NewTREND
NEW Integrated Methodology and Tools for Retrofit Design Towards a Next Generation of ENergy Efficient and Sustainable Buildings and Districts

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NEW INTEGRATED METHODOLOGY AND TOOLS FOR RETROFIT DESIGN TOWARDS A NEXT GENERATION OF ENERGY EFFICIENT AND SUSTAINABLE BUILDINGS AND DISTRICTS
GA NO. 680474

DELIVERABLE D5.4:

STANDARDS, RATING AND SUSTAINABILITY DESIGN FOR RETROFIT PROJECTS

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ABBREVIATIONS AND ACRONYMS

ACRONYM	DEFINITION
CDP	Collaborative Design Platform
DIM	District Information Model
EeB	Energy-efficient buildings
GA	Grant Agreement
IA	Innovation Action
NewTREND	NEW integrated methodology and Tools for Retrofit design towards a next generation of ENergy efficient and sustainable buildings and Districts
UC	Use Case
WP	Work Package
KPI	Key Performance Indicator
IDM	Integrated Design Methodology
EU	European Union
EPBD	Energy performance of Buildings Directive
DHW	Domestic Hot Water
ERDF	European Regional Development Fund
HVAC	Heating, Ventilation and Air Conditioning
ICT	Innovation and Communication Technology
U	Overall heat transfer coefficient
qm	Specific heat loss factor
Um	Mean heat transfer coefficient
Ep	Integrated energetic indicator
qb	Mean thermal load during cooling season for the period of use
qtot	Total volume of ventilated air
SEAP	Sustainable Energy Action Plan
GHG	Greenhouse Gas
PV	Photovoltaic
NEEAP	Plan Nacional de Acción de Eficiencia Energética / National Action Plan on Energy Efficiency
CTE	Código Tecnicó de la Edificación / Technical Building Code
RITE	Reglamento de Instalaciones Térmicas en los Edificios / Regulation on Building Heat Installation
PACTE	Pla d'Alineació i Competitivitat Estratègica / Strategic Competetiveness and Alignment Plan
CAPEX	Capital Expenditure
ESCO	Energy Service Company
LPG	Liquefied Petroleum Gas
KEHOP	Környezeti és Energiahatékonysági Operatív Program / Operative Program for Environment and Energy Efficiency
SME	Small and Medium Enterprises
CHP	Combined Heat and Power
OP	Operative Program
GINOP	Gazdaságfejlesztési és Innovációs Operatív Program / Operative Program for Economic Development and Innovation
EEM	Energy Efficient Mortgage
LCA	Life Cycle Assessment
KGA	Kommunalgebäudeausweis / Municipal Building Pass
PHPP	passive house projecting package
PACA	Provence – Alpes – Cote d'Azur region

EXECUTIVE SUMMARY

The European Union supports energy efficiency investments to help take maximum advantage of available and emergent financial and business instruments whilst also ensuring compliance with local legislation. The NewTREND project aims to align its IDM with this goal, as defined in the European Union 2012/27 Energy Efficiency Directive.

Such compliance can be proven by connecting NewTREND Key Performance Indicators (KPIs) and the performance measures in the examined instruments. The instruments consist of the energy efficiency legislation that define the legal structure for the energy efficiency goals of the EU, the financial and business instruments that incentivize the achievement of the above mentioned goals and the regional rating schemes that use standardised methods to evaluate and communicate building performance.

The study thus focuses on an in-depth analysis of the energy efficiency legislation of the European Union, the supporting financial incentives and rating schemes and the main objective is to compare NewTREND KPIs with the way energy performance is measured by current and emerging practices of legislation, financial incentivisation and rating in the EU and provide recommendations to improving them.

The research methodology consisted of identifying and collecting the relevant EU level and national energy efficiency legislation, financial incentives both from EU countries and from round the world and regional sustainability rating schemes. The legislation data collection consisted of a general description and the main sustainability performance measures included in the legislation. The supporting financial instruments were grouped by their type and the following information was listed for each of them: instrument name, classification (tax incentive, non-refund financial support, loan, financial security, energy performance contracting), in force / not available, country, short description, incentive and performance standard. The collected data for the rating schemes were: general description, related incentive programs, in use / not available, related grants, related national or regional law, applicable buildings and the difficulty of assessment. After the data collection, the analysis focused on the relation between incentives, performances and scores, and the connections between the instruments and the NewTREND project and its KPIs.

The analysis of the legislation showed that the NewTREND KPIs included in the Environment category are overlapping the EU and national level performance measures described in the energy efficiency legislation (primary energy demand occurs in 57 % of analysed legislative instruments, on-site renewable energy in 17 %, impact on climate change in 4 %, comfort related KPIs in 12 % and operational costs in 4 %). This makes the results of the NewTREND methodology relevant to current policy trends. The national, regional and local level energetic action plans and strategies connect cost effectiveness to the topic of energy efficiency so a number of Economic indicators reflect this. Thermal, air quality and acoustic comfort are usually included in energy legislation as minimum thresholds (e.g. minimum ventilation level necessary for a space function). The ideal levels are defined in separate legislation or standards. However, NewTREND attempts to integrate these viewpoints into one system as most of the energy used in buildings aims at guaranteeing conditions of well-being, comfort and health for the buildings' occupants.

For the analysis of the financial and business incentives, the 50 financial instruments from T5.1 were incorporated and another 82 instruments were collected. Incentives provide a financial benefit package awarded for achieving sustainability performance, either measured through rating schemes, percentage based compliance with legislative thresholds, custom indicators, or a list of approved interventions. The analysis showed that most incentives are still backed by public institutions, simply to fast-forward the

sustainable transition of the built environment. Trickling down from the EU level to national, regional and local policy, a diverse array of instruments emerged in the past decade not only to directly incentivise end-users to sustainability interventions, but also to incentivise the market of bankable entities to sponsor them. In the scope of retrofitting, incentives either provide the liquidity to break down the entry barriers, or support competitive entities to make their own liquidity services more accessible. While improving the energy performance of the built environment yields realistic return on investment, many incentives – especially those aimed at residential buildings and public institutions – do not expect a payback. This is due to the fact that sustainability projects that are still on the way to becoming widely appreciated and deeply embedded in society. Governments fast-forward the transition with attractive, non-refund incentives. The share of refundable financial supports can be expected to grow as the solutions adopted in the projects mature. Moreover, market-based solutions, such as energy performance contracting, are expected to succeed public sector sponsored incentives.

For this study 6 rating schemes from 3 European countries were collected (Protocolo ITACA and Biover2 from Italy, KGA and Housing Subsidy from Austria, BDM and Social Housing Eco Compliance from France). These schemes all based on similar incentive policies and similarly structured environmental performance assessment systems. All chosen rating schemes address the challenge to evaluate buildings through the application of an assessment tool concerning environmental, economic and social aspects, but they are very different in composition, choice of criteria and calculation methods, because they come from different contexts. Applying a rating scheme could generate a reduction of costs consequently to an efficient use of environmental resources. The use of an assessment system could also improve the sustainability performance of the buildings over their lifecycle, encouraging performance monitoring during the in-use phase. Out of the three main instrument categories (legislations, financial incentives, rating schemes), the NewTREND indicator framework is the closest to rating schemes as it has multiple objectives related to the different dimensions of sustainability.

The research question – Are NewTREND KPIs compatible with the way energy performance is measured by current and emerging practices of legislation, financial incentivisation and rating in the EU? – has been answered by dissecting 105 financial initiatives, the legislative background of the EU and the three demo sites, and 6 rating schemes tied to financial incentive programs. Only 7 of the examined instruments did not refer to NewTREND KPIs or similar. Especially the energy related indicators, and in particular primary energy demand, appeared to be the most common metrics. Comfort is the least covered theme among financial incentives and comfort indicators are more prevalent among rating schemes that aim for wholeness and among legislation, due to the comfort-related criteria present in all EU country building codes. On the other hand, cost reductions are more prevalent among incentives, especially in the case of market-based ESCOs, where the revenue stream is directly derived from reduced utility costs. Public financial incentives focus directly on energy demand and renewable energy.

This study tries to bridge the gap between the current market of financial incentives, rating schemes, the legislative background of the energetic sector of the building industry and NewTREND. It has the most relevance to the KPI list developed in T2.2, the methodology from T2.6 and the other financial tasks (T5.1, T5.2, T5.3).

Connecting KPIs to financial instruments can help to consider the financial and business instruments and the legislative environment of the particular project. Therefore, based on the findings of this study it is worth to consider the inclusion of the following updates to the KPI list, either in the near future or on a longer term:

- Harmonizing the energy efficiency requirements specified in EU member state legislation with KPI benchmarks would be beneficial for designers and decisionmakers as the legislative viability of a selected scenario can be determined quickly in each member state. As most states define energy efficiency requirements for major renovations this comparison would be later a necessity.
- Alternatively, users could customize their energy indicator benchmarks to a preferred legislation or performance measure of a financial incentive or rating scheme
- Going further with connecting NewTREND to the current field of financial instruments would be the development of an energy efficiency calculation methodology that can substitute performance calculations when applying for financial aid and compatible with EU/specific national calculation methodologies. One of the main constraint here is that the current energy consumption methodologies in most EU member states do not use dynamic energy simulations.

1. INTRODUCTION

This report addresses Task 5.4 of the NewTREND project, which comprises an in-depth analysis of the energy efficiency legislation of the European Union, the supporting financial incentives and rating schemes. This task has been carried out between December 2016 and August 2017.

Energy efficiency is one of the main objectives of the European Union[1]. Energy efficiency policies are developed to reduce greenhouse gas emissions, increase security of supply, competitiveness, sustainability of the European economy and job creation. The main target is a 20% energy use reduction by 2020 and 27% reduction by 2030[2].

In order to reach the aforementioned goals, the European Union also supports energy efficiency investments with performance based financial instruments. According to 2012/27 Energy Efficiency Directive, energy efficiency investments should be supported by specific financial instruments with criteria ensuring the achievement of environmental and social objectives[3].

The NewTREND project aims to align its IDM with the current European legislation. Therefore the methodology aims to help take maximum advantage of available and emergent financial and business instruments whilst also ensuring compliance with local legislation. Such compliance can only be proven by connecting transferable information sets embedded in NewTREND with the examined instruments. In all cases, the transferable information set will be the indicators of energy performance.

NewTREND uses Key Performance Indicators (KPIs) for determining the energy and cost efficiency of retrofitting projects. They set benchmarks for minimum and best performances. The KPIs need to be put in context of the current industrial goals and averages. Decision-makers involved in retrofitting projects however, will primarily comply with the standards set out in the applied incentive. When describing the project in terms of NewTREND KPI targets, decision-makers must be able to tell whether they can consider a specific incentive or not. This is possible only if there is a clear transferability between the indicators of NewTREND, and the indicators commonly used in the EU. At a bare minimum, KPIs must be able to describe energy performance criteria of legislative instruments. Desirably, financial incentives that are on their way in, the typical funding schemes of a maturing energy retrofitting market focus on aspects of energy performance covered by NewTREND. And finally, NewTREND KPIs should be able to position itself among the leading rating schemes – not as a disruptive innovation, but as a natural improvement. This triad objective is verified via the analysis of the connection between the performance requirements of legislation, financial instruments, rating schemes and NewTREND through the KPIs; in other words, by answering:

Are NewTREND KPIs compatible with the way energy performance is measured by current and emerging practices of legislation, financial incentivisation and rating in the EU? (*Figure 1)*

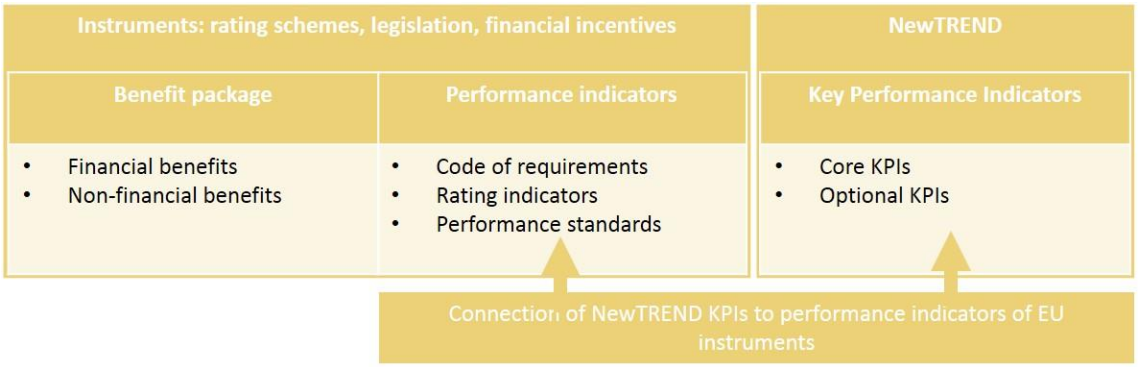


FIGURE 1: TASK 5.4 APPROACH TO ANALYSE INCENTIVES, LEGISLATION AND RATING SCHEMES

The study uses materials from previously reported NewTREND tasks and other tasks in progress as well. The main tasks on which this particular deliverable has built on further, are T2.2 and T5.1. Task 2.2 Definition of Sustainable Key Performance Indicators defines the core KPI set used for the performance analysis of the current state and the design scenarios of retrofitting projects. Task 5.4 Financing and Business models aims to further analyse the core KPI set from this study. Task 5.1 provides a review of the scope, applicability and constraints of the various financing and business models available for district-scale, energy efficient renovations. Our study further analyses the collected financial instruments and their performance requirements and incentive structure.

The research in this report progressed with the following steps:

1. Collection of relevant energy efficiency legislation, financial instruments and rating schemes. The collection focused mainly, but not exclusively, on the countries containing the NewTREND demo sites (Hungary, Finland, Spain). Measures from other EU and non-EU countries were also collected to provide good practices.
2. The collected measures were grouped into the 3 main types (legislation, financial instruments, rating schemes) then were compared to each other and to the NewTREND relevant practices.
3. The performance requirements and the incentive structure of the collected financial measures are analysed
4. Based on the results of the analysis recommendations were made how to improve the established core KPI set.

The structure of the deliverable reflects the research methodology. At first the analysis of the three main topics, which have significant influence on energy efficiency retrofitting projects and their financial background, are presented:

- Energy legislation, standards
- Financial & business instruments
- Rating schemes

Then the deliverable presents its recommendations to the retrofitting project stakeholders based on the results of the analysis, and also provides recommendations to the integration of other NewTREND tasks.

2. ENERGY LEGISLATION, STANDARDS

To reach its goals for energy efficiency in the building sector the EU has developed a number of energy efficiency legislation. The directives provide general rules for implementation in all member states. Each EU country develops its specific energetics policy individually meanwhile relying on the pooled knowledge of all member states. The country specific strategies are turned into national legislation, which gets further detailed in regional and local level.

The following chapters detail the current EU level energy efficiency legislation. Afterwards, the country specific policies are described for the 3 demo locations (Hungary, Finland, Spain) on national, regional and local level as well.

Then the described legislation it put into context with the NewTREND methodology to show their complementing features and mayor differences.

2.1. EUROPEAN CONTEXT

The building sector is responsible for about 40% of energy consumption and 36% of CO2 emissions in the EU[4]. Thus, improving the energy efficiency in the building sector is one of the key instruments to achieve EU 2020 targets which aim at increasing the energy efficiency by 20% and a 20% reducing the greenhouse gas emissions in comparison to values of 1990s and to have 20% of the energy generated from renewable energy sources. For 2030 the EU have set new, more ambitious targets, hence by 2030 the EU aim to achieve a 40% reducing the greenhouse gas emissions in comparison to values of 1990s, to have 27% increase in the energy efficiency and that 27% of the energy that is consumes in EU originate from renewable energy sources[5].

To reach these goals the EU has issued a number of specific energy efficiency directives aimed at reducing the energy consumption and CO2 emissions of buildings and promote the use of renewable energy sources and the development of the necessary policies and measures to comply with other international agreements such as the Kyoto protocol from 1997 and the Paris agreement of 2015. The first of these directives is the Energy Performance of Buildings Directive (Directive 2002/91/EC, EPBD), that dates back to 2002 in which all the EU countries were required to improve their energy regulations and to introduce energy certification schemes for buildings as well as to introduce minimum energy performance requirements for new as well as renovated buildings in their territory.

In 2010 the EPBD of 2002 was subsequently updated to become Directive 2010/31/EU. The recast dealt with some of the implementation challenges of the 2002 Directive. Under the EPBD directive from 2010 the energy performance certificates are to be included in all advertisements for the sale or rental of buildings and displayed in all buildings occupied by a public authority and frequently visited by the public, where a total useful is over to 250 m² as of July 2015. According to the EPBD directive, the energy performance of a building can be determined on the basis of the calculated or actual annual energy consumption.

Furthermore, the Directive instructs all EU Member States to establish inspection schemes for heating and air conditioning systems or put in place measures with equivalent effect. In addition, all new buildings must be nearly zero energy buildings by 31 December 2020 (public buildings by 31 December 2018) and to set minimum energy performance requirements for new buildings, for the major renovation of buildings, and for the replacement or retrofit of building elements (heating and cooling systems, roofs,

walls and so on) as well as to set lists of national financial measures to improve the energy efficiency of buildings.

Given that about 60% of the EU's buildings were built when energy efficiency requirements were limited or non-existent[6], renovating the building stock can be seen as the one of key aspects in reaching the EU 2020 and 2030 goals, this is clearly reflected in a number of provisions of European Directives related to energy such as article 7,8 and 10 of Energy Performance of Buildings Directive (EPBD, 2010/31/EC), article 4,5 of the Energy Efficiency Directive (EED 2012/27/EU) and the Renewable Energy Directive (2009/28/EC. A summary of these provisions is provided in Table 1. below:

Directive	Explanation
	Article 7: When buildings undergo major renovation[1], the energy performance of the building or the renovated part thereof needs to meet the minimum energy performance requirements as far as this is technically, functionally and economically feasible.
	Article 8: Member States shall set system requirements for new, replacement and upgrading of technical building systems (HVAC and hot water systems) and shall be applied as far as they are technically, economically and functionally feasible.
	Article 10: The Commission shall, where appropriate, assist upon request Member States in setting up national or regional financial support programmes with the aim of increasing energy efficiency in buildings, especially of existing buildings
Renewable Energy Directive (2009/28/EC)	Member States should introduce measures to increase the share of energy from renewable sources in new and renovated buildings
	Article 4: Member States shall establish a long-term strategy for mobilising investment in the renovation of the national stock of residential and commercial buildings, both public and private.
	Article 5: A renovation quota of 3% of all public buildings owned and occupied by central government shall be achieved.

TABLE 1: EXAMPLES OF RENOVATION RELATED PROVISIONS OF EUROPEAN DIRECTIVES

Thus and in accordance with the EBPD of 2010, all EU Member States have introduced a set of minimum energy requirements for buildings that undergo major renovations, below (Table 2) is a summary of the main aspects of minimum energy requirements and the expected or targeted energy saving for most EU Member States:

State	Energy requirements for renovated buildings	Expected or targeted energy saving	Note
AT	Specific maximum heating energy demand targets for major renovation of residential and non-residential buildings. Values for renovated buildings are around 25-38% higher than new build requirements. Heat recovery must be	3% building sector energy use reduction in the in 2020, compared to 2013.	Estimated

[1] "major renovation" is the renovation of a building where: (a) the total cost of the renovation relating to the building envelope or the technical building systems is higher than 25 % of the value of the building, without the land value; or (b) more than 25 % of the surface of the building envelope undergoes renovation; EU Member States can choose one the two alternatives to define major renovations

	added to ventilation systems when renewed. Maximum permitted U values for different elements in case of single measure or major renovations. Prescriptive requirements to limit summer over-heating.		
BE	There are specific component requirements (i.e. maximum U-values) as well as additional prescriptive requirements such as for ventilation, summer comfort etc. is the renovated volume > 800 m³: same requirements as for new buildings (U/R-value, ventilation and summer overheating). For renovation project with a volume ≤ 800 m³: only U/R-values for new and renovated parts of the building as well as ventilation	4288 GWh of final energy and 4581 GWh for primary energy saved by 2020.	Estimated for Belgium (Flanders)
BG	Regulations requiring performance-based standards of existing housing and other buildings after renovation. Requirements for new and renovated buildings are the same	n/a	
CH	Renovated buildings are required to use no more than 125% of the space heating demand of an equivalent new building. A single element approach may also be applicable for renovations.	n/a	
CY	Minimum energy performance requirements (class A or B) for buildings over 1 000 m2 undergoing major renovation	n/a	
CZ	Performance-based requirements when a building over 1 000 m2 is renovated. Requirements for new and renovated buildings are the same. Individual parts of the building envelope and systems in the buildings have to fulfil minimum requirements. If it is not possible to achieve the minimum performance criteria, this has to be proven by means of an energy audit. There are also minimum requirements in case of major renovation of individual building elements such as for U-values, thermal bridging, thermal stability of the room in summer and in winter, minimum efficiency of boilers	77 PJ saving of energy (45% reduction compared to current consumption) for heating in residential buildings.	Estimated
DE	Both energy performance and specific component-based requirements. For renovations of single components or systems, there are specific requirements for these components/systems. Alternatively, the building owner can choose to prove that the primary energy demand requirements for retrofitted buildings are met (140 % of the demand for a comparable new building). Building surface components and building system components must not be changed in a way that decreases the energy performance of the building. There are additional cost effective obligations that need to be fulfilled by the building owners within a	337 PJ/year energy savings for period 2008-2020	Estimated

	specific time-frame for: insulation of hot water pipes and top floor ceilings, retrofit of HVAC systems and replacement of electrical heat storage systems.		
DK	Component level requirements when existing buildings are refurbished for change of use of the building and for complete or partial renovation of building elements or technical systems, regardless of the building size. Individual parts of the building envelope and systems in the buildings have to fulfil certain minimum requirements in the renovated building. Thus, there is no overall performance requirement for the renovated building, but only for the individual components and systems. Minimum U-values and linear losses requirements. The partial renovation measures must be cost-effective (i.e. payback time shorter than 75% of the measure's lifetime). If the implementation of the full requirement is not profitable to the owner, a lower level of renovation or indeed none at all, has to be implemented. In case of replacement of floors, external walls, doors, windows or roof structure, requirements apply regardless of cost-effectiveness. Thermal bridging should be avoided in external construction elements.	35% reduction in net energy consumption for heating and hot water in the building stock by 2050, compared to 2011.	Estimated
EE	Performance-based requirements for all building types when buildings undergo major renovations. Values for renovated buildings are around 25-38% higher than new build requirements.	3.5 PJ/y energy savings the building sector to be achieved by 2016.	Targeted
ES	Existing buildings over 1000 m2 must comply with the same minimum performance requirements as new buildings if more than 25% of the envelope is renovated. There are additional energy efficiency requirements for building elements, heating and lighting systems, minimum solar-thermal contribution and in certain cases also for minimum solar photovoltaic contribution.	n/a	
FI	There are three ways to achieve minimum energy requirements: a) by improving the heat retaining capacity of building parts that need reparation or renewal, b) improving the energy efficiency of the building by examining the whole building's energy consumption in relation to its surface area, c) reducing the building's E-number (the total calculated energy use of the building), by reducing the total energy consumption of the buildings. Technical systems (like heating and ventilation) have their own requirements and should be checked when insulation is added to	Saving of 8115 GWh by 2020, and 36889 GWh by 2050	Estimated

	the building, when air-tightness is improved, or when systems are renewed.		
FR	Performance-based requirements for buildings undergoing renovation apply for residential buildings and values depend on the climate and type of heating (fossil fuel/electricity). Requirements for components also apply during building renovation. For large renovations, a minimum summer comfort level is required in order to avoid the use of cooling systems. Smart systems should be installed every time there is major renovation work on a building	38% reduction of energy consumption of buildings by 2020 AND 400.000 dwellings per year should be energy renovated starting from 2013.	Targeted
GR	Individual parts of the building envelope and systems in the buildings have to fulfil certain minimum requirements in the renovated building. Minimum thermal resistances defined for different types of building components and also different efficiency of systems. Thermal bridges are also considered	At least 80% of the existing building stock renovated by 2050	Targeted
HU	Performance-based requirements (in terms of primary energy) apply for residential buildings, offices and educational buildings. Requirements for new and renovated buildings are the same. The specific primary energy consumption in kWh/m² must comply with the requirement, either for the renovated zone or for the whole building - option that can be selected by the designer. The requirement cannot be met if the components are of low quality	49PJ/y primary energy saving for the building sector at 2020	Targeted
IT	Energy performance requirements are based on single components, with the same requirements as new buildings. There are also minimum energy efficiency requirements for boilers	4.9 Mtoe/y final energy savings of the building sector by 2020 (3.67 Mtoe/y in the residential sector, 1.23 Mtoe/y in service sector) have been targeted; it is estimated that this could lead to a 24% reduction of primary energy consumption in comparison with the business as usual scenario	Targeted/ Estimated
LT	Buildings over 1 000 m2 undergoing major renovation must achieve the energy performance standard of a Class D building where D corresponds to 110 kWh/m2 yr for buildings > 3 000 m2; 130 kWh/m2 yr for buildings from 501 to 3 000 m2; 145 kWh/m2a for buildings up to 500 m2. Not less than efficiency class D. Individual parts of the building envelope and systems in the buildings have to fulfil certain minimum requirements depending on renovation	At least 500 GWh of thermal energy to be saved (i.e. for space heating) by 2020.	Targeted
LV	Requirements on different elements are applicable	50% reduction of consumption of thermal	Targeted/ Estimated

		energy for heating against the current indicator is the target to be achieved by 2030. It is estimated that by renovating 3% of State owned and used building areas each year, 186 GWh energy savings could be achieved over the period 2014–2020.	
MT	U-value requirements for building renovation	n/a	
NL	For renovations, the same EPN (energy performance coefficient) requirements as for new buildings apply. Stricter efficiency requirements for heating, hot water, cooling and ventilation systems in existing homes and large buildings	300,000 existing buildings per year to improve by at least two energy label steps; Average social rental property to achieve label B; 80% of private rental to achieve minimum label C by 2020; At least an average energy label A for buildings by 2030.	Targeted
NO	Building regulation requirements as for new buildings only apply when the purpose or use of the building is changed at renovation or in case of major renovations. The requirements are either for the renovated zone or for the whole building (an option of the designer)	n/a	
PL	For major renovations or system component replacement there are the same requirements as for new buildings.	n/a	
PT	Special requirements for buildings over 1000 m2 and over a specified energy cost threshold. A mandatory energy efficiency plan must be prepared and all energy efficiency improvement measures with a payback of less than 8 years must be implemented (compulsory by law). The threshold is based upon 40% of the worst performing buildings by typology. Minimum requirements for thermal resistances defined for different types of building components and for energy efficiency of buildings systems. There are minimum energy requirements for the building as a whole as well as minimum insulation levels for the building envelope and minimum requirements for shading of windows.	n/a	
RO	The renovated building has to fulfil certain minimum requirements for the individual components and systems as well as an overall performance requirement	n/a	
SI	Minimum requirements apply to major renovations (i.e. if at least 25 % of the envelope is renovated). There are also minimum requirements for heating systems	At least 16% final energy consumption in building decreased by 2020; 30% by 2030 (compared to 2005); almost carbon-free energy	Targeted

		use in the building sector by 2050	
SE	The renovated zone has to fulfil the energy requirements for new buildings. In case of heritage buildings or when renovation may negatively influence other features of the building, then the energy requirements may be lowered. In case of major renovation, the minimum energy efficiency requirements may be extended also to other parts of the building.	12-25% reduction of final energy consumption for heating and domestic hot water (DHW) in buildings.	Estimated
SK	For major renovations, the requirements set limits to improve the thermal performance by at least 20%. There are minimum requirements in terms of energy use and energy performance (delivered energy), U-value for building structures as well as, walls, roofs, windows, insulation of heat and hot water systems, thermal comfort and indoor air quality	6928.6 GWh energy savings up to 2030	Estimated

TABLE 2: SUMMARY OF BUILDING REQUIREMENTS IN CASE OF MAJOR RENOVATIONS AND EXPECTED RESULTING ENERGY SAVING ([7] &[8])

However, in practice, a study by ICF International "Energy Performance of Buildings Directive (EPBD) Compliance Study" revealed that in most of EU Member States only 55 to 70% of the buildings comply with the energy performance requirement for renovated building[9]. This moderate level of compliance can be increased by providing appropriate financial and / or technical support[10]

Therefore, it can be said that all the EU Member States is using one or a combination of financial support schemes that target the improvement energy performance of existing buildings. The way Member States apply these instruments varies from country to the other as seen in Table 4 regarding the main in use financial by each EU Member State in 2013[11]. In the following table (Table 3), a summary of the most commonly used financial instruments used in the EU:

Instrument	Description
Direct grants or subsidies	Grants are non-repayable funds or products usually offered by public funds and are directly allocated by the authorities or, more typically, accessed through banks or foundations.
Preferential loan schemes	Preferential loan are loans that are below market interest rates to encourage energy efficient practices and are typically supported via national bodies by regulatory measures, by sharing the risks with the banks and/or by covering a share of the loan interest
Taxes, tax incentives or tax refunds	Usually can take one of three forms: a) A tax on energy, b) Sales tax incentives to promote market penetration, c) Tax refund given in recognition of energy savings investments. The energy and/or climate taxes may be used to create a fund for financing measures that contributes to the reduction of the energy consumption and associated GHG emissions.
Energy Efficiency Obligation (EEO)	Under the Energy Efficiency Directive (Directive 2012/27/EU), EU countries must set up an energy efficiency obligation scheme. This scheme requires energy distributors or retail energy sales companies to achieve 1.5% energy savings per year through the implementation

	of energy efficiency measures (i.e. funding energy savings amongst their customers).

TABLE 3: SUMMARY OF COMMONLY USED FINANCIAL INSTRUMENTS USED IN THE EU[12]

The following table (Table 4) shows the financial instruments used by EU member states in 2013 targeting energy renovations.

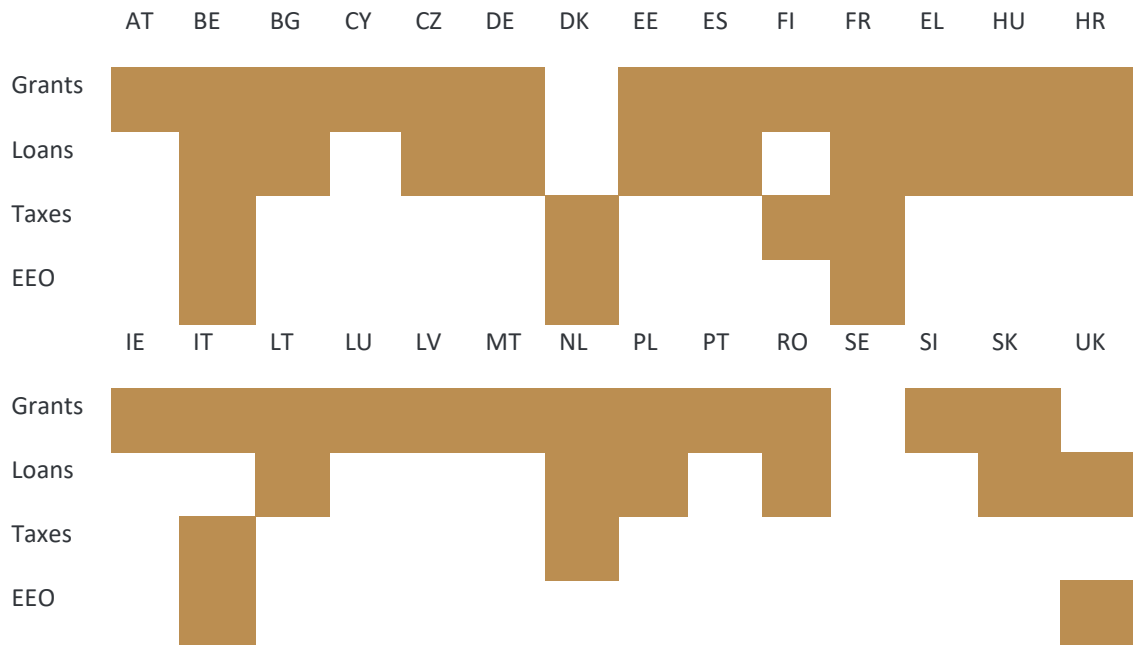


TABLE 4: FINANCIAL INSTRUMENTS USED BY EU MS IN 2013 TARGETING ENERGY RENOVATIONS[11] (SHADED AREAS INDICATE THE APPLIED FINANCIAL INSTRUMENT)

2.2. National Legislation via the Demo Site Context

The three demo site countries legislative background is described as a brief discourse analysis. The goal of this section is to highlight the occurrence and relevance of New TREND concepts, goals, components, Key Performance Indicators in the legislative and public strategic discourse. After a concise introduction to the system of energetic legislation and execution in each country, the individual legislative instruments and strategies are analysed following a logic of scale, going from the national, via the regional, to the local level.

Hungary

Introduction

Hungarian policy regarding energetics is rooted in article P of the foundation of the Fundamental Law of Hungary, protecting natural resources and enacting their preservation for future generations. Structurally, energetics policy heavily relies on the pooled policymaking of member states in the European Union. Directives coming from the Commission and the Council are implemented via national strategies, which the turn into legislation supporting the implementation. Most importantly in the context of energetics, this includes the provision of budget and writing in energy related criteria and responsibilities into law on the national level.

Regional governance implements Government action plans to meet the standards defined via legislation. Regional planning balances between the input from the national level and the operative programs coming from the EU level, also tailored for the regional scale, as there is still a significant reliance on ERDF. From demo-site perspective, the regional legislative context includes the city of Budapest and the city-scale policy. Regional planning in Budapest consists of a development strategy, a structural plan, and local building regulation. The same plan types appear for individual boroughs as well, with the addition of action-area plans wherever necessary. Voluntary commitments supplement the official planning structure – most notably for energetics, these are the sustainable energy action plans.

National policy

Legislative grounding of national energy policy

The Parliamentary decree 40/2008. (IV.17.) defines priority axes of the national energy policy in the 2008-2020 period. The wording of the document includes phrases referring to indicators building energy, representing the direction of the Hungarian legislative environment:

- Specific energy consumption
- Share of renewables in the energy split
- Share of waste-based sources in the energy split
- Diversity of energy sources
- Energy efficiency
- Energy demand
- Security of supply
- Compliance to climate targets
- Compliance to EU law

The same document authorises government to devise and implement national energy strategies. The incumbent is the National Energy Strategy 2030, a document outlining the approach, goals and conditions to reach these goals for the state.

National Energy Strategy 2030

Along the overall national and interregional energy grid, compatibility to other relevant strategies and higher-level legislation, buildings are also considered a focus area, mostly from demand mitigation perspective. The strategy acknowledges that 40 % of energy consumption occurs in buildings and that two-thirds of this is spent on heating and cooling. Around 70 % of residential and public buildings do not meet contemporary thermo-engineering standards. The two key metrics referred to are „energy consumption by source", and „refurbishment depth" – mean savings of intervention regarding thermal energy demand. Among the perspectives, thermal energy efficiency, a share of renewables, modernising HVAC and lighting systems, and supporting ICT services are mentioned on the building level. On the district level, a case is made in support of decentralised energy systems, with goals of simplifying integrations with the larger grid, and supporting mixing technologies.

The key phrases referring to building/district level energy indicators are:

- Energy consumption by source
- Refurbishment depth
- Energy efficiency

- District heating potential (undefined)
- Cooling energy consumption
- Green urban management (undefined)
- Consumer cost reduction
- Municipal cost reduction
- Air quality (emissions perspective)

Regarding building and district level energetics, the National Energy Efficiency Action Plan and Building Energetics Strategy are the most relevant subsidiaries of the overall strategy. While the building Energetics Strategy is a specification of the National Energy Strategy on the focus point of building energetics, the National Energy Efficiency Action Plan contains the specific "to-do-list" and assigns resources to accomplish the above policies.

National Energy Efficiency Action Plan

All EU countries present an Energy Efficiency Action plan every three years for the Commission, presenting progress and planning for meeting national energy efficiency goals, listing policies to implement the Energy Efficiency Directive 2012/27/EU.

From a procedural standpoint, the action plan identifies the lack of financial instruments as a major obstacle, also mentioning the complicated preparation of refurbishment projects. Knowledge-sharing is an important focus point, promoting the demonstration and dissemination of best practises, recent technologies, implementation lessons, practical knowledge among site managers, building owners, consultancies and the public sector. Interventions should provide means of monitoring on the project level in a transferable way to support upcoming energy performance statistics plans.

The action plan includes financial instruments to accomplish energy performance goals. The metrics used for their evaluation scheme follows the 7/2006. (V.24.) classification and the 176/2008. (VI.30.) certification schemes.

Building Energetics Strategy

The Building Energetics Strategy contains the energetic evaluation of the national building stock, and based on refurbishment scenarios, proposes a system of goals and tools.

Refurbishment scenarios are constructed to estimate larger scale funding demand. The input parameters for classification in the case of residential buildings are floor area, construction year, and building type (detached house, row house, condominium). The output parameters are primary energy consumption prior refurbishment and after "cost-optimised level" refurbishment (see National rating schemes), primary energy savings and estimated refurbishment costs.

The key indicator for the goal structure is the primary energy savings, aimed to be reduced by 49 PJ/a until 2020 and 111 PJ/a until 2030. Of the 49, 40 PJ/a savings are expected to come from residential and public building refurbishment, 4 from commercial building refurbishment, and 5 from energy savings by conscious use.

National building codes

National energy performance criteria

In accordance to the Directive 2010/31/EU of the European Parliament and of the Council of 19 May 2010, the requirements for the energetic performance of buildings is defined by the Ministerial Decree 7/2006. (V.24.). The criteria presented there are to be fulfilled to obtain a building permit.

Metrics used in the decree:

Input parameters	Criteria parameters	Dimension
General energy performance		
Type of enveloping structure	Overall heat transfer coefficient	U [W/m2K]
Area to volume ratio	Specific heat loss factor	qm [W/m3K]
Area to volume ratio	Mean heat transfer coefficient	Um [W/m2K]
Building function		
Area to volume ratio		
Criteria for cooling		
Thermal mass		
Difference between mean indoor and outdoor temperatures		
Criteria for indoor conditions		
	Minimum/maximum indoor temperature during heating/cooling season	t [K]
	Thermal range during heating/cooling seasons	t [K]
Criteria for HVAC systems		
Number of users		
Effective floor area		
	Indoor CO2 concentration compared to outdoor levels	[ppm]
	TVOC emission	[mg/m2h]
	Formaldehyde emission	[mg/m2h]
	Ammonium emission	[mg/m2h]
	IARC emission	[mg/m2h]
	Thermal controlling options	N/A
Ventilation unit type	Pressure loss for ventilation units	[Pa]
Ventilation system category		
Static pressure		

TABLE 5: METRICS USED IN THE NATIONAL ENERGY PERFORMANCE CRITERIA

The decree also imposes methodology for technical-environmental and economic validation of the following alternative energy systems: district heating and cooling, CHP, distributed systems utilising renewable energy, heat pumps.

Regarding the thresholds, three categories of performance are described: general level, cost-optimised level, near-zero energy level. The latter two are amendments as of Government decree 1246/2013. (IV. 30.), which in turn introduces requirements of 2010/31/EU. The following Table 6 displays some of the corresponding metrics and their thresholds.

Indicator	General	Cost-optimised buildings	Near-zero energy buildings

Heat transfer coefficient for external walls [W/m2K]	0,45	0,24	N/A
Heat transfer coefficient for flat roofs [W/m2K]	0,25	0,17	N/A
Specific heat loss factor, given 0,3 ≤ A/V ≤ 1,3 [W/m3K]	0,38*(A/V)+0,086	0,27*(A/V)+0,079	0,2296*(A/V)+0,05143
Integrated energetic indicator for residential buildings, given 0,3 ≤ A/V ≤ 1,3 [kWh/m2a]	120*(A/V)+74	30 *(A/V)+101	100
Minimum share of renewables	N/A	N/A	25 %

TABLE 6: TABLE PERFORMANCE METRICS AND THEIR TRESHOLDS IN THE *NATIONAL ENERGY PERFORMANCE CRITERIA*

The target category is also legally binding. New buildings from 2021 must comply to near-zero energy levels, with buildings used by public authorities must do so from 2019. If the building is finished from 2018 and/or is subject to national or EU grants and subsidies, the cost-optimised level applies. All other new buildings fall in the soon-to-be phased out general category. The same timescale applies for reconstructions and upgrades, with a possible limiting of the scope of the category to parts of the building affected by refurbishment. The criteria for energy performance are weaker than those of heritage protection, however. Finally, the applicability of alternative energy systems must be assessed in all new constructions and major refurbishments.

According to the legislation, the demo site refurbishment must comply with cost-optimised levels, meaning more disciplined thresholds for energy performance as of Table 6, but without the necessity of phasing in renewables. Additionally, the building must comply with all metrics listed in Table 5Table 1: criteria for the structure, HVAC, and indoor conditions.

National energy certification

The 176/2008. (VI.30.) Government Decree regulates certifications regarding energy performance. Energy performance certification is mandatory for all new constructions, transaction or lease of existing buildings and building units, and buildings public authorities larger than 250 m2. The 7/2006. (V.24.) decree contains the necessary calculations that partly also define energy performance categories within the certificate. In general, the classes are determined by their integrated energetic indicator in relation to the benchmark value derived from 7/2006. (V.24.). This benchmark represents class “BB”, and corresponds to near-zero energy category. Additionally, “AA” class requires that the heat generator is controlled according to weather, all thermal systems are controllable in each room separately, functional units (single apartments) are monitored separately.

Class	Integrated energetic indicator as a percentage of the benchmark value	Meaning
AA++	<40	Minimal-energy demand
AA+	40-60	Exceptionally high energy efficiency
AA	61-80	Exceeding near-zero energy building level
BB	81-100	Satisfying near-zero energy building level
CC	101-130	Modern
DD	131-160	Sub-modern
EE	161-200	Post-average
FF	201-250	Average
GG	251-310	Sub-average
HH	311-400	Weak

II	401-500	Bad
JJ	500<	Exceptionally bad

TABLE 7: RATINGS OF THE NATIONAL ENERGY CERTIFICATION SCHEME OF HUNGARY

Smart grid regulations

As a step towards district level schemes, the Government Decree 156/2016. (VI.23.) regulates the conditions of feedback from distributed renewable energy sources to the grid. The levels of incentives are: mandatory takeover, brown premium and green premium.

If the performance of the power generation unit is less than 5 MW (bar wind-power generation) the excess is subject to mandatory takeover, for the prices calculated from norms defined by the decree. It is the responsibility of the provider to deliver scheduling, monitoring and billing.

Additionally, providers can apply for brown and green premiums respectively. Biogas and biomass based energy generation is subjected to brown, renewable based electricity generation is subjected to green premiums respectively.

Regional policy

Budapest 2030

The examined region for legislative background is city of Budapest. The concept of urban development defines the long-term development goals and direction of changes on the city-scale, based on its environmental, economic, and social attributes. The concept for the capital, called Budapest 2030 was approved with Budapest General Assembly Resolution 1988/2011 (VI.22.).

One of the priority axes of Budapest 2030 is “Climate protection and efficient use of energy”. In accordance to 2010/31/EU, the priority axis focuses on the building stock, defining goals of: high energy performance, near-zero energy demand, high ratio of renewable sources for buildings. It proposes the definition of sustainable building in local plans and the application of sustainability criteria for the whole lifecycle in local building regulations. However, these concepts have yet to surface in city-scale regulations. Additionally, several tasks to achieve goals are proposed along the priority axis, detailed in Table 8.

Task	Mentioned tools as indicators
	Building density
	Area of active green surface
	Area of water surface
	Surface albedo
	Surface permeability
	Ratio of impervious surfaces
	Ratio of cool-roof area
	Number of greenfield developments
	Energy management planning
	Life-cycle assessment
	Refurbishment potential
	Building stock database
	Available subsidies
	Available tax credits
	Available ESCOs

	Available subsidised loans
	Non-profit consulting services
	Available demonstration projects, best practises
	Local certification scheme
	Local energy performance standards
	Available BIM model
	Building material selection
	Construction technology selection
	Stormwater mitigation options
	Renewable energy potential by source
	Feedback incentives
	District solar potential
	Local wind profile
	Geothermal potential
	Waste-heat potential
	District energy sharing & management
	Brownfield site
	Priority site
	Partnership involvement
	Refurbishment potential

TABLE 8: TOOLS TO REACH METRO-REGION SUSTAINABILITY GOALS REPHRASED AS POTENTIAL INDICATORS

SEAP Budapest

Sustainability Energy Action Plans, or "SEAPs" are strategies made by Covenant of Mayors member cities. The covenant is an initiative of the European Commission for eager municipalities that pledge to exceed EU GHG targets of 2020. The SEAPs comprise of goals, actions and partnerships to reach the overall, voluntary objective of the covenant.

The energy related goals of the plan – as all goals – are devised from the core objective of GHG emission. Because the initiative itself heavily relies on consistent monitoring, it operates with clear, measurable indicators related to emission. For instance, 1 MWh of electricity consumption is translated to 0,575 tons of CO2 emission, since roughly 60 % of the national electricity is produced in coal, or hydrocarbon plants.

The document estimates 40 % energy savings via refurbishment projects of prefabricated residential housing estates, 25 % in detached houses, and further 30 % in inner city buildings. This results in an overall 35 % energy savings prediction for the entire residential building stock. The specific actions needed to reach these goals are generally insulation installations on the envelope structure, changing doors and windows, modernising HVAC systems, and deploying differentiated monitoring and controlling options.

Local policy

Development strategy of Pestszentlőrinc-Pestszentimre

In relation to New TREND, in its situation review, the document mentions excessive costs of utility in roughly 50 % of residential building stock, the increasing maintenance cost of public buildings, and a disjoint local NGO ecosystem as social obstacles. It also acknowledges heat-island effect at several residential hotspots, noise discomfort for residents living near the airport, and the wicked problem of brownfield redevelopment as technical-environmental obstacles.

Two of the key thematic goals of the strategy are: high quality, energy-efficient residential building stock, and sustainable municipal asset management; while one of the three horizontal goals is climate-conscious, sustainable approach. Specific actions to reach these goals include: refurbishment of housing estates, incentives and consulting services for residential energy-efficiency and renewable energy investments, heat-island mitigation at housing estates, refurbishment and renewable shift in public buildings used by authorities, and promotion of green technologies.

Local keystone project "sustainable, efficient energy consumption" comprises of modernising building envelope structures, doors and windows, heating systems, increasing the ration of renewable share in the energy mix. The refurbishment projects at the Budapest demo site belong to this larger keystone project defined in the local development strategy. The project has the overall outcome indicator of 20 % CO2 emission reduction of municipally managed institutions, and two output indicators of one community thinktank of energetics and a full energetic survey and diagnostics of municipally owned institutions.

SEAP Pestszentlőrinc-Pestszentszentimre

The local SEAP mirrors in structure, goals, and mentioned indicators the SEAP Budapest, citing reductions in GHG emissions, exceeding the 20-20-20 objectives of EU legislation. The SEAP proposes HVAC modernising, Thermal insulation deployment, changing doors and windows to reduce energy demand by 30-40%. The document cites 2010/31/EU and 1246/2013. (IV. 30.) as sources of indicators and thresholds to satisfy and exceed. It also mentions the need to connect homeowners to financial instruments and consulting services, as the lack of information and the inability to invest are still the greatest obstacles for private energetic refurbishment projects.

Local plan of Pestszentlőrinc-Pestszentszentimre

Local plans for each settlement define the norms of construction specific to the area, with possible, but defined deviations from the national legislation. In the case of Budapest, the national, city-scale and borough scale plans compile the general rules.

There are few mentions of relevant indicators, as the national legislation on energetics is directly applied. The local plan for the borough of the demo site mentions rules for placing energy generation appliances, such as PV panels and wind turbines. The zoning does not include the sustainability metrics suggested in Budapest 2030.

FINLAND

National policy

National Energy and Climate Strategy[13]

The foundation of energy legislation in Finland is the National Energy and Climate Strategy, a collection of goals and actions to achieve 80-95 % reduction in greenhouse gas emissions before 2050, and to hit medium term milestones set out in EU level strategy for 2030. Renewable energy use in final energy consumption is expected to reach 50 % in the energy mix, while reliance on imported energy is to drop to 45 %. Especially imported oil use is to be reduced by 50 %. The key target area of interventions – outside sectors of the emissions trading systems – is the transportation sector with an expected number of 250.000 electric and 50.000 gas-powered vehicles. Biofuels in transportation are to reach a share of 30 %, while in heating, the same target is 10 %. Regarding electricity, the main goals are to improve flexibility both in supply and demand, and to improve efficiency on the system level.

The built environment is singled out for being responsible for 38 % of GHG emissions in Finland. To mitigate climate change, the strategy identifies policies promoting energy-efficient land use planning, improving energy performance of building stock, reducing carbon footprint of building materials and the promotion of the wider use of renewable sources. Approximately 0,9 Mt annual emissions cut by 2030 is expected from measures related to building-specific heating, waste management and cuts in industrial gas emissions, most notably by increasing renewable share in heating, improving combustion technology for burning wood and blending light fuel oils for heating with biofuels.

National Energy Efficiency Action Plan[14]

All EU countries present an Energy Efficiency Action plan every three years for the Commission, presenting progress and planning for meeting national energy efficiency goals, listing policies to implement the Energy Efficiency Directive 2012/27/EU.

In Finland, 75 % of the buildings are residential and 90 % of them use district heating – the multiple-unit housing estates more so than detached houses. Altogether 43 % of the building stock is heated through district heating systems, 22 % with electricity, 6 % with heat pumps, 19 % with biofuels and 10 % with fossil fuels. 32 % of the district heating network runs on renewable sources and it is not encouraged by government to replace district heating with on-site renewable energy based sources. However single-unit houses that rely on electricity for heating can achieve efficiency improvements with the introduction of heat pumps.

The action plan identifies buildings as the target area contributing the bulk of the energy savings (11 % of the consumption by 2016 and 15 % by 2020 respectively) through a variety of national government measures:

- Regulations of energy efficiency for new construction;
- Regulation of energy efficiency for renovations;
- Public-sponsored subsidies for residential buildings energy performance improvements;
- Heat pumps for smaller scale residential buildings;
- Mandatory water metering per residential unit;
- Energy efficiency agreements for oil-heated houses and residential letting associations.

Measures for the public building stock are also reported in the action plan.

The metrics mentioned in the report:

Parameter	Dimension
Primary energy consumption	TJ
Total final energy consumption	TJ
Final energy consumption by sector: industry, transport, households, services.	TJ
Gross value added per sector: industry, services.	EUR million
Disposable income of households	EUR million
Gross domestic product	EUR million
Electricity generation from thermal power plants	GWh
Electricity generation from combined heat and power plants	GWh
Heat generation from thermal power plants	GWh

Heat generation from combined heat and power plants, including industrial waste heat	GWh
Fuel input for thermal power plants	TJ
Fuel input for combined heat and power plants	TJ
Passenger kilometres	Mill.
Tonne kilometres	Mill. tonne
Population	capita
Average disposable household income	EUR/household
Number of households	pcs
Energy transmission and distribution losses	GWh
Separate production of district heating	TJ
Fuel input for district heating	TJ

TABLE 9: KEY METRICS MENTIONED IN THE FINNISH NATIONAL ENERGY EFFICIENCY ACTION PLAN

National Strategy on the Energy Renovation of Buildings[15]

The National Strategy on the Energy Renovation of Buildings is the transposition of 2012/27/EU Article 4 into national law. The strategy is less focused on imposing criteria of performance and more on instruments to trigger investment in energy efficiency measures during scheduled and reactionary maintenance in both residential and commercial sectors. These instruments include financial incentives, decision-making support, consulting services, communication measures and various training programs for professionals. In the public sector, instead of compliance with the 3 % renovation target for central authorities in force by 2012/27/EU, Finland implements alternative, voluntary goals, calculated to achieve similar results as an annual 3 % renovation action. These alternative means include demand-side management measures, such as smart metering, tenant behaviour management, a bonus-malus contracting scheme, energy-efficiency improvements during maintenance, user-related services, streamlining space-use, an adding energy-efficiency measures to standard renovation projects. As for other public authorities, the strategy cites voluntary energy efficiency agreements (EEA) for municipalities. Although not directly linked to the EPBD, energy efficiency agreements comprise of actions contributing to energy performance improvements, such as auditing and monitoring commitments.

National Energy Performance Requirements (from national building code) [15]

Decree No 4/13 transposes the Energy Performance of Buildings Directive by introducing energy performance criteria to be met by building renovations, functional changes of buildings, and refurbishment of the technical installations. The criteria are added to the national building code, thus are requirements for obtaining building permits.

The calculation methodology is a national method appropriated with CEN principles – both standards can be used. The regulation is prescriptive, with fixed value thresholds for key energy performance metrics, but also for thermal comfort, indoor air quality, infiltration, thermal bridges and shading. Infiltration may be assessed via audit, on-site testing or other accepted quality management method in the building industry. The cornerstone indicator for overall energy consumption – as in other countries, is the primary energy factor, the amount of primary energy required to generate a unit of final energy: electricity or useable thermal energy. The threshold values depend on type and area of the building. While the code includes all heating sources it promotes the use of renewable energy sources.

The metrics mentioned in the building code:

Additional inputs	Criteria	Dimension
Coefficient for energy type: electricity, district heating, district cooling, fossil fuels, renewables	Primary energy factor	E=[kWh/(m2*a)]
Building category (i.e.: detached residential)		
Building useful area		
	Controlling room temperature	Boolean
	Summer room temperature	Degree hours
Pressure test according to EN 13829	Air tightness	q=[m3/(h*m2)]
	Heat transfer coefficient	U=[W/(m2*K)]
Heat transfer coefficients for individual structures: external walls, roof, doors/windows, surface floor	Combined thermal loss of building envelope	∑H=[W/K]
Areas of individual structures		
	Energy efficiency of ventilation systems	kW/(m3/s)

TABLE 10: KEY METRICS OF ENERGY PERFORMANCE MENTIONED IN THE FINNISH BUILDING CODE[16]

Energy Performance Certification[17]

National energy performance certificates must be supplemented to building permit applications for new and renovated buildings or when a unit of the building is sold or rented. The ruling was introduced progressively from 2013 to July 2017. The Housing Finance Development Centre of Finland is the responsible authority enforcing certification, controlling the quality of the certificates and the qualifications of assessors.

The energy efficiency rating is expressed as an energy label that classifies buildings according their percentage based compliance with the primary energy factor criterion of the national building code (Table 11 shows the specific values for apartment buildings). For new buildings, this is a calculated value, for existing buildings, actual energy consumption must be reported when available. For renovated buildings, an on-site assessment if required for technical thermal components: the building envelope, heating and sanitary hot water installations, ventilation, lighting and other electrical installations. The certificate must also include recommendations for cost-effective energy efficiency improvement, albeit the exact suggestions are up to the experiences and qualifications of the assessor. The certificate is valid for 10 years.

Energy efficiency label	Total energy consumption by primary energy factor [KWh/(m2*a)]
A	E-value < 75
B	76 < E-value < 100
C	101 < E-value < 130
D	131 < E-value < 160
E	161 < E-value < 190
F	191 < E-value < 240
G	241 < E-value

TABLE 11: ENERGY PERFORMANCE CERTIFICATE CATEGORIES AND THE CORRESPONDING E-VALUES

Energy Efficiency Act18

The Energy Efficiency Act 1429/2014, with the purpose of promoting the energy efficiency transformation of the built environment, outlines regulations for energy auditing, for cost-benefit analyses of combined heat and power systems, and obliges energy suppliers to promote cost and energy efficient use in their customers operations. Obligatory investigation and documentation of the progress and potential benefits of energy efficient transformation helps anchor the need to invest in such transformation in corporate strategy. The law applies to energy providers, corporate energy audits and auditors, and owners and managers of district heating/cooling networks, including power plants.

The law serves as a legal framework to generate data on the energy performance of enterprises on a regular basis, to monitor and evaluate improvement measures and to track progress in the national strategies related to energy efficiency. For large enterprises, the audit is mandatory and to be taken every four years. The audit covers all operations of the company and comprises of individual site audits, assessing current and historical energy performance, reporting on the measures taken so far to improve the figures and plans for improvement. The law also outlines the qualification requirements of auditors. Apart from energy auditing, the act also requires the conduction of cost-benefit analyses to be undertaken when designing or retrofitting small/medium scale power generation/distribution systems – an obligation relevant for district, or campus scale energy interventions. The analyses are carried out to assess the viability of adding sustainability improvements to standard retrofits or new designs. Affected measures include: condensation plants above 20 MW capacity to asses retrofit as CHP, industrial power plants to assess the exploitation of surplus heat, and district heating/cooling grid (re)constructions to assess the availability and possible exploitation of local surplus heat sources.

Local policy

Energy efficiency agreements[19]

The municipality of Seinajöki has joined the voluntary Energy Efficiency Agreements initiative. The agreements are tools for companies and municipalities to fulfil national energy performance obligations transposed from the EU level. Agreement periods last eight years, the current term lasts from 2017 to 2025.

The agreements are the voluntary alternative to obligatory legislative instruments to reach transposed European energy efficiency targets. Participants agree to achieve 7,5 % energy savings for the eight year period with a 4 % milestone set up for 2020; altogether with the previous agreement, 10,5 % savings are targeted for the 2014-2025 period with a 7 % milestone for 2020. The target is presented as final energy consumption [MWh]. Specific measures to reach these targets are outlined by each participant in action plans submitted to Motiva, the officially responsible organisation providing consultation to public and private sector entities on resource efficiency and sustainability[20]. Participants agree to:

- include energy efficiency as a criterion during tendering public procurements, and planning negotiations,
- implement energy audits and follow-up audits,
- use various funding schemes such as guarantees or energy performance contracting to ensure investment in energy efficiency during procurements,
- monitor consumption and feed the data in decision making,
- invest in training and communication of results to lead by example,

- promote the use of renewable energy,
- produce annual reports.

Builders Guide Seinajöki[21]

The builders guide includes municipal guidelines and procedures to energy and environment related measures and issues of construction and building maintenance. It is not a legally binding code per se, but a document sharing practical information on energy efficiency, renewables, water management, and electric and communication systems useful for local professionals and laypeople.

The guide offers a selection process for the right heating systems for residential units. It highlights the importance to investigate the willingness and the effort the builder can muster adopt a more energy-saving household, behaviour, to invest in more expensive energy efficiency interventions. The heating systems are encouraged to be assessed against the comfort requirements of the builder, the costs and benefits should account for individual differences in the price and effort of procuring fuels – such as a willingness to obtain wood personally.

In simple terms, the document describes the differences between the various heating options, lays down the common criteria for heating derived from national and local strategy, and suggestions when and when not to use them. It provides comparative sample prices of different installations such as solar collectors, fireplaces, geothermal collectors, pellet boilers, heat pumps for various house sizes, numbers of inhabitants and population densities. It also digs deeper in the profitability, payback periods, legal backgrounds and procedures to obtain of various technologies to help generating a mock-up business model for residential energy efficiency investment, especially renewable sources such as solar energy or connecting to a district heating network.

Municipal regulations[22,23]

The municipal environmental regulations, issued by the city council of Seinajöki, are written to take account for local conditions to prevent and reduce pollutions in compliance with the Environmental Protection Act 86/2000. It contains provisions concerning wastewater management, natural- and stormwater management, air quality, noise pollution, waste management, and the disposal of chemicals and other dangerous wastes. Provisions for air quality and the exploitation of freshwater have some implications for building energy systems, as some substances within groundwater are considered hazardous, hindering geothermal energy use, while combustion of certain materials, such as treated timber, or plastics, are harmful for both health and environment.

The municipal building code contains amendments and locally binding provisions for the national building code. It is concerned with all areas and there is no separate document focusing on building energy performance. It contains a single section regulating environmental management, obligating certain structures, installations and equipment to be kept in appropriate condition and not to degrade the environment. The local Environment Committee selects auditors to inspect areas from time to time and such audits have the legal authority to result in the termination of construction unless misconduct is ceased.

SPAIN

National policy

NEEAP - National Action Plan on Energy Efficiency

As a general compliance with 2012/27/EU, the action plan (Plan Nacional de Acción de Eficiencia Energética; acronym: NEEAP) is a broad assessment of energy consumption and production in the country, an overview of national energy efficiency targets, and the executive measures to reach these targets. The document is reviewed every three years, here discussed is the NEEAP 2017-2020.[24]

Alongside transportation, public organisations, agriculture, and efficiency of the grid, NEEAP identifies the building sector, and urban heating systems as the main target areas of energy efficiency policies. As a review document, it is concerned with reporting on the state of previously established indicators and introducing the policies and actions currently in force. The key mentioned indicators are: primary energy demand in toe; energy consumption by source; energy intensity indicator (=energy consumption/gross domestic product)[25]; annual change in energy prices; energy consumption by use. The document reports a solid decrease in total final energy demand in the building sector, reaching a total consumption of 29,7 % compared to the EU total of 38,5 %. The largest contributor to this output is the residential sector, with a predominant reliance on combustible sources. It is therefore acknowledged that countries in the European South, such as Spain, will likely always deliver better results on energy indicators. This also means that while heating will still take the largest share in the mix of household energy demands, the relative importance of hot season cooling, electronic appliances, and warm water production increases. The electricity use is even more prevalent in buildings of the services sector.

Long-term Strategy for the Energy Rehabilitation of the Building Sector

According to NEEAP 2017-2020, the most important action regarding building energy efficiency is the Energy rehabilitation strategy is the transcription of 2012/27/EU Article 4 to Spanish governance. It outlines a situation review, strategic goals, scenarios of implementations and necessary actions to deliver investment in the energetic refurbishment of the Spanish building stock, and is reviewed triennially.[26] The scenarios represent the costs and benefits of delivering refurbishment ambitions to various extents. They are used as arguments for a public-lead, public-private partnership based approach by quantifying investments and exploitable direct impacts as well as externalities related to building energy efficiency in a business-as-usual, a public subsidization, and subsidies progressively replaced by adequate loans scenario. Each scenario is evaluated by the number jobs generated (socio-economic impact), number of houses rehabilitated (complex impact), Kteps of energy saved, and million tons of CO2 emissions reduced (both environmental impact) – all metrics favouring public subsidies, progressively replaced by adequate loans[27]. Most notably, a variety of actions are defined for multiple key players:

- Regulatory measures and the adaptations to EU directives;
- Information and communication actions, such as trainings and campaigns;
- Administrative measures, such as procedural simplification;
- Measures to enforce the presentation of the energy efficiency of buildings in the business strategies on the company level;
- Facilitation of financing and development, such as public funding allocation and private funding incentivisation.[27]

CTE - Technical Building Code (RD 314/2006; last amendment as of writing this document: FOM 588/2017)[28]

The Technical Building Code (Código Tecnicó de la Edificación; from hereafter abbreviated as CTE) is the basic normative framework defining criteria for construction. It consists of basic documents (abbr.: DB) holding prescriptive standards regarding: structure, fire safety, safe use, sanitation, noise protection, and most notably, energy saving. The introduction of the energy performance thresholds is progressively registered in the basic document – energy saving (abbr.: DB-HE), last raised by amendment FOM/1635/2013. The document is structured into six parts, with the first four referring to energy efficiency and the rest to the use of renewable energy (Table 12). The standards are prescriptive, for each criterion, there is a quantification, a process of verification, justification rules for compliance and calculation methodology.

Acronym	Title	Description
DB HE0	Limiting Energy Consumption	Describes the energy rating based on final primary energy demand.
DB HE1	Limiting Energy Demand	Refers to requirements for the building envelope.
DB HE2	Performance of Thermal Installations	Application of Regulation on Building Heating Installations (discussed in following section).
DB HE3	Performance of lighting installations	Includes energy efficiency of appliances and rules for controlling.
DB HE4	Minimum solar contribution to domestic hot water	Sets the minimum proportion of thermal energy to be captured from sunlight.
DB HE5	Minimum photovoltaic contribution to electricity	Sets the minimum proportion of electrical energy to be captured from sunlight.

TABLE 12: STRUCTURE OF ENERGY PERFORMANCE CRITERIA WITHIN THE TECHNICAL BUILDING CODE

The metrics mentioned in the building code:

Input parameters	Criteria	Dimension
Useful surface of living spaces		
Correction factor for surface energy consumption		
Baseline non-renewable energy consumption per climate zone		
RD 235/2013 (to be discussed in section: Energy Efficiency Certification)	Energy rating	Discrete value
Useful surface of living spaces		
Correction factor for surface thermal energy demand		
Baseline non-renewable thermal energy demand per climate zone		
Climatic zone	Cooling energy demand	kWh/(m2*a)
	Thermal transmittance (overall)	W/(m2*K)
	Thermal transmittance (walls and structures with ground contact)	W/(m2*K)
	Thermal transmittance (other structures with air contact)	W/(m2*K)
	Thermal transmittance (holes)	W/(m2*K)

	Air tightness	m2/(h*m2)
Power of lamp plus auxiliary equipment		
Illuminated surface		
Luminous emittance [lux]		
Building function	Maximum power of illumination	W/m2
Light transmittance coefficient of glazing		
Area of glazing		
Area of facades		
Total energy demand for hot water production		
Climate zone		
Inclination/orientation		
Shades		
Solar accumulation volume	Area of collectors	m3/m2
Climate zone		
Surface of constructed building		
Inclination/orientation		
Shades		

TABLE 13: QUANTIFIED INDICATORS AND OTHER METRICS MENTIONED IN THE BASIC DOCUMENT FOR ENERGY SAVING[29]

RITE – Regulation on Building Heating Installations (RD 238/2013)[30]

Regulation on Building Heat Installation (es.: Reglamento de Instalaciones Térmicas en los Edificios abbr.: RITE) is the law specifically regulating DB HE2 – Performance of Thermal Installations – section of the Technical Building Code. The law sets standards for designing, dimensioning, assembling, maintenance, and inspection on technical grounds, and more generally for administrative conditions, execution of installations, commissioning, inspection, manufacturers.

Alongside energy efficiency and security, the legislation recognizes so-called welfare & hygiene requirements, including thermal comfort, air quality, hygiene and acoustic comfort. In the context of the legislation, indoor air quality refers to adequate ventilation, and thresholds for pollutant levels, hygiene refers to the biochemical quality of sanitary hot water, and acoustic comfort thresholds regulate vibration and noise levels of thermal installations. Thermal comfort and air quality include a set of quantified indicators, hygiene requirements are fulfilled by following specific instructions depending on the installation, while acoustic criteria are listed in a separate basic document.

Criteria	Dimension
Thermal comfort	
Average air velocity	m/s
Relative humidity	%
Operating temperature	C°
Air quality	
Rate of ventilation	m3/(s*person)
Perceived air quality	decipols
CO2 concentration	Ppm
Outdoor air quality	Discrete values
Exhaust air quality	Discrete values

TABLE 14: INDICATORS MENTIONED IN THE REGULATION ON BUILDINGHEATING INSTALLATIONS

Energy Efficiency Certification (RD 235/2013)[31]

The Royal Decree defining the national scheme of energy efficiency certification is a transposition of 2010/31/EU – which is in turn an amendment of 2002/91/EC – into Spanish law. It establishes the basic methodology for calculating a single energy efficiency rating, as well as the technical and administrative conditions for certification. As per RD 56/2016, it also enforces an obligation that all buildings constructed after 2020 to be near-zero energy consumption buildings.

The certification itself is obligatory – it is part of the design documentation delivered to authorities for a building permit. The document contains:

- Identification of the building/part
- Indication of a recognized calculation procedure
- Reference to corresponding legislation
- Description of energy characteristics of the building/part
- Energy efficiency rating expressed on the energy label
- Recommendations for existing buildings for energy efficiency improvement
- Description of tests carried out
- Compliance with environmental requirements of thermal installations

The cornerstone of the certificate is the label, which is to be exhibited in the buildings themselves, and to be presented during promotion, bids, sale or lease contracts. The rating is defined as a percentage of the energy consumption benchmark set by the national energy performance criteria.

Regional policy

As an autonomous region with its own government, considerable executive and legislative responsibilities are devolved to the regional level. Catalonia has its own Energy and Climate Change Plan, specific strategy for the energy refurbishment of buildings, even more specifically, strategy for the assets owned by the Catalan Generalitat, the devolved government. The region may also develop different thresholds for the national energy performance standards, but since the criteria themselves are similar to the national level, they are not discussed here.[32]

The Energy and Climate Change Plan of Catalonia 2012-2020[33]

The Energy and Climate Change Plan of Catalonia (Plan de la Energía y Cambio Climático de Cataluña 2012-2020) is the general framework of the devolved government for horizontal policies based on the inherent relationship between energetics and climate change. Its primary objectives are to ensure decision making is headed for a greater safety and quality in energy supply, economically sound regional energy model with less dependence on external sources, increase the proportion of renewables, reduce fossil fuel consumption, and improve efficiency of use. It consists of a regional energy modelling methodology as a foundation for strategic priority axes, among which it identifies the barriers of sustainable energy transition

The regional plan analyses a base and a high-commitment scenario with a hybrid energy modelling methodology including a bottom-up approach based on consumption patterns per sector and top-down econometric models to forecast the impact of policy on regional energetics. Among the quantified 2020

EU targets transposed to Catalonia (regarding primary energy consumption per sector, transportation losses, renewable mix, and emissions), the key regional energetics indicators focus on the consumption and grid losses of electric energy and natural gas:

- Electric energy demand
- Final consumption of electric energy
- Natural gas demand
- Automotive fuel consumption[34]

Other transferable insights are the main entry barriers in the way of sustainable energy transition. Barriers to the regional energy goals are identified as lack of technology and knowledge, the low returns on investments and high unaccounted externalities, low priority of efficiency actions, and the fragmentation of policy across sectors.[33] In other words, technical barriers, economic barriers and collaboration deficiencies must be overcome by policy, manufacturing, financial and advisory efforts to lead successful energy transition in Catalonia.

The Building Energetic Refurbishment Strategy of Catalonia (ECREE)35

The Building Energetic Refurbishment Strategy of Catalonia (cat.: Estrategia catalana para la renovación energética de edificios; abbr.: ECREE) is one of the nine unique strategies within the regional energy and climate change plan. It is a long term strategy defining goals and specific actions for the Catalan building stock, both residential and tertiary, both public and private.

Theme	Objective
Energy	14,4 % reduction in estimated final energy consumption in the regional building sector
Emissions	22 % reduction of CO2 emissions from the regional building stock.
Economy	21 % savings on the cost of buildings throughout their lifecycle.
Buildings	Energy refurbishment in 61 % of the buildings in the region.
Investment	Securing 1.400 million euros for 120 macroprojects in renewable energy.
Jobs	Creation/recycling of 14.000 jobs.

TABLE 15: GOAL STRUCTURE OF THE BUILDING ENERGETIC REFURBISHMENT STRATEGY OF CATALONIA

To achieve the goals of the strategy (Table 15), five actions are defined in the face of the five main barriers of energy transition specifically in the built environment. First, an information and planning system with tools and platforms supporting the execution energy refurbishment projects is promoted to overcome networking barriers. Second, training programs are to be initiated to stimulate demand and prepare personnel on the supply side of building energy refurbishment, eventually to artificially kick-start the energy renewal market of buildings. Action three is the identification, selection and facilitation of innovation among building energy efficiency products and services. It intends to afford a collection of, and a competition to produce best practices to disseminate. Next, an organisational model of management and coordination is to be established for the rest of the actions and to carry on facilitating and simplifying the public administrative end of energy renewal. Finally, an investment program is proposed to overcome financial barriers with the task of defining specific investments, plans to mobilise funding and to identify relevant financial instruments.

The Plan on Savings and Energy Efficiency in the State Assets of the Generalitat of Catalonia [36]

The Plan on Savings and Energy Efficiency in the State Assets of the Generalitat of Catalonia (cat.: Plan de Ahorro y Eficiencia Energética en los edificios y equipamientos de la Generalitat de Cataluña) is an investment framework for the energy transition of state owned buildings and facilities within the region. It intends to serve an example to follow, highlighting the environmental and economic benefits of energy services contracting. For the 2015-2017 period, the plan aims to reduce energy (operational) expenditures by 16 % compared to 2014 levels in each department. 5,9 % reduction is expected from demand response – optimising the contract of electricity utilities – while 10,1 % will be achieved from energy efficiency investments to reduce overall consumption. The execution of the measures is to be left to ESCOs, while the devolved government promotes investment platforms for their own and other energy efficiency projects, providing a more streamlined access to financing.

Local policy

The municipality of Sant Cugat shares local plans, strategies, targets and monitoring via their e-governance and open data platform PACTE – Strategic Competetiveness and Alignment Plan (Pla d'Alineació i Competitivitat Estratègica).[37] Energetics is represented within the Municipal Action Plan (A Un PAM De La Ciutat Que Volem. Pla d'actuació municipal) as part of the higher level priority area: sustainability and urban quality (Sostenibilitat i qualitat urbana).[38] The document identifies the reduction of energy demand specifically in the commercial sector, biomass-based district heating networks, and public-private energy efficiency initiatives as key action to reduce greenhouse gas emissions and promote renewable energies.38 The local government also defined key performance indicators for – among others – its sustainability goals: the commitment to protection of the environment and accessible, clean and tidy city (Table 16). Each indicator is presented with a predicted and a measured value, and describes sustainability performance aggregated at the municipal level. It is worthwhile to note however that since its 2012 implementation, there has not been any measured data registered.

Commitment to protection of the environment	
Indicator	2015 prediction
Factors that result in climate change	
Assessment of parks and green areas	8,5
Proximity to basic urban services	No data
Streets of pedestrian priority	18
Annual production of renewable energies	**80**
Final energy consumption	**1,3**
Emission of greenhouse gases	**7.000 Tn**
Number of enterprises with environmental management systems or voluntary environmental commitments	34
Protection of natural environment	
Areas under natural protection	47
Biodiversity of green areas	
Biodiversity of tree-lined roads	15
Consumption of natural resources	
Municipal water consumption	219
Water consumption per inhabitant	120
Irrigated water	18
Recovery of municipal waste	+5
Utilisation of municipal waste facilities	0,23

Urban agriculture	
Locally cultivated land for agriculture	5.000 m^2

TABLE 16: EXCERPT OF THE INDICATORS DEFINED BY THE MUNICIPALITY OF SANT CUGAT TO MEASURE THE REALISATION OF SUSTAINABILITY COMMITMENTS. BOLD TEXT INDICATES NEWTREND CORRESPONDENCE.[39]

2.3. CONNECTIONS WITH NEWTREND PROJECT KPIS

In this section the above collected energy efficiency focused policies, strategies are analysed in context with NewTREND. The comparison with NewTREND is at first on EU level, then the national policies are examined as well.

The Energy Performance of Buildings Directive (2010/31/EU) and the related other European level policies aim at improving energy efficiency of buildings, reduce their CO2 emissions and increase the use of renewable energy sources. The indicators defined for the Environment category of the NewTREND KPI list covers the same topics (Table 17).

Policy	Relevant theme	Corresponding NewTREND KPI
Energy Performance of Buildings Directive	Energy efficiency	B1.1 B1.2
Renewable Energy Directive	Share of energy from renewable sources	B1.3
Energy Efficiency Directive	Energy efficiency	B1.1 B1.2

TABLE 17: ANALYSED EU POLICY PERFORMANCE MEASURES AND THE CORRESPONDING NEWTREND KPIS

The Hungarian policy performance measures and the corresponding NewTREND KPIs are shown in Table 18. The national energy efficiency related strategies aim to comply with the EU directives, so the main focus is on energy consumption and the share of renewables. Regional and local policies also include CO2 emissions reduction goals and a few of them extend the topic of energy efficiency towards sustainability and define goals related to water management, heat island effect reduction etc.

Policy / legislation	Corresponding indicator/theme in the legislation	Corresponding NewTREND KPI
National policy		
Parliamentary decree 40/2008	Specific energy consumption; Share of renewables in the energy split; Share of waste-based sources in the energy split; Diversity of energy sources; Energy efficiency; Energy demand; Security of supply; Compliance to climate targets; Compliance to EU law	B1.1 B1.2 B1.3
National Energy Strategy 2030	Energy consumption by source; Refurbishment depth; Energy efficiency; District heating potential (undefined); Cooling energy consumption; Green urban management (undefined); Consumer cost reduction; Municipal cost reduction; Air quality (emissions perspective)	B1.1 B5.1 D1.1 B10.1
Building Energetics Strategy	Primary energy consumption prior refurbishment and after "cost-optimised level" refurbishment; Primary energy savings; Estimated refurbishment costs	B1.1
National Energy Efficiency Action Plan	Heat transfer coefficient for envelope elements; Specific heat loss factor; Integrated energetic indicator; Minimum share of renewables	B1.1 B1.3

National energy performance criteria	Heat transfer coefficient for envelope elements; Specific heat loss factor; Integrated energetic indicator; Minimum share of renewables	B1.1 B1.3
National energy certification	Integrated energetic indicator	B1.1
Regional policy		
Budapest 2030	Building density; Area of active green surface; Area of water surface; Surface albedo; Surface permeability; Ratio of impervious surfaces; Ratio of cool-roof area; Number of greenfield developments; Energy management planning; Life-cycle assessment; Refurbishment potential; Building stock database; Available subsidies; Available tax credits; Available ESCOs; Available subsidised loans; Non-profit consulting services; Available demonstration projects, best practises; Local certification scheme; Local energy performance standards; Available BIM model; Building material selection; Construction technology selection; Stormwater mitigation options; Renewable energy potential by source; Feedback incentives; District solar potential; Local wind profile; Geothermal potential; Waste-heat potential; District energy sharing & management; Brownfield site; Priority site; Partnership involvement; Refurbishment potential	D1.1 D1.3
SEAP Budapest	Indicators related to CO2 emission	D2.1
Local policies		
Development strategy of Pestszentlőrinc-Pestszentimre	CO2 emission reduction of municipally managed institutions, energetic survey and diagnostics of municipally owned institutions	B1.1 B2.1
SEAP Pestszentlőrinc-Pestszentszentimre	Indicators related to CO2 emission	B2.1
Local plan of Pestszentlőrinc-Pestszentszentimre	refers to national legislation	

TABLE 18: ANALYSED HUNGARIAN POLICY PERFORMANCE MEASURES AND THE CORRESPONDING NEWTREND KPIS

The above detailed Finnish policy performance measures and the corresponding NewTREND KPIs are shown in Table 19. The Finnish energy efficiency strategies and policies also adhere to the EU directives. They also formulate forward looking themes and indicators that target energy efficiency and other sustainability measures beyond the state of the art.

Policy / legislation	Corresponding indicator/theme in the legislation	Corresponding NewTREND KPI
National policy		
National Energy and Climate Strategy	Reduction in greenhouse gas emissions, share of renewable energy, reliance on imported energy, energy performance of building stock	B1.1 B2.1 B1.3
National Energy Efficiency Action Plan	Primary energy consumption; Total final energy consumption; Final energy consumption by sector: industry, transport, households, services; Gross value added per	B1.1 B1.2 D1.1

	sector: industry, services; Disposable income of households; Gross domestic product; Electricity generation from thermal power plants; Electricity generation from combined heat and power plants; Heat generation from thermal power plants; Heat generation from combined heat and power plants, including industrial waste heat; Fuel input for thermal power plants; Fuel input for combined heat and power plants; Average disposable household income; Energy transmission and distribution losses; Separate production of district heating; Fuel input for district heating	D1.2
National Strategy on the Energy Renovation of Buildings	demand-side management measures; tenant behaviour management; a bonus-malus contracting scheme, energy-efficiency improvements during maintenance, user-related services, streamlining space-use, an adding energy-efficiency measures to standard renovation projects	B1.1
National Energy Performance Requirements (from national building code)	Heat transfer coefficient for envelope elements; Specific heat loss factor; Integrated energetic indicator; Minimum share of renewables	B1.1 B1.3
Energy Performance Certification	Integrated energetic indicator;	B1.1
Energy Efficiency Act	condensation plants above 20 MW capacity to asses retrofit as CHP, industrial power plants to assess the exploitation of surplus heat, and district heating/cooling grid (re)constructions to assess the availability and possible exploitation of local surplus heat sources	D1.1 D1.2
Local policies		
Energy efficiency agreements	final energy consumption reduction	B1.2
Builders Guide Seinajöki	-	
Municipal regulations	-	

TABLE 19: ANALYSED FINNISH POLICY PERFORMANCE MEASURES AND THE CORRESPONDING NEWTREND KPIS

The described Spanish policy performance measures and the corresponding NewTREND KPIs are shown in Table 20. The Spanish national level building codes and other regulations stick to energy efficiency topics, or add indicators that measure the additional impact of the energy efficiency interventions (e.g.: the Long-term Strategy for the Energy Rehabilitation of the Building Sector measure the number of jobs generated by the building rehabilitation program). The regional and local policies also define cost effectiveness of the energy interventions among their main goals.

Policy / legislation	Corresponding indicator/theme in the legislation	Corresponding NewTREND KPI
National policy		
NEEAP - National Action Plan on Energy Efficiency	Primary energy demand in toe; Energy consumption by source; Energy intensity indicator; Annual change in energy prices; Energy consumption by use	B1.1 B1.2
Long-term Strategy for the Energy	Number jobs generated (socio-economic impact), Number of houses rehabilitated (complex impact), Kteps of energy	B/D1.1 B/D2.1

Rehabilitation of the Building Sector	saved, and million tons of CO2 emissions reduced (both environmental impact)	
CTE - Technical Building Code (RD 314/2006; last amendment as of writing this document: FOM 588/2017)	Energy consumption from non-renewable sources; Energy rating; Energy demand for heating; Cooling energy demand Thermal transmittance (overall); Thermal transmittance (walls and structures with ground contact); Thermal transmittance (other structures with air contact); Thermal transmittance (holes); Air tightness; Energy efficiency value for lighting installations; Maximum power of illumination; Threshold for light transmittance of glazing; Minimum solar contribution of hot water; Collector losses; Area of collectors; Nominal PV power; PV losses	B1.1
RITE – Regulation on Building Heating Installations (RD 238/2013)	Average air velocity; Relative humidity; Operating temperature; Air quality; Rate of ventilation; Perceived air quality; CO2 concentration; Outdoor air quality; Exhaust air quality; Acoustic comfort	B5.1 B6 B8.1
Energy Efficiency Certification (RD 235/2013)	Energy efficiency rating expressed on the energy label	B1.1
Regional policy		
Plan de la Energía y Cambio Climático de Cataluña 2012-2020	Electric energy demand; Final consumption of electric energy; Natural gas demand; Automotive fuel consumption	B1.2
Estrategia catalana para la renovación energética de edificios (ECREE)	*Main themes:* *final energy consumption; reduction of CO2 emissions; savings on the costs of buildings throughout their lifecycle*	B1.1 B2.1 B10.1
Plan de Ahorro y Eficiencia Energética en los edificios y equipamientos de la Generalitat de Cataluña	*Main theme:* *Reduce energy (operational) expenditures*	B1.1 B10.1
Local policy		
PACTE – Strategic Competetiveness and Alignment Plan	Factors that result in climate change; Assessment of parks and green areas; Proximity to basic urban services; Streets of pedestrian priority; Annual production of renewable energies; Final energy consumption; Emission of greenhouse gases; Number of enterprises with environmental management systems or voluntary environmental commitments; Protection of natural environment; Areas under natural protection; Biodiversity of green areas; Biodiversity of tree-lined roads; Consumption of natural resources; Municipal water consumption; Water consumption per inhabitant; Irrigated water; Recovery of municipal waste; Utilisation of municipal waste facilities; Urban agriculture; Locally cultivated land for agriculture	B/D1.1 B/D1.3 B/D2.1

TABLE 20: ANALYSED SPANISH POLICY PERFORMANCE MEASURES AND THE CORRESPONDING NEWTREND KPIS

In conclusion, a significant overlap among demo site legislative context and NewTREND are evident in the prevalence of NewTREND KPIs among legal energy efficiency criteria: primary energy demand occurs in

57 % of analysed legislative instruments, on-site renewable energy in 17 %, impact on climate change in 4 %, comfort related KPIs in 12 % and operational costs in 4 %. This makes the results of the NewTREND methodology relevant to current policy trends. The national, regional and local level energetic action plans and strategies connect cost effectiveness to the topic of energy efficiency so a number Economic indicators reflect this. Thermal, air quality and acoustic comfort in usually included in energy legislation as minimum thresholds (e.g.: minimum ventilation level necessary for a space function). The ideal levels are defined in separate legislation or standards. However, NewTREND attempts to integrate these viewpoints into one system as most of the energy used in buildings aims at guaranteeing conditions of well-being, comfort and health for the buildings' occupants. This creates the need to attempt the highest possible energy savings without compromising the comfort, health and productivity of the building users.

3. FINANCIAL AND BUSINESS INSTRUMENTS

In general, financial incentives are specific economic benefits tied to a specific range of actions. Schemes of incentivisation are usually deployed to overcome the economic barriers of socially valuable endeavours. In the context of NewTREND, building and district sustainability, particularly energy performance and its impact on comfort, emissions, and costs, are in focus. Incentivising interventions that benefit sustainability come from a multitude of sources and in a multitude of forms, and this heterogeneity is partly explained by the heterogeneity of the concept itself, but also because in many cases, the existence of the economic barrier itself is not at all apparent. From a return-on-investment viewpoint, projects can be classified into four groups (Table 21).

The project is…	**Socially not valuable**	**Socially valuable**
Financially not viable	The project should not be realized.	The project is desirable, the lack of market interest should be overturned with subsidies. Usually realized by the public sector.
Financially viable	The project is not desirable, a market interest should be counteracted through regulation.	The project is desirable, the public sector should promote it, but the project is a competitive investment, usually realized by the private sector.

TABLE 21: PROJECT CATEGORISATION FROM A RETURN OF INVESTMENT VIEWPOINT[40]

Interventions falling under the NewTREND scope are socially valuable, and shifting towards financially viable. Both the public sector and the private sector have deployed instruments with sustainability incentives. It is worth noting, that sustainability projects specifically under NewTREND scope target a realistic return on investment. The costs in this case are mainly capital expenditures, such as reinforcing the building thermal envelope or installing renewable power generation systems. The revenue paying for the investment – and yielding profit after the return period – comes from reduced utility bills. The maturity of the technology involved determines whether the payback period exceeds the project lifetime, but most instruments – including public sector ones – rewards financially viable projects. The economic barrier to overcome is the exceptionally high CAPEX of sustainability projects. Especially in the case of retrofitting, high-reward architectural interventions require a considerable sum of liquid cash spent in a very short timeframe. This entry barrier already locks out many privately owned residential units from sustainable transition. Thus, an overwhelming majority of incentives involve a bankable entity.

If technologies are incubated to maturity, the market will eventually produce competitive means of delivering sustainability interventions. However, most incentives are still backed by public institutions, simply to fast-forward the sustainable transition of the built environment. This level of public sector commitment is rooted in the urgency dictated by EU policy targeting global leadership in sustainability, and the obligations of international treaties such as the Kyoto Protocol, and the Paris Accords. Trickling down to national, regional and local policy (see the legislations in demo site context described in Chapter 2.2), a diverse array of instruments emerged in the past decade not only to directly incentivise end-users to sustainability interventions, but also to incentivise the market of bankable entities to sponsor them. This fast-forwarding is the key to understand the taxonomy of incentives.

In the scope of retrofitting, incentives either provide the liquidity to break down the entry barriers, or support competitive entities to make their own liquidity services more accessible. The creditor can either

be a public, or a private institution. The former is achieved through direct (such as grants and loans) and indirect financial support (such as tax credits and loan subsidies), the latter through security (such as loan guarantees). Some financial supports are not expected to be paid back based on the fast-forwarding principle of EU strategy. While improving the energy performance of the built environment yields a realistic return on investment, projects are still "on the way" to become widely appreciated by and deeply embedded in society. The share of refundable financial supports can be expected to grow as the solutions adopted in the projects mature. For now, the diverse pool of incentives can be classified in the following categories:

- **Tax incentives** generate benefits by easing or tightening public obligations;
- **Non-refund financial supports** offer liquid cash to fund the project partially or fully;
- This liquid cash is expected to be paid back in a set period in the case of **loans**;
- Risk of lending is alleviated by **loan guarantees**, indirectly incentivising sustainability;
- **Energy performance contracting** is a business model binding revenue to energy performance, eliminating both risk, and CAPEX for the end-user.

The structure of incentives varies, but at their core, they all consist of a certain benefit package targeted at a barrier to the desired behaviour and a set of performance standards describing the desired behaviour itself. Performance standards are clearly defined, quantifiable, and in most cases, explicitly quantified indicators of improved sustainability. They are the basis of feedback towards legislation, as policies triggering the incentives also define a causal chain of activity, output, outcome, impact, all feeding into the sustainability goals of said policy, and all measured by a set of causally connected indicators. Performance standards are often bound to a comprehensive system of indicators within a rating scheme. Ratings are tried and tested methods to evaluate and communicate building performance, with standardised, repeatable and transferable procedures of evaluation. Official rating schemes may appear in legislations, especially in continental EU, but are also produced independently for various certificates. Certification is itself a competitive economic activity, a market of certificates offers a variety of products with different value propositions (see Chapter 4 for the detailed analysis of rating schemes). Finally, performance standards also provide means to compare the incentives with the scope of NewTREND, by associating them with NewTREND key performance indicators.

In this task, the 50 financial instruments from T5.1 were analysed and another 108 instruments, legislation and rating schemes were collected in T5.4. From the 107 collected items 82 were categorized as financial instruments. This chapter analyses the 82+50=132 collected instruments.

The data collection has been conducted in different phases of the project (before 2016 October for T5.1 and between 2017 January and June) Therefore some of the instruments could be out of use since its collection. In July 2017 107 of the 132 instruments were in use, the status of the other programs was not in use anymore, planned or just theoretical.

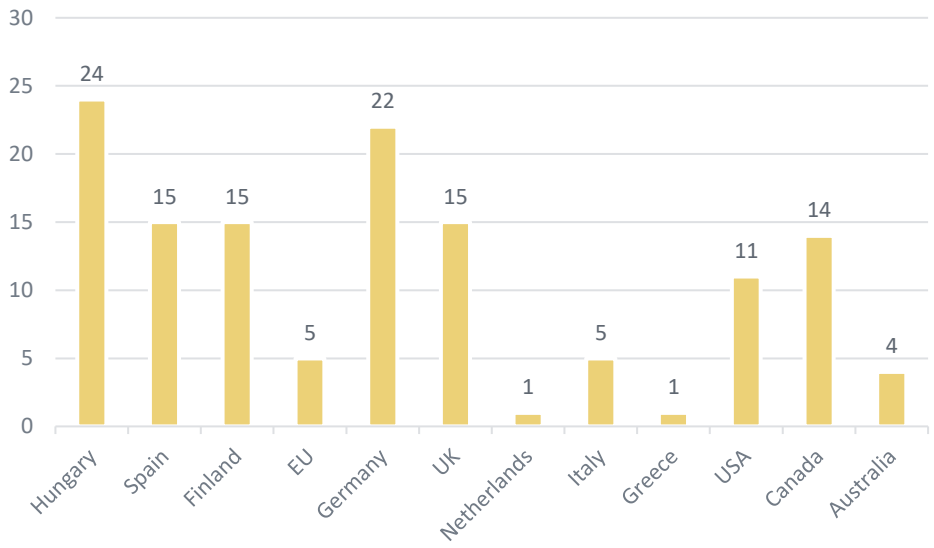


FIGURE 2: NUMBER OF COLLECTED INSTRUMENTS BY COUNTRIES

The instruments from T5.1 were mainly collected from European Union countries, especially from two of the countries with NewTREND demo sites (Finland and Spain). During T5.4 additional instruments were collected from the third country with demo site (Hungary) and also non-EU mechanisms from the US, Canada and Australia were included to provide a more complete perspective of current practice and potential initiatives. The Figure 2: shows the number of instruments collected from the different countries.

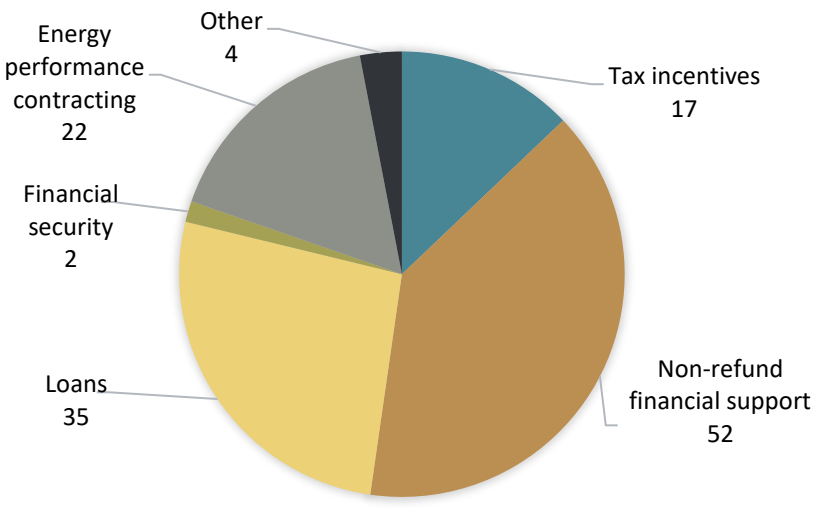


FIGURE 3: TYPES OF FINANCIAL INSTRUMENTS ANALYSED

As mentioned earlier, the collected diverse list of instruments has been classified into 5 categories based on their methods of incentivization. Most of the collected mechanisms are in the category non-refund financial support. Energy performance contracting instruments (mainly related to ESCOs), tax incentives

and loans are also represented in high numbers. Only 2 mechanisms were collected related to the financial security category. The Figure 3: shows the number of collected instruments by categories.

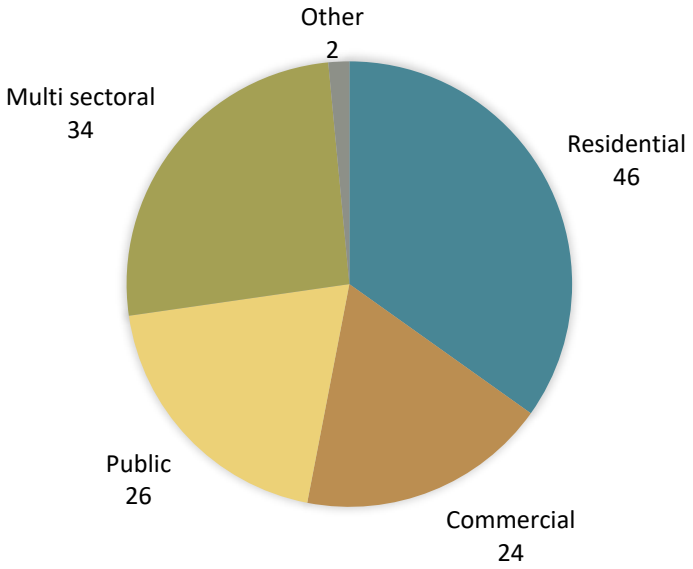


FIGURE 4: SECTORAL TARGETING OF FINANCIAL INCENTIVES

The collected mechanisms usually target one or more building types (Figure 4:). 34 of the 132 instruments are not specifically targeted, or can be used in multiple sectors, while 46 target the residential, 26 the public, and 24 the commercial building sector respectively.

In the following chapters, the collected instruments are analysed. The mechanisms were first grouped into the five above mentioned categories and then their incentivization methods and related benchmarks were compared with the required performance from the buildings or building systems. The goal of the comparison is to determine the most common performance requirements of these mechanisms and the financial benefits of their use. The second part of the analysis focuses on the connection to the NewTREND Key Performance Indicators. The KPIs were evaluated based on their usefulness for financial planning. Their calculation methods were compared in detail to the generally used methods in the collected mechanisms.

3.1. ANALYSIS OF THE INDICATORS/BENCHMARKS USED IN THE FINANCIAL INCENTIVES

3.1.1. TAX INCENTIVES

Tax incentives are part of instruments established by public institutions, exploiting their power over defining public obligations to ramp up their benefit package. These instruments come in the form of tax exemptions, deductions, rebates, depreciation ease, and levies. The exact benefit package tied to specific performance standards, as well as their associated NewTREND key performance indicators are analysed in Table 22. The following paragraphs describe the key implications of this analysis through the introduction to specific financial incentives.

Among the targeted performance standards energy efficiency is highly represented. In relation to NewTREND indicators, 10 out of 14 incentives refer to efficiency, with standards for energy savings, thermal/electrical energy demand, efficiency of building envelope, energy factor for electric appliances

and efficiency of equipment within energy system. 6 out of 14 incentivise renewable energy production, including solar, biomass, and heat pump energy sources among eligible measures. Only the two levies include environmental impact indicators. For example, entities subjected to the carbon pricing mechanism in Australia, had to pay AUD 230 for every tonne of carbon or carbon equivalent GHG that was emitted.

Benefit packages vary by target group and country substantially, and are in most analysed cases (79 %) defined progressively via a formula. 36 % of the incentives are based on investments, the cost of the interventions, while 45 % use achieved performance. Only 3 out of the 14 offer a flat tax credit. This means a substantial amount of tax incentives does not bind the size of the benefit to performance. In such cases, the sustainability goals are ensured by a list of supported interventions, manufacturers or technologies. For example, homeowners could receive a tax credit of 10%-30% of investment costs, by applying to the Residential Energy Efficiency Tax Credits of the Department of Energy in the United States[41]. The credit was tied to energy efficiency improvements in the building envelope of existing homes and for the purchase of high-efficiency heating, cooling and water-heating equipment. Includes insulation, energy efficient exterior windows, doors, certain roofs, geothermal heat pumps, small wind turbines and solar energy systems for both existing homes and new construction. The conditions clearly indicate which items can be and which cannot be subjected to tax credits. For instance, labour costs do not qualify, apart from HVAC, and renewable power generation. In other cases, performance is tied to a rating scheme. Section 179d of the Green Building Tax Deduction of the United States deduces depreciation for new or existing building owners up to 1.80 USD/sqft if they invest in energy efficiency[42]. Qualification for the scheme depends on cutting the power cost of the building to half of the minimal standards of ASHRAE 90.1-2007.

Tax related mechanisms also include negative incentives. Generating interest to reach sustainability goals may not only come from levelling financial obstacles but also by artificially constructing obstacles for not aspiring sustainability. Such strategy refers to Table 21 endeavours that are financially viable but socially – in this case environmentally – damaging, which is deterred by the removal of financial viability. For example, the Climate Change Levy (CCL) was instated in 2001 to encourage energy efficiency and reduce GHG emissions in the United Kingdom[43]. The levy applies to energy carriers, such as gas, electricity, liquefied petroleum gas (LPG) and coal. The rates of the levy are based on the potential energy exploitable from the different carriers. Also, in Australia, as a part of the carbon pricing mechanism, liable entities had to pay a price for every tonne of carbon or carbon equivalent of other greenhouse gases emitted[44]. Liable entities were to be required to report on their emissions, and can meet their obligations by either surrendering the appropriate number of allocated units, or paying a unit shortfall charge. A price on carbon pollution was expected to create incentives for Australia's biggest polluters to reduce their emissions and invest in clean energy. The levies presented here target non-domestic users, such as commercial and industrial ventures. As technologies mature and the urgency for sustainability accelerates, negative incentives might gain more ground, for instance, an EU-wide carbon tax scheme is becoming more plausible recently to supersede the carbon trading model.[45]

Instrument name	Incentive	Performance standards	KPI ref
White Certificates	Contribution (tax) of EUR 68/MWh	Energy savings	B.1.1; D.1.1
Household allowance - State of Finland	The amount of deduction can be 45 % of the cost of work charge (including value added tax) when using a company, or when hiring	List of accepted technologies	B.1.3

	a person, 15 % of the salary costs and employers' contributions. The household deduction can be at most 2400 € per person. The deduction is personal, so a couple can get at most 4800 € deduction per year. An excess of 100 € per person needs to be paid first.		
Legge	Tax rebate covering 55-65% of energy related cost	Cost saved per kWh; heating energy demand; cooling energy demand; sanitary hot water production energy demand; renewable energy generated on-site;	B.1.1; B.1.2; B.1.3
Energy Investment Allowance (EIA)	Tax deduction; 58% of expenditures; min EUR 2.500/a; for investments between EUR 450 and EUR 120M	List of accepted interventions	B.1.1; B.1.2; B.1.3; D.1.1; D.1.2; D.1.3
Tax deductions Greece	Income tax reduction; max EUR 15.000	List of accepted interventions	B.1.1; B.1.2; B.1.3; B.6.1; B.6.2; B.6.3
Section 179d (Green Building Tax Deduction)	max 1,80 USD/sqft tax deduction	The used system should reduce the building's total energy and power cost by 50%. Based on ASHRAE 90.1 2007 calculation.	B.10.1
Residential Energy Efficiency Tax Credits	10-30% of investment cost as tax credit	Energy efficiency: thermal efficiency, fuel utilization rate, energy factor - for all deployed appliances; Energy Star certification references	B.1.1; B.1.2
Energy Investment Tax Credit (ITC)	30% tax credit for solar, fuel cells, wind; 10% for geothermal, microturbines and CHP	List of accepted interventions	B.1.3
Accelerated Recovery Period for Depreciation of Smart Meters and Smart Grid Systems	The depreciation schedule allows taxpayers to recover the cost of the property over a 10-year period instead of the 20-year general recovery period for this type of property.	List of accepted interventions	B.1.1; B.1.2; D.1.1; D.1.2
Landlords Energy Saving Allowance (LESA)	Capital allowance up to GBP 1500	List of accepted interventions	B.1.1; D1.1; D.10.1; B.10.1
Climate Change Levy	Tax up to 0,01551 GBP/unit (2017)	kWh electricity demand; kWh natural gas demand; kg	B.2.1; D2.1

		LPG demand; kg other taxable energy carriers	
Enhanced Capital Allowances (ECA) - Energy Technology List	Full rebate as tax allowance	List of approved technologies for: energy efficiency; on-site renewable generation; demand management; Safety of supply; warm season thermal comfort; cold season thermal comfort	B.1.1; B.1.2; B.1.3; B.5.1; B.6.2; B.6.3
Climate Change Agreements	65 % tax allowance off Climate Change Levy	Energy use; carbon emission	B.1.1; B.1.2; B.2.1
Exemption from Climate Change Levy for Good Quality CHP	Full tax exemption from Climate change levy	Renewable energy generated on-site; Energy efficiency of equipment	B.1.1; B.1.2; B.1.3
Reduced VAT for energy-saving materials	Flat 12,5% decrease on VAT rate	List of accepted interventions	B.1.1; B.1.2; B.1.3
Carbon Pricing Mechanism	AUD 230/carbon unit	Annual carbon-dioxide equivalent emission	B.2.1; D.2.1
Special purpose entity model	Various tax credits	Varies	D.1.3

TABLE 22: TAX INCENTIVES

3.1.2. NON-REFUND FINANCIAL SUPPORTS

Non-refund financial supports are offered mostly by public institutions – in some cases, by utility providers as per their legal obligations. Non-refund financial supports are grants, co-financing schemes, uncharged consulting services and project cost rebates. The exact benefit package tied to specific performance standards, as well as their associated NewTREND key performance indicators are analysed in Table 24. The following paragraphs describe the key implications of this analysis through the introduction to specific financial incentives.

In the European context, grants ensure the sustainability performance of their supported actions through a rigorous project management framework conditionally imposed on grant recipients. EU grant calls are extensive documents, defining conditions for application, attachments, list of fully or partially supported actions, technical criteria for the intervention, criteria for project duration, milestones, realization, and perhaps most importantly, indicators. The KEHOP 5.1.1-17 EU funded operative program in Hungary supports installation of renewable electricity generation and CHP generation - linked to grid, not building-based – for corporations, excluding SMEs. To be considered for the grant, applicants must deliver a feasibility study, a licence for legal status of the company, annual report for the last two years, official decree of ownership for the concerned property, verification of deductibles, notification letter towards electricity suppliers about the project claim and a positive response not older than 30 days, all necessary approvals from various authorities, environmental impact assessment, declaration to avoid double financing, declaration concerning the source of the biomass (when applicable), certification for satisfactory procurements (when applicable), and finally a declaration about transparency [46]. It is questionable how many prospective projects fall out of grace simply because of the rigidity of grant

procedures. When designing projects for non-refund subsidies in the EU, the project managers and owners should be prepared for strict compliance rules and laborious reporting commitments.

EU funds apply indicators to comply with sustainability goals. Indicators are clear, measurable, comparable, quantifications of performance standards. EU environmental strategy defines a log-frame for indicators: input, output, outcome, goal. The framework defines the translation of overall goals to specific project performance. Take KEHOP 5.2.2 for example. The call defines the indicators, dimension, type according to the log-frame, target value (in the example, this refers to targets for the entire program, not a single project) and an ID (Table 23). At least 75 % of the target value defined in the contract is expected to be reached, and if it is to be lowered – which is possible while negotiating the contract – the grant amount is to be proportionally reduced[47].

Indicator	Dimension	Type	Target value (for sum of projects)	ID
Further capacity to generate renewable energy	MW	Shared output	181,45	CO30
Amount of energy generated from renewable sources	PJ/a	OP output	1,45	12
Annual GHG emission reduction	t CDE/a	Shared output	206.942	CO34
Annual primary energy use reduction in public buildings	kWh/a	Shared output	403.644.846	CO32
Reduction in primary energy use via energy efficiency projects	PJ/a	OP output	1,45	14

TABLE 23: INDICATORS DEFINED IN KEHOP 5.2.2. FOR MEASURING PROJECT PERFORMANCE

The benefit package for grants are defined by intensity and total maximum amount. Intensity refers to the percentage of project costs subjected to co-financing, as in most analysed grants, there are deductibles involved. Deductibles are leverages from the side of the grant recipient, to ensure both parties have a stake, and take at least some risk by investing in energy efficiency. From 45 analysed grant schemes, 7 do not mention intensity of support. These either have an unspecified benefit package, determined on a case-by-case basis, give a flat amount of money regardless the project costs, or in a few cases, calculate amount from performance. The Renewable Heat Incentive of the UK targeting domestic users, subsidizes biomass boilers, solar water heating, and certain heat pumps based on the thermal energy generated from renewable sources for seven years. In the third quarter of 2017, the tariffs for biomass were 3,85 p/kWh; for air heat pumps: 7,63 p/kWh; for soil heat pumps: 19,64 p/kWh; for solar: 20,06 p/kWh[48]. Out of the 38 remaining grants, 5 offer less than 30 % coverage, an additional 13 offer less than 50 % coverage, 4 more offer less than 70 % coverage and 4 more offer less than 100 % coverage. 12 schemes offer full coverage – these are mostly targeted at bottom-of-the-pyramid earners, pensioners or other socially disadvantaged groups.

Instrument name	Incentive	Performance standards	KPI ref
The European Investment Bank (EIB) "ELENA – European Local Energy Assistance "	Non-refund financial support; min EUR 30M; duration 2-4 years; max 90% intensity	CO2 reduced; Renewable energy generated; Energy consumption reduced; Energy source transition	B.1.1; B.1.2; B.1.3; D.1.1; D.1.2; D.1.3

PAREER	Non-refund financial support, 20-30% intensity, max EUR 3.000; zero-interest loan, 60-70% intensity 12 years duration, max EUR 6.000	kg CO2/(sqm*a)	B.2.1
Promotion for the rehabilitation of residential buildings	Max € 11,000 for dwelling or for 100 square meters (€ 12,000 for historical buildings). The way to calculate the grant is: a) € 2,000 in rehabilitation works. Possibility to add € 1,000 plus if the action includes a sustainability action. b) € 2,000 in civil works in relation to improve the quality and the sustainability. This amount increases until € 5,000 if the actions expect energy savings over 50% of the original consumption. c) € 4,000 in accessibility actions Those amounts can add 10% if it's a historical building. The maximum amount is 35% of the eligible cost.	Energy consumption; energy efficiency of appliances; Renewable energy generated	B.1.1; B.1.2; B.1.3
ELY & TEM - energy grant	Grant intensity up to: · 60 % for municipal renewable energy surveys · 50 % for municipal, micro-enterprise and small and medium enterprise energy audits · 40 % for other energy audits, analyses and surveys · 40 % for renewable energy and energy efficiency investments, new technologies · 30 % for renewable energy and energy efficiency investments, common technologies · 30 % for other investments reducing the environmental impacts of energy production	List of accepted interventions	B.1.1; B.1.2; B.2.1; B.1.3; D.1.1; D.1.2; D.2.1; D.1.3
Contratti di Quartiere (CdQ)	Non-refund financial support, max 45% intensity	Consumption of resources; Containment of winter energy consumption; Primary energy for winter air conditioning; Thermal transmittance construction casing; Sanitary hot water; Containment of summer energy consumption; Solar radiation control; thermal inertia; Natural lighting; Electricity from renewable sources; Eco-	B.1.1; B.1.2; B.1.3; B.2.1; D.1.1; D.1.2; D.1.3; D.2.1

		compatible materials; Renewable materials; Recycled / recovered materials; drinking water; Drinking water for irrigation; Drinking water for indoor use; Maintenance of the building envelope performance; Greenhouse gas emission	
Conto Termico	Total grant = Incentivised percentage of total expenditure (40% intensity) * (EUR cost of intervention/sqm area of intervention) * sqm area of intervention; OR Total grant = Incentivised percentage of total expenditure (40% intensity) * ratio between the expenditure incurred in euros and the heat output of the equipment installed in kWt * The sum of the rated thermal outputs of the installed heat generators in kWt; max EUR 250.000	Thermal transmittance (U-value); thermal efficiency of equipment	B.1.1; B.1.2
*Heating Optimisation Funding Programme	Non-refund financial support; 30% intensity; max EUR 25.000	List of accepted interventions	B.1.1; B.1.2
Weatherization Assistance Program (WAP)	Full funding and management of retrofit	Monitoring: Base energy consumption; Energy expenditures; Safety of electrical system; Health impact of HVAC components; Airtightness	B.1.1; B.1.2; B.10.1
EnergySmart Schools	0,05 USD/Kwh saving in the first year, up to 100% project cost	Energy consumption	B.1.1; B.1.2
Low Income Homeowner Service	Full funding and management of retrofit	None	None
Home Winterproofing Program	Full funding and management of retrofit	None	None
Energy Efficiency Incentive Program (EEIP)	50-100% rebate	Envelope thermal resistance; decrease in air leakage; EnerGuide rating; energy efficiency of appliances	B.1.1; B.2.1
Commercial Energy Audit Program	Full rebate up to CAD 1.000	Monitoring: All contents of an accredited energy audit	B.1.1; B.2.1; B.5; B.6; B.10.1
Commercial New Construction Program	Technical assistance; customised funding offers	Potential electricity savings; Monitoring: Window-wall ratio; thermal bridging; effective building envelope thermal	B.1.1; B.2.1; B.5;

		transmittance; ventilation capacity; water heating demand; plug load; lighting power density and schedule; equipment efficiencies; appliance energy demands	B.6; B.10.1
Ontario saveONenergy: Retrofit Program	The incentive depends on type of solution adopted	Monitoring: Demand savings; energy savings; lighting wattage; equipment performance; appliance demands; building envelope thermal performance; automation system savings	B.1.1; B.2.1
Quebec Implementation Incentive for Energy Efficiency Measures for Gas (GazMétro)	Financial support; max CAD 175k; max 50 % intensity; USD 0,25/m3 gas saved	cubic meter of natural gas saved for the first year following the implementation of an energy efficiency measure.	B.1.1; B.2.1
Custom Business Efficiency Program	rebate up to 15 cents per estimated annual kilowatt hour saved	Annual kWh saved	B.1.1; B.2.2
British Columbia Energy Distribution Project Incentives	Financial support; max CAD 500k; 75% intensity; from CAD 0.015 to CAD 0.029 per kilowatt hour	Annual kWh saved	B.1.1; B.1.2; D.1.1; D.1.2
Energy efficient renovation (430) - investment subsidy	Non-refund financial support; max 30.000 EUR per living unit	KfW Effizienzhaus: Primary energy demand; Heat transfer coefficient; Equipment efficiency	B.1.1; B.1.2
Energy efficiency building and renovation (431) - Subsidy building supervision	Subsidy up to 4.000 EUR; 50% intensity	KfW Effizienzhaus: Primary energy demand; Heat transfer coefficient; Equipment efficiency	B.1.1; B.1.2
Energy efficiency building and renovation (433) - subsidy fuel cell	A basic subsidy: fixed amount of 5,700 euros and An additional subsidy: performance-dependent amount of 450 euros per 100 W electrical power for the power classes of 0.25 to 5.0 kW of electrical power.	Energy stored [100 W electrical power]	B.1.1; B.1.2
On-site consultation	Subsidy up to 800 EUR; 60% intensity	None	None
Energetic Urban Renovation - 432	Subsidy up to 65% of personal and material costs	largest energy users in the neighbourhood; potentials for energy saving and efficiency; total energy balance of the district after the renovation; Cost, feasibility and profitability of the measures	D.1.1; D.1.2; D.10.1

RHI (Domestic renewable heat incentive)	Up to 0,206 GBP/kWh	Renewable heat generated on-site	B.1.3; D.1.3
Scotland - Public Sector Central Energy Efficiency Fund (CEEF)		Energy savings; Energy expenditure savings; carbon savings	B1.1; D1.1; B.2.1; D.2.1 D10.1; B10.1
Affordable Warmth Scheme	Grant up to GBP 10.000	List of accepted interventions	B.1.1; B.1.2; B.5.1
Community Energy Efficiency Program	Non-refund financial support; 33-67% intensity; up to mAUD 5,3	Monitoring: Energy consumption; Energy expenditures; GHG emissions; Energy efficiency	B.1.1; B.1.2; B.2.1; D.1.1; D.1.2; D.2.1
Otthon Melege Program ZFR-KAZ/2017	Non-refund financial support, max 40 % intensity, max 700 kHUF	CO2 emission reduction per annum; energy savings per annum	B.2.1; D.2.1; B.1.1; D.1.1
Otthon Melege Program HGCS/2017	Non-refund financial support, max 50 % intensity, max 45 kHUF	Energy efficiency class (legislation)	B.2.1; D.2.1; B.1.1; D.1.1
KEHOP - Environment and Energy Efficiency Operative Programme 5.1.1-17	Non-refund financial support; 10-45 % intensity; 2000-4300 mHUF	GHG emission reduction; Renewable energy capacity; Energy generated from renewable sources	B.1.3; D.1.3
KEHOP - Environment and Energy Efficiency Operative Programme 5.2.8	Non-refund financial support, max 80 % intensity; 50-250 mHUF	Renewable energy capacity; Primary energy consumption reduction; GHG emission reduction; Energy generated from renewable sources	B.2.1; D.2.1; B.1.1; D.1.1; B.1.3; D 1.3
KEHOP - Environment and Energy Efficiency Operative Programme 5.3.1-17	Non-refund financial support, 10-50 % intensity; 20-4000 mHUF	GHG emission reduction; Primary energy consumption reduction	B.2.1; D.2.1; B.1.1; D.1.1
KEHOP - Environment and Energy Efficiency Operative Programme 5.2.2	Non-refund financial support; 100 % intensity, sum defined in relevant budget	Renewable energy capacity; Primary energy consumption reduction; GHG emission reduction; Energy generated from renewable sources	B.2.1; D.2.1; B.1.1; D.1.1; B.1.3; D.1.3
KEHOP - Environment and Energy Efficiency	Non-refund financial support, max 50 % intensity; 20-2500 mHUF	GHG emission reduction; Renewable energy capacity;	B.1.3; D.1.3

Operative Programme 5.3.2-17		Energy generated from renewable sources	
TOP - Territorial and settlement operative program 6.3.2-16	Non-refund financial support, 100 % intensity, amount defined individually for counties	Area of rehabilitated or new open space; Population involved in redevelopment; Length of stormwater mitigation infrastructure; Number of rehabilitated public or commercial buildings; Area of rehabilitated or new green space	B.2.1; D.2.1
TOP - Territorial and settlement operative program 2.1.2-16	Non-refund financial support, 100 % intensity, amount defined individually for counties	Area of rehabilitated or new open space; Population involved in redevelopment; Length of stormwater mitigation infrastructure; Number of rehabilitated public or commercial buildings; Area of rehabilitated or new green space	B.2.1; D.2.1
TOP - Territorial and settlement operative program 6.3.1-16	Non-refund financial support, 100 % intensity, amount defined individually for cities	Area of rehabilitated soil; Population involved in redevelopment; Length of stormwater mitigation infrastructure; Number of rehabilitated public or commercial buildings; Area of rehabilitated or new green space	B.2.1; D.2.1
TOP - Territorial and settlement operative program 2.1.1-16	Non-refund financial support, 100 % intensity, amount defined individually for counties	Area of rehabilitated soil; Population involved in redevelopment; Length of stormwater mitigation infrastructure; Number of rehabilitated public or commercial buildings; Area of rehabilitated or new green space	B.2.1; D.2.1
TOP - Territorial and settlement operative program 6.1.1-16	Non-refund financial support; 25-50 % intensity, amount defined individually for cities	Number of enterprises receiving support; Number of enterprises receiving non-refund financial support; Number of enterprises receiving non-financial support; Area of rehabilitated soil; Area of developed or new industrial areas; Length of modernised roads	B.2.1; D.2.1
TOP - Territorial and settlement operative program 4.3.1-16	Non-refund financial support, 100 % intensity, amount defined individually for counties	Number of rehabilitated residential units; Area of rehabilitated or new open space; Population involved in redevelopment; Population covered by social rehabilitation action site	B.2.1; D.2.1

TOP - Territorial and settlement operative program 6.5.1-16	Non-refund financial support, 100 % intensity, amount defined individually for cities	GHG emission reduction; Primary energy consumption reduction; Renewable energy capacity; Energy generated from renewable sources	B.2.1; D.2.1; B.1.1; D.1.1; B.1.3; D.1.3
CMHC Green Home	15-25% premium refund	EnergySTAR; R-2000 standards	B.1.1; B.1.2; B.2.1; B.10.1

TABLE 24: NON-REFUND FINANCIAL SUPPORTS

3.1.3. REFUND FINANCIAL SUPPORTS

Financial support may also be subject to refund. The traditional tool to overcome high investment costs has always been borrowing, but in the context of sustainability, a long return period with a modest slope in cash flow is common – raising further barriers before investment. Refund financial supports are often subsidized to offer more attractive terms – interest rates, payback periods – than conventional loans. The exact benefit package tied to specific performance standards, as well as their associated NewTREND key performance indicators are analysed in Table 25. The following paragraphs describe the key implications of this analysis through the introduction to specific financial incentives.

Various entities can be issuers of loans. Subsidized loans are traced back to public entities, government agencies (e.g. Salix project in Scotland), Municipalities (e. g. Home Energy Loan Program, Toronto), or the EU (e. g. GINOP, Operative Program for Economic Development and Innovation). There can be financial intermediaries involved, either publicly (e.g. KfW in Germany) or privately managed (e.g. Raiffeisen Bank retrofit loans for public institutions in Hungary).

Compared to non-refund financial support, the benefit packages of loans are usually larger, both in terms of support intensity and maximum absolute amount. Out of the 12 analysed loan schemes, 8 does not mention an intensity ceiling, 3 sets intensity to at least 60 %, and only 1 below. The differences are directly comparable within combined instruments, such as the Spanish PAREER: Aid Programme for Energy Rehabilitation in Buildings in the Household and Hotel Sectors. PAREER offers financial aid to improve energy efficiency, GHG emissions reduction, and renewable energy generation in buildings built before 2014. The benefit package is adjusted to four intervention types: thermal envelope energy efficiency, energy efficiency of appliances, biomass thermal energy generation, geothermal energy generation. The IDEA subsidy component of the scheme may cover 30, 20, 25, and 30 % of the intervention costs respectively, while the loan component goes up to 60, 70, 65, and 60 %. The cap imposed on the amount is EUR 3.000 for the grant and EUR 6.000 for the loan.[49] The trend carries over to loans in general: while grants are usually applied to co-financing type schemes, also relying on deductibles, loans can often be used to finance entire projects – precisely because a refund with interest is expected anyway.

The primary metrics of loans are not the amount and intensity, but the interest rate and the term of repayment. Interest rates and terms define the cost of borrowing adjusted to a timescale, which in turn defines the cash-flow, thus the viability of obtaining the loan in the first place. The diversity of loan types connected to improving energy performance of buildings is rooted in fiddling with interest rates and terms to lower the threshold of viability, thus to include more, otherwise left-behind borrowers to fast-forward national sustainability goals. The differences are clear when comparing commercial loans with subsidized loans in the same country. The conventional Deutsche Bank Privatkredit for non-commercial customers

operate with a 3,95-10,99 % interest rate for sums EUR 1.000-75.000 with 3 to 4-year terms according to their offer 09-08-2017[50]. The KfW (Kreditanstalt für Wiederaufbau), a German government owned development bank offers various soft loans with lowered interest rates, around 1-1,5 % for analysed instruments (refer to Table 25). KfW Instrument 167 "Energieeffizient Sanieren" supports the replacement of existing heating systems with one based on renewable energies (solar collectors, heat pumps, biomass heat generation, combined renewable-fossil systems). For a single residential unit, up to EUR 50.000 is available with 1,31 % effective interest rate to be repaid over a 10-year term[51].

Loan amounts are usually calculated from investment costs and performance standards, and subsidies may or may not be fine-tuned based on social vulnerability, while performance is also used as threshold for eligibility. The IKK Energieeffizient Bauen und Sanieren loan repayment subsidy offers to cover 17,5 % of loan amount for retrofit and 5 % for new constructions. Strictly speaking this is a grant, but since it is always bound to a loan, together they are practically operating as a subsidized loan. The conditions for eligibility include a list of approved interventions that are subjected to the subsidy, and a compliance to one of the KfW Effizienzhaus categories. Effizienzhaus buildings take Energieeinsparverordnung (EnEV, in Eng.: Energy Conservation Act) metrics as a starting point, and exceed the criteria for primary energy demand and thermal transmittance by a certain amount. The number in each Effizienzhaus category reflect the percentage of energy requirement the building has, compared to EnEV standards – KfW-Effizienzhaus 55 has 55 % energy demand of the reference buildings described in EnEV[52]. IKK subsidy amount and intensity are both bound to Effizienzhaus categories: 70, 100, Denkmal (monuments) for retrofit and 55 for new constructions. A maximum of 175, 100, 75 and 50 EUR/m2 subsidies can be granted to cover 17,5 %, 10 %, 7,5 %, and 5 % of the loan amounts respectively[53].

Instrument name	Incentive	Performance standards	KPI ref
PAREER	Non-refund financial support, 20-30% intensity, max EUR 3.000; zero-interest loan, 60-70% intensity 12 years duration, max EUR 6.000	kg CO2/sqm*a	B.2.1
JESSICA-FIDAE funds	- Amount: up to 70 % of eligible expenditure, with the limit of the budget available in each region. - Amortization depending on project need. Up to 15 years, with 3 years of grace period. - Interest rate: Euribor plus spread based on credit rating and guarantees provided. Rates of interest ranging from Euribor to Euribor + 0.75 % + 4 %. Projects in which the recipient of the funding is a public service and have no economic activity: - Amount: up to 100 % of eligible expenditure, with the limit of the budget available in each region. - Interest rate: 0%.	Energy savings per annum; energy cost savings per annum	B.1.1; B.1.2; B.10.1; D.1.1; D.1.2; D.10.1
Housing Fund of Finland - Loans for renovations	Loan guarantee covering max 70%, guarantee fee 2% of loan capital; subsidized loan, 3,4-3,5% interest rate	None	NULL

KfW - EE Construction and refurbishment Programme - KfW – RES Programme – Standard KfW – RES Programme - Storage	subsidized loan; 100% intenstiy;1-1,15% interest rate; 2-year term; max 17,5% repayment bonus	KfW Effizienzhaus standard: primary energy demand; Thermal transmittance	B.1.1; B.1.2
Home Energy Assessment Program	Low interest financing (OAC) up to CAD 25.000 for 5 years; Up to CAD 5.000 in rebates	Individual audit: Thermal envelope integrity; efficiency of energy appliances; energy demand	B.1.1; B.2.1; B.10.1
Home Energy Loan Program (HELP)	2-3,5% interest rate loans for 5-15-year terms	List of accepted interventions	B.1.1; B.1.2
Commercial and Industrial New Construction Program	Zero-interest loan up to CAD 500k, free consulting	Monitoring: Energy demand; energy expenditures	B.1.1; B.2.1; B.10.2
Energy efficient renovation (151, 152)	*27.5% of the loan sum, max EUR 27.500 per residential unit*	KfW Effizienzhaus 55 standard: primary energy demand; Thermal transmittance; list of accepted interventions	B.1.1; B.1.2
Energy efficient renovation (167)	Credit loan up to 50.000 EUR for replacing existing heating system with renewable energy based heating system with a max period of 10 years with effective rate of 1,26 % per living unit.	Renewable energy generation (nominal heat output for heat pumps and biomass; panel area for solar)	B.1.3
Energy efficient building and renovation (217/218)	Credit loan with no maximum amount	KfW Effizienzhaus standard: Primary energy demand; Heat transfer coefficients; list of accepted interventions	B.1.1; B.1.2
Renewable Energies - Standard (270)	Credit loan up to 50 Mil EUR with a rate of 1.05% for period of 20 years	Renewable energy generation (Act for the Expansion of Renewable Energies of 21 July 201); Energy stored	B.1.1; B.1.2; B.1.3
Renewable Energies - storage (275)	Credit loan with a rate of 1.00% for period of 20 years	The power of the installed photovoltaic system connected to the battery storage system shall not exceed 30 kWp.	B.1.3

TABLE 25: REFUND FINANCIAL SUPPORTS

3.1.4. FINANCIAL SECURITY

The public sector can also encourage sustainability investments indirectly. The buildings in the worst conditions, where a sustainability retrofit is most relevant and desirable are the ones who are more likely to fail securing funds. Given the associated financial risks, the users of these buildings deliver, it is no

surprise that financial institutions – who are more inclined to give money to those who do not need it – are not eager to lend. To alleviate risks, public institutions, exploiting the fact that they shepherd over a steady, secure income, act as collaterals to incentivise lending.

The indirect incentives to invest in energy efficiency come in the form of loan guarantees and collateral funds. Take for example, the Energy Efficient Mortgages in the US. Homeowners can leverage EEMs for energy efficiency and renewable energy generation investments either for retrofit or new construction. In order to avert revenue losses from default and expanding the target group, the Federal House Authority or Veteran Affairs programs provide insurance, covering up to the total costs of the investment for 15 or 30-year terms.[54]

Among the examined instruments, performance standards are defined by legislation in the European cases, and by accredited certification schemes in US cases. The exact benefit package tied to specific performance standards, as well as their associated NewTREND key performance indicators are analysed in Table 26.

Instrument name	Incentive	Performance standards	KPI ref
EUROPEAN COMMISSION - LIFE PROGRAMME Private Finance for Energy Efficiency instruments (PF4EE)	Up to 80 % collateral funding; loan EUR 40k-5M; 75 % intensity; duration max 20 years; technical consultancy	Heat supply cost; renewable energy generation; cost-optimum energy efficiency; primary energy savings	B.1.1; B.1.2; B.1.3; B.10.1; D.1.1; D.1.2; D.1.3; D.10.1
Housing Fund of Finland - Loans for renovations	Loan guarantee covering max 70%, guarantee fee 2% of loan capital; subsidized loan, 3,4-3,5% interest rate	None	NULL
Finnvera - Environmental loan guarantee	Loan guarantee covering max 80 %; 10-year term	Environmental impact; energy efficiency; Renewable energy generated	B.1.1; B.1.3; D.1.1, D.1.3
PACE Financing	Loan guarantee	Determined program by program, recommended use of national certification scheme: Energy Star	B.1.2; B.10.1
Energy Efficient Mortgages	Loan guarantee covering max 100 %; 15/30-year term	Energy efficiency (Energy Star)	B.1.1; B.1.2

TABLE 26: FINANCIAL SECURITIES

3.1.5. ENERGY PERFORMANCE CONTRACTING

Energy performance contracting is an umbrella term for innovative, for-profit business models that seek revenue from energy performance. There is a wide variety of possible models, all harnessing reduced costs of more efficient/productive energy balance of buildings. The three most common types of business models based on energy performance are: demand response mechanisms, ESCOs, and prosumption. The exact benefit package tied to specific performance standards, as well as their associated NewTREND key performance indicators are analysed in Table 27. The following paragraphs describe the key implications of this analysis through the introduction to specific financial incentives.

Demand response mechanisms involves streamlining energy consumption to reduce costs for the consumer. This means the exploitation of loopholes in the energy provision, such as the uneven daily distribution of demand (peak hours versus off hours), pricing accuracy (lump sums versus smart metering), or interruptible energy. For instance, participants of Enel Info+ program receive invoices based on actual consumption via smart metering. They also receive Info+ kits, a modular energy performance monitoring system, with user-friendly interfaces allowing the revision and adjustment of user behaviour, thus energy demand directly. The incentive is twofold: first, the accuracy of consumption-based pricing can provide up to 15 % savings on electricity utility invoices, and second, feeding back the analytics to the customer encourages further cost-reduction behaviour changes. For that purpose, the Info+ kit includes a "smart info display", a touch-screen showing nigh real-time and accumulated data on consumption and tariffs, a "smart info manager" application for computers, and an "app smart info mobile" for smartphones, both to access and analyse detailed energy consumption information remotely. For demand response, the system offers custom consumption thresholds and alarms, and the system is compatible with on-site energy production as well.[55]

Prosumption models build on the massive distribution of power generation, incentivising on-site, small-scale renewable energy generating projects. The term prosumption means production by consumers, and is gaining traction with the advent of technologies with a small footprint such as photovoltaic panels, small-scale combined heat-power generators, heat pumps or household wind power rotors. Apart from high investment cost, another key entry barrier for these technologies come from the uneven and in some cases difficult-to-predict production curve. A lot of excess power is generated, with limited storage options, creating an opening on the market for smart grids. To incentivise prosumption, the infrastructure to absorb excess, a clear framework for feed-in conditions, and attractive pricing schemes are required. The British Office of Gas and Electricity Markets offer state-subsidized feed in tariffs since the coalition government. The threshold for eligibility is a capacity of 5 MW for solar photovoltaic, wind, hydro, and anaerobic digestion based power generation and 2 kW for micro CHP plants. The tariffs are paid by energy suppliers on a quarterly basis, according to the meter reading the prosumer submits. The specific rates change quarterly, and vary for energy carriers. For a standard PV capacity between 10-50 kW, the rates were 4,07 p/kWh in Q3, 2017.[56]

Energy services companies, or ESCOs are bankable entities whose business model is to invest in energy performance improving interventions to gain revenue from a percentage of the reduced utility costs of the customer. The contracts tie revenue to performance standards – the reduction in operational expenditures – incentivising the ESCO to a) investigate which projects yield higher energy savings potential, b) rigorously assess the most cost-efficient intervention applicable. There are multiple variations of the ESCO model. Ener-G, Syscolux and Savesco are Hungarian examples for conventional, private sector ESCOs taking up investments costs altogether, receiving monthly payments based on the reduced primary energy. Syscolux is originally a retailer of modern lighting products, also providing related services, such as energy audits and electrical planning. Therefore, the company can build on its existing product stock and expertise to venture into ESCO financing – in fact, for Syscolux, the model is merely a restructuring of the sales channel and revenue stream to expand to previously unattained customer groups.[57] ESCOs can also be public entities, as in the case of the Canadian Federal Buildings Initiative. The FBI provides an implementation model, supporting documents, information and advice to facilitate the development of energy savings projects for public institutions.[58] Within the framework of the Green Deal, UK household investments could pay for their CAPEX through the utility bills.[59] A common public-private-partnership option – not exclusively applied for energy performance projects – is the "BOOT", or build-

own-operate-transfer model, in which private entities design, construct and run an infrastructure as their own business, reap the benefits for return on investment, and after a specific period (usually long-term, 40 years or more) the capital is transferred to the public entity.[60] Similarly, energy-saving interventions among private entities can run as a BOOT arrangement, with the buyer having a purchase option on the installed equipment after the end of the pre-specified BOOT term.

When planning to seek financial incentives to increase energy performance, it is worthwhile to note that as technology matures, market options such as energy performance contracting become more viable against public financing products. The ESCO industry revenue in the US in 2011 was reportedly around USD 5,3 billion[61], compared to the USD 4,9 billion in 2009[62], meaning a 9 % annual growth rate, drastically exceeding the US GDP growth of average 1,9 %[63]. In Europe, between 2010-2013 most of the EU countries also experienced market growth for energy performance contracting, albeit in some countries the market stagnated or declined (Hungary, Austria, the Netherlands)[64].

Instrument name	Incentive	Performance standards	KPI ref
BOOT	Capital investment coverage, share in savings	Energy cost savings	B.10.1; D.10.1
Guaranteed savings EPC contract	Capital investment coverage, share in savings	Energy cost savings	B.10.1; D.10.1
Interruptible service	Less utility expenditures	Energy consumption	B.1.1; D.1.1
ESCO	Capital investment coverage, share in savings	Energy cost savings	B.10.1; D.10.1
ESCO / leasing - solar power financing	Capital investment coverage, share in savings; Non-refund financial support, 25% intensity	Energy cost savings	B.10.1; D.10.2; B.1.3; D.1.3
Fortum Fikso	max 15% savings on energy bill	Energy cost savings; energy efficiency	B.1.1; B.1.2; B.10.1
ENEL info/info+	Savings from streamlined invoicing	Primary energy consumption	B.1.1; B.1.2
Green Deal	Capital investment coverage, share in savings	Energy cost savings	B.1.1; B.1.2; B.1.3; B.10.1
Federal Buildings Initiative (FBI)	Capital investment coverage, share in savings	Monitoring: Energy consumption; Energy expenditures; site-specific metrics	B.1.1; B.2.1; B.10.1
FIT (feed-in tariffs)	Up to 0,0557 GBP/kWh	Energy generated on-site	B1.3; D1.3
Ener-G ESCO	Capital investment coverage, share in savings	Primary energy consumption reduction	B.2.1; D.2.1; B.1.1; D.1.1; B.10.1; D.10.1
SyscoLux ESCO	Capital investment coverage, share in savings	Primary energy consumption reduction	B.2.1; D.2.1; B.1.1; D.1.1;

			B.10.1; D.10.1
Savesco ESCO	Capital investment coverage, share in savings	Primary energy consumption reduction	B.2.1; D.2.1; B.1.1; D.1.1; B.10.1; D.10.1
Savesco EPA	Purchase guarantee	Locally generated energy	B.1.3; D.1.3
Savesco PBI	Emergency investment coverage, share in savings	Primary energy consumption reduction	B.2.1; D.2.1; B.1.1; D.1.1
Utility-sponsored model	Buy-in option for local power generation	Renewable energy generated	B.1.3, D1.3

TABLE 27: ENERGY PERFORMANCE CONTRACTING INCENTIVES

3.2. CONNECTIONS WITH NEWTREND KPIS

In this subchapter, we analysed the indicators of the collected financial instruments in relation to the NewTREND KPIs. As Table 28 shows the NewTrend core KPIs set of 10 indicators and that only 6 of them are considered in financial instruments. The improvement of indoor air quality, summer comfort, and acoustics comfort are not deemed worthy for incentivisation.

ID	KPI name	Core / Optional	Financial instruments
B.1.1	Operational Primary Energy Demand	Core	considered
B.1.2	Delivered Energy Demand	Core	considered
B.1.3	Renewable Energy on Site	Core	considered
B.2.1	Global Warming Potential	Core	considered
B.5.1	Indoor Air Quality	Core	not considered
B6.1	Summer Comfort without Cooling	Core	not considered
B6.2	Thermal Comfort in the Heating Season	Core	considered
B6.3	Thermal Comfort in the Cooling Season	Core	not considered
B8.1	Acoustic Comfort	Core	not considered
B.10.1	Operational Energy Costs	Core	considered

TABLE 28: KPIS CONSIDERED IN THE COLLECTED FINANCIAL INSTRUMENTS

In some instances, the financial instruments use similar indicators for measuring performance as NewTREND. In other cases, the purpose of the NewTREND indicators are in line with the goals of the financial instruments. Table 29: shows that most of the collected instruments consider energy use reduction as their targets, similarly to B1.1 Operation Primary Energy Demand and B1.3 renewable Energy on Site indicators. Also, global warming is also frequently considered by the instruments similarly to operational energy costs. Thermal comfort improvement is only considered for tax incentives and non-refundable instruments. The reason could be that energy efficiency improvements are more quantifiable, therefore it's easier to tie performance requirements to them. Also, efficiency is straightforward to monetize, thus provide a return to pay back external funding, while comfort is considered an externality. The comfort related instruments mainly target low income housing where the target is reaching the minimal levels of human comfort.

	KPI	Tax incentives	Non-refund	Refund	Security	EPC
	B.1.1 Operational Primary Energy Demand	10	29	12	3	9
	B.1.3 Renewable Energy On Site	6	13	11	2	4
B.2 Impacts	B.2.1 Global Warming Potential	2	24	7	0	5
B.6 Thermal comfort	B.6 Thermal Comfort indicators	2	3	0	0	0
B.10 Operational costs	B.10.1 Operational Energy Costs	1	5	4	2	10
D.1-10	District scale indicators	5	28	11	2	12

TABLE 29: INCENTIVES IN RELATION TO NEWTREND KPIS

Instruments relevant to the district scale are few in our collection. However, mostly the same instrument can be used for individual or groups of buildings as well. These district scale indicators mainly consider energy use reduction and operational cost of the district, but not thermal comfort.

COMPARISON OF NEWTREND AND INCENTIVES CALCULATION METHODOLOGIES

NewTREND calculation method is based on the method of PREN 15603 Energy performance of buildings – from the overarching standard: EPBD. The method is focused on the operational primary energy demand only the life cycle stage "B6" is considered in the calculations according to the EN 15978 standard.

The PREN 15603 standard provides a systematic, comprehensive and modular overall structure on the integrated energy performance of buildings, in order to ensure consistency among all CEN standards required to calculate the energy performance of buildings according to the EPBD (2010/31/EU).

The NewTREND energy use KPIs are calculated with the use of IES VE software. The NewTREND cost KPIs and the Global Warming Potential KPI use the output of the energy calculations as an input for their calculation formula. Therefore, these methods are analysed together in the following.

Comparison of energy and cost KPI calculations

The analysis of the financial instruments shows that they use different type of energy use calculation methods. The type of operational energy use / cost calculation methods in incentives are listed in the following:

- Based on the EPBD
- ASHRAE 90.2
- Energy audits
- Energy Star
- Monitoring data
- Custom guidelines

EPBD BASED CALCULATION

The main legislative instrument to calculate energy savings in the building sector of the European Union is the Energy Performance of Buildings Directive (EPBD - Directive 2010/31/EU) and its supplements. This

directive is closely supported and complemented by other Directives: Energy Efficiency Directive, Renewables Directives and Ecodesign and Labelling Directive.

In 2012, the comparative methodology framework for calculating cost-optimal levels of minimum energy performance requirements for buildings and building elements has been published. The regulation specifies rules for the following:

- comparing energy efficiency measures
- incorporating renewable energy sources
- calculation based on the primary energy performance and the cost attributed to the implementation of measures
- rules for identifying cost-optimal levels of minimum energy performance requirements. [65]

The energy performance of variants needs to be calculated following CEN standards or national standards. CEN technical report TR 15615 (Umbrella Document) gives the general relationship between the EPBD Directive and the European energy standards. Standard EN 15603:2008 provides the overall scheme for energy calculation.

The collected financial instruments use the national variants of the general energy efficiency framework. The current minimum performance calculations for new buildings are based on a national calculation method that follows the main principles of CEN standards. These instruments are mainly from the following countries:

- Germany (Standard Kfw Effizienzhaus)
- Hungary (7/2006 TNM rendelet)
- Finland

The EPBD based calculation method has the same legislative basis as the NewTREND calculation methodology. The calculation processes of the member states do not require dynamic energy simulation based calculations, they can use simplified methods.

ASHRAE 90.2

The ASHRAE 90.1 standard is developed by the American Society of Heating, Refrigerating and Air-Conditioning Engineers. The standard provides Standard Energy Procedures for Rating Efficiency of an entire building. It states minimum requirements for the energy efficient design of buildings as well as Performance Rating Method (PRM), G, which is used in rating the building designs that exceed the minimum requirements of the standard. The general principle of the PRM rating is to compare cost or energy consumption of the proposed design to the baseline that satisfies the minimum standard requirement. The Performance Rating Method includes the total energy consumption of all end uses. The standard allows for variations in Climate, Building Sizes, Building Types, HVAC systems.

The performance is calculated by using detailed dynamic simulation programs. The baseline design is used to determine the specific proposed building's energy performance rating, typically expressed as the percentage of improvement in total energy cost in comparison to the design base benchmark value.

Supportive financial instrument name	Country	Instrument type	Target	Promoter-funder

Section 179d (Green Building Tax Deduction)	USA	One-time depreciation deduction	Residential or commercial buildings	Department of Energy (DOE)
Commercial and Industrial New Construction Program	Canada	Loan	Commercial and industrial buildings	Efficiency Nova Scotia - Provincial government agency
Commercial New Construction Program	Canada	Financial Incentive	Commercial and multi-unit residential buildings (new construction)	BC Hydro

TABLE 30: USE OF ASHRAE 90.1 STANDARD FOR PERFORMANCE CALCULATIONS

Table 30 shows that the ASHRAE 90.1 standard is widely used in instruments targeting the building sector of the US and Canada. It is used for various types of instruments who target multiple building types.

The ASHRAE 90.1 based calculation is similar to the NewTREND method in the use of dynamic energy simulation software. However, while the ASHRAE method defines energy use reduction compared to a reference building with predefined materials and systems, the NewTREND method defines the baseline as the actual existing building.

ENERGY STAR

The Energy Star rating is mainly used in the US and Canada. The performance standard has different paths to rate buildings for the different building types:

- Residential buildings
- Non-residential existing buildings
- Non-residential new buildings

For residential buildings, the ENERGY STAR certification can be obtained through a prescriptive or a performance path. The Prescriptive Path provides a single set of measures that can be used to construct an ENERGY STAR certified home. Energy simulation is not required. The Performance Path provides flexibility to select a custom combination of measures for each home. Equivalent performance is assessed through energy modelling. Energy modelling should be conducted using a RESNET-accredited Home Energy Rating software.

Existing non-residential (commercial and industrial) buildings can use the ENERGY STAR Portfolio Manager to upload the measured (monthly) energy / water consumption data. If the building performs among the top 25 percent of similar buildings nationwide the building earns the ENERGY STAR certification.

New non-residential building should use the third-party modelling path. The expected building performance can be compared to the existing building performance database and earn ENEGY STAR rating.[66]

Supportive financial instrument name	Country	Instrument type	Target	Promoter-funder
Residential Energy Efficiency Tax Credits	USA	Tax credit	Residential buildings	Department of Energy (DOE)
PACE Financing	USA	Loan guarantee	Residential and commercial buildings	Department of Energy (DOE)

Energy Efficient Mortgages	USA	Loan guarantee	Residential buildings	Department of Housing and Urban Development
Federal Buildings Initiative (FBI)	Canada	ESCO	Public buildings	Natural Resources Canada's Office of Energy Efficiency
CMHC Green Home	Canada	Mortgage loan insurance premium refund.	Residential buildings (homeowners)	Canada Mortgage and Housing Corporation (CMHC)

TABLE 31: USE OF ENERGY STAR FOR PERFORMANCE CALCULATIONS

Table 31 shows the financial instruments using ENEGY STAR for performance measurements. It is used for various types of instruments who target multiple building types.

The ENERGY STAR performance path uses measured data or simulated data similarly to NewTREND advanced or premium modes. The benchmarking of the measure is different, as it compares a building to a sector-wide average performance.

MONITORING DATA

Actual building energy use data and actual cost data is also used by several financial instruments. These instruments are mainly taxes or demand response programs where the already operating building receives funs or pay taxes based on their previous performance.

The data requirements of these mechanisms are similar to those of NewTREND premium mode energy and cost KPIs. The difference is that NewTREND converts the data to primary energy use, but the taxes and demand response programs use energy end use data.

Supportive financial instrument name	Country	Instrument type	Target	Promoter-funder
FIT (feed-in tariffs)	UK	Subsidized feed-in tariffs	The FIT scheme is available for anyone who has installed, or is looking to install, one of the following technology types up to a capacity of 5MW, or 2kW for CHP: • Solar photovoltaic (solar PV) • Wind • Micro combined heat and power • Hydro Anaerobic digestion (AD)	Office of Gas and Electricity Markets
Salix Project	UK	Subsidized loan	non-residential existing buildings	Salix Finance Ltd
Climate Change Levy	UK	Tax	non-residential sector	HM Revenue and Customs
Fortum Fikso	Finland	Demand Response Mechanism	utility consumers	
Enel Info/Info+	Italy	Demand Response Mechanism	residential and small commercial users	

White certificate	Spain	Tax	obligated parties are the suppliers of electricity and natural gas, and wholesale retailers of oil products and LPG	
Interruptible Service	Spain	Demand Response Mechanism	Large commercial and industrial buildings.	

TABLE 32: USE OF MONITORING DATA FOR PERFORMANCE CALCULATIONS

ENERGY AUDITS

Incentive programs from the US and Canada also determine building performance through energy audits. These performance measurements are used only for existing buildings for several building types. The use of an established energy use calculation method is the responsibility of the energy auditor who collect all necessary data and determines the building performance and later suggests refurbishment options. By contrast, the NewTREND calculation method provides an automated calculation process.

Supportive financial instrument name	Country	Instrument type	Target	Promoter-funder
Federal Energy Management Program: Energy Savings Performance Contracts (ESPCs) for Federal Agencies	USA	Public/private partnership: contracts with ESCOs	Existing Federal Buildings	Environmental Protection Agency (EPA)
Home Energy Assessment Program	Canada	Low-interest loan	Residential buildings (homeowners)	Efficiency Nova Scotia - Provincial government agency
Commercial Energy Audit Program	Canada	Financial support	Commercial, institutional and multi-unit residential buildings	Efficiency PEI (Price Edward Islands) - Provincial government agency

TABLE 33: USE OF ENERGY AUDITS AS PERFORMANCE CALCULATIONS

CUSTOM GUIDELINES

Several incentive programs differ from the international standards when determining building performance. These instruments developed custom procedures to assess the current the energy use or energy costs of the buildings and predict the effects of the retrofitting measures. Two main type of custom procedures can be discovered among the collected instruments:

- Custom guideline, spreadsheets: these instruments provide a guideline about how to assess the performance of the building or a spreadsheet to fill with the required data.

- Recommendation by accredited expert: these instruments require an assessor, often with a third-party accreditation to perform the necessary measurements, calculations to determine the building performance

These custom procedures largely differ from the NewTREND methodology as they either require expert assessment or filling an often simplified custom guide or spreadsheet.

Supportive financial instrument name	Country	Instrument type	Target	Promoter-funder	Performance measure calculation method
Ontario saveONenergy: Retrofit Program	Canada	Financial Incentive	Commercial buildings	Independent Electricity System Operator (IESO)	custom spreadsheet Energy use calculation: Measurement and Verification (M&V) Procedures shall be consistent with one of the method from IPMVP Protocol: A) Engineering calculations B) Metering and monitoring C) Utility bill analysis D) Computer simulation models
Quebec Implementation Incentive for Energy Efficiency Measures for Gas (GazMétro)	Canada	co-financing	institutional, industrial and commercial sector	Gaz Métro	Recommendation by accredited expert
Custom Business Efficiency Program	Canada	Rebate	Commercial/ institutional/ industrial buildings	FortisBC - Electricity - For Business & Industry	Recommendation by accredited expert
British Columbia Energy Distribution Project Incentives	Canada	co-financing	Industrial districts /residential districts	BC Hydro	Recommendation by accredited expert
RHI (Domestic renewable heat incentive)	UK	Governmental grant	Residential buildings	Office of Gas and Electricity Markets	Custom guideline, spreadsheets
Carbon Pricing Mechanism	Australia	Tax	Commercial; industrial	Department of the Environment	Custom guideline, spreadsheets
Clean Energy Finance Corporation (CEFC)	Australia	Government fund	multi-sectoral	Clean Energy Finance Corporation	Custom guideline, spreadsheets

TABLE 34: USE OF CUSTOM GUIDELINES IN PERFORMANCE CALULATIONS

Comparison of comfort KPI calculation

The comfort KPIs calculations inputs are based on custom modules integrated into IES software, specifically developed for NewTREND. Their formula and benchmarks are specified according to EN 15251:2007 Indoor environmental input parameters for design and assessment of energy performance of buildings addressing indoor air quality, thermal environment, lighting and acoustics.

The analysed financial instruments rarely incentivize interventions targeting comfort improvements. One of the 5 instruments that do cover comfort, uses Protocollo ITACA for performance standard. This rating scheme includes comfort related KPIs, which are further detailed in Chapter 744.1.1. Other instruments defined a list of accepted interventions to improve comfort that can be incentivized. For example, the Affordable Warmth Scheme from the UK defined a list of interventions for low income housing to improve energy efficiency and to reach minimum comfort levels in residential buildings.

4. RATING SCHEMES

Certification systems are quantitative standards to measure the concept of sustainable development in any region. By defining a set of criteria and a rating system to score them, these schemes assess projects during a specific process, but all of them have a specific tool for assessing and measuring sustainability.

On the international scene, there are several types of rating schemes and many of these are based on the evaluation of sustainability across design, construction and operation of infrastructure. Sustainability evaluation includes environmental, social, economic and governance aspects of projects and assets. Rating schemes usually aims to support decisions to deliver enhanced environmental and social benefits for civil engineering works and better economic outcomes that benefit society. In general, rating schemes can be used as part of the initiation and development phase of project planning to incorporate sustainability considerations and outcomes into the overall project phases.

Rating schemes may be associated with an economic Incentive, and these incentives could be different in the amount of financial contribution, in the method of the delivery, in the accessing conditions, etc. Beneficiaries are those receiving the grants and also responsible for the application of the rating scheme. Usually the support is granted on the basis of the type of project and the achieved score. Economic incentives are grants disbursed by one party (often a government/public institution, corporation or foundation/trust), to a recipient (a non-profit entity, a public institution, a business or an individual/consortium). Incentives can be arranged to serve a very specific purpose through a one-off targeted project and provided by municipalities, regions and by government agency level for smaller projects. In order to receive a grant related to a rating scheme, the application of an assessment tool is required. It is also important to underline that not all project types are eligible for receiving the incentives.

A large number of high performance buildings can act as a driver to push also the market toward a better sustainability. But to reach effective and real results, an incentive based program requesting high environmental and energy performances needs to be supported by adequate tools and training. For this reason, the implementation of an integrated process to support the design and construction of high performance buildings is fundamental. This process should include assessment tools/criteria catalogues, hotline, website, training, observatories.

The benefits of applying a rating scheme with a sustainable assessment tool, which allows to obtain economic incentives as part of project evaluation could be:

- An efficient use of environmental resources and consequently a reduction of costs;
- An improvement of the sustainability performance of the buildings over their lifecycle;
- A broader engagement across project's team to get better performance and so more financial support from economic incentives;
- To improve the capacity to make better decision and so to deliver more sustainable outcomes;
- To enhance the understanding of the importance of sustainability.

In the construction field, there has been a growing movement towards sustainable construction since the second half of the 1980s, leading to the development of various methods for evaluating the environmental performance of buildings.

In urban planning, the interest in the criteria of sustainability of energy and environment is relatively recent, since recent are scientific approaches to coding procedures and parameters. In the building sector instead, coexist different protocols (BREEAM, LEED, CASBEE, GBC, HEQ, ITACA, CASACLIMA) well-

established, based on a series of indicators that allow to control the entire building process, from the supply of building construction materials, to their disposal and / or reuse at the end of the life cycle assessment (LCA), including maintenance and in use phase, with relative energy consumption and consequent pollutant emissions.

It is quite obvious how essential and indispensable is the alignment between architectural design and sustainable urban planning. It is important to be aware of the importance of developing it as an assessment tool for the environmental performance of groups of buildings, not just for individual buildings.

In the international scene, there are a lot of building sustainability assessment systems that use metrics that evaluate the performance of a so-called "green building". I “Green” Buildings are high performance structures that also meet certain standards for reducing natural resource consumption, these buildings are characterized by an efficient management of energy and water resources, a management of material resources and waste, a protection of health and indoor environmental quality and an analysis of the life cycle costs and benefits of materials and methods. So, Green standards measure different environmental qualities of buildings.

A comparative approach between different rating systems and sustainable building certification systems is not simple because Each of these systems has its own core set of indicators, a different weighing method, and a final score expressed differently for each.

Below the main current green building certification systems:

• BREEAM CERTIFICATION – GB, (BRE Environmental Assessment Method) Communities developed by the Building Research Establishment that is a centre of excellence based in Britain, consisting of experts in the fields of construction, energy, environment, security and fire. This rating scheme is the leading and most widely used environmental assessment method for buildings. It is in fact one of the first sustainability evaluation systems set up, born in 1990, beyond the concept of energy certification and takes into consideration also environmental aspects.

• LEED CERTIFICATION – USA, LEED Green Building Rating System is a voluntary protocol that collects standards for the development of sustainable energy-efficient buildings. Members of the United States Green Building Council are representative of all segments of the construction industry and working for innovation and development. Developed in 1998, it takes a step forward with respect to social issues so far neglected.

• CASBEE CERTIFICATION – JAPAN, (Comprehensive Assessment System for Building Environmental Efficiency) is a method for evaluating and rating the environmental performance of the building. Japan Sustainable Building Consortium (JSBC, with the Institute for Building Environment and Energy Conservation as secretariat) was established in April 2001, with the support of the Ministry of Land, Infrastructure and Transport. Since then it has been working on the research and development of CASBEE as a joint project between government, industry and academia. In evaluating building environmental performance, CASBEE examines both the environmental quality and the environmental load on the exterior.

• HQE - FRANCE, (Haute Qualité Environnemental), is the French certification awarded to building construction and management as well as urban planning projects, it puts energy efficiency, respect for the environment, and the health and comfort of occupiers first. It was born in 2002 and covers the entire

lifecycle of a building (construction, renovation and operation); it adds value to certified buildings thanks to the ability to issue certificates worldwide by combining generic and specific criteria and common indicators, and also having technical schemes that cover all categories of non-residential buildings.

• PROTOCOLLO ITACA - ITALY, the Italian "Institute for Innovation and Transparency in Procurement and Environmental Compatibility", launched its certification system in 2002. The main goal was to encourage sustainability of buildings promoting a scoring system to allow setting purposes and measurable objectives in public policies and programs. The name of this rating scheme is Protocollo ITACA.

• DGNB – GERMANY, (Deutsche Gesellschaft für Nachhaltiges Bauen), more recent than the previous one since it was born in 2008. It has as an added value the introduction of criteria related to economic aspects. The DGNB System covers all of the key aspects of sustainable building: environmental, economic, sociocultural and functional aspects, technology, processes and site and the assessments are always based on the entire life cycle of a building. The first four quality sections have equal weight in the assessment. This means that the DGNB System is the only one that gives as much importance to the economic aspect of sustainable building as it does to the ecological criteria.

As described above, the existing rating schemes present in the European context are very diverse and all present unique characteristics. In this extensive scenery, the analysis of rating schemes has focused on the Italian, French and Austrian cases as all based on similar incentive policies and similarly structured environmental performance assessment systems. All chosen rating schemes address the challenge to evaluate buildings through the application of an assessment tool concerning environmental, economic and social aspects. For each scheme, the analysis consists of a brief description, financial incentives that adopt them, a demonstration of how the rating scheme quantifies the impact of incentives, and finally, correspondence to NewTREND key performance indicators.

Also, all the following rating schemes analysed ensure that economic incentives can be obtained through the application of an assessment tool based on the achieved scores.

4.1. RATING SCHEMES IN THE ITALIAN CONTEXT

Concerning Italian rating schemes, "Protocollo ITACA" and "Biover2" have been analysed according to their basic principles and in their own origin Region. The first was developed in Piedmont Region but rapidly expanded its interests also in many other regions, while the second one has spread in Veneto Region and it is consistent with the Protocollo ITACA.

In the Italian territory, there are many other rating systems but they are not connected with an economic incentive, as the official system of the Italian Regions, Protocollo ITACA is strongly focused on a broad assessment base, aiming at the widest application possible of the performance assessment approach in the everyday practice of designers and developers. It's based on the mass orientation principles.

4.1.1. PROTOCOLLO ITACA – PIEDMONT REGION

NAME OF THE RATING SCHEME	***Protocollo ITACA***
REGIONAL APPLICATION	*Piedmont Region (Italy)*
RELATED INCENTIVES PROGRAMS	*"Programma Casa", "Contratti di Quartiere" and "PRUACS" Incentives Programs*
IN USE AT THIS MOMENT	*In use*

RELATED GRANTS AT THIS MOMENT	*Already finished: "Programma Casa", "Contratti di Quartiere" and "PRUACS" Incentives Programs* *Active: "POR- F.E.S.R. 2014-2020" the Regional operational programme about competitiveness and employment objective*
RELATED NATIONAL/REGIONAL LAW	*Based on National and Regional Law*
TYPE OF BUILDINGS TO BE APPLIED ON	*Residential buildings, non-residential buildings (schools, offices, commercial and industrial buildings).)*
DIFFICULTY OF THE ASSESSMENT	*Medium difficulty for the calculation of energetic criteria.*

TABLE 35: SYNTHETIC SCHEME WITH KEY INFORMATION ABOUT PROTOCOLLO ITACA

In 2001, ITACA, the "Institute for Innovation and Transparency in Procurement and Environmental Compatibility", launched an interregional working group on green building to develop the tools needed to make regional policies more sustainable in sustainable construction.

The main goal was to develop a scoring system to allow to set purposes and measurable objectives in public policies and programs, to encourage sustainability of buildings.

The international tool called SBTool, promoted by the non-profit organization iiSBE (International Initiatives for a Sustainable Built Environment) and developed under the Green Building Challenge, has been adopted as a scientific reference for the development of the ITACA Protocol Assessment System. The basic principle of SBTool is to share a common methodology and indicators safeguarding, at the same time, the possibility of contextualizing the assessment tools to reflect their priorities and characteristics.

The first version of the ITACA Protocol was produced by the Piedmont Region and published in 2003 in response to the previous call for applications for urban redevelopment programs called "*Contratti di Quartiere*".

The official version of the ITACA Protocol for Residential Buildings was then approved on 15 January 2004 by the Conference of Regions and Autonomous Provinces. Subsequently, the Protocol was adopted by numerous Regions and other public administrations and used in policies, building codes, procurement, urban planning, etc. In 2009 the Piedmont Region published an updated version of the ITACA Regional Protocol, composed of criteria aligned with the national version of the ITACA protocol and published, first, the version of ITACA Protocol for School Buildings (2007), Commercial Buildings (2010), High Buildings (2011) and Service Stations (2015).

The Piedmont Region Protocols have subsequently become ITACA's assets which adopted and published them as National Protocol. Through the CABEE project, Piedmont Region has developed the first pilot version of the ITACA Protocol for Buildings in use and for urban areas (clusters). The latter was awarded to ITACA for the adoption at national level and in 2016 ITACA Protocol at Urban Scale was published.

ITACA protocol is an assessment tool, based on the methodology SBTool of iiSBE, whose purpose is the classification of the performance of a building.

The end result is a score, a kind of "scoreboard", which indicates the level of sustainability of construction as an increase compared to current practice. The latter is defined by assigning weights to criteria and benchmarks for the regulations and technical standards in force. The ITACA Piedmont Region Protocol is

in fact contextualized with respect to the Piedmont context and aligned with the regulations and standards of the region.

The weighing system is nothing more than the aggregation through criteria, categories that arise following normalization of the scores. in particular, after the normalization step, a new set of data is available, composed of the normalized scores associated with each criterion. Scores are then combined to produce the final score, and this is done in three steps:

• Aggregation through criteria: normalized scores associated with all criteria in the same category are aggregated to produce a single score for each category. Aggregation is performed by linear aggregation of data through some coefficients, called weighting factors, these quantify the relative weight of each criterion with respect to all criteria in the same category. It follows that can be interpreted as a weighted sum of the performance score obtained by the building in regard of each criterion, so the performance score computed for a given category represents the urban area average performance with respect to all criteria included in that category. The result of aggregation through criteria is a set of normalized scores, each of them corresponding to a category.

• Aggregation through categories: normalized score associated with categories in the same issue (these resulting from aggregation through criteria) are further aggregated to produce a single score for each issue.

• Aggregation through issues: normalized scores associated with issues (these resulting from aggregation through categories) are aggregated to produce the final concise score.

In this way, the weights and therefore the relative importance of the system's criteria, are defined. In order to carry out the assessment of the final score of a building, the SBMethod should take shape in a tool that is its operative realization and it is called SBTool. Each criterion receives a score from -1 to 5, where zero is the standard performance and the best practice is 3. Scores obtained for each aspect evaluated are then aggregated through a weighed sum to define a single final total score, also expressed on the scale from -1 to +5. So, a building that gets a zero rating on all criteria is conceptually a standard building (benchmark) where the current regulatory limits have been respected. If design is advanced in terms of sustainability, the level gained will increase positively towards a practice of excellence (5 points).

The protocol is organized into five areas of assessment: Site Quality, Resource Consumption, Environmental Load, Indoor Environmental Quality and Quality of Service. The criteria of ITACA Protocol cover themes ranging from the environment (energy, resources, impacts) and society (comfort, safety, usability). The third sustainability pillar, economy, is not explicitly covered, although some criteria have direct financial impact, such as heating energy efficiency (reducing operational costs in winter), passive performance in summer (reducing cooling costs) and the use of renewable energy.

The building is always analysed by comparing to all the major environmental issues: energy, water, materials, impact on the site, comfort, efficiency. Depending on the performance achieved for each criterion, the construction receives a score from -1 to 5. The zero value is the "benchmark", representing standard performance, level 3 represents the best current practice, the 5th the excellence. The scores obtained are aggregated to determine the overall score, also from -1 to +5.

A specific rating also allows evaluating the quality of the localization. The complexity of the evaluation process depends mainly on the nature of the building and its intended use. The system guarantees the objectivity of the evaluation, using indicators and validated verification methods. Specific design

strategies and solutions are not required, but the quality of construction is analysed in terms of performance. ITACA Protocol is strongly focused on user experience. While resources and impact criteria have their strongest impact on the environment (and are therefore only remotely relevant to the users, unless they have a very strong ethical preference for sustainability), the energy criteria add to the environmental impacts and positive effect on overall energy consumption a relevant improvement on heating and cooling costs, and on comfort both in winter and summer. Furthermore, the assessment system devotes two categories to the users' experience, dealing with the quality of the indoor environment and the service.

Protocollo ITACA is strongly focused on a broad assessment base, aiming at the widest application possible of the performance assessment approach in the everyday practice of designers and developers. The ITACA workgroup gives high relevance to the applicability of criteria and ease of use for technical experts, including the seamless introduction of the assessment in existing project development workflows. To achieve mass adoption of the system, Protocollo ITACA tends towards simplicity of use. The indicators are already part of the skillset of architects and building engineers, with a short course recommended to achieve full confidence in the assessment methodology.

Protocollo ITACA it's an open source protocol, all versions of the assessment system are freely available online for download, both on the ITACA website and on the dedicated sections of Regions. As said before, the indicators used in Protocollo ITACA derive from the international assessment tool SBTool, based on the SBMethod developed by iiSBE since 1996, which is itself open source and free to use for non-commercial applications. The key indicators have been studied for decades and shared among systems all over the world, and are constantly revised to ensure comparability across assessment systems. SBEMethod is a generic multi-criteria analysis methodology for assessing the sustainability of the built environment. Starting from a set of assessment entries (called criteria), SBMethod provides a final concise score about a building, urban area or territory overall performance.

The main elements of the SBMethod can be summarized in a set of assessment entries, called criteria, a set of physical quantities, called indicators, which allow to quantify performances with respect to each criterion, a normalization method (described before) and an aggregation method (described before).

The SBMethod is organized in issues, categories and criteria. Issues describe general themes, recognized as relevant for assessing the sustainability of a building. Categories concern particular aspects of issues. Criteria detail specific aspects of categories and represent the basic assessment entries used to characterize buildings since the very beginning of the assessment process. The main goal of the SBMethod is to provide a final concise score, which summarizes the overall performance of the building with respect to all criteria. Such a score is called 'final score', and is computed starting from indicator values. The mathematical procedure used to compute the final score is called assessment procedure, and is articulated in three main steps: the characterization, the normalization and the aggregation.

The output of the characterization step is composed by a set of numerical values (the indicators' values), each of them representing the building's performances in regard to each criterion. Indicators' values are rescaled in a suitable interval called normalization interval. The output of the normalization step is represented by a set of normalized scores, each of them is associated with a criterion. Normalized scores are combined together (or aggregated) in order to compute the overall performance score.

WHERE THE RATING SCHEME IS USED: REGIONAL CONTEXT

Protocollo ITACA was born in Piedmont Region but it's today present and developed for their s regional versions in Marche, Puglia, Umbria, Piemonte, Valle d'Aosta, Friuli Venezia Giulia, Lazio, Basilicata and Calabria as well[67].

Protocollo ITACA is fully contextualized to the standards and laws in force in Italy, and is updated according to policy evolutions. Furthermore, in its capacity as a framework for assessment in different areas, it has been modified and adapted according to the context of various Italian regions, while maintaining the recognizable structure and key performance indicators.

INCENTIVES PROGRAMS RELATED TO THE RATING SCHEME

In 2006, Piedmont Region launched a six-year social housing funding program, called "Programma Casa 10.000 alloggi per il 2012" (Housing programme: 10.000 apartments for 2012), to support a wider access to housing for the population. Participants were required to evaluate their project using the sustainability assessment system Protocollo ITACA. On the scale from -1 to 5, new constructions were required a mandatory score of 2, while retrofitting projects were required a minimum score of 1.

The program further included an extensive and rigorous process of external technical review carried out by iiSBE Italia, tasked as validators of the assessment developed by the experts and designers working with the developers requesting the funding. The validation process included a review of the assessment in the design phase and of any necessary revisions during the construction phase, and a construction monitoring activity, to verify the adherence of the construction works to those elements which had been declared in the sustainability assessment. A large number of buildings were assessed through Protocollo ITACA because this program had a high participation[68]. The plans and the programs set criteria and timing for the implementation of the interventions, the identification of the actuators and the allocation of contributions. The innovative measures of the "Programma Casa", generate projects and actions to respond to the needs of the weakest bands of society, such as young people, elderly and economically vulnerable people. From the analysis of the interventions financed with the first biennia, it has disclosed as they are characterized by the application of design solutions aimed at reducing energy consumption, environmental resources and the use of renewable sources.

The number of interventions concluded and validated with the ITACA Protocol was 132. Thirty were concerned with the renovation, while the remaining 102 were new construction works and actuators are private and public. This phase was mainly about projects of facilitated construction, experimental and subsidized facilitation.

Another important funding program for the environmental and social restoration of large parts of the urban territory, especially with regards to affordable and social housing was called "Contratti di Quartiere"[69], born after the Law 8 February 2001, n°21. Call for tenders for urban regeneration projects, was co-financed by the Italian Department of Infrastructures and Transport and co-financed and managed by each regional government.

Total financing was € 694.460.000, the sources of funding are:

- Italian Department of Infrastructures and Transport and Piedmont Region: € 117.986.483,76 (17% of total financing, 65% from central government and 35% from regional government)
- Municipalities € 113.693.295,80 (16% of total financing)
- Private funding € 375.399.658,59 (55% of total financing)
- Other public funding €. 86.156.575,03 (12% of total financing).

The total financing is divided into different types of intervention:

- Housing 49%
- Secondary infrastructures (schools, public buildings, etc) 18%
- Primary infrastructures (streets, networks, etc) 13%
- Offices & Retail 11%
- Actions & Services 9%

The funding program has envisaged the promotion of innovative urban programs aimed at increasing, with the participation of private investment, the infrastructure of municipalities with strong housing and employment disadvantages. Programs should also include measures and interventions to increase employment, to promote social integration and adaptation of housing supply.

The *Contratti di Quartiere* were located in several Turin municipalities; the typologies of intervention concerned the facilitated construction, subsidized housing and primary and secondary urbanization works, while the involved operators were both private (Building Cooperatives and Construction Companies) and Public (Territorial Agencies for Home and Municipalities). This experience has enabled for the first time the construction of a large number of social building buildings with high environmental energy quality and has created the basis for the adoption of the ITACA Protocol as a reference point for funding programs. Piedmont Region was the first in Italy to have included a score rating tool within an urban recovery plan. It was a very important step because it has gone from qualitative objectives, to the indication of quantitative and measurable objectives. This has made sustainability requirements much more effective and verifiable.

Another important incentive program related with the Protocollo ITACA in Piedmont Region is known as "PRUACS" which stands for Redevelopment Urban Programs for Sustainable fee Accommodations which started with Ministerial Decree 2295 (26 mar 2008). PRUACS are programs for the environmental and social restoration of large parts of urban territory, especially with regards to affordable and social housing. State and regional funding, overall intended for this purpose, was about 32 million euros. The proposals submitted by the Municipalities were eleven and the ones eligible for funding were seven. PRUACS referred to the ITACA Piedmont Region Protocol updated in 2009.

The Protocol is a particularly important tool since, considering state and regional legislation on environmental sustainability and energy efficiency in construction, it is contextualized to Piedmont realities. The sources of funding are:

- Italian Department of Infrastructures and Transport and Piedmont Region: € 31.667.657,42 (44% of total financing, 70% from central government and 30% from regional government)
- Municipalities € 12.301.522,13 (17% of total financing)
- Private funding € 15.919.616,88 (22% of total financing)
- Other public funding €. 12.301.522,13 (17% of total financing)

The Total financing is € 72.361.894,91.

The breakdown of financing for types of intervention are:

- Private residential: 167 dwellings - Private investment in residential: €. 15.675.272,17

- Social housing: 152 dwellings - Central-regional government financing for social housing: € 16.101.471,42 (12% of which for sustainability testing and extra costs) - Central-regional government financing for infrastructures: € 15.566.105,66

Related Economic Incentives

In the funding program called "Programma Casa 10.000 alloggi per il 2012", the developers would receive 5.000 € in funding for each apartment, as recognition of extra costs required to implement sustainability principles and performances in the design. Furthermore, the achievement of a higher performance (2,5 for new buildings and 1,5 for retrofitting) was rewarded with an additional 5.000 € per apartment, bringing the funding to a total of 10.000 € per apartment[70].

In the funding program called "Contratti di Quartiere", the incentive mechanism was quite simple; programs were selected and financed based on a series of indicators: Environmental, Social and Economic sustainability. For the last one, the minimum criteria to participate to the call was: Housing covered at least 60% by central-regional government financing, Infrastructures covered at most 40% by central-regional government financing, Municipalities financing at least 10% of quota of central-regional government financing, Environmental sustainability testing for housing, no less than 20% and no more than 25% of the central-regional government financing, and maxed at 12.500 € per dwelling.

The notice for the funding program Contratti di Quartiere contained the first version of the ITACA Piedmont Region Protocol for residential buildings, according to the score obtained through the Protocol, social construction workers were able to receive a bonus of up to € 12,000 per accommodation. This was the first time that the social housing operators have managed the process of construction of a building with the aim of achieving a high standard of sustainability.

The notice has required the application of the ITACA Protocol on each building in the urban area covered by the Contratti di Quartiere. An overall value of the ITACA Protocol was subsequently calculated by operating a weighted average compared to the surfaces of individual buildings of scores obtained at the individual building level.

Relation between incentives, performances and score

The analysis of the program called "Programma Casa 10.000 alloggi per il 2012" (Housing program: 10.000 apartments for 2012) has homogeneous data because concerns 100 projects that have been assessed in the 2010-2012 period by using the Protocollo ITACA 2009 Piedmont Region version.

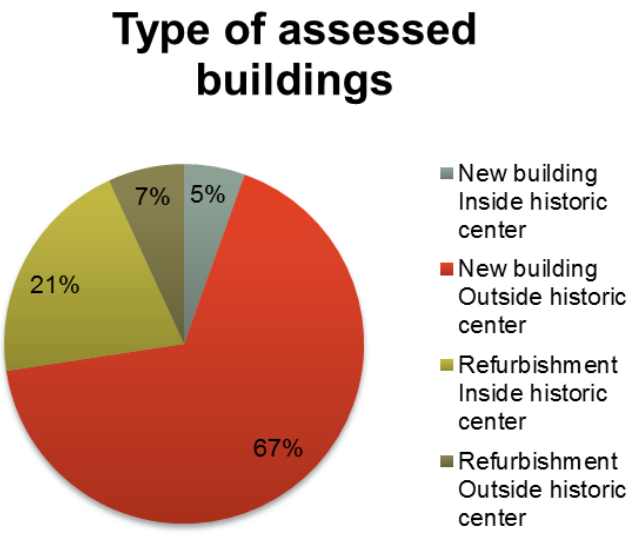


FIGURE 5: TYPES OF BUILDINGS ASSESSED WITH PROTOCOLLO ITCACA

The territorial impact of the program was high, with only 1/3 of the assessed buildings located in the Region capital (Torino) while the others were in the 7 major cities (Province capitals).

It is interesting to highlight the fact that the application of the program on new construction (or integral substitution of existing buildings) was prevalent, with almost 3/4th of the cases and most of these projects were carried out outside of historic city centres. The average scores for new buildings was 2,2. Regarding retrofitting projects, the majority were carried out in historic centres and the average score for them was 1,9.

Following the assessment criteria of the ITACA Protocol Piedmont Region 2009 tool.

Protocollo ITACA Regione Piemonte 2009 – ASSESSMENT CRITERIA
1. Site quality
1.1 Site conditions
1.1.2 Level of site urbanization
2. Resource use
2.1 Non-renewable primary energy use during life cycle
2.1.2 Thermal transmittance of the building envelope
2.1.3 Net energy for heating
2.1.4 Primary energy for heating
2.1.5 Control of solar radiation
2.1.6 Thermal inertia of the building
2.1 Renewable energy
2.2.1 Thermal energy for Domestic Hot Water

2.2.2 Electric energy
2.3 Sustainable materials
2.3.1 Materials from renewable sources
2.3.2 Recycled/reused materials
2.4 Potable water
2.4.2 Potable water for indoor uses
3. Environmental loads
3.1 CO2 emissions
3.1.2 Emissions in operation phase
4. Indoor environmental quality
4.2 Thermal comfort
4.2.1 Air temperature
4.3 Visual comfort
4.3.1 Natural lighting
4.5 Electromagnetic pollution
4.5.1 ELF-EMF (50 Hertz)
5. Service quality
5.2 Performance in operation phase
5.2.1 Availability of technical documents of buildings
5.4 Home automation
5.4.1 Quality of cabling
5.4.2 Video control
5.4.3 Access control and safety
5.4.4 Systems integration

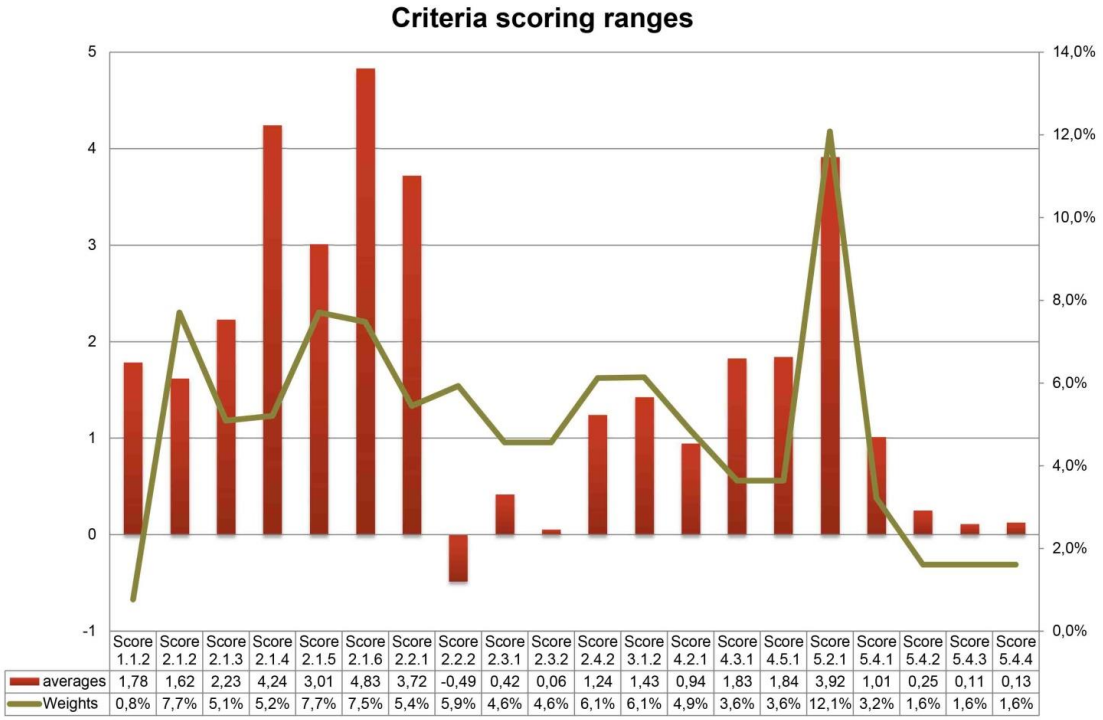
TABLE 36: PROTOCOLOO ITACA ASSESSMENT CRITERIA FOR PIEDMONT REGION IN 2009

The assessment areas analysis shows the most interesting results. In general, the main strategies for reducing energy consumption are due to the reduction of thermal transmittance of opaque and transparent structures and also the use of thick walls, characterized by high thermal inertia. In about 90% of the cases studied there was a widespread use of solar collectors for the production of hot water and photovoltaic panels for the production of electricity. The adopted mechanical systems solutions often involve the installation of centralized condensing boilers, often combined with radiant floors, in other cases instead of connecting to district heating and in a few other interventions to the use of geothermal plants. However, regardless of the solution adopted, the goal remains to reduce CO2 emissions in the air.

In terms of reducing drinking water consumption for indoor use, many of the analysed projects have included systems such as double-cot kettle taps, faucet aerators, which can save on drinking water. In order to reduce the consumption of outdoor drinking water, mainly used for irrigation, several projects have planned the installation of rainwater and wastewater recovery systems. Water, captured mainly by

the roof surfaces, will be stored and purified by means of special filters that will allow it to be used both for irrigation and for filling the dual flush toilets.

Closely related to the theme of water is the topic of permeability of external areas. In the projects, they have tried to use high permeability pavements that do not minimize the interruption of natural water flows. Analysing the scores obtained, it is noted that the vertical bars show the individual scores (from -1 to 5) obtained by the Protocol criteria. These criteria are organized in five evaluation areas: Site Condition, Resource Consumption, Environmental Load, Indoor Environmental Quality and Quality of Service. The level of satisfaction of these criteria is verified through objective performance indicators.



	Score 1.1.2	Score 2.1.2	Score 2.1.3	Score 2.1.4	Score 2.1.5	Score 2.1.6	Score 2.2.1	Score 2.2.2	Score 2.3.1	Score 2.3.2	Score 2.4.2	Score 3.1.2	Score 4.2.1	Score 4.3.1	Score 4.5.1	Score 5.2.1	Score 5.4.1	Score 5.4.2	Score 5.4.3	Score 5.4.4
averages	1,78	1,62	2,23	4,24	3,01	4,83	3,72	-0,49	0,42	0,06	1,24	1,43	0,94	1,83	1,84	3,92	1,01	0,25	0,11	0,13
Weights	0,8%	7,7%	5,1%	5,2%	7,7%	7,5%	5,4%	5,9%	4,6%	4,6%	6,1%	6,1%	4,9%	3,6%	3,6%	12,1%	3,2%	1,6%	1,6%	1,6%

FIGURE 6: THE AVERAGE SCORES OF CRITERIA (RED BARS) AND THE RELATIVE IMPORTANCE OF EACH CRITERION (BROWN POLYLINE).

The energy criteria showed very high average values in those indicators derived directly from the energy certification, specifically regarding the performance of the envelope and the primary energy required for heating. However, the average absolute values were not particularly high when compared to the certification standards, which led to a revision of the assessment scales towards a stricter adherence to the energy certification levels.

On the other hand, the materials criteria (2.3.1 – 2.3.2) showed very low values, which strongly correlated to the low weight of the criteria in the system. A closer study revealed that the indicators, assessing the percentage of renewable or recycled materials, considered the material weight, which proved unfavourable for materials more expensive than standard construction materials. The indicators were therefore revised to calculate the volume percentage, and the weight in the system was adjusted to increase the relevance of the subject in the overall assessment. What attracts the attention is the negative value of Criterion 2.2.2 - "Electricity": the reason is the poor use of systems for the production of electricity from renewable sources.

Among the evaluation areas there is also the one that evaluates the quality of the site, as the sustainability of a construction cannot depart from its location and, consequently, from the location choice, favouring settlement choices that minimize the impact of construction. The average score reached for criterion 1.1.2 - " Level of site urbanization " is 1.78, this means that the projects involved areas with low urbanization (peripheral areas).

The assessment area represented by the "Environmental Loads", whose purpose is to assess the impact of a building on the surrounding environment by addressing the issue of CO2 emissions, has as its only criterion the 3.1.2 - " Emissions in operation phase ", which gets 1.43 points; this is not a good result in absolute terms but, despite that, compared to the other criteria it is however an element not ignored by design.

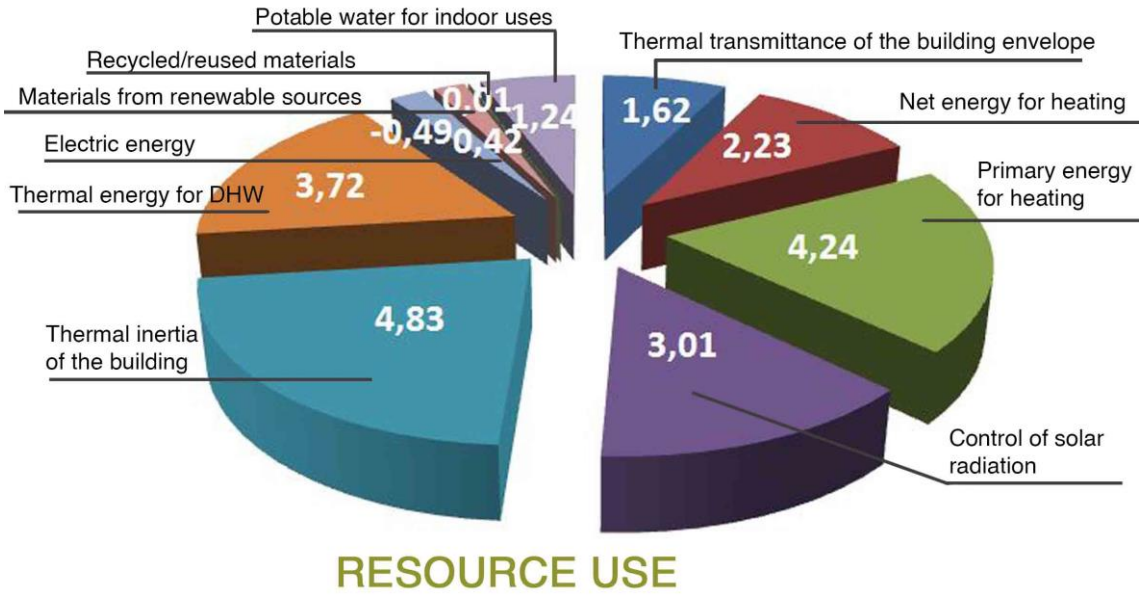


FIGURE 7. PIE CHART SHOWING THE PERCENTAGE DISTRIBUTION OF RESOURCE USE CRITERIA SCORES, SHOWING THE RELATIVE EFFORT OF DESIGN SPENT ON ASPECTS WITHIN IN RESOURCE USE.

Great importance has been addressed to the problems associated with the production of hot water, Criterion 2.2.1 - " Thermal energy for Domestic Hot Water " reaches the average score of 3.72, which has grown considerably (Figure 7). The installation of solar collectors has in this case favoured the reduction of energy consumption for the production of hot water through the use of solar energy. Minimizing the consumption of new raw materials is another of the indispensable elements of sustainability assessed by the ITACA Protocol. In fact, it is rewarded the reuse of existing structures, the use of reusable materials, recycled and/or recovered from renewable sources.

The results have not been particularly positive; neither Criterion 2.3.1 - " Materials from renewable sources " nor Criterion 2.3.2 - " Recycled/reused materials " exceeded the threshold of 1 point as the average value among the cases analysed, reaching values of the order of 0.4. Criterion 2.4.2 - " Potable water for indoor uses " keeps on discrete score values. The attention to the issue appears to be felt but the poor use of items, such as taps and low-water flushes, makes the performance decrease in terms of attention to the consumption of drinking water.

Surprising instead, the good average value achieved by Criterion 2.1.5 - "Control of solar radiation" equal to 3.01 points. In fact, the attention to solar radiation control has grown considerably. Its importance is not to be questioned as it allows to evaluate the efficiency of transparent building envelope elements and solar control systems to reduce solar inputs in the summer.

The following pie chart (Figure 8) shows the scores obtained in the "Indoor Environmental Quality" assessment area, which includes all measures to protect those who use buildings. The three criteria involved verify the level of comfort in indoor environments. The highest average score is obtained from Criterion 4.5.1 - "ELF-EMF (50 Hertz)" with 1.84 points. Through a performance scale, the presence of strategies in the electrical system for the reduction of exposure to electric and magnetic fields is evaluated. Criterion 4.3.1 also achieves a high score - " Natural lighting" that evaluates visual comfort in order to ensure adequate levels of natural illumination in all primary occupied spaces. The 1.83 value achieved shows that the average daylight factor has been considered by many of the projects analysed, so the visual welfare of users will be ensured.

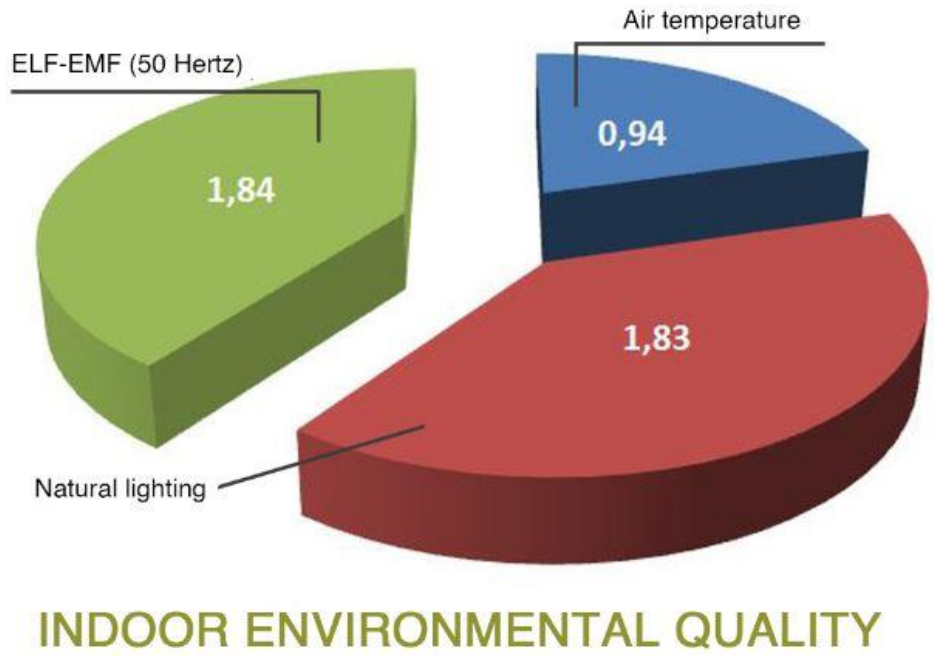


FIGURE 8: THE PERCENTAGE DISTRIBUTION OF INDOOR ENVIRONMENTAL QUALITY CRITERIA SCORES, SHOWING THE RELATIVE EFFORT OF DESIGN SPENT ON ASPECTS WITHIN INDOOR ENVIRONMENTAL QUALITY

Lastly, the score of Criterion 4.2.1 - "Air Temperature" has been considered, which got a score of 0.94. The indicator measures the heat exchange mode with the surfaces according to the type of distribution of the heating and cooling system, therefore if the score is not very high performing it may be due to the type of heating systems used. The need is to maintain a satisfactory level of thermal comfort while limiting energy consumption.

At the conclusion of the analysis, some considerations on the evaluation area represented by the "Quality of Service", Home automation, maintaining performance during operation and efficient maintenance, are the issues addressed in this area. A peak was found in the quality of service assessment area, specifically regarding the availability of technical documentation (5.2.1). In this case, high scores were easy to achieve, and the weight of the criterion was very high, leading a lot of assessors to rely on this criterion to increase

the overall score of the assessment. While the indicator itself was considered appropriate, the weight has been reduced to bring other criteria further to the attention of assessors[68].

FIGURE 9: PIE CHART SHOWING THE PERCENTAGE DISTRIBUTION OF SERVICE QUALITY CRITERIA SCORES, SHOWING THE RELATIVE EFFORT OF DESIGN SPENT ON ASPECTS WITHIN SERVICE QUALITY.

Less importance is given to the criteria for system integration, control and video control, probably because during the second biennia these instruments were not widely disseminated, as little known.

While Criterion 5.4.1 - " Quality of cabling " occupies an important slice of the pie chart, reaching an average value of 1.01. The indicator evaluates the presence and the characteristics of structured wiring in the common parts or housing through a performance scale to allow data transmission within the building for different purposes.

INTERCONNECTIONS WITH NEWTREND PROJECT

There is strong correspondence between many of the criteria of the ITACA Protocol and the key performance indicators of the NewTREND Project, some of them are exactly the same. The table below describes analogies and similitudes among criteria of this two assessment tools.

ITACA Protocol Criteria	NewTREND Criteria	Comparison
2.1 Renewable energy 2.2.1 Thermal energy for DHW 2.2.2 Electric energy	B.1.3 Renewable Energy on Site	In both cases, it's calculated by the ratio of on-site yearly production of renewable energy and yearly average of operational energy demand [%].
4. Indoor environmental quality 4.2 Thermal comfort 4.2.1 Air temperature	B.6 Thermal comfort	The criteria are similar, in the case of ITACA Protocol the objective is to maintain a satisfactory level of thermal comfort, limiting energy consumption and emissions. While, for NewTREND criteria, it is established a quality category (I-IV)

		according to EN 15251 assigned on CO2 concentration above outdoor [ppm].
4. Indoor environmental quality 4.3 Visual comfort 4.3.1 Natural lighting	Availability of Daylight Solar Access	In both cases the daylight factor is calculated. The solar access of NewTREND is the number of hours in which indoor environments receive natural light, is directly comparable with the Natural lighting of the ITACA Protocol.
2. Resource use 2.1.3 Net energy for heating	B.6.2 Thermal Comfort in Heating Season	NewTREND criterion is calculated according to ISO 7730, about thermal comfort standards while the criterion of ITACA Protocol is based on the verification compliance with the minimum thermal transmittance requirements of the existing legal framework at regional or national level (Legislative Decree 192/05 and Legislative Decree 311/06).

TABLE 37: COMPARISON OF PROTOCOLLO ITACA CRITERIA TO NEWTREND KEY PERFORMANCE INDICATORS

4.1.2. BIOVER2 – VENETO REGION

NAME OF THE RATING SCHEME	***BIOVER2***
REGIONAL APPLICATION	*Veneto Region (Italy)*
RELATED INCENTIVES PROGRAMS	*"Piano Casa" Incentive Program*
IN USE AT THIS MOMENT	*Yes*
RELATED GRANTs AT THIS MOMENT	*Yes, through the "Piano Casa" Incentive Program, until* al 31st December 2018
RELATED NATIONAL/REGIONAL LAW	*Based on the Regional Law 4/2007 "regional initiatives and measures for sustainable building"*
TYPE OF BUILDINGS TO BE APPLIED ON	*Residential buildings*
DIFFICULTY OF THE ASSESSMENT	*Medium difficulty for the calculation of some energetic criteria.*

TABLE 38: SYNTHETIC SCHEME WITH KEY INFORMATION ABOUT BIOVER2

The building evaluation system called BIOVER2 was born in Veneto Region for the mass certification of buildings, with the aim to assess their performance and to allocate public incentives for sustainable building by local administrations. This rating scheme has been defined in collaboration with the Veneto's Metadistretto of Bioedilizia sector and is consistent with the Protocollo ITACA. The Regional Law 4/2007, known as the "regional initiatives and measures for sustainable building", is the main reference for sustainable building in Veneto. This Law was developed by the Public Work section of the Region in collaboration with the Consortium for the Green Building. Thanks to this Law, the framework requirements for sustainable building in Veneto was defined, it was promoted its adoption by local administrations in their urban planning instruments and it was used for public aids, financial or volumetric incentives. After the approval of this Law, a regional certification system for buildings was defined; this rating scheme covers all the aspects of sustainability, criteria are linked to the environmental sustainability including energy and resources, some aspects linked to the social and economic sustainability with particular reference to the maintenance and operational costs of the building. Biover2 criteria evaluate

just the design phase and do not include the provision of user manuals or monitoring of the in-use phase that would be particularly important in the case of a regional certification process of public buildings.

The application of the scheme is greatly simplified. it does not require special software/tools nor any special expense, training, specialized equipment, nor intensive special training. Biover2 has a calculation tool that greatly simplifies collecting and elaborating the data needed for the evaluation. Special training on the implementation of the tool is available for designers, companies and technical public administration involved. Regarding the implementation of low carbon materials, a database of reference materials that allows the verification of this criterion is unfortunately too limited.

Regarding the operability aspects, it's quick to assess effectively (at most a couple of hours including collection of the information), it has a moderately time consuming for the evaluation but a highly time consuming to collect information and/or process to calculate the final score. Therefore, the rapidity of the evaluation basically depends on the quickness of retrieval of the data required for the calculation; it strongly depends on the type of data you are looking for and even by those who must provide it. A consolidated, accessible and up-to-date archive database reduces data acquisition times.

WHERE THE RATING SCHEME IS USED: REGIONAL CONTEXT

The building evaluation system BIOVER2 is used by the Veneto Region and by local administrations to allocate public incentives for sustainable building. Veneto Region has adopted, since 2007, a law for green building, called the 4/2007 that, combined with an assessment protocol, has awarded grants.

This protocol, defined in collaboration with the Veneto Metadistretto of Bioedilizia, is coherent with the Protocollo ITACA. The protocol is currently widely disseminated throughout the region and has been adopted to provide incentives from numerous public administrations such as the City of Verona and the Province of Treviso.

Residential buildings have been subject to public funding in the period 2007-2009 through the application of the Regional Law 4/2007; interventions are mostly for single-family homes and are distributed on the whole regional territory including both new construction and retrofitting.

The tool considers the climatic conditions of the region and each of the criteria included in the tool was assigned a relative weight and an absolute weight appropriate to local conditions: climate, cultural, environment and availability of natural and human resources of the territory. In general, if there is no codified regional practice, the tool uses the national standards and regulations.

The protocol Biover2, the calculation tool and its user manuals are freely downloadable from the website of the Veneto Region and are made on the Open Office platform to encourage a free and open access to anyone[71].

INCENTIVES PROGRAMS RELATED TO THE RATING SCHEME

This rating scheme is the reference for some incentives of the Program called "Piano Casa", because this rating scheme is sufficiently simple to use, affordable in terms of cost and time of compilation, contextualized locally and open source.

The incentive program called "Piano Casa" was born to revitalize construction sector of the Italian economy. The government has launched a proposal for a plan that offers the possibility for individual citizens to carry out extensions and /or reconstruction of their home, taking advantage of incentives.

"Piano Casa" had been introduced in 2008 with Legislative Decree no. 112 of June 25 and it came into force at April 1st, 2009, through an agreement between the State and the Regions, each of which has created its own "Piano Casa".

The agreement was that for an "exceptional" period, originally planned for a year and a half, the "Piano Casa" would allow, by way of derogation from the existing instruments, volumetric bonuses up to 20% for extensions and up to 35% for most radical replacements. Another element to be considered is its precise regional characterization: each region has its own "Piano Casa" to facilitate people that are really involved and are potentially interested in consistent construction work.

The incentives for building renovation, although originated from the primary idea of the "Piano Casa", making them converge in parallel tax reliefs, with rules that govern them depending on energy efficiency, seismic consolidation, up to furnishing bonuses and incentives for young couples.

Related Economic Incentives

As said before, after the approval of the 4/2007 Law Biover2, a regional certification system for buildings, was defined; in a similar way to what was described for the ITACA Protocol, also this rating scheme combines public aids to the achievement of a minimum score in the regional evaluation system.

Relation among incentives, performances and score

The BIOVER2 evaluation system is implemented though a software tool based on 34 criteria grouped into 17 categories belonging to 7 evaluation areas, it assigns to the analysed construction project a score from -1 (worse than the current practice) to 5 (high sustainability).

The evaluation areas of the Biover2 protocol include:

1. external environmental quality (urbanization level, re-use existing structures, water pollution);
2. resources consumption (renewable and not renewable energy, building and system energy performances, low carbon and eco-friendly materials, potable water);
3. environmental loads (CO2 emissions, wastewater, heat island effects);
4. indoor environmental quality (air pollutants, acoustic, light quality etc.);
5. service quality (use of TSB and BACS);
6. quality management (building documentation, maintenance and waste management system);
7. transport (accessibility to public transport).

The following table shows the assessment criteria of the BIOVER2 tool.

BIOVER2 - ASSESSMENT CRITERIA
Urbanization level of the site
Existing structure reuse
Water pollution
Energy incorporated in constructing materials
Thermal transmittances in the building envelope
Primary energy for central heating
Solar radiation control
Thermal inertia of the building
Thermal energy for Domestic Hot Water
Electric energy

Materials from renewable sources
Recycled/Regenerated materials
Recyclable and detachable materials
Potable water for irrigation
Potable water for indoor uses
Ongoing expected emissions
Grey water sent to the sanitary sewer
Collected and stocked meteoric water
Soil permeability
Heat Island Effect with roofs
Heat Island Effect with paved external areas
Ventilation
Air pollutant control of Radon emissions
Air pollutant control of VOCs emissions
Air temperature
Natural day lighting
Acoustic insulation of the building envelope
Electromagnetic field of industry frequency (50Hz)
BACS (Building Automation and Control System) and TBM (Technical Building Management)
Available technical documentation of the building
Development and implementation of a maintenance plan
Maintenance of the performance factors of the building envelope
Waste management system
Accessibility to public transports

TABLE 39: ASSESSMENT CRITERIA FOR THE BIOVER2 TOOL

In the CABEE Project (http://www.cabee.eu/) different projects, that have applied Biover2 as rating scheme, were analysed and very interesting results have been produced.

By looking at the average scores reached by the assessed projects per evaluation area, results show that the evaluation areas that had a higher weight for the determination of the final score were those in which evaluated projects had the best performance. Within these areas it is interesting to see which criteria has contributed the most. The assessment area that contributes the most to the achievement of the final score is resource consumption (45%) followed from the area related to the environmental loads with 25% and the quality of the indoor environment (17%).

Within Area 2, about resource consumption, all the energy criteria get higher average scores thanks to the incentive policies for energy from renewable sources and to the existence of prescriptive rules for the energy performance of buildings, like for example the energy certification. The results achieved in this area are really important because represent the 45% of final score. Energy criteria considered are primary energy for heating, thermal inertia of the building and energy for DHW

Environmental criteria, for example the use of materials from renewable sources, recycled and recyclable materials, water treatment, are less performing. Another important sustainable aspect is directly connected with low carbon materials, the limitation of the database of reference materials makes the application in retrofitting project very difficult and the resulting score may not be reliable.

The evaluation Area 3 about environmental loads represent the 25% of final score and contains criteria strongly linked to CO2 emissions of building and high average scores were reached by analysed construction projects

Area 4 represents the comfort and the healthiness of the internal environments, it is related to the indoor environmental quality and represents the 17% of the final score. The scoring in this category suffers from the influence of the individual client that has strongly influenced the results, there are in fact a great disparity in scoring from the minimum to the maximum. [68]

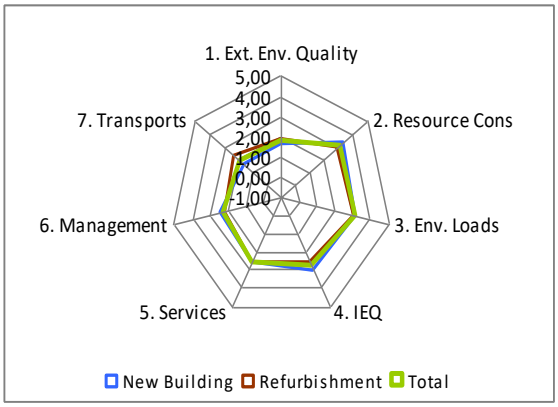


FIGURE 10: AVERAGE SCORES PER EVALUATION AREA

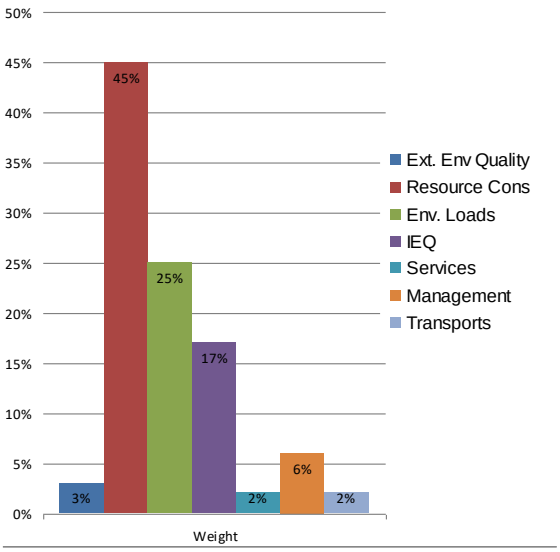


FIGURE 11: WEIGHT OF BIOVER2 EVALUATION AREA

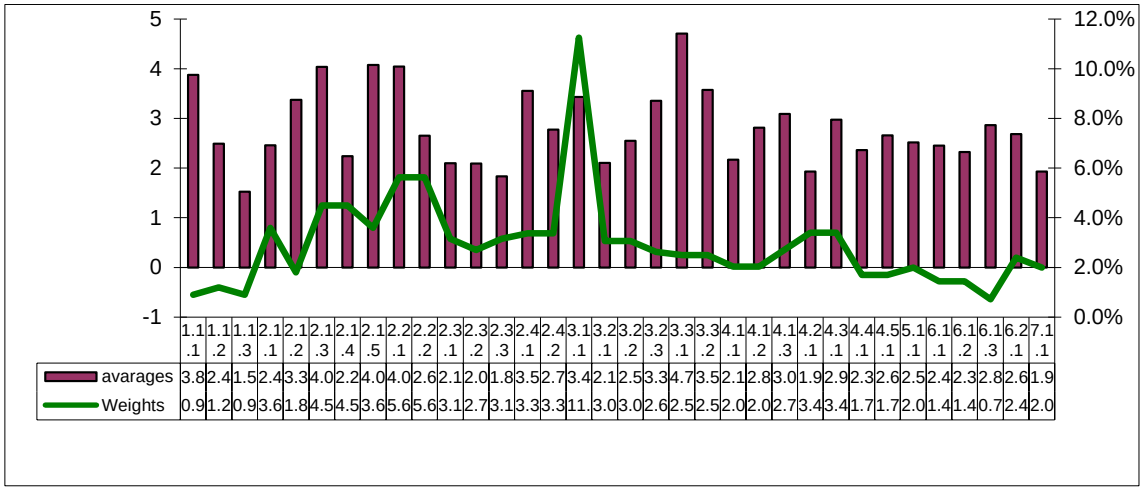


FIGURE 12: WEIGHT AND AVERAGE SCORES OF THE CRITERIA

INTERCONNECTIONS WITH NEWTREND PROJECT

The correspondence among many of the criteria contained in the Biover2 assessment tool and the key performance indicator of the NewTREND Project it is evident, actually some of them are exactly the same. In the chart below are described analogies and similitudes among criteria of this two assessment tools:

Biover2 Criteria	NewTREND Criteria	COMPARISON
Thermal energy for DHW Electric energy	B.1.3 Renewable Energy on Site	In both cases, it's calculated the ratio of on-site yearly production of renewable energy and yearly average of operational energy demand [%].
Air pollutant control of VOCs emissions Air pollutant control of Radon emissions Air temperature	B.5.1 Indoor Air Quality	The criteria are very similar, in the case Biover2 the objective is to ensure indoor air quality reducing the emissions. While, for NewTREND criteria, it is established a quality category (I-IV) according to EN 15251 assigned on CO2 concentration above outdoor [ppm].
Natural day lighting	Availability of Daylight Solar Access	In both cases is calculated the daylight factor while, the solar access of NewTREND, that is the number of hours in which indoor environments receive natural light, is directly comparable with the Natural lighting of Biover2.
Primary energy for central heating	B.6.2 Thermal Comfort in Heating Season	NewTREND criterion is calculated according to ISO 7730, about thermal comfort standards while the criterion of Biover2 is based on the verification compliance with the minimum thermal transmittance requirements of the existing legal framework at regional or national level (Legislative Decree 192/05 and Legislative Decree 311/06).

Acoustic insulation of the building envelope	B.8.1 Acoustic Comfort	In NewTREND is verified the indoor sound pressure level (day and night) [dB] while the criterion of Biover2 is focused on the acoustic insulation but the aim is the same.

TABLE 40: COMPARISON OF BIOVER2 CRITERIA AND NEWTREND KEY PERFORMANCE INDICATORS

4.2. RATING SCHEMES IN THE AUSTRIAN CONTEXT

In the Austrian context, two types of rating schemes were analysed, both widespread in the Vorarlberg Region, they are the "KGA" also known as the "Municipal Building Pass" and the "Subsidisation of housing (wohnbauförderung)". The first one was developed in 2010 and used the first time in 2011. The KGA is only for public buildings and it could be applied to the new buildings as well as to refurbishments. KGA was connected with a funding system of the state of Vorarlberg, municipalities could gain up to 4% points of additional funding doing the KGA certification. The amount of additional certification was connected with the points they achieve in the KGA. The more points, the higher the funding. The assessment tool is a MS Excel™-Tool, it contains criteria about process and planning quality, energy and building system, health and comfort, building materials and construction and it is available for free and downloadable for everyone.

Concerning the "Subsidisation of housing (wohnbauförderung)", also this rating scheme has an incentive mechanism based on the ability of increasing the points related to the environmental assessment tool and so, the more points, the higher the funding.

4.2.1. KGA, THE "MUNICIPAL BUILDING PASS"

NAME OF THE RATING SCHEME	KGA (Kommunalgebäudeausweis) also known as "Municipal Building Pass"
REGIONAL APPLICATION	In Vorarlberg, Austria and suitable in whole central Europe
RELATED INCENTIVES PROGRAMS	Programs established with the Consulting team
IN USE AT THIS MOMENT	In use
RELATED GRANTS AT THIS MOMENT	Yes
RELATED NATIONAL/REGIONAL LAW	Based on Regional standard. Data input from PHPP (passive house projecting package)
TYPE OF BUILDINGS TO BE APPLIED ON	Only for public building, it is working for new buildings as well as for refurbishments
DIFFICULTY OF THE ASSESSMENT	Easy to assess

TABLE 41: SYNTHETIC SCHEME WITH KEY INFORMATION ABOUT KGA

The KGA (in German: Kommunalgebäudeausweis, abbr. KGA) defines the standard for sustainable construction and refurbishment of public buildings in Vorarlberg, Austria since 2010. It is also known as the "Municipal Building Pass"[72].

The state of Vorarlberg has very different climate zones with its area of 2.601 km² and with 375.282 inhabitants (as with January 1st, 2014), it is the most western of the nine federal states of Austria.

KGA has been developed in that country in 2010, it is applicable only to public buildings as town halls, secondary and elementary schools including multi-functional halls and gymnasiums, concert halls, residential care home for elderly, kindergartens, social centres, vicarages, municipal offices, sport halls and music schools. The "Kommunalgebäudeausweis" (KGA – public building certificate) was used the first time in 2011 and now it is applicable to refurbishment and new buildings.

Before the KGA was developed, the buildings planned during that time being accompanied by the consulting team, that is formed by a group with members of different knowledge areas but with the same goal in focus without having unrealistic or too ideological thoughts, fulfil almost completely the same criteria as the newer ones having a KGA. Since the KGA started most public buildings (especially those consulted by the service team) received a KGA. It is not 100% possible to separate between the KGA and the consultancy because the development team of the KGA and the consulting team for almost all public buildings in Vorarlberg is the same[68].

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At the beginning of the 2015 was published a version of the KGA for public building certificate for partly heated buildings which enables to evaluate also buildings only partly heated, or not permanent heated, or non-heated at all. It is important to underline that not all the building could be evaluated with this system, for example, recycling centres, fire department, municipality maintenance yards cannot be evaluated with this system.

The comfortable and healthy indoor environment of the building is a key topic of the rating scheme because the intent of KGA is to create benefit for users allowing himself working in the highly efficient and ecological buildings. The mass orientation of this system is clear also for the choice of the calculation system uses that is Microsoft Excel, a basic program widely spread; another possible data input comes from PHPP (passive house projecting package) that makes the KGA international, as the PHPP is one of the few tools in the world basing on building physics.

WHERE THE RATING SCHEME IS USED: REGIONAL CONTEXT

The referring regional contest is the state of Vorarlberg, but the system could be applied also in region having the same climate conditions. The KGA is a real 100% mass certification tool and the test of the mass certification approach has been implemented as part of the consulting process. It is an absolutely

mass oriented system as it is freeware and all criteria are descripted in the public handbook, there are also no certification or license fees and everybody is allowed to use it.

INCENTIVES PROGRAMS RELATED TO THE RATING SCHEME

Since the beginning the KGA was connected with a funding system of the state of Vorarlberg. Incentives Programs are established with the Consulting team, the government and the administration see in this evaluation system an opportunity to increase the heritage of certified buildings.

RELATED ECONOMIC INCENTIVES

The connection with the funding system of the state of Vorarlberg has allowed the wider dissemination of this evaluation system, in fact, municipalities can gain additional funding when they are doing the KGA certification. This additional amount is directly connected with the achieved result in the KGA; the more points, the higher the funding. In general, thanks to the score obtained, all buildings doing the KGA received an additional funding.

RELATION BETWEEN INCENTIVES, PERFORMANCES AND SCORE

KGA assessment system is based on 14 criteria grouped into 4 evaluation Areas. Most points of the KGA focus on sustainable issues like energy efficiency, ecology, health and so on. In terms of economic sustainability, the KGA is influencing the process due to extra points for life cycle assessment.

The assessment criteria of the KGA tool is shown in the following table.

KGA, the "Municipal Building Pass" ASSESSMENT CRITERIA
PROCESS AND PLANNING QUALITY
A.1.1 – Definition of checkable energetic and ecologic goals – program of sustainable building
A.1.2 – Simplified calculation of economic efficiency
A.1.3 – Product management – Use of regional, environmental friendly and low-polluting building products and constructions
A.1.4 – Detailed verification of the energy calculation according to PHPP
A.1.5 – Bicycle parking spaces
ENERGY AND SUPPLY
B.1.1 / B.1.1b – Space heat demand
B.1.2 / B.1.2b – Primary energy demand
B.1.3 / B.1.3b – CO2-emissions
B.1.4 / B.1.4b – PV systems
B.1.5 / B.1.5b – Differentiated collection of energy consumptions
HEALTH AND COMFORT
C.1.1 – Thermal comfort in summer
C.1.2 – Measuring indoor air quality
BUILDING MATERIALS AND CONSTRUCTION
D.1.1 – Avoidance of PVC
D.2.1 – OI3BG3, BZF ecological index of the total mass of the building

TABLE 42: ASSESSMENT CRITERIA OF KGA

During the progress of the EU CABEE project (http://cabee.eu/), 27 public buildings were analysed with the KGA assessment method to evaluate their performances. The analysis allows to compare the buildings

by criteria groups, building type and also the minimum, maximum, average, median and the standard deviation was calculated for each criterion. The increase of subsidies was also calculated.

The image below describes, the results obtained in the four main criteria groups (process and planning quality, energy and supply, health and comfort, building materials and construction) as well as the achieved points for every single sub-criterion.

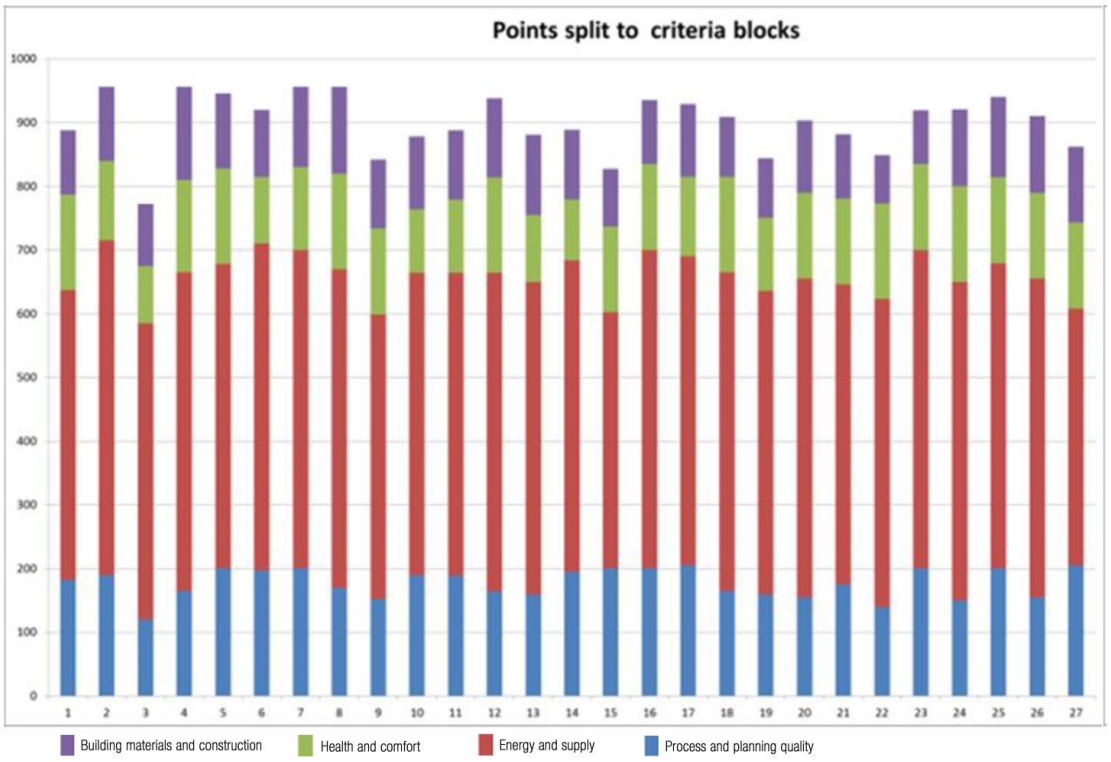

FIGURE 13: RESULTS OBTAINED IN THE FOUR MAIN CRITERIA GROUPS

The minimum received points of all 27 analysed KGAs are 772 out of 1000 possible points, so that even this building receives more than ¾ of all points. This means that this building receives 2,5 % additional funding as the additional subsidies start at 600 points with 1% and increases every 50 points with 0,5 % points (to the maximum of 4% at 900 points). Means that all buildings with KGA are receiving additional funding.

The maximum points obtained was 956. The arithmetical average of the total points of all buildings is exactly 900 points and it is confirmed by the analysis of the median. So, the average of the total points means that 90 % of all points where received and, bases on average, all buildings overleap the threshold of the highest funding level. [68]

INTERCONNECTIONS WITH NEWTREND PROJECT

The correspondence is high between the criteria of KGA assessment system and the key performance indicator of the NewTREND Project, many of them are exactly the same.

In the chart below are described analogies and similitudes between the criteria of this two assessment tools.

KGA	NewTREND Criteria	Comparison
B.1.4 / B.1.4b – PV systems	B.1.3 Renewable Energy on Site	In both cases it's calculated by the ratio of on-site yearly production of renewable energy but for the KGA rating system the renewable energy considered is produced by PV systems.
C.1.2 – Measuring indoor air quality	B.5.1 Indoor Air Quality	The criteria are exactly the same, in both cases the objective is to maintain a satisfactory level of indoor air quality, limiting emissions. It is established a quality category (I-IV) according to EN 15251 assigned on CO2 concentration above outdoor [ppm].
B.1.2 / B.1.2b – Primary energy demand A.1.4 – Detailed verification of the energy calculation according to PHPP C.1.1 – Thermal comfort in summer	B.6.2 Thermal Comfort in Heating Season	NewTREND criterion is calculated according to ISO 7730 thermal comfort standard while the criterion of KGA is based on the verification compliance with the thermal transmittance requirements of the PHPP through UNI EN 832 (ISO 13 790) "Calculation of energy use for heating".
A.1.2 – Simplified calculation of economic efficiency	B.10 Operational Energy Costs	In NewTREND assessment tool the criterion is calculated by multiplying the energy demands and the energy price by fuel types then normalizing the operational energy costs for the buildings based on the reference floor area while KGA system is based on the optimal allocation of every resource.

TABLE 43: COMPARISON OF KGA ASSESSMENT CRITERIA TO NEWTREND KEY PERFORMANCE INDICATORS

4.2.2. HOUSING SUBSIDY

NAME OF THE RATING SCHEME	Housing subsidy - Wohnbauförderung
REGIONAL CONTEXT	In Vorarlberg, Austria
RELATED INCENTIVES PROGRAMS	Related to the implementation of the Subsidisation of Housing's in Vorarlberg municipality
IN USE AT THIS MOMENT	In Use
RELATED GRANT AT THIS MOMENT	Yes
RELATED NATIONAL/REGIONAL LAW	Based on Regional standard
TYPE OF BUILDINGS TO BE APPLIED ON	Private buildings, new and refurbished buildings
DIFFICULTY OF THE ASSESSMENT	Easy to assess

TABLE 44: SYNHTETIC SCHEME WITH KEY INFORMATION ABOUT HOUSING SUBSIDY

The Housing Subsidy (in German: *Wohnbauförderung*) was developed and applied in Vorarlberg, Austria; it defines the standard for sustainable construction and refurbishment of private buildings contrary to the KGA, which was applied on public buildings.

The Housing Subsidy allows to analyse the performances of private buildings within an area. It was developed in accordance with the Vorarlberg Regional Administration and the Department of Housing Promotion at the Office of the Provincial Government.

Regarding the promotion of residential building, the regional government, in their work program 2014-2019, revised and simplified guidelines for the promotion of residential construction (for new construction and redevelopments), and will continue to do so in the coming years in such a way that housing is made affordable for the population. This requires an even stronger consideration of the social conditions of the beneficiaries. Despite the focus on affordable housing, the promotion of residential housing will also create the prerequisites for resource-conserving and energy-efficient housing construction in the future[73].

For the Vorarlberg state government, affordable houses and apartments are important. A special concern for the country is the ecological housing construction. Only those who are environmentally friendly are promoted. Support is also provided for barrier-free building, so that housing will become receptive for all generations.

The rating scheme for residential house renovation applies from 1 January 2017 for one year. In 2017 the subsidy model will be fixed in the residential housing promotion scheme. In its basic system, the residential housing directive was not changed from that of 2015 and 2016. In 2016, only a few clarifications and definitions of the new Directive 2016/2017 for private housing and clarifications of administrative practices were included in the Guidelines. In 2016 the possibility of property promotion to owner-owned communities was created.

WHERE THE RATING SCHEME IS USED: REGIONAL CONTEXT

As said before, this rating system was developed in accordance with the Vorarlberg Regional Administration and the Department of Housing Promotion at the Office of the Provincial Government. For that reason, the assessment system is completely calibrated on the Vorarlberg Regional context and there applied.

INCENTIVES PROGRAMS RELATED TO THE RATING SCHEME

The incentives programs by the Housing Subsidy are all related to the implementation of this rating scheme. Vorarlberg municipality has the power to grant incentives for private residential buildings in accordance with some specifications that will be described in the next paragraph.

RELATED ECONOMIC INCENTIVES

To incentivize performance described in their rating scheme, the Department of Housing Promotion provides loans for:[74]

- Individuals for private homes, double and row houses, condominiums, service apartments, additions, conversions and extensions to homes.
- Legal persons and partnerships for employer accommodation.

- Non-profit building associations, corporations, institutions and foundations for rental and buying accommodation, dormitories, supervised apartments as well as emergency and start-up apartments.

Basic prerequisites for private individuals to receive housing promotion are:

- Austrian citizenship or under the EU law or contract
- Compliance with income limits and building codes
- Accommodation is available
- Secure financing
- Proven property and building rights
- Reasonable price for construction and land
- The maximum living area must not be exceeded
- Financing defaults are available
- Commercial title of the developer according to Austrian law

Housing subsidies are bound to income limits: for one person, EUR 3.000, for more, EUR 5.300. (the income calculation for workers are calculated by the statutory insurance contributions, the subsidies for housing subsidies, chamber contributions and wage tax are deducted from the annual gross distance including all special payments and subsidies. The income calculation for self-employed persons: premature depreciation, investment reserves and special expenses are added to income). If the income limits are exceeded, subsidies will be reduced by 5% for each additional € 50.

The minimum size of a subsidized apartment is 25 m² of usable space (room, kitchen, wet cellar). Smaller apartments are not supported. The maximum housing size depends on the number of residents: up to a five-person household, the usable area can be 150 m². From a six-person household, the residential area is limited to 170 m². For private homes with two apartments, the total usable area is 200 m². In the case of residential buildings without a basement and attic, additional areas of up to 25 m² can be built for storage or technical use, without affecting the upper floor.

Bonuses are linked to different aspects of the sustainability, following some examples on how to calculate rates for new construction and renovation loans:

- Energy-saving bonus:
    - Improving the heating demand: up to € 120.
    - Improvement of primary energy demand: up to € 120.
    - Third improvement in CO2 emissions: up to € 120.
- Environmental Bonus:
    - Improving the OI3 index: up to € 120. This surcharge is calculated from the improvement of the values for the ecological index.
    - Windows, doors and shutters PVC free: € 50. This supplement is ensured for all the windows and doors (including interior doors) of the above-ground stores, together with the corresponding roller and folding shutters and slat blinds
- Wooden facade:
    - € 20, this surcharge is granted if the facade without windows, is covered by at least 60% of untreated wood. The ecological minimum requirements under section is that wood must come from sustainable production. Wood composite panels should have a wood content of greater than 80% of the

volume. Coatings or other active substance-containing treatments are permissible if these meet the criteria according to Austrian wood preservative list or German RAL quality mark.

- Use of renewable insulating materials:
  - € 30, this surcharge is granted if the insulation of the building façade without windows is based on land, at least 90% of renewable insulation materials. Insulation materials from renewable raw materials are flax, grass, fibre, hemp, wood fibre, wood chip, jute, coconut fibre, cork, sheep wool, reed, straw and cellulose insulation materials.
- Bonus for barrier-free execution:
  - for residential buildings with lift € 80.
  - for residential buildings without elevator or at € 30.

RELATION BETWEEN INCENTIVES, PERFORMANCES AND SCORE

This Directive applies to applications for funding from 1 January 2017 to 31 December 2017. The assessment criteria of the Housing subsidy tool are shown in the following table.

Housing Subsidy ASSESSMENT CRITERIA	
Action catalogue 2016 - Residential House Refurbishment	
A - PLANNING - COMFORT AND FUNCTIONALITY	Points max 22
1.a Planning of the conversion / renovation by authorized building planners	4
1.b Carry out a planning competition	10
2.a Planning of the house technology by authorized building technicians	2
2.b Refurbishment consultants from the recommendation list	2
2.c Refurbishment consultants from the recommendation list to acceptance	4
3. Summer availability calculated according to ON B 8.110-3	2
4.a Building envelope, window connection heat bridges	2
4.b Building envelope heat bridges calculated	6
5.a Building envelope - air tightness standard	2
5.b Building envelope optimized for air tightness	6
A - LOCATION - SURFACE AND BASIC REQUIREMENTS	max 11
8.a Bicycle route Standard	3
8.b Bicycle parking space optimized	6
8.c Electric connection for electric bicycles at the bicycles	1
9. Provision of car-sharing parking spaces	4
B - ENERGY - HEATING DEMAND	max 100
1. Heating heat demand (HWB)	0-100
C - DOMESTIC APPLIANCES - POWER SUPPLY	max 32
1. Innovative climate-relevant heating system with additional options	7
2. Reduction of local air pollutants	3
3.a Heat pump as central heating	13
3.b Heat pump as central heating with green electricity	18
3.c Biomass heating or connection to biomass local heat or waste heat	25
C - DOMESTIC APPLIANCES, HEAT DISTRIBUTION, WATER HEATING	max 55
4. Warm water and buffer storage optimized insulated	5
5. Distribution system optimized insulated	6
6.a Solar water heating	22

6.b Solar water heating with heating	30
7.a Fresh air system	9
7.b Comfort ventilation with heat recovery	15
C - HOME APPLIANCES - WATER AND ELECTRIC POWER	max 23
8. Floor sealing a maximum of 5 m² per living unit	2
9. Near-natural drainage of rainwater	2
10. Rain water use or roof greening	4
11. Energy efficient household appliances	2
12. Energy-efficient lighting of general areas	2
13. Heating and circulation pumps of the energy class	4
14. Photovoltaic system	15
D - MATERIAL SELECTION - ECOLOGICAL ASSESSMENT	max 38
1. Building materials, insulation materials, construction elements	0
2. Correct disposal of insulation materials and material containing asbestos	6
3.a Windows, doors, roller shutters in the upper floors PVC free	6
3.b Windows, doors, roller shutters, light shafts in the basement, PVC free	3
4.a Electrical installation PVC, halogen-free - partial design	3
4.b Electrical installation PVC, halogen-free - optimized	6
5. Pipes in buildings, foils, waterproofing sheets, floor coverings, wallpaper PVC free	0
6. Sewage pipes and wall ducts in the ground PVC free	4
7. Polyurethane free thermal insulation	2
8. Thermal insulation of the connecting joints with filling materials, sealing tapes	3
10. Plaster with a maximum of 6% plastic content, glue cement-bonded	2
11. Facade coating solvent and biocide free	2
12. Bitumen pre-paints, paints and adhesives are solvent free	3
13. Wood from the region	5
14. Wood from primary forest not allowed (North and South America, Asia, Africa)	0
D - MATERIAL SELECTION - ECOINDEX 3	max 22
15. Ecological assessment of thermal sheath materials	0-22
D - MATERIAL SELECTION - SERVICE LIFE AND MAINTENANCE	max 19
16.a Barrier-free construction - partial extension	5
16.b Barrier-free construction - full configuration	15
18. Weather resistance of façade and windows	3
19. Domestic installations easy to access vertically	1
20. Improved intrusion protection	2
E - INTERIOR - LOW EMISSION	max 12
1. Laying materials low-emission	2
2. Floor coverings including surface treatment low-emission	2
3. Wall, ceiling paints, glue low-emission, softener-free	2
4. Metal and wood paints low-emission	2
5.a Fresh air system optimized	2
5.b Comfort ventilation optimized	4
6. Electrobiological home installation	2

TABLE 45: HOUSING SUBSIDY ASSESSMENT CRITERIA FROM THE ACTION CATALOGUE 2016

INTERCONNECTIONS WITH NEWTREND PROJECT

Housing Subsidy	NewTREND Criteria	Comparison

13. Heating and circulation pumps of the energy class **14. Photovoltaic system** **3.c Biomass heating or connection to biomass local heat or waste heat**	B.1.3 Renewable Energy on Site	NewTREND's criterion calculates the ratio of on-site yearly production of renewable energy, into the Housing Subsidy system are considered many aspects and typologies of renewable energies, as for example the installation of biomass heating systems, the production of renewable energy by PV systems, etc.
1. Laying materials low-emission 2. Floor coverings including surface treatment low-emission 3. Wall, ceiling paints, glue low-emission, softener-free 4. Metal and wood paints low-emission 5.a Fresh air system optimized 5.b Comfort ventilation optimized 6. Electrobiological home installation	B.5.1 Indoor Air Quality	The criteria are exactly the same, in both cases the objective is to maintain a satisfactory level of indoor air quality, limiting emissions. In the Housing Subsidy system, big importance it's given to this aspect, in fact it's dedicated to the theme a whole area of the assessment system called E - INTERIOR - LOW EMISSION.
7.a Fresh air system **7.b Comfort ventilation with heat recovery**	B.6.3 Thermal Comfort in Cooling Season	Optimising the cooling systems is crucial to reduce the energy consumption, in both cases the purpose of this criterion is to assess and measure improvement in the cooling systems to guarantee the users' health and well-being.

TABLE 46: COMPARISON OFHOUSING SUBSUDY ASSESSMENT CRITERIA AND NEWTREND KEY PERFORMANCE INDICATORS

4.3. RATING SCHEMES IN THE FRENCH CONTEXT

In France, the analysis has focused on two different rating schemes related to an economic incentive: the "Social Housing Eco Compliance" developed in Auvergne Rhone Alpes and the "BDM". About the first one, that was focused on social aspects, all the owner of social housing had to use it if they wanted financial assistance from the Region. But last year it was stopped by the regional authorities and so today in Auvergne-Rhône-Alpes there is no rating system at regional level. This rating system for the social housing was abandoned with the new majority at the regional council.

In the perspective of this work analysis, is still important to demonstrate the operation of this assessment tool in relation also to the loans granted because, in the previous year, it was very well known in the territory.

Instead, BDM it's a rating system very popular, spread across French territory with 378 projects certified. The BDM approach was born in PACA for the Mediterranean territory and it was supported by the Region Council of PACA by financial incentives. Today it is no longer the case because it is now well known to the owners and many actors integrate it into their specifications. Economic incentives stopped last year, in 2016 so BDM it's now strongly recommended but no longer linked with economic incentives. Despite this, the analysis of this system is really significant because of its widespread on the territory and its large numbers produced: 378 projects with 1.236 million m2 certified.

4.3.1. Social Housing Eco Compliance

NAME OF THE RATING SCHEME	Social Housing Eco Compliance subsidies
REGIONAL APPLICATION	Rhône-Alpes region, France
RELATED INCENTIVES PROGRAMS	Social Housing Program
IN USE AT THIS MOMENT	Not in use
RELATED GRANTS AT THIS MOMENT	No
RELATED NATIONAL/REGIONAL LAW	Relation with Regional measures and National law (under energetic aspects)
TYPE OF BUILDINGS TO BE APPLIED ON	New and retrofitted social housing
DIFFICULTY OF THE ASSESSMENT	The development of the knowledge for environmental high-quality building of the Staff of social housing and consultants

TABLE 47: SYNTHETIC SCHEME WIT HKEY INFORMATION ABOUT SOCIAL HOUSING ECO COMPLIANCE

Faced with the challenges of energy renovation, many tools have been developed over the past few years and a large network of players exists in the Rhône-Alpes region. Qualitative and quantitative progress are considerable, also in the Rhône-Alpes region the aim is to achieve mass production of sustainable buildings.

The rating scheme analysed in this document is called "*Social Housing Eco Compliance", it* was born in 2007 and it's applied to new and retrofitted social housing. Several changes have been made over the years due to the updating regional laws and varied social needs, now it's no longer in use, but during the period it was in use, it has produced significant results in certification and more than 1000 new housing and more than a hundred retrofitted housing are concerned by these regional subsidies (about 2000 to 4000 € by housing)[68].

The development of this rating system began after the increasing understanding of the vulnerability of people living in social housing. These social housings are old and their energy consumption very high, so the improvement of the energy efficiency of these buildings is the best answer to reduce rental charges. The regional action plan for environmental high-quality buildings encourages to integrate more environmental quality and energy efficiency projects by conditioning aid to project performance and accompany them to change current practices.

The responsible organization of the implementation are the regional Council of Rhône-Alpes, the ADEME-French Environment and Energy Management Agency and the ARRA HLM regional association for social housing.

The Organisation for the delivering is RAEE, Rhônalpénergie Environnement and it is the regional energy and environment agency of the Auvergne-Rhône-Alpes region. It aims at promoting, coordinating and developing programs and actions in favour of sustainable energies in the building and transport sectors, climate change mitigation and adaptation, environment protection and sustainable development.[75] RAEE coordinates multiple regional level thematic networks, allowing regional and local stakeholders to share experiences and to mass reproduce sustainable construction, RAEE is encouraging public authorities to set up regional sustainable construction strategies. For several years, RAEE has been involved in the CESBA inter-regional initiative aimed at promoting a regional sustainable construction development model based on sharing of services and indicators amongst construction players[76].

WHERE THE RATING SCHEME IS USED: REGIONAL CONTEXT

Rhône-Alpes region estimates 6,021 million of inhabitants on a surface of 43.698 km^2. The region has 2,531,122 main homes, 81.8% of dwellings. The dwellings are divided between 46.2% of houses and 52.6% of apartments. 56.9% of households own their residence[77].

Building is one of the main sources of energy consumption (43% of final energy consumption) and of greenhouse gas emissions (25%) in France and the main challenge concerns existing buildings and the ability to renovate them in order to reduce their impact. Different rating schemes exist in the Rhône-Alpes region (high environmental quality private systems of reference, social housing systems of reference, secondary school systems of reference, Grand Lyon systems of reference etc…), unfortunately, their varied nature and sometimes their complexity have an effect which is more restrictive than inclusive.

This type of assessment system has generated an emulation effect where local authorities have adapted their own subsidies system with the same assessment tool.

INCENTIVES PROGRAMS RELATED TO THE RATING SCHEME

The main incentives programs related to the Social Housing Eco Compliance subsidies are the Social ones, directly connected with the regional association for social housing in Rhône-Alpes, ARRA HTL[78].

Founded in 1975, the Regional Association of the HLM Organisms of Rhône-Alpes, brings together 79 social housing organizations based in the Rhône-Alpes region: 24 Public Office for Housing, 24 social enterprises for the dwelling, 15 Cooperative Production Companies, 8 Societies Cooperatives of collective Interest into the access to the property and 8 Local Public Enterprises.

These agencies, in the 8 departments of the region, manage 417,400 social rental housing units (survey of January 2011)[79].

Social incentive program includes:

- An assessment tool (criteria catalogue) with levels of energy efficiency, compulsory targets to guarantee exemplary projects and soft targets for projects with local specificities. It is important to underline the fact that the catalogue of criteria is updated each year according to practices change and thermal regulation. This approach is specific to Rhône-Alpes but is consistent with other approaches like CEE (Energy savings certificate), loans at subsidized rates of “Caisse des Dépôts” and subsidies of local authorities,
- Training sessions for social housing staff and designers,
- Subsidies for study design and conception,
- Higher subsidies for efficient projects,
- A Website: http://www.logementsocialdurable.fr/ with all tools (assessment, Life cycle cost calculation, best practice examples…),
- A hotline for social housing staff and designer teams.

The main innovation of this rating scheme is the strong involvement of social housing staff and designers trough training sessions, web site and hotline. Training and assistance for design studies are supported by regional Council and ADEME.

RELATED ECONOMIC INCENTIVES

Since 2007 subsidies of the regional council of Rhône-Alpes for new and retrofitted social housing are conditioned to the environmental quality of projects, with a joint procedure between regional Council of Rhône-Alpes, ADEME-French Environment and Energy Management Agency and the ARRA HLM-regional association for social housing. Since 2007, more than 1000 new housing and more than a hundred retrofitted housing are concerned by these regional subsidies of about 2.000 to 4.000 € by housing. In 2011, 60% of new social housing was ahead of the regulation.

The following financial aid can be obtained, depending on the level of performance achieved:

- A "baseline" level consisting of a simple commitment to apply the Social Housing Eco Compliance (project management system) methodology that does not qualify for aid to the works.
- A "high-performance" level: implementation of the project management and building life requirements as well as the 5 themes of the technical reference, evaluated according to the detailed grid included, quantifying targets and receiving aids to support and work.
- A "low consumption" level: same level "very efficient" but with more ambitious objectives on energy and stronger demands on control of the comforts, giving right to assistance to accompany and work.

A key condition for the success of this incentive program is due to a very efficient assistance, a strong involvement of the regional Council, ADEME and, above all, of social housing owners and contractors.

However, the subsidies have to cover all costs. The main reasons for energy efficiency in social housing are: reduction of consumption costs for tenants, reduction of fossil energy consumption and greenhouse gas emissions, contribution to local employment.

This support for high quality and energy efficiency in social housing is a proactive approach specific to the Rhône-Alpes region.

RELATION BETWEEN INCENTIVES, PERFORMANCES AND SCORE

As stated at the beginning of the chapter about rating schemes, the implementation of an integrated process to support the design and construction of high performance buildings is fundamental, and this process should include assessment tools/criteria catalogues, hotline, website, training, and observatories.

The cost of such process is elevated and should be taken in account properly when the funds available for a social housing program are established.

The assessment criteria of the Social Housing Eco Compliance tool are shown in the following. It is subdivided into two macro areas:

- Management needs
- Technical requirements

The first one is divided into two categories of criteria:

- Project management
- Building's life cycle

This chapter includes the environmental management actions, load control-related studies and actions to the transition between the production and life cycle of the building.

Social Housing Eco Compliance ASSESSMENT CRITERIA	
MANAGEMENT NEEDS	
PROJECT MANAGEMENT	
Requirement	Type*
A.1. References from one or more members of the Design Team The contracting authority will require and analyse the references and qualifications of the teams during the consultation	F
A.2. Existence of a project coordinator in the project management team The contracting authority will require the presentation of the qualifications of the coordinator, who will also be responsible for a project management assignment, as an architect	F
A.3. Performing an initial environmental analysis of the site The website analysis will be carried out upstream of the program and consultation of the project management. It will identify the characteristics of the site and present them in the form of assets and constraints, dealing at least with the following themes: Urban planning constraints Built environment and human / infrastructure nearby / transport Climate data Solar potential (solar passive and solar active) Local networks / resources (energy, water) Natural / technological risks Nuisances (acoustic, visual, olfactory, air quality) Pollution of the natural environment (pollution of air, soil, groundwater) A standard site analysis document is proposed as an annex to the repository. The Owner is free to use it or to propose another framework.	S
A.4. Implementation of an environmental program The environmental requirements of the client will be structured according to the themes proposed by the Region and integrated into the program of the operation. The environmental program will include, in particular, the target level of the reference system as well as the choice of requirements retained by the contracting authority.	F
A.5. Realization of an operational scoreboard and environmental validation The contracting authority will maintain an operational dashboard to trace the history of the environmental design phase by phase. This requirement will not be accepted if this document is not considered useful by the contracting authority. A standard dashboard document is proposed as an annex to the standard. The owner is free to use it or to propose another framework. The contracting authority will validate the elements submitted by the prime contractor through this dashboard.	S
A.6. Production of an environmental manual An environmental notice will be produced by the coordinator and will detail the answers given to the requirements of the program according to the 5 themes of the reference system.	S
A.7. Business skills Invitations to tender will incorporate a rating of the skills and experience in Social Housing Eco Compliance of companies, on the basis of a technical brief comprising at least: rating scheme references and method of management of the green building site	S
A.8. Training of companies (implementation of insulation, thermal bridges, air tightness, installations and adjustments of systems, etc.) Implementation of training courses for companies	S
BUILDING'S LIFE CYCLE	

Requirement	Type*
B.1. Estimated expenses Calculate the estimated costs by considering following items: - Heating - Common and individual electrical uses - Common and individual water consumption - Renewable electricity production	S
B.2. Comparative energy study Provide the energy comparative study of the 2 to 3 most relevant heating systems / DHW systems on the project, showing the investment cost and the environmental impact (CO2, SO2, NOx, nuclear waste). For buildings whose surface area is greater than 1000m², this study is imposed since 1 January 2008 and described in the decree of 18 December 2007. For buildings whose surface area is less than 1000m², the method of calculation is left free as far as the elements mentioned above are present.	S Surface< 1000m² F Surface> 1000m²
B.3. Realization of a tenant's booklet At the delivery and at each change of tenants, a booklet "acts verts" will be given to the new occupants. As an illustrated document, it will include: - Information about the materials and equipment of the residence - Advice on the use and maintenance of these materials and systems - Green actions focusing on heating, electricity and water savings, waste management and the choice of furniture and maintenance products (impacts on air quality).	F
B.4. Creation of a management booklet At the delivery of the building, a maintenance booklet (10 to 20 pages) will be handed over to the manager. As an illustrated document, it will include: - Description of the materials and equipment of the residence (position, technical characteristics, photograph) - Maintenance actions to be provided on each of these equipment - Name of the maintenance company or the person in charge of these actions.	S
B.5. Consumption monitoring / Evaluation: simplified dashboard Set up a monitoring / evaluation system for the residence on the basis of the scoreboard provided in the appendix. It has been designed to allow internal monitoring / evaluation by the contracting authority.	F

TABLE 48: SOCIAL HOUSING COMPLIANCE ASSESSMENT CRITERIA. TYPE*: (F) INDISPENSIBLE TO OBTAIN GRANT, (S) FLEXIBLE REQUIREMENT

The second macro area called "**Technical requirements** "encloses all technical requirements and it is divided into five categories:

1. Building integration into the site: bioclimatic design, considering the quality of the layout of outdoor spaces and the management of rainwater.
2. Building materials and products: energy content and proximity of supply, wood, mineral fibres, prohibited materials, materials to avoid, glues, paints, varnishes and glazes.
3. Flow control: energy and water.
4. Control of the comforts: summer hydrothermal comfort, visual comfort.
5. Reduction of nuisances, pollution and risks: water quality, indoor air quality, household waste, clean building site.

The description of criteria related to each one of the five categories is shown in the following.

TECHNICAL REQUIREMENTS

1 - BUILDING INTEGRATION INTO THE SITE	
Requirement	Type*
1.1. Considering comfortable modes of travel - Presence of a sufficiently sized bicycle room. - Facilities facilitating pedestrian travel, bikes on the plot and access to public transport. - Reflection on the place of the car: reduction of the number of parking lots (provide the number of places / housing), collective parking away from housing	S
1.2. Passive approach and bioclimatic design The objective is to passively address the requirements of comfort and reduction of energy requirements. This will result in: - Optimized orientation of the building and dwellings. - The search for compactness of the building, while maintaining a balance with access to natural lighting. - A distribution of the perforations and a choice of solar protections favouring passive solar contributions in winter and limiting them in summer. - The use of vegetation in the treatment of summer comfort. These issues will be addressed based on local parameters arising from site analysis.	F
1.3. Quality of treatment of outdoor spaces - Create pleasant and comfortable outdoor spaces that consider in their development the following elements: protection to prevailing winds, rain protection, noise protection, shaded areas. - When the operation allows, consider setting up and access for tenants to shared gardens.	S
1.4. Stormwater management Integrate an alternative management of rainwater on the plot: valleys, infiltration ponds, rainwater harvesting for watering and / or internal uses.	S

TABLE 49: SOCIAL HOUSING COMPLIANCE TECHNICAL REQUIREMENTS. TYPE*: (F) INDISPENSIBLE TO OBTAIN GRANT, (S) FLEXIBLE REQUIREMENT

2 - BUILDING MATERIALS AND PRODUCTS	
Requirement	Type*
2.1. Proximity of supply and materials with low grey energy Justify by a note the reflection that has been carried out in this direction and the choices of materials that have been made.	S
2.2. Calculation of the energy content ("grey energy") of the building After having met the previous requirement, calculate the grey energy of the building (within the limits of the information available to date on the materials used). Indicate the consumption in total kWhEP and in kWhEP of renewable origin. The objective here is to identify the share of construction in the overall energy consumption of a building and to reduce it gradually.	S
2.3. Promote wood construction Promote the use of wood as a building material. Calculate the quantity of wood used according to the method of calculation provided in annex and justify the achievement of the following objective: 45 dm^3/m^2 Area.	S
2.4. Origin of woods Promote local species, implement FSC or PEFC certified wood and justify their origin.	F
2.5. Inland wood and treatment products: limiting their impact on health Prefer woods that do not require treatment (class adapted for use). If treatment is needed, focus on natural treatments. Require minimum CTB-P + certification of treatment products. It demonstrates the effectiveness of preservative products and their	F

safety in terms of human health and environmental impacts. The list of certified products is available on the CTBA website. Agglomerated wood (kitchen furniture and bathrooms, cupboards, etc.): require E1 classification to guarantee a low formaldehyde content (according to EN13 986).	
2.6. Glues, paints, varnishes and glazes: limit their impact on health and the environment Require waterborne paints for walls, ceilings, wood and VOC <1g / L for walls and ceilings. Prohibit the use of paints containing glycol ethers. Require adhesive flooring with the EMICODE EC1 label (low VOC emissions). Promote eco-labelled products.	F
2.7. Mineral wool: limiting their impact on health Limiting the use of mineral wool inside the building, exclude mineral wools blown and require carcinogenicity tests.	F
2.8. Prohibit products that are hazardous to the environment and health Require the safety data sheets of the following products: glues, mastics, paints, varnishes, glazes, wood treatment products, sealants, cleaning products. In design and on site, check the risk phrases of the products mentioned above. Prohibit, as far as possible, all products with a risk phrase. Where no alternative is available, allow only risk phrases: R10-R11-R22-R25-R36-R37-R38-R42-R43	S
2.9. Avoid materials that may contain endocrine disrupters and emit toxic gases in case of fire No polyurethane insulation, PVC replaced by another material on the two following posts: exterior joinery, floor coverings.	S

TABLE 50: SOCIAL HOUSING COMPLIANCE BUILDING MATERIALS AND PRODUCTION CRITERIA. TYPE*: (F) INDISPENSIBLE TO OBTAIN GRANT, (S) FLEXIBLE REQUIREMENT

3 - FLOW CONTROL	
Requirement	Type*
3.1. Compact and efficient insulation - U ≤ 0.6 W / m²K and U ≤ 0.5 W / m²K - Insulation rating = Loss by walls (W / K) / Living area (m²) Insulation rating ≤ 0.8 W / m²K and ≤ 0.7 W / m²K	F
3.2. Area of bays Optimize bay surfaces in order to limit leakage while promoting winter solar contributions and natural lighting: 0.12 ≤ S bays / S inhab ≤ 0.20	F
3.3. Energy consumption in primary energy - Very High Level: Consumption ≤ 60 kWhep / m² Area x (a + b) - Low Consumption: Consumption ≤ 50 kWhep / m² Area x (a + b)	F
3.4. Building air-tightness control - High performance level: I4 ≤ 1.2 m3 / h.m² for collective dwellings I4 ≤ 0.8 m3 / h.m² for single-family houses - Low consumption level: I4 ≤ 1 m3 / h.m² for collective dwellings I4 ≤ 0.6 m3 / h.m² for single-family houses The achievement of this performance will be justified by a test at the end of the construction. It is also advisable to provide a leakage test during construction to allow identification of weak points.	F
3.5. Operation - 0 ≤ Consumption ≤ 40 kWh ep / m² area x (a + b) - Implementation of a leakage test justifying the achievement of the I4 value considered in the calculation and at a minimum the values below: I4 ≤ 0.6 m3 / h.m² for collective dwellings I4 ≤ 0.4 m3 / h.m² for single-family houses	S

NB: the financing of the test and the follow-up of operation will be guaranteed by the ADEME for all the operations respecting this requirement.	
3.6. Electricity of general services Implement the following technical solutions to reduce electricity consumption in general services: - Natural lighting of halls, circulations, level floors and stairwells (within the limits of technical and architectural constraints). - Detection of presence and brightness in halls, circulations and floor levels. - Timers or presence detection on stairwells. - Low consumption lamps or fluorescent tubes with electronic ballast in common areas (inside the building + car parks). - Lighting control of parking areas by presence detection. - External lighting control on clock - Low consumption fans. - Lifts with on-board machinery, without speed reducer, cabin lighting controlled by actual operation. This requirement will be fulfilled if at least 7 of the 8 points above have been met.	S
3.7. Electricity of the private areas - Impossibility of juxtaposing cold and cooking appliances. - Favour the drying of the laundry outside. - Individual boiler: control of the circulator to the room thermostat. - Natural lighting in bathrooms and toilets. - Low consumption lamps in the lodgings (stays and rooms). This requirement will be fulfilled if at least 4 of the 6 points above have been met	S
3.8. Water Consumption - Pressure limiting devices adapted not to exceed 3 bars at the origin of each housing. - Flow restriction devices on shower and kitchen mixers and bathroom - 3 / 6L double-flush flushers. - Absence of irrigation system outside the first 2 years of plant growth.	F
3.9. Domestic Hot Water networks: limitation of losses - The length of distribution between the hot water production point and each point of discharging will be limited to 10 meters. - Compliance with this requirement will be justified by a table specifying the lengths of distribution of each dwelling.	S
3.10. Share of renewable energies The share of renewable energies in the overall energy balance will be at least 20% in very efficient 40% in low consumption. The calculation note justifying these results will be provided with the grant application file. The method of calculation used may be either: - the toolbox proposed by the BET TRIBU - TH-CE calculation The renewable energies considered are: passive solar, solar thermal, solar photovoltaic, biomass, wind. Details of the two methods of calculation are given in the appendix.	F

TABLE 51: SOCIAL HOUSING COMPLIANCE FLOW CONTROL CRITERIA. TYPE*: (F) INDISPENSIBLE TO OBTAIN GRANT, (S) FLEXIBLE REQUIREMENT

4 - CONTROL OF THE COMFORTS	
Requirement	Type*
4.1. Summer thermal comfort: the principles Justify the devices put in place to ensure the summer comfort of the dwellings (orientations, through-holes, inertia, sun protection, night ventilation ...)	F
4.2. Summer thermal comfort: optimization for the buildings	S

Justify 80% of houses crossing or bi-oriented on the building	
4.3. Thermal summer comfort: optimization by dynamic thermal simulation Perform a dynamic thermal simulation on at least 20% of the dwellings (retaining the most exposed dwellings in summer) in order to optimize the comfort conditions.	S
4.4. Visual Comfort Specify the arrangements put in place to ensure the visual comfort of the dwellings. Optimize the natural illumination of the houses by simulating the daylight factor and justify by these simulations the respect of the objectives below (minimum 4 of the most disadvantaged premises): Light Average Day Factor (FLJ) for bedrooms 1.5%, for living rooms 2%.	S

TABLE 52: SOCIAL HOUSING COMPLIANCE CRITERIA TO CONTROL OF COMFORTS. TYPE*: (F) INDISPENSIBLE TO OBTAIN GRANT, (S) FLEXIBLE REQUIREMENT

5 - REDUCTION OF NUISANCES, POLLUTION AND RISKS	
Requirement	Type*
5.1. Water Quality Specify by a note the devices used to control the legionella risk (looping, limitation of dead arms, limiting the distances between production and consumption, etc.)	F
5.2. Indoor air quality Specify by a note the arrangements made to facilitate the maintenance of ventilation installations (ventilators, networks, outlets in dwellings). Observe the following conditions: - Windows in 50% of the minimum washrooms. - Outdoor space for laundry drying. - In the case of dual-flow ventilation, fresh air intakes shall be kept away from all sources of pollution and the installed filter shall be at least Class F5 and easily accessible for maintenance. Study the possibility of placing in the kitchen a high-capacity activated charcoal extractor hood which will operate in a closed circuit.	S
5.3. Household waste: collective rooms Allowing local sorting: - Sufficiently dimensioned: references of abacuses available in appendix. - Easy access: on the usual route of the tenants. If necessary, arrange several rooms to meet this requirement. - Easily cleanable (water point and evacuation).	F
5.4. Household waste: private rooms Provide a space for sorting waste in the dwellings (space under sink, cellar, etc.) equipped with minimum 3 bins. For dwellings benefiting from a private garden, plan a composter.	S
5.5. Low-noise site: management of the green building site Write a site charter with low nuisances. Ensure the sorting of construction waste, either by setting up sorting bins and a suitable management system, or by installing a common dumpster to a specialized sorting centre.	F
5.6. Low-noise site: management of construction waste Separate the hazardous waste on site, store it in a leakproof and covered container and then evacuate it to a specialized treatment centre. Justify the waste management by a balance at the end of the work (types and quantities of waste evacuated, difficulties encountered).	F

TABLE 53: SOCIAL HOUSING COMPLIANCE CRITERIA FOR REDUCTION OF NUISANCES, POLLUTION AND RISKS. TYPE*: (F) INDISPENSIBLE TO OBTAIN GRANT, (S) FLEXIBLE REQUIREMENT

In general, after the evaluation of several projects, the main results achievable through the application of the Social Housing Eco Compliance assessment system and this kind of structured programs are:

- higher quality of buildings,
- reduction of consumption costs for tenants,
- better indoor environmental quality for tenants,
- reduction of fossil energy consumption and CO2 emissions,
- contribution to local employment,
- improvement of the knowledge of social housing staff,
- better understanding of the impact of policies.

INTERCONNECTIONS WITH NEWTREND PROJECT

In the chart below are described analogies and similitudes among criteria of this two assessment tools, with some considerations about. The correspondence among many of the criteria contained in the Social Housing Eco Compliance assessment tool it's evident, as shown in the table below.

Social Housing Eco Compliance Criteria	NewTREND Criteria	Comparison
3.10. Share of renewable energies	B.1.3 Renewable Energy on Site	In both cases renewable energies considered are: passive solar, solar thermal, solar photovoltaic, biomass, wind. In NewTREND it's calculated by the ratio of on-site yearly production of renewable energy and yearly average of operational energy demand [%], while the SHEC method evaluates the share of renewable energies in the overall energy balance.
5.2. Indoor air quality	B.5.1 Indoor Air Quality	The criteria are not so similar, in the case of SHEC the objective is to evaluate the arrangements made to facilitate the maintenance of ventilation installations (ventilators, networks, outlets in dwellings). While, for NewTREND criteria, it is established a quality category (I-IV) according to EN 15251 assigned on CO2 concentration above outdoor [ppm]. SHEC is a qualitative indicator not quantitative.
4.4. Visual Comfort	Availability of Daylight Solar Access	In both cases the daylight factor is calculated, The solar access of NewTREND, that is the number of hours in which indoor environments receive natural light, is directly comparable with the Natural lighting of SHEC.
4.1. Summer thermal comfort: the principles 4.2. Summer thermal comfort: optimization for the buildings 4.3. Thermal summer comfort: optimization by dynamic thermal simulation	B.6.2 Thermal Comfort in Cooling Season	NewTREND criterion is calculated according to ISO 7730, about thermal comfort standards while the criteria of SHEC are based on the performing a dynamic thermal simulation on at least 20% of the dwellings (retaining the most exposed dwellings in summer) in order to optimize the comfort conditions. While in criteria 4.1 and 4.2 the request by the evaluation system is to justify the devices put in place to ensure the summer comfort of the dwellings (orientations, through-holes, inertia, sun protection, night ventilation ...).
5.5. Low-noise site: management of the green building site 5.6. Low-noise site: management of construction waste	B.8.1 Acoustic Comfort	In NewTREND the indoor sound pressure level (day and night) [dB] is verified while the criteria of SHEC are focused on the acoustic insulation in the site, related mainly to the management of construction waste.

TABLE 54: COMPARIOSN OF SOCIAL HOUSING ECO COMPLIANCE CRITERIA AND NEWTREND KEY PERFORMANCE INDICATORS

4.3.2. BDM

NAME OF THE RATING SCHEME	BDM
REGIONAL APPLICATION	PACA and mainly in French and Mediterranean territory
RELATED INCENTIVES PROGRAMS	Programs established by the Region Council of PACA
IN USE AT THIS MOMENT	Yes
RELATED GRANTS AT THIS MOMENT	No
RELATED NATIONAL/REGIONAL LAW	Based on Regional standard
TYPE OF BUILDINGS TO BE APPLIED ON	Individual private houses, collective housing (university residences), schools, offices, public facilities and tertiary buildings.
DIFFICULTY OF THE ASSESSMENT	Easy to assess

TABLE 55: SYNTHETIC SCHEME WITH KEY INFORMATION ABOUT BDM

BDM is a very popular rating system, spread across French territory with 378 projects certified. The BDM approach was born in PACA for the Mediterranean territory, only recently been taken up by other regions. When it was developed in 2008, it was supported by the Region Council of PACA by financial incentives, it contributed greatly to the launch of BDM, to its notoriety and therefore to its sustainability. Today it is no longer the case because it is now well known to the owners and many actors integrate it into their specifications. This is the case of the Regional Council for its high schools (the high schools are regional heritage). Any new high school or renovation, follows the BDM approach[80].

Despite of the stop of the economic incentives last year, in 2016, the analysis of this system is really significant because of its widespread on the territory and its large numbers produced: 378 projects with 1.236 million m2 certified. In PACA region, BDM approach is used more in the coastal urban areas which are also the most populated. Projects are available on the map available at this link: http://polebdm.eu/projets.

Proposed by the professional association Envirobat-BDM, BDM is not a certification, it is an effective guide that allows constructions to move towards a more "sustainable approach" within available resources. The mission of that assessment system is, to circulate and become increasingly prevalent all over the French territory and out of the country, to evaluate lots of buildings through the transversality of the application and the systemic approach and the other intent of BDM is to educate professionals, public contracting authorities, professional organizations, builders and craftsmen to the Bâtiment Durable Méditerranéen's practice.

BDM differs itself from other environmental certifications thanks to three particular aspects: it is local, participative and gives systematic feedback based on the experience. Indeed, obtaining a BDM recognition level is conditional on a validation that integrates the three main stages of the construction: design, implementation and operation. The BDM approach is adapted to all buildings built or refurbished in the Mediterranean or mountain environments[81].

How does the Rating scheme work?

In most cases, it's the owner of the building who decides to assess with BDM rating scheme his building, he chooses the so-called "*accompagnateur*" who is the person that develops the evaluation of the project, according to the BDM's practice, and several times he's a member of the design team. Training of this professional is mandatory. Based on the final score you want to get (there are 4 levels: Base, Bronze, Silver

and Gold), an access to a platform called “Beluga” is given to the *accompagnateur* which has to perform the evaluation of the building through the application of the criteria calibrated on the basis of the pre-set level.

Each BDM project is assessed before a professional commission starting from the designing of the project (in the case of new construction), going through the completion of the works and the operation with the users. BDM commissions are free and open to the public, it’s composed by at least 6 people, usually one commission per month is established.

WHERE THE RATING SCHEME IS USED: REGIONAL CONTEXT

The approach BDM is particularly adapted to the context of all the Mediterranean arc but also alpine and pre-alpine because during 2011 was established a working group for "Sustainable Alpine Building" and the BDM rating scheme was enriched with criteria calibrated in this context. The application is mainly developed in PACA region, where the system was born, but many evaluated buildings are also present in the Rhone Alpes, Roussillon, Auvergne regions and few isolated cases are also present in North America, in the San Francisco area.[82]

INCENTIVES PROGRAMS RELATED TO THE RATING SCHEME

Economic incentives stopped last year, in 2016 so BDM it’s now strongly recommended but no longer linked with economic incentives. There are two main reasons for the stop of the economic aid: the change of political majority in the Regional Council and the significant drop in community budgets. The combination of the two brought other priorities to the agenda.

RELATED ECONOMIC INCENTIVES

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RELATION BETWEEN INCENTIVES, PERFORMANCES AND SCORE

The structure of BDM rating scheme is organized around seven themes:

1) Territory and Site
2) Materials
3) Energy
4) Water
5) Comfort and Health
6) Social and Economy
7) Project management

The assessment system of BDM tool is shown in the following table.

ASSESSMENT CRITERIA BDM
1 - TERRITORY AND SITE
1.1.1 Promoting urban density
1.1.2 Participate in urban renewal

1.1.3 Facilitate the access to local shops and services
1.1.4 Promote the use of alternative transport to the individual car
1.1.5 Optimize the benefits of the plot
1.1.6 Flow and parking management
1.2.1 Respect the rules of bioclimatic architecture
1.2.2 Provide spaces according to usage and needs
1.2.3 Do not create discomfort to the neighbourhood and to the immediate environment
1.3.1 Managing soil
1.3.2 Creating transition spaces between inside and outside
1.3.3 Promote the maintenance and development of biodiversity
2 - MATERIALS
2.1.1 Use eco-materials in significant quantities
2.1.2 work and bio sourced finishes
2.1.3 HHT and development
2.2.1 Encourage the development of local networks of eco-efficient materials
2.3.1 Minimize the use of new materials
3 - ENERGY
3.1.1 Search superior energy performance regulatory requirements
3.2.1 Reduce power consumption
3.2.2 Optimize energy efficiency of equipment
3.3.1 Production of renewable energies
4 - WATER
4.1.1 Reduce water consumption
4.2.1 Re-use rainwater and wastewater
4.3.1 Limiting soil waterproofing
4.3.2 Manage waste water
4.3.3 Preventing the pathologies of the building related to water and water vapor
5 - COMFORT AND HEALTH
5.1.1 Satisfying thermal comfort
5.1.2 Protect yourself from solar inputs in summer and use them in winter
5.2.1 Acoustic comfort consideration
5.2.2 Promote natural light and views
5.3.1 Limiting indoor pollution
5.4.1 Limit exposure to health risks
6 - SOCIAL AND ECONOMY
6.1.1 Using sustainable design tools
6.2.1 Generate participation
6.2.2 Promoting the social and solidarity economy
6.3.1 Promote social mix
6.3.2 Pooling equipment and services
6.4.1 Facilitate scalability and modularity
6.5.1 Improving the prevention of risks to the health and safety of workers
6.5.2 Preventing and compensating for prejudice
7 - PROJECT MANAGEMENT
7.1.1 Program and design your project in BDM approach
7.1.2 Finalize the BDM design phase
7.1.3 Monitor the progress of the BDM site and manage waste and nuisances
7.1.4 Monitor the energy and water consumption of the BDM building in operation

7.2.1 Promote competent professionals in Mediterranean Sustainable Buildings

TABLE 56: BDM ASSESSMENT CRITERIA

INTERCONNECTIONS WITH NEWTREND PROJECT

BDM Criteria	NewTREND Criteria	Comparison
3.3.1 Production of renewable energies	B.1.3 Renewable Energy on Site	NewTREND's criterion calculates the ratio of on-site yearly production of renewable energy, into the BDM system are considered the production of renewable energy by PV systems, calling for 100% of electricity supply from renewable resources.
5.3.1 Limiting indoor pollution	B.5.1 Indoor Air Quality	The objective of this criteria is to maintain a satisfactory level of indoor air quality, limiting emissions. BDM system targets the objective by evaluating the mechanical ventilation system, as well as the type of materials used and their emissions. In addition, an air quality monitoring stage is also ensured during the in-use phase of the building.
5.1.1 Satisfying thermal comfort	B.6.2 Thermal Comfort in Heating Season	NewTREND criterion is calculated according to ISO 7730 thermal comfort standard while in the BDM assessment system it's evaluated if the construction has a natural ventilation system at night in summer (warm period), if the heating control of the building is equipped with 2 climate sensors, if conditioned spaces will respect the Act of 1 July 2007 prohibiting air conditioning at less than 26 ° C
5.1.1 Satisfying thermal comfort	B.6.3 Thermal Comfort in Cooling Season	NewTREND's criterion has the purpose of optimising the cooling systems to reduce the energy consumption, while in BDM system it is considered more users' health and well-being through the evaluation of the heating temperature, that in winter has to be 19°C (and not air temperature) and if permanent use spaces have highly inertial.

TABLE 57: COMPARISON OF BDM CRITERIA AND NEWTREND KEY PERFORMANCE INDICATORS

4.3.3. IMPACT OF USING RATING SCHEMES

The use of rating schemes on retrofit projects raise awareness to the sustainable refurbishment of buildings and enhance the understanding of the importance of sustainability. The application of an assessment system allows to measure the performance before and after the intervention to expose underperformance, and showcase the improvement, decline, or stagnation, of performance. Rating schemes, as we have seen from previous analyses, are very different in composition, choice of criteria and calculation methods, because they come from different contexts. What unites them is the measurement of the environmental, social and economic sustainability of projects and assets, to support professionals delivering enhanced environmental benefits to obtain better social and economic outcomes.

They can be used during the initiation and development phases of the retrofitting project planning, to incorporate sustainability considerations into the overall project. Another important point is that a specific tool application process for retrofitting projects is usually required to receive a grant, for that reason rating schemes are really relevant also to get economic incentives through the application of an assessment sustainable tool. Applying a rating scheme could generate a reduction of costs from a more efficient use of resources. The use of an assessment system could also improve the sustainability performance of the buildings over their lifecycle, encouraging performance monitoring during the post-retrofit phase.

5. CONCLUSIONS, RECOMMENDATIONS

Legislations, incentives and rating schemes are the instruments to implement the sustainable transition of the built environment – they are the tools to turn ideas into reality. In the most concise way to put it, rating schemes allow us to organise sustainability goals, legislation is the formal agreement of society to (and how to) reach them, while incentives provide the muscle to push the process forward.

At the heart of each instrument are indicators: specific, quantified, measurable, clear information describing – more broadly – sustainability and – in NewTREND context – energy efficiency. Indicators are used to express a deficit in the first place, upon which legislation can register a social contract to overcome. National and supranational strategies set out targets for energy consumption, energy efficiency, renewable share for various sectors, including buildings, expressed through indicators and ask the legislative to transpose these targets into criteria embedded into technical codes of building.

Energy performance is generally economically advantageous, but significant investment costs and a long and risk-ridden return period with low returns discourage potential adopters and erect impassable entry barriers for others. Depending on the maturity of the technical solutions delivering them, implementing energy performance is a venture between financially not viable but socially valuable and financially and socially viable. Thus, public institutions agree to generate financial incentives to offset technical immaturity, bridge entry barriers, and eventually fast-forward sustainable transition. An incentive is a benefit package tied to energy performance standards, and the key difference between incentives and legislation is that the former makes energy performance more desirable, while the latter makes it obligatory.

No matter how we call them – targets, criteria or performance standards – performance indicators transmit the operation and impact of one instrument type to the other. To clarify and communicate complex energy and sustainability performance, indicators are organised into comprehensive frameworks: rating schemes. Rating schemes allow to easily compare projects, cities, regions, countries, and are often tied to financial incentives. There is a specific market for different rating schemes, but in the EU, national ratings are written into law for energy performance of buildings – derived from the calculations and thresholds from the energy performance criteria within building codes.

The research question – Are NewTREND KPIs compatible with the way energy performance is measured by current and emerging practices of legislation, financial incentivisation and rating in the EU – has been answered by dissecting 105 financial incentives, the legislative background of the EU and the three demo sites, and 6 rating schemes tied to financial incentive programs. Among the analysed instruments, the representation of indicators that are similar to NewTREND are very high (Table 58). Especially the energy related indicators, more specifically primary energy demand appeared to be the most common metrics. Comfort indicators are more prevalent among rating schemes that aim for wholeness and among legislation, due to the comfort-related criteria present in all EU country building codes. On the other hand, cost reductions are more prevalent among fincancial incentives, especially in the case of market-based ESCOs, where the revenue stream is directly derived from reduced utility costs. There were only seven incentives not mentioning related KPIs, these achieve sustainability goals solely via a list of approved interventions/manufacturers. The appearance of NewTREND KPIs are, on the one hand reassuring, as the professional and general discourse approaches energy performance similarly. On the other hand, effort must be directed to communicate how NewTREND KPIs provide additional value.

KPI	Legislation within demo site context	Incentives	Rating schemes
Primary energy demand	57 %	60 %	100 %
Renewable energy generated on-site	17 %	34 %	100 %
Impacts	4 %	36 %	No data
Comfort	12 %	5 %	100 %
Operational costs	4 %	21 %	17 %

TABLE 58: OCCURRENCE OF NEWTREND KPIS AMONG ANALYSED INSTRUMENTS BY INSTRUMENT TYPE

Specific insights can be drawn by looking at the three instrument types separately. EU level legislation defines the market for the application of NewTREND, by stating that the building sector is responsible for about 40% of energy consumption and 36% of CO2 emissions in the EU and that in most of EU Member States only 55 to 70% of the buildings comply with the energy performance requirements for renovated buildings. National and regional strategies also identify the key barriers for sustainable transition, which are directly transferable challenges that NewTREND applications must also address. First, to kickstart the energy renewal market of buildings, both the demand side and the supply side needs to be far better equipped with knowledge, both general and technical. The former to shape attitude and create a culture for sustainability, and the latter to share recent technologies, practical knowledge for site managers, building owners and best practices. Second, key stakeholders in often extensive networks temporarily coming together for a single project need to meet and share the necessary information to create an appetite for refurbishment. Finally, there are financial barriers explained before and addressed by incentives. In short, NewTREND must overcome barriers of information dissemination, barriers of collaboration, and barriers of funding.

Looking at incentives give insights on where the energy refurbishment market is headed. As technical solutions mature, they become cheaper and more accessible to segments of the society currently reached with incentives. The energy efficiency sector in the EU nowadays is pushed by an urgency to show leadership in the commitments of international treaties such as the Kyoto Protocol and the Paris Accords. Most intensive form of incentives are public and private (charitable) non-refund financial supports, followed by subsidized loans and tax incentives. At the end of the chain, energy performance contracting, unless subsidized, is a purely market based financing form. The EU is progressively shifting from grants to loan schemes, and in the meantime, the ESCO market is steadily growing – albeit it does so more consistently overseas.

Finally, the wide variety of rating schemes and their application to financial incentives raise a significant challenge to the NewTREND KPI system and methodology. Rating schemes, as seen from previous analyses, are very different in composition, choice of criteria and calculation methods, because they come from different contexts. This implies that there is no one-size-fits-all approach, and any new indicator system must be able to transform from application regime to application regime, which is one of the key values of the modular calculation methodology of NewTREND KPIs. This is extremely relevant given that many incentives require a specific or an equally qualified assessment methodology, and in these cases, the funding for a NewTREND supported project might depend on how easily this qualification can be proven. At the same time, NewTREND is in competition with other rating schemes, thus it must have a clear position that delivers added value compared to the rating schemes analysed here.

To summarize the results of this report, the key findings regarding the research question are:

1. Only 7 out of 141 units of analysis did not refer to NewTREND KPIs or similar.
2. The NewTREND indicator spectrum is wide enough to cover all common incentive type.
3. Out of the three main instrument categories (legislation, financial incentive, rating scheme), NewTREND indicator framework is the closest to rating schemes.
4. Comfort is the least covered theme among financial incentives.
5. Market-based financial incentives focus mainly on operational cost reduction.
6. Public financial incentives focus directly on energy demand and renewable energy.

Additionally, further key insights to NewTREND platforms and methodology are:

1. Energy retrofitting must overcome barriers of information dissemination, barriers of collaboration, and barriers of funding.
2. Financial incentives progress to more commitment-reliant, and market based options.
3. Predesigned channels to localize NewTREND KPIs open up possibilities to exploit established rating schemes connected to funding.

5.1. Feedback to other NewTREND tasks

It is necessary to examine how this study can reflect upon the previously developed NewTREND tasks and what added value does the study provide for them.

This study tries to bridge the gap between the current market of financial incentives, rating schemes, the legislative background of the energetic sector of the building industry and NewTREND. It has the most relevance to the KPI list developed in T2.2, the methodology from T2.6 and the other financial tasks (T5.1, T5.2, T5.3).

The NewTREND KPI system helps the retrofit project to analyse the current state of a building or district and select an optimum refurbishment scenario. Connecting KPIs to financial instruments can help to consider the financial and business instruments and the legislative environment of the particular project. Therefore, based on the findings of this study it is worth to consider the inclusion of the following updates to the KPI list, either in the near future or on a longer term:

- Harmonizing the energy efficiency requirements specified in EU member state legislation with KPI benchmarks would be beneficial for designers and decisionmakers as the legislative viability of a selected scenario can be determined quickly in each member state. As most states define energy efficiency requirements for major renovations this comparison would be later a necessity.
- Alternatively, users could customize their energy indicator benchmarks to a preferred legislation or performance measure of a financial incentive or rating scheme
- Going further with connecting NewTREND to the current field of financial instruments would be the development of an energy efficiency calculation methodology that can substitute performance calculations when applying for financial aid and compatible with EU/specific national calculation methodologies. One of the main constraint here is that the current energy consumption methodologies in most EU member states do not use dynamic energy simulations.

This task can also reflect back on the NewTREND IDM:

- Ideally, NewTREND methodology would cover the process of obtaining funding for the project or suggest specific incentives to the relevant stakeholders.

- The collaborative design platforms could also be adjusted to include energy performance contractors and other emerging stakeholders on the investor end.

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[47] https://www.palyazat.gov.hu/kehop-522-kzpletek-kiemelt-pletenergetikai-fejlesztsei

[48] https://www.ofgem.gov.uk/environmental-programmes/domestic-rhi/contacts-guidance-and-resources/tariffs-and-payments-domestic-rhi/current-future-tariffs

[49] http://www.boe.es/boe/dias/2013/10/01/pdfs/BOE-A-2013-10201.pdf

[50]https://www.deutsche-bank.de/pk/kredit/kredit-im-ueberblick/privatkredit.html?tp=aktuellesangebot

[51]https://www.kfw.de/inlandsfoerderung/Privatpersonen/Bestandsimmobilien/Finanzierungsangebote/Energieeffizient-Sanieren-Erg%C3%A4nzungskredit-(167)/

[52]https://www.kfw.de/inlandsfoerderung/Privatpersonen/Bestandsimmobilie/Energieeffizient-Sanieren/Das-KfW-Effizienzhaus/

[53]https://www.kfw.de/inlandsfoerderung/%C3%96ffentliche-Einrichtungen/Energetische-Stadtsanierung/Finanzierungsangebote/Energieeffizient-Sanieren-Kommunen-(218)/

[54] https://www.hud.gov/offices/hsg/sfh/eem/eemhome.cfm

[55] http://www.advancedfp7.eu/Home/AD-Projects-Map/Enel-Info

[56] https://www.ofgem.gov.uk/environmental-programmes/fit/fit-tariff-rates

[57] http://www.syscolux.hu/en

[58] http://www.nrcan.gc.ca/energy/efficiency/buildings/eefb/3705

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[67] http://www.itaca.org/valutazione_sostenibilita.asp

[68] CABEE (2015). Towards assessing 100 % of Public Buildings.

[69] http://www.comune.torino.it/rigenerazioneurbana/recuperourbano/cdq.htm

[70] http://www.regione.piemonte.it/edilizia/progrCasa.htm

[71] http://www.regione.veneto.it/web/lavori-pubblici/incentivi-urbanistici-per-ledilizia-sostenibile

[72] http://www.umweltverband.at/bauen/kommunalgebaeudeausweis-kga/

[73] http://vorarlberg.at/vorarlberg/land_politik/politik/landesregierung/start.htm

[74] http://vorarlberg.at/vorarlberg/bauen_wohnen/wohnen/wohnbaufoerderung/start.htm

[75] http://www.raee.org/en/who-are-we/company-profile.html

[76]http://www.raee.org/fr/raee-agence-regionale-de-lenergie-et-de-lenvironnement-en-auvergne-rhone-alpes.html

[77] http://www.arra-habitat.org/

[78] http://www.arra-habitat.org/

[79] http://www.arra-habitat.org/Presentation-et-missions.html

[80] http://www.zemeds.eu/sites/default/files/Pr%C3%A9sentation%20d%C3%A9marche%20BDM_1.pdf

[81] polebdm.eu/page/quest-ce-que-la-demarche-bdm

[82] http://polebdm.eu/projets

7. ANNEXES

ANNEX A - PROTOCOLLO ITACA'S CASE STUDIES

Some examples of the application of the ITACA Protocol in the incentives Programs analysed in the following.

Project type	**Refurbishment of a residential building block (with common facilities, socialization areas and a gym)**
Location	Ex I.P.A.I. Via Forlanini, located in Vercelli
Project area	8,860 m2
Main stakeholders	House Territorial Agency of the municipality of Vercelli
Incentive program used	"Programma Casa"
Assessment tool used	ITACA Protocol
Implemented technologies	This refurbishment has provided the insulation of the concrete structure, the replacement of the windows, the renovation of the plants, the insertion of a photovoltaic system for the needs of the residential structure and a thermal power station with condensing boilers

ANNEX_TABLE 1: REFURBISHMENT OF A RESIDENTIAL BUILDING – CASE STUDY PROFILE

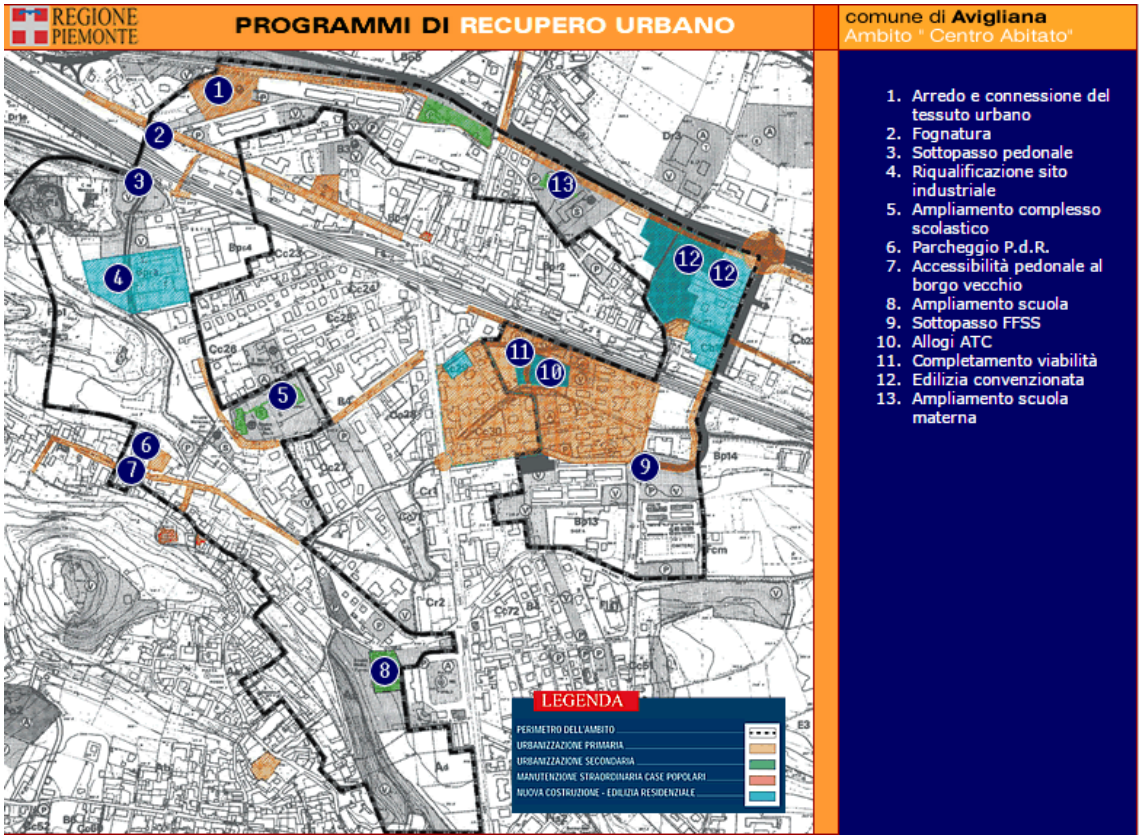
Following some images regarding the state of the building before and after the intervention and the technologies implemented into the project.

ANNEX_FIGURE 1: EX I.P.A.I. IN THE MUNICIPALITY OF VERCELLI, ITALY, PHOTOGRAPHED BY GIANNA DAMONTE

Project type	Historical centre, partly covered by the urban restoration project
Location	**Avigliana**, small city near Turin
Project area	The size of the intervention area is 28 hectares
Main stakeholders	the municipality of Avigliana, Piedmont Region, the Local government, the House Territorial Agency of Turin, Social housing organization and Local construction companies and cooperatives
Incentive program used	"*Contratti di Quartiere*"
Assessment tool used	ITACA protocol
Implemented technologies	The activities carried out included the retrofitting of three residential buildings, the realization of new infrastructures (street network, green areas, schools) and the reconnection of the medieval part of town with the more recent development[2]. The principles outcomes were the recovery of abandoned structures, the revitalization of town centre, a heightened social mix and support for fragile sectors of society.

ANNEX_TABLE 2: HISTORICAL CENTRE RESTORATION PROJECT – CASE STUDY PROFILE

[2] http://www.sistemapiemonte.it/cms/pa/territorio-edilizia-e-opere-pubbliche/servizi/833-riqualificazione-urbana/3205-programmi-di-recupero-urbano-pru



ANNEX_FIGURE 2: AVIGLIANA REFURBISHMENT MAP[3]

[3] http://www.sistemapiemonte.it

Project type	Two blocks of historic buildings with heritage value
Location	**via Dina, in Turin**
Project area	
Main stakeholders	owned by the City of Torino
Incentive program used	"Contratti di Quartiere" The distribution of the financing for type of intervention is broken down as follows: Actions & Services 48%, Housing 34%, Secondary infrastructures (schools, public buildings, etc) 10%, Primary infrastructures (streets, networks, etc.) 8%, Offices & Retail 0%.
Assessment tool used	ITACA Protocol [4]
Implemented technologies	The district is in the south edge of the city, and was recently refurbished through the EU program URBAN (which excludes social housing refurbishment). Additional work includes completing the existing infrastructures and connecting with the more recent built environment. 550 are dwellings refurbished through central-regional government funding. The outcomes of the refurbishment project are an increment of outdoor areas are permeable and a decreasing in energy consumption.

ANNEX_TABLE 3: TWO BLOCKS OF HISTORIC BUILDINGS WITH HERITAGE VALUE – CASE STUDY PROFILE

[4] http://www.atc.torino.it/www/comunicato1225.aspx

Project type	Social housing district built in the first half of '900 (1942)
Location	Via Ghedini, in Turin (IT),
Project area	The refurbishment area, whose perimeter is bounded by via Cimarosa, Via Bologna, via Pergolesi, via Cravero, via Ancina and via Petrella, is located in Turin area known as "Barriera di Milano".
Main stakeholders	municipality of Turin, Piedmont Region, Local government, the House Territorial Agency of Turin, Social housing organization and Local construction companies and cooperatives
Incentive program used	Contratti di Quartiere The distribution of the financing for type of intervention is broken down as follows: Housing 68%, Primary infrastructures (streets, networks, etc) 17%, Secondary infrastructures (schools, public buildings, etc) 9%, Actions & Services 6%, Offices & Retail 0%.
Assessment tool used	ITACA Protocol
Implemented technologies	Both the building and the surrounding area were in a state of neglect: the aim of the program was to restore green areas and provide services for social cohesion. 300 were dwellings refurbished through central-regional government funding. The principles outcomes were the reduction of need for additional cooling units during the summer, the reducing heating costs, the improvement of outdoor space quality for inhabitants and the safer buildings for aging population.

ANNEX_TABLE 4: SOCIAL HOUSING DISTRICT BUILT IN 1942 – CASE STUDY PROFILE

ANNEX_FIGURE 3: SOCIAL HOUSING DISTRICT BUILT IN 1942[5]

[5] http://www.torinoclick.it/?p=16946

Project type	Historic center of the small town of Nole
Location	City of Nole, near Turin (IT)
Project area	Project area is in the historic center of Nole (IT)
Main stakeholders	Municipality of Nole
Incentive program used	The regional government funding was of € 2.899.196,76 while the municipality funding: € 416.737,70 (covered by a 25-year management of the dwellings as social housing). The distribution of the financing for type of intervention is broken down as follows: Architectural: 49,37%, Structural: 30,10%, Systems: 20,53%.
Assessment tool used	ITACA protocol
Implemented technologies	The historic centre of the small town of Nole suffered from abandonment and decay, worsened in 2006 by the collapse of the 16th century bell tower, which severely damaged collateral structures, including the church. The adjacent block, called the home of the priest, was chosen as part of a larger refurbishment effort to revitalize the centre of the town and recover its historical value. The interventions and strategies/solutions applied for the Environmental sustainability were: Thermal insulation with new external insulation in walls (conductivity of 12 cm insulating panel < 0,036 W/mK) and new windows, wood frame, stratified low emitting glazing (U<1,7 W/m2K) Natural ventilation, optimization for natural cooling Hot water production with solar thermal panels (36 m^2 panels) Photovoltaic modules on the roof High permeability of outdoor areas The interventions and strategies/solutions applied for Social sustainability were: 15 new social housing dwellings, 3 of which to be completely accessible 2 areas for community use New green area for public use

ANNEX_TABLE 5: HISTORIC CENTRE OF SMALL TOWN NOLE – CASE STUDY PROFILE

ANNEX B - BIOVER2's Case Studies

Project type	**Day care centre for people with disabilities[6],**
Location	Pederobba (TV), Italy
Project area, characteristics	940,00 m² The building is sized for a maximum of 30 disabled people and 10 operators. Accessibility is a strong point, integration and proximity to the town centre and its services in favour of a greater connection with the community and the distribution system has strong reciprocity between inside and outside. It is important to add also that participatory design has played an important role, particularly in the design of buildings for people with disabilities, both for new and renovated. The architectural quality and the energy performance must be accompanied by a space able to meet the needs of users (the disabled and operators) to ensure optimal conditions for the permanence and activities. This work has highlighted the importance of considering and further improve these aspects on a larger scale.
Main stakeholders	"Vita e Lavoro" Social cooperative, while the contact for the implementation of the project is Venetian "Metadistretto della Bioedilizia", the Urban Organization and Landscape Department Veneto Region (REGVEN) The Day care centre has been built thanks to the agreement among the municipality, the local health authority and the cooperative of families of people with disabilities that is managing the centre and that had for long time expressed the expressed the need for new spaces, larger and more comfortable. Proximity to the centre and integration within the community are the keys of the success of this project.
Incentive program used	Part of the structure was financed by the family members of the cooperative's part thanks to charities donations and public funding.
Assessment tool used	Biover2
Implemented technologies	Structure is realized in wood and steel, with wood infill panels made from PEFC certified European forests, relating to this aspect, it's necessary to underline the importance of a quality environments for users and how this has a positive influence especially for these categories of users[7]. Between the two volumes there is the main entrance, on the ground floor there are an exhibition area, bathrooms, physical activities rooms, a small office and a technical space; on the first floor, there are 3 workshop areas, a massage room, a canteen with relative services and rest room. On the ground floor, the chromatic and perforated patterns choices make use of traditional constituent principles, with the use of coatings exposed face plastered surfaces alternating with respect to internal use. As said before, the main structure is made of spruce wood from PEFC and CFC certified European forests. The OSB panels used in the construction are made with the scraps of the trunks of coniferous wood. Other wood-based materials used in the construction of the building are the mineralized wood and insulation wood fibre panels which always use the scraps of the trunks of coniferous wood. The choice of wood as the main structural material allows a lower environmental impact, and the

[6] http://www.vitaelavoro.it/servizi/centri-diurni/ceod-pederobba.html

[7] http://wiki.cesba.eu/w/images/4/48/CABEE%2C_front_runner%2C_Daycare_center_for_people_with_disabilities%2C_description.pdf

	energy used for the production of the raw material is significantly lower than that used for the production of the normal traditional building materials. In terms of humidity the wooden structure, especially if exposed, ensures optimum hygrometric regulation and better comfort. Thanks to the precise design of the mechanical systems and of the building envelope, winter heat losses are very limited and, in order to minimize the summer loads, special care has been taken in shielding the glass surfaces. For the same purpose were also used natural elements such as hedges, trees, creepers. Briefly are described some adopted solutions: a radiant floor with heating and cooling function, an air exchange system with heat recovery and dehumidification. The generation of heat and cooling energy is provided by a geothermal heat pump that picks up heat into the ground or discharge depending on the season. The whole building-system is self-sufficient with the installation of a photovoltaic system that provides equal energy (and surpluses) to that consumed for heating and cooling the building. For the production of domestic hot water are installed solar thermal panels that cover 50% of the domestic hot water needs of the structure. Analysing the first year of operation, the data obtained show a very positive result, since the building has produced more than it consumed: Energy consumed for heating, air conditioning, air exchange, hot water = 8,500 KWh Energy produced by the PV in the winter months = 5,022 KWh Specific primary energy = 17 kWh / m² year Annual energy produced by PV13.44 kWp = 13,500 KWh.

ANNEX_TABLE 6: DAY CARE CENTRE FOR PEOPLE WITH DISABILITIES – CASE STUDY PROFILE

ANNEX_FIGURE 4: DAYCARE CENTER FOR PEOPLE WITH DISABILITIES, PEDEROBBA (TV), ITALY[8]

ANNEX_FIGURE 5: STRUCTURE REALIZED IN WOOD AND STEEL[9]

[8] http://www.vitaelavoro.it/servizi/centri-diurni/ceod-pederobba.html

[9] http://wiki.cesba.eu/w/images/4/48/CABEE%2C_front_runner%2C_Daycare_center_for_people_with_disabilities%2C_description.pdf

ANNEX C - KGA's Case Studies

CASE STUDIES IN THE COUNTRY

Project type	Bezau Middle School[10]
Location	Platz 138, 6870 Bezau, Vorarlberg, Austria.
Project area	Gross floor area 6,426 m^2, Cubature 32,187 m^3. Energetic reconstruction and extension of a school building from 1972 in the passive house standard. The Middle School and Polytechnic School Bezau is a massive construction located in the centre of town right next to the church. It was built during the years 1969 to 1972 and has an annexed gym.
Main stakeholders	Building owner that is the municipality of Bezau
Incentive program used	Programs established with the Consulting team of Vorarlberg
Assessment tool used	KGA (Kommunalgebäudeausweis) also known as "Municipal Building Pass"
Implemented technologies	Part of the renovation work involved extension of the gym to the north and west in order to meet standard gym norms. Thermal improvements of the old school house included a new outer shell with an insulated wooden facade, an insulated attic floor and new, wood-aluminium windows. A new massive construction was added to the school grounds for multi-purposes. While the building is mainly characterized by a wooden facade, the distinguishing factor is the black, eternit covering. The old building's gable roof is counterpoint to the new building's flat roof. On the ground floor, the two buildings are connected by a large foyer, which can be converted into a seminar room using a mobile partition. The forecourt was raised to the same height as the rooms and made accessible via a ramp. Below that area, underground parking was built with 16 spaces. A lift was installed between the two buildings making the entire complex wheelchair accessible Energy and supply • 19 kWh/(m2GFAa) heat demand according to OIB based on the conditioned gross floor area • heating demand from long-distance heat Health and comfort • ventilation system with >85 heat recovery Building materials and construction • usage of ecological materials and avoidance of PVC

ANNEX_TABLE 7: BEZAU MIDDLE SCHOOL – CASE STUDY PROFILE

[10] Thomas Rosskopf, Beatrix Dold, Sabine Erber Energieinstitut Vorarlberg

ANNEX_FIGURE 6: ENERGETIC RECONSTRUCTION AND EXTENSION OF THE MIDDLE SCHOOL IN BEZAU VORARLBERG, AUSTRIA[11]

[11] Photos published with the kind permission of the municipalities, architects and photographers

Project type	Langenegg Municipal Building[12]
Location	Bach 127, 6941 Langenegg, Austria.
Project area	Gross floor area 1,473 m2, Cubature 3,980 m3. The municipal offices in this building include the Vorderwald social welfare office, home health care, the fire department with team room, and four apartments. In 2002, the top story and roof were renovated.
Main stakeholders	Building owner that is the municipality of Langenegg
Incentive program used	Programs established with the Consulting team of Vorarlberg
Assessment tool used	KGA (Kommunalgebäudeausweis) also known as “Municipal Building Pass”
Implemented technologies	The complete building shell renovation incorporated exterior insulation of 20 cm thickness in the outer walls, and new, triple glass windows that were added in 2008. By tearing down a retaining wall, a larger meeting place could be designed at the building’s entrance. When the wall was torn down, the building’s proportions could be well seen and gave it a rightful place in the village square. Already built on the roof in 1993, 63 m2 of solar panels have been providing the necessary hot water heating for offices and a nursing home. The community building in Langenegg is connected to its own local, wood chip, heating network, which covers the premise’s energy demand. By optimizing heat distribution in the building, adding a new heat control system as well as a ventilation system with heat recovery, energy efficiency could be improved. The ventilation system also provides pleasant, indoor air quality with low concentrations of CO2. It was calculated that the amount of energy saved by the municipal building renovation equals more than the energy needed to run the new food market in the town’s centre. This made retainment of the biomass plant still reasonable and hindered its removal. For the renovation work, only environmentally acceptable and sustainable building materials were used. Energy and supply • 13.6 kWh/(m2GFAa) heat demand according to actual consumption • 63 m2 solar thermal plant for hot-water heating • heat demand from communal district heating network • minor heat demand enables the supply of the supermarket without an extension of the biomass heating plant Health and comfort • comfortable indoor air quality with minor CO2concentration through efficient ventilation system with heat recovery Building materials and construction • usage of building materials which are unobjectionable in terms of building ecology and sustainability

ANNEX_TABLE 859: LANEGEGG MUNICIPAL BUI8LDING – CASE STUDY PROFILE

[12] Thomas Rosskopf, Beatrix Dold, Sabine Erber Energieinstitut Vorarlberg


ANNEX_FIGURE 7: LANGENEGG MUNICIPAL BUILDING, AUSTRIA. PHOTOS BY ROBERT FESSLER[13]

Project type	Dornbirn Wallenmahd Elementary School[14]
Location	Bachmähdle 11, 6850 Dornbirn, Austria.
Project area	Gross floor area 3,250 m2, Cubature 17,500 m3. Reconstruction (approx. 65) and extension (approx. 35) as an accessible school building with passive house components; heat demand and hot water from district heating Hatlerdorf.
Main stakeholders	Building owner that is the municipality of Dornbirn
Incentive program used	Programs established with the Consulting team of Vorarlberg
Assessment tool used	KGA (Kommunalgebäudeausweis) also known as “Municipal Building Pass”
Implemented technologies	The building’s shell was carefully renovated so that its original character was maintained. The school’s rear annex, caretaker house, and gym’s equipment were torn down. Instead, a new single-story building was added, which includes an entrance with disability access, day care, and library. This annex is a concrete construction with internal insulation. A glassed corridor and single-pitch roof connects school and gymnasium. The roof also offers a weather protected area during breaks. The classrooms have suspended, acoustic ceilings, which allow a small space for plumbing fixtures and air ducts for ventilation. The staircase was enclosed with fire resistant glass to ensure an escape route. In addition to stairs, there is also a lift for the handicapped. The opaque surface of the building’s shell was optimized by adding thermal insulation. Triple-glass windows offer good transmission of direct sunlight. Shade is provided by blinds controlled by the building management system. Unnecessary heat loss can be prevented by installing a controlled ventilation system. This will also provide good indoor air quality that supports a comfortable learning

[13] Photos published with the kind permission of the municipalities, architects and photographers

[14] Thomas Rosskopf, Beatrix Dold, Sabine Erber Energieinstitut Vorarlberg

	environment. Heating and hot water is locally supplied via Hatlerdorf. In accordance to safety standards and indoor emission levels, all building materials were examined in advance for their sustainable value and their local point of origin. Energy and supply • 17.7 kWh/(m2GFAa) heat demand based on the conditioned gross floor area Health and comfort • indoor air quality: VOC category 3, formaldehyde category 1 Building materials and construction: • usage of ecological, regional materials • ecological index of the total mass of the building

ANNEX_TABLE 9: DORNBIRN WALLENMAHD ELEMNTARY SCHOOL – CASE STUDY PROFILE

ANNEX_FIGURE 8: REFURBISHMENT OF THE DORNBIRN WALLENMAHD ELEMENTARY SCHOOL[15]

[15] Photos published with the kind permission of the municipalities, architects and photographers

ANNEX D - Housing Subsidy Case Studies

CASE STUDIES IN THE COUNTRY

Project type	Social housing building named "Kennedy"
Location	in Rhône-Alpes
Project area, characteristics	Kennedy is a building of 96 apartments (6500 m²) located in Bourgoin Jallieu and managed by the social housing OPAC38, an important social housing society in Rhône alps with more than 20 000 dwellings[16]. About 350 people occupies it.
Main stakeholders	Managed by the social housing OPAC38
Incentive program used	Social Housing Program
Assessment tool used	Social Housing Eco Compliance
Implemented technologies	Several refurbishment scenarios were examined. Four principal steps have been defined to make a success refurbishment action: 1. Be aware of the site, technical choices and performance levels expected. A summary factsheet is prepared summarizing the technical characteristics of the project, the conditions of use and the expected performance. It is based on the design phase and documents. The monitoring needs are expected to be able to monitor real consumption. 2. Attend to "Prerequisites Operations Reception" (OPR) of the Social Housing Eco Compliance tool. AGEDEN, a local energy agency, operates during the reception phase highlighting the differences between the conception and what has actually been implemented, verifying the correct installation and proper operation of equipment (heating, ventilation...) and monitoring systems. 3. Check the good functioning of the facility monitoring the building. During the first year, AGEDEN intervenes to check if energy performance is achieved. For this reason, the consumption of heating and hot water as well as temperature departures and returns are recorded every month. This statement of consumption ensures that the system operates correctly. A survey is also conducted among the people to know their feelings and how to use the building. 4. Assessments of results. The report at the end of the first year can identify whether there is over-consumption and to investigate whether the problem is technical or it is related to improper use of the equipment. In this way, it is possible to propose a corrective maintenance and eventually reach the goals of energy efficiency. In addition, the analysis of consumption for heating and hot water proves that the project is a success because the wood boiler responds favourably to the demand for heating and hot water without necessarily resorting to the extra gas. Real consumptions of heating are very close to the expected ones. Coming back to the refurbishment actions implemented to project, one of the most relevant is the varying of the insulation thickness. Initially in fact, the building was not insulated and units were individually heated by gas or electricity. The building has been insulated from outside with 15 cm of insulation because the study showed that the additional cost of increasing insulation thickness was quickly paid off through

[16] http://wiki.cesba.eu/wiki/Front_runner_projects_CABEE

	energy savings. An energy optimization study was conducted. It showed the need to improve the building and set up a centralized automatic wood chip boiler. Before the refurbishment, the ventilation was done naturally. However, by performing external insulation, the building has a good airtightness, which can degrade the indoor air quality. Controlled mechanical ventilation has been implemented to ensure good indoor air quality. Heat distribution has also been made to supply each housing by the central heating system. With 280 kW power, the wood boiler can cover 80% of the heating needs and hot water, it is equipped with a buffer silo with a storage volume of 60 m^3 to ensure a sufficient autonomy during heating period while a gas system provides extra[17]. One thing to point out as not trivial, it's the fact that this operation gives a feedback to the manufacturers of the real conditions of implementation and use of their products and the identification of training needs / awareness for companies and design tools for designers. At the end of the experience some weaknesses were identified during the main phases of the refurbishment action. During the "Design phase" systems oversize has occurred, poor coordination between design and maintenance and loss of simple systems. During the "phase of implementation" comments are more technical, there were poor insulation of pipes, disorder in hydraulic and ventilation systems and settings were unrealized as provided in the design phase. While in the "Reception phase" there were difficulties to use centralized management of the building, adjustment of technical facilities was done and the difficulty for users to make companies come back after the delivery of the building. In the last phase, the "Operating" one, users have demonstrated a lack of information on the functioning of the building.

ANNEX_TABLE 1060: SOCIAL HOUSING KENNEDY – CASE STUDY PROFILE

ANNEX_FIGURE 914: KENNEDY BUILDING IN RHÔNE-ALPES[18]

[17] http://wiki.cesba.eu/wiki/Front_runner_projects_CABEE

[18] http://wiki.cesba.eu/wiki/Front_runner_projects_CABEE

ANNEX E - BDM'S CASE STUDIES

CASE STUDIES IN THE COUNTRY

Project type	Alexandra David Neel High School
Location	Digne les Bains City (04), France[19]
Project area	Extension and refurbishment of the high school Alexandra David NEEL, Digne les Bains, with a net floor area of 11 000 m2
Main stakeholders	Region Provence-Alpes-Cote d'Azur
Incentive program used	Programs established by the Region for the new high school or renovation, which had to follow the BDM approach
Assessment tool used	BDM system (Batiment Durable Méditerranéen)
Implemented technologies	The NEEL high school, built in the 1960s, is composed of functionalistic buildings of great heights inscribed on a very large plot. The project involves the restructuring of the existing buildings and the construction of new buildings at the juncture of the old ones: 11,000 m² of which 3,500 m² of new wood extensions (structure and envelope). The insertion of this new construction between existing concrete buildings of different heights compliance with seismic regulations. The use of wood for new buildings, the treatment of existing wooden claddings, the greening of exteriors and roofs, restore humanity and conviviality to this school with a rational structure, improving urban perception and enhancing existing buildings. The interventions and strategies/solutions applied for the Energy and Environmental sustainability were: Heating system: Wood boiler and Solar thermal Hot water system: Solar Thermal Panels Ventilation system: Single flow and Double flow heat exchanger Renewable systems: Solar photovoltaic, Solar Thermal and Wood boiler Use of Bio-sourced and recycled materials, solid wood panels for floors and structure Waste management Concerning Urban environment, were realized new public square, parking areas and differentiated service, playgrounds, green spaces and secure pedestrian relations with the Beau de Rochas High School. Delivery Date was August 2013 and the level obtained was silver.

ANNEX_TABLE 11: ALEXANDRA DAVID NEEL HIGH SCHOOL – CASE STUDY

ANNEX_FIGURE 1015: EXTERNAL AREA OF ALEXANDRA DAVID NEEL HIGH SCHOOL[19]

ANNEX_FIGURE 1116: INTERNAL AREA OF ALEXANDRA DAVID NEEL HIGH SCHOOL[19]

[19] https://www.construction21.org/case-studies/fr/alexandra-david-neel-high-school.html

Project type	Renovation of the médiathèque Meyrargues
Location	Municipality of Meyrargues (Bouches-du-Rhône), France
Project area	Refurbishment of the Multimedia library of Meyrargues
Main stakeholders	Region Provence-Alpes-Cote d'Azur
Incentive program used	Programs established by the Region for the thermal rehabilitation of buildings
Assessment tool used	BDM system (Batiment Durable Méditerranéen)
Implemented technologies	The municipal library was destroyed in a fire disaster occurred in 2008, were destroyed much of the installations, insulation and interior trim were completely destroyed. The framing and its insulation are heavily degraded and must be repainted, as well as the joineries, including their aluminium frames. The municipality wanted to take advantage of the reconstruction to improve the energy and environmental performance of the multimedia library, in order to offer on the one hand an exemplary place in terms of energy consumption, air quality, interior comfort but also place of awareness of the citizens to the Today's Issues. From a technical point of view, energy performance is based on building insulation, proper sizing and use of ventilation, heat generation and cooling systems, and the use of sun protection devices. The installation of photovoltaic panels on the building was not desired by the municipality. It was envisaged the implementation of a recovery tank of rainwater destined to the toilets and watering the green spaces.

ANNEX_TABLE 1261: RENOVATION OF THE MEDIATHEQUE MEYRARGUES – CASE STUDY PROFILE

ANNEX_FIGURE 12: MULTIMEDIA LIBRARY OF MEYRARGUES[20]

[20] http://www.flickriver.com/photos/25831000@N08/22394429373/

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