Attractive, Acceptable and Affordable deep Renovation by a consumers orientated and performance evidence based approach

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Revision and history chart:

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Glossary of terms

Accreditation
Accreditation is a quality assurance process under which services and operations of (educational) institutions or programs are evaluated by an external body to determine if applicable standards are met. If standards are met, accredited status is granted by the appropriate agency. (Wikipedia)

API
Application Programming Interface. This is used to query separate databases in a secure way.

BIM-Skills Matrix
A Qualification Framework developed in H2020 BIMplement, usable to connect tasks and related subtasks to Unit of Learning Outcomes, BIM-elements and RIBA project phases

BIMplement Qualification Framework
The BIMplement Qualification Framework consists of a flexible methodology that allows definition of professional activities, related skills, required competences in order to achieve a desired quality in the field of nZEB. It is setup as a set of re-usable classifications. These classifications can be used in BIM-projects to describe items in a standardized, unified way and to link them to existing classifications that describe involved technologies, project-stages and involved actors.

BUILD UP Skills
The BUILD UP Skills initiative is an initiative from the EU commission for accelerating massive upskilling of the workforce required for sustaining the Built environment

do-creator platform
A digital environment in which stakeholders and the building sector cooperate in creating successful nZEB concepts

Competence
The ability of an individual/organisation to do something effectively. It consists of a cluster of related abilities, commitments, knowledge, and skills that enable a person (or an organization) to act effectively in a job or situation.

CPD
Continuing Professional Development (CPD) is a structured way of maintaining and developing your competence as a qualified professional by engaging in regular learning activities. CPD can be either structured or informal. “Structured” CPD will often be in a classroom, though it can also be through distance learning or online learning. Structured CPD activities will have clear learning aims and outcomes which will have been given to you by a teacher, speaker or tutor. Informal CPD will usually mean quick, free and self-directed activities, such as reading. It may not always be obvious that these informal activities are CPD, but if you can learn from them, they can help you to stay up to date in a general way.

Cross-level
Interactions between persons with different EQF-levels. For example between white collars and blue collars

Cross-trade
Interactions between persons with a different occupation/trade/profession

EQF
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The European Qualifications Framework (EQF) is a translation tool that helps understand and compare qualifications awarded in different countries and by different education and training systems.

Its eight levels are described in terms of learning outcomes: knowledge, skills and competences.

**Just in time and just in place learning**
Learning at the right moment and on the right place

**Learning loops**
A loop that enables learning within a project, within multiple projects and within a system. (See the GA for more information.)

**Multi-layered qualification**
A multi-layered qualification is a description of tasks that have to be performed to be effective. It consists of a layer with basic tasks and one or more layers of context specific layers. For example nZEB related tasks, BIM-related tasks or Indoor air quality (IAQ) tasks.

**Occupation**
An occupation is a job or profession

**Post-initial training**
Training people receive after leaving initial training. In general, professional post-initial training is based on demand from market parties for retraining. These (short) trainings results most times in a certificate, which offers a limited validity. They do not result in the earning of a certain EQF level.

**Profession**
A profession is a specialized occupation characterized by profession specific education and training.

**Qualification**
A pass of an examination or an official completion of a course, especially one conferring status as a recognized practitioner of a profession or activity.

**Qualification schemes**
A validated scheme with Unit of Learning Outcomes usable for education and training purposes

**Self-inspection**
Inspection by the involved worker itself. The worker who applies a material or installs a measure is performing an inspection of his/her own work

**Self-instruction**
An instruction that is notified to the involved professional and then successfully digested/followed. For example a step by step installation manual

**Unit of Learning Outcome**
A Unit of Learning Outcome is an element of a Qualification Scheme describing a coherent set of a competence, skills and knowledge involved.
1. Introduction

The TripleA-reno concept involves addressing the performance gap between designed and realized performance by implementing a general approach for quality improvement enabled by Continuing Professional Development (CPD) and underlying Qualification Schemes (QS). As there is an increasingly strong body of evidence available on the ‘performance gap’ relating to energy consumption. There is also a growing interest in the measurable aspects of indoor environmental quality and personal health. Both elements will be addressed. TripleA-reno will tackle this issue by:

1. involving the occupants/consumers in the project and collect real performance data in use;
2. implementing methodologies on enhanced quality control of related projects like IEE QUALICHeCK and H2020 BIMplement.

In order to tackle the challenge a 3-level gamified platform is foreseen. With on Level 1 co-design in design phase, on Level 2 Quality assurance during construction phase and in Level 3 performance monitoring in the in use phase. Gamification will be implemented to nudge the users of the platform.

In work package 3 content, design, game-rules and user-stories needed to fill the TripleA-reno platform are delivered and hooked up to a voluntary certification scheme for achieved quality and performance.

![Figure 1 Visualisation of the TripleA-reno platform](image)

This deliverable will address the challenge of implementing a general approach for quality improvement enabled by Continuing Professional Development (CPD) and underlying Qualification Schemes (QS), in other words the Level 2 functionality.
2. The TripleA-reno approach on Quality Assurance

TripleA-reno is focusing on:

a) Using just in time and just in place learning tools to deliver self-instruction content and to foster self-inspection of realized quality; based on open standards to make easy (future) implementation in BIM and other quality and planning systems possible.

b) Triggering and encouraging workers and professionals to take responsibility (by gamification) using the data collected to enable learning loops for ‘the solution’ providers.

With the objective to create awareness of workers and professionals about each other’s responsibilities and required skills, cross-level and cross-trade. With as a result optimized solutions, products and a renovation process that delivers quality and performance.

In order to reach these goals several element have to be addressed.

1. A task based qualification; addressing all knowledge, skills and competences needed.
2. A process oriented workflow; enabling just in time and just in place delivery of learning content
3. Interactions / tools for learning and Quality Assurance (AQ); for empowering learning and AQ
4. Links to design phase and ‘formal’ inspection; for assuring that cross-phase learning is silvered and quality assured.

Figure 2 Elements in the TripleA-reno approach
2.1 Task based Qualification

TripleA-reno will implement the in BIMplement (GA 745510) developed BIM-enhanced Qualification Framework empowering nZEB construction and the Qualification Database co-developed to host developed Qualifications in H2020 projects BIMplement and NEWCOM (GA 754148).

The BIMplement Qualification Framework consists of a flexible methodology that allows definition of professional activities, related skills, required competences in order to achieve a desired quality in the field of nZEB. It is setup as a set of re-usable classifications. These classifications can be used to describe items in a standardized, unified way and to link them to existing classifications that describe involved technologies, project-stages and involved actors. The BIMplement qualification framework is in other words setup as a multi-layered qualification matrix. It is composed out of tasks that have to be performed to be effective. It consists of a layer with basic tasks and one or more layers of context specific layers. For example nZEB related tasks, BIM-related tasks. If needed more layers can be added, for example for Indoor air quality (IAQ) tasks or Circular Building tasks.

The corresponding database identifies for each technology which professions and specialisms are involved in each phases, the needed skills, competences and descriptors, i.e. the related qualifications and which trainings, courses, learnings are available.
In TripleA-reno this information will be connected to the measures in the proven measures/concepts carousel. Based on this information advice on upskilling activities, building team composition and critical inspection points can be provided to the construction team. These connections can be made in several ways; in interaction with WP4 choices in these matter have to be made:

1. Automatic; based on normalized use of measure names
2. Automatic; using a linking table, that links measures to specialisms in the database
3. Dynamic; using an API structure
2.2 Process oriented workflow

To facilitate just in time, just in place and fit for purpose delivery of learning and/or inspection content a process oriented workflow is needed. To attain this TripleA-reno will use the in BIMplement developed Model nZEB Cross-trade Quality and BIM-Skills Matrix.

The BIMplement Model nZEB Cross-trade Quality and BIM-Skills Matrix is a structure for overall quality control. This structure helps to analyse and optimize the linkage between the process, qualifications and classifications. It can be applied to control the production process including specifications, design, construction, hand-over and operation. This from perspective of focus on avoiding failures on all strategic aspects and moments in this process. It is an instrument for controlling the total process of making building services and can be applied for advanced ventilation systems and concepts (i.e. ventilation systems in relation to properties of the building and other building services). It contains all operational techniques and activities, necessary to realize a defined level of quality.

The quality level has to be precisely formulated. In the framework “Quality” means that the delivered performance matches the required and precisely formulated requirements and expectations of the principal, including time planning, budgets as all technical aspects. The Quality Control should focus on:
- avoiding failings in all the phases of the process, starting with the program phase up to and including the operational phase;
- assuring reliability in defined time intervals

In order to deliver a good final product the activities of all individual building partners as well as their skills (and skills levels) must be geared to one another. In all the phases of the process several activities will be carried out that have an impact on the quality of the final product. For example, a client is perhaps not able to formulate her/his requirements and expectations in the program phase. This leads to the risk that technical ideas are developed in the design phase and elaborated in the elaboration phase that will not be financially feasible or match with the overall expectations. Another risk is the development of technical ideas in the design phase that has a certain level of technical complexity. If the required skills of installers are not well defined there is a major risk of failures during the execution and the operation of the installation.

Quality Control in BIMplement (the ‘Model nZEB Cross-trade Quality and BIM-Skills Matrix’) is based on a general model that can be applied for all kinds of processes (building and building services, industrial etc.). For example regarding HVAC systems it is possible to elaborate a Quality Control system for the total HVAC system or for separate elements (i.e.: heating, cooling, ventilation). The most important characteristic for the BIMplement Quality and BIM-Skills Matrix is a structure that follows all the process phases. This enables
to build in a number of strategic decision and quality control moments in the (construction or renovation) process and to assess if a ventilation system meets the targets and requirements, as defined in the program phase. As the total quality is determined by several aspects (not only technical but also financial, organization and communication) 10 different quality control aspects can be discriminated. This leads to the basis of the BIMplement Model nZEB Cross-trade Quality and BIM-Skills Matrix. On the horizontal axis of the matrix the phases of the process are distinguished. On the vertical axis of the matrix ten distinguished quality control aspects are listed.

<table>
<thead>
<tr>
<th>Project phase</th>
<th>I Programme</th>
<th>II Design</th>
<th>III Elaboration</th>
<th>IV Realisation</th>
<th>V Operation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Quality control aspect</td>
<td>0 General</td>
<td>1 Organisation</td>
<td>2 Communication</td>
<td>3 Requirements</td>
<td>4 Means</td>
</tr>
</tbody>
</table>

**Process phases:**

**I Program phase:** In the program phase an inventory takes place of requirements, demands and expectations of the ventilation system. Also all limiting boundary conditions must be listed and formulated. For the preliminary selection of the concept and type of HVAC system the main consequences are visualized. At the end of the program phase the principal, architect and (ventilation) consultant have enough information to make a first selection of the ventilation concept/system.

**II Design phase:** In the design phase the ventilation concept, as preliminary selected in the program phase, is elaborated by the ventilation consultant. Communication with architect and constructor takes place to tune building technical and architectural boundary conditions with the ventilation concept and vice versa. There will feedback to the starting points of the programm phase. At the end of the design phase a final selection of the ventilation concept takes place.

**III Elaboration phase:** In the elaboration phase the ventilation concept will be elaborated to a system level and a component level. Specifications will be elaborated and materialization takes place in this phase. This includes also detailed financial calculations.

**IV Realization phase:** In the realization phase the actual construction of the ventilation system takes place. This phase ends with the acceptance and hand-over of the installation. Note that during this phase, and in particularly during the acceptance, “commissioning” takes place according to the “English” definition (i.e.: testing of the installation of realization to check if it meets the terms of reference).

**V Operation phase:** In this phase the actual operation of the building and ventilation system takes place after the acceptance and hand-over of the installation. In ASHRAE publication 1996-1 this phase is called “post-acceptance phase”, in BREEAM this is called “post construction review (PCR)”. In this phase commissioning is the continued adjustment optimization and modification of the ventilation system, including maintenance to meet and to maintain the specified requirements.
Quality Control Aspects:

0 **General:** Description the general objective(s) of each phase including the starting points, boundary conditions and points of particular interest.

1 **Organization:** Description and allocation of tasks and responsibilities.

2 **Communication:** Description and recording of the necessary information exchange between all parties involved in the process is reported including a description about the necessary consultations including which parties, when, the objective and deliverables of each consultation.

3 **Requirements:** Inventory of internal and external requirements including a base level of legal and technical requirements like buildings regulations, standards and others as well as recommendations, according to (higher) quality level.

4 **Means:** Listing of all necessary calculation methods, execution protocols, assessment and evaluation tools including references to standards (like calculation, determination and measurement methods) measurement instruments and literature.

5 **Purchase:** Description of necessary external expertise that has to be purchased.

6 **Time:** Guarding of the object planning as well as process planning.

7 **Finance:** Controlling and guarding of the object costs (i.e. ventilation installation) as well as the process costs (co-ordination, consulting, commissioning).

8 **Documentation:** Reporting of the input and output of all sequencing phases.

9 **Experience:** Evaluation of the process at the end of the phases

From the main cells in the matrix that will be references to other cells. In these cells is stated which subjects and partial subjects are addressed. In separate specification sheets these (partial) subjects are further elaborated:

<table>
<thead>
<tr>
<th>QC MATRIX</th>
<th>CELL CONTENTS &gt; BIM</th>
<th>SPECIFICATION SHEET II.3-2</th>
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<td>8</td>
<td></td>
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</tr>
<tr>
<td>9</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Using the BIMplement Model Quality and BIM-Skills Matrix it is not necessary (and often not possible) to fill in all cells. But every information that is available can be "recorded and stored" in logical way in a cell, elaborated in specification sheets. Often this information is spread over two or more phases, consequently, over several specification sheets, corresponding with the distinguished phases and/or quality control aspects. It is important to analyse exactly in which phase and for what quality control aspect the information is necessary. Therefore it is important to know the meaning of each different quality control aspect. It is not possible and necessary to address all the quality control aspects. Parts 5, and specially 6, 7 and 9 are much more related to specific projects. On the other hand it is possible to write general guidelines for quality control of ventilation systems within this BIMplement Model Quality and BIM-Skills Matrix structure without addressing these aspects.

BIMplement Model Quality and BIM-Skills Matrix is not only for consultants and installers. All partners in the building process have to deal with the BIMplement Model Quality and BIM-Skills Matrix and will have to confirm to it. Also the principle must be aware of the fact that his responsibility reaches further then only the financial aspects. He has an important role during the program phase to formulate functional specifications, that can be “translated” by his consultants in a technical design and specifications.

The BIMplement Model Quality and BIM-Skills Matrix structure provides a perfect basis for the implementation of commissioning within a (production) process. Within the matrix cells can be identified which should be addressed for commissioning. Specification sheets can be further elaborated. As a commissioning document on ventilation has a general character (i.e. not related to a particular project) not all cells can be filled in. More over all descriptions and specification sheets will give in many cases guidance how to fill in specifications related to a “real” project (this will be the case for organization, communication, purchase, time, finance and experience). On the other hand, aspects as requirements, means and realization can be elaborated in detail.

Within TripleA-reno the BIMplement Model Quality and BIM-Skills Matrix will be used mainly for analysis purposes. Based on the analysis trigger points for the gamification engine that steers the learning and QA process can be distilled.
An example
In general, following the BIMplement Model Quality and BIM-Skills Matrix cells can be filled regarding Quality Control and commissioning:

<table>
<thead>
<tr>
<th>quality control aspect</th>
<th>project phase</th>
<th>I programme</th>
<th>II design</th>
<th>III elaboration</th>
<th>IV realisation</th>
<th>V operation</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 general</td>
<td>I.0</td>
<td>II.0</td>
<td>III.0</td>
<td>IV.0</td>
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</tr>
<tr>
<td>2 communication</td>
<td>I.2</td>
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<tr>
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<td></td>
</tr>
<tr>
<td>4 means</td>
<td>I.4</td>
<td>II.4</td>
<td>III.4</td>
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<td>V.5</td>
<td></td>
</tr>
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<tr>
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<tr>
<td>7 finances</td>
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<td>III.7</td>
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<td>8 documentation</td>
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<td>V.8</td>
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<tr>
<td>9 experience</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>IV.9</td>
<td></td>
</tr>
</tbody>
</table>

I Program phase:
In 0 quality control must be mentioned as one of the boundary conditions in a project. This means that in the program phase provisions must be described in the ToR to execute all necessary activities for quality control (like BEMS, measuring points, balancing provisions, provisions for scheduled maintenance etc. etc.). In 1 can be stated who will be responsible for organizing quality control (as described in 0) in the program phase and in following phases and which other parties should be involved. In 2 can be described during which phases which parties should discuss quality control, what kind of meeting(s) are necessary as well as the deliverables of the meetings. Very important is 3, in a direct way as well as in an indirect way. Indirect means that proper specifications and the understanding that a principal knows what he asks and what he gets (i.e. that the specifications meets his expectations) is the beginning of good quality control. Of course all necessary provisions for quality control (mostly needed in phase IV and V) must be specified already in phase I. Of special concern is specification of components and provisions that allows maintenance and cleaning.

II Design phase:
In the design phase all necessary provisions for quality control must be take into account in the final design and specifications.

III Elaboration:
In the elaboration phase final selection of provisions for quality control are selected. This means that component specifications must be given under 3 and selection criteria and methods for components must be given under 4. Purchase costs must be reported and guarded under 7. Special concern is that for the final selection of components special requirements must be given to allow maintenance and cleaning. For example, if a ventilation concept contains metal ducts special requirements must be given for duct joints to avoid clogging and to allow cleaning (no screws!). Ventilation provisions in the facade must be selected such that cleaning is possible without the risk of destroying the controls and mechanisms or without the change to disturb adjustments.

IV Realization:
In this phase actual quality control takes place. This means that in 1 the organization of the quality control must be arranged (i.e. definition of responsibilities, who is doing what, quality control authority/organization, installers, etc.). If specialist and external expertise must be hired in it must
be reported under 5. Under 2 is arranged if meetings to arrange and discuss quality control and quality control results are necessary. Directives and guideline values are reported in 3. Tools, instruments, checklist procedures, measurement methods etc. etc. are listed in 4. Guarding of planning and costs are described in 6 and 7. In 8 is precisely described how the quality control results must be reported and documented; (note; in 2 the authorization and approval of these reports is arranged).

V Operation:
In the operation phase the continuous quality control process is arranged. Although the organisation and management structure that was operational during a building process is not available anymore in the operational phase the organisation of the continuous quality control can be described. It clearly will be another organisation and management structure then reported under I – IV. The tools and instruments as described under 4 will be partly the same as described in phase IV. Special attention in phase V is needed for maintenance. This also includes schedules for maintenance, to be reported in 6, and costs (i.e. cost reservations), to be reported in 7. As in phase IV precisely described quality control results must be reported in 8.

Note that this description only gives a preliminary idea how to arrange and organise quality control in a logical way in the sequential phases of a production process. This structure can be elaborated if necessary. It can also be used to fill in specification sheets on particular places where they are needed. In practice this can often follow from quality control aspect “9 – Experiences”.

Elaborated example on a MVHR system (Mechanical Ventilation with Heat Recovery)
For example, in an experimental site a MVHR system is selected to be applied in dwellings. For designing, selecting and installing a MVHR system in a dwelling, in the design phase a professional designer will be involved who should have knowledge of all the principles of MVHR, the (legal) requirements conform the building regulations, but also about the required level of air change rate of the dwelling. The designer should also be able to communicate with the architect, in order to optimize dwelling design in relation to the necessary duct work (i.e. in the matrix it can be indicated (under 2. Communication) that a meeting/consultation between the designer and architect should take place, including the expected outcomes).

The output of the design phase is an actual design of the system (which can reported under 8. Documentation). This output must be understandable for the purchaser (in the elaboration phase-III) to order right components and craftsmen (in the realisation or execution phase - IV) who have to do the actual installing work.

Under 3. Requirements the actual requirements of the MVHR system can be listed (i.e. required air flows, maximum energy use, control possibilities, maximum sound levels). These specifications are the basis for the handover in the realization phase (IV).

Under IV.4 means the methods of measurements and verification can be described. For exampleing, a description of the measurement procedures and equipment for measuring air flows as well as the way of reporting (in IV.8). In the next layer, the competences and vocational training can be listed to be able to perform the measurements.
2.3 Interactions for learning and QA

2.3.1 Learning

Concerning learning, training and qualification schemes should ensure that worker qualifications keep pace with the technical complexity of renovation process of the buildings and building components and to make sure that workers are tuned to technological development also educational seminars. TripleA-reno level 2 functionality will facilitate the workers with relevant knowledge needed to create the right performance. Awarding of using and/or contributing to inspection protocols will be strengthened by earning XP-points linked to personal professional development and/or keeping earned recognitions fresh.

Overview of the BUILD UP Skills advisor-app

The BUILD UP Skills advisor-app has several linked elements:
1. A course database with tagged online and offline learning interactions
2. A personal profile with a track record and personal notification settings
3. An LTI link to external e-learning systems, such as aNewSpring
4. A building errors interactions that enables to learn from real practice.

Figure 7 Overview of the BUS-app platform

For communication between the different IT-elements a secure Application Programming Interface is used, this will be extended in cooperation with developers in WP3 and WP4.
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Select e-learning (NL)
Follow e-learning (NL)

See available courses
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View course details

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2.3.2 Quality Control

Concerning the quality control, and the derived (voluntary) labelling schemes, different professions and professional levels will be identified for the specific crucial topics needed for deep renovation (nZEB technologies, concepts, products), as a function of the phases in the construction process.

TripleA-reno level 2 functionality will facilitate:
- workers and designers with small and relevant inspection protocols & tools to enhance these protocols.
- home owners with easy to understand quality reports and means to hire affordable assistance of certified Quality Assurers / Inspectors.

Workers and designers
For workers and designers functionality will be developed that can be used for quick and easy creation of visual quality inspections/self-checks. In the following mockups an overview of the functionality we have in mind.

Overview of available inspections/self-checks
Overview of an inspection

Development of an inspection

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Home owners

- Can view a report
- Can order a formal inspection (mock-uped in more detail after M12.)

Inspectors

- Can accept to validate an inspection

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Further interactions will be mock-upped in more detail after M12.
2.4 Linked to design and inspection

The linkage of performed self-checks and self-checks validated by inspectors will be provided by automated connections between the measures and concept database and linked Qualification element.

Figure 8 Linking to enable learning loops

The metadata required for this is added within the Qualification

Metadata in the form of links to professions and specialism