iNSPiRe
Systemic energy renovation of buildings

D8.5 Position Paper on Industrial Standards Implementation

Development of Systemic Packages for Deep Energy Renovation of Residential and Tertiary Buildings including Envelope and Systems

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1 Introduction

In this document, compliance of the developed Renovation Kits with actual standards is assessed. Specific requirements for the façade kits are defined in terms of:

- Resistance and reaction to fire, external fire performance, bullet resistance, burglar resistance, and pendulum body impact resistance.
- Resistance against sudden temperature changes and temperature differentials.
- Wind-snow load resistance.
- Direct airborne sound insulation.
- Thermal and optical properties.
- Electrical and chemical compatibility.
- Materials usability, durability and maintenance needs.

On the other hand, also generation and distribution kits will have to respect specific requirements such as:

- Reduced electricity consumption of pumps, valves and control.
- Compliancy to EU minimum requirements in terms of primary energy and global warming potential requirements.
- Ventilation requirements.
- Minimum lighting requirements.
- Ceilings height constraints.

Pre-normative activity is carried out on the basis of the background of the institutions involved in the partnership. Elaborated information, regarding energy performance of the developed components and systems is collected and organized, to be successively inserted in European standards and buildings national regulations.

2 General considerations

In the recent past, the European Union institutions (Commission, Council and Parliament) have been active in the implementation of energy policies targeted at increasing the energy efficiency of all the so called “energy-related products” (ErP) sold in the European market. The key legislative acts for implementing these policies are the European Directive 2009/125/EC, establishing a framework for the setting of eco-design requirements for energy-related products, and European Directive 2010/30/EU, on the indication, by labelling and standard product information, of the consumption of energy and other resources of energy-related products. Following these directives, many different European Regulations or Amendments, each one for specific product categories were published, in particular for heating and cooling components and systems and for electric and electronic products to be installed in households.

2.1 EU Construction Products Regulation

A 'construction product' means "any product which is produced for incorporation in a permanent manner in construction works, including both buildings and civil engineering works," such as buildings, bridges, highways and other civil engineering projects.

From July 2013 a new regulation laying down harmonized conditions for the marketing of construction products is effective in the EU. The objectives of the regulation are the same as already in Council Directive 89/106/EEC which it replaces: to promote free trade and use of construction products in the common market – without endangering levels of protection. An additional objective of the directive was to "standardize the manufacturing of construction products and guarantee the unlimited use of these products within the EU."

The Construction Products Directive provided the following four main elements:

- A system of harmonized technical specifications (European Standards and Technical approvals).
- An agreed system of attestation of conformity for each product family.
- A framework of notified bodies.
- The CE marking of products.

The Directive did not aim to harmonize regulations. Member States and public and private sector procurers were free to set their own requirements on the performance of works and therefore products. What the CPD sought to harmonize was the methods of test, the methods of declaration of product performance values, and the method of conformity assessment. Choice of value for intended use was left to the regulators in each Member State.

2.2 European technical approval

The European Technical Approval is a generally accepted evidence for the technical fitness of a construction product within the meaning of the Construction Products Regulation in the

EU Member States. An approval is required only for construction products which are not covered by the scope of a harmonized European Standard.

Reviews of the European Technical Approval are based on tests, investigations and technical analyzes recognized by institutions designated by the Member States of the EU and by the European Organization for Technical Assessment. A request for approval may be made by a manufacturer only to a single body. The approval bodies designated by the Member States form an organization, which is obliged to work in close coordination with the Commission.

The common procedural rules for making the request, the preparation and the granting of approvals are drawn up by the organization comprising the designated approval bodies. The common procedural rules are adopted by the Commission.

2.3 CE marking of products

CE Marking is obligatory for every product placed on the EEA (European Economical Area) market and is a declaration by the manufacturer that the product meets certain public safety requirements. There are six essential requirements which need to be addressed (by committee) and satisfied, when relevant, by the product prior to being put on the market:

A. Mechanical resistance and stability

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

- Collapse of the whole or part of the work.
- Major deformations to an inadmissible degree.
- Damage to other Parts of the works or to fittings or installed equipment.
- Major deformation of the load-bearing construction.
- Damage by an event to an extent disproportionate to the original cause.

B. Safety in case of fire

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

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

C. Hygiene, health and the environment

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

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

D. Safety in use

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

E. Protection against noise

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

F. Energy economy and heat retention

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

It is worth noticing that the CE Marking requires that the manufacturer “complies with all relevant provisions of the applicable implementing measure”, which means that there is the need to comply with all the implementing measures which potentially affect the product. There is no norm that classifies products explicitly, stating the relevant Directives for a given product. The manufacturers must check every EU Directive regulating a given field to understand if the Directive applies to their products or not. If the Directive is applicable, often it references implementing measures or international standards containing the technical details needed for design and testing. Currently, there are tens of CE mark related directives in the EU legislation. The process of identifying all the relevant directives and related standard is therefore exhaustive.

3 Review of applicable regulations for the developed Kits

This chapter discusses the compliance of the developed Renovation Kits with current legal and technical requirements, at least for the country in which the Kit was developed or applied (demo case buildings). When possible, a link between national and European norms is stablished. It also discusses about regulation improvements that would incentive the Kit implementation in the market

3.1 Wooden frame envelope kits

The timber-frame façade (with integrated mechanical and electrical installations) is developed to meet both the local requirements and those defined by EU regulations. It lies on the manufacturer´s responsibility to make sure that all requirements are fulfilled by his building parts. Since the timber frame manufacturer usually has the necessary knowledge for the timber construction only, he appoints companies which will handle the appropriate mounting of the pipes, tubes and wires.

The applicable structural requirements in ultimate limit state, serviceability limit state and fire design for timber structures recommended for the design of the timber box are:

- EN 338: Structural timber - Strength classes
- EN 1990 Basis of structural design
- EN 1991-1: General actions - Densities, self-weight, imposed loads for buildings
- EN 1991-1-2: General actions - Actions on structures exposed to fire
- EN 1991-1-2: General actions - Snow loads
- EN 1991-1-4: General actions - Wind actions
- EN 1995-1-1: Design of timber structures: General - Common rules and rules for buildings
- EN 1995-1-2: Design of timber structures: General - Structural fire design
- EN 14081: Timber structures - Strength graded structural timber with rectangular cross section - Part 1: General requirements

All regulations have to be used in combination with the National Annex (NA) according to the country in which the building is located. These regulations give the values for the material properties of timber, the loads imposed to the structure and the rules for structural calculation of the timber structure. In combination with high normal forces may lead to the necessity of a detailed structural calculation including structural design under fire conditions. For buildings with more than two residential units, in Germany it has to be proven that fire will not reach from one apartment to the ones located above via the façade until all inhabitants were rescued from the building (see below, regulations for fire safety).

A minimal U-Value must be achieved according to applicable requirements, as well as air tightness details, certificate of free of condensation and thermal bridges. It is recommended

that a thermal bridge model is carried out, in order to assure the compliance of all aforementioned requirements.

Requirements on building's thermal insulation:

- EN ISO 6946: Building components and building elements - Thermal resistance and thermal transmittance - Calculation method
- EN ISO 10211: Thermal bridges in building construction - Heat flows and surface temperatures - Detailed calculations
- EN ISO 10456: Building materials and products - Hygrothermal properties - Tabulated design values and procedures for determining declared and design thermal values
- EN 12086: Thermal insulating products for building applications - Determination of water vapour transmission properties
- EN 12431: Thermal insulating products for building applications - Determination of thickness for floating floor insulating products
- EN 13162: Thermal insulation products for buildings - Factory made mineral wool (MW) products – Specification
- EN 13163:
- EN 13187: Thermal performance of buildings - Qualitative detection of thermal irregularities in building envelopes - Infrared method
- EN ISO 13786: Thermal performance of building components - Dynamic thermal characteristics - Calculation methods
- EN ISO 13788: Hygrothermal performance of building components and building elements - Internal surface temperature to avoid critical surface humidity and interstitial condensation - Calculation methods
- EN ISO 14683: Thermal bridges in building construction - Linear thermal transmittance - Simplified methods and default values
- EnEV: Currently applicable is the version from 2014. German regulation for reducing energy consumption of buildings. This regulation incorporates the directive 2010/31/EU on the energy performance of buildings and the guideline 2012/27/EU for energy efficency.
- DIN 4108-2 is the normative, technical background for the EnEV. It is entitled "Thermal insulation and thermal energy storage; requirements and guideline for planning and implementation."

For renovation projects, less strict values apply. The requirements on each building part in Germany are given by EnEV, annex 3, table 1. During planning and construction it has to be provided that the thermal insulation is sufficient despite thermal bridges.

Requirements on building's airtightness:

- EN 13829:2001-02: Thermal performance of buildings – Determination of air permeability of buildings – Fan pressurization method

- DIN 4108-7: Thermal insulation and energy economy in buildings - Part 7: Air tightness of buildings - Requirements, recommendations and examples for planning and performance

In Germany, construction of airtight building envelopes is part of carpenters' basic education. The regulation for building's airtightness can be found within DIN 4108-7 and EN 13829:2001-02, which are both included to the values given in ENEV, annex 4.

Fire safety requirements:

- EN 1366: Fire resistance tests for service installations –
- Part 1: Ventilation ducts
- Part 3: Penetration seals
- Part 5: Service ducts and shafts
- Part 11: Fire protective systems for cable systems and associated
- EN 13501: Fire classification of construction products and building elements
- components
- DIN 4102: Fire behaviour of building materials and building components
- Part 6: Ventilation Ducts; Definitions, Requirements and Tests
- Part 9: Seals for cable penetrations; concepts, requirements and testing
- Part 11: pipe encasements, pipe bushings, service shafts and ducts, and barriers across inspection openings; terminology, requirements and testing
- Part 12: Circuit integrity maintenance of electric cable systems; requirements and testing
- Part 15: Fire behaviour of building materials and elements "Brandschacht"
- Part 20: Particular verification of the fire behavior of cladding for external walls
- MBO: Model Building Regulation (German regulation for requirements on buildings, 'Muster Bauordnung', current version from 2012),
- MLAR: Model Conduction Systems Regulation (German regulation for requirements on conduction systems, 'Muster Leitungsanlagen Richtlinie')

The manufacturer has to certify the correct application of all fire protection measures according to the vendor's instructions. These are specified in the European Technical Approval which has to be provided for each product. Combinations of materials and products have to match the conditions given in the Approval.

Depending on the building size additional regulations for the use of timber may apply. In Germany this is the case for buildings of category 4 (MBO) and for "special" buildings (Sonderbauten). Here the M-HFHHolzR applies, which is the model regulation for fire safety requirements on highly fire resistant building parts made from timber. The current version is from 2004.

3.1.1 Special considerations about the integration of pipes and tubes

The concept of renewing the building's domestic water, heating and electrical installation via integration to the façade includes an installation shaft for distributing pipes, tubes and wires vertically over the building height. The installation shaft is prefabricated in the timber manufacturer's factory. It is offered to the client as a turn-key solution. Therefore the shaft has to fulfill all regular requirements for offsite manufactured building components.

The shaft itself, as a prefabricated element should be designed and produced according to the current timber design code, including structure requirements.

As the shaft forms part of the new envelope, the same criteria have to be applied for an external wall. The installation shaft had to be equipped with high performance insulation, since space was very limited and normal insulation thicknesses could not be applied. Without this high performance insulation the shaft would present a severe thermal bridge.

The installation shaft is part of the façade and permeates the airtight layer of the building with through lets for pipes, ducts and wires and with the fastening of structural parts. The shaft itself is prefabricated with an airtight exterior wall. When mounted to the building it is integrated to the new exterior wall, which consists of the prefabricated façade elements. Therefore it is connected to the façade's airtight layer by taping. Structural screws and other fasteners must not penetrate this layer or be sealed separately. Special attention has to be paid on sealing corners and the lower and upper lid.

The installation of pipes and ducts through building components with fire requirements has to be done according to national guidelines, norms and approvals. Some manufacturers have developed solutions with national approvals, which may facilitate planning and manufacturing. If these products are used, the design of the timber construction has to be often modified in order to meet the requirements of the specific products.

In this project, for calculation of the shaft's structural fire resistance, the regulations given for the timber frame façade apply. Pipes and ducts have to be run from and into the installation shaft through the enclosing layer of rooms and building. In Germany MLAR gives rules for fire safety of these through lets according to EN 13501, EN 1366 and DIN 4102. Aim of the regulations is preventing fire and smoke from reaching from one fire section to another and restricting the temperature increase on the building parts not directly opposed to fire, in order to enable rescue of people and animals and effective fire-fighting operations. Therefore fire and smoke are not allowed to enter or to leave the installation shaft. Fire inside cavities has to be prevented, since it is hard to detect and to extinguish. Pipes and ducts are mounted inside the cavity between old and new façade, requiring fire protection sealing between installation shaft and cavity. Additionally the cavity has to be filled with non-combustible insulation according to EN 13162.

Regulations for dimensioning and mounting of building services:

- EN 442-1: Radiators and convectors - Technical specifications and requirements
- EN 806-1: Specifications for installations inside buildings conveying water for human consumption
- EN ISO 8497: Thermal insulation - Determination of steady-state thermal transmission properties of thermal insulation for circular pipes
- EN 12056-1: Gravity drainage systems inside buildings

- Part 1: General and performance requirements
- Part 2: Sanitary pipework, layout and calculation
- Part 3: Roof drainage, layout and calculation
- Part 4: Wastewater lifting plants, layout and calculation
- Part 5: Installation and testing, instructions for operation, maintenance and user
- EN 12831: Heating systems in buildings - Method for calculation of the design heat load
- EN ISO 13792: Thermal performance of buildings - Calculation of internal temperatures of a room in summer without mechanical cooling - Simplified methods
- EN 14304: Thermal insulation products for building equipment and industrial installations - Factory made flexible elastomeric foam (FEF) products – Specification
- EN 14307: Thermal insulation products for building equipment and industrial installations - Factory made extruded polystyrene foam (XPS) products
- EN 14308: Thermal insulation products for building equipment and industrial installations - Factory made rigid polyurethane foam (PUR) and polyisocyanurate foam (PIR) products
- EN 14313: Thermal insulation products for building equipment and industrial installations - Factory made polyethylene foam (PEF) products - Specification
- EN 15241: Ventilation for buildings - Calculation methods for energy losses due to ventilation and infiltration in buildings
- EN 15242: Ventilation for buildings - Calculation methods for the determination of air flow rates in buildings including infiltration
- EN 15243: Ventilation for buildings - Calculation of room temperatures and of load and energy for buildings with room conditioning systems
- EN 15255: Energy performance of buildings - Sensible room cooling load calculation - General criteria and validation procedures
- EN 15450: Heating systems in buildings - Design of heat pump heating systems
- EN 15665: Ventilation for buildings - Determining performance criteria for residential ventilation systems
- EN ISO 15758: Hygrothermal performance of building equipment and industrial installations - Calculation of water vapour diffusion

The regulations show necessary design values. One is the pipe diameter, which has to be adapted to demand, length and pressure. Others are pipe gradient, pipe material, combination of pipe materials and testing of the system's impermeability. Also material and thickness of pipe insulation is described. The mounting of building services has to be carried out by qualified companies with experience and according to all vendors' instructions. In order to take the advantage of prefabrication inside the production hall, the integration of pipes and ducts to the installation shaft and façade elements will be carried out in the timber manufacturer's workshop. Therefore it is necessary to contractually define responsibilities

assigned to the timber manufacturer and the mechanical and electrical companies. Tightness and functionality of building services will be guaranteed by the mechanical and electrical companies while airtightness, insulation and structural integrity are obligations of the timber manufacturer.

Important factors for integrating building services are pipe / wire diameter, pipe material (combustible / non-combustible), pipe insulation and type of transported medium. These values decide about necessary space inside the construction, also due to the necessary gradient of pipes and ventilation of pipes. And not at least these properties are decisive for the necessary fire safety measures.

3.1.2 Special considerations about the integration of an air-to-air micro heat pump

The micro air-to-air heat pump has been developed to be implemented in prefabricated wooden façades for the purpose of heating and ventilation of small apartments. As façade-integration is completely new to the market, specific standards do not yet exist. Therefore, the existing standards for ventilation devices had to be applied. This section comments on the Austrian standards that have been considered and followed in the development of the micro air-to-air heat pump:

- OIB-Regulation 330.2-011/15: fire protection (March 2015).
- Section 3.4 of the document deals with the requirements of fire protection in case ducts, funnels or pipes are integrated in walls or go through walls.
- Section 3.5 defines the fire protection regulation for façades referring especially to the aspect of insulation (material, thickness, correct use).
- OIB-Regulation 330.3-009/15: hygiene, health and environmental protection (March 2015).
- Section 10 of the document defines the requirements for natural and mechanical ventilation and heating devices.
- ÖNORM H 6038: defines the requirements for controlled ventilation and waste heat recovery of ventilation devices.
- ÖNORM H 6039: defines special standards referring to ventilation in school buildings
- ÖNORM EN 13141-7: technical check of ventilation units
- EU guideline 1253 and 1254/2014: requirements for the environmentally sound design of ventilation devices, minimum efficiencies and energy efficiency classification.

The Austrian relevant regulations referring to the cryogenic cycle are listed below:

- ON M 7826: soldering of copper pipes for installation purposes.
- ON EN 13136: cooling devices and heat pumps, pressure release and calculation methods.
- ON EN 1057: seamless pipes for water- and gas plumbing.
- ON EN 14276: pressure equipment for cooling devices and heat pumps, vessels and

pipes.

- ON EN 12735: seamless copper pipes for air-conditioning and refrigeration technologies.
- ON EN 16084: refrigeration devices and heat pumps, qualification and tightness of connections.
- VDMA 24243: tightness of refrigeration devices and heat pumps, part 1 and 2.
- ON EN 14511-4: air conditioning, heat pumps with electrically driven compressors for heating and ventilation, part 4 – requirements.
- ON B 8115-6: sound insulation and acoustics in buildings, part 6 – measuring methods.
- ON EN 12693: safety and environmental requirements of refrigeration devices and heat pumps.
- ON EN B 8110: thermal insulation of buildings.
- ON EN 378-4: refrigeration devices and heat pumps, safety and environmental relevant requirements, parts 4: operation and maintenance and recovery.
- EAVG: law text (energy label buildings).
- WFLKG, StLGbl. Nr. 27, K-BV, Vorarlberger LGBl. Nr. 58/2008, NÖ-BO: local Austrian requirements (Vienna, Styria, Lower Austria. Vorarlberg, Carinthia).
- 2002/91/EG: guidelines for the overall energy efficiency of buildings.
- ON EN 15240: ventilation of building – guidelines for the inspection of air-condition devices.
- NspGV 1995, ETG 1992, ESV 2003, ETV 2002: electro-technical requirements.
- EMVV 2006: electro-magnetical compatibility.
- BV/116: fire-protection of electrical devices.
- ÖVE-EN 1, part 3 (§41 and 42): dimension and lying of cables.
- ÖVE EN60204-1: General requirements.

3.1.3 Special consideration about the integration of solar collectors

The integration of new solar thermal technologies into a prefabricated timber envelope for renovation generally requires a technical approval from the authorized relevant body. The requirements for the technical approval can vary strongly between different countries and even between regions due to different building regulations. Solar thermal facades usually do not match the properties of the other established building products. Solar thermal facades that have a customized absorber integrated in the wall structure cannot be certified with the collector standards EN 12975 or EN 12976, since there are only valid for standardized collectors under specific conditions. Even for collectors with a certification, an approval can be necessary.

In Germany, the DIBt (Deutsches Institut für Bautechnik) is responsible for the categorization of building products and their approval. According to the list of critical products [1] published by DIBt, solar thermal collectors with a tilt angle of more than 75° or an area of more than 3

m² need an approval. In Germany there are two different ways to achieve the approval. For a "general construction permission" (allgemeine bauaufsichtliche Zulassung, abZ), it is necessary to apply and to fulfil the requirements that will be given by the DIBt. Since this means that a general permission is expected, for which many different tests including simulations and measurements are required, the permission can be very costly. Another solution is the "approval for individual cases" (Zustimmung im Einzelfall, ZiE). Building owners must apply at the building supervisory authority of the federal state for every single building. The cost for a ZiE ranges from 400 to 26000 € according to the web page [2] (accessed in December 2015). This web page does not specify whether the cost for the required reports and documents is included. It is expected that the requirements for further buildings with the same design of the solar thermal façade collector are not as extensive as long as the building is constructed in the same federal state. One part of the approval is usually the fire safety assessment. In general the fire safety requirements are higher for taller buildings but also vary between different federal states.

The collector standard EN 12975 defines how a collector must be characterized and measured. This includes a stationary measurement with the same ambient temperature at the front and the rear of the collector. In the case of building integrated solar thermal technologies the rear temperature can be different. For integrated flat plate technology without ventilated air gaps, it can be the interior temperature of the building. In this case the thermal mass between the absorber and the rear temperature of the façade collector can become high. Therefore it is expected that, even within the fluctuation of a whole day, stationary conditions will not be achieved.

The standard EN 12976 describes the characterization of solar thermal "factory made systems". This includes solar thermosiphons. The categorization is not possible due to similar reasons as for EN 12975. For solar thermal facades, the integration of the absorber into the architecture of the whole building can require the customization of the collector components. Therefore the standardization is difficult in general. Also the standard EN 12977 is not suitable, since it is based on EN 12975.

The following list of standards, which might be relevant also for solar thermal facades, has been generated in the project Aktifas [3]. The two standards considered most important are discussed in more detail below.

- EN 14351-1: 2006 08 01 Windows and doors. Product standard, performance characteristics. Windows and external pedestrian doorsets without resistance to fire and/or smoke leakage characteristics
- EN 13830: 2003 11 01 Curtain walling. Product standard
- EN 1027: 2000 10 01 Windows and doors. Watertightness. Test method
- EN 12154: 2000 03 01 Curtain walling. Watertightness. Performance requirements and classification
- EN 12155: 2000 10 01 Curtain walling. Watertightness. Laboratory test under static pressure"
- EN 12208: 2000 02 01 Windows and doors. Watertightness. Classification
- EN 12865: 2001 09 01 Hygrothermal performance of building components and building elements. Determination of the resistance of external wall systems to driving rain under pulsating air pressure

- EN 13050: 2006 04 01 Curtain Walling. Watertightness. Laboratory test under dynamic condition of air pressure and water spray
- EN 13051: 2001 11 01 Curtain walling. Watertightness. Site test
- EN ISO 15927-3: 2006 10 01 Hygrothermal performance of buildings. Calculation and presentation of climatic data. Calculation of a driving rain index for vertical surfaces from hourly wind and rain data (ISO/DIS 15927-3:2006)
- EN 13830 defines the most important properties of curtain walls and gives a systematic framework for the performance requirements and the test criteria in order to match the central requirements of the construction-products directive and to provide rules for the technical specification. Curtain walling is defined as an external vertical building envelope, which is constructed mainly with metal, wood or synthetic materials. The term curtain wall includes a wide range of different constructions. However, the main categories are mullion-transom constructions, element constructions or parapet constructions. This standard is valid for curtain walls that are vertical or have a tilt angle of up to 15° relative to the vertical axis. Tilted glazing elements, which are part of the façade, can also be included. Curtain walls cannot be understood as a product that can completely be finished in a factory. Curtain walls consist of a set of components and/or prefabricated elements that are assembled on-site to become the final product. This standard is valid for the entire curtain façade including the connections to the internal walls, the ceilings, external connections to surrounding constructions and attics.
- EN 14351-1: 2010-08 defines most of the properties and performance classes of windows and external doors in Europe, independent of materials. This standard provides planners, consumers and manufacturers with the basics for the assessment of doors and windows in general, but also in specific cases. The determination of the specific performance requirements must be completed by the planer taking national regulations into account carefully. In addition this standard implements the European construction-products directive. This is done in the annex ZA and leads to the CE label, which serves as the official approval. In many cases the CE label is not enough to describe the performance of a product. Usually further properties (e.g. from EN 14351-1: 2010-08) are required besides the properties from annex ZA. These are not considered in the CE label.

3.2 Metal-glass façade module for office buildings incorporating sorption collectors

The technical and economic viability of the sorption collectors is based on various system characteristics that should be aptly exploited in each application. The collector gives the intrinsic possibility to design totally modular pre-engineered ‘plug-and-play’ systems allowing for greater flexibility in addressing installations of varying sizes. As a solar thermal device integrated in a facade, this kit shall comply with the requirements of the current standards and regulations in terms of the efficiency, safety, flexibility and durability.

The currently available standards in relation to solar thermal systems in EU include:

- EN 12975:2006 Thermal solar systems and components – Solar collectors
- Part 1: General Requirements
- Part 2: Test methods;

- EN 12976:2006 Thermal solar systems and components – Factory made systems
- Part 1: General Requirements
- Part 2: Test methods
- EN 12977:2008 Thermal solar systems and components – Custom built systems –
- Part 2: Test methods for solar water heaters and combisystem
- Part 3: Performance test methods for solar water heater stores
- Part 4: Performance test methods for solar combistores
- Part 5: Performance test methods for control equipment
- prEN12975-3-1 Qualification of solar absorber surface durability

In the first and fourth standards, the focal point is on the collector while it's on the system for the second and third standards. In general, the items addressed in the standards contain high temperature resistance, exposure, external thermal shock, internal thermal shock, rain penetration, impact resistance and mechanical load. Most of those provisions are applied to system testing. There are only a few standards, e.g., European Standards EN 12975-1, EN 12978-1 and EN12977-1, address the quantified provisions relating to the kit 5 (metal glass façade with sorption collector integrated, see D3.6).

However, since this kit has a customized absorber integrated in the collector, it cannot be certified with the collector standards EN 12975 or EN 12976; because they are only valid for standardised collectors under specific conditions. Moreover, different countries and/or regions have different standards and regulations.

As discussed in the previous section, efforts have been made when updating the EN 12975 standard in order to address the global concerns in evaluating the conventional and advanced solar thermal products.

Moreover, a great focus has been put on creating the multi-parts standards for various solar collectors including their components and materials. These include:

Vienna Agreement

Part 1: evacuated tube durability and performance;

Part 2: Heat pipes for evacuated tubes – Durability and performance lead by ISO; Part 3: Absorber surface durability; and some more parts to address glazing and insulation materials lead by CEN" [1,2] .

Some of the components of the kit are conventional construction components. The currently available standards for such components include

Regulation 305/2011 that addresses the essential requirements for life cycle;

ETAG023 and ETAG025 that address the technical requirements for the prefabricated building units and metal frame kits [6]

Construction Products Directive (CPD) and Construction Products Regulation (CPR)

Directive on the Energy Performance of Buildings (EPBD)" [7]

It is important to note that due to the problems faced by Grupo Tosoni, the façade module manufacturer for the developing this kit, it was not possible to finalize the development of this kit. Thus the implemented standards cannot be presented as a final list.

3.3 Standardised hydronic module for hybrid heating and cooling systems

The Energy Hub (EH) is the multi-functional hydronic module that is used to connect hydraulically the components of energy efficient heating and cooling system, typically composed by a solar device, one or more storage tank, space or combination heater (with the possible addition of dry coolers, geothermal probes) and distributions system (radiators, fan coils, radiant ceiling or radiant floors). The EH modules are equipped with a micro-processor for performing measurement and control operations. They are also normally connected to a central processing unit, called Energy Manager (EM), via a serial communication line and communicate with it using the Modbus protocol.

The proposed energy efficiency concept (Energy Management Network constructed via Energy Hub modules) is totally in line with the spirit of the eco-design and labelling Directives. It recognises that the heating and cooling systems being currently proposed on the market present a system architecture that tends to be significantly more complex than traditional installations and provides a method to implement such systems in a low cost way leveraging on modularity and pre-fabrication. Also, it considers the metering requirements set by the European Directive 2012/27/EU (Energy efficiency, Art. 9, 10 and 11) and can be used to provide energy consumption figures to auditors.

From the point of view of industrialization, the EH manufacturing is matter of hydraulic engineering (the part dealing with the energy vector fluid), electronic engineering (the sensors and drivers and control equipment) and software engineering (the software run by the micro-controller). It is then reasonable to expect that the organization of its manufacturing is affected by norms, standards and good practices from these three sectors. In the next section, an analysis of the European normative framework affecting the EH modules industrialization is performed.

The EH modules are not yet a fully industrialized, commercially available product. Therefore, in the present section, is provided a list of EU directives, regulations, implementing measures and standards that a potential vendor must consider for selling the units in the European market.

Quite naturally this investigation is performed starting from the European directives that seem more relevant for the given product and from there is expanded to find all the relevant technical requirements. For the EH modules, the starting point are the eco-design, energy labelling, pressure equipment and measurement instruments Directives. To give an idea of the complexity of the matter, the reference directives are listed along with their amendments or implementing measures.

- DIRECTIVE 2009/125/EC (establishing a framework for the setting of ecodesign requirements for energy-related products)
- COMMISSION REGULATION (EU) No 813/2013 Ecodesign requirements for space heaters and combination heater
- COMMISSION REGULATION (EU) No 814/2013 Ecodesign requirements for water

heaters and hot water storage tanks

- COMMISSION REGULATION (EC) No 1275/2008 Ecodesign requirements for standby and off mode electric power consumption of electrical and electronic household and office equipment
- COMMISSION REGULATION (EU) No 801/2013 (amendment)
- DIRECTIVE 2010/30/EU on the indication by labelling and standard product information of the consumption of energy and other resources by energy-related products
- COMMISSION DELEGATED REGULATION (EU) No 811/2013 Energy labelling of space heaters, combination heaters, packages of space heater, temperature control and solar device and packages of combination heater, temperature control and solar device
- COMMISSION DELEGATED REGULATION (EU) No 812/2013 Energy labelling of water heaters, hot water storage tanks and packages of water heater and solar device)
- COMMISSION DELEGATED REGULATION (EU) No 518/2014 Labelling of energy-related products on the internet

Note that both the above directives, dating back to 2009 and 2010, are amended by the energy efficiency directive (EED):

- DIRECTIVE 2012/27/EU on energy efficiency, amending Directives 2009/125/EC and 2010/30/EU and repealing Directives 2004/8/EC and 2006/32/EC

The EU directives above mention “packages” of space or combination heater, temperature control and solar device. The packages mentioned in the Directives are not to be confused with the EH or other user or satellite modules. In light of the EU regulations, the EH are better understood as a way to implement the so called “temperature control” infrastructure. As it seems that there is not specific bindings for this type of modules (the reader is invited to note that there is a rising market of these type of objects, see D4.6 section 1, so it could be interesting to set up a uniform way to certify their quality), it has been decided to comply to the spirit of the eco-design, energy labelling and energy efficiency directives by requiring compliancy of the components which the EH integrates.

The fundamental components of the EH, from the point of view of energy usage, are the circulator(s), the control valve(s) and the heat exchanger. Other (electrical) energy using components are the temperature sensors, the flow meter(s) and the input-output and control board. In particular, the circulators and the heat exchanger are fundamental components affecting the energy performance of the module. Despite all of the above cited components fall in the category of energy-related products, only the circulators are considered in the implementing measures of the eco-design directive and have an established development line set-up by the directive. The low-voltage electric motors regulating the aperture of the three way valve(s) installed in the EH are not regulated by the European legislator (the low voltage Directive does not cover electrical equipment supplied with a voltage below 75 V DC and 50 V AC).

The European norms that affect the EH are: the pressure equipment Directive (PED), the construction product Directive/Regulation(CPD/CPR), electromagnetic compatibility Directive (EMC), the restriction of hazardous substances Directive (RoHS), the low voltage Directive

(LVD) (for circulators and EM), the measuring instrument Directive (MID). Their reference are listed and briefly commented in the following.

- DIRECTIVE 2014/68/EU on the harmonisation of the laws of the Member States relating to the making available on the market of pressure equipment

The Pressure Directive applies to the piping, circulators, heat exchanger and "pressure accessories" (flow meter). The EH manufacturer is expected to acquire these components on the market. All these components should be already certified following this Directive if purchased on the European market.

- DIRECTIVE 2004/22/EC on measuring instruments
- DIRECTIVE 2009/137/EC on measuring instruments in respect of exploitation of the maximum permissible errors, as regards the instrument-specific annexes MI-001 to MI-005
- DIRECTIVE 2014/32/EU on the harmonisation of the laws of the Member States relating to the making available on the market of measuring instruments

The MID Directive affects the temperature and flow measurements and the heat flow measurement derived from them. This directive is very important for the EH modules which must comply with the energy efficiency Directive.

- DIRECTIVE 2004/108/EC on the approximation of the laws of the Member States relating to electromagnetic compatibility
- DIRECTIVE 2002/95/EC on the restriction of the use of certain hazardous substances in electrical and electronic equipment

The EMC Directive and the so called RoSH Directive apply to all the electronic equipment of the EH and EM, in particular to the EH IOC board.

Other implementing measures that could apply to the EH (EM) are:

- REGULATION (EU) No 305/2011 Laying down harmonised conditions for the marketing of construction products
- COUNCIL DIRECTIVE 1991/263/EEC on the approximation of the laws of the Member States concerning telecommunications terminal equipment, including the mutual recognition of their conformity

The relevance of the former mostly depends on whether the EH is considered a block for the construction of the HCS (this is the philosophy behind it) or a product to be installed on site (which could be convenient also because it is not clear if in the first case the norm covers it or not). The latter is probably irrelevant, because neither the EH nor the EM are connected directly to public networks (e.g. like routers). It should however be kept in mind for the manufacturer willing to exploit the integration of such components in the EM.

Finally, some variants of the EH module can be used to provide the DHW preparation service. In this case the modules contain a heat exchanger whose secondary side comes in contact with drinking water. Albeit the EU has harmonized regulation regarding the quality of drinking water, the norms regarding the components and the materials used in the construction have not been harmonized at the same level. Many the EU member states have specific regulations regarding the components that come in contact with drinking water. There is a Decision of the European Commission regarding the so called “sanitary tapware” that can be considered as an attempt to harmonize the matter in the framework of the eco-labelling Directive.

- COUNCIL DIRECTIVE 98/83/EC on the quality of water intended for human consumption
- COMMISSION DECISION 2013/250/EU establishing the ecological criteria for the award of the EU Ecolabel for sanitary tapware
- REGULATION (EC) No 66/2010 on the EU Ecolabel

From the point of view of uniformed standards, the most relevant the EH should comply with are those covering the heat (temperature, mass flow) and electric meters. Also some parts of the ISO 50001 standard regarding the energy management systems are relevant to the EM.

- EN 1434 Heat meters
- EN 50470 Electricity metering equipment (a.c.)
- EN ISO 50001 Energy management system

Other standards covering electronic equipment that could be of relevance for the EH and EM electronic components are:

- EN 62026-1:2007 Low-voltage switchgear and controlgear - Controller-device interfaces (CDIs) - Part 1: General rules
- EN 50295:1999 Low-voltage switchgear and controlgear - Controller and device interface systems - Actuator Sensor interface (AS-i)
- EN 50065-1:2011 Signalling on low-voltage electrical installations in the frequency range 3 kHz to 148,5 kHz - Part 1: General requirements, frequency bands and electromagnetic disturbances
- EN 50065-2-1:2003 Signalling on low-voltage electrical installations in the frequency range 3 kHz to 148,5 kHz - Part 2-1: Immunity requirements for mains communications equipment and systems operating in the range of frequencies 95 kHz to 148,5 kHz and intended for use in residential, commercial and light industrial environments
- EN 60730-1:2011 Automatic electrical controls for household and similar use - Part 1: General requirements
- EN 60730-2-8:2002 Automatic electrical controls for household and similar use - Part 2-8: Particular requirements for electrically operated water valves, including mechanical requirements

- EN 60730-2-9:2010 Automatic electrical controls for household and similar use - Part 2-9: Particular requirements for temperature sensing controls
- EN 60730-2-14:1997 Automatic electrical controls for household and similar use - Part 2-14: Particular requirements for electric actuators
- EN 60730-2-15:2010 Automatic electrical controls for household and similar use - Part 2-15: Particular requirements for automatic electrical air flow, water flow and water level sensing controls
- EN 60870-2-1:1996 Telecontrol equipment and systems - Part 2: Operating conditions - Section 1: Power supply and electromagnetic compatibility
- EN 61131-2:2007 Programmable controllers - Part 2: Equipment requirements and tests

The PED Directive places some requirements on the materials used in the construction of the pressure holding components: a) the material must comply with an Harmonised Standard; b) it must be covered by a European Approval of Materials (EAM); c) it must be subject of a particular material appraisal (PMA). Harmonised standards also cover many hydraulic components. A few general standards that are surely relevant for the EH modules is cited hereafter, but the list is not exhaustive.

- EN 13480:2012 Metallic industrial piping
- EN 1057:2006+A1:2010 Copper and copper alloys — Seamless, round copper tubes for water and gas in sanitary and heating applications
- EN 1983:2013 Industrial valves - Steel ball valves
- EN 13547:2013 Industrial valves - Copper alloy ball valves
- EN 14276:2006+A1:2011 Pressure equipment for refrigerating systems and heat pumps

Local regulations regarding the components and the materials to be used in the construction of drinkable water distribution systems refer to different standards depending on the member country or may contain the technical information directly in the body of the law. The situation for North America, France, Germany, Italy and United Kingdom is reported below.

- ACS Attestation de conformité sanitaire (France)
- KTW Kunststoffe und Trinkwasser (Germany)
- Ministerial Decree of 6 April 2004, No 174 (Italy)
- WRAS Water Regulations Advisory Scheme (UK)

The following table summarizes the compliancy scheme adopted for the EH modules with regard to the European Directives.

EH component	Compliancy
Circulators	Eco-design directive (ErP), energy labelling directive, PED, LVD, EMC directive
Heat exchanger	PED
Control valves	PED
Temperature sensors	MID
Flow meters	MID, PED
Piping	PED
Non return valve	PED
IOC board	EMC directive, MID, RoHS Directive

Table 1: Compliancy scheme for the components of the EH

The regulations that affect the components used to assemble the EH modules are mostly well established and understood by the industry. It is not possible to quantify the impact of changes in the regulation on the market implementation of the EMN technology. In this section, however, are discussed some of the difficulties emerged in the process of defining the normative framework relevant for the EH modules and in the forthcoming industrialization process.

Regarding the normative framework, a comment is about how the EH modules, as whole hydronic components, are considered in the norms. It seems very reasonable for these modules to be required to comply with the prescriptions contained in the eco-design directive (Directive 2009/125/EC) and related regulations regarding the “energy-related products” (ErP). In fact the EH modules are device that controls energy flows. Unfortunately, the directive and following regulations do not cover hydronic components for the construction of heating and cooling system explicitly, although they consider “packages” of space or combination heater, temperature control and solar device. A legal recognition of such components and a common definition of the relevant efficiency and performance figures could help industries to work with and to sell this type of solutions.

The conformance of the EH modules to the European regulations requires careful examination with respects of the following components:

1) Conformance of the heat meters;
2) Conformance of the control electronics;
3) Conformance of the hydraulic parts.

Difficulties regarding the conformance of the heat meters may arise due to the technology currently used to perform the temperature measurements. Moreover, control electronics is required to be certified under the RoHS, ECM and MID Directives. The latter because the

controller performs also the function of the so called calculator part of the heat meter. A substantial effort has to be made by the manufacturer to comply with these directives from the technical point of view. Finally, the hydraulic components of the EH modules and their assembly are expected to comply with PED Directive and its referenced Harmonised Standards. It is expected that compliance with these prescriptions is not a problem for the EH manufacturer who essentially buys and integrates hydraulic components on the market and has to assure compliance of the assembly only.

The EM is currently in an earlier stage of industrialization compared to the EH and the discussion of relevant standards is premature. It can be remarked, however, that the EM is essentially electronic equipment performing supervisory control functions. Directives regarding electronic equipment are expected to be relevant, as well as the MID and EED directives, as the EM it is part of the infrastructure needed to convey the energy consumption information to the final user.

Regarding the description of the EH modules at a normative level, every module should be characterized by their “transfer” efficiency, the ratio between the energy leaving the EH module compared to that entering (values less than 100% are due to the losses along the EH pipes and components, for the EH models without heat exchanger; and are due to losses along the EH pipes, components and those within the heat exchanger, for the EH models with the heat exchanger), and by the efficiency of the circulators. The procedure to allow the certification of the modules, including the case of modules connection three sub circuit should be defined in the first place by the manufacturer. Also, the operative condition of the EH are known to be very variable and therefore the comments done in the deliverable D4.7 about modern heating and cooling systems apply. Specific performance figures or testing procedures to these type of hydronic modules should be employed.

Finally, regarding the installation of the EMN itself, it is remarked that the energy labelling directive requires that the installer of the EMN provides an energy label of the whole heating or cooling “package”. In fact, the solar addition is seen as a method to reach values of the ratio between – paid - primary energy and final energy delivered to the user higher than one. This is also relevant for the EH modules themselves, although the EH concept seems to be beyond the scope of the norm.

3.4 Multifunctional ceiling panel for heating and cooling, ventilation and lighting

This section comments on the Austrian and international standards regarding fire protection, soundproofing, heating and cooling tests, which have been considered and followed in the development of the multifunctional ceiling panel and its application to Madrid’s demonstration case. The examination of related CE test is currently in progress.

- EN 13964 – Suspended ceilings Requirements and test methods EN13964:2014.
- EN 520, *Gypsum plasterboards — Definitions, requirements and test methods*
- EN 1168, *Pre-cast concrete products — Hollow core slabs*
- EN 1520, *Prefabricated reinforced components of lightweight aggregate concrete with open structure with structural or non-structural reinforcement*
- EN 1992-2, *Eurocode 2: Design of concrete structures — Part 2: Concrete bridges — Design and detailing rules*

- EN 1993-1-1, *Eurocode 3: Design of steel structures — Part 1-1: General rules and rules for buildings*
- EN 10244-2, *Steel wire and wire products — Non-ferrous metallic coatings on steel wire — Part 2: Zinc or zinc alloy coatings*
- EN 12354-6, *Building acoustics — Estimation of acoustic performance of buildings from the performance of elements — Part 6: Sound absorption in enclosed spaces*
- EN 12602, *Prefabricated reinforced components of autoclaved aerated concrete*
- EN 13658-1, *Metal lath and beads — Definitions, requirements and test methods — Part 1: Internal plastering*
- EN 13963, *Jointing materials for gypsum plasterboards — Definitions, requirements and test methods*
- EN 13986, *Wood-based panels for use in construction — Characteristics, evaluation of conformity and marking*
- EN 14190, *Gypsum plasterboard products from reprocessing — Definitions, requirements and test methods*
- EN 14195, *Metal framing components for gypsum plasterboard systems — Definitions, requirements and test methods*
- EN 14246, *Gypsum elements for suspended ceilings — Definitions, requirements and test methods*
- EN 14566, *Mechanical fasteners for gypsum plasterboard systems — Definitions, requirements and test methods*
- EN 14716, *Stretched ceilings — Requirements and test methods*
- EN 15283-1, *Gypsum boards with fibrous reinforcement — Definitions, requirements and test methods — Part 1: Gypsum boards with mat reinforcement*
- EN 15283-2, *Gypsum boards with fibrous reinforcement — Definitions, requirements and test methods — Part 2: Gypsum fibre boards*
- HD 384, *Electrical installations of buildings*
- ETAG 001-1, *Metal anchors for use in concrete — Part 1: Anchors in general*
- ETAG 001-2, *Metal anchors for use in concrete — Part 2: Torque-controlled expansion anchors*
- ETAG 001-3, *Metal anchors for use in concrete — Part 3: Undercut anchors*
- ETAG 001-4, *Metal anchors for use in concrete — Part 4: Deformation-controlled expansion anchors*
- ETAG 001-5, *Metal anchors for use in concrete — Part 5: Bonded anchors*
- ETAG 001-6, *Metal anchors for use in concrete — Part 6: Anchors for multiple use for non-structural applica-tions*
- ETAG 018-4, *Fire protective products — Part 4: Fire protective board, slab and mat products and kits*
- ETAG 020-1, *Plastic anchors — Part 1: General*
- ETAG 020-2, *Plastic anchors — Part 2: Plastic anchors for use in normal weight concrete*
- ETAG 020-3, *Plastic anchors — Part 3: Plastic anchors for use in solid masonry*

- ETAG 020-4, *Plastic anchors — Part 4: Plastic anchors for use in hollow or perforated masonry*
- ETAG 020-5, Plastic anchors — Part 5: Plastic anchors for use in autoclaved aerated concrete (AAC)
- EN 14240 Ventilation for buidlings Chilled ceilings
- Testing and rating
- EN14037 - Free hanging heating and cooling surfaces for water with a temperature below 120 °C

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