4RinEU

Reliable models for deep renovation

D6.2

WP6

Analysis of regulatory framework and standardization needs

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Foreword

Despite the low energy performances of the European building stock, the yearly renovation rate and the choice to perform a building deep renovation is strongly affected by uncertainties in terms of costs and benefits in the life cycle.

The project 4RinEU faces these challenges, offering technology solutions and strategies to encourage the existing building stock transformation, fostering the use of renewable energies, and providing reliable business models to support a deep renovation.

4RinEU project minimizes failures in design and implementation, manages different stages of the deep renovation process - from the preliminary audit up to the end-of-life - and provides information on energy, comfort, users' impact, and investment performance.

The 4RinEU deep renovation strategy is based on 3 pillars:

- *technologies* - driven by robustness - to decrease net primary energy use (60 to 70% compared to pre-renovation), allowing a reduction of life cycle costs over 30 years (15% compared to a typical renovation);
- *methodologies* - driven by usability - to support the design and implementation of the technologies, encouraging all stakeholders' involvement and ensuring the reduction of the renovation time;
- *business models* - driven by reliability - to enhance the level of confidence of deep renovation investors, increasing the EU building stock transformation rate.

4RinEU technologies, tools and procedures are expected to generate significant impacts: energy savings, reduction of renovation time, improvement of occupants IEQ conditions, optimization of RES use, acceleration of EU residential building renovation rate. This will bring a revitalization of the EU construction sectors, making renovation easier, quicker and more sustainable.

4RinEU is a project funded by the European Commission under the Horizon 2020 Programme and runs for four years from 2016 to 2020 (extended to 2021).

The 4RinEU consortium is pleased to present this report which is one of the deliverables from the project work.

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Executive Summary

The analysis of regulatory framework at EU and national level and standardization related to 4RinEU technology solutions we included in the deep renovation packages enabled to highline boundary conditions potentially affecting the project expected impacts. Building energy performance and structural aspects, integration of RES, grid & smart grid related legislation are possible drivers/barriers for the main project objective, i.e. market deployment of deep renovation technologies.

Analysis of the initiatives to promote building renovation are analysed establishing a clear view of the current situation and its evolution and, in consequence determine the most appropriate business models for different target countries.

Construction Products Regulation, CE marking, building codes, etc. which could affect the pre-industrial stages of project results are analysed. The lack of specific regulation for renovation elements in the past has been one of the main sources for uncertainty amongst architects, planners and all the related value chain, increasing possible technical and financial risks in applying novel technology solutions. These includes concerns about products not complying with mechanical or safety & security requirements. Also related to that, durability issues and lack of reliable business plan to support investments, have built a significant barrier for deep renovation market deployment.

Demo cases' experience has been used in order to recognize possible limits and restriction to 4RinEU renovation approach. From the analysis it seems that no specific barriers were encountered by using 4RinEU key technologies, and usual guidelines for standard renovation intervention have been taken into account. In the three demos, most critical points for the deep renovation implementation were mainly related to the use of the prefabricated façade system, in particular concerning structural issues and fire safety. Nevertheless, main decision factors in the retrofit design have been related to timber constructor experiences and economic drivers, rather than National regulation or constraints.

1 The EU policies and legislative framework

One of the goals established by the European Commission is to reduce its annual primary energy consumption of 20% by the 2020. Thanks to this, a reduction in CO2 emissions of 780 million tons and savings for €100 billion in fuel consumption per year are expected. Since buildings are responsible for the 40% of final energy use in Europe, acting on the building sector is for sure essential in order to meet the set goal.
The above-mentioned energy target for the 2020 was suggested in the Green Paper on Energy Efficiency of the 2005 and then confirmed in the Action Plans and Council Decision.
Later, the Communication "Energy Efficiency Plan 2011" by the EU commission confirmed the target on the 8th March 2011. In this contest, it has been recognized by the EU that the actual strategy was not successful to reach the expected energy savings and more effort had to be invested.
In the 2016, the Annex "Accelerating Clean Energy in Buildings", the European Commission claimed again the severity of buildings accounting related to the total energy consumption and that around 75% of them are energy inefficient. Energy efficiency in buildings is affected by few investments and several barriers. It is also claimed that, often due to the lack of capital, clear information, building skills and doubts on the benefits and results of the intervention, the energy saving investments are not fully exploited in the maintenance and improvement works on buildings. These uncertainties and non-awareness represent a huge barrier for meeting the 2020 defined goals.
Finally, in December European Commission presented the new European Climate plan called "Green Deal". The Green Deal aims at reaching climate neutrality in 2050 and thus promoting economic growth. To do so it foresees a program of massive public expenditure that crosses all sectors of European economy. The document acknowledges that the annual renovation rate of building stock must importantly increase while a "Renovation wave" is necessary to transform all European cities.
The following chapter aims to report a brief overview of the actions taken at European level to promote the transformation of EU building stock and improve its energy efficiency.

1.1 Overview of financial instruments[1]

The improvements in energy performances of buildings are supported by several financial instruments made available around Europe, and they can be used depending on each State's context. In Figure 1 the main possible financial instruments are presented and can be divided in two main categories: conventional and innovative.
On the one hand, conventional instruments include grants and subsidies, loans and tax incentives. There have also been funds in the form of loans and grants, coming from international financial institutions that often provide financing. Another funding source, also known as carbon credit (defined by the Kyoto Protocol) can come from the selling of Assigned Amount Units (AAUs), which represent the allowed emission levels for each Nation.

[1] *Main source: Energy Efficiency Policies in Buildings – The use of financial instruments at Member State level, Buildings Performance Institute Europe (BPIE), 2012 (http://bpie.eu/wp-content/uploads/2015/10/HR-Financing-Paper1.pdf)*

On the other hand, Energy Performance Contracting (often known as Third Party Financing) where the investment is hold by a third institution, and Energy Supplier Obligations (often known as White Certificates) where a monetary value is assigned in form of obligation depending on the achieved energy savings, belong to the innovative typology of financial instruments.

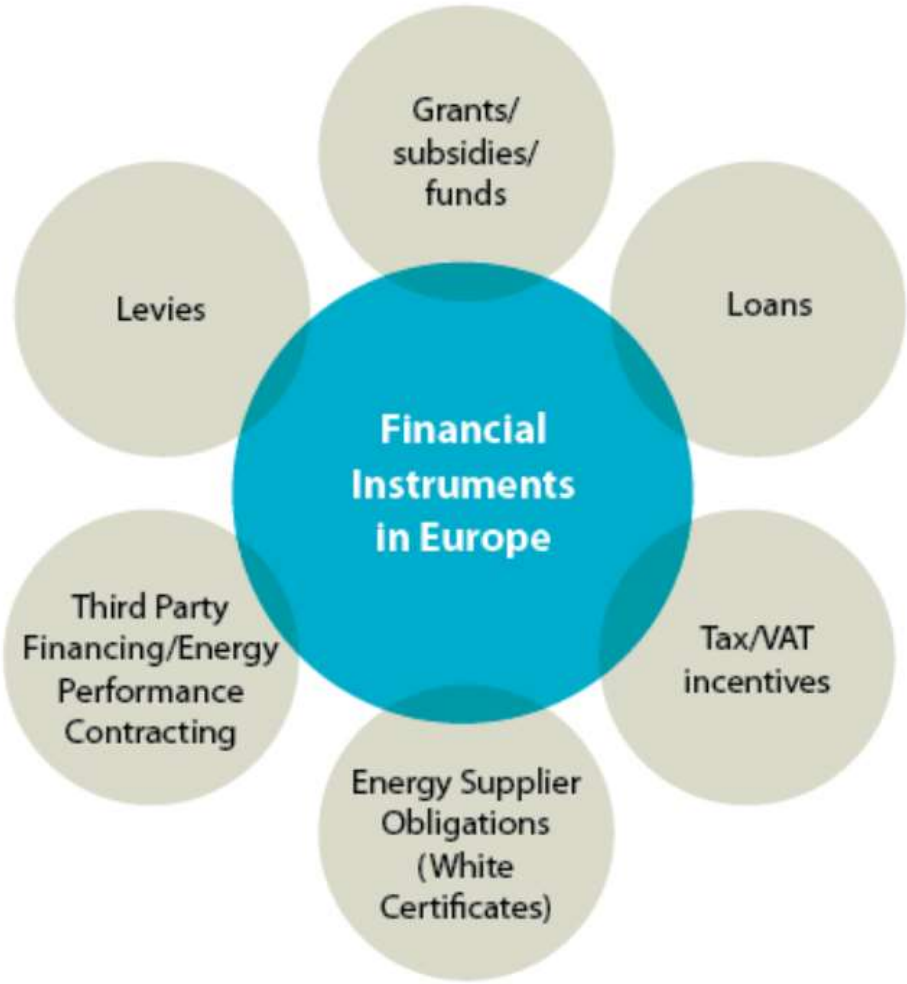

Figure 1 Financial instruments supporting buildings energy renovation (Source: http://bpie.eu/wp-content/uploads/2015/10/HR-Financing-Paper1.pdf)

In the following list, mainly taken from an Energy Charter Secretariat document[2], a brief explanation of the available European financial instrument is reported:

- **Subsidies** allow prices to be kept low. They may be provided, for example, to manufacturers of energy efficient equipment such as compact fluorescent light bulbs.
- **Grants** are targeted at households, industrial or other energy consumers to pay for part or all the cost of introducing energy efficient processes – such as enhanced building insulation.

[2] *Energy Charter Secretariat, Fiscal Policies for Improving Energy Efficiency: Taxation, Grants and Subsidies, ECS, Brussels, 2001, pp. 11-13.*

Both above-mentioned instruments can be directly financed by the state or local authority budget or thanks to hypothecated taxes (i.e. to dedicate the revenues form a specific tax to a particular purchasing purpose).

- **Loan schemes** to encourage energy efficient practices can be introduced with subsidised interest rates or credit risk support. Subsidies provided by the local authority or state budget to banks offering low interest rates are a fiscal policy.
- **Value Added Tax (VAT)** normally affects the final consumer but not the producer – who passes the cost onto the consumer. Differential VAT rates can be used to influence the choice of energy efficient technology by householders.
- **Levies** on consumption or production may be used to create a fund (e.g. a levy on electricity sales to fund renewable energy schemes).
- **Third Party Financing (TPF), Energy Performance Contracting (EPC) and Contract Energy Management (CEM)** are all terms used to cover a wide variety of contracting and financing techniques for energy efficiency and renewable energy projects.[3]
- An **Energy Efficiency Obligation** is a requirement on a group of market actors in one or more sectors of the energy industry in a given territory to achieve a specified energy saving target.[4]

Considering that, at today's rate of renovating around 1% of buildings each year, it would take a century to upgrade the building stock to modern, near-zero energy levels[5], the EU has increased the amount of public funds available for energy efficiency. In order to meet the objectives of the Energy Union and support the transition to a clean energy system, it has been claimed a further urgency to unlock private financing in order to foster energy efficiency investments. Therefore, it has been estimated that an additional €177 billion per year will be necessary over the period 2021-2030 to reach the EU's energy and climate objectives for 2030.
In 2016, the European Commission has promoted the *Smart Finance for Smart Buildings* (SFSB) initiative, as part of the '*Clean Energy for All Europeans*'[6] package, which includes some practical solutions to make private investments available for building energy renovation in the following areas:

- **More effective use of public funds**: the aim is to maximize the use of available public funding using financial instruments that give attention to identified market failures and better allocating grants.
  The European Structural and Investment Funds (ESIF) is a European fund managed by the European Commission and the EU countries. Its purpose is to invest in job creation, economy and environment.
  At the EU level from 2014 to 2020, it will allocate €18 billion to energy efficiency.

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[3] *Energy Charter Secretariat, Third Party Financing: Achieving its Potential, ECS, Brussels, 2003*

[4] *Dan Staniaszek and Eoin Lees, Determining Energy Savings for Energy Efficiency Obligation Schemes, eceee, 2012*

[5] *Impact Assessment for the amendment of the Energy Performance of Buildings Directive, SWD (2016) 414*

[6] *Clean Energy For All Europeans COM (2016)*

(https://ec.europa.eu/energy/sites/ener/files/documents/com_860_final.pdf)

ESIF is focused mainly on five areas: research & innovation, digital technologies, supporting the low-carbon economy, sustainable management of natural resources and small business.
The 5 European structural and investments funds (ESIF) are:

- European regional development fund (ERDF) which promotes a balanced development in the different EU regions from economic and social point of view.
- European social fund (ESF) which supports the employment-related projects through Europe and invests in Europe's human capital
- Cohesion fund (CF) which aims at transport and environment projects in countries where the gross national income per inhabitant is less than 90% of the EU average. Its purpose is the reduction of economic and social disparities, and the promotion of a sustainable development.
- European agricultural fund for rural development (EAFRD)
- European maritime and fisheries fund (EMFF)

Another fund aiming at increasing the financing of sustainable energy projects is the European Fund for Strategic Investments (EFSI). EFSI comes from the collaboration between the European Investment Bank, the European Investment Fund and the European Commission to increase the investment rate in the EU. It is a €26 billion guarantee from the EU budget, complemented by a €7.5 billion allocation of the EIB's own capital. The total amount of €33.5 billion aims to unlock additional investment of €500 billion by 2020. EFSI fund is dedicated to those projects where the investment risk is higher than the one usually financed by banks.

Moreover, other support schemes and funding programs have been created by the EU to improve the financing of energy efficiency projects.
For instance, Horizon 2020 and Horizon Europe, where €5.9 billion goes towards energy projects, aiding the creation and improvement of clean energy technologies, such as smart energy networks, tidal power, and energy storage.
Relevant examples of Horizon2020 projects boosting energy efficiency investment in existing buildings are EuroPACE[7] and Energy efficient Mortgages Action Plan[8] (EeMAP).

As claimed in the Financing Energy Efficiency document[9] the SFSB initiative "aims to facilitate the deployment of financial instruments across Europe and better target subsidies towards vulnerable consumers or specific market failures.
As part of the SFSB initiative, the Commission is developing with the European Investment Bank (EIB) a flexible model of guarantee facility to be deployed primarily at national level. This instrument aims to encourage the combination of different public financing strands, with a special attention being given to the EFSI and ESIF, to get the best possible results. It will allow financial intermediaries such as commercial banks to

[7] *EuroPACE – Integrated Home Renovation Platform (http://www.europace2020.eu/)*

[8] *Energy Efficient Mortgages Initiative (https://energyefficientmortgages.eu/)*

[9] *Financing Energy Efficiency, European Commission (2015) (https://ec.europa.eu/energy/en/topics/energy-efficiency/financing-energy-efficiency)*

develop and deploy attractive financial products for the energy renovation of buildings, in particular, home renovations."
The SFSB initiative also supports the use of Energy Performance Contracts (EPCs) in the public sector. In these types of contracts, usually applied to public buildings, the initial investment is initially paid by a private entity and later repaid thanks to the obtained energy savings.

- **More assistance to create project pipelines:** Of course, the availability of several financial instruments is crucial to widely foster renovation activities. Unfortunately, it may happen that, due to lack of skills or capacities of project promoters and investors, some ambitious renovation projects have difficulties in being held. Therefore, in order to assist promoters, the Project Development Assistance (PDA) has been created by the European Commission. This instrument can guide the implementation of an investment idea towards its financing process.
  An example of this approach is the ELENA initiative by the European Investment Bank (EIB) where private and public investment projects above €30 million are financed up to 90% for their project development costs.
  Another example is represented by the PDA H2020 initiative, focusing on small and medium sized energy investments, which can be financed 100% for their development costs.

- **Changing the risk perception of financers and investors**: the risks associated with energy efficiency investments is often negatively perceived by the market, although it has been demonstrated that "the associated probability of default is lower than in other types of investment"[10]. However, this kind of risk assessment is difficult for investors to be evaluated and a better understanding of the possible benefits has to grow. This awareness on real benefits and risks in energy efficiency investments can be reached thanks to two products developed by the European Commission.
  The former is the De-Risking Energy Efficiency Platform, where data about more than 10000 buildings energy efficiency projects are shared and made available for other possible investors' evaluations.
  The latter instrument, launched in the 2017, is the Energy Efficiency Financial Institutions Group (EEFIG) Underwriting Toolkit for evaluating risks related to investment projects.
  The toolkit is "designed to assist financial institutions to scale up their deployment of capital into energy efficiency."[11]

[10] *Financing Energy Efficiency, European Commission, 2015 (https://ec.europa.eu/energy/en/topics/energy-efficiency/financing-energy-efficiency)*

[11] *The EEFIG Underwriting Toolkit (https://valueandrisk.eefig.eu/introduction)*

2 Demo-cases national frameworks

In this chapter, focused on three 4RinEU demo-cases (Norwegian, Dutch and Spanish), an insight on the legislations dealing with building energy performance and structural aspects, integration of renewable energy sources, grid and smart grid will be given. Possible drivers/barriers for the main project objective will be pointed out.
Considering the 4RinEU's renovation framework, it is analysed whether the presence of specific building codes or National regulations has been a limiting factor the design or the use of specific renovation technologies. In particular, the aspects related to mechanical, safety or security requirements are investigated.

2.1 Norway

Norway demo case consists on a 2-story-height small multi-family house. The 4RinEu approach adopted here includes the renovation with the multifunctional prefabricated timber façade integrating PV modules facing south, the retrofit of the roof using another prefabricated timber enclosure and the installation of a centralized mechanical ventilation system with ducts integration within the new façade.

Concerning the Norwegian demo renovation, it can be stated that design and construction phase have not been influenced by any Construction Products Regulation, CE marking, building codes or lack of specific regulation. Indeed, the use of technologies has been determined by cultural and economic reasons.

Moreover, being the works performed within the framework of a research project, no certifications were needed in order perform the renovation as designed. In case a replication of the intervention should be done, a certification process would probably occur, in particular concerning the prefabricated multifunctional timber façade approach and all the other non-conventional elements used. Sintef Technical Approval would be the certification needed, ensuring that each installed product fulfils the requirements of the Norwegian Technical Regulations for Buildings (TEK).
A list of SINTEF's approved and certified products is present at the company's website (https://www.sintefcertification.no/Contents).

Renovation had of course to fulfil some requirements to satisfy in terms of energy performances the Norwegian regulations. Thanks to a careful design and energy simulations performed by SINTEF, the Passive House standards have almost been reached. Anyway, no intervention has been adopted for the ground floor, although new foundations for the prefabricated element have been built.

Prefabricated timber façade utilization has been mainly influenced by standard procedures and regulations in terms of new buildings. In fact, there are no Norwegian norms uniquely dedicated to timber-prefabricated structures for renovation projects.
Some specific consideration has been done in order to ensure emergency exits in staircase areas, but the use of the prefabricated structure did not influence in a relevant manner these aspects.

2.1.1 Fire protection

Fire issues regarding the new façade and the integration of components (PV and ventilation ducts) have been analysed by a fire expert during the design process. Fire regulations did not influence the use of technologies and, vice versa, the renovation of the building did not affect the fire design concept or evacuation plan as well. In fact, the number of tenants, the number of stories, or story height did not increase, resulting in new escape routes. The existing escape routes were not altered since the renovated windows had the same size, function, and placement as the old ones. Due to the above-mentioned reasons, considering that pre-retrofit fire security concepts have not been affected by the retrofit, no specific interventions were needed on this side.

2.1.2 Structural and seismic safety

Concerning seismic regulation, no specific constraints are present in the Norwegian building code since it is not considered as a risky seismic area.
On the other hand, designing the new prefabricated roof structure, the structural calculation has been performed taking into account the presence of a snow load.
Another determining factor influencing the structure and stiffness calculation of the prefabricated modules have also been the transportation issue.
The dimension of the modules has been kept below a certain level to allow transportation on standard trucks.
Moreover, modules rigidity had to allow the modules to be hung and moved by cranes during truck loading and construction on building site.

2.1.3 RES and non-standard technologies integration

Concerning specific technologies use, some precautions had to be taken into account. For instance, it has been necessary to cover PV modules with laminated safety glass since the façade and the integrated modules are facing public areas, for security reasons. Safety glass is required according to the building code (TEK17 §12-17), which is also referring to NS 3510:2015 Safety glass in buildings (Norwegian standard, see www.standard.no).

PV panels have been integrated in the prefabricated South façade of the renovated building. This technology has been preferred to solar thermal collectors because the apartments were already equipped with electric heating and cooking systems. Nevertheless, due to legislation issues, private owners in multifamily houses are prevented from directly use the electricity produced by the installed PV systems. The electricity is only available for common areas and devices for the whole building. In Norwegian demo case, most of the produced electricity by the installed PVs is used by public offices in the near area, but a change in the regulation would be needed in case of standardization of the intervention, since this can be considered as a limiting factor in the wider use of PV in residential facades.

Particular attention has also been paid in relation to the use of the mechanical ventilation system; noise emissions had to respect technical regulations (TEK 17 §13-6 and NS 8175:2012), therefore silencers have been used.
Precautions have also been used during the design in order to avoid the unbalance ventilation system.

Decentralized ventilation has not been used since it is not a common practice in Norway; it has been considered that with this kind of technology, it is difficult to assess the required ACH per apartment. Moreover, demo owners were afraid of noise issues that could occur frequently. With the use of centralized ventilation systems it has been considered easier to avoid such problems by insulating the technical rooms that host the air-handling units. Therefore, for Norway demo case, centralized ventilation system has been preferred not because of limitations due to regulations or building codes, but more due to technological considerations.

No ceiling fans have been installed in the Norwegian demo case. Due to the weather conditions and typically cold temperatures, the presence of the ceiling fan has not been considered necessary.

In general, any prototyping tests have been required during the project implementation. This approach has also been possible thanks to detailed analyses at each design stage of the intervention.

2.2 Nederland

The Dutch government issues minimum energy performance requirements, which are valid for new buildings and buildings which undergo a major renovation. For existing buildings much lighter rules apply, and only in case a renovation or insulation of a component occur. For new buildings, a standardised energy calculation for the full building related energy flows and primary energy impact is mandatory as part of the procedure to obtain a building permit. For existing buildings only minimum values per component are required.
For existing buildings, the Energy Label calculation is more relevant, though there are no legal obligations to achieve a certain Energy Label in the residential sector. Every building must have an energy label at the time of sale or lease. The social housing sector therefore has issued energy labels for almost their full building stock.
The social housing sector has agreed to achieve an average of Energy Label B for their whole building stock by 2021. In the tertiary sector the government requires a minimum of Energy Label C for individual office buildings, larger than 100 m2, as of 2023 (Source: https://zoek.officielebekendmakingen.nl/stb-2018-380.html).

2.2.1 Analysis of the minimum energy performance requirements

Minimum insulation standards have been defined in The Netherlands. Since 2015 the levels are reported in Table 1.

Minimum insulation values for **new constructions and major renovations**			
			for international comparison
	Rc value	U value	U value
	[m²K/W]	[W/m²K]	[W/m²K]
Roof	6.0		0.16
Facade	4.5		0.21
Glazing		2.2	2.20
Floor	3.5		0.27

Table 1 Minimum thermal transmittances for components in new constructions and major renovations

Most of the existing buildings follows the rules for other situations, such as minor renovation interventions. Minimum requirements only apply for components which are being insulated and values are reported in Table 2, or where insulation is being replaced, Table 3

Minimum insulation values for measures on **existing buildings**			
			for international comparison
	Rc value	U value	U value
	[m²K/W]	[W/m²K]	[W/m²K]
Roof	1.3		0.69
Facade	1.3		0.68
Glazing		2.2	2.20
Floor	1.3		0.68

Table 2 Minimum thermal transmittance for components in existing buildings

Minimum insulation values for measures on existing buildings, when replacing insulation			
			for international comparison
	Rc value	U value	U value
	[m2K/W]	[W/m2K]	[W/m2K]
roof	2,0		0,47
facade	1,3		0,68
glazing		2,2	2,20
panels in window frames		2,2	2,20
floor	2,5		0,37
Source: Bouwbesluit, artikel 5.6 lid 2			

Table 3 Minimum thermal transmittance for components in existing buildings, replacing insulation

In daily practice and in order to achieve Energy Label B or A, roofs are being insulated in a range from U values between 0.68 to 0.3 W/m²K; facades at levels around 1.5 to 2.0 W/m²K; floors are either left uninsulated or at levels of 0.5 – 0.3 W/m²K. Low E glazing with U values around 1.1 W/m²K using existing window frames is rather common when residential buildings undergo energy improvement measures. Combined with demand controlled mechanical exhaust ventilation the net heat demand of Energy Label B or A buildings is in the range of 70 – 90 kWh/m².

Dutch building regulations for energy performance will be renewed by January 2021. Nearly Zero Energy Regulations will apply for new construction. The same new energy calculation method will also apply in the background of the calculation of Energy Labels.
The new method will report energy figures in primary energy units in kWh/m².
The new regulation will consist of three steps. For each building use different recommendations apply. The following recommendations will apply as of 2021 for new residential buildings:

1. Calculation of the space heat demand, using mechanical exhaust ventilation. For new constructions, the requirement is 55 kWh_{th}/m^2 net heat demand, or more in case the building has a relatively large exterior surface.

2. Calculation of the primary energy consumption based on the inputs for energy systems and energy sources, deducted with the yearly on-site renewable energy generation, expressed in avoided primary energy figures. The resulting figure should be maximum 50 kWh/m^2 floor area.

3. Amount of on-site renewable energy generation. The minimum should be 40 kWh/m^2 floor area.

Energy Classes for existing buildings will be defined using the same structure, but these figures have not been disclosed at the time of writing of this report.

It can be remarked that the Dutch building energy requirements are not very tight for space heat demands, both for new construction and for existing buildings. Therefore, a relatively and absolutely large part of the zero-energy equation should come from renewable energy generation.

2.2.2 Exceptions in case of special conditions

Historical buildings and monuments can get exemptions of minimum insulation requirements. Better performance in terms of lower heat demands, and higher renewable energy production is being rewarded by a law which allows social housing owners to generate a second income stream on top of rental income. Tenants pay up to 1.45 €/m^2 on top of the rent, if the new or renovated building meets specific energy requirements. These requirements will be reformulated under the new Net Zero Energy Calculation method. Nowadays the requirements are a net heat demand below 30, 40 or 50 kWh/m^2 and renewable energy generation which equals the yearly energy demand for space heating, hot water, appliances and plug loads together.

2.2.3 Energy production

Currently The Netherlands has the lowest share of renewable energy (less than 8%), and the highest distance of the agreed renewable targets agreed among EU member states. (Source: Eurostat). The majority of end uses in all sectors in The Netherlands are fossil fuel based: gas, oil and coal. Within the framework of a national Climate Agreement in 2019 (Klimaatakkoord) future plans are being elaborated for all sectors to reduce emissions by 50% in 2030 and 90% by 2050. These plans include major shifts in energy production and uses.

The Netherlands promotes the application of on-site renewables in buildings. Since 2012 there is a net-metering system on yearly basis of the exported and imported energy from and to a building. It has been this incentive that resulted in zero energy bills for houses which generate the same as what they use on a yearly basis. This incentive was the basis for the Energy-Performance-Surcharge model to shift the savings on the energy bill to an investment cost monthly payable by tenants for the next 40 years. However, when the net metering comes to a gradual end as of 2023, the logic behind this model will gradually disappear since the energy bills will no longer be zero.

For large scale investments subsidies on wind energy, large scale use of biomass and guaranteed prices for large scale PV are in place to increase the renewable energy share in the Dutch energy market.

2.2.4 Fire protection

The Netherlands has fire protection rules as part of the Building Code. New Buildings must meet the latest requirements. For existing buildings, the existing situation is legal, but must be improved to better criteria when a major renovation takes place. In general, for maintenance works, and works without structural changes, works can be done without a building permit. In case of structural changes and changes in the appearance a building permit is required.
One speaks of major renovation if 25% of the façade area is being renewed or enlarged. A major renovation must include the whole building envelope. The full renovation project in 4RinEU demo has applied for a building permit. Renewed parts must follow the requirements for new construction. Typically, the fire protection rules require 60 minutes fire protection for new buildings and 30 minutes for existing buildings. There are specific rules about material choices, building volumes, escape routes, sprinklers etc. which in the renovation project have been verified by experts and did not represented fire safety issues.

2.2.5 Structural and seismic safety

The Netherlands are using Eurocodes transferred into NEN-EN-codes for structural safety. Seismic safety only recently has been added for particular areas where seismic risks are present caused by natural gas extraction. Nevertheless, the demo site is not located in such areas.

2.3 Spain

Spanish demo case consists of a 3-story-height multi-family residence, which includes 15 dwellings. The 4RinEu approach adopted here includes the renovation with the multifunctional prefabricated timber façade integrating PV modules in the East façade. Additional PV modules are placed on the roof. The roof will be previously thermally insulated. The intervention includes other improvements, such as decentralized mechanical ventilation and ceiling fans. In the Spanish demo case, the energy hub will not be installed.

In general, National building codes and other Eurocodes and specific standards are applied. However, even if the Spanish Building Code (CTE) is not compulsory for partial renovations (except for the energy performances regulations), its requirements are followed as much as possible. The codes are not fully compulsory because in the 4RinEU Spanish demo a total refurbishment in not foreseen. Anyway, the prefabricated multifunctional façade needs to comply with CTE in terms of energy efficiency (e.g. thermal transmittance values of envelope components).

For the Bellpuig demo case no specific certification or procedure was needed in order to perform the renovation and to use the selected technologies, apart from the already carried out studies in structures, fire and energy efficiency. In general, for other buildings, the Technical Assessment could be a good option (ETA guidelines, as for the EU version, or the DAU Document d'Adequació a l'ús if used within Spain).

Nevertheless, the AHC has asked for support from local experts, through two specific subcontracting, in order to ensure the timber solution in terms of quality and technical feasibility.
On one hand, an expert in timber structures has performed and taken the responsibility of the corresponding calculations.
On the other hand, a bioclimatic architect expert in timber construction was contracted in order to guide during the design of the construction process considering the local timber to be used in the demo in Bellpuig.
So, no specific technical procedure was undergone but local experts were included in the project to verify key technical issues, adapt G&M solution and, somehow, guaranteeing the solution.

2.3.1 Fire protection

Fire protection has been studied for the new façade. It is in compliance with the CTE regulations. Fire resistance of the timber panel is considered to be at least R30 and the façade is confirmed to respect EI 60 (required value).
The local fire department confirmed that no specific review from their side were needed as the building is not open to general public, nor it is a high-rise residential block.

Spanish regulation just establishes that for facades with less than 18m height, the minimum class of reaction to fire of the materials used in the ventilated rooms up to a height of 3.5m is Euroclase B-s3, d2. This restriction is applied when the lower inlet of the façade is accessible to public from the outside, and also has to be accomplished in the upper part of the facade if the roof is accessible. The rest of the facade has no specific fire safety demand.
For the determination of the maximum actions in structures exposed to fire, the nominal temperature-time curves are used. These curves are defined in the norm EN 1363-1 and 2 in Eurocode 1.

2.3.2 Structural and seismic safety

As regards the prefabricated multifunctional façade, a specific structural study has been carried out to check the structural risks, to check the compliance with structure standards and requirements, to ensure the response capacity of the existing building when supporting the additional façade, to define the requirements for the materials (included in the tendering process documents) and to dimension the anchoring systems. These studies were carried out using specific numerical software, skilled teams and specific technical meetings with experts. Working with timber elements is not the common approach, so additional guidance was needed.

For each timber element, the following checks have to be carried out, in accordance with the corresponding articles of the CTE-SE-M.

- Parallel fibre traction: Article 6.1.2.
- Compression parallel to the fibre: Article 6.1.4
- Flexion: Article 6.1.6
- Cutting: Article 6.1.8
- Torsion: Article 6.1.9
- Combined traction and flexion: Article 6.2.2
- Combined compression and flexion: Article 6.2.3

It has also been necessary to accomplish EAE2011 (Structural Steel Instructions) to guarantee the structural safety of the anchoring system, and EHE-08 (Structural Concrete Instructions) to assure that the existing concrete structure will correctly support the Prefabricated Multifunctional façade.

The façade is required to last for 50 years (in terms of structural safety, according to CTE, EHE-08 and EAE 2011). Other elements, as replaceable structural ones, such as railings, can have a reduced lifespan according to their functions and maintenance plan.
A complete structural study was carried out as mentioned above, but no prototyping and in-situ tests have been required for implementing the renovation solution.

Bellpuig is not a seismic zone and the existing building does not need any additional study in this regard.
In general, no specific limitations were encountered due to legislations. Main issues among the performed renovation had to deal with the lack of expertise in timber construction among the building sector, which implied a higher investment in time and knowledge.

2.3.3 RES and non standard technologies integration

Also concerning the use of specific 4RinEU related technologies no particular requirements had to be satisfied apart from those in the building codes applicable for standard solutions. These requirements apply to minimum performance related to structural safety, user safety, health, fire protection, energy savings, noise, air quality.
Because of not having specific requirements, no important barriers were found for 4RinEU technologies to be integrated in the Spanish pilot case.

In terms of renewable energy, solar thermal panels were already present within the demo building. Moreover, new PV modules are being installed in the façade and roof, but apart from the economic investment, there is a limiting factor for their installation. In fact, current legislation in Spain (RD 244/2019) allows and encourages self-consumption and allows being compensated for energy surpluses (in terms of economic balance with the grid consumption), but it is not considered as advantageous to produce more energy than needed to sell it to the energy market.
This is due to the fact that energy surpluses are bought at approximately the same price as the electricity consumption from the grid (no benefit nor disadvantage is created).

PV installation has been conceived as a shared self-consumption installation connected to the grid, which is in line with the new trend in Spain, but not innovative in a EU framework. Centralized PV meters will monitor the generated and consumed electricity. PV generation will be distributed among the 15 dwelling units, according to previously established coefficients.

However, the framework is changing and nZEB will be a reality very soon, so it can be expected that PV generation will be more and more encouraged in the coming years.

3 Financial support strategies and available incentives

A review of the initiatives to promote building renovation for different European countries is reported in the following chapter. The programs and initiatives are listed in chronological starting order. Some of them will be concluded before the end of the 4RinEU project but it has been considered useful to mention them in this report for further completeness.

3.1 Financing Needs for European Buildings[12]

Under Directive 2012/27/EU of the European Parliament and the Council, each EU countries must provide a national document to estimate energy consumption, planning energy efficiency measures and pointing out the improvements they want to achieve. This document is called National Energy Efficiency Action Plans (NEEAP) and it has to be update every three years.
In the following Table 4, the National Energy Efficiency Action Plan's most relevant measures for energy efficiency in buildings is presented for some European countries, also involved in 4RinEU project. The plan refers to the period from 2017 to 2020. The projects reported below can be found in each respective Country's NEEAP or on the European Energy Poverty Observatory's website in the section 'Policies and Measures'[13].

Table 4 National Energy Efficiency Action Plan for European 4RinEU involved countries

COUNTRY	PROGRAMS
Spain	FIDAE: Energy diversification and saving investment fund (2011 - ongoing). It is a JESSICA (Joint European Support for Sustainable Investment in City Areas) holding fund with a budget of €123 million, the purpose of which is to finance urban energy-efficiency and renewable-energy-use projects. It was set up following a financing agreement signed between the European Investment Bank (EIB) and the IDAE on 1July2011. Projects to be financed had to fall within one of the eligible sectors (construction, industry, transport and energy-related public service infrastructure) and had to come under one of the following priority areas: - Energy efficiency and energy management projects. - Solar thermal energy, off-grid photovoltaic and biomass projects. - Projects related to clean transport that help to improve energy efficiency and encourage renewable energy use. BIOMCASA II, GEOTCASA, SOLCASA and GIT (2011-2013) These programmes, managed by the Instituto para la Diversificación y ahorro de la Energía (IDEA), have a dual purpose: on the one hand, to promote energy service companies and, on the other, to encourage, via project financing,

[12] *Main source: Financing Mechanisms for Europe's Buildings Renovation - Assessment and Structuring Recommendations for Funding European 2020 Retrofit Targets (https://www.eurima.org/uploads/Eurima-Financing_Mechanisms.pdf)*

[13] *Understanding Energy Poverty in Europe, European Commission (https://www.energypoverty.eu/)*

	efficient hot water, heating and cooling systems powered by biomass, solar or geothermal energy. State Plan to promote housing rental, building refurbishment and urban regeneration (2013-2015) Adopted by the Spanish government in April 2013, was designed to achieve various objectives, in particular to provide incentives for building refurbishment and urban renewal through improvements of the quality of buildings and to their energy efficiency. To do this, the Plan contained a specific programme to promote building refurbishment aimed at financing building and maintenance work, as well as improvements to fixed installations, individual equipment and communal parts of residential buildings. The maximum amount of aid depended on the type of measures carried out. PAREER-CRECE (2013 - 2016): Aid programme to improve the energy efficiency of existing buildings. This programme main aim is to promote comprehensive measures to improve energy efficiency and the use of renewable energies in existing residential building stock. The measures for which support was provided had to fall into one or more of the following categories: - Improvement of the energy efficiency of the thermal envelope. - Improvement of the energy efficiency of heating and lighting systems. - Replacement of conventional energy with biomass in heating systems. - Replacement of conventional energy with geothermal energy in heating systems. The measures receiving support must improve the overall energy rating of the building by at least one letter on the carbon dioxide emissions scale (kg CO2/m2per year) when compared with the building's initial energy rating. That improvement in its energy rating may be achieved by adopting one measure or a combination of several measures. PAREER-II (2018 - ongoing) This programme is a follow up of PAREER-CRECE, remarking the same objectives; the budget is of €125.6 million and is provided by the Energy Efficiency National Fund.
Hungary	Warmth at Home Programme (WAH) (2014 - ongoing) First GEFS (Green Economy Financing System) funded program announced in 2014. Several sub-programmes have been announced under the WAH, and new sub-programmes are being announced continuously. The main impact area of the current sub-programmes of the Warmth at Home Programme launched in 2014 is a complex energy efficiency renovation of private and public buildings. Some of the most remarkable WAH programmes are listed here below: - Heating modernisation (Furnace Replacement) sub-programme - Replacement of large household appliances (resulting in energy savings) sub-programme 2014 (Replacement of refrigerators)

	- Facade door and window replacement sub-programme - Subsidy for modernisation and renovation of condominiums resulting in energy savings - Replacement of large household appliances (washing machine) generating energy savings - Sub-programme for modernisation and renovation of detached houses resulting in energy savings (2016) - Sub-programme for replacement of large household appliances (refrigerators and freezers) resulting in energy savings (2016) - Sub-programme supporting modernisation of heating systems (2017) - Sub-programme for replacement of large household appliances (refrigerators or freezers, washing machines or washer-dryers) (2017) - Replacement of natural gas convectors (2017) KEHOP Environmental and Energy Efficiency Operational Programme (2014 – 2020) This programme aims at modernising building energy efficiency by combining the use of renewable energy sources. VEKOP (2016 – 2018) This programme aims at the improvement of external funding opportunities for projects in order to increase the energy efficiency and the use of renewables in the Central Hungary region.
Poland	Subsidised loans for the construction of energy-efficient houses (2013 – 2018) The purpose of this programme is energy saving and reducing or avoiding CO_2 emissions through the co-funding of projects, which improve the efficiency of energy use in newly constructed residential buildings. The funding is a grant for partial repayment of the principal of a bank loan, provided through a bank under a cooperation agreement with the National Fund for Environmental Protection and Water Management (NFOŚiGW). LEMUR -Energy Efficient Public Buildings (2013-2020) The aim of the scheme is to reduce energy consumption, and thus to reduce or avoid CO_2 emissions through the design and construction of new energy efficient public buildings and collective accommodation buildings. Funds are used for the subsidy for project documentation amounting to 60%, 40%, 20%, depending on building energy efficiency class (A, B or C). Moreover, loan for the construction of new energy-efficient buildings of up to PLN 1200.00 per m^2 for class A, and up to PLN 1000.00 per m^2 for classes B and C, with the possibility of redemption of 60%, 40%, 20%, depending on the building energy efficiency class (A, B or C). Prosumer – co-financing facility for the purchase and assembly of RES micro-installations (2014-2022) The purpose of the programme is to reduce or avoid CO_2 emissions by increasing renewable energy production through the purchase and assembly of small RES installations or RES micro-installations for the production of electricity or heat and electricity for natural persons and housing associations or housing cooperatives. The programme promotes new RES technologies and prosumer

	attitudes (raising investor's and environmental awareness), and stimulates the growth of the market of equipment suppliers and installers, as well as the growth of jobs in the sector. The co-funding will be available for installation producing electricity or heat, such as photovoltaic systems, small wind farms, micro-cogeneration systems, heat pumps and solar collectors. BOCIAN – dispersed renewable energy sources (2014-2022) The purpose of this programme is to limit or avoid CO2emissions by increasing the production of energy by installations using renewable energy sources, such as wind farms, solar systems, geothermal water energy and small hydroelectric power stations. Improvement of air quality. Part 2 – Reduction of energy consumption in the construction sector (2016 – 2022) The aim of the programme is to improve the air quality in buildings by the limitation of CO_2 emissions through the increased use of renewable energy sources using subsidies and loans. The budget is up to PLN 500 million. Operational Programme Infrastructure and Environment 2014-2020 Measures 1.3.1, 1.3.2 –Supporting energy efficiency in public buildings and in the public sector (2014 – 2023) The aim of this programme is to improve energy efficiency in multi-dwelling residential buildings and in public buildings. The budget is €431.10 million from the European Cohesion Fund in forms of grant and loans. SERIES OF Regional Operational Programmes (ROPs) (2016 – 2020) Funds from the European Regional Development Fund (ERDF) and the European Social Fund (ESF) will be allocated for 16 regional programs for improvement of energy efficiency in building sector.
United Kingdom	Re:Fit (2009-ongoing) The Re:fit programme is a procurement initiative for public bodies wishing to implement energy efficiency and local energy generation measures on their buildings. The framework uses a robust, flexible and tested Energy Performance Contracting approach. Initially developed by the Greater London Authority in 2009, the use of the framework is growing, with teams now supporting organisations across England and Wales. Over 250 organisations have already engaged Re:fit. Over £165 million of works has been procured across more than 700 buildings and the current pipeline is over £65 million and growing. Public sector Energy Efficiency Loans Scheme (2015 – 2020) The Department for Business, Energy and Industrial Strategy (BEIS) funds a scheme of interest-free loans to support wider public sector bodies in England (outside central government) to carry out energy efficiency works. The scheme is managed by Salix Finance Ltd, providing a revolving fund. Total BEIS funding for the scheme is currently over £130 million. A further £255 million was allocated in the Spending Review (SR) 2015 for the five-year period to 2020.

	Home Energy Efficient Programmes (HEEPS) (2016-ongoing) Heeps consists of three programmes: HEEPS: Area Based Schemes (ABS) includes the programmes designed and delivered by Local Authorities targeting fuel poor areas in order to provide energy efficiency measures to several buildings and to reduce the fuel poverty. HEEPS: Warmer Homes Scotland was formally launched in September 2015with the delivery contract being awarded to Warmworks Scotland (a partnership between Changeworks, the Energy Saving Trust and Everwarm). Warmer Homes Scotland is worth up to £224 million over a seven-year period and is expected to help around 28,000 householders make their homes warmer and cheaper to heat. It has a strong focus on fabric measures, such as insulation, to improve the energy efficiency of the Scottish housing stock. HEEPS: Loans launched in the summer of 2015 are available to all private sector households in Scotland (both owner, occupiers and private property owners) who wish to install energy efficiency measures. The scheme offers an interest-free loan of up to £10,000 per household. Loan funding is also made available to Registered Social Landlords to assist them improve the energy efficiency of their stock. This kind of loan can be combined with ECO or HEEPS: ABS.
Netherland	**Reduced VAT rates on labour costs for installing insulation and glass (2009 – ongoing)** This program provides a tax benefit from 21% to 6% for homeowners and encourages energy-saving investments in case of works on houses. Until 1.1.2014 the reduced rate for insulation activities also applied to the materials and to all other maintenance and renovation work, but as of 1.1.2014 the reduced rate only applies to the labour involved in installing insulation material. **The Nationaal Energiebespaar Fonds (National Revolving Fund for Energy Saving) (2014-ongoing)** The Nationaal Energiebespaar Fonds is a loan targeting homeowners, housing associations and owners' associations; it encourages investments in the energy saving for existing buildings. **Energy-saving at Home (2016, 2017, 2018)** This subsidy is due to homeowners and is needed as a stimulus to extend energy savings measures. It is issued in case at least two of the following renovations are performed: wall insulation, cavity wall insulation, roof insulation, floor or ground insulation and replacing windows with low-emissivity glass. **Investment Subsidy for Sustainable Energy (2016 – ongoing)** This program provides subsidies to households encouraging the acquisition of small renewable heating sources, such as solar water heaters, heat pumps, biomass boilers and pellet stoves. **The Energy performance surcharge (2016 - ongoing)** The Energy performance surcharge bill was adopted on 17 May 2016 and it took effect on 1 September 2016. Property owners who renovate their properties so that they are nearly zero-energy or zero-energy can charge an energy

	performance surcharge to their tenants to earn back major investments in the rental property. The property owner and the tenant must reach an agreement on the sum of the fee. **The Energy Performance in the Rented Housing Sector Incentive Scheme (Stimuleringsregeling Energieprestatie huursector STEP) (2014 – 2018)** The STEP initiative aims at providing property owners in the social rental sector with a €400 million subsidy for investing in energy efficiency in buildings. The STEP subsidy encourages the short-term investments to make residential rental properties energy efficient.
Ireland	**Better Energy (2011 – ongoing)** The Better Energy Programme includes three existing energy programmes: Home Energy Saving Scheme (HES), Warmer Homes Scheme (WHS) and Greener Homes Scheme (GHS). The programme is designed to ensure that there are supports available for householders who wish to reduce their energy consumption and achieve real and lasting energy cost savings. The programme is administered by the Sustainable Energy Authority of Ireland (SEAI). Fixed grants are provided towards the cost of a range of measures including attic insulation, wall insulation, heating systems upgrades, solar thermal panels. The Better Energy Warmer Homes scheme is a housing retrofit scheme targeted at those living in, or at risk of, energy poverty. Energy efficiency upgrades are delivered free of charge. Measures available include draught proofing, attic insulation, lagging jackets for hot water tanks, low energy light bulbs and cavity wall insulation. **Housing Aid for Older People (2010 – 2016)** The Department of Housing, Planning, Community and Local Government administers the Housing Aid for Older People scheme which provides grants of up to €8,000to assist older people living in poor housing conditions to have necessary repairs or improvements carried out. Grant eligible works include structural repairs or improvements, re-wiring, repairs to or replacement of windows and doors, provision of water supply and sanitary facilities, provision of heating, cleaning and painting. **Better Energy Communities Programme (2012 – ongoing)** This is a pilot scheme to support sustainable energy upgrades to clusters of buildings, services, facilities and processes in a local community and to support an area-based approach to tackling energy poverty. The scheme encourages community-based partnerships to improve the energy efficiency of homes, community facilities and local businesses. **Warmth and Wellbeing Pilot Scheme (2016 – 2018)** The objective of the pilot is to validate, in the Irish context, the international evidence that suggests making homes warmer and more energy efficient can have a positive effect on the health and wellbeing of people in energy poverty who are also living with a chronic respiratory condition such as COPD & Asthma. **Deep Retrofit Pilot Scheme (2017 – ongoing)** The aim of the project is to encourage deeper retrofit of residential buildings.

4 Construction products regulation

This section presents how EU regulation 305/11 on construction products can affect the implementation of 4RinEU technologies. A special focus will be devoted for the prefabricated multifunctional façade, stated it is quite peculiar prefab technology solutions. PPEH and ceiling fans are also key technologies in 4RinEU deep renovation packages, but they are not properly construction products. It is as well important to define the right boundary conditions for their uses.

Indeed, the lack of specific regulation for novel renovation solutions or novel configuration of existing solutions has been one of the main sources for uncertainty amongst architects, planners and all the related value chain.

The European regulation 305/2011 (Construction Products Regulation, CPR) aims to define a clear framework to support the introduction on the market of new products.

Along with the definition of rules for the assessment and verification of the performances of the construction products, it also defines the responsibilities of manufacturers, distributors and other different actors involved in the commercialization process related to a specific product.

A relevant part from the technical point of view is reported in the ANNEX 1 of the regulation. Here, the *basic requirements for construction works* are listed and it is stated that "*construction works as a whole and in their separate parts must be fit for their intended use, taking into account in particular the health and safety of persons involved throughout the life cycle of the works. Subject to normal maintenance, construction works must satisfy these basic requirements for construction works for an economically reasonable working life.*"

Therefore, seven essential requirements which construction works and products must satisfy are described, although each Member State owns the responsibility on how they have to be applied nationally. Then, the CE marking shall recognize that the specific products fulfill the conformity to these essential requirements.

1. Mechanical resistance and stability

   The structure and construction products must ensure no collapses, deformations or damages to other structures or people.

2. Safety in case of fire

   The structure and construction products must guarantee, in case of fire, the load-bearing capacity of the constructions and a limited fire propagation. Moreover occupants and rescue teams safety must be ensured.

3. Hygiene, health and the environment

   Construction products must ensure, during their whole life cycle, the proper hygiene and good health condition to building occupants, as well as not causing emission of dangerous substances in construction, use and demolition phase.

4. Safety and accessibility in use

In general, construction products should guarantee that their use does not create risks of accidents or damages to the users. Moreover, accessibility for disabled persons must be taken into consideration.

5. Protection against noise

   Occupants and nearby people should not be disturbed by construction products' noise emissions.

6. Energy economy and heat retention

   Construction products must be designed and built in order to require low energy consumptions, both in construction, use and dismantling phases, aiming in general to energy-efficiency principles.

7. Sustainable use of natural resources

   The reuse and recycling of the construction products, as well as their durability must be guaranteed.

Following the principles described by the CPR 305/2011, each construction products' specific performances and information must be provided, fulfilling the European Technical Assessment (ETA) documents, turned into European Assessment Document (EAD) since 2014, drafted by the European Organization of Technical Approvals. The ETA certifications will then allow the Europe-wide market commercialization of the product.

4.1 Prefab facade

Concerning the prefabricated timber façade, the ETA Guidelines 019[14] deals with the prefabricated wood-based loadbearing stressed skin panels for use in roofs, external walls, structural partitions and floors.
In this ETA the guidance for the assessment of the fitness for the use of this specific family product is provided and all the above-mentioned 7 requirements are analysed in detail. Furthermore, the methods available to verify the product characteristics and guidance on assessing and judging methods to confirm fitness for the intended use of the stressed skin panels are described.
Finally, the ETA identifies the materials and components which constitute the prefabricated wood-based loadbearing stressed skin panels, stated that specifications of materials and components should as far as possible provide maximum flexibility to choose alternative products for a panel, without affecting the declared performances or the fitness for the intended use. In the ETA, references to typical European or relevant product specifications are also addressed.

4.2 Plug&Play Energy Hub

[14] ETA guidelines : ETAG 019 at https://ec.europa.eu/growth/tools-databases/nando/index.cfm?fuseaction=cp.nb_hs&hs_id=750

In order to be commercialized in Europe, the Plug&Play Energy hub technology must follow different Directives. The most relevant, also common to other hydronic components are reported here:

- Low Voltage Directive 2014/35/UE
- Electromagnetic compatibility Directive 2014/30/UE
- Pressure equipment Directive 2014/68/UE
- Restriction of Hazardous Substances Directive 2011/65/UE
- Energy-related Product Directive 2009/125/UE.

Main norms complied are the CEI EN 60335, CEI EN 61000, CEI EN 55014, UNI EN 378 and UNI EN 12735.

4.3 Ceiling fan

The Smart Ceiling Fan system developed within 4RinEU project is in compliance with the European directive 2014/53/UE (Radio Equipment Directive).
The essential requisites of the RED are mentioned here below:

- Safety and health issues, aiming at protecting users' health. The most relevant Directives and Norms followed in this area are the Low Voltage Directive 2014/35/UE, the EN 62311, the EN 60335 and EN 62233.
- EMC requisites, providing electromagnetic compatibility following the Directive EMC 2014/30/UE, EN 61000 and EN 55014.
- Radio Spectrum issues, following the ETSI EN 300328.

4.4 BiPV

Although BiPV is not a technology specifically developed within 4RinEU project, it represents for sure one of most suitable applications to be used in combination with the timber prefabricated façade in order to enhance the use of renewables energies and to contribute to a deep renovation approach.
When adopting building integrated photovoltaic technologies there are two main norms to be taken into account: the EN 50583-1:2016 concerning with BiPV modules and the EN 50583-2:2016 concerning with BiPV system.
These two norms describe in detail all the required criteria (Standards, guidelines, test methods) for BIPV modules that are subject to the 7 Essential Requirements, as specified in the European Construction Product Regulation CPR 305/2011.
In particular, the ETAG 002 is mentioned in case BIPV modules are used as part of a structural sealant glazing system.

5 Conclusions

The lack of specific regulation for renovation elements in the past has been one of the main sources for uncertainty amongst building constructors, increasing possible technical and financial risks in applying novel technology solutions.

It is clear that, at European and National level, a great variety of regulatory framework, incentives and loans instruments are available to foster the renovation in building sector. Nevertheless, these financing support strategies have to be supported by a strong standardization process both in terms of performance characterisation and calculation within energy certification schemes, and definition of shared metrics to make easier dialogue among market players (manufacturers, designers, general contractors, facility managers, etc) and final users.

This standardization framework combined with available financial instruments could represent the key to help the market commercialization of new innovative products.

Beside this long-term strategy, the exploitation of the Open and Participative Innovation approach could also support the renovation process.

The idea behind this European initiative is to adopt various open innovation actions and approaches to industry and to other innovation partners in order to stimulate and strengthen competitiveness, promoting the use of prototyped solutions in order to accelerate innovation applicability and, therefore, promote renovation.