ENERGY EFFICIENT BUILDINGS
AN ECTP COMMITTEE FOR INNOVATIVE BUILT ENVIRONMENT

EeB PPP Project review 2021

February 2022

Foreword

The ECTP and its Energy Efficient Buildings (E2B) Committee are pleased to introduce the ninth edition of the EeB PPP Project Review. This publication presents the progress of a portfolio of 103 projects co-funded within the EeB PPP under the Horizon 2020 programme between 2014 and 2020.

The Energy Efficient Buildings (EeB) Public Private Partnership (PPP) is a joint initiative of the European Commission (EC) and the construction industry, represented by the Energy Efficient Buildings (E2B) Committee of the European Construction, built environment and energy efficient building Technology Platform (ECTP). This initiative aims at promoting research on new methods and technologies to accelerate the process of reduction of energy use in new and retrofitted buildings and to improve the European industrial competitiveness. One of the contractual PPP commitments consists in monitoring the impact and exploitable outcomes generated by the projects.

This 2021 edition of the Project Review highlights current results and achieved or expected benefits of the EeB PPP projects. The overall target is to develop breakthrough affordable technical and business driven solutions at building and district scale. The projects demonstrate scientific and technological excellence, across the whole value chain, from early stage conception to demonstration of almost ready-to-market innovations. Categorised into 7 technology-clusters defined according to the construction-related research & innovation value chain from the EeB PPP Roadmap (Design, Technology Building Blocks, Advanced materials and nanotechnology, Construction process, Energy performance monitoring & management, ICT and BIM), the 103 research projects presented in this brochure illustrate the diverse innovation approaches and the importance of embracing all aspects of the building and construction sectors.

We hope you will enjoy reading this new edition of EeB PPP Project Review while inspiring fruitful future cooperation within those clusters.

Javier Bonilla
ACCIONA,
Chair of the ECTP Energy Efficient Buildings Committee

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The information on each project has been kindly provided by the project participants. Neither the ECTP nor the European Commission can assume responsibility for any errors.

Contents

< Back to the previous page

H2020

< Back to the previous page

< Back to the previous page

H2020 EeB PPP Impact Key Performance Indicators

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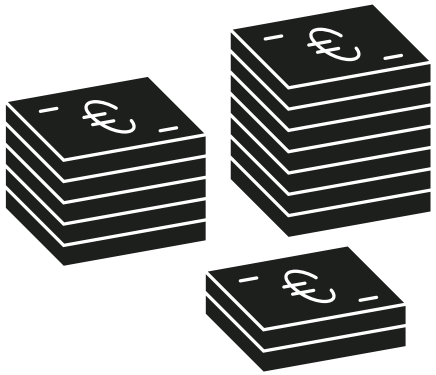
Figures are based on the EeB PPP monitoring questionnaire circulated in February 2019 during Q4 2021. Average values were calculated from relevant figures provided by the Horizon 2020 H2020 EeB PPP projects in the questionnaire.

All projects were not always concerned by each KPI: therefore, the average values do not necessarily represent the whole set of 103 projects featured in this document.



Average budget (M€)

5.6

Duration (month) (average per project)

44

Highest budget (M€) (**SPHERE**)

12.5

Share of participation of SMEs

39%

Highest additional private investment mobilised in the project (M€)(**MOEEBIUS**)

2

< Back to the previous page

Technology Readiness Level for all clusters

- 9 — Actual system proven in operational environment
- 8 — System complete and qualified — The highest for this cluster
- 7 — System prototype demo in operational environment
- 6 — Technology demonstrated in relevant environment
- **5.9** — Average for all clusters
- 5 — Technology validated in relevant environment
- 4 — Technology validated in lab
- 3 — Experimental proof of concept — The lowest for this cluster
- 2 — Technology concept formulated
- 1 — Basic principles observed

Average reduction of energy use due to the innovation

24.7%

Most represented cluster

Energy performance monitoring and management

Number of systems & technologies developed by the cPPP projects

440

Average reduction of waste due to the innovation

16.5%

Number of spin-offs & start ups resulting from cPPP projects

10

Number of patents application (average/project)

0.6

Full scale demonstrators (average/project)

5.8

Training & events (average/project)

13

Average CO2 emission reduction due to the innovation

24.2%

Average reduction in the use of material resources

10.8%

Number of people trained (average/project)

730

Design

These 9 design projects experiment numerous approaches improving the performance and the comfort of buildings and achieving energy savings in the fight against climate change.

The projects mainly focus on residential buildings and cover the promotion of NZEB (Nearly-Zero Energy Buildings) and PEB (Positive Energy Buildings) which are made possible by using new materials, technologies and building components. The deep renovation wave introduced with the Energy Efficiency Directive 2012/27/EU is largely addressed. As well known, the European building stock is old and not energy efficient. Indeed, "More than 220 million building units, representing 85% of the EU's building stock, were built before 2001. 85-95% of the buildings that exist today will still be standing in 2050 » [1]. This topic of deep renovation is more than crucial to make Europe climate-neutral by 2050, that is the reason why it is one of the priority topics covered by these projects [15, 24, 64, 66, 73, 77].

The research works and innovations covered by the design projects are heterogeneous, but there are major topics which are quite transversal when considering the design of energy efficient and sustainable buildings, neighborhoods, or districts:
1) the recurrent user-centric design approach,
2) the push for circular economy principles, and
3) the use of ICT for exploring scenarios, supporting design choices, improving energy management or enabling collaboration between stakeholders.

User-centric design

The first generation of H2020 projects about energy efficiency in building has highlighted the need to develop user-centric approaches to improve the design of NZEB/PEB buildings. Original research is developed in order to capture the user requirements and behaviors in order to improve the quality of the design. For example, socio-cultural (e.g. traditions, habits) and climatic considerations are taken into account in the PEB design [20] .From the methodological point of view, participatory design mechanisms are put in place to support the design stage and the acceptance of retrofit solution by the occupants [64].

The scale also evolves form the building to the district level. Projects focus on the transition of NZEB into PEB and develop a user-centric approach relying on ICT opportunities, e.g. for optimising the interplay of local generation, storage, consumption at the building and district level [24]. The combination of both technological innovations and social innovation (i.e. citizen involvement, stakeholder interaction, and capacity building) contribute to the development of the PED (Positive Energy District) concept [94].

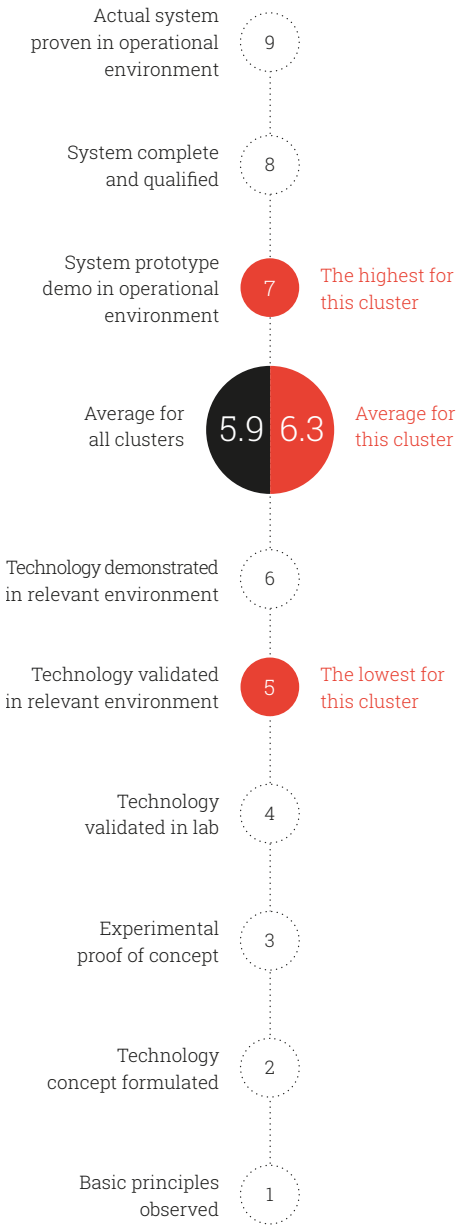
Furthermore, the challenge of the energy efficiency of buildings is largely extended to the topics of human health and well-being as a consequence of a design centered on the occupant. The question of the comfort inside building goes beyond the classical approach focusing on thermal comfort and includes acoustic and visual comfort [77], people's expectations, daily habits and cultural practices [20, 24], as well as aesthetic concerns, etc. Understanding the occupants and proposing retrofit solutions based on their characteristics and needs are key components in a successful retrofit

Circular deep renovation

Construction and demolition waste (CDW) is responsible for about one third of all waste produced in the EU. CDW arises from activities such as the construction of buildings and civil infrastructure, total or partial demolition of buildings and civil infrastructure, road planning and maintenance. Due to the large amounts that are generated by the construction industry, it is becoming a priority stream for the European Commission. Several projects are considering their developments according to the principles of Circular Economy.

1 https://ec.europa.eu/energy/sites/ener/files/eu_renovation_wave_strategy.pdf

Technology Readiness Level for this cluster



Project [15 and 24] develop and deploy circular renovation solution in pilots, and study new circular business models in order to make deep renovation environmentally friendly, faster and cost effective for end-users. The design of new building components relies on the will of reducing the need for raw materials, the improvement of product performance and the value at the end-of-life by putting into practice the "design for disassembly" principles.

The combination of the use of both Life Cycle Assessment (LCA) and Life Cycle Cost assessment (LCCA) is also used in several projects to support respectively the analysis of the environmental and economic convenience of the renovation approach in order to reach energy savings during the operation stage [15, 73].
These methods enable a systemic analysis contributing to better design choices. They allow, amongst other things, assessing the impact of decisions during the design stage on the maintenance and operational costs, and reaching a greater economic return when considering an investment for improving the energy efficiency of an existing building. Moreover, they contribute to the promotion of the construction of Life Cycle Zero Emission Buildings with zero environmental impact [15].

ICT platform & Digital Twins

Designers needs new tools and methodologies for supporting the process of deep renovation. ICT platforms and digital twin technologies are aligned to the new design processes. Collaborative design platforms are developed in order to support the integrated design methodology for retrofit towards energy efficient and sustainable buildings and districts [64, 66]. Simulation and optimization functionalities are included in the IT tools to explore retrofit scenarios and support design choices.
Other projects make use of ICT platform to support intelligent energy management assuring the trade-off between indoor air quality, energy and comfort, adapting to climate conditions and user preferences [77].
Moreover, ICT developments offer possibilities for optimising the interplay of local generation, storage, consumption at the building and at the neighborhood / district level [40, 94].

Safety upgrades to face future earthquakes

In addition to the previous topics which are more transversal, a project focuses on another type of weakness of the European building stock: the fragility of buildings to earthquakes in seismic zones [73]. Buildings in Europe are not prepared to face important earthquakes. That is why the project [73] focuses on the integration of different technologies to achieve a multi-benefit approach combining safety upgrades to face future earthquakes in seismic zones and nearly zero energy consumption to be aligned with EU climate change reduction targets.
As a general conclusion, all these projects explore solutions to leverage the existing technical barriers, financial barriers and social barriers towards more efficient, healthy and comfortable buildings, neighborhoods and districts. More than ever, combining technical solutions with social innovations and engaging all the stakeholders in the retrofit process is a key element for the decarbonization of the European building stock.

Techology building blocks

Currently, about 35% of the EU's buildings are over 50 years old and almost 75% of the building stock is energy inefficient, but only a small share is renovated each year due to difficulties in approaching the renovation process. Many projects faced this challenge, proposing systemic solutions with sounding business models. Solutions for new buildings are rightly very ambitious to meaningfully contribute to the whole building stock energy balance and make achievable the climate neutrality goal by 2050. Building performance, higher efficiency of the construction process, people needs and circularity in the life cycle are key drivers addressing development at building and component scale. In the following, highlights from financed projects organized by topics.

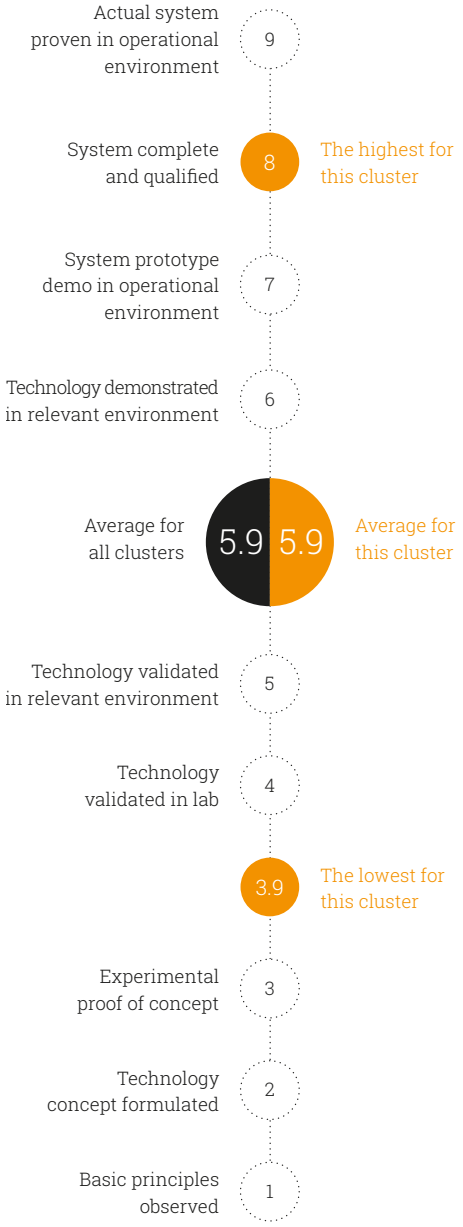
Renovation strategy

Low-impact deep renovation technology packages, based on prefab solution to minimize risks and failures, managing different stages of the deep renovation process [1]. Building energy renovation with timber prefabricated modules and digital data flow supported by RenoBIM tool for design, energy savings calculation and estimation of ROI [6]. Transformation of the existing envelope into an active element, adaptable to a dynamic environment and to occupants' requirements during building lifetime [14]. Industrialised, modular and flexible HVAC, façade and ICT systems, that leverage investments by aggregating customers into energy efficient communities that are attractive to large investors [15]. Multi-building approach for large-scale renovations enabling the access to funding, while providing integrated set of services: investment planning, renovation design, quality assurance, energy consumption analysis, and tenant engagement [23]. Adaptive and adaptable envelope and building solutions for maximizing RES harvesting, by integrating: versatile click&go PV substructure, solar window block, modular BIPV, heat and ventilate package [33]. Modular, plug&play concept/product for adaptable/dynamic building envelopes, considering circular economy principles, energy saving and renewable energy harvesting [69]. Web- based collaborative knowledge sharing platform including adaptable solutions combined with business models, which allow to invest with confidence [91].

Building system for renovation

Module added to the insulation layer embeddings air exchange system with a heat recovery and a PCM-based thermal storage, connected to a BMS allowing optimal piloting and adaptability [25]. Prefabricated building envelope components with a new class of low-CO2 binders based on Belite-Ye'elimite-Ferrite, and finishing technology for a multi-functional surfaces enabling thermal reflection, anti-stain, anti-bacterial and self-cleaning [26]. Lightweight solution for envelope insulation, complying with national building codes: environmentally friendly foams,lightweightthindoublepanevacuumglasses,multi-functional thermo-tunable coatings [31]. Modular envelope mesh facilitating mechanical assembly & interconnection of components and a related digital platform supporting all stages of the renovation process [34]. Wood-based technical solutions and implementation guidelines, co- design protocols, socially oriented business models and financial tools, engagement and training of a wide variety of actors [38]. Multifunctional retrofit toolkit where different subcomponents - ICT, BEMS, HVAC, BIPV and Envelope Technologies - cooperate synergistically to transform an existing building into a Smart Building [44]. Prefabricated panels to reduce energy demand while preserving building aesthetics, coupled with an iterative design methodology integrated with a cloud-based BIM database [51]. All-in-one industrialised envelope technologies resulting in both cost and time reduction, with attention to the life cycle perspective and the design for assembly and disassembly, including end-of-life residual value [53]. Prefabricated geo- polymeric panels to be used in energy efficient buildings for eco-insulating facades and eco-friendly indoor radiating system [55]. Plug&play solutions for prefabricated modular renovation elements, integrating components for indoor climate control, energy saving, building physics and aesthetics [63]. Scalable, adaptable and ready-to-implement plug&play prefab solutions for deep renovation of building envelopes and technical systems [67]. Guidelines

Technology Readiness Level for this cluster



and web-tool with pre-calculated examples of brick and stone walls, for evaluation building suitability for internal insulation, respecting architectural and cultural value [84]. Plug&play renovation technologies made of a preassembled facade solution and a heating system with PCM storage [90].

New plus energy building

Modular solutions for Positive Energy Buildings, accounting for climate and cultural differences to create comfortable, efficient, and affordable indoor environments, while optimising value/cost ratio [20]. Technical concepts for Positive Energy Buildings including renewable energy production and an ICT architecture profiling comfort while forecasting energy generation and demand [40]. Solutions for the building envelope, energy generation and management at building and settlement level towards zero energy balance (ZERO-Plus EE).

Envelope material/component

Wiki collaboration platform for advanced Materials and Nanotechnology [3]. All-in-one single, durable, affordable and easy to install panel including a nano-insulation aerogel core and an eco-composite skin layer [41]. Analysis of construction demolition waste streams to select, process and use suitable materials for manufacturing product for building energy efficiency [42]. Super- insulation panel with very low thermal conductivity, thin, light, non-flammable and with no VOC emissions [49]. Glass façade and glass interior wall system based on cost affordable Fluid Flow Glazing elements, which give maximum daylight utilization and comfort by means of variable radiant heating and cooling [52]. Vacuum- insulation panels improving thermal performance over the entire lifetime, making VIPs adjustable, mountable and machineable, reducing the density and decreasing costs [54]. Insulating materials combining existing bio- derived aggregates with dedicated binders to produce durable composite construction materials [57]. Façade and window elements using glass microfluidic functionality: low-cost thin and strong cover glasses, micro-structured rolled glasses of architectural quality, laminated glass filled with a heat storage liquid designed for transparency [58]. Insulation system with multi-functional energy- storing and energy-saving cementitious: ultra-high porous foam shows excellent insulation properties by embedding phase change and nano materials [65]. Eco-innovative, cost-effective and smart material solutions to renovate existing facade systems of both double skin and advanced integrated curtain walls, based on nano-formulated VIP, PCM, flexible thin glass perovskite solar cells and multi- functional nano-enabled coatings [71]. Aerogel-based, high-performance insulation products: interior plaster, external render, insulation material filled bricks, patching filler and thermal coating finish, including business plan and certification [101].

Thermal system

Heat battery based on potassium carbonate, a thermochemical material analyzed with special emphasis on the mechanical stability [19]. Highly versatile, scalable and replicable solution for buildings heating and DHW system retrofitting allowing 70% of RES fraction [43]. Integrated thermal storage system, based on thermochemical storage [46]. Compact hybrid electrical/ thermal storage systems for buildings [50]. Compact integrated heating, cooling and electricity storage adaptable to existing systems in residential buildings; based on a high-performing thermochemical material reaction combined with parallel hot and cold PCM, while it stores electrical energy in a Lithium-ion battery that responds to grid signals [60]. Technology sizing toolbox, two-way substation and real-time district thermal energy management system [97].

Continuous commissioning

ICT tools to allow for fast and robust scalability of quality management services for handling building performance in the design, construction, commissioning and operation phase as a means to close the gap between predicted and actual energy performance [75].

Performance assessment method

Methodology capable of implementing expandable and adaptable dynamic energy performance certification [28].

Advanced materials and nanotechnology

Several research projects developed significant innovative contributions related to materials in the built environment. To this aim, [3] implemented a collaboration platform on advanced materials and nanotechnology projects approved in the frame of the EeB-PPP. Four main research areas can be identified.

Materials with reduced embodied energy

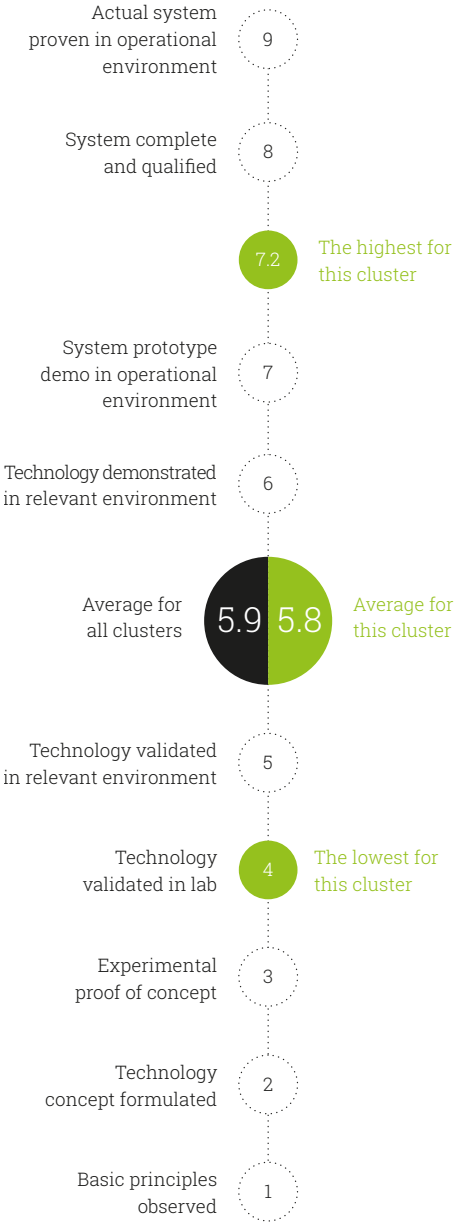
Ordinary Portland Cement (OPC) production causes elevated CO2 emissions. Recently many studies focus on the development of more environmentally friendly construction materials. To this aim, [26] focuses on the development of prefabricated building envelope components by fully replacing OPC with belite-ye'elimite-ferrite new class of low-CO2 based binders. The new components developed in [26] have more than 30% lower embodied energy, 20% improved insulation properties and 15% lower cost than the actual solutions based on OPC. On the other hand, [57] combines existing bio-derived aggregates with innovative binders to develop composite construction materials that are hygrothermally efficient and have high insulating properties, low embodied energy and low embodied carbon. In details, [57] seeks to consume 50% less embodied energy than conventional materials and improve insulation by 20%; these expected improvements will lead to lower construction costs by 15%.

Construction and demolition waste (CDW) is the heaviest and most voluminous waste streams generated in the European Union (EU). It consists of numerous materials, including concrete, bricks, gypsum, wood, glass, metals, plastic, solvents, asbestos, and excavated soil. CDW has been identified as a priority waste stream by the EU. In this regard, [76] develops a prefabricated energy-efficient building that can be easily assembled and disassembled for future reuse, containing up to 65% in weight of CDW, namely recycled materials and reused structures thanks to the development of an innovative CDW sorting system based on automated robotics. [100] aims at reducing the embodied energy of buildings through the incorporation of higher levels (at least 75% by weight) of CDW inorganic recycled materials in two novel multilayer precast concrete elements (PCEs). These new PCEs are obtained by the smart combination of concrete, cost-effective aerogel composites and 3D printed plastic sides and shuttering pieces.

High-performance materials for insulation

Advanced nano-porous materials such as aerogel and vacuum insulation panels (VIPs) are promising Super-Insulation Materials (SIM). [41] creates a novel cost-effective, durable, industrialized, and easy to install composite insulation cladding system based on a functional bio-polymer composite and an advanced foamable extrudable aerogel for modular façade insulation. The foreseen main impacts will be 20% lower embodied energy than traditional oil-based panels and more than 40% energy savings in building refurbishment actions. [49] develops a new silica Advanced Aerogel-Based Composite material for new super-insulation panel possessing the lowest thermal conductivity of all insulation materials. These new insulation technologies do not only possess very high thermal insulation performance but also are thin, light, non-flammable, and with low CO2 and VOC emissions. [54] uses a new type of protective envelope and alternative fillers in Vacuum insulation panels (VIPs) for effective insulation systems in buildings that will improve their thermal performance over the entire lifetime by at least 25%. These new products, thanks to the low-density and/or alternative core material together with less expensive VIP-envelopes as gas barrier, will be sold by more than 20% lower price. [71] develops an innovative façade solution based on the integration of super-insulative elements, solar energy harvesting and active energy storage features, such as nano-formulated VIP, phase change materials (PCM), flexible thin glass perovskite solar cells and multi-functional nano-enabled coatings. [101] focuses on 5 innovative, aerogel-based, high-performance insulation products: interior plaster, external render, insulation material filled bricks, patching filler and thermal coating

Technology Readiness Level for this cluster



finish. These products/systems provide top insulation performance as well as improved comfort, indoor air quality, fire safety, durability and sustainability.

Novel solutions for energy storage systems and decreased energy consumption

Energy storage systems are based on a wide range of technologies to manage the power supply, create more resilient energy infrastructures, and bring cost savings. Materials plays a fundamental role in energy storage systems. [35] uses standard photovoltaic (PV) solutions for roof and new thermal solutions for building façades for thermal and electrical energy harvesting.
In particular, it develops four innovative technologies: solar heat collectors based on the usage of near infrared (NIR) absorbing colored coatings, covered solar heat collectors using colored NIR transparent glasses, smart ventilated heat harvesting window and PV harvesting glasses. [45] develops a highly energy efficient solution for building retrofitting aiming to achieve a reduction of at least 30% in energy consumption. These solutions integrate gas and solar thermally driven adsorption heat pumps, solar PV assisted DC powered heat pump connected to an advanced modular PCM heat storage system, and energy recovery from sewage water. [60] produces a compact integrated thermal storage system for achieving sustainable heating, cooling and electricity storage. It is based on a high-performing thermochemical material reaction combined with parallel hot and cold PCM and it will ensure an energy savings of 40%. [87] optimizes multi-energy generation, storage, and consumption of local renewable energy (electricity and heat) and grid supply for the transition towards a zero-energy built environment. [96] develops an advanced thermal energy storage system that combines two renewable energy technologies (solar and geothermal) and uses integrated enhanced PCM.

Novel materials for smart windows

Large windows help to reduce the energy demand for heating in winter; however, they may significantly increase the energy demand for cooling and air-conditioning in summer. [58] develops glass-based façade and windows with capillary elements used for circulation of a liquid for adaptive harvesting of environmental heat and solar energy, heat transport and distribution across the building, indoor hydronic cooling, shading and adaptive façade coloration. [93] develops Switchable Glass Solutions, namely electrochromic (EC) and thermochromic (TC) windows, that modulate the radiation energy transfer through windows and reduce by up to 70% the cooling energy demand of buildings with large windows and glass façades.
[31] focuses on the development of commercial insulating products for building envelope, such as highly insulating foams and lightweight, thin, double pane vacuum glasses.

Construction process, end of life, cross-cutting information

The analysis carried out among the 20 projects entailed by the cluster Construction Process, end of life, cross-cutting information, under Horizon 2020 programme, presents the main pillars in innovation which trigger the Construction Process, driven by the energy efficiency and sustainability of the buildings.

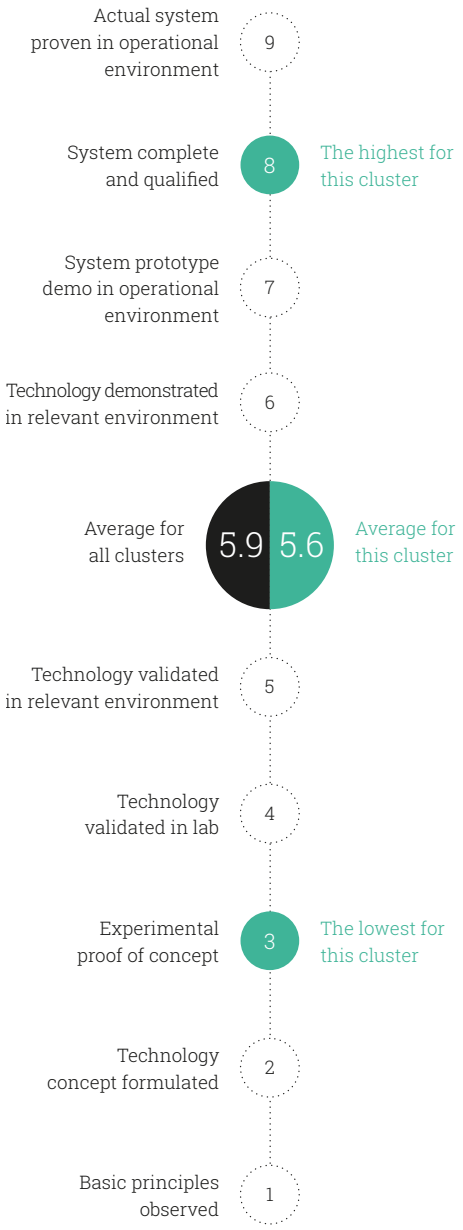
The **Construction process** is critical in achieving energy efficient performance. When standards are high, the complexity of buildings and technical equipment increase significantly. Therefore, the quality control is crucial to avoid errors, potentially jeopardizing the durability of the building. There is a need to increase effectiveness and quality, improving the prospect for a highly performant building and an optimal process. This requires exploration of the potential for prefabrication considering a Life cycle perspective, new procedures for detailed performance control and tracking the construction sites, supported by virtual design and construction process relied on BIM Management and Data Driven Digital Tws.

One key aspect in the construction process to extend the buildings lifespan in pursuit of the sustainability is the quality of project execution. **Self-inspection techniques** are used by the construction value chain to reduce the complexity and inspection time, facilitating the final thermal, acoustic and energy performance of the building. The challenge is to develop interoperable and cost-effective solutions for quality management supported by affordable ICT-based technologies, which provides data in real time to the workers, thereby enhancing productivity and safety and reducing deviations. Innovative onsite tools for energy efficiency enhancing quality checks such as 3D imagery and thermal imaging, air-pulse airtightness test, acoustic & IAQ tools are developed [16]. Software running on smart glasses or BIM-based Augmented Reality guide construction workers and inspectors and enable site-managers to access on-site sensors and project data and dashboards, enabling real-time collaboration among all actors [2, 56].

Advanced and automated processes for new and energy retrofitting buildings using **Prefabricated modular systems** are key for the construction optimization. Prefabrication aims to reduce on-site construction time, whilst improving health of workers and reducing the embodied energy of the building. Furthermore, the usage of recycled and reused materials in these systems promote the circular economy. With the support of 3D scanning and BIM, new pre-assembled off-site envelop systems, can be customised to the existing façade. Innovative retrofitting systems for prefabricated elements have been successfully deployed at a building scale [6], and district scale [78]. The integration of renewable energy technologies in the prefabricated façade components together with the optimization of the Kits manufacturing process allow to accomplish the objectives for the deep retrofitting [70]. Robust solutions for energy retrofitting of historical buildings, respecting architectural and cultural aspects and guidelines to assess the feasibility are also developed [84].

Those systems together with **novel renovation processes, methods and tools** will allow to accelerate the rate of deep renovation in the EU by reducing the time, effort and cost of deep renovation while improving energy performance and stakeholders' satisfaction. Technologies such as AR, VR, Iot or Scan to BIM are deployed, together with BIM Management systems to manage different stages of the process and optimize the flow of information. [10]. The solutions must be cost-attractive, environmentally friendly, multi-functional and easily applicable. Their integration in a platform working also as repository and marketplace aligned with the circular economy principles triggers novel business models [85]. Key to the success of the Smart cities initiative is the integration of systems from building to neighbourhood level. In this regards, technological solutions for the massive retrofitting of the built environment are developed encouraging the consumption of high-grade secondary raw materials. [100].

Technology Readiness Level for this cluster



Further to the challenges identified in each step of the value chain, new integration of the processes is needed to implement large scale demonstration and also to minimize costs of validated solutions. **Systemic integration of components and subsystems** is a key target area, where cross-cutting information streamlines the workflows, integrating the value chain into the whole process. A systemic approach, as is tackled in most analysed projects, is crucial for the dynamic multi criteria design tools, which leverages to design energy-efficient buildings from varied perspectives including, among others, cost-effectiveness, environmental friendliness and return of investment, through LCA/LCC analysis and energy simulation tools.

The construction process requires reliable information to make decisions based on real data intended to optimize the process. It feels necessary a dynamic digital thread system for construction sites, that goes beyond the static information which might enable the European construction industry to significantly improve its productivity, while reducing cost and ensuring safe work conditions. In this sense, the deployment of Data-driven **Digital Twin platform (DTP)** for 4D simulation and visualisation of the process allows to synchronise the as-designed and the as-built model and up to date the decision making to the data-driven performance. Accordingly, the DTP becomes an assistant on real time to track the planning and execution works, enhance the quality control, guarantee the occupational safe and healthy and monitor the usage of equipment. The inputs for the DTP are provided by technologies such as IoT systems, advanced robotic solutions, point clouds scans and drones. The assessment of the on-site construction process regarding the aforementioned domains is achieved by developments based on computer vision, IA and AR/VR technologies [9, 12]. The concept of Digital Twin for those purposes can be also applicable for design, virtual operation and maintenance, whereas the standardization for the open source Digital Twin Platform is addressed [4].

End of life must be considered in tandem with deeper refurbishment, at a design and demolition level. Selective deconstruction to reuse single components and LCA approaches will be pursued whilst waste recovery increases in importance in the sector. Innovation is expected in lowering both embodied energy and also resource usage, allowing the utilisation of components and materials from construction and demolition waste [42]. The circular renovation is promoted for the decarbonization of the EU building stock by a consumer centred and locally based circular renovation strategy with life cycle perspective. The reusing and recycling available materials by urban mining identifies local drivers that motivate building owners for deep renovation [24]. The usage of CDW materials in prefabricated buildings and all-in-one industrialised envelope technologies for deep renovation enhance the CO2 and energy savings, the resource efficiency and reduce the waste generation in building construction and renovation. The sorting process can be optimized by means of automated robotics and BIM based platforms, as well as innovative design concepts for assembly and disassembly of the prefabricated elements arisen [53, 76].

Training schemes for continuous improvement of worker skills are set up to meet the demand for a SME workforce specialized in energy-efficient buildings. Design tools, processes and business models that enable building owners to increase awareness on efficient refurbishment on building and district level are also developed [61].

To **speed up the innovation take-up** at member state level, innovative business models arise to accelerate the acceptance of the consumers and the market to invest with confidence at the same time that innovative solutions are promoted. The Renovation Hub presents the variety of existing Business Models which support energy renovation, guiding the user to find out the most suitable renovation package and providing recommendations for replication [91].

Energy performance monitoring and management

Energy performance monitoring and building management are among the most effective mechanisms to achieve the deep energy renovation. Although this is a huge and ambitious challenge faced by the construction sector, by accounting for occupant behaviour, integrating novel ECP models, ICT applications and energy flexibility as key approaches as well as improving monitoring methodologies and DSS for smart building ecosystems, the energy-gap might be mitigated, and the EU building stock would be energy upgraded.

Energy monitoring and management for deep renovations

Integrated solutions adopted by H2020 projects are supported with quality management services, replicable ICT tools and cost-effective technology packages for designing, constructing and operating both renovated and emerged low energy buildings [1, 75], as well as interactive, web-based tools and novel plug-n-play systems to exhaustively inform the key factors intervening in the energy upgrade process [79].

Special care is taken in monitoring the built environment, in terms of holistic performance optimization, led through integrated energy services, it enables building owners to activate deep renovations at multi-building and district level, creating tools to improve the understanding of large-scale targets [23, 61]. In addition, customized action deep renovation action plans are proposed for cost-efficient and near zero energy retrofitting by means of suitable combinations of innovative technologies through refurbishment assessment tools, which are based on operational interfaces with augmented intelligence characterised by occupant-centred approaches [77, 85].

Accounting for occupant behaviour as part of energy performance management

Multiple projects embrace an innovative approach via the integration of user needs, behaviour and expectations as part of the monitoring, controlling, and managing processes of building energy performance. So much so that this concept is identified as the scope of the performance assessment framework by integrating user behaviour patterns into EPCs development based on friendly data monitoring, smart technologies and tools [36, 37, 99, 102], likewise user-centred Demand Respond (DR) approaches that allow the deployment of cost-effective, interoperable tools to control, monitor and upgrade the smartness of legacy management equipment [68, 82]

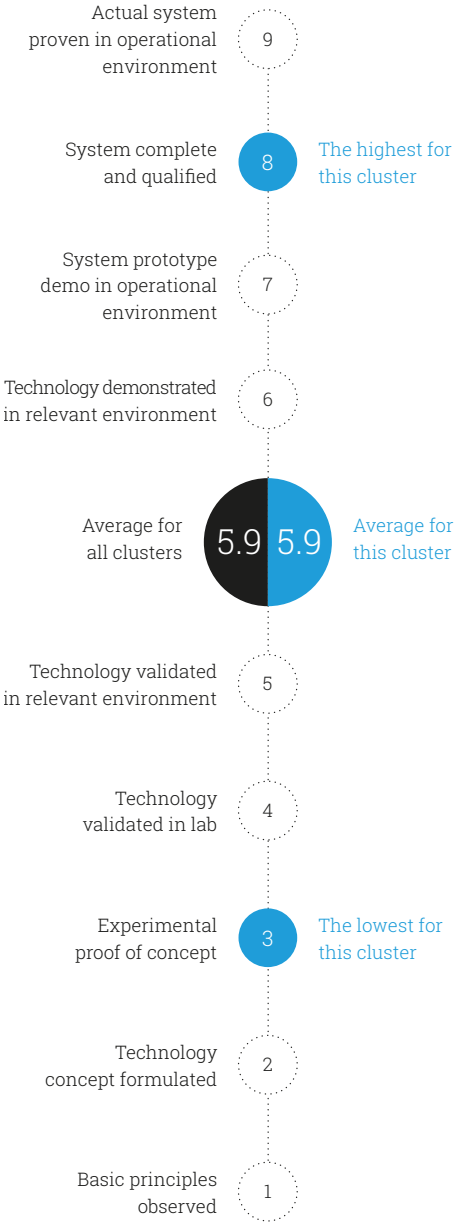
Others investigate how smart building systems improve flexibility, smart tools and passive solution design by means of user-centred approaches for energy transition -such as prioritising natural ventilation and cooling through a novel free running strategy- [72, 88]. As long as user needs and affordability are gathered for the selection of adequate RES technologies and facade components as well as involving seismic and energy approaches, these may optimise building renovations, improving energy performance and designing plug-n-play tools for different building types [38, 70].

Integrated building management to mitigate the energy-gap

Several projects are defining new trends on improving and evolving Energy Performance Certificates (EPCs) and assessment methods to lead the transformation of the EU building stock. Digital platforms for EPCs using the digital twins' concept and operational data which are proposed to improve user awareness and well-being while providing sets of indicators that integrate indoor comfort [21], as well as novel dynamic certification schemes to reduce steady- label discrepancies with post occupancy behaviour and the performance gap [28].

In order to bridge the gap between predicted and measured energy use, a new user self-assessment and optimisation platform demonstrates how innovative ECPs schemes might become efficient [86], but also quality enhanced EPCs need consensus as part of convergence of building assessment as well as coherent recommendations for building renovation [74]. Also,

Technology Readiness Level for this cluster



the new generation of BMS solutions with plug-n-play analytics and modular systems which tackle the energy performance gap and provide decision support [47], likewise other approaches achieve it by mitigating the uncertainty in design, installation, and operation, through plug-n-play renovation technologies [90].

ICT applications and energy flexibility as key performing management approaches

Open-interoperable platforms have been developed to share data and services to external third-parties providing information on building subsystems, occupancy monitoring and external context for the development of new business models [61], besides that innovative applications addressing ICT-based systems proposed that self-correcting BMS will optimise operational strategies for thermal driven technologies [45], as well as solar-generation systems that will improve building heating and cooling based on underground storage and ground-source heat pumps [81].

The flexibility concept has become a key driver for most building projects dealing with energy performance monitoring and management, these aim to integrate pioneering components as part of BMS which could enable yearly positive energy outcomes in order to make the most from RES and accounting for user diversity within both single and block buildings [20, 40], as well as harnessing different building typologies at district/city level [94]. Data-driven platforms will allow users to benchmark energy uses and to make the most of the load-matching schemes to maximize RES harvesting [33, 39]. Energy communities and cooperatives leading smart building ecosystems -based on open-source standards and friendly BMS for legacy equipment integration into collaborative data networks- may enable the market penetration of flexible energy services. [18, 80].

Other relevant solutions implemented have considered an internet-based or a cloud-based service infrastructure to manage real-time information flows (32, 98) which provide dynamic assessment of the interactions between buildings and electric grids, and holistic approaches based on DR frameworks [48], with reference to the optimization and modelisation of RES, energy storage/production and energy management strategies [62], furthermore specific objectives, e.g. cost, environmental impact, are based on whole-building performance approaches and multifunctional retrofit toolkits to enable smart transformations [44].

Monitoring methodologies and DSS for multiple typologies of smart building ecosystems

Moreover, building envelopes are part of holistic and integrated solutions, such as innovative glass systems developed towards satisfying cooling requirements, hot water needs and modulating radiation energy transfer [52, 93]. Focused research was conducted to innovate building energy management systems to measure both envelope and energy use of retrofitted buildings [14] and ventilated facades with integrated heat exchangers [25]. Others integrate envelope solutions to adapt building performance to dynamic environments [14, 25], or reuse construction and demolition waste materials for insulated facades and indoor radiating systems [55], likewise new modular plug-n-play concepts for adaptable and dynamic envelopes with AI and RES harvesting [69].

Similarly, integrated electronic systems and software applications allow energy monitoring on interacting devices based on multiple qualitative databases and demand response schemes [78, 95], also BMS are expanded to better manage the loads and resources that help to reduce operational costs on a district scale rather than on a single building by enabling the visualization of energy consumption [35, 103], or by thermal energy management and compact storage systems for retrofitting, together with disruptive thermal insulations with breakthrough storage materials, which gather end-user feedback and are based on real-time district and building performance[19, 46, 65, 96, 97]. Lately, Data-driven technologies and AI are deployed for DSS models by means of technologies using Digital Twins and real-life analytics to promote collaborative retrofit ecosystems towards an annual renovation and the optimisation of energy performance management of buildings [27, 59, 83].

83 REZBUILD
85 RINNO
86 SATO
88 SMART2B
90 StepUp
93 Switch2save
94 syn.ikia
95 TABEDE
96 TESSe2b
97 THERMOSS
98 TOPAS
99 U-CERT
102 X-tendo
103 ZERO-Plus

ICT

Among the 26 projects entailed by the cluster, a thorough analysis enabled to highlight 12 main enabling systems, identifying trends such as IoT/Construction 4.0, AI, Big Data, BIM, Digital Twins, Ontologies and Machine learning.

Web based and Cloud Based Platforms: collaboration and exchange of data were advanced extensively by the use of online infrastructure that enabled multiple of services and applications to be accessed in parallel [2, 7, 8, 13, 16, 22, 34, 39, 47, 68, 80, 86, 92 and 95] various cloud computing models have been integrated with a wide range of tools such as, solution as a next-generation Big Data Platform and AI Analytics Toolkit for (data sharing-based) Energy-as-a-Service (EaaS) applications, combining several Software as a Service solutions to be connected to the Demand Side Response, and deploying PaaS and SaaS Apps (tools) into the renovation operations [7, 68, 89].

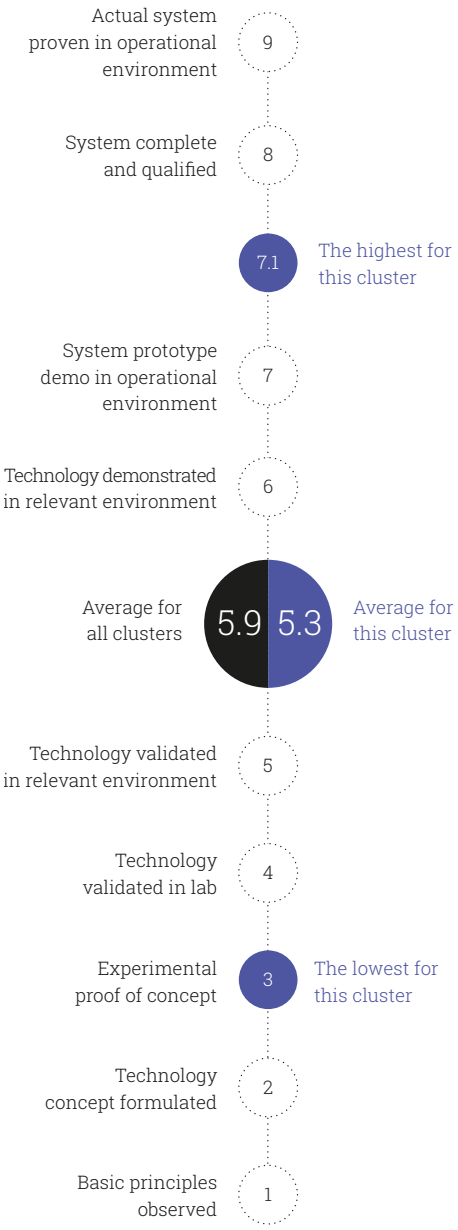
BIM Based Tools and Management: the involvement of BIM services within European Projects is not only focused on its 3D visual contribution but also its interoperability attributes that provide a standardised format exchange to improve occupancy model interfaces. Open data exchanges between BIM and webservices/cloud platforms have enabled storage of interpreted information and the automated creation of enhanced models for HVAC monitoring of IoT devices linked to energy analytics during the building life cycle [4, 8, 9, 11, 13, 16, 17, 34, 37, 47, 62, 86, 89 and 92] the majority of the projects involved the monitoring of various building life cycle phases of renovation: design, construction, commissioning, operation, refurbishment and demolition with emphasises on the concept to establish a digital Construction 4.0 tool-box COGITO.

3D Technologies and relevant information: the requirements of providing accurate representation of the real-world conditions pushed the conventional methods of documentation, design, acquisitions, and shared specifications to advance 3D Technological techniques for example: scan-to-BIM Tool that receives digital documentation data from the site, by means of terrestrial laser scanners and photographic cameras [11, 16] and 3D data acquisitions being applied within a project [13, 16], and shared design specifications, 3D models and relevant information on regulatory frameworks [13], and the use of collaborative dashboard [4].

Decision Support Systems & Research Policy Makers: The productivity measurement of cost-effective technological solutions in the construction industry was a major metric for the European projects [4, 5, 13, 18, 34, 47, 80] various projects featured effective ICT tools for monitoring data from different sources such as smart meters, sensors, innovative control algorithms, machine learning and AI to assist energy predicative analytics [8, 9, 13, 16, 17, 22, 27, 95] the use of ontologies as communicating agents [11, 22, 89] and other knowledge sharing representation [11, 13, 37] were created to describe the different aspects of building renovation processes (e.g. energy efficiency, occupancy, building information models, etc.); the modification of consumer demand for energy was also a key enabler addressed in the projects [18, 27, 47, 68]. Databases and tools were recognised as leverages to support building managers, designers, citizens, industry and policy makers to provide meaningful data and the knowledge to create an energy efficient, healthy and comfortable built environment [39] other actors that can benefit from decision policies were city representatives including the urban planning department, architects and energy planners, with collaboration between engineers and designers of energy companies, developers, consultants, land owners, water companies, environmental protection agencies as well as building owners and users [40].

A tracking system: the projects used tracking technology to observe the movement of construction process flows for instance; lean planning and control processes that integrate all parties that need to work together on a construction site, and monitoring controls such as building performances and operation [2, 4, 16, 39, 40] and capture data and create solutions via emerging technologies for energy monitoring for instance controls for heating, cooling, ventilation and lighting, IoT, and wide range of sensors (including photogrammetric sensors) [4, 5, 37] collective intelligence deployed repositories and AI coupled data presented

Technology Readiness Level for this cluster



methods for ICT integration of environmental and GIS data such as meteorological data, energy consumptions, indoor temperature, into the building design layout [13, 18, 89, 47].

Information System Technology: the capabilities of collecting, processing, storing, and distributing information to support building operations and enhance performance of ICT interaction with the construction stakeholders was evident in projects implementing Digital Twins and BIM [4, 9, 11, 13, 17, 89, 92] the development of big data platforms and the integration of big data (volume, variety, velocity and veracity) technologies and libraries, with building sector legacy systems, external data sources to accelerate the data management into stake holders valuewereprevalentinprojects[7,8, 27,68]toprovidebuilding characteristics, comfort and energy efficiency measures, contracts and investments; the stakeholders requirements for energy efficiency enabled ICT network systems to perform diagnostics of HVAC systems [13], indoor environmental quality checks [16, 39], control based on distributed sensors and actuators to energy conscious behaviour for occupants domOS, and improve the thermal satisfaction of occupants [89].'

Mobile computing & wireless and Real-Time Data: mobile devices such as smart Glasses, smartphone applications, crowdsourcing applications, GoPro camera or images from flying drones, tablets and desktop computers allowed end- users access to centrally store captured information (via cloud infrastructure, web services and APIs) to advance monitoring/ coordination and interaction on the construction's sites [2, 9, 11, 13, 16, 95] the projects also capitalised on real-time data for the timely detection of health & safety hazards to humans, construction quality defects as well as a constantly up-to-date workflow management [17]; interacting processes within energy systems with the grid [18, 62] and Environmental Forecasting and the energy consumption data from the BMS to produce 24-hour, day-ahead forecasts [95].

Knowledge Management Systems: the process of creating, sharing, using and managing the knowledge was recognised in various projects to advance the knowledge transfer for energy-efficient construction [2], provide seamless integration of all stakeholders within and across the design/ engineering, construction, and maintenance of buildings and infrastructure [4], to impact the three key figures in the building sector (building managers, designers and policy makers) [39], and to improve stakeholder's collaboration supporting knowledge sharing and user communities; the [89] project in particular demonstrated an Integrated Design and Delivery Solution (IDDS) framework where partners will monitor, centralise, and share information in different ways for every stakeholder, including BIM models; a variety of ICT technologies were used to transfer knowledge on numerous of projects such as, protocols and data models being used in building automation and energy management systems and smart grids [5, 18, 47, 62, 86, 95].

Simulation & Analysis and Virtual Reality Technology: analytics for energy analysis required various forms of simulations that are actually needed to design a project and exploit the analytics during the real-time operation of the buildings [7, 8, 11, 62] interoperability was achieved using standard data models, XML schema's (gbXML) and software such as EnergyPlus/OpenStudio simulation tool with the purpose to support operational improvements; construction practices were also influenced by simulators on numerous of projects for instance, 4D Construction site simulator for early design ASHVIN, and to address the quality of workflow through simulation, prediction, formulation and recommendation of proposed changes to construction plans and/or building designs to improve performance [9]; performance based simulation was evident in many of the projects, involving thermal comfort and indoor air quality assessment in renovation projects [13], to measure thermal properties of solids and analyse and explore diagnostic methods for thermal parameters of buildings in situ [16] other components included the use of Computational Fluid Dynamics (CFD) simulations to adapt cooling systems, IT devices [27], and to analyse and optimise HVAC control strategies in targeted zones of a building [47]; assessment tools to enable life cycle analysis were advanced by the use of AI [89], and to provide performance requirements on building materials and structures at early design stages [86]; many projects in particular also focused on AR/VR [2, 5, 9, 11, 13, 16] for integration of captured data into the virtual construction management platforms.

BIM/ Data/ Interoperability

Energy-efficient and sustainable built environment is increasingly complex and multi-faceted. Our buildings and districts require a broad range of expertise and competencies throughout their life-cycle, from design and construction to operation and deconstruction.
A strong focus is also given to renovation of the existing building stock, which has a huge impact on the capability to meet the environmental impacts reduction target set by the European Commission. While the construction industry needs to tackle those challenges, all its stakeholders have to engage in the digital transformation, the twin transition which is foreseen to affect almost all the processes, and take benefits of it. The impacts are huge for the private and public actors: more productivity and profits for the companies, reduced environmental impacts and even increased well-being, healthy conditions indoor and comfort for us, the occupants of our buildings.

Building Information Modelling (BIM) appears in this context as an instrument to help the structuring, managing and integration of building projects' information, facilitating the design, simulation, analysis and operation of energy efficient solutions. BIM technology supports the development of accurate 3D virtual and parametric models of a building containing precise geometry and relevant information needed to support all the building life cycle activities which effectively contributes to increase collaboration, efficiency (materials, costs, time) and project quality. By making virtual reality simulations possible, BIM emphasizes integrated and coordinated decision-making in supply chains, providing the construction industry with an instrument to support consistent decisions throughout the building's life cycle. True benefits of BIM are obtained when the technology is applied throughout the project lifecycle, from design to demolition. The data contained in the BIM-based design model can be shared throughout the project, thus reducing the heavy human workload and manual errors in traditional work. The capacity of BIM to integrate building information and create a collaborative environment makes it a powerful tool for developing simulations of a wide range of specialties, such as energy analysis.

While BIM authoring commercial tools are now well established and significantly penetrated the market of architecture and engineering design practice, using BIM-based workflows further in construction, deconstruction and renovation, as well as operational management of built assets faces several challenges. Besides the lack of clear, value-added and consensual business use cases, the interoperability of BIM-based workflows remains a critical pitfall.

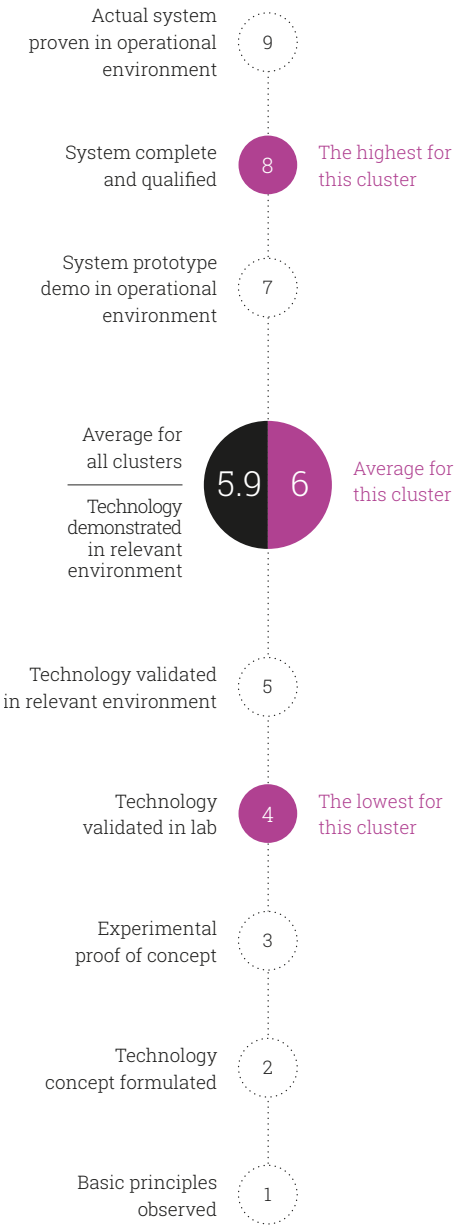
Semantic interoperability

To address this problem, standard formats have been developed. In order to provide interoperability among tools of different software developers, an open BIM standard, i.e. IFC (Industry Foundation Classes) has been defined by buildingSMART. IFC is an object-oriented interoperable format enabling the creation of holistic building models, and supporting lifecycle integration. While IFC offers a lot of flexibility to share information, extending its scope and aligning it with other standards outside of the core BIM business is an ongoing challenge [92].

Therefore the semantic interoperability of the various BIM-related datasets is a challenge addressed by several projects. Digital construction initiatives aim at connecting 3D/BIM design models to construction management data and tools [12], offsite prefabrication [63] but also to strengthen interaction with occupants [10] and deliver building passport [13]. For the operational building management, BIM provides building-related information for energy optimization or comfort assessment, and can also refer to technical systems data [72].

According to the particular use cases addressed, the issue of interoperability is likely to be tackled by re-using, mapping and extending existing ontologies for building construction and operation (e.g. IFCowl, SAREF, s4bldg, s4city, BOT)[11, 22 and others], as well as for further integration with external systems, e.g. the energy grid, and their specific ontologies (OneM2M, USEF, OpenADR...). Interestingly, the SWIMING project analysed the use of building data for Building Life Cycle Energy Management processes, by reviewing use cases formulated from 33

Technology Readiness Level for this cluster



H2020 projects. It addressed in particular the challenge of harmonizing data requirements across use cases and their alignment with existing standards and ontologies.

Applications of BIM in renovation

BIM workflows are central to numerous projects tackling the renovation of existing buildings (a.o. 10, 11, 32, 63, 66, 67, 79, 83). With a view of deploying holistic renovation solutions, based on integrated information management and decision-making environments, those projects include BIM-based technologies for:

- The assessment of buildings, aiming at capturing the as-is conditions, often based on Scan to BIM approaches (lasers canning, photogrammetry),
- The identification of suitable deep renovation scenarios, including time and cost saving potential and generating forecasting models for delivering optimized asset management strategies [67],
- The selection of the retrofitting approach with final solutions (e.g. prefabricated building modules with HVAC components) integrated into the BIM model [79],
- The actual retrofit on the site, where the construction/ installation activities are planned and monitored in relation to BIM elements, and the production streamlined thanks to communication with CNC manufacturing machines [73, 79],
- The monitoring and evaluation, via continuous commissioning based on measurements, verification, post-occupancy surveys etc. which implies extending BIM models to consider in-use datasets provided by sensors and/or technical building equipment.

Some of these tools are offered by construction companies and/or product manufacturers [79] to allow architects to embed the renovation solutions in their design BIMs, smoothing the decision making and information flow.

As the renovation strategies are even more impactful at district level (e.g. considering portfolios of buildings), techniques for reducing energy simulation time are required. BIM models, combined with city information using CityGML, are used in [66] for developing a retrofit planning tool for districts, and test techniques for reducing simulation times.

Applications of BIM for energy management and sustainability

While BIM and Building Energy Models are more broadly used, the Energy Performance in Building Directive (EPBD) requires harmonized Energy Performance Assessment across Member States. A series of projects invents the next generation of Energy Performance Certification (a.o. 36, 37, 102), which will rely on trusted, dynamic building consumption data and occupants' feedback. The vision is not only to improve the accuracy of the assessment, but also to reflect the operational conditions, user behavior and perceived comfort, as part of a broader assessment of sustainable buildings.

The Smart Readiness Indicator will extend the EPC to reflect the smart readiness of buildings, and their ability to interact with the occupants or provide flexibility in relation with the energy grid. Again BIM, as a standard data schema, is certainly a means to gather and extract data for smoothing the calculation of this indicator [37]

Digital Twins and data trends

In the last years, the Internet of Things (IoT), Artificial Intelligence (AI) and Machine Learning, or 5G communications are giving a new impetus to the digital transformation of the Construction industry. Digital Twins (DT) are attracting significant attention and interest in the industry. Recent projects have been launched with a focus on pushing Digital Twins abilities to the construction sites [17, 89].

The amount of digital product data generated and collected over the construction and operation stages is growing exponentially, opening avenues to new data-driven services and associated novel business models [7, 8, 59].

Predictive analytics are foreseen as a new means to optimize the operation of buildings, while Virtual Reality & Augmented Reality and autonomous machines will support and strengthen human decision-making (e.g. the DT is seen as the "site manager subconscious" - [12]).

H2020

2014

2016

2018

4RinEU
Accept
AMANAC
Ashvin
Auto-DAN
BERTIM
BEYOND
BIGG
BIM2TWIN
BIM4EEB
BIMERR
BIMprove
BIM-SPEED
BRESAER
BuildHEAT
BUILT2SPEC
COGITO
COLLECTiEF
HAPPENING
HEART
HEAT4COOL
HEAT-INSYDE
HIT2GAP
HOLISDER
HomeSkin
Hybuild
IMPRESS
InDeWag
INFINITE
INNOVIP
InnoWEE
Insiter
ISOBIO
LaWin
MATRYCS
MiniStor
RINNO
SATO
SCORES
SMART2B
SPHERE
StepUp
Stunning
SWIMing
Switch2save
syn.ikia
TABEDE
TESSe2b
THERMOSS
TOPAS
U-CERT
VEEP
WALL-ACE
X-tendo

< Back to the previous page

2020

CREATE
CULTURAL-E
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domOS
DREEAM
DRIVE 0
E2EVENT
ECO-Binder
ECO-Qube
E-DYCE
EeB-CA2
EEBERS
EENSULATE
ENCORE
EnergyMatching
ENSNARE
ENVISION
ePANACEA
EPC RECAST
e-SAFE
EXCEED
EXCESS
GELCLAD
Greeninstruct
MODER
MOEEBIUS
Moreconnect
New TREND
NRG-STORAGE
OptEEmAL
P2Endure
PHOENIX
Plug-N-Harvest
PLURAL
POWERSKIN PLUS
PRELUDE
Pro-GET-OnE
QualDeEPC
QUANTUM
RE4
ReCO2ST
Rennovates
RenoZEB
REScoopVPP
RESHeat
RESPOND
REZBUILD
RIBuild
ZERO-Plus

*
Projects funded under the
2014, 2015, 2016, 2017, 2018, 2019 and 2020
calls for proposals

< Back to the previous page

Technology building blocks
Energy performance monitoring and management

4RinEU [1]

Robust and Reliable technology concepts and business models for triggering deep Renovation of Residential buildings in EU

In 4RinEU we defined robust, cost-effective, low-impact deep renovation technology packages supported by usable methodologies, feeding into reliable business models. The project aims to minimize risks and failures, managing different stages of the deep renovation process, from the preliminary audit up to the end-of life, while providing information on energy, comfort, users' impact, and investment performance. The first deep renovation package was successful implemented in a first demo-case.

Start date	October 2016
Duration	57 Months
Status	Completed
Total budget	4.6 M€
Website	**www.4rineu.eu**
Coordinator	EURAC, Italy
Partners	**Germany**: Gumpp & Maier GmbH **Italy**: Aderma, Thermics Energie, R2M Solution **Netherlands**: Trecodome, Stichting Woonzorg Nederland **Norway**: SINTEF, Oslo Kommune **Spain**: Aiguasol, ACCIONA, Agencia De L'habitatge De Catalunya **United Kingdom**: IES

Construction process, end of life, cross-cutting information
ICT

ACCEPT [2]

Assistant for quality check during construction execution processes for energy-efficient buildings

ACCEPT consists of 3 software apps to support the construction industry in knowledge transfer and quality assurance to improve energy efficiency of buildings. CoOp App runs on smart glasses guiding construction workers with Augmented Reality; site managers access a tablet app linked to on-site sensors and project data; a dashboard links designers to ACCEPT so all users can collaborate in real-time.

	January 2015
	36 Months
	Completed
	4.46 M€
	www.accept-project.com
	Ascora GmbH, Germany
	Belgium: Entreprises Jacques Delens s.a., University of Liege - LUCID.
	Cyprus: EPITESSERA Architects.
	Germany: Fraunhofer-Gesellschaft
	Italy: Fraunhofer Italia
	Netherlands: TIE Nederland B.V.
	Spain: AnswareTech s.l., CYPE SOFT, S.L., Ferrovial Agroman.
	United Kingdom: Ingleton Wood LLP.

Advanced materials and nanotechnology
Technology building blocks

AMANAC [3]

Advanced material and nanotechnology cluster

AMANAC developed an effective collaboration platform between the FP7 & H2020 Advanced Materials and Nanotechnology projects in EeB PPP, to maximise impact via targeted common dissemination, exploitation and communication activities. The wiki, materials photo gallery and database development supported by the joint action plan, thematic workshops and specific workshops are the most innovative aspects.

	January 2015
	24 months
	Completed
	0.48 M€
	www.amanac.eu
	NTUA, Greece
	Germany: Fraunhofer ICT, Universität Bayreuth.
	Italy: CETMA.
	Poland: FASADA.
	Spain: Tecnalia.
	Sweden: CBI Betonginstitutet AB.
	United Kingdom: UBAH, TWI Limited.

Construction process, end of life, cross-cutting information
ICT

Ashvin [4]

Assistants for Healthy, Safe, and Productive Virtual Construction Design, Operation & Maintenance using a Digitial Twin

ASHVIN aims at enabling the European construction industry to significantly improve its productivity, while reducing cost and ensuring absolutely safe work conditions, by providing a proposal for a European wide digital twin standard, an open-source digital twin platform integrating IoT and image technologies, and a set of tools and demonstrated procedures to apply the platform and the standard proven to guarantee specified productivity, cost, and safety improvements.

Start date	October 2020
Duration	36 months
Status	Ongoing
Total budget	5 M€
Website	**www.ashvin.eu**
Coordinator	TU Berlin, Germany
Partners	**Austria**: ASI. **Croatia**: INFCON **Germany**: DTT, SBP **Greece**: CERTH **Netherlands**: EUR, NGEO **Poland**: FAS **Spain**: UPC, AUS **Sweden**: PlanB, NCC **Serbia**: MFL

Energy performance monitoring and management
ICT

Auto-DAN [5]

Deploying Augmented intelligence solutions in EU buildings using Data analytics, an interoperable hardware/ software Architecture and a Novel self-energy assessment methodology.

The Auto-DAN project aims to enable homes and small businesses across the EU to optimize their energy consumption and provide an assessment of the live energy performance of a building which takes into account the quality of appliances/systems installed, user operational habits and the smart readiness of a building. The solution will leverage Augmented Intelligence to empower the building occupants to improve their building's performance.

	October 2020
	48 months
	Ongoing
	5.7M€
	www.autodan-project.eu
	IES R&D
	Ireland: IES R&D, TU Dublin, MSEMICON TEORANTA, O Cualann Cohousing Alliance Company Limited By Guarantee **Italy**: RINA, CIVIESCO SRL, FLAIRBIT SRL, SCHNEIDER ELECTRIC SPA, DELTA ECOPOLIS - SOCIETA COOPERATIVA **Spain**: CARTIF, Universidad de Burgos **Turkey**: ARCELIK A.S.

Technology building blocks
Construction process, end of life, cross-cutting information

BERTIM [6]

Building energy renovation through timber prefabricated modules

BERTIM project is developing a timber prefabricated system for building energy retrofitting and a holistic renovation process based on customized mass manufacturing methodologies, supported by building information models (BIM). The timber solution provides the opportunity to renovate buildings improving energy performance and the RenoBIM tool, based in a digital data flow in BIM, enables reduction of renovation operation time and make more efficient the renovation process

	June 2015
	48 months
	Completed
	4.9 M€
	www.bertim.eu
	Tecnalia, Spain
	Denmark: BBBO. **France**: FCBA, POBI, Dietrichs'. **Germany**: TU München **Poland**: ASM. **Spain**: Empresa Municipal de la Vivienda y Suelo de Madrid SA, EGOIN. **Sweden**: SP, Martinssons, Collage.

BIM/ Data/ Interoperability
Energy performance monitoring and management

BEYOND [7]

A reference big data platform implementation and AI analytics toolkit toward innovative data sharing-driven energy service ecosystems for the building sector and beyond

BEYOND H2020 project develops and offers a big data platform and a set of technologies that allow a data consumer to search, find and utilize data generated by buildings (data owners). Based on these, the data consumers can run analytics and simulations that are actually needed to design a project and exploit them during the real-time operation of the buildings so as to optimize their operation and energy performance.

Start date	December 2020
Duration	36 Months
Status	Ongoing
Total budget	5.2 M€
Website	**beyond-h2020.eu**
Coordinator	UBITECH, Greece
Partners	**Croatia**: KONCAR **Cyprus**: SUITE5 **Finland**: VTT **France**: ARTELYS **Greece**: IGM CONSTRUCTIONS ANONYMI KATASKEVASTIKI KAI EMPORIKI ETAIREIA, MYTILINAIOS ANONIMI ETAIREIA **Spain**: CIRCE, Montajes Eléctricos Cuerva, Sistemas Urbanos de Energías Renovables **Serbia**: Preduzece Za Informacione Tehnologije I Elektronsko Trgovanje Belit Doo, Beogradske Elektrane

ICT
BIM/ Data/ Interoperability

BIGG [8]

Building Information aGGregation, harmonization and analytics platform

Application of big data technologies and data analytic techniques for the complete buildings life-cycle of more than 4000 buildings in 6 large-scale pilot test-beds, achieved by: 1)The Open Source BIGG Data Reference Architecture 4 Buildings for collection, processing and exchanging data from different sources; 2) An interoperable buildings data specification, BIGG Standard Data Model 4 Buildings; 3) An extensible, open, cloud-based BIGG Data Analytics Toolbox of service modules.

	December 2020
	36 Months
	Ongoing
	4.9 M€
	www.bigg-project.eu
	Inetum Realdolmen, Belgium
	Belgium: Inetum Realdolmen, IMEC, ECTP **France**: CSTB, Helexia **Greece**: DOMX, ENGIE, HERON **Italy**: Intuicy **Spain**: CIMNE, Infraestructuras de Cataluña, ICAEN

Construction process, end of life, cross-cutting information
ICT

BIM2TWIN [9]

Optimal Construction Management & Production Control

BIM2TWIN aims to build a Digital Building Twin (DBT) platform for construction management that implements lean principles to reduce operational waste of all kinds, shortening schedules, reducing costs, enhancing quality and safety and reducing carbon footprint. BIM2TWIN proposes a comprehensive, holistic approach. It consists of a (DBT)platform that provides full situational awareness and an extensible set of construction management applications.

	November 2020
	42 months
	Ongoing
	6 M€
	bim2twin.eu
	CSTB, France
	Denmark: Aarhus Universiteit **Finland**: FIRA GROUP OY. **France**: CSTB, INRIA, SPADA CONSTRUCTION, ORANGE SA **Germany**: TU München, Ruhr-Universität Bochum, Siemens AG **Italy**: Università Politecnica delle Marche, UniSMART - Fondazione Università degli Studi di Padova **Spain**: Tecnalia, ACCIONA, IDP **United Kingdom**: University of Cambridge **Israel**: Israel Institute of Technology, INTSITE LTD

ICT

BIM4EEB [10]
BIM-based toolkit for Efficient rEnovation in Buildings

BIM4EEB focuses on implementing a complete BIM-based toolkit to be adopted in the renovation of existing residential buildings in order to make the flow of information efficient, decreasing intervention working time while improving building performances, quality and comfort for inhabitants.

Start date	January 2019
Duration	42 months
Status	Ongoing
Total budget	6.9 M€
Website	**bim4eeb-project.eu**
Coordinator	Politecnico di Milano, ITALY
Partners	**Cyprus**: SUITE5 Data Intelligence Solutions Limited. **Finland**: VTT Technical Research Centre of Finland; VisvaLink Oy; Caverion Suomi Oy. **France**: Conseil des Architectes d'Europe **Germany**: Technische Universitaet Dresden **Ireland**: University College Cork - National University of Ireland, Cork **Italy**: Regione Lombardia; ALER Azienda Lombarda Edilizia Residenziale; One Team Srl **Spain**: Solintel M&PS.L **Sweden**: RISE Research Institute of Sweden AB; CGI Sverige AB

BIM4EEB
BIM based fast toolkit for Efficient rEnovation in Buildings

Technology Building Blocks

BIMERR [11]
BIM-based holistic tools for Energy-driven Renovation of existing Residences

BIMERR intends to design and develop a new toolkit to support renovation stakeholders from the AEC community during the renovation process of existing buildings, from concept to delivery. It should comprise of tools, such as an automated creation of enhanced BIMs, a renovation decision support system and a process management tool which will optimize the design and on-site construction process toward optimal coordination and minimization of renovation time and cost.

	January 2019
	45 Months
	Ongoing
	6.9 M€
	www.bimerr.eu
	Fraunhofer gesellschaft
	Austria: Xylem, BOC Asset Management **Belgium**: Merit consulting house **Cyprus**: UBITECH limited ; SUITE5 **Greece**: Ethniko Kentro Erevnas kai Technologikis Anaptyxis; Hypertech; Anonymus Etaireia Kataskevon-Technikon Ergon, Emporikon, Viomichanikonkai Nautiliakon Epicheiriseon Kon'kat, Univeristy of Peloponnese **Italy**: GLASSUP SRL Poland: BUDIMEX SA **Slovakia**: NOVITECH AS **Spain**: Universidad politecnica de Madrid **United Kingdom**: Exergy ltd ; heriot-watt university

BIMERR
RENOVATION 4.0

BIM/ Data/ Interoperability
Construction process, end of life, cross-cutting information

BIMProve [12]
Improving Building Information Modelling by Realtime Tracing of Construction Processes

The consortium behind the project BIMprove intends to employ digital twin technology to develop a dynamic digital thread system for construction sites that goes beyond the static Building Information Modelling (BIM) process currently in use. The technology will introduce profound disruption to the construction sector, which has experienced prolonged stagnation and is ripe for digitalization.

	September 2020
	36 Months
	Ongoing
	5.59 M€
	www.bimprove-h2020.eu
	SINTEF, Norway
	Finland: VTT **Germany**: Fraunhofer Gesellschaft IAO, DIN e. V., University of Stuttgart IAT **Spain**: Vías y Construcciones, S.A, Robotnik Automation S.L.L., AUSTRALO INTERINNOV MARKETING LAB S.L. **Switzerland**: Zurich University of Applied Sciences, HRS Real Estate AG **Norway**: Delete, repeate in the coordinator Catenda AS, AFGruppen AS

BIM prove

BIM/ Data/ Interoperability
ICT

BIM-SPEED [13]

Harmonised Building Information Speedway for Energy-Efficient Renovation

BIM-SPEED promotes a transdisciplinary approach to a renovation process where BIM is adopted in a cost-effective, flexible and modular way by all key stakeholders. The project will develop an integrated BIM cloud platform - the BIM Speed innovation highway - that provides a holistic infrastructure to facilitate BIM based processes, tools, and data for achieving long-term EEB deep renovation at an affordable level and within a significantly reduced delivery time frame.

Start date	November 2018
Duration	48 Months
Status	Ongoing
Total budget	6.9 M€
Website	**www.bim-speed.eu**
Coordinator	TU, Germany
Partners	**Belgium**: ACE, EBC Construction **Bulgaria**: ARCHITECTURAL SPIES EOOD **France**: CSTB, FIEC **Germany**: HOCHTIEF ViCon, Planen-bauen 4.0, Metabuild **Italy**: Università Politecnica delle Marche, STRESS **Netherlands**: Van Berkel & Bos U.N. Studio B.V., Erasmus Universiteit Rotterdam, REHVA **Poland**: FASADA, Mostotal Warszawa **Romania**: Arcadis project engineering SA **Spain**: CARTIF; CYPE SOFT SL ; LKS INGENIERIA, S COOP ; VISESA

Technology Building Blocks
Energy performance monitoring and management

BRESAER [14]

Breakthrough solutions for adaptable envelopes for building refurbishment

BRESAER is putting forward new solutions to be adopted by the European existing building stock with the aim to get near zero energy buildings by the transformation of the envelope into an active element rather than passive, enabling it to adapt to a dynamic environment and to occupants' requirements during its lifetime. It has been validated under European Standards, the demonstration in a real building and the business models development is currently on-going and will end in 2019.

	February 2015
	54 months
	Completed
	5.8 M€
	www.bresaer.eu
	ACCIONA, Spain Belgium: Youris.
	France: Technofi.
	Greece: NanoPhos.
	Hungary: EMI. Israel: Technion.
	Italy: Stam.
	Netherlands: TNO.
	Spain: AENOR, Ascamm, CARTIF, Mondragon, Solarwall, Tecnalia.
	Turkey: Ekodenge, Ministry of Education.

Technology Building Blocks
Design

BuildHEAT [15]

Standardized approaches and products for the systemic retrofit of residential Buildings, focusing on heating and cooling consumptions attenuation

BuildHeat aims to elaborate a set of reliable, energy efficient and affordable retrofit solutions for multifamily houses, which execution is facilitated by industrialised, modular and flexible HVAC, façade and ICT systems made available on the market. BuildHeat aims to leverage private and public investments by aggregating customers into energy efficient communities that are attractive to large investors.

	September 2015
	48 months
	Completed
	3.4 M€
	www.buildheat.eu
	EURAC , Italy
	Austria: Pink Energie- Und Speichertechnik
	Belgium: Youris.Com, Airria
	Germany: Allplan, HALFEN, EWE-Forschungszentrum , MIG
	Italy: SiTI, Clivet, Schneider Electric, Rete RI.GE.N.E.R.A
	Spain: ACCIONA, CIRCE, Sociedad Municipal Zaragoza Vivienda
	United Kingdom: Ove Arup & Partners International, The University Of Salford, Salix Homes

Construction process, end of life, cross-cutting information
ICT

BUILT2SPEC [16]

Built to specifications: Self-inspection, 3D modelling, management and quality-check tools for the 21st century construction worksite

BUILT2SPEC will ensure the quality of construction activities on site by developing new, innovative on- site tools including: EE quality checks, 3D imagery & thermal imaging, BIM and smart building components, air pulse airtightness test, acoustic & IAQ tools. All these technologies are to be connected to a virtual construction management platform supporting the collection and sharing of all project data, from initial design to delivery.

Start date	January 2015
Duration	48 months
Status	Completed
Total budget	6 M€
Website	**www.built2spec-project.eu**
Coordinator	NOBATEK/INEF4, France
Partners	**France**: Blue Industry & Science, ENSA Nantes, LogiRep, Université de Bordeaux. **Germany**: Passive House Institute **Italy**: De Cinque, R2M Solution **Ireland**: ECOFIX, National University of Ireland Galway, Oran Precast **Spain**: EURECAT, FUNITEC, OHL **Switzerland**: ETH Zurich **Netherlands**: TNO **United Kingdom**: BRSIA, LakeHouse, The University of Nottingham, VRM Technology

BIM/ Data/ Interoperability
ICT

COGITO [17]

COnstruction-phase diGItal Twin mOdel

COGITO aims to contribute to the digitalisation of the construction industry by harmonizing Digital Twins with Building Information Models and building a digital Construction 4.0 toolbox. Services will be delivered to facilitate the timely detection of health & safety hazards to humans, support timely identification of quality defects, and provide means for real-time workflow management on site. Methods & technologies to ensure interoperability are applied within the Digital Twin platform.

	November 2020
	36 Months
	Ongoing
	5.9 M€
	cogito-project.eu
	Hypertech, Greece
	Austria: RHOMBERG SERSA **Denmark**: Aarhus Universiteit **Greece**: CERTH, QUE Technologies OLYMPIA ODOS ANONYMI ETAIRIA PARACHORISIS GIA TON AUTOKINITODROMO ELEUSINA KORINTHOS PATRA PYRGOS TSAKONA **Pland**: ASM **Slovakia**: NOVITECH AS **Spain**: Universidad Politécnica de Madrid, Ferrovial Construcción **United Kingdom**: University College London, University of Edinburg

Energy performance monitoring and management
ICT

COLLECTiEF [18]

Collective Intelligence for Energy Flexibility

COLLECTiEF Collective Intelligence for Energy Flexibility. COLLECTiEF will enhance, implement, test and evaluate an interoperable and scaleable energy management system based on Collective intelligence (CI) that allows easy and seamless integration of legacy equipment into a collaborative network with reduced installation cost, data transfer and computational power while increasing data security, energy flexibility and climate resilience.

	June 2021
	48 months
	Ongoing
	4.59 M€
	www.collectief-project.eu
	NTNU, Norway
	Cyprus: The Cyprus Institute **France**: CSTB **Hungary**: Geonardo Environmental Technologies Ltd. **Italy**: Energy@Work, R2M Solution, CETMA, LSI Lastem , Teicos UE SRL **Sweden**: Lund University, NODA Intelligent Systems AB, Virtual Manufacturing AB **Norway**: EM Systemer AS, Ålesund Municipality

Technology building blocks
Energy performance monitoring and management

CREATE [19]

Compact retrofit Advanced Thermal Energy storage

In CREATE, a heat battery based on the Thermochemical Materials technology is developed and demonstrated. The material of choice is potassium carbonate.
For the material development, special emphasis is put on the mechanical stability, using different production technologies and additives. A prototype storage module with minimal volume through a prismatic shape is built and tested. Subsequently, a system of 3 modules is built and now tested in the laboratory, for later demonstration in a house.

Start date	October 2015
Duration	59 months
Status	Completed
Total budget	5.9 M€
Website	**www.createproject.eu**
Coordinator	TNO, Netherlands
Partners	**Austria**: AEE Institut Fur Nachhaltige Technologien **Belgium**: Tessenderlo Chemie **Czech Republic**: Fenix TNT **France**: EDF **Germany**: Vaillant, Dow Wolff Cellulosics **Italy**: D'appolonia **Netherlands**: TU, Caldic Nederland **Poland**: Mostostal Warszawa **United Kingdom**: Luvata

Design
Technology building blocks

CULTURAL-E [20]

Climate and cultural based design and market valuable technology solutions for Plus Energy Houses

CULTURAL-E aims to define modular and replicable solutions for Positive Energy Buildings, accounting for climate and cultural differences to create comfortable, efficient, and affordable indoor environments. Technologies and tailored solution-sets are developed to address energy demand and solar energy harvesting as affected by local climate and socio-cultural contexts, to enable a comprehensive optimization of value/ cost ratio of PEBs.

	October 2019
	60 months
	Ongoing
	9.69 M€
	www.cultural-e.eu
	EURAC, Italy
	Belgium: ACE **France**: VILOGIA SA, NOBATEK INEF 4 **Germany**: University of Stuttgart, STEINBEIS, Wohnbau-Studio **Italy**: Università Ca' Foscari Venezia, EUROFINESTRA, Vortice, Aabitcoop **Spain**: RMIT Spain, Advantic Sistemas y Servicios **Norway**: SINTEF, BAERUM KOMMUNE **United Kingdom**: Brunel University London, VENTIVE LTD

Energy performance monitoring and management
BIM/ Data/ Interoperability

D^2EPC [21]

Next-generation Dynamic Digital EPCs for Enhanced Quality and User Awareness

D^2EPC proposes a digital platform for the issuance and update of EPCs, integrates a GIS environment and provides value added services (recommendations for energy renovation, benchmarkin and forecasting of buildings' performance). It will be fed by operational data and adopts the 'digital twin' concept to advance Building Information Modeling, calculate a novel set of energy, environmental, financial and human comfort/ wellbeing indicators, and through them the EPC classification.

	September 2020
	36 months
	Ongoing
	2.99 M€
	www.d2epc.eu
	CERTH , Greece
	Austria: Austrian Standards International, Osterreichische Energieagentur Austrian, Energy Agency **Cyprus**: Frederick research Center **Germany**: CLEOPA GMBH, SEnerCon GmbH **Greece**: Hypertech **Netherlands**: TU Kauno **Lithuania**: DEMO CONSULTANTS BV **Spain**: AENOR, SGS TECNOS SA

ICT
BIM/ Data/ Interoperability

domOS [22]

Operating System for Smart Services in Buildings

More and more connected devices and appliances are installed in existing buildings. Online systems are operated as independent silos, thus forbidding in practice the deployment of applications involving several appliances as required for energy management. By defining an ecosystem based on IoT standards, the domOS project decouples the in- building infrastructure and the application layers and enables the deployment of applications not bound to a single type of appliance or device.

Start date	September 2020
Duration	36 months
Status	Ongoing
Total budget	4.97 M€
Website	**www.domos-project.eu**
Coordinator	HES-SO, Switzerland
Partners	**Czech Republic**: FENIX TNT SRO **Denmark**: Aalborg Universiteit, NEOGRID Technologies, Suntherm, Aalborg Energi Holding **France**: ELECTRICITE DE France **Switzerland**: CSEM, ALIUNID AG, OIKEN SA **Slovenia**: INEA

Technology Building Blocks
Energy performance monitoring and management

DREEAM [23]

Demonstrating an integrated Renovation approach for Energy Efficiency At the Multi-building scale

DREEAM is a pan-European project focusing on nZEB renovation of residential buildings.
The uniqueness of DREEAM's approach is its multi-building focus. The project investigates the benefits of large-scale renovations on potential energy efficiency gains, inclusion of renewables and access to funding. DREEAM supports housing companies through an integrated set of services: investment planning, renovation design, quality assurance, energy consumption analysis, and tenant engagement.

	February 2015
	48 months
	Completed
	7.9 M€
	www.dreeam.eu
	Chalmers University Of Technology, Sweden
	Belgium: EURHONET **Germany**: 3C PRECON, Wuppertal Institut **Italy**: ATER TREVISO **Poland**: NAPE **Spain**: Bax & Compagny, OpenDomo Services, Sinceo 2 Ingenieria Energetica, Exeleria **Sweden**: Aktiebolaget Landskronahem, Sveriges Tekniska Forskningsinstitut **United Kingdom**: Savills, Places For People Group, ENERGYPRO

Design
Construction process, end of life, cross-cutting information

DRIVE 0 [24]

Driving decarbonization of the EU building stock by enhancing a consumer centred and locally based circular renovation process

Drive 0 aims at accelerating deep renovation processes through the design of a consumer-centred circular renovation strategy. Building on proven deep renovation products and concepts from the experience of past EU projects, DRIVE 0 focuses on the deployment of local available materials and components from the existing building stock, with great emphasis given to plug & play prefab solutions for building envelop elements and building services. Additionally, DRIVE 0 identifies specific local drivers that motivate and persuade building owners for deep renovation.

	October 2019
	48 months
	Ongoing
	4.75 M€
	www.drive0.eu
	Huygen Installatie Adviseurs
	Belgium: Housing Europe, International Union of Property Owners ACE **Greece**: National and Kapodistrian University of Athens, Salfo **Ireland**: TU Dublin, COADY Architects Vision Built **Italy**: University of Bologna, ALIVA **Netherlands**: ISSO, WEBO, Factory Zero, ZUYD University of Applied Science **Spain**: Pich Architects, Valencian Institute of Buildings **Estonia**: Tallinn University of Technology, Timbeco Woodhouse **Slovenia**: Knauf Insulation, Institute for Innovation and Development of University Ljubljana

Technology building blocks
Construction process, end of life, cross-cutting information

E2VENT [25]

Energy efficient ventilated facades with integrated heat exchangers for optimal adaptability for the refurbishment of existing buildings

The E2VENT team is developing a module for the refurbishment of residential buildings.
Adding to the classical insulation layer, the module embeds an air renewal system with a heat exchanger to ensure air quality while limiting the energy losses and a PCM based thermal storage for cooling.
The Building Management System allows optimal piloting and adaptability. Pilots buildings in Burgos (Spain) and Gdansk (Poland) are now renovated and being monitored.

Start date	January 2015
Duration	42 months
Status	Completed
Total budget	3.4 M€
Website	**www.e2vent.eu**
Coordinator	NOBATEK/INEF4, France
Partners	**Belgium**: European Aluminium Association. **Czech Republic**: Fenix TNT SRO. **Greece**: AUTH, Greece. **Italy**: D'Appolonia, Elval. **Poland**: Fasada. **Spain**: Tecnalia, ACCIONA, CARTIF, UBU, Pich-Aguilera architects. **United Kingdom**: University of Hull.

Advanced materials and nanotechnolog
Technology building blocks

ECO-Binder [26]

Development of ICFs based on novel low CO2 binders for a new family of eco-innovative, durable and standardised energy efficient envelope components

Heat4Cool aims to demonstrate the efficient and cost-effective integration of gas and solar thermally driven adsorption heat pumps, solar PV assisted DC powered heat pump connected to an advanced modular PCM heat storage system, and energy recovery from sewage water. A Self-Correcting Intelligent Building Energy Management System will optimize operational strategy. Implementation of four retrofitting projects.

	January 2015
	48 months
	Completed
	7.6 M€
	www.ecobinder-project.eu
	D'Appolonia, Italy
	Czech Republic: Fenix TNT. **Denmark**: Danish Technological Institute. **France**: LafargeHolcim Centre de Recherche, VICAT. **Germany**: Heidelberg Cement. **Greece**: NTUA **Hungary**: Geonardo. **Italy**: Nuova Tesi System. **Romania**: Drobeta Turnu Severin City Hall, Novel Technologies Center. **Spain**: ACCIONA, Tecnalia. **United Kingdom**: Building Research Establishment.

Energy performance monitoring and management
ICT

ECO-Qube [27]

Artificial-Intelligence-Augmented Cooling System for Small Data Centres

ECO-Qube is a holistic management system which aims to enhance energy efficiency and cooling performance by orchestrating both hardware and software components in edge computing applications. ECO-Qube is a data driven approach which utilizes valuable unused data from active data centre components.
Created big data is being used by an artificial intelligence augmented system which detects cooling and energy requirements instantaneously.

	October 2020
	36 months
	Ongoing
	3.67 M€
	www.eco-qube.eu
	Lande Endüstriyel Metal Ürünler Sanayi ve Ticaret A.Ş. , Turkey
	Germany: Sustainable Digital Infrastructure Alliance **Netherlands**: Green IT Amsterdam **Spain**: R2M Solution Spain **Swizerland**: HELIO AG, EMPA **Sweden**: TU Lulea **Turkey**: LANDE, D&S TECH, ENDOKS Energy, BitNet

Energy performance monitoring and management
Technology Building Blocks

E-DYCE [28]
Energy flexible DYnamic building Certification

Steady-state labels result in high discrepancies with post occupancy behaviour - performance gap. This inaccuracy does not allow the building owner to make informed decisions on time and restricts the potential of economical exploitation of the building. E-DYCE will combine innovative approaches with established and widely available tools, to create a methodology capable of implementing expandable and adaptable dynamic energy performance certification.

Start date	September 2020
Duration	36 months
Status	Ongoing
Total budget	2.94 M€
Website	**edyce.eu**
Coordinator	Aalborg Universiteit, Denmark
Partners	**Denmark**: Neogrid Technologies **Germany**: EMTECH **Greece**: Core Innovation and Technology **Italy**: Politecnico di Torino, ENEA, L'Energia e lo Sviluppo Economico Sostenible, TPM **Swizerland**: ESTIA, Office cantonal de l'énergie Genève

Construction process, end of life, cross-cutting information

EEB-CA2 [29]
Energy efficient buildings cluster activities coordination action

EeB-CA2 developed a set of technology and geo-clustering instruments as well as services for integrated dissemination and technology transfer. EeB-CA2 has contributed to increase public presence and awareness of EeB PPP activities, to stimulate networks and alliances for further RTD and industrial innovation in the addressed technology and application areas, and to speed up industrial exploitation of EeB PPP projects

	February 2015
	24 months
	Completed
	0.5 M€
	www.e2b-clusters.eu
	CSTB, France
	Italy: D'appolonia SPA. **Belgium**: ECTP. **Germany**: Steinbeis.

ICT
BIM/ Data/ Interoperability

EEBERS [30]
Energy efficient buildings ICT clusters

EEBERS aims to identify opportunities for synergies in ICT related RTD in the EeB (energy efficient buildings) domain and to engage stakeholders in networking for future RTD and exploitation of results. EEBERS booklets and finally the main public reports have been used in discussions in current projects and project preparations. The EEBERS taxonomy and the pictures and descriptions of the technological solutions are a good starting point to further development.

	February 2015
	24 months
	Completed
	0.5 M€
	www.eebers.eu
	VTT, Finland
	Germany: Fraunhofer Gesellschaft **Spain**: Solintel M&P Sl. **United Kingdom**: Loughborough University.

< Back to the previous page

Technology building blocks
Advanced materials and nanotechnology

EENSULATE [31]

Development of lightweight and highly insulating energy efficient components and associated enabling materials for cost-effective retrofitting and new construction of curtain wall facades

Development of an affordable and lightweight solution for envelope insulation to bring existing curtain wall buildings to "nearly zero energy" standards while complying with structural limits and national building codes. Commercial insulating products developed: environmentally friendly highly insulating foams and lightweight, thin double pane vacuum glasses with multi-functional thermo-tunable coatings.

Start date	August 2016
Duration	42 months
Status	Completed
Total budget	6.7 M€
Website	**www.eensulate.eu**
Coordinator	D'Appolonia, Italy
Partners	**Belgium**: AGC Glass Europe **Czech Republic**: Fenix TNT **Germany**: Evonik Nutrition & Care **Italy**: SAES Getters, Focchi, Universita Politecnica Delle Marche **Netherlands**: Van Berkel & Bos U.N. Studio **Poland**: Selena Labs Spolka Z Ograniczona Odpowiedzialnoscia, Bergamo Tecnologie Spzoo, Gmina Miejska Dzierzoniow **Spain**: TVITEC **United Kingdom**: University College London, University Of Ulster

BIM/ Data/ Interoperability
Energy performance monitoring and management

ENCORE [32]

Energy-aware BIM Cloud Platform in a Cost-effective Building Renovation Context

ENCORE proposes BIM services for performing renovation projects aiming at higher energy efficiency and comfort: -surveying of properties (interior and envelop) -generation of BIM from Point Clouds or Photos -semantic classification of components- BIM for EE simulations -AR/MR for quick feedback -automatic generation of tasks for construction crews. ENCORE will be validated at "EDEA Project": reference and experimental housings used to evaluate the effectiveness of renovation strategies.

	January 2019
	42 month
	Ongoing
	5.6 M€
	www.encorebim.eu
	ATB, Germany
	Croatia: University of Zagreb
	Cyprus: RTD TALOS
	Denmark: BIM EQUITY
	Italy: Universitá Politecnica delle Marche; CNR-ISTI
	Portugal: SPA
	Spain: Universidad de la Laguna; Laurentia Technologies; Junta de Extremadura
	Switzerland: ETH ZURICH
	United Kingdom: SmartGateways

Technology building blocks
Energy performance monitoring and management

ENERGY MATCHING [33]

Adaptable and adaptive RES envelope solutions to maximise energy harvesting and optimize EU building and district load matching

EnergyMatching aims at developing adaptive and adaptable envelope and building solutions for maximizing RES (Renewable Energy Sources) harvesting: versatile click&go substructure for different cladding systems, solar window package, modular appealing BIPV envelope solutions, RES harvesting package to heat and ventilate.
Such solutions are integrated into energy efficient building concepts for self-consumers connected in a local area energy network.

	October 2017
	58 month
	Ongoing
	7.0 M€
	www.energymatching.eu
	EURAC, Italy
	France: Bouygues Construction, Solarwall Europe
	Germany: Wirtschaft und Infrastruktur GMBH & co Planungs KG
	Italy: Casa S.P.A, Eurofinestra SAS di Ecosistema SRL, Pellini SPA, R2M Solution
	Netherlands: Plastica Plaat BV, Tulipps BV
	Spain: Tecnalia, Onyx Solar Energy S.L
	Sweden: Ferroamp Elektronik AB, Hogskolan Dalarna, Ludvikahem Aktiebolag, Nibe Aktiebolag

Technology building blocks
ICT

ENSNARE [34]

ENvelope meSh aNd digitAl framework for building Renovation

The overall contribution is to provide a systemic methodology combining products, systems and solutions to boost the adoption of novel and advanced technologies in the renovation sector looking to achieve high energy efficiency standards for buildings. To accomplish this, 2 main structures are developed: 1) Modular envelope mesh facilitating mechanical assembly & interconnection of components 2) A digital platform, including a set of digital toolboxes, that supports all stages the process.

Start date	January 2021
Duration	49 months
Status	Ongoing
Total budget	1.02 M€
Website	**www.ensnare.eu**
Coordinator	Tecnalia
Partners	**Belgium**: Balkanika **Estonia**: Tartu Linn Finland: Once Click LCA **France**: NOBATEK/INEF4 Germany: TUM **Hungary**: Abud Ireland: IES R&D **Italy**: Civiesco, COAF, UNIPD **Netherlands**: Trespa, TUDELFT N.R. Macedonia: Kamel Solar **Spain**: Riventi, ONYX, ENAR, R2M Solution Spain

Energy performance monitoring and management
Advanced materials and nanotechnology

ENVISION [35]

Energy harvesting by Invisible Solar IntegratiON in building skins

ENVISION aims at developing and demonstrating an integrated renovation concept using all the available building surfaces for thermal and electrical energy harvesting. This will allow to exploit the currently unused 60 billion square meters of facades existing in the European Union. The ENVISION renovation concept will use standard PV solutions for roof and new thermal solutions for the building façade.

Start date	October 2017
Duration	54 months
Status	Ongoing
Total budget	6.0 M€
Website	**www.energy-envision.eu**
Coordinator	TNO, Netherlands
Partners	**France**: Electricité de France **Germany**: Pilkington Deutschland BV **Italy**: Rina Consulting SPA **Netherlands**: Akzo Nobel Decorative Coatings BV, BAM Techniek BV, BAM Woningbouw BV, Emergo Hout & Bouw BV, Pilkington Nederland BV, Stichting Vestia **United Kingdom**: Imperial Chemical Industries Limited

Energy performance monitoring and management
BIM/ Data/ Interoperability

ePANACEA [36]

Smart European Energy Performance AssessmeNt And CErtificAtion

ePANACEA develops an innovative, holistic and flexible methodology for Energy Performance Assessment and Certification of buildings with improved consideration of occupant patters, inclusion of smart and novel technologies and use of building monitoring data to increase accuracy. The methodology will be integrated on an online, self- calibrated platform.

Start date	June 2020
Duration	36 month
Status	Ongoing
Total budget	2.65 M€
Website	**epanacea.eu**
Coordinator	CENER, Greece
Partners	**Austria**: TU Wien, Energie Agentur Steiermark **Belgium**: VITO **Finland**: Teknologian tutkimuskeskus VTT Oy **Greece**: CRES, Sympraxis **Spain**: CENER, Certificación Energética, IZES, Instituto para la Diversificación y Ahorro de la Energía

Energy performance monitoring and management
ICT

EPC RECAST [37]

Adaptable and adaptive RES envelope solutions to maximise energy harvesting and optimize EU building and district load matching

EPC RECAST H2020 project sets a well-structured process and a toolbox, supporting the development, implementation and validation of a new generation of Energy Performance Assessment and Certification, with a deliberate focus on residential buildings, more specifically existing ones, for which retrofit is one of the most challenging and pressing issue. By enhancing EPCs usability, reliability, and comparability, and by linking them to renovation roadmaps and digital building logbooks, EPC RECAST can achieve unprecedented user-friendliness and user awareness of building performance.

Start date	September 2020
Duration	40 month
Status	Ongoing
Total budget	2.75 M€
Website	**epc-recast.eu**
Coordinator	CSTB, France
Partners	**France**: ELECTRICITE DE France, ENGIE, BIMEO **Germany**: Fraunhofer Gesellschaft **Netherlands**: REHVA **Luxembourg**: LIST **Italy**: POLIMI, R2M solution **Slovakia**: ENBEE SRO **Spain**: Tecnalia

Technology building blocks
Energy performance monitoring and management

e-SAFE [38]

Energy and Seismic AFfordable rEnovation solutions

Innovative wood-based technical solutions and implementation guidelines, novel co-design protocols, new socially oriented business models and financial tools, engagement and training of a wide variety of actors: the e-SAFE approach to the deep energy and seismic renovation of the non-historic building stock. e-SAFE aims to transform the EU market of building renovation in earthquake-prone countries and to contribute to reaching the EU targets for 2030 and 2050.

	October 2020
	48 months
	Ongoing
	4.59 M€
	esafe-buildings.eu
	University of Catania, Spain
	Austria: Pink GmbH (PINK)
	Belgium: Moverim, BPIE Cyprus: DELOITTE
	Greece: SALFO
	Italy: University of Catania, University of Bologna Istituto Autonomo Case Popolari Catania,, Engineering
	Netherlands: TIMMERFABRIEK WEBO BV
	Norway: NMBU
	Turkey: SAMPAS

Energy performance monitoring and management
ICT

EXCEED [39]

European Energy Efficient building & district Database: from data to information to knowledge

ExcEED H2020 project has the overall objective of creating a European self-sustainable and dynamic database for measured and qualitative data on beyond the state of the art buildings. The advanced tools and KPIs associated to the database (also available here http://kpidb.eurac.edu/) will allow the analysis of real energy performance and environmental quality at the level of single building, geo-cluster of buildings, and European new or renovated building.

	December 2016
	37 month
	Completed
	0.7 M€
	www.exceedproject.eu
	EURAC, Italy Belgium: 3E NV, BPIE
	Italy: Hoval
	Ireland: Wattics

Technology Building Blocks
ICT

EXCESS [40]
FleXible user-CEntric Energy poSitive houseS

EXCESS - FleXible user-CEntric Energy poSitive houseS – brings together 21 partners from 8 countries to showcase how nearly-zero energy buildings can be transformed into positive energy buildings. EXCESS will spearhead four innovative demonstration projects, introducing technical solutions that enable buildings to produce more renewable energy than they consume over the course of a year, in demo projects in the Nordic, Continental, Oceanic and Mediterranean climate zones.

Start date	September 2019
Duration	48 months
Status	Ongoing
Total budget	9.24 M€
Website	**positive-energy-buildings.eu**
Coordinator	Joanneum Research, Belgium
Partners	**Austria**: AEE Intec, Bar, TS IT consulting, NETx **Belgium**: VITO, Prospex, CORDIUM **Cyprus**: SUITE5 **Finland**: VTT, Mouvitech, Gebwell, Tom Allen Senera **France**: Dualsun **Germany**: ICLEI **Greece**: CGSOFT, Urbatelier **Spain**: CENER, AAE, TRYCSA

Advanced materials and nanotechnology
Technology Building Blocks

GELCLAD [41]
Highly efficient cladding eco-panels with improved nano-insulation properties

Gelclad is developing the manufacturing technologies to provide the building market with a superior façade insulation modular system that comprises a nano-insulation aerogel core and an eco-composite skin layer. Gelclad will be an all-in-one single, durable, affordable and easy to install panel solution, capable of delivering strict energy efficiency requirements and outstanding traditional multi-product systems.

	September 2016
	36 months
	Completed
	5.5 M€
	www.gelclad.eu
	Instituto Pedro Nunes, Portugal
	Germany: TECNARO GmbH, Fraunhofer Institute for Chemical Technology **Portugal**: LNEC, Active Aerogels **Slovenia**: Navodnik Kemijski Inzeniring, Slovenski Gradbeni Grozd-GIZ, JUB d.o.o **Spain**: Construcciones Garcia Rama **United Kingdom**: Brunel University London, Vannplastic, BRE

Technology Building Blocks
Construction process, end of life, cross-cutting information

Green INSTRUCT [42]
Green Integrated Structural Elements for Retrofitting and New Construction of Buildings

The underlining theme of the project is to achieve sustainability and cost savings through CDW sourced materials, while maintaining recyclability of the components in a C2C approach.
The construction block will be BIM-optimised and include: photocatalytic and self-cleaning coating; continuous extrusion fabrication technology for low carbon cementitious materials; integration of a green wall technology for CO2 capture, greywater cleaning and a healthy micro-climate for living.

	October 2016
	42 months
	Completed
	7.6 M€
	www.greeninstruct.eu
	Brunel University London, United Kingdom
	Austria: Alchemia-Nova **Cyprus**: CETRI **Greece**: NTUA, Artia Nano - Engineering & Consulting Ike **Italy**: STRESS, Collanti Concorde **Poland**: Nr-Gia **Portugal**: Universidade De Aveiro, Cool Haven - Habitacoes Modulares E Eco Sustentaveis **Spain**: Fundacion Cidetec, Acondicionamiento Tarrasense Associacion, ACCIONA **United Kingdom**: EXERGY

Technology building blocks

HAPPENING [43]

HeAt PumPs in existing multi-family buildings for achieving union's ENergy and envIromeNtal Goals

HAPPENING aims (1) at demonstrating a highly versatile, scalable and replicable solution for buildings heating and DHW system retrofitting allowing 70% of RES fraction, (2) at developing near-zero planning, implementation and operation processes, (3) at developing new financing and business models for building renovations, and (4) at unleashing the full potential of the solutions developed. To accomplish these, there are 3 demo sites in Ispaster (Spain), Verzuolo (Italy) and Liezen (Austria).

Start date	October 2020
Duration	42 month
Status	Ongoing
Total budget	2.96 M€
Website	**www.happening-project.eu**
Coordinator	Tecnalia, Spain
Partners	**Austria**: AEE **Germany**: Fraunhofer Gesellschaft **Italy**: EURAC, TECNOZENITH SRL, INNOVA SRL, RINA CONSULTING SPA **Spain**: GIROTZE SL, EZE BARRIZAR KOOP E Z E Barrizar Koop Elk Txikia, Green Building Council España, ANESE

Technology building blocks
Energy performance monitoring and management

HEART [44]

Holistic Energy and Architectural Retofit Toolkit

HEART aims at developing a multifunctional retrofit toolkit where different subcomponents - ICT, BEMS, HV AC, BIPV and Envelope Technologies - cooperate synergistically to transform an existing building into a Smart Building. Based on a whole-building performance approach, the toolkit is conceived to achieve extremely high levels of energy efficiency in the existing residential building stock, with particular reference to Central and Southern Europe.

	October 2017
	54 months
	Ongoing
	6.6 M€
	www.heartproject.eu
	POLIMI, Italy
	Austria: Heliotherm
	Belgium: Housing Europe, Revolve Water
	Croatia: STILLE
	France: ENTPE Lyon, Est Métropole Habitat
	Italy: EURAC, ACER RE, ZH
	Luxembourg: VuzVoice
	Slovenia: University of Ljubljana
	Spain: CTIC Technology Center, GarciaRama
	Swiss: Quantis
	United Kingdom: Turbo Power Systems

Advanced materials and nanotechnology
Energy performance monitoring and management

HEAT4COOL [45]

Smart building retrofitting complemented by solar assisted heat pumps integrated within a self-correcting intelligent building energy management system

Heat4Cool aims to demonstrate the efficient and cost-effective integration of gas and solar thermally driven adsorption heat pumps, solar PV assisted DC powered heat pump connected to an advanced modular PCM heat storage system, and energy recovery from sewage water. A Self-Correcting Intelligent Building Energy Management System will optimize operational strategy. Implementation of four retrofitting projects.

	October 2016
	54 months
	Completed
	7.5 M€
	www.heat4cool.eu
	Belgium: EHPA
	Bulgaria: Balkanika Energy
	Germany: SorTech AG
	Greece: Hypertech AE
	Hungary: Thermowatt Ltd.
	Poland: IZNAB
	Spain: SOLINTEL, SYMELEC RENOVABLES, Tecnalia
	Switzerland: HOCHSCHULE LUZERN
	United Kingdom: AES Ltd, Sunamp Ltd

Technology Building Blocks
Energy performance monitoring and management

HEAT-INSYDE [46]

Bringing Advanced Heat Batteries in Residential Heat and Electric Systems Closer to Market through Real Life Demonstration in Different Climates

The HEAT-INSYDE project aims to establish an integrated thermal storage system, based on thermochemical storage, in real-scale pilot demonstrations in residential buildings. This will be achieve by gathering end-user feed-backs in three different climatic regions across the European Union. These large-scale pilots will include both rented and privately-owned configurations.

Start date	October 2019
Duration	54 months
Status	Ongoing
Total budget	7.69 M€
Website	**www.heat-insyde.eu**
Coordinator	TNO, Spain
Partners	**Belgium**: Bureaux D'Etudes Solaires SPRL Belgisch Laboratorium van de Elektriciteisindustrie Laborelec CVBA **France**: Ventilairsec, CEA **Germany**: Evonik Performance Materials GmbH **Netherlands**: TU, Caldic Nederland BV, Gemeente Eindhoven, Stichting Sint Trudo **Poland**: Fasada **Switzerland**: Accelopment AG

Energy performance monitoring and management
ICT

HIT2GAP [47]

Highly Innovative building control Tools Tackling the energy performance GAP

The HIT2GAP project aims to elaborate and develop new methods and tools for the better assessment of energy use within a building or a block of buildings in order to minimise the gap between predicted and measured energy consumption. In its essence, HIT2GAP aims to deliver an open approach for A NEW GENERATION OF BMS SOLUTIONS with plug and play analytics tools and modular services using a win-win strategy (between service providers, BMS manufacturers and cutting-edge SMEs).

	September 2015
	48 months
	Completed
	7.9 M€
	www.hit2gap.eu
	NOBATEK/INEF4 , France **Cyprus**: CY.R.I.C **France**: Bouygues Energies & Services, Evolution, Universite De Pau Et Des Pays De L'adour **Germany**: Fraunhofer-Gesellschaft **Greece**: Applied Industrial Technologies **Ireland**: Zutec Inc., Enerit, National University Of Ireland, Cylon Controls **Italy**: R2M Solution, ABO DATA, **Poland**: Mostostal Warszawa, Miasto Stołeczne Warszawa **Spain**: Fundacio Eurecat, Fundacion Tekniker, Giroa S.A, Universitat De Girona **Turkey**: Ege Universitesi **United Kingdom**: BRE, University Of Strathclyde

Energy performance monitoring and management
BIM/ Data/ Interoperability

HOLISDER [48]

Integrating Real-Intelligence in Energy Management Systems enabling Holistic Demand Response Optimization in Buildings and Districts

HOLISDER introduces a Holistic Demand Response Optimization Framework that enables significant energy costs reduction at the consumer side, while introducing buildings as a major contributor to energy networks' stability. HOLISDER brings together a wide range of mature technologies and integrates them, comprising of a fully-fledged suite of tools, addressing the needs of the whole DR value chain. It will be validated in 4 large-scale pilot sites, located in Greece, UK, Finland and Serbia.

	October 2017
	42 months
	Completed
	5.1 M€
	www.holisder.eu
	Tecnalia, Spain **Croatia**: KONKAR **Czech Republic**: HONEYWELL **Finland**: CAVERION **Greece**: HYPERTECH, MYTILINEOS **Netherlands**: TNO **Poland**: ASM **Serbia**: BEOELEK, BELIT **Spain**: ETRA, Solintel **United Kingdom**: KIWI

Advanced materials and nanotechnology
Technology Building Blocks

HOMESKIN [49]

Homes key insulating material

The HOMESKIN project has developed a new super-insulation panel possessing the lowest thermal conductivity of all insulation materials. The proposed solution brings to the market an insulation technology that do not only have high thermal insulation performance but also is thinner, lighter, non-flammable and with no VOC emissions.
This new material is suitable to new buildings as well as to old buildings retrofits.

Start date	February 2015
Duration	36 months
Status	Completed
Total budget	6.3 M€
Website	**www.homeskin.net**
Coordinator	Enersens, France
Partners	**Germany**: University of Stuttgart. **France**: ARMINES, CEA, Parex. **Italy**: FLAG, Trocellen. **Luxembourg**: Kurt Salmon. **Spain**: ITeC. **Switzerland**: SORANE.

Technology Building Blocks

HYBUILD [50]

Innovative compact HYbrid electrical/thermal storage systems for low energy BUILDings

The HYBUILD develops two innovative compact hybrid electrical/thermal storage systems for buildings: one for the Mediterranean climate primarily meant for cooling energy provision, and one for the Continental climate primarily meant for heating and DHW production. Sub-system components have been validated in the lab environment to perform in line with expected energy and GHG emission savings. Simulations of the integrated solution have been developed and are guiding the integration process.

	October 2017
	54 months
	Ongoing
	6 M€
	www.hybuild.eu
	Comsa, Spain
	Austria: AIT, FRESNEX GMBH, Ochsner Warmepumpen GMBH, PINK GMBH – Energie und Speichertechnik **Cyprus**: Municipality of Aglantzia, University of Cyprus **Czech Republic**: Mikrometal Sro **France**: R2M Solution, NOBATEK/INEF4 **Germany**: AKG Verwaltungsgesellschaft, Sortech AG **Greece**: Daikin Air-conditioning Hellas SA, NTUA **Italy**: EURAC, CNR, Engineering – Ingegneria Informatica Spa, STRESS **Spain**: Ajuntament almatret, Universidad de Lleida (UdL) **Switzerland**: CSEM

Technology Building Blocks
Construction process, end of life, cross-cutting information

IMPRESS [51]

New easy to install and manufacture pre-fabricated modules supported by a BIM based integrated design process

IMPRESS will develop innovative prefabricated panels to reduce energy demand while preserving or improving the building aesthetics. An iterative design methodology has been developed, incorporating all stages of the Design-Construct-Install-Operate process, integrated with a cloud based BIM database. A decision support software tool has also been developed to help the end user choose the most suitable renovation option.

	June 2015
	48 months
	Completed
	4.6 M€
	www.project-impress.eu
	IES, UK
	Hungary: Geonardo Environmental Technologies. **Ireland**: Temperature, Techrete. **Italy**: STRESS, Hypucem, CSP, Biesse Tape Solutions. **Poland**: BG Technologies. **Romania**: Novel Technologies, Municipiul Drobeta Turnu Severin. **Spain**: Alonso Hernandez & Asociados Arquitectos. **United Kingdom**: Coventry City Council, Queen's University Belfast, TEKLA

Technology Building Blocks
Energy performance monitoring and management

InDeWaG [52]
Industrial Development of Water Flow Glazing

The main objective of InDeWaG is the fabrication industrialization of a disruptive glass façade and glass interior wall system based on cost affordable Fluid Flow Glazing elements (FFG), which give maximum daylight utilization and maximum interior comfort by means of variable radiant heating and cooling with appealing glass surfaces at energy consumption level of nZEB and significant cost reduction of construction and installation.

Start date	September 2015
Duration	52 months
Status	Completed
Total budget	5 M€
Website	**indewag.eu**
Coordinator	Universität Bayreuth, Germany
Partners	**Bulgaria**: Architectonika Studio, Central Laboratory SENES BAS, ETEM Bulgaria **Germany**: Bollinger + Grohmann Consulting , HTCO , Fraunhofer ISE **Spain**: Savior Venture Capital, Universidad Politecnica De Madrid, Cerviglas

Technology Building Blocks
Construction process, end of life, cross-cutting information

INFINITE [53]
Industrialised Durable Building Envelope Retrofitting by All-In-One Interconnected Technology Solutions

The INFINITE project will pave the way for the decarbonisation of the EU building stock by facilitating the uptake of all-in-one industrialised envelope technologies. INFINITE ´s approach for deep renovation of buildings will result in both cost and timing reduction, with attention to the life cycle perspective and the design for assembly and disassembly, including end-of-life residual value and the construction and demolition waste.

	November 2020
	54 months
	Ongoing
	1.02 M€
	infinitebuildingrenovation.eu
	EURAC
	Austria: GRÜNSTATTGRAU
	France: NOBATEK INEF4, Bouygues Cosntruction, ARAMIS, POLYOUVRAGES
	Germany: GREENDELTA
	Italy: ONE TEAM, RUBNER HOLZBAU, VORTICE CASASPA, EDERA
	Netherlands: Huygen Installatie Adviseurs, PHYSEE
	Spain: LEITAT, Instituto Valenciano de la Edificación
	Switzerland: SUNAGE
	Slovernia: Innovation and Development Institute of the UL, Stanovanjsko podjetje

Advanced Materials & Nanotechnology
Technology Building Blocks

INNOVIP [54]
Innovative multi-functional Vacuum-Insulation-Panels (VIPs) for use in the building sector

INNOVIP Consortium reinvents the top-of-the-line insulating material vacuum-insulationpanels (VIP) by improving their thermal performance over the entire lifetime by at least 25 % and making VIPs adjustable, mountable and machineable. By reducing the density and/or using an alternative core material together with less expensive VIP-envelopes as gas barrier, the costs will decrease by 25 %.

	October 2016
	36 months
	Completed
	5.8 M€
	innovip-h2020.eu
	Forschungsinstitut für Wärmeschutz e. V. München, Germany
	Denmark: Nordisk Perlite
	France: SOPREMA, LNE
	Germany: va-Q-tec, Fraunhofer-Gesellschaft IVV
	Israël: Hanita Coatings Rca
	Poland: Mostostal Warszawa
	Portugal: ITeCons
	Spain: Tecnologia Navarra De Nanoproductos , L'urederra
	United Kingdom: Oxford Brookes University

Advanced materials and nanotechnology
Technology Building Blocks

InnoWEE [55]

Innovative pre-fabricated components including different waste construction materials reducing building energy and minimising environmental impacts

The project target is the development of an optimized reuse of Construction and Demolition Waste materials producing high added-value prefabricated geopolymeric panels to be used in Energy-Efficient Buildings for eco-insulating facades (ETIC panels, ventilated façade panels) and eco-friendly indoor radiating system (monolithic and assembled panel) with low environmental impact, low embodied energy, low CO2 emissions, high thermal performance.
The panels were realised and installed in the demo.

Start date	October 2016
Duration	48 months
Status	Completed
Total budget	3.3 M€
Website	**www.innowee.eu**
Coordinator	Consiglio Nazionale delle Ricerche, Italy
Partners	**Greece**: Proigmenes Erevnitikes & Diahiristikes Efarmoges Dimos Varis - Voulas - Vouliagmenis **Italy**: R.E.D. SRL, Guidolin Giuseppe - Eco. G. **Poland**: IZNAB Sp.z.o.o **Romania**: Pietre Edil , Magnetti Building **Slovenia**: Zavod Za Gradbenistvo Slovenije **Spain**: Tecnalia

Construction process, end of life, cross-cutting information
Technology Building Blocks

INSITER [56]

Intuitive self-inspection techniques using augmented reality for energy-efficient buildings made of prefabricated components

The key innovation of INSITER is intuitive and cost-effective Augmented Reality for self-inspection that connects virtual and physical buildings in real-time. It will ensure that the targeted performance in the design model is realised; by eliminating the gaps in quality and energy-performance between the design and realisation of energy-efficient buildings made of prefabricated components.

	December 2014
	48 months
	Completed
	6 M€
	www.insiter-project.eu
	DEMO Consultants, Netherlands
	Belgium: Siemens Industry Software. **Bulgaria**: RDF. **Germany**: 3-L, Fraunhofer, Hochtief ViCon. **Italy**: AICE Consulting, Ipostudio, Università Politecnica Delle Marche. **Netherlands**: DWA, Stichting ISSO, SBRCURnet. **Spain**: CARTIF, Dragados.

Advanced materials and nanotechnology
Technology Building Blocks

ISOBIO [57]

Development and demonstration of highly insulating, construction materials from bio-derived aggregates

The ISOBIO project is developing a new approach to insulation materials by combining existing low embodied energy bio-derived aggregates with innovative binders and surface treatments. These novel composites will have lower embodied energy than traditional insulation and will take advantage of the natural moisture release characteristics of the aggregates, resulting in improved indoor air quality.

	February 2015
	48 months
	Completed
	6.3 M€
	www.isobioproject.com
	TWI, United Kingdom.
	Belgium: Greenovate! Europe. **France**: Universite de Rennes I, CAVAC Biomateriaux, BCB. **Germany**: CLAYTEC. **Norway**: Norsk Institutt for Skog og Landskap. **Spain**: ACCIONA, ProGETIC. **United Kingdom**: University of Bath, ModCell, STRAMIT International.

Advanced materials and nanotechnology
Technology Building Blocks

LAWIN [58]
Large area fluidic windows

LaWin targets the development of glass-based façade and window elements which make use of microfluidic functionality comprising: low-cost thin and strong cover glasses, microstructured rolled glasses of architectural quality, a glass-glass laminate of the two filled with a heat storage liquid which is designed for transparency. Additional functions such as polychromism will be added.

Start date: January 2015
Duration: 36 months
Status: Completed

Total budget: 8.1 M€
Website: **www.lawin.uni-jena.de**
Coordinator: University of Jena, Germany
Partners:
Austria: Lisec.
Belgium: Ducatt.
Czech Republic: Glass Service.
Germany: Schott TGS, Ungricht, Fickert & Winterling, Folienwerk Wolfen, Clariant, Eura Innovation, Bauhaus University, Beuth Hochschule, Eilenburger Fenstertechnik, Flachglas Sachsen.

Energy performance monitoring and management
BIM/ Data/ Interoperability

MATRYCS [59]
Modular Big Data Applications for Holistic Energy Services in Buildings

MATRYCS aims to capitalise and combine existing modern technological breakthroughs in the areas of ML / DL and big data, in order to develop a new decision-making and data analytics solution for energy-efficient buildings. MATRYCS will realise a holistic, state-of-the-art AI-empowered framework for decision-support models, data analytics and visualisations for Digital Building Twins and real- life applications.

October 2020
36 months
Ongoing

4.58 M€
matrycs.eu
Engineering Ingegneria Informatica spa, Italy
Belgium: Housing Europe
Czech Republic: SEVEn
Germany: RWTH, ICLEI
Greece: HOLISTIC IKE, NTUA
Latvia: LEIF
Italy: ENGINEERING - INGEGNERIA INFORMATICA SPA, ASM TERNI SPA, EURAC
Poland: FASADA, MIASTO GDYNIA
Portugal: COOPERNICO
Spain: CARTIF, VEOLIA, EREN
Slovenia: COMSENSUS, BTC

Advanced materials and nanotechnology
Technology Building Blocks

MiniStor [60]
Minimal Size Thermal and Electrical Energy Storage System for In-Situ Residential Installation

MiniStor will design and produce a compact integrated thermal storage system for achieving sustainable heating, cooling and electricity storage that can be adapted to existing systems in residential buildings. It is based on a high-performing thermochemical material reaction combined with parallel hot and cold phase-change materials for flexibility and usage year-round. It also stores electrical energy in a Lithium-ion battery that responds to grid signals and can sell to the electrical grid.

October 2019
54 months
Ongoing

8.53 M€
ministor.eu
University College Cork - Tyndall National Institute, Ireland
France: CNRS-PROMES
Greece: CERTH, DUTH
Hungary: EMI, WOODSPRING
Ireland: IERC, Cork City Council
Italy: R2M Solution
Poland: Enetech Spolka Z Ograniczona Odpowiedzialnoscia
Spain: CARTIF, University of Santiago de Compostela, ENDEF, SGS TECNOS SA, Fundación Empresa Universidad Gallega (FEUGA)
Switzerland: HSLU
United Kingdom: The University of Edinburgh (UEDIN)

Energy performance monitoring and management
Construction process, end of life, cross-cutting information

MODER [61]

Mobilization of innovative design tools for refurbishing of buildings at district level

MODER develops processes and practices that enable building owners to activate refurbishment at district level with the help integrated project delivery models needed in refurbishment at district level. The project has also produced visalisation tools for better unerstanding of a large scale district level project and its targets.

Start date	September 2015
Duration	36 months
Status	Completed
Total budget	4 M€
Website	**www.moderproject.eu**
Coordinator	Sweco, Finland
Partners	**Austria**: Ertex Solartechnik GMBH **Finland**: VTT, FinnEnergia Oy **Germany**: Fraunhofer Institute for Building Physics, SIEMENS AG **Latvia**: Rem Pro SIA **Netherlands**: W/E Consultants for Sustainable Building **Slovenia**: Gradbeni Institut ZRMK Doo, Leag Lokalna Energetska Agencija Gorenske Javni Zavod

Energy performance monitoring and management
ICT

MOEEBIUS [62]

Modelling Optimization of Energy Efficiency in Buildings for Urban Sustainability

MOEEBIUS introduces a Holistic Energy Performance Optimization Framework that enhances current building modelling approaches and delivers innovative simulation tools to reduce the gap between predicted and actual energy performances at the level of buildings and blocks of buildings. Once the simulation models and technical components of the framework have been developed, the MOEEBIUS solution is being roll-out in 3 pilot sites (UK, Serbia, Portugal) for its validation.

	November 2015
	42 months
	Completed
	7.2 M€
	www.moeebius.eu
	Tecnalia, Spain
	Czech Republic: Honeywell
	Germany: Fraunhofer – Gesellschaft, Technische Hochschule Nurnberg
	Greece: Hypertech
	Ireland: University College Cork, National University Of Ireland, CIT
	Netherland: Almende **Poland**: ASM
	Portugal: ISQ, Municipio De Mafra
	Serbia: Beogradske Elektrane, Preduzece Za Informacione Tehnologije I Elektronsko Trgovanje Belit
	Spain: SOLINTEL **United Kingdom**: Grindrop, Kiwi Power

Technology building blocks
BIM/ Data/ Interoperability

MORE-CONNECT [63]

Development and advanced prefabrication of innovative, multifunctional building envelope elements for modular retrofitting and smart connections

MORE-CONNECT will develop and demonstrate Plug & Play solutions for prefabricated modular renovation elements, including integration of components for climate control, energy saving, building physics and aesthetics. It will develop tailor-made renovation concepts, in a standardised manufacturing process with NZE performance, a maximum ROI of 8 years and a renovation time of less than 5 days.

	December 2014
	54 month
	Completed
	5.5 M€
	www.more-connect.eu
	Huygen Installatie Adviseurs, Netherlands
	Czech Republic: Czech Technical University in Prague, RD Rýmařov.
	Denmark: Cenergia, Innogie ApS, Invela ApS.
	Estonia: Tallinn University of Technology, AS Matek, REF Ehitustööd.
	Latvia: Riga Technical University, Latvia Wood Construction Cluster, Technological Centre of Zemgale.
	Netherlands: Zuyd University, BJW, WEBO.
	Portugal: University of Minho, Darkglobe.
	Switzerland: Econcept.

< Back to the previous page

Design
ICT

New TREND [64]

New integrated methodology and Tools for Retrofit design towards a next generation of energy efficient and sustainable buildings and Districts

NewTREND is developing a new participatory integrated design methodology targeted to the energy retrofit of buildings and neighbourhoods, establishing energy performance as a key component of refurbishments.
Its implementation is supported by a set of tools enabling structured and standardized data collection and evaluation of retrofitting needs guiding decision makers to select the best energy retrofitting strategy.

Start date	September 2015
Duration	36 months
Status	Completed
Total budget	4.7 M€
Website	**newtrend-project.eu**
Coordinator	IES, United Kingdom
Partners	**Finland**: Granlund **Germany**: dr. jakob energy research, University of Applied Science Munich **Hungary**: Advanced Building & Urban Design **Ireland**: University College Cork, University College Dublin **Italy**: IISBE, STAM, Universita Politecnica Delle Marche **Spain**: REGENERA, Ajuntament de SantCugat **United Kingdom**: IES, London Business School

NewTREND
NEW Integrated Methodology and **T**ools for **R**etrofit Design Towards a Next Generation of **EN**ergy Efficient and Sustainable Buildings and **D**istricts

Energy performance monitoring and management
Technology Building Blocks

NRG-STORAGE [65]

Integrated porous cementitious Nanocomposites in non-Residential building envelopes for Green active/ passive energy STORAGE

Thermal insulation materials are an integral part of building envelopes. They reduce heat transfer and optimise the inner thermal comfort. The EU-funded NRG-STORAGE project aims to launch a novel breakthrough insulation system that replaces available insulation materials with a multi-functional energy-storing and energy-saving cementitious foam (NRG-Foam). This ultra-high porous foam shows excellent insulation properties by embedding phase change and nanomaterials.

Start date	April 2020
Duration	48 months
Status	Ongoing
Total budget	6.85 M€
Website	**nrg-storage.eu**
Coordinator	TU Darmstadt, Germany
Partners	**Argentina**: CIMEC-UNL-CONICET **Bulgaria**: Glavbolgarstroy Holding **Czech Republic**: Cervenka Consulting SRO **Germany**: Netzsch Gerätebau GmbH, RÖSER Ingenieurbeton GmbH **Italy**: Sphera Encapsulation SRL **Netherlands**: Delft University of Technology **Poland**: Silesian University of Technology **Spain**: Materials Physics Center (CSIC), Tecnalia, EnergiGune, Graphenea SA

BIM/ Data/ Interoperability
ICT

OptEEmAL [66]

Optimised Energy Efficient Design Platform for Refurbishment at District Level

The project is developing an Optimised Energy Efficient Design Platform able to provide a set of scenarios that are based on different energy conservation measures to improve the energy behaviour of a district. The platform will deliver an integrated and systemic design based on an Integrated Project Delivery approach for buildings and district retrofitting projects, and bring together BIM and IFC, District Performance Indicators, Energy Conservation Measures, and Implementation of ontologies.

Start date	September 2015
Duration	42 months
Status	Completed
Total budget	4.7 M€
Website	**www.opteemal-project.eu/**
Coordinator	CARTIF, Spain
Partners	**France**: NOBATEK/INEF4 **Germany**: Steinbeis-Europa-Zentrum **Greece**: TU Crete **Ireland**: United Technologies Research Centre Ireland **Italy**: Expert System, Distretto Tecnologico Trentino **Spain**: Tecnalia, Fundació Privada Universitat I Tecnologia, ACCIONA,, Fomento San Sebastian **Sweden**: Lunds Kommun **Turkey**: Argedor Information Technologies Ltd.

OptEEmAL
OPTIMISED ENERGY EFFICIENT DESIGN PLATFORM FOR REFURBISHMENT AT DISTRICT LEVEL

< Back to the previous page

Technology Building Blocks
BIM/ Data/ Interoperability

P2Endure [67]

Plug-and-Play product and process innovation for Energy-efficient building deep renovation

P2ENDURE provides scalable, adaptable and ready-to-implement innovative Plug-and-Play prefab solutions for deep renovation of building envelopes and technical systems. Within P2ENDURE the innovative solutions are complemented with a proof-of-performance, which is based on pilot implementation and monitoring in 11 live demonstration projects representing deep renovation characteristics in all main EU geo-clusters.

Start date	September 2016
Duration	54 months
Status	Completed
Total budget	5.3 M€
Website	**www.P2Endure-project.eu**
Coordinator	DEMO Consultants, Netherlands
Partners	**Denmark**: Invela **Germany**: Lenze-Luig 3-L-Plan, Fermacell, TU Berlin **Italy**: Becquerel Electric, SGR Servizi, D'appolonia, Universita Politecnica Delle Marche **Netherlands**: Huygen Installatie Adviseurs, Panplus Architektuur, Camelot Vastgoed **Poland**: Bergamo Tecnologie, Fasada. Sp. Z.o.o, Mostostal Warszawa, Miasto Stoleczne

ICT
Energy performance monitoring and management

PHOENIX [68]

Adapt-&-Play Holistic cOst-Effective and user-frieNdly Innovations with high replicability to upgrade smartness of eXisting buildings with legacy equipment

Project PHOENIX (coordinators).
Project to investigate ways of upgrading the smartness of buildings transforming legacy equipment, and developing new solutions.
2020 – 2023.

	November 2015
	42 months
	Completed
	5.2 M€
	eu-phoenix.eu
	Universidad de Murcia **Austria**: Siemens Austria **Cyprus**: SUITE5 **Greece**: KaMa, Elin Verd, UBITECH, Merit Consulting House **Ireland**: Arden energy **Spain**: OdinS, MIWenergía **Sweden**: SKEBIT, Lulea TU

Technology building blocks
Energy performance monitoring and management

Plug-N-Harvest [69]

PLUG-N-play passive and active multi-modal energy HARVESTing systems, circular economy by design, with high replicability for Self-sufficient Districts Near-Zero Buildings

The main strategic goal of Plug-n-Harvest is to design, develop, demonstrate & exploit a new modular, plug-n- play concept/product for Adaptable/ Dynamic Building Envelopes, considering circular economy principles, deployable to both residential & non-residential buildings, able to provide high energy use reductions & energy harvesting from Renewable Energy Sources both at the single-building and the district scale while requiring medium-to-low installation costs & almost- zero operational costs.

	September 2017
	57 months
	Ongoing
	6.9 M€
	www.plug-n-harvest.eu
	CERTH, Greece **Germany**: RWTH - Aachen University **Greece**: ALUMIL, Region of Western Macedonia – RWM **Spain**: Agencia de l'Habitatge de Catalunya, Eco Intelligent Growth, S.L, ETRA, Odin Solutions S.L, Sistemes Avancats De Energia Solar Termica SCCL-AIGUASOL **Romania**: Siemens SRL - SIE **United Kingdom**: Cardiff University, County Council of the City and County of Cardiff, Energy Transition Limited

Energy performance monitoring and management
Construction process, end of life, cross-cutting information

PLURAL [70]

Plug-and-Use Renovation with Adaptable Lightweight Systems

The PLURAL project aims to develop and demonstrate "Plug-and-Use" kits, that incorporate energy and control systems and take into account user needs. The key is to understand how to select and integrate various renewable energy technologies, incorporate them in specially designed prefabricated façade components and optimize their performance for different building types, climates and socio-economic conditions. It focuses on kit manufacturing while minimising energy, cost and renovation time.

Start date	October 2020
Duration	48 months
Status	Ongoing
Total budget	9.66 M€
Website	**www.plural-renovation.eu**
Coordinator	NTUA, Greece
Partners	**Czech Republic**: CTU, Obec Kašava, FENIX TNT s.r.o., RD Rymarov, RECUAIR s.r.o **Germany**: ZRS Architekten **Greece**: Advanced Management Solutions, Municipality of Vari-Voula-Vouliagmeni, Daikin Airconditioning Hellas SA **Luxemburg**: INTRASOFT International S.A **Poland**: BG Tec Bergamo Tecnologie Sp.z o.o. **Spain**: ITeC, IREC, DENVELOPS TEXTILES S.L., AHC, Pich Architects **Switzerland**: Institute for Solar Technology SPF University of Applied Sciences HSR

Technology Building Blocks
Advanced materials and nanotechnolog

POWERSKIN PLUS [71]

Highly advanced modular integration of insulation, energising and storage systems for non- residential buildings

POWERSKIN+ develops eco-innovative, cost-effective and smart material solutions to renovate existing facade systems of both double skin and advanced integrated curtain walls. It integrates unprecedented highly innovative insulations and renewable energy technologies, with breakthrough features based on nano-formulated VIP, PCM, flexible thin glass perovskite solar cells and multi-functional nano-enabled coatings.

	October 2019
	48 months
	Ongoing
	6.59 M€
	www.powerskinplus.eu
	Instituto Pedro Nunes, Portugal
	Czech Republic: FENIX TNT SRO, České vysoké učení technické v Praze **Germany**: Fraunhofer Gesellschaft, Friedrich-Schiller Universität Jena, Flachglas Sachsen **Greece**: Proigmenes Erevnitikes & Diahiristikes Efarmoges **Italy**: Politecnico di Torino **Poland**: SAULE SA, Politechnika Warszawska, Fundacja Saule Research Institute **Portugal**: Instituto Pedro Nunes **Slovenia**: NAVODNIK KEMIJSKI INZENIRING d.o.o. **United Kingdom**: Brunel University London, Oxford Brookes University

Technology Building Blocks
Energy performance monitoring and management

PRELUDE [72]

Prescient building Operation utilizing Real Time data for Energy Dynamic Optimization

Project focuses on assessing the right level of smartness necessary for any given household and then providing the tools according to the needs of the user. It is designed to be versatile and adapt to the engagement, monitoring and automation level of the building. Passive solutions, such as natural ventilation and cooling, will be prioritized through a free running strategy. Predictive maintenance will be implemented to reduce costs, emphasizing RES (Renewable Energy Sources).

	December 2020
	42 months
	Ongoing
	9.8 M€
	https://prelude-project.eu/
	Aalborg University, Denmark **Austria**: Forschung Burgenland **Belgium**: EUROCORE **Finland**: Tampere University **Greece**: DAEM, EMTECH SPACE, CORE, LIBRA **Italy**: LA SIA, Politecnico di Torino, STAM, UniSMART, Iren **Poland**: BLOK ARCHITEKCI **Spain**: 1A Ingenieros, AIMEN, INCOTEC, TREE Technology **Switzerland**: CPEG, Estia **United Kingdom**: Brunel University London

Design
BIM/ Data/ Interoperability

Pro-GET-OnE [73]

Proactive synergy of integrated Efficient Technologies on buildings' Envelopes

The innovative aspect in Pro-GET-OnE consists in the integration of pre-assembled component with the highest performances in terms of:
- Energy requirements – by adding new plug-and-play high energy performing envelopes;
- Safety – by using appropriate steel structures to reduce horizontal loads and implementing the structural safety while supporting the new envelopes; - Social sustainability – increasing the desirability of retrofit options.

Start date	May 2017
Duration	60 months
Status	Ongoing
Total budget	3.7 M€
Website	**progetone.eu**
Coordinator	UNIBO, Italy
Partners	**Belgium**: ABT **Germany**: TU München **Greece**: National and Kapodistrian University of Athens, Municipality of Peristeri, Athens **Italy**: ACERRE, SAVIO, Bloomfield, ALIVA, CLIVET **Netherlands**: Huygen Installatie Adviseurs, BJW **Romania**: Municipality of Brasov **Spain**: LIMA **Switzerland**: ANERDGY

Energy performance monitoring and management

QualDeEPC [74]

High-quality Energy Performance Assessment and Certification in Europe Accelerating Deep Energy Renovation (QualDeEPC)

QualDeEPC works on EU-wide convergence of building assessment and the issuance, design, and use of quality-enhanced energy performance certificates (EPCs) as well as their recommendations for building renovation. The aim is to make recommendations coherent with deep energy renovation towards a nearly-zero energy building stock by 2050. Project partners work to create consensus in the participating countries and beyond, and to implement as many improvements as possible during the project period.

	September 2019
	36 months
	Ongoing
	2 M€
	qualdeepc.eu
	Wuppertal Institute, Germany
	Belgium: FEDARENE
	Bulgaria: Energy agency of Plovdiv Association
	Germany: Deutsche Energie-Agentur GmbH (dena) , EPC Project Corporation Climate. Sustainability. Communications. mbH
	Greece: Center For Renewable Energy Sources
	Hungary: Energiaklub Szakpolitikai Intezet Modszertani Kozpont Egyesulet Budapest University of Technology and Economics
	Latvia: EKODOMA
	Italy: Escan SL
	Sweden: ENERGY MANAGEMENT AB

Technology building blocks
Advanced materials and nanotechnolog

QUANTUM [75]

Quality management for building performance - improving energy performance by life cycle quality management

The goal of this project is to develop and demonstrate pragmatic services and appropriate tools with high replication potential supporting quality management (QM) for building performance in the design, construction, commissioning and operation phase as a means to close the gap between predicted and actual energy performance in European buildings. The project focusses on ICT tools to allow for fast and robust scalability of QM services.

	January 2016
	48 months
	Completed
	6.8 M€
	www.quantum-project.eu
	IGS, TU Braunschweig, Germany
	Austria: e7 Energie Market Analyse
	Belgium: Factor 4 BVBA
	Czech Republic: Ceske Vysoke Uceni Technicke v Praze, ENESA a.s.
	Denmark: COWI A/S
	Germany: Synavision
	Greece: National and Kapodistrian University of Athens
	Italy: Energy Team, POLIMI
	Latvia: EKODOMA
	Netherlands: REHVA
	Norway: Norges Teknisknaturvitenskapelige Universitet
	United Kingdom: Building Research Establishment

Advanced materials and nanotechnolog
Construction process, end of life, cross-cutting information

RE^4 [76]

Reuse and recycling of CDW materials and structures in energy efficient prefabricated elements for building refurbishment and construction

RE4 targets to develop a fully prefabricated building integrating high ratios of recycled materials and reused structures from CDW. This has involved the development of an innovative CDW sorting system based on automated robotics, the definition of new quality classes for CDW-derived materials, the design of the fully prefabricated and reusable RE4 building concept, a number of CDW-based materials and prefabricated building components with more than 75% of virgin material replacement.

Start date	September 2016
Duration	42 months
Status	Completed
Total budget	4.8 M€
Website	**www.re4.eu**
Coordinator	CETMA, Italy
Partners	**Belgium**: ACR+ **Czech Republic**: Fenix TNT **Germany**: Roswag Architekten Gesellschaft Von Architekten **Italy**: STRESS, Vortex Hydra, STAM **Spain**: ACCIONA **Sweden**: CBI Betonginstitutet **Taiwan**: National Taiwan University Of Science And Technology **United Kingdom**: CDE Global, Creagh Concrete Products, The Queen's University Of Belfast

Technology Building Blocks
Construction process, end of life, cross-cutting information

ReCO2ST [77]

Residential Retrofit assessment platform and demonstrations for near zero energy and CO2 emissions with optimum cost, health, comfort and environmental quality

The RECO2ST project intends to develop customized action plans for cost-efficient and near zero-energy retrfofitting. A series of innovative technologies are being developed for that purpose and a suitable combination of those, the Retrofit-Kit, will be selected through a Refurbishment Assesment Tool to be implemented in demonstration sites across Europe. An Integrated Project Delivery process is also being developed to support the tendering of the nZEB refubrishment projects.

Start date	January 2018
Duration	48 months
Status	Completed
Total budget	8.4 M€
Website	**www.reco2st.eu**
Coordinator	Aalborg University, Denmark
Partners	**Austria**: Alchemia-Nova GMBH **Belgium**: European Cool Roofs Council **Denmark**: Frederikshavn Boligforening, Horn Irene **Germany**: VA-Q-TECH AG **Greece**: Core Innovation and Technology OE **Ireland**: United Technologies Research Centre Ireland, University College of Cork **Spain**: ACCIONA, Ayutamiento de Cadiz, Universidad de Cadiz **Switzerland**: Estia SA, Groupe E Greenwatt SA, Quantis, Retraites Populaires United Kingdom: Brunel University London

Construction process, end of life, cross-cutting information
Energy performance monitoring and management

Rennovates [78]

REnnovates - Flexibility activated zero energy districts

Rennovates is a holistic systemic deep renovation concept using smart services and developing smart energy-based communities resulting in energy-neutral housing up to and beyond Zero Net Energy by reducing energy consumption and maximizing the use of renewable energy. Old or outdated buildings will be aligned with up-to-date comfort levels : this will increase its value and longevity up to 50ys. REnnovates aims to get smart neighbourhoods into the realm of feasible business.

Start date	September 2015
Duration	36 month
Status	Completed
Total budget	7 M€
Website	**www.rennovates.eu**
Coordinator	Koninklijke Bam Groep, Netherlands
Partners	**Belgium**: Enervalis, VITO, Belfius Banque **Finland**: Massivecell Technologies **Germany**: KEO **Netherlands**: Stedin Netbeheer **Poland**: Mostostal Warszawa **Spain**: MONDRAGON

Energy performance monitoring and management
BIM/ Data/ Interoperability

RenoZEB [79]

Accelerating Energy renovation solutions for Zero Energy buildings and Neighbourhoods

The project aims to unlock the nZEB renovation market leveraging the gain on property value through a new systemic approach to retrofitting that will include innovative components, processes and decision making methodologies to guide all value-chain actors in the nZEB building renovation process. A multifunctional modular "plug and play" system, a renovation methodology for better decision making, cloud collaborative environment will be demonstrated into 2 real / 3 virtual demos.

Start date	October 2017
Duration	52 months
Status	Completed
Total budget	8.7 M€
Website	**www.renozeb.eu**
Coordinator	Solintel M&P, Spain
Partners	**Belgium**: ACE, UIPI **Bulgaria**: Balkanika Energy AD **Cyprus**: HIT Hypertech Innovation **Estonia**: Korteriuhistu Rennaliiva, Mittetulundusuhing Tartu Regiooni Energiaagentuur **France**: CSTB

la Marche
vables

Energy performance monitoring and management
ICT

REScoopVPP [80]

Smart Building Ecosystem for Energy Communities

REScoopVPP gathers energy cooperatives to create the most advanced community- driven smart building ecosystem for energy communities. The ecosystem is based on out-of-the shelve equipments and open-source standards (Home Assistant) in order to enable energy communities to provide flexibility services like the ones of aggregators, ESCO's, BRP's and suppliers of RES. The aim is to make REScoopVPP tools available to all EU citizen energy cooperatives after the project.

	June 2020
	36 months
	Ongoing
	4.52 M€
	www.rescoopvpp.eu
	SNAP! Partners , Portugal
	Belgium: EnergieID, REScoop.eu, Ecopower, Energent, University of Ghent **France** : Enercoop **Germany**: Bürgerwerke, Bündnis Bürgerenergie e.V. **Spain**: Som Energia **Slovenia**: University of Ljubljana **United Kingdom**: Carbon Co-op

Energy performance monitoring and management

RESHeat [81]

RENEWABLE ENERGY SYSTEM FOR RESIDENTIAL BUILDING HEATING AND ELECTRICITY PRODUCTION

RESHeat is an energy trigeneration system, used for building heating and cooling. The main components of the system are sun-tracked PVT pannels and sun-tracked solar collectors which are charging underground energy storage unit. The system allows to achive high COP of the ground source heat pump by using the ground regeneration technique.
The system will be installed in Poland (Cracow and Limanowa) and Italy (Palombara Sabrina).

	December 2020
	48 months
	Ongoing
	2.87 M€
	resheat.eu
	Politechnika Krakowska
	Finland: Oilon Technology Oy **Italy**: ATER Provincia di Roma, La Sapienza University of Rome **Poland**: Politechnika Krakowska, F.H.U. Urządzenia Chłodnicze Marek Czamara, ELFRAN Franciszek Ścisłowicz, **Municipality of Cracow**: Zarząd Budynków Komunalnych w Krakowie **Czech Republic**: Brno University of Technology

BIM/ Data/ Interoperability
Energy performance monitoring and management

RESPOND [82]

Integrated demand REsponse Solution towards POsitive NeighbourhooDs

RESPOND will deploy and demonstrate an interoperable, cost effective and user-centered demand response solution. The solution will use energy automation, control and monitoring tools to integrate a cooperative demand response program into legacy energy management systems. To this end, RESPOND will use an integrated approach to optimize energy dispatching in real time, taking account both energy demand and supply while exploiting all available energy assets at each site.

Start date	October 2017
Duration	36 months
Status	Completed
Total budget	3.7 M€
Website	**project-respond.eu**
Coordinator	Fenie Energia SA, Spain
Partners	**Czech Republic**: Energomonitor **Denmark**: ALBOA, Aura Radgivning AS, Aalborg Universitet, Develco Products **Ireland**: National University of Ireland Galway, Comharchumann Fauinnimh Oileain Arann Teoranta **Serbia**: Institut Mihajlo Pupin **Spain**: Fundacion Tekniker, Dexma Sensor SL

Energy performance monitoring and management
BIM/ Data/ Interoperability

REZBUILD [83]

Refurbishement decision making platform through advanced technologies for near zero energy building renovation

The REZBUILD project is aimed at defining a collaborative refurbishment ecosystem focused on the existing residential building stock. H2020 Framework Programme is taking action for the support and promotion of business research and innovation in Key Enabling Technologies (KETs) through energy-efficient buildings. Thus, REZBUILD will address these challenges by opening the construction sector through the integration of innovation technologies in order to pave the way towards an annual renovation.

	October 2017
	48 months
	Ongoing
	9 M€
	www.rezbuildproject.eu
	Officinae Verdi Group SpA, Italy
	France: ESTIA **Italy**: Rimond Engineering Procurement and Construction Management Srl **Norway**: Obos Prosjekt AS, SINTEF **Spain**: Comunidad de Madrid, Exploded View SL, CARTIF, Onyx Solar Energy S.L, Saint-Gobain Placo Iberica SA, Vias y Construcciones SA, Zabala Innovation Consulting SA **United Kingdom**: The University of Nottingham

Technology Building Blocks
Construction process, end of life, cross-cutting information

RIBuild [84]

Robust internal thermal insulation of historic buildings

RIBuild develops guidelines to help building owners deciding whether their buildings are suitable for internal insulation, respecting architectural and cultural value. Guidelines focus on solutions with a good hygrothermal performance, based on experience from case study measurements. Depending on the outcome of a feasibility study, RIBuild will include a web tool based on pre-calculated examples of typical external walls of brick or natural stone and different types of internal insulation.

	January 2015
	66 months
	Completed
	5 M€
	www.ribuild.eu
	Aalborg University, Denmark
	Belgium: Katholieke Universiteit Leuven. **Denmark**: Technical University of Denmark, Intro Flex A/S, Erik Møller Architects. **Germany**: TU Dresden. **Italy**: Università Politecnica delle Marche. **Latvia**: Riga Technical University. **Sweden**: SP Technical Research Institute of Sweden. **Switzerland**: Haute Ecole Spécialisee de Suisse Occidentale.

Energy performance monitoring and management
Construction process, end of life, cross-cutting information

RINNO [85]

An augmented intelligence-enabled stimulating framework for deep energy renovation delivering occupant-centered innovations

RINNO envisions to deliver a framework solution that will help drastically accelerating the rate of deep renovation in EU building stock reaching an ambitious annual renovation rate of 3.5%. Its ultimate goal is to develop, validate and demonstrate an operational interface with augmented intelligence and an occupant-centered approach that will streamline and facilitate the whole lifecycle of building renovation (planning-design, retrofitting, monitoring).

Start date	June 2020
Duration	48 months
Status	Ongoing
Total budget	4.8 M€
Website	**rinno-h2020.eu**
Coordinator	Rina Consulting S.p.A., Italy
Partners	**Austria**: Pink GmbH Energie und Speichertechnik **Denmark**: Avedøre Boligselskab, EKOLAB APS, European Green Cities **Finland**: VTT **France**: Bouygues Construction, Lille Metropole Habitat OPH de la Metropole Europeenne de Lille **Greece**: GREENSTRUCT, CERTH, Elliniko IPAK, Motivian Anonymos Etaireia Kainotomon Lyseon Pliroforikis **Ireland**: Dublin City University **Poland**: K-FLEX, Narodowa Agencja Poszanowania Energii **Spain**: CIRCE , REGENERA LEVANTE SL **United Kingdom**: Northumbria University Newcastle

ICT
Energy performance monitoring and management

SATO [86]

Self Assessment Towards Optimization of Building Energy

Energy performance certificates rate how energy efficient a building is on a scale of A to G and provide recommendations on how to improve energy efficiency. It is important to bridge the gap between designed and measured energy use. With this in mind, the EU-funded SATO project will establish a new energy self-assessment and optimisation platform to integrate all energy consuming instruments in any given building. It will also develop and integrate into the platform a self-assessment framework

	October 2020
	36 months
	Ongoing
	7.02 M€
	www.sato-project.eu
	Faculty of Sciences - University of Lisbon, Portugal **Austria**: SIEMENS AG Österreich **Denmark** : Aalborg Universiteit, XTEL, Wireless APS, Frederikshavn Boligforening **Greece**: Core Innovation and Technology **Italy**: POLIMI, Commune di Milano, Knauf Insulation **Portugal**: FCIENCIAS.ID, Vieira & Lopes,, SONAE MC, AMESEIXAL, SIEMENS SA **Spain**: CYPE SOFT SL **Switzerland**: EK ENERGIEKONZEPTE AG

Advanced materials and nanotechnolog

SCORES [87]

Self Consumption Of Renewable Energy by hybrid Storage systems

The main aim of the SCORES project is to develop and demonstrate a building energy system including new compact hybrid storage technologies, that optimizes supply, storage and demand of electricity and heat in residential buildings, increasing self-consumption of local renewable energy in residential buildings at the lowest cost and deferring investments in the energy grid.

	November 2017
	54 months
	Ongoing
	6 M€
	www.scores-project.eu
	TNO, Netherlands **Austria**: AEE INTEC, Saltzburg AG für Energie, Verkehr und Telekommunikation **Czech Republic**: Fenix TNT SRO **Denmark**: König Metall GmbH &Co. KG **France**: Campa, Electricité de France SA, Forsee Power, Heliopac **Italy**: Rina Consulting **Netherlands**: Siemens Nederland NV **Portugal**: Instituto Politécnico de Setúbal

Energy performance monitoring and management

SMART2B [88]
Smartness to existing Buildings

Smart2B will create a smart building system, consisting of the Smart2B devices, platform and services, that places citizens, building users and Citizen Energy Communities at the heart of the building energy transition that uses Emerging ICT and IoT technologies to enable smart buildings to interact with their occupants and the grid in real- time to untap energy efficiency and local flexibility.

Start date	September 2021
Duration	36 months
Status	Ongoing
Total budget	4.71 M€
Website	**www.smart2b-project.eu**
Coordinator	EDP,
Partners	**Austria**: TU Graz **Belgium**: VITO **Denmark**: Alberstlund Kommune **Germany**: RWTH Aachen University **Greece**: Centre for Research and technology – Hellas **Italy**: Day One, Enerbrain **Portugal**: EDP, Santa Casa da Misericórdia de Lisboa, FCiências.ID **Spain**: Odin Solutions

ICT
BIM/ Data/ Interoperability

SPHERE [89]
Service Platform to Host and SharE REsidential data

SPHERE aims to provide a BIM-based Digital Twin Platform to reduce costs and improve energy efficiency in residential buildings.
Users will be able to interact with this model, based on the building's information and a scalable set of different software tools (energy demand/ performance simulation tools, Decision Support and Coaching Systems, BEMs or IoT enabled Predictive Maintenance Algorithms), allowing for the vertical integration and optimization of the building lifecycle

	November 2018
	48 months
	Ongoing
	12.9 M€
	www.sphere-project.eu
	IDP Ingeniería y Arquitectura Iberia S.L.U., Spain **Austria**: CREE Rhomberg **Belgium**: NEANEX **Finland**: VTT; CAVERION; **France**: Octopussy **Germany**: BASF GmbH; Ascora GmbH; **Ireland**: National University of Ireland, Galway; VRM Technologies; **Italy**: R2M Solution; DE5 **Netherlands**: Nederlandse Organisatie Voor Toegepast Natuurwetenschappelijk Onderzoek Tno **Spain**: COMSA Instalaciones y sistemas industriales SA ; Fundació Eurecat ; Comet Technologies ; Empresarios Agrupados Internacional **United Kingdom**: EKODENGE

Technology Building Blocks
Energy performance monitoring and management

StepUp [90]
Solutions and Technologies for deep Energy renovation Processes UPtake

StepUP wants to make decarbonisation of existing buildings a reliable, attractive investment by reducing uncertainty in design, installation and operation. Partners have developed plug&play renovation technologies, a preassembled facade solution and a heating system with PCM storage, that will be deployed in two pilots (Spain and Hungary).
Physics- based digital twins help minimise the performance gap. Innovative financing models and technology provider clusters will accelerate the market uptake.

	August 2019
	42 months
	Ongoing
	4.81 M€
	www.stepup-project.eu
	Integrated Environmental Solutions Limited, United Kingdom **Belgium**: ENERGINVEST **Denmark**: SUNTHERM APS **Hungary**: ABUD Mérnökiroda, Budapest Fovaros XVIII Kerulet Pestszentlorinc, Pestszentimre Onkormanyzata **Ireland**: IES R&D **Italy**: UniSMART - Fondazione Università degli Studi di Padova, Manni Group **Spain**: Fundación Eurecat, Construcciones ACR

Technology building blocks
Construction process, end of life, cross-cutting information

Stunning [91]

Sustainable business models for the deep renovation of buildings

STUNNING's goal is to identify and promote innovative refurishment packages to accelerate their acceptance. Data on adaptable solutions, combined with innovative business models which allow consumers and the market to invest with confidence, are synthesised so as to select, fine-tune and validate the most promosing ones. The generated infomation is then presented on a web-based collaborative knowledge sharing platform (the Renovation Hub), providing key facts on these packages.

Start date	October 2017
Duration	24 months
Status	Completed
Total budget	1 M€
Website	**www.stunning-project.eu**
Coordinator	TECHNOFI, France
Partners	**France**: CSTB **Germany**: Steinbeis 2I GMBH **Italy**: RINA **Spain**: SOLINTEL

BIM/ Data/ Interoperability
ICT

SWIMing [92]

Semantic web for information modelling in energy efficient buildings

-SWIMing has worked with EeB projects to identify shared data requirements, promote data harmonization for improved interoperability, and identify where linked open data technologies can be utilized to make data more accessible and hence easier to exploit. SWIMing approached over 100 EeB projects, analyzing 53 in detail, resulting in 49 use cases from 33 projects of particular relevance to BIM and interoperability.

	February 2015
	24 months
	Completed
	0.5 M€
	Trinity College Dublin, Ireland
	Germany: KIT, AEC3. **Greece**: CERTH. **Ireland**: Tyndall

Advanced materials and nanotechnolog
Energy performance monitoring and management

Switch2save [93]

Lightweight switchable smart solutions for energy saving large windows and glass façades

Large-area glazing is a continuing trend because of its appearance and design variety, However,large-area glazing may significantly increase the energy demand for air-conditioning in hot summers. Switch2Save aims at demonstrating Switchable Glass Solutions, in particular electrochromic (EC) and thermochromic (TC) windows, that modulate the radiation energy energy transfer through windows and so may reduce cooling energy demand by up to 70%, in two operational buildings.

	October 2019
	48 months
	Ongoing
	6.36 M€
	switch2save.eu
	Fraunhofer FEP, Germany **Belgium**: Van Rompaey Sara **Czech Republic**: University of West Bohemia, AMIRES, The Business Innovation Management Institute, z.u. **Germany**: Fraunhofer Institute for Silicate Research ISC **Greece**: School of Mechanical Engineering @ National Technical University of Athens, General State Hospital of Nikaia "Agios Panteleimon **Latvia**: SIA AGL Technologies **Sweden**: ChromoGenics AB, FASADGLAS BÄCKLIN AB, Vasakronan AB

Design
Energy performance monitoring and management

syn.ikia [94]
Sustainable Plus Energy Neighbourhoods

The H2020 syn.ikia innovation project aims to increase the share of highly energy efficient neighbourhoods with surplus renewable energy in different contexts, climates and markets in Europe. The syn.ikia concept relies on the interplay between novel technologies at the neighbourhood scale, integrated energy design, energy efficiency and flexibility, energy sharing among users, good architectural and spatial qualities, sustainable behavior, community awareness and social engagement.

Start date: January 2015
Duration: 36 months
Status: Completed

Total budget: 7.44 M€
Website: **www.synikia.eu**
Coordinator: NTNU, Norway
Partners:
Austria: Demo Neighbourhood – HEIMAT OSTERRICH, SIR, ECA
Belgium: BPIE, HOUSING EUROPE
Denmark: DTU, ENFOR
Hungary: ABUD
Netherlands: Demo Neighbourhood– AREA WOVEN, TNO
Norway: SINTEF, Demo Neighbourhood – OBOS/ ARCA NOVA
Spain: IREC, Catalonia Institute for Energy Research, Demo Neighbourhood– INCASOL .

Energy performance monitoring and management
ICT

TABEDE [95]
TowArds Building rEady for Demand rEsponse

TABEDE will pave the way to a new generation of Building Management Systems (BMS) to maximise the adoption of demand-response schemes. TABEDE BMS-extender will allow the building manager to lower energy cost without affecting occupant comfort. On the other hand, the energy provider will be able to take advantage of the building flexibility to maximize the usage of renewable energy and ensure power quality. TABEDE relies on 3 test-beds in France, Italy and the UK to demonstrate the solutions.

November 2017
42 months
Completed

3.8 M€
www.tabede.eu
Tractebel Engineering, Belgium
France: Schneider Electric Industries, CEA
Italy: R2M Solution, Schneider Electric
Switzerland: CSEM
United Kingdom: Cardiff University

Advanced materials and nanotechnolog
Energy performance monitoring and management

TESSe2b [96]
Thermal Energy Storage Systems for Energy Efficient Buildings. An integrated solution for residential building energy storage by solar and geothermal resources

TESSe2b is developing an innovative thermal energy solution which combines two renewable energy technologies (solar and geothermal) with an advanced thermal energy storage system that uses integrated enhanced phase change materials. The pre-prototypes for heating, cooling and DHW using paraffins and hydrated salts have already made and tested with successful. The prototypes have already made and installed in the three demo sites. The three demo sites have already started running.

October 2015
48 months
Completed

4.3 M€
www.tesse2b.eu
Instituto Politecnico De Setubal, Portugal
Austria: Geoteam Technisches Buro Fur Hydrogeologie, Geothermie Und Umwelt
Cyprus: Z & X Mechanical Installations
Germany: Ruhr-Universität Bochum
Greece: CRES, Technologiko Ekpedeftiko Idrima Stereas Elladas, University of Ioannina
Poland: WARSAW Univeristy of Life Sciences WULS-SGGW
Spain: Asociacion Ecoserveis
United Kingdom: Phase Change Material Products

Energy performance monitoring and management
Technology building blocks

THERMOSS [97]

Building and district thermal Retrofit and Management solutions

The main goal of THERMOSS is to study, develop and demonstrate innovative technologies and tools to optimise the economic and energetic performance of standalone buildings and districts. Key outcomes are a technology sizing toolbox, a two-way substation and a real-time district thermal energy management system, which will lead to a smart grid of thermal energy.

Start date	September 2016
Duration	42 months
Status	Completed
Total budget	8.7 M€
Website	**http://thermoss.eu**
Coordinator	EXERGY LTD, United Kingdom
Partners	**Czech Republic**: Fenix TNT **France**: CSTB, CEA **Germany**: Bosch Thermotechnik **Italy**: Schneider Electric, Stamtech, D'appolonia **Spain**: GIROA S.A **Switzerland**: Planair, CSEM **United Kingdom**: Cardiff University, University Of Southampton

Energy performance monitoring and management
ICT

TOPAs [98]

Tools for Continuous Building Performance Auditing

The TOPAs continuous performance auditing framework enables a better understanding of the actual energy performance and facilitates continuous performance improvement during the building operation. TOPAs provides decision support tools, visibility on how energy related decisions impact cost, occupant comfort and general management processes. TOPAs targets a reduction in the existing gap (between predicted and actual) to 10% and additional energy savings in the pilot sites of up to 20%.

	November 2015
	36 month
	Completed
	6.1 M€
	www.topas-eeb.eu
	Motorola Solutions Israel, Israel **France**: CEA, Azimut Monitoring, EMBIX **Germany**: TU Dresden, Fraunhofer-Gesellschaft **Ireland**: CIT, Arden Energy, IBM Ireland

Energy performance monitoring and management

U-CERT [99]

Towards a new generation of user-centred Energy Performance Assessment and Certification; facilitated and empowered by the EPB Center

Energy-performance certificates have been introduced in order to inform building tenants and owners about the building energy-performance ratings and recommendations for cost-effective improvements. U-CERT project aims to make the new certification schemes more practical and reliable via a holistic and user-centred approach. It also aims to make the new set of energy-performance standards easily accessible to a wide range of users by leveraging the diverse services offered by the EPB centre.

	September 2019
	36 month
	Ongoing
	2 M€
	u-certproject.eu
	Huygen Installatie Adviseurs Belgium: REHVA **Bulgaria**: EnEffect **Denmark**: DTU **Estonia**: Tallinna Tehnikaülikool **France**: TIPEE **Hungary**: Comfort Consulting **Italy**: AICARR **Netherlands**: EPB Center B.V., Stichting ISSO, TNO **Romania**: AIIR, FILIALA VALAHIA **Slovenia**: Inovacijsko-razvojni institut Univerze v Ljubljani **Spain**: Instituto Valenciano de la Edificación, FUNDATECYR **Sweden**: Kungliga Tekniska Hoegskolan

Construction process, end of life, cross-cutting information
Advanced materials and nanotechnolog

VEEP [100]

Cost-effective recycling of CDW in high added value energy efficient prefabricated concrete components for massive retrofitting of our built environment

Growing interest in green buildings and circular economy is encouraging the consumption of high- grade secondary raw materials in the building sector. In this context VEEP is developing and demonstrating a series of technological solutions for massive retrofitting of our built environment, aiming at cost efficient reduction of building energy consumption.

Start date	October 2016
Duration	54 months
Status	Completed
Total budget	4.9 M€
Website	**www.veep-project.eu**
Coordinator	D'appolonia, Italy
Partners	**Belgium**: BIBM **Czech Republic**: Fenix TNT **Finland**: Tiihonen Ismo **France**: NOBATEK/INEF4, Keey Aerogel **Italy**: Nuova Tesi System, Stamtech **Netherlands**: Technische Universiteit Delft, Universiteit Leiden, Strukton Civiel , ADR Technology **Spain**: Tecnalia, ACCIONA, AENOR

Technology Building Blocks
Advanced materials and nanotechnolog

WALL-ACE [101]

Wall insulation novel nanomaterials efficient systems

Wall-ACE develops 5 innovative, aerogel-based, high-performance insulation products: interior plaster, external render, insulation material filled bricks, patching filler and thermal coating finish. The practical development of the products is completed. The scale-up to industrial level is done and applications on demonstration sites are ongoing. From now, the focus will be on the business plan as well on the certification of the new highly efficient and mineral wall-insulation solutions.

	October 2016
	36 months
	Completed
	6.25 M€
	www.wall-ace.eu
	Quick-Mix, Germany
	France: Enersens, Toupret , Wavestone Advisors, CEA **Germany**: Leipfinger-Bader Kg, Universitaet Stuttgart **Italy**: Vimark, Politecnico Di Torino, Agenzia Territoriale Per La Casa Del Piemonte Centrale **Switzerland**: EFFINART, AGITEC **United Kingdom**: BRE

Energy performance monitoring and management
BIM/ Data/ Interoperability

X-tendo [102]

eXTENDing the energy performance assessment and certification schemes via a mOdular approach

The main objective of the project is to support public-authorities on the implementation of next-generation EPCs, by demonstrating and encouraging the roll-out of ten innovative features.
These features fall into two main categories:
1) innovative indicators used within EPC assessment processes and 2) innovative approaches to handle EPC data and maximise their value for public authorities and end-users.
The developed features methodologies will be tested in nine countries and consist of three different ways: in building testing, stystem testing and user testing.

	September 2019
	36 months
	Ongoing
	2.06 M€
	x-tendo.eu
	TUW, Austria
	Austria: E-think, Energie Agentur Steiermark **Belgium**: VITO, BPIE **Denmark**: ENERGISTYRELSEN **Estonia**: Tartu Regiooni Energiaagentuur MTÜ **Greece**: CRES **Italy**: ENEA **Poland**: Narodowa Agencja Poszanowania Energii **Portugal**: ADENE **Romania**: Asociația Auditorilor Energetici pentru Clădiri din România **United Kingdom**: Energy Saving Trust

Technology Building Blocks
Energy performance monitoring and management

ZERO-Plus [103]

Achieving near Zero and Positive Energy Settlements in Europe using Advanced Energy Technology

A comprehensive, cost-effective system for Net Zero Energy (NZE) settlements is developed and implemented in four EU case studies. The system is composed of innovative solutions for the building envelope and for energy generation and management at building and settlement level. The implementation results will be monitored, analyzed and disseminated. A business plan for commercial exploitation will be developed.

Start date	October 2015
Duration	48 months
Status	Completed

Total budget	4.17 M€
Website	**www.zeroplus.org**
Coordinator	National and Kapodistrian University of Athens, Greece
Partners	**Cyprus**: The Cyprus Institute, George Vassiliou Ltd. **France**: OPAC38 **Germany**: TU München **Greece**:Technical University of Crete, FIBRAN Insulating Materials **Israël**: Ben-Gurion University Of The Negev **Italy**: Università Degli Studi Di Perugia, ABB SPA, Consorzio ARCA, CONTEDIL DI RICCO MARIA & C SAS **Switzerland**: ANERDGY **United Kingdom**: Oxford Brookes University, E Co., Joseph Rowntree Housing Trust

Credits

The European Construction, built environment and energy efficient building Technology Platform (ECTP) founded in 2004, is a leading membership organization promoting and influencing the future of the Built Environment in Europe. Its more than 140 member organizations have the opportunity to influence European innovation and Strategic Research Agendas and to be connected to a wide network of organizations promoting and realizing innovations in the Built Environment.

The ECTP Energy Efficient Buildings (E2B) Committee's vision is to steer the creation of a knowledge-based building industry which turns energy efficiency into sustainable business, within the public-private partnership on Energy efficient Buildings (EeB PPP) under Horizon 2020.

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The general objectives of E2B Committee are to:

- Developtechnologiesandsolutionsenablingtospeedupthe reduction in energy use and GHG emission in line with the 2020 goals, e.g. through a higher renovation rate of the building stock at lower cost and to meet regulatory needs;
- Developenergyefficiencysolutionsinordertoturnthebuilding industry into a knowledge-driven sustainable business, with higher productivity and higher skilled employees;
- Developinnovativeandsmartsystemicapproachesforgreen buildings and districts, helping to improve the competitiveness of EU building industry by providing cost-effective, user-friendly, healthy and safe products for smart cities.

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ECTP
INNOVATIVE BUILT ENVIRONMENT

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