EuroPHit

D4.2_Increasing the confidence of Financial Institutions in Refurbishments through Energy Efficiency and Quality Assurance

INTELLIGENT ENERGY – EUROPE II

Energy efficiency and renewable energy in buildings

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EuroPHit

[Improving the energy performance of step-by-step refurbishment and integration of renewable energies]

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1 Introduction

One of the major barriers to the scaling-up of energy efficient retrofits in buildings has been identified as being the level of uncertainty regarding the actual performance of the refurbished building against the designed performance, known as the performance gap. Additionally, people often adapt their behaviour in ways that increase consumption after an energy efficiency project, also known as rebound effects.

Performance gaps and rebound effects are often not taken into account when assessing benefits to residents like a reduction in bills or improvements in thermal comfort. If future savings have been over-estimated, it is residents who are doubly and disproportionately penalised, firstly, because what has been promised is not delivered and, secondly, because they pay the energy bills. [1]

The difference between the design and as-built performance can vary dramatically, over 200% in one study of thermal retrofit examples in Germany [2]. A UK study found that the introduction of new gas central heating systems, although theoretically more efficient had no impact in reducing the amount of fuel consumed [3].

The Zero Carbon Hub identified a number of issues affecting the performance gap, across the design process, procurement, construction, commissioning and completion, construction joint details and knowledge and skills. “Lack of adequate quality assurance on site and responsibility for QA” was identified as being one of the issues contributing towards the performance gap. [4]

This paper describes the purpose and importance of Quality Assurance (QA) systems in improving as-built performance and thereby increasing the confidence of financial institutions.

2 About Quality Assurance (QA)

2.1 The Role of QA

QA is used in many industries in order to improve efficiency and meet customer demands for more consistent quality. Rather than being a criticism of current ways of working, it is a way to enable improvement.

While there are a number of definitions to describe what constitutes QA, the following seems to be the most appropriate to the construction industry: *“An objective demonstration of a builder’s ability to produce work in a cost effective way to meet the customer’s requirements.”*

The construction of buildings has evolved from what was a craft process, to one where the critical work of connecting interdependent units is done, in the main, by semi-skilled labour. This makes great demands upon supervision and management systems. This is another reason why QA systems are of great value.

QA is concerned with developing and planning the necessary technical and managerial competence to deliver desired results. It is also about the attitudes of all of those involved in the construction process. The philosophy of QA is intended to ensure that the work satisfies the customer’s requirements and offers a fair return on the inputs of resources. It becomes a way of doing things.

A designated individual is often made responsible for over-seeing and ensuring the implementation of QA procedures on-site. A planned system of communication and training for all those affected by the QA system should be carried out to ensure that procedures are adopted. The work may be regulated by an external independent audit to provide additional rigour. [5]

Intended outcomes of using a QA system include the following:

1. Economic and environmental savings.
2. Avoidance of sub-optimisation.
3. Improved communication within the project.
4. Improved feedback within the organisation.
5. More satisfied customers/tenants.

Aspects of QA to consider include the following:

- **Assurance:** The act of giving confidence, the state of being certain or the act of making certain.
- **Quality Assurance:** The planned and systematic activities implemented in a quality system so that quality requirements for a product or service will be fulfilled.
- **Control:** An evaluation to indicate needed corrective responses; the act of guiding a process in which variability is attributable to a constant system of chance causes.
- **Quality Control:** The observation techniques and activities used to fulfil requirements for quality.

3 Passivhaus QA Requirements

The Passivhaus buildings standard requires all of the following, although this list is not exhaustive:

1. The use of Passivhaus Planning Package (PHPP) – a bundle of both software and guidance notes - and the entry of the correct data.
2. That all relevant design assumptions and boundary conditions accord with those established by the PHPP.
3. That the conductivities of all materials, products, components and constructions (including thermal bridging) satisfy the relevant EN standards.
4. That the internal surface temperature of the windows will not fall below 17°C on the coldest day of the year.
5. That pressure tests have been undertaken in accordance with EN 13829 (with the variant that both pressurisation and depressurisation should be undertaken and that the mean result be used during certification procedures).
6. That where mechanical ventilation heat recovery (MVHR) is utilised it satisfies the PHI's strict performance requirements for those systems.
7. That MVHR systems be commissioned in accordance with the requirements of the Passivhaus standard.
8. That the contractor writes a declaration confirming that the building has been built in accordance with the contract documentation.
9. Photographic records of the project.
10. A comprehensive set of construction drawings and documentation.
11. That the above tools and documentation be used to demonstrate that the energy performance standards established by the Passivhaus Institute have been satisfied.

Certification by an approved certifier is a quality assurance mechanism that ensures that all of the above requirements have been met. This is supported, and recommended, by both the Passivhaus Institute and the Passivhaus Trust.

A building can achieve the Passivhaus standard (and indeed be a Certified Passivhaus building) using products that are not certified by the Passivhaus Institute, provided that the products used meet the necessary performance requirements. It should be noted that the use of Passivhaus Certified, or Passivhaus suitable, products and materials is not evidence of suitability in all cases. However the use of certified components does simplify the audit trail that is utilised by the standard.

3.1 EnerPHit QA Requirements

For QA and verification of the specific energy values achieved, buildings that have been modernised using Passive House components and that do exceed the Passive House boundary values (for existing building substance reasons), can receive the "EnerPHit – Quality-Approved Modernisation with Passive House Components" certificate.

Additional quality assurance of the construction work by the certifying body is particularly expedient when the construction management has no experience with the modernisation of existing buildings using Passive House components.

4 Other Industry Examples

This section of the report details a number of other examples of QA-related systems and processes that can be applicable to the construction industry.

4.1 ISO 9000

The ISO 9000 family addresses various aspects of quality management and contains some of ISO's best known standards. The standards provide guidance and tools for companies and organisations who want to ensure that their products and services consistently meet customer's requirements, and that quality is consistently improved. [10]

Standards in the ISO 9000 family include:

- ISO 9001:2008 - sets out the requirements of a quality management system.
- ISO 9000:2005 - covers the basic concepts and language.
- ISO 9004:2009 - focuses on how to make a quality management system more efficient and effective.
- ISO 19011:2011 - sets out guidance on internal and external audits of quality management systems.

4.1.1 ISO 9001:2008

ISO 9001:2008 sets out the criteria for a quality management system and is the only standard in the family that can be certified to (although this is not a requirement). It can be used by any organisation, large or small, regardless of its field of activity. ISO 9001:2008 is implemented by over one million companies and organisations in over 170 countries.

This standard is based on a number of quality management principles including a strong customer focus, the motivation and implication of top management, the process approach and continual improvement. Using ISO 9001:2008 helps ensure that customers get consistent, good quality products and services, which in turn brings many business benefits.[10]

4.2 SQUARE – A System for Quality Assurance when Retrofitting Existing Buildings to Energy Efficient Buildings

A QA system can be used to track the requirements written into the retrofit contract. These requirements/targets could include legal requirements, guidelines and recommendations. Requirements and targets include:

- Energy requirements and targets for the indoor environments in the building under construction
- Requirements concerning the indoor environment
- Quality requirements and targets for the construction process, including components

- Performance requirements for critical components.[8]

An example model for the implementation of a QA system for retrofit projects:

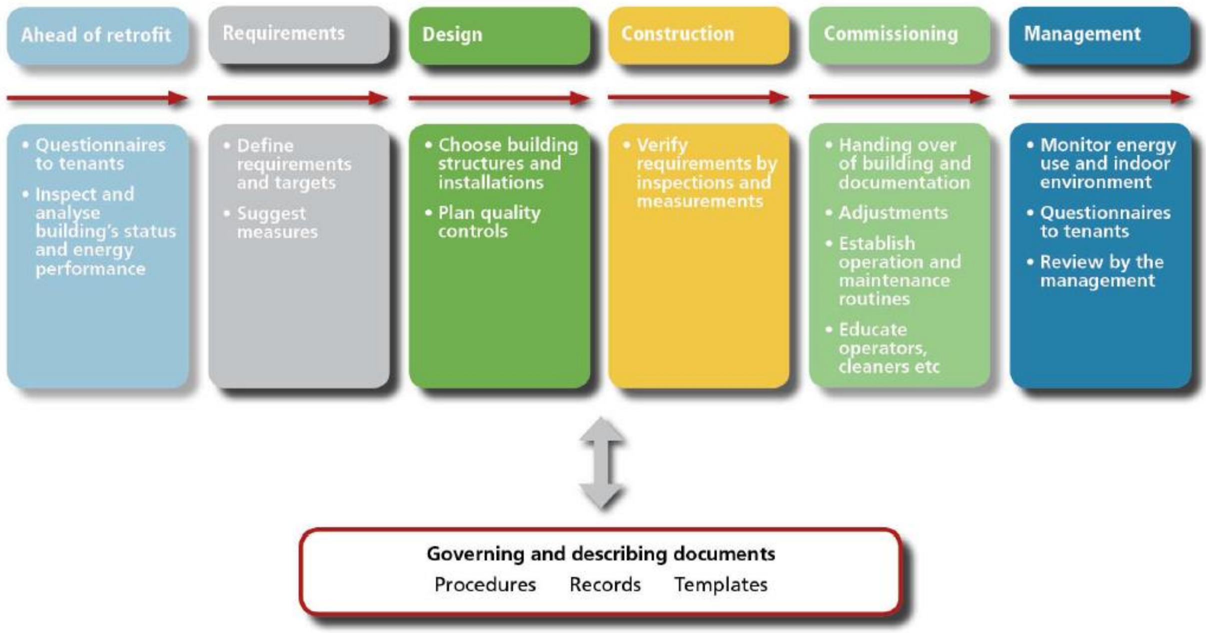

Figure 1: **Model for implementation of a QA system for retrofit projects** [8]

The following list sets out examples of QA-related aspects and issues throughout the construction process. [8]

1. Setting requirements and targets:
    a. Minimised ventilation heat losses.
    b. Improved indoor environment.
    c. Rectification of construction damage.
2. Design stage:
    a. Active participation with stakeholders.
    b. Communicate the importance of quality construction work in order to reach performance targets.
    c. Present and discuss new energy efficient concepts and products.
    d. Discuss methods for quality checks.
    e. Agree who will undertake checks and how results will be reported.
    f. Discuss third-party testing and control of new/advanced components used.
3. Construction stage:
    a. Inspections and measurements to verify requirements.
    b. Supervise, collect reports and relevant documentation.
    c. Continue dialogue, encourage knowledge-sharing and feedback.
4. Commissioning:

   a. Handover of building and documentation.
   b. Adjustments to the building and services.
   c. Documented plans for operation and maintenance.
   d. Training.
5. Property management:
   a. Follow-up of energy use, including comparison with target values.
   b. Regular checks of building performance and indoor environment.
   c. Post-occupancy evaluation with occupants, with continuous feedback.

4.3 The Better Retrofit Partnership, UK

In the UK, high percentages of retrofit projects are not performing as expected, and in some cases are actually increasing the risks to long-term fabric viability and occupant health. Measures that are widely accepted in the industry consistently have unintended impacts on building fabric and performance.

The Better Retrofit Partnership [6] was formed to provide a comprehensive performance pledge for retrofit to cover risks that have the potential to affect projects. Different measures cannot be taken in isolation, but must be fully integrated across the whole house. All aspects of building performance must be taken into account.

The Partnership comprises home energy efficiency consultant Parity Projects, ventilation specialist Aereco, building materials manufacturer Baumit and sustainable materials supplier National Building Technologies (NBT).

The intention is to consider design in detail and offer appropriate approaches to retrofit using established evidence. The offering is fully integrated at every stage from the initial impartial survey through to post-occupancy work and monitoring.

The performance pledge begins with a comprehensive survey, energy assessment and risk assessment. A tailored and cost-effective design and specification is produced and then delivered by approved installers. The works are then tested post-completion through monitoring and feedback.

Performance is measured using a combination of survey-based modelling and pre- and post-completion testing (thermographic and airtightness). Ongoing monitoring and feedback, including internal temperature, relative humidity and occupant surveys, provide additional evidence. The methodology and metrics are fully declared, transparent and based on current best practice and understanding.

The Partnership is believed to be the UK's first comprehensive performance assurance, covering whole house performance, usability and maintenance.

The ambition is to raise standards and understanding for the industry and deliver material benefits to the occupants. Ultimately, the aim is to secure insurance-backed guarantees for projects undertaken under the Partnership, giving external validation. [7]

4.4 Impacts of Quality Management on Companies

The table below demonstrates the differences in approach between companies without a formalised QMS, and those with a comprehensive QMS. [11]

No Formal Quality Management System (Typical Construction)	Greater Quality Management (Comprehensive QMS)
Corporate Culture of Quality	
Finishing the job quickly is most important. Senior management does not create accountability to quality; there is no overall culture of quality.	Senior management values QA and is committed to its QMS, communicates this commitment, and holds all workers accountable in a corporate culture of quality.
Statistical Measurement of Performance Including Customer Satisfaction	
Minimal tracking of statistics and minimal feedback for continuous improvement. Customer satisfaction is not a primary driver for improvement.	Comprehensive feedback loops using statistics and lessons learned are consistently evaluated resulting in continuous improvement. Customer satisfaction is a primary driver for quality improvement.
Company Quality and Financial Performance Results	
Company financial (such as gross/net profits) and quality performance (such as callback ratios) are average.	Company financial (i.e., gross and net profits) are above industry average and quality performance (i.e., callback ratios) are below industry average.
Company Operational Policies and Procedures	
Few policies and procedures are documented, they are not effectively communicated or monitored, and they are often not understood or followed.	Many policies and procedures are written, effectively communicated, and monitored to ensure that they are followed; procedures are typically followed.
Installation Process and Performance Standards and Tolerances	
Inconsistent installation and no agreement for installation process and tolerances.	Consistent application and common agreement for installation process and tolerances.
Inspection Process and Feedback Loops	
Ineffective, unstructured, or undocumented inspection process with minimal or ineffective feedback loops.	Effective, structured, and documented inspection process with effective feedback loops for continuous improvement.
Design Process	
Design planning process is minimal or ineffective with minimal feedback loops.	Comprehensive design and planning process with feedback loops from all relevant parties.
Specifications	
Specifications are minimal, incorrect, or unclear and often undocumented.	A detailed process is used to develop and document clear and detailed specifications.
Application of Building Science	
Understanding of local, state, and federal energy codes.	Thorough understanding of building science applied to design and construction process.
Material Selection and Approval	
There is no clear material approval process, and no or ineffective material inspection.	There is a detailed material selection and approval process and material inspection.
Installer Skills and Training	
Unskilled and/or untrained labor with little accountability for results.	Labor is trained and held accountable to performance standards.

Figure 2: How issues are addressed in residential construction based on company level of quality management

Some of the key steps to implementing an effective quality management system include the following [11]:

1. **Assess and prioritise company needs.** Assess where the company is on the quality path. Prioritise quality improvement activities.

2. **Develop a strategic plan.** Appreciate the value proposition of quality management and understand the basic quality concepts. Give longer-term direction to the quality program and identify resources to be allocated in pursuit of the strategy.
3. **Create a corporate culture of quality.** Starting with top management, become committed to quality management; foster a culture of quality throughout the company.
4. **Implement quality improvements.** Adopt quality management tools and techniques from an assessment of current designs and processes.
5. **Expand to comprehensive QMS.** Develop and implement a company-wide QMS.
6. **Become third-party certified.** Achieve third-party quality certification.
7. **Apply for quality award.** Be recognized; use awards as a marketing tool.

4.4.1 Financial Impacts of Quality

There is a compelling relationship between implementing a comprehensive QMS and a company's bottom line. The NAHB Research Center's NHQ program has recorded remarkable results from home building companies that have implemented quality management systems. A survey of the NHQ program18 revealed that, after achieving NHQ certification [11]:

- 80% of trade contractors reported a reduction in call-backs.
- 88% achieved an increase in employee accountability.
- 79% improved relationships with builders.
- 65% overall improved their bottom line.
- 70% of builders improved their bottom line.
- 75% reported a reduction in call-backs and improved relationships with trades.
- Trade contractors reported up to 25% reduction in cycle time.

Further, NHQA winning builders have noted tremendous effects from implementing QMS. A sampling of results includes:

- 98% homes zero defects at closing, net profit increased 9% (Grayson Homes, Maryland).
- Reduced cycle time by 15% (Pringle Homes, Florida).
- 95% of trades list builder as the best to work for (Estes Homes, Washington).
- 33% of homeowner recommendations resulting in sale (TS Lewis, Arizona).

Finally, a 1997 NAHB study reported the average builders' net income before taxes was 5.1% and gross margin was 18.5%; NHQA builders, on the other hand, achieved an average net income of 11.2% and gross margin of 25.5%.

5 Questionnaire Responses

A questionnaire was developed to gather information from refurbishment projects on QA practices and the impact of these practices on the economics of a project. The questionnaires were shared through the EuroPHit partner contacts, amongst other routes. Feedback was limited but is summarised below.

5.1 Energy efficiency project financing

58% of the responses thought that it was difficult to access energy efficiency project financing. Furthermore, 26% of the respondents were not aware of any specialist financial institutions that have specific credit lines for encouraging energy efficiency projects. However, 81% of the respondents answered that they were aware of Government investment programmes, which can be adopted to fund energy efficiency projects.

There were four investment programmes that the respondents highlighted. These are:

- 58% of the respondents have stated that these investment programmes will provide a direct subsidy as a percentage of the investment.
- 25% stated that tax credits/tax rebated for highly efficiency EE technology.
- 8% of the respondents stated white-certificates (carbon trading) are applied for encouraging energy efficiency.
- 8% stated that credit guarantee schemes are used to promote energy efficiency

A total of 75% said they were not aware of any finance institute encouraging owners to achieve higher EE standards that required by national regulations.

64% of the respondents had no experience of using any finance model to fund an energy efficiency refurbishment project. The respondents saying that they had used some form of finance model, specified the following mechanisms they have used:

- A Bank loan.
- GDHIF voucher.
- Contingent grants (forgivable loans), soft and convertible loans.
- KfW programme.
- Reduced interest rate mortgage for energy efficient construction.

From the returned responses the majority of the projects were self-financed. Some received grant funding, whereas some received council funding.

5.2 Influence of QA

In most cases it was the architect who carried out the refurbishment design and associated energy calculations/assessment. From the responses returned, the most common method of QA, was through the PassivHaus Planning Package (PHPP), and site visits by the architect. From the retuned responses, it is not possible to say if the quality assurance process, had increased the value or rental value of the building as a result of the refurbishment.

6 Conclusion – Effects of QA and energy efficiency solutions on economics

This report has outlined the background to QA processes, industry examples, and impacts. Limited information has been obtained to show a strong link between QA in isolation and property values, but marks of building certification that include aspects of QA are looked upon favourably. QA can also be a way of overcoming a number of market barriers to retrofit projects.

Lack of trust is a barrier; trust in assessors, energy companies, Government, builders, installers, suppliers, etc. and consumers are unable to find trusted sources of advice. The renovation sector is negatively associated with poor quality and there is a cowboy view of many trades. Bad press from failed projects and bad publicity has not helped. There is a fear of miss-selling, problems with the installations, vandalism/damage to the installations, damage to the structure, spoiling of the appearance and character of the property. An additional barrier is the high risk involved, with health problems associated with increased airtightness, mould and damp issues, uncertainty and scepticism in less familiar technologies. [12] It is clear that appropriate QA could help to overcome such barriers.

An analysis of seven building projects of various sizes in Australia has demonstrated that 'quality does not cost – it pays'. Through the implementation of a pro-active quality system that costs about 1% of the project value (the prevention cost), the expenditure as a result of repair (the failure cost) drops from 10% to 2%, representing a saving of 7%.

QA systems also have other potentially less obvious benefits. For a contracting company, a well-established quality system is a marketing tool, especially when the company has gone through third party certification. The quality system helps promote the image of the company and provide the much needed competitive edge in a competitive market. [9]

Aesthetic improvements, construction quality and operational costs are certainly likely to be factors in the decision to undertake a retrofit and are likely to add market value. As to whether the market value will be affected specifically by the use of a QA system, is unclear. For example in the UK, energy performance in domestic properties is not currently reflected in property value (in both the rental and sales market). [12]

Financial institutions are likely to have more confidence in projects that have used a recognised and well-established QA system. In this way, the institution can have greater certainty that the project will perform as intended, and therefore lead to successful repayment of the financing.

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Technical References

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