers. There is a seal of quality for
companies targeting installers and providers of solar thermal systems. In Austria, the company and training provider Sonnenplatz offers a training across trades on passive house technologies. In the context of this training craftsmen acquire theoretical knowledge on the passive house technology, intensified by practical exercises and study topics across the trades. Target audience: craftsmen of the building industry, foremen, masons, (construction) carpenters, ventilation technicians, roofers, tinsmiths, plumbers, electricians, manufacturers and installers of windows, etc..

- In Malta, on-site-training is considered beneficial for improving the quality of the work while maintaining the cost for the contractors at very low levels (the time spent on training is during actual construction works). The suggested process requires all workers to become fully trained and certified while working on projects where financial incentives are being granted. Such a process is expected to gradually increase the rate of trained workers.

REFERENCES

➔ klimaaktiv programme, the Austrian national climate protection programme: http://www.klimaaktiv.at/
6.6 Specific issues for (deep) renovations

CONTEXT AND MOTIVATION:
Member States have set action plans to stimulate deep energy renovations. This stresses the relevance of qualification and quality control targeting the specific challenges encountered in the major renovation of existing buildings (see example from Austria below).

Improving energy efficiency in existing buildings requires specific knowledge regarding the as-built situation in the past construction periods as well as up-to-date technical know-how to assess which energy efficiency measures are suitable in the specific building to be renovated. Sometimes problematic situations are hidden and cannot be detected during the baseline study. Damages have to be eliminated before renovation works can start. Therefore, staff working on-site must be qualified to identify critical situations when they become evident and react accordingly in order to achieve good quality of the works.

Depending on the building stock of a country, specific standard renovation measures can be defined (see example on cavity wall insulation from Belgium below) and a tailor-made quality framework can be developed to ensure quality of the works. These frameworks can be applied in the course of a deep renovation as well as in the course of a single renovation measure.

EXAMPLES OF PROBLEMATIC SITUATIONS
- Cost increase and additional cost caused by quality control: Energy related payback times are often not realistic due to the rebound effect and the influence of user behaviour in general. Hidden damages which have to be eliminated or repair works which turns out to be necessary before energy measures can be implemented derange the planned budget. There is not much support to accept additional cost for quality assurance although this will pay in the long run.

CONSIDERATIONS REGARDING PROCEDURAL ASPECTS:
- Effort needed to attain the formal qualification requirements (course attendance and examination) must be proportionate to business opportunities opening up for companies meeting the qualification requirements.
- Cost of a voluntary quality framework must be acceptable for the client or it must be made mandatory to create equal conditions on the market.

APPROACHES WITH RELEVANCE FOR THIS TOPIC:
In Belgium / Flemish region, the “Enforcement framework for cavity wall insulation of existing buildings” allows a quality approach based on the certification by an accredited organisation and targeting a specific renovation measure:
- This approach foresees that accredited organisations can approve insulation techniques meeting well defined specifications in combination with the certification of installers which meet the criteria.
- Regular inspections are done regarding the various procedural aspects.
- The installers have to follow two training courses, i.e. one by the supplier of the insulation technology and one by a neutral organism (including examination).

In Austria, the platform of qualified companies active in building renovation “Traumhaus Althaus” under Energieinstitut Vorarlberg, the regional Energy Agency of Vorarlberg represents a network of more than 60 companies specialised in building renovation. Members are committed to continuous further education and training and high quality ecological and energy standards for successful renovations. The energy agency checks interested companies applying for membership whether they comply with the rules set by the energy agency. During membership, training is mandatory and member companies are checked on an annual basis. Training offered by the platform is free for members. Trainings are not limited to a specific area of expertise but address all relevant issues regarding high quality renovations.
REFERENCES

→ EPBD Concerted Action http://www.epbd-ca.eu/
→ Platform of qualified companies active in building renovation “Traumhaus Althaus”, platform governed by Energieinstitut Vorarlberg, the regional Energy Agency of Vorarlberg in Austria: http://www.energieinstitut.at/unternehmen/partnerbetriebe-traumhaus-althaus/mitglied-werden/
6.7 Influence by European and national legislations and standards

CONTEXT AND MOTIVATION:

Although the Services Directive has been implemented by all EU countries by 28 December 2009, the construction business is still dominated by local companies executing the work. Trade regulation takes place at national level and conditions for practising a defined job vary among Member States, strongly influencing the actual knowledge level of skilled trades. The Services Directive aims at creating a legal framework to ensure the freedom of establishment and the free movement of services between the Member States. However, this Directive does not affect the freedom of Member States to define, in conformity with Community law, what they consider to be services of general economic interest, how those services should be organised and financed, in compliance with the State aid rules, and what specific obligations they should be subject to. Freedom of establishment for providers must be guaranteed, but authorisation schemes will be possible if the authorisation scheme does not discriminate against the provider in question. In terms of mandatory qualification requirements and quality frameworks requiring authorisation, this means that authorisation schemes must be non-discriminatory, justified by an overriding reason relating to the public interest; proportionate to that public interest objective; clear and unambiguous; objective; made public in advance; transparent and accessible (Article 10).

The Construction Product Regulation imposes the free circulation of construction products in the EU’s Single Market, meaning that products have to be tested only once according to a harmonised European standard or European Assessment Document. This has to be taken into account when setting rules how to check the quality of the works.

The Public Procurement Directive supports the life-cycle costing approach (Article 68) and thus also employment of qualified workforce. In addition it says: “Furthermore, with a view to the better integration of social and environmental considerations in the procurement procedures, contracting authorities should be allowed to use award criteria or contract performance conditions relating to the works, supplies or services to be provided under the public contract in any respect and at any stage of their life cycles from extraction of raw materials for the product to the stage of disposal of the product, including factors involved in the specific process of production, provision or trading and its conditions of those works, supplies or services or a specific process during a later stage of their life cycle, even where such factors do not form part of their material substance.”

Certification of qualified individuals according to EN ISO/IEC 17024 (e.g. certified heat pump installers, certified solar thermal installers, certified PV installers, certified ventilation installers) can be an option to enhance qualification. However, certification according to EN ISO/IEC 17024 requires the establishment of a body operating the certification and the respective certification scheme. The procedure takes time and is costly.

Besides relations with EU legislation and standards, there are also links with national legislation, for example:

- National privacy legislation: it is not allowed to inspect a building unit in use after building completion, thus limiting the possibilities to check quality of the works during building utilisation.
- National building legislation: There are no obligations regarding commissioning and inspection to ensure the quality of the works although standards and voluntary systems are available.
- National energy efficiency in buildings subsidy scheme: a quality framework is imposed and is a condition to receive financial support.

EXAMPLES OF PROBLEMATIC SITUATIONS

- The effort needed for designing functioning quality frameworks is underestimated: Quality frameworks are designed without thorough discussion of pros and cons with all affected parties and without sufficient legal expertise, resulting in cancellations, and as a consequence, also resulting in a loss of societal support.

CONSIDERATIONS REGARDING PROCEDURAL ASPECTS:

- To be in line with EU-Directives, quality frameworks addressing qualification and quality of the works must be transparent and non-discriminatory.
APPROACHES WITH RELEVANCE FOR THIS TOPIC:

- See examples listed in other sections of this source book.

REFERENCES

- EN ISO/IEC 17024 Conformity assessment - General requirements for bodies operating certification of persons
7. Documented set of best practices PART 3: Operational framework for better compliance and effective penalties related to quality of the works

7.1 The willingness to check

CONTEXT AND MOTIVATION:
The willingness to check quality depends on the advantages or benefits gained from the checking procedure in relation to the resources and thus cost caused by the checking procedure.

The willingness to check refers to:
- the government willing to check the quality of the works to boost energy efficiency and to support the establishment of new technologies necessary for the realisation of nearly zero energy buildings,
- entities operating quality assurance schemes which are a precondition to achieve access to financing schemes,
- entities operating quality assurance schemes which address companies targeting an edge over the competitors on the market,
- companies committing themselves in the framework of voluntary quality assurance schemes (self-control).

The willingness to check might increase if building owners actively demand for quality checks addressing critical situations, or at least are ready to tolerate or even support them.

EXAMPLES OF PROBLEMATIC SITUATIONS
Not applicable

CONSIDERATIONS REGARDING PROCEDURAL ASPECTS:
Not applicable

APPROACHES WITH RELEVANCE FOR THIS TOPIC:
- **Willingness to check due to financial implications:** In UK, a voluntary programme operated by SWIGA (Solid Wall Insulation Guarantee Agency) provides 25 years guarantees for insulations fitted by registered installers respecting the organisations’ quality frameworks including qualification and training requirements and control procedures. Requirements and control procedures are transparent and publicly available at: [http://www.swiga.co.uk/wp-content/uploads/2012/08/2.1LV-SWIGA-Members-Rules-of-Conduct.pdf](http://www.swiga.co.uk/wp-content/uploads/2012/08/2.1LV-SWIGA-Members-Rules-of-Conduct.pdf).
- **Willingness due to check due to public interest:** In Spain, the process of quality control during construction includes mandatory execution control. The entity control will raise a schedule of visits according to the characteristics of the work, to check elements of the thermal envelope, aspects relating to thermal bridges, and the facilities including renewable energy technologies. A variable number of visits to examine the quality of the works is carried out depending on the type, complexity and size of the building. After each inspection, there is a report that informs about the results obtained during the inspection, especially of those aspects in need of improvement. The report contains photographs and necessary measurements. The final report contains all results of the realized visits. The modifications with regard to the presented project will be reflected so that the above-mentioned information can be used in cross-checking the EPC.

REFERENCES

➔ SWiGA (Solid Wall Insulation Guarantee Agency): [http://www.swiga.co.uk/](http://www.swiga.co.uk/)
7.2 The resources to check

CONTEXT AND MOTIVATION:
Irrespective of whether checks are mandatory or voluntary, regarding resources needed for checking it should be distinguished:

- Human resources: availability of qualified staff
- Time resources: sufficient time to carry out the work properly according to specifications
- Financial resources: availability of monetary budget to pay for quality checks

Depending on the type of check, resources needed to check will be different:

- From the client’s perspective (the one who is checked):
  - Third party checks require qualified in-house staff, time for carrying out defined procedures to comply with requirements, and budget to commission the authorised company/expert to check. Third party checks should provide an additional benefit for the one who is checked, e.g. demonstration of trustworthiness by awarding a certificate, a label, or granting access to a financing scheme, in order to justify the effort.

- From the scheme operator’s perspective (the one who checks):
  - Systematic checks are more expensive than sample-based checks. Therefore, systematic checks must be well justified, for example if a specific weakness in quality of the works is prevalent and region-wide improvement will be necessary.

EXAMPLES OF PROBLEMATIC SITUATIONS

- Allocation of human resources and budget is not realistic: The time pressure at the construction site and the cost pressure in general contradict the amount of time theoretically allocated to checking.

CONSIDERATIONS REGARDING PROCEDURAL ASPECTS:

- Usually there is a construction site supervisor (supervising engineer) having the duty to verify that the building is built in accordance with the plans and specifications, and also having the duty to verify the good quality of the construction. The task description could be extended and cover energy-related aspects, as well (self-checks). Self-checks can reduce the number of third-party checks needed and thus reduce cost.
- Visual checks are less costly than functional checks (measurements). However, they are not exchangeable but complement each other.
- Provided that a well-developed database is in place, archive checks can be much cheaper than on-site checks, but they are also more prone to fraud: ideally, both are combined and systematic archive checks are used to select the samples for the on-site check.

APPROACHES WITH RELEVANCE FOR THIS TOPIC:

Initiatives to increase the quality of the works and to limit the resources needed for third-party checks at the same time:

- In Belgium, the project OPTIVENT (2010 – 2013) found that ventilation installations are often incorrectly adjusted: too high flow rates in some spaces and too low in others. It was concluded that recommendations and tools for installers are needed which are now available on the website www.optivent.be and will be soon published as a Technical Note of the Belgian Building Research Institute (BBRI). This tool enables the sizing of the ducts, the selection of the fans and describes also a set procedure. In addition, guidelines for airflow rate measurements are proposed (type of methods, conditions of measurement, etc.) in order to support installers in the compliance checking.
- UK responds to the challenge of poor ventilation installations, among others, by producing a freely available flow measurement guide.
- In Austria, the independent platform called Komfortlüftung offers certified trainings and information such as the quality criteria framework for good ventilation installations, including
installation guideline and specific requirements (60 requirements) allowing also for checking the built-in situation. Material is available for single-family buildings, multi-unit residential buildings, offices, schools and kindergartens. 

(http://www.komfortlüftung.at/fileadmin/komfortlueftung/MFH/60_QK_Komfortlueftung_MFH_V_2.0_mit_Erlaeuterungen.pdf)

REFERENCES


➔ Professional centre offering information material for tender specification, installation guidelines and requirements for checking: http://www.komfortlüftung.at/proficenter/


➔ French quality label for renewable energy systems installation companies: http://www.qualit-enr.org/professionnels/audit/
7.3 Effective sampling schemes

CONTEXT AND MOTIVATION:

Effective sampling schemes for control differ depending on the error-proneness of a technology, the impact of faulty installations, and the respective qualification level of the workforce. Samples can refer to buildings, technologies, companies, and individuals.

Sampling schemes can be based on random samples or targeted samples addressing a specific subsample. Effective sampling schemes operate with dynamic sample sizes: at the beginning when a new technology is introduced, there will be the need to control more buildings and craftsmen, in order to gain better insight and learn about the reasons for lacking quality of the works. The appropriate response, e.g. targeted qualification measures, may result in improvements and sample sizes may be reduced. Therefore, evaluation and feedback loops are part of effective sampling schemes.

Sampling of well-established technologies advocates sampling schemes equivalent to those applied for EPC control which are usually between 1% and 5%. Other technologies such as ventilation systems installation is regarded crucial for building performance and still problematic in terms of quality of the works and may require larger samples.

Experience shows that the simple fact that a check could take place (random check by government or voluntary quality assurance programme or measurement requested by client) results in improved workmanship.

EXAMPLES OF PROBLEMATIC SITUATIONS

- There is not much information available about the quality of installations on the market which makes it difficult to design an effective sampling scheme.
- The sampling scheme is not well developed and feedback loops for constant improvements are not clear. Thus, it is not effective and societal support will get lost.
- There are several sampling schemes targeting companies and individuals in terms of qualification and technologies in terms of installation quality; the schemes are not well synchronised and cost saving potentials are not made use of.

CONSIDERATIONS REGARDING PROCEDURAL ASPECTS:

- Method to decide on the sampling type and sampling size: e.g. problematic technology, inconsistencies in reporting of construction site supervisor, …
- What is the right moment to control the chosen sample, and how to receive the relevant information
- Method how to choose samples: e.g. execution companies marked with warnings, ...
- Method of data collection and administration of results
- Method of evaluating results and feedback loop to revise decision making on sampling size and choosing samples

APPROACHES WITH RELEVANCE FOR THIS TOPIC:

Governmental schemes, targeted samples:

- **5% sample of one crucial element**: In Denmark, the airtightness of new buildings is a mandatory requirement. To check, the pressure test is mandatory for 5% of new buildings. The local authority selects the houses to be tested. The owner pays the test. In this way, the awareness of craftsmen is raised for air tightness.
- **100% sample of one crucial type of installation**: Since several years, the testing of ventilation systems has been mandatory for most building types in Sweden. Two types of certified testers exist: A control has to be done at the moment of delivery of the installation and also at regular intervals. These intervals (3, 6 or 9 years) are defined depending on the type of building. This scheme serves on the one hand to ensure good quality installations, and on the other hand to ensure that quality is maintained during operation. Health concerns might be at least as important as the motivation to improve energy efficiency.
No sampling scheme: In Germany, since 2009 every craftsman has to declare that the quality of the works is in compliance with the energy saving regulations. The "craftsmen declaration" leads to fewer infringements because of increasing awareness and responsibility. The building owner has to retain the contractor’s declaration for at least 5 years. The building owner has to present the declaration to the responsible authority on request.

Voluntary schemes, targeted samples:

- Full control: The French non-governmental voluntary quality label Effinergie+ plans to reinforce ventilation controls, introducing ventilation airflows and duct leakage measurements at commissioning. In France, ventilation commissioning is considered a necessary step to ensure a well working installation upon receipt, with an in-use performance corresponding to the planned one.

- Random control: The French association Qualit’EnR governs voluntary quality labels for companies installing solar thermal systems, PV systems, wood boiler installations and heat pumps. Qualit’EnR has developed check-up files helping the installer to control the quality of the own work. A hot line is available for technical advice. The quality of actually carried out installations is checked regularly (at least once in three years).

REFERENCES


7.4 Effective penalties

CONTEXT AND MOTIVATION:

Not meeting the requirements for qualification of staff working on-site and quality of the works in general should be subject to the execution of penalties.

For implementation, clear definitions must be available regarding:

- the expected and accurately specified quality of the works and / or qualification;
- methods how to determine the specified quality and / or qualification;
- based on which parameter the penalty will be due;
- the conditions of execution.

These aspects should be highlighted in the presentation of the respective quality framework to make affected parties aware of the conditions.

Financial support is crucial for improving the energy efficiency of new buildings as well as of existing buildings. Therefore, withdrawal of financial support is a very effective penalty.

Other effective penalties:

- Obligation to improve the quality of the works according to the requirements
- Mandatory training

EXAMPLES OF PROBLEMATIC SITUATIONS

- Only few companies respond to a voluntary quality framework because requirements and penalties are considered too strict.
- Quotations are unreasonably expensive because companies calculate a risk premium to cover possible penalties in case of defective quality of the works identified by third-party checks.
- Lack of credibility due to non-execution of penalties:
  - Penalties are defined but there is no actual execution due to lack of procedures or too much administrative effort.
  - Penalties are defined but there is no actual execution due to obviously problematic consequences for the addressed individuals or companies (e.g. attitude of professional association: “we protect our weakest member”).

CONSIDERATIONS REGARDING PROCEDURAL ASPECTS:

- The timing of introducing the appropriate type of penalties must be well chosen: qualification levels must be already high region-wide, if severe penalties such as fines and loss of licence are suggested, otherwise there will be a lack of societal support and penalties will not be effective. If qualification levels are still low, effective penalties will be warnings and mandatory trainings.
- The monetary amount must be well chosen: if too small, companies might take the risk of paying it without improving the quality of the works; if too high, this will act as a deterrent resulting in the attempt to bypass the penalty.
- Professional associations are important stakeholders and could be involved by working with them on the integration of aspects addressing quality of the works and related penalties in model contracts.

APPROACHES WITH RELEVANCE FOR THIS TOPIC:

- In France, several certifications of equipment installers/contractors have been implemented (QUALIBAT, QualiEnR, QUALIFELEC, ECO Artisan, Les Pros de la Performance Énergétique) to secure the quality of the works. They generally cover quality requirements for the company and for the individual persons that operate the works. They may rely on dedicated training and requirements about the organization and the working tools/equipment that have to be used by the company. These certifications are voluntary, but they are required in order that the building owner benefits from public funding or subsidies.

REFERENCES

No references available
7.5 Handling of market complaints

CONTEXT AND MOTIVATION:
Market complaints arise as a by-product of applying quality frameworks. Complaints may for example emerge from building owners doubting the result of the third-party control procedure, from installers detecting weaknesses of the control procedure, or from authorised experts excluded from the quality framework for specific reasons. While individual complaints have to be resolved, complaint resolution efforts should also be regarded as one element of the quality assurance process and as a chance to improve the effectiveness of third-party quality control frameworks. To make use of this potential at the level of organisations operating quality frameworks, market complaints have to be collected, processed, and evaluated.

EXAMPLES OF PROBLEMATIC SITUATIONS
- A procedure for complaint management is published but not respected in practice, e.g. due to lack of resources

CONSIDERATIONS REGARDING PROCEDURAL ASPECTS:
The following points have to be clarified at the level of organisations operating quality frameworks:
- Who is the contact point for market complaints;
- How to reach the contact point (e-mail, telephone, operating hours, etc.);
- How to differentiate between complaints (serious and unjustified, classification by type of complaint, etc.) and how to deal with the different types of complaints;
- How to organise the follow-up procedure to come up with specific solutions;
- How to organise the follow-up procedure to feed in relevant information into the feedback loop for constant improvement of the quality framework;
- What are the resources needed to operate the unit handling market complaints.

Complaint management procedures should be transparent and published.

APPROACHES WITH RELEVANCE FOR THIS TOPIC:
No example available

REFERENCES
- EPBD Concerted Action [http://www.epbd-ca.eu/]

QUESTIONS:
- What are usual solutions to handle market complaints in relation with third-party quality frameworks in your country?
8. About innovation

8.1 Introduction

Over the last decade, substantial progress has been achieved in terms of product and system performances regarding energy efficiency and renewable energies. The type of progress can take different forms, e.g.:
- Better energy efficiency of systems (e.g. heat recovery, efficiency of heat pumps, ...)
- New technologies (e.g. vacuum insulation panels, LED lighting, deep geothermal energy, ...)
- Cost reductions for various types of energy efficient technologies and renewable energies

Energy performance regulations should correctly assess all kind of technologies and, as a result also stimulate and/or allow the market uptake of innovative technologies.

Some thoughts about the current development:
- The role of electricity is changing, due to the German Energiewende. Looking at the national economy it can be useful to consume electricity from renewables
- Building integrated renewable energy technologies for self-sufficiency
- Energy optimisation at the neighbourhood level, not at the building level
- Building as a whole is used to store energy
- Demand response and trading of electricity demand flexibilities
- Etc.

The following will not change, and therefore it should be focus: Transmission characteristics and cold bridges are the most crucial parameters because good U-values and avoiding cold bridges are preconditions for building energy efficiency in all European climates.

Recent research projects indicate that in future, the “final energy” indicator might be no longer associated with energy cost. In this regard, EPC as information tool for potential buyers and tenants (and they are mostly interested in cost) might loose its function and will be a purely legal requirement to meet.

8.2 Simplified procedures are important but should not be a barrier for innovation

The availability of simplified procedures is often considered as a major element for market acceptance. At the same time, it is important that innovation is not blocked due to oversimplification in the EPBD calculation methods.

In practice, there are various possibilities for dealing correctly with better performing products and it is crucial to foresee at least one of these possibilities.

Examples:
- Existing technology: condensing boiler
  - The use of a fixed value for the efficiency of condensing boilers is not stimulating the use of more energy efficient condensing boilers. A possibility to stimulate innovation is to allow to use specific product data, whereby it still is possible to have a default value when using a condensing boiler
- New technology not covered by the standard procedure: shower with heat recovery
  - In case such technology is not covered in a given country, and if considered a relevant technology, it is important that the legislation foresees a procedure for handling such technologies. See also §xxxx.
- Very innovative building designs
  - In case specific and rather unique design concepts are implemented, it might be necessary to foresee the possibility of a project specific assessment method, if not innovation will be blocked. See also §XX.
8.3 Need of a robust framework for assessing technologies not covered by the classical procedures

8.3.1 The problem
Technical building services systems are changing fast, how to consider in the EPC calculation programme
Are there any basic parameters which always remain the same and can be checked easily?

8.3.2 Possible solutions
Assessment at product or system level
  ➔ Examples in FR, NL, BE
Assessment at project level
  ➔ Examples in Brussels region, …
9. Importance of societal support for compliance and enforcement

9.1 Effective enforcement not evident without strong societal support

It is in most countries for governments not evident to have (strict) enforcement schemes regarding EPC compliance (including penalties) if such enforcement is criticised by a (substantial) part of the market. The motivation for setting strict enforcement rules might be weak without societal support, and in case there are enforcement rules, the risk that the enforcement will be diminished or stopped once there is strong market opposition when penalties are large.

Therefore, it is very important to work on the required societal support, which involves varies activities, including stakeholders concertation in the development phase, the development of well balanced and pragmatic enforcement mechanisms and, once in operation quick action in case of market reactions.

9.2 Raising societal awareness regarding reliability of EPC

In general, and this is not surprising, there often are negative reactions in case someone or a part of the market is penalised in case of non-compliance. “This is not fair”, “the procedure is too heavy, too costly, …”.

Therefore, it is very important that all relevant stakeholders organisations get the occasion to be involved in the preparation process of compliance and enforcement procedure.

What can be the objectives for such stakeholders involvement:

- **Before implementation:**
  - To inform them about the motivations for an enforcement framework, e.g. by sharing experiences of problems with the EPC (EPC is not available, wrong information in the EPC, …)
  - To discuss the procedures for determining the EPC (PART 1 of this source book), which will allow them to assess the complexity, the type of technologies covered/not covered, …
  - To discuss the principles of the legal framework for compliance and enforcement (PART 2 of this source book)
  - To discuss the principles for practical implementation fo the enforcement (PART 3 of this source book)

- **During implementation:** regular evaluation if the procedure is well balanced and/or if improvements are needed, e.g.
  - Is there a need for a modification in the procedures for determining the EPC (PART 1 of this source book);
  - Is there a need for a modification of the principles of the legal framework for compliance and enforcement (PART 2 of this source book)
  - Is there a need for a modification of the principles for practical implementation fo the enforcement (PART 3 of this source book)

Practice shows that it is requires substantial efforts for the stakeholders to obtain the overall picture and therefore it often is time consuming for reaching the required support. Moreover, it is important to acknowledge that many stakeholders organisations have a multi-layer approach, whereby it is for issues as compliance and enforcement often important that there is a broad support at different levels:

- Individual members
- One or more committees dealing with EPC issues
- Some organisations have a permanent staff which is assumed to represent the views of the stakeholders

A strong interaction requires time but can have various substantial advantages:

- Identification of opportunities for improvement
- Increased credibility of the overall approach in case there is support from the stakeholders
- Better understanding by the stakeholders of the reasons for certain choices and therefore more support in case of negative reactions from market players
In the Flemish Region a comprehensive evaluation of the EPB-regulation is foreseen every 2 years. Stakeholders participate in this process, and quality issues are brought up. If necessary legislation is adapted or actions such as communication, adaptation financial incentives are foreseen.

Lack of compliance regarding input data lead to bad quality EPCs.
EPC must be regarded as reliable source of information for potential buyers and renters during the decision making process
Real estate agents have to promote the EPC as useful and not as an additional burden

It's a chicken-and-egg question

There must be a clear communication about the EPC based on default values/serving to provide orientation on the market and to compare buildings, and the EPC based on specific building data serving to provide specific information about the building.
…awareness of building users

Some food for thought:
I am rather pessimistic about this because:
- There is a lack of affordable residential buildings in Europe and people take what they can get; however, if they take energy efficiency into account during decision-making, the information must be correct. Compliance of input data does not guarantee a correct EPC but increases the chance to have a correct EPC
- Results from psychological research show that human brain prefers short term advantage (immediate reward) instead of long term benefit, and quality assurance from design to operation is a long-term undertaking; this is why it is “attractive” the break the law
Societal values have been overruled by stock-exchange betting and it has become acceptable to cheat wherever it is possible because politicians provide the respective role model (how many politicians and influential persons have been taken to court or jailed in Europe due to fraud, corruption, etc. – some cases in Austria).
How to tell people that they should comply, if the government does not?

9.3 Societal support for effective compliance
… it is for governments very difficult to come to effective compliance schemes without a support by stakeholders
… examples?
There are some companies committed to CSR (really, not just as a PR measure) and good practice; e.g. the housing association and the government authority participating in the QUALICheck Austria new data collection study: they use the study to improve the existing quality assurance schemes and to develop together what is still missing
…

10. Economics of compliance
The cost issue is often heard in the context of compliance issues. But it has different dimensions. It seems useful to briefly present these different dimensions.

10.1 Effective compliance framework on reliable data requires efforts
10.2 Who pays for it?
Depending on the type of non-compliance, cost will arise for different societal groups:
European tax payers pay for infringement procedures
Citizens of Member States pay for fines and other penalties
Building owners and/or occupants pay for additional expenses caused by wrong reporting

10.3 What are the costs of poor compliance?

Not meeting energy minimum requirements and will cause infringement procedures due to violating the European legal framework, resulting in additional workload for civil servants and fines. It will probably have a negative impact on climate protection obligations, because usually energy efficiency in buildings is a condition for achieving CO2-reduction targets. Missing CO2-reduction targets causes penalties, as well. No reporting will cause additional efforts in substituting information otherwise provided by EPCs, e.g. for reporting according to Article 5 EED or to meet other reporting obligations. If EPCs are not available, data collection studies will have to be carried out to provide the necessary information. In the long run, expenses for these studies might be higher than cost of implementing and running a successful compliance scheme. Wrong reporting results in wrong information about the building energy performance and associated costs for operation and improvement, thus misleading potential buyers and tenants during the decision making process, but also building owners if they plan to use the building themselves.

10.4 Lower total cost?

Often, energy efficiency in buildings is motivated by lower life cycle costs. However, in practice, this is often not true. The reason is that the Standard on LCC (ISO 15686-5:2008) allows a broad range of interpretation: Similar to LCA, also LCC starts with the scoping and definition of objectives. Crucial parameters dominating the calculation result such as interest rate, intensity of maintenance and repair, and lifespan of products and systems can be defined by the person carrying out the analysis. Apart from these crucial parameters the following choices for calculation may lead to unrealistic results:

- Additional cost for energy efficiency is calculated instead of total renovation cost;
- Cleaning cost is neglected although important in energy efficient buildings due to extensive; application of glas in order to making use of solar gains;
- Assumed energy consumption used for calculation is not realistic due to prebound and rebound effect;
- User needs and user behavior might change over time and is not taken into account.

Lower Whole Life Costs (terminology according to ISO 15686-5:2008)

Cheap financing of stimuli for innovation?
11. Conclusions

(TO BE WRITTEN END OF 2016)
12. ANNEXES

12.1 The meaning of ‘quality’ in the technical literature

For industry, the notion of ‘quality’ has received increased importance. Quality management is a key issue for many sectors and companies and, therefore, there is a lot of literature in relation to quality related issues.

In the framework of this source book, the following descriptions in literature seem very relevant:

- The most important document is probably ISO 9000:2015, whereby the following terms are of specific relevance for this thesis: quality, entity, requirements for quality, requirements of society, customer, process, product, organisation, supplier, quality assurance. See figure 12.1 and figure 12.2.

---

**Figure 12.1: Quality related aspects (terms in bold are explained in text)**

- **Supplier**
  - Quality is achieved if entity is able to satisfy stated and implied needs

- **Requirements for quality**
  - They should fully reflect the stated and implied needs of the customer

- **Requirements of society**
  - All requirements of society should be taken into account when defining the requirements for quality

---

‘Quality’ is defined as:

- *Totality of characteristics of an entity that bear on its ability to satisfy stated and implied needs*

  **Note:**
  1. In a contractual environment, or in a regulated environment, such as the nuclear safety field, needs are specified, whereas in other environments, implied needs should be identified and defined.
  2. In many instances, needs can change with time; this implies a periodic review of requirements for quality.
  3. Needs are usually translated into characteristics with specified criteria (see requirements for quality). Needs may include, for example, aspects of performance, usability, dependability, safety, environment (see requirements of society), economics and aesthetics.
  4. The term ‘quality’ should not be used as a single term to express a degree of excellence in a comparative sense, nor should it be used in a quantitative sense for technical evaluations. To express these meanings, a quantifying adjective should be used. For example, use can be made of the following terms:
     a. ‘relative quality’ where entities are ranked on a relative basis in the degree of excellence or comparative sense;
     b. ‘quality level’ in a quantitative sense (as used in acceptance sampling) and ‘quality measure’ where precise technical evaluations are carried out;
  5. The achievement of satisfactory quality involves all stages of a quality loop as a whole. The contributions to quality of these various stages are sometimes identified separately for emphasis; for example, quality due to definition of needs, quality due to product design, quality due to conformance, quality due to product support throughout its lifetime.
  6. In some references, quality is referred to as ‘fitness for use’ or ‘fitness for purpose’ or ‘customer satisfaction’ or ‘conformance to the requirements’. These represent only certain facets of quality, as defined above.

‘Entity’ is defined as:

- *That which can be individually described and considered.*

  **Note:** An ‘entity’ may be for example:
  - An activity or process,
  - A product,
  - An organisation, a system or a person,
‘Requirements for quality’ is defined as:

‘Expression of the needs or their translation into a set of quantitatively or qualitatively stated requirements for the characteristics of an entity to enable its realisation and examination.’

Notes:
1. It is crucial that the requirements for quality fully reflect the stated and implied needs of the customer.
2. The term ‘requirements’ covers market-based and contractual as well as an organisation’s internal requirements. They may be developed, detailed and updated at different planning stages.
3. Quantitatively stated requirements for the characteristics include, for instance, nominal values, rated values, limiting deviations and tolerances.
4. The requirements for quality should be expressed in functional terms and documented.

‘Requirements of society’ are defined as:

‘Obligations resulting from laws, regulations, rules, codes, statutes and other considerations.

Notes:
1. ‘Other considerations’ include notably protection of the environment, health, safety, security, conservation of energy and natural resources.
2. All requirements of society should be taken into account when defining the requirements for quality.
3. Requirements of society include jurisdictional and regulatory requirements. These may vary from one jurisdiction to another.’

‘Customer’ is defined as:

‘Recipient of a product provided by a supplier’.

‘Process’ is defined as:

‘Set of inter-related resources and activities which transform inputs into outputs’.

Note: Resources may include personnel, finance, facilities, equipment, techniques and methods.

‘Product’ is defined as:

‘Result of activities or processes’

Notes:
1. A product may include service, hardware, processed materials, software or a combination thereof.
2. A product can be tangible (e.g. assemblies or processed materials) or intangible (e.g. knowledge or concepts), or a combination thereof.
3. A product can be either intended (e.g. offering to customers) or unintended (e.g. pollution or unwanted effects).

‘Organisation’ is defined as:

‘Company, corporation, firm, enterprise or institution, or part thereof, whether incorporated or not, public or private, that has its own functions and administration’.

‘Supplier’ is defined as:

‘Organisation that provides a product to the customer’.

‘Grade’ is defined as:

‘Category or rank given to entities having the same functional use but different requirements for quality’

Notes:
1. Grade reflects a planned or recognised difference in requirements for quality. The emphasis is on the functional use and cost relationship.
2. A high-grade entity (e.g. a luxurious hotel) can be of unsatisfactory quality and vice versa.
3. Where grade is denoted numerically, the highest grade is usually designated as 1, with the lower grades extending to 2, 3, 4, etc. Where grade is denoted by a point score, such as a number of stars, the lowest grade usually has the least points or stars.

‘Quality assurance’ is defined as:

‘All the planned and systematic activities implemented within the quality system and demonstrated as needed, to provide adequate confidence that an entity will fulfil requirements for quality.’

Notes:
1. There are both internal and external purposes for quality assurance:
   a. Internal quality assurance: within an organisation, quality assurance provides confidence to the management;
   b. External quality assurance: in contractual or other situations, quality assurance provides confidence to the customers or others
   c. ...
   d. Unless requirements for quality fully reflect the needs of the user, quality assurance may not provide adequate confidence.
figure 12.2: Relation between requirements for quality, requirements of society and customer needs
The sole responsibility for the content of this publication lies with the authors. It does not necessarily reflect the opinion of the European Union. Neither the EASME nor the European Commission are responsible for any use that may be made of the information contained therein.