



**Built4People Partnership
Strategic Research & Innovation Agenda
2021-2027**

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Built4People – SRIA/Roadmap

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1. General information

Title of the European Partnership

Built4People | People-centric sustainable built environment

Lead entity (main contact)

ECTP (European Construction, built environment and energy efficient building Technology Platform) represented by Alain Zarli and Antoine Aslanides.

Europe Regional Network of WorldGBC (World Green Building Council) represented by Stephen Richardson, Alicja Kuczera and Marco Caffi.

Commission services

DG ENER (lead and main contact) | Margot Pinault, Pierluca Merola, Anette Persson, Nina Neumann, Andrea Hercsuth, Jens Bartholmes

DG RTD | Olga Rio, Piero De Bonis

DG CLIMA | Sven Damman

DG CNECT | Matthias Kuom

DG EAC | Anne Grady, Hughes Becquart

DG EMPL | Inmaculada Placencia Porrero

DG ENV | Josefina Lindblom

DG GROW | Ilektra Papadaki, Philippe Moseley

DG MOVE | Rafal Stanecki

2. Context

2.1 Investment and research into the built environment are key to people-centric sustainable future and economic growth

Every single citizen in the European Union has a profound, interactive relationship with the built environment. We spend 90% of our time in buildings. Our daily lives benefit from safe, effective, well-designed and maintained buildings and infrastructure, which provide spaces, mobility and essential services that have the potential to significantly enhance the quality of our lives.

The built environment is designed, created, maintained, renovated and upgraded by the construction sector. Investment in this sector's activities represents 9% of EU 27 GDP, sustains annually around 18M jobs; and the industry supports 3M enterprises across Europe – 95% of these are SMEs.

The built environment is undergoing a rapid and irreversible transformation, which will touch every citizen in unimaginable ways. Already today, we are increasingly living and working in smart buildings and in the short term future, we will get from A to B, using interconnected, intelligent and sustainable transport infrastructure, which will use its symbiotic interaction with us to learn from our behaviour and constantly adapt and improve itself accordingly.

In order to maximise the potential of the future built environment and ensure that it is “built for people” in the complete sense of the expression, the EU, its citizens and the construction sector need a dynamic, future-proof research agenda, with objectives, outputs and outcomes that serve the needs of all stakeholders and citizens. The agenda also needs to support the Sustainable Development Goals and the Built for People partnership (B4P) objectives.

Moreover, this research agenda will both complement and deliver the wider EU policy agenda. Specifically, this will feature a programme that supports digitalisation, the ambitions of the European Green Deal, the health and well-being of citizens and an inclusive society. The agenda will also support the Sustainable Development Goals and include programmes that will develop solutions for our buildings, such as energy efficiency and decarbonisation, to not only mitigate but also adapt to the climate crisis. In general, the research results should be replicable in the shortest space of time, to the widest range of real-life situations.

2020 saw a new challenge in the Covid-19 crisis, which delivered a seismic shock to the EU economy and the lives of all its citizens. The way we live, work and interact with each other may have profoundly changed forever and the built environment may need to be adapted accordingly. The crisis demonstrated the important role of well-designed healthy homes and workspaces, digital infrastructure and workflows, smart appliances, etc. Independently from this, studies showed that a people-centric built and healthy environment improves learning and productivity, while it reduces the cost of health insurance and prevents energy poverty at the same time.

Horizon Europe will provide significant support for some of the urgent research that needs to be done to rapidly transform our built environment. The BUILT4PEOPLE partnership will be the body that drives the relevant programmes. This Strategic Research and Innovation Agenda for the built environment sets out the objectives, outputs and outcomes that provide the framework for value for money, relevant, replicable and people-centric research, aligned with the priority EU policy objectives, including of course research policy. The SRIA will

ultimately transform the built environment into what we need for our economic prosperity, environmental protection and sustainable and fairly distributed health and well-being of all citizens in the EU.

For further information, see also the [BUILT4PEOPLE partnership proposal](#).

2.2 Challenges

Innovation uptake and R&D investments in construction are lower than in any other sector. However, these elements are crucial to develop a sustainable built environment which will contribute to achieve Europe's goals in terms of economic growth, environmental protection as well as digital development. Thus, what are the main obstacles that hinder the transformation of the built environment? The Built4People proposal identifies three main challenges to innovation:

- 1) **Lack of holistic innovation with systemic approach and life cycle perspective:** the inherent complexity and fragmented nature of the sector hinder a holistic approach to innovation. This results into low integration of various technologies developed in the value chain involving many economic sectors working towards multiple policy objectives, targets and regulatory frameworks, which are not necessarily coordinated. In addition, resource and energy efficiency gains remain untapped when assessing the overall system performance instead of single-technology/single-product approach.
- 2) **High carbon and environmental footprint of the built environment and construction:** The ageing European built environment suffers from low renovation rates and a large stock of poorly performing buildings and infrastructure, being responsible for approximately 40% of energy consumption and 36% of CO₂ emissions in the EU. Moreover, construction with its linked sectors is responsible for about half of the globally extracted materials whereas construction and demolition waste accounts for approximately 25-30% of the waste generated in the EU. The complexity of the sector and its SME nature make it difficult to develop a common vision for the sector's decarbonisation and sustainability, exacerbated by a lack of awareness and a skills gap (including digital) that are limiting performance-based approaches. Companies struggle to seize opportunities for greening their business operations through adoption of innovative sustainable solutions and circular business models. Potentially innovative solutions that might reduce embodied emissions and the environmental and climate impact of buildings face numerous barriers: a lack of reliable data, a lack of qualified/trained people who can adopt the solutions developed, and business models and contracts that are not adapted to sustainable ways of designing and delivering built works. "
- 3) **Low uptake of innovation and limited potential to produce lasting change:** although many innovative technological and socioeconomic solutions have been developed in the last decade, they have not been fully implemented in practice, which is hindering the adaptation of the built environment to new uses, challenges and requirements related to climate change and sustainability. Sustainable low-carbon alternatives in comparison to traditional solutions may often be substantially more expensive, less convenient, lacking service ecosystem, distribution channels or creating trade-off in terms of altered functionality or performance. They are often not adapted to the existing building stock and its architectural constraints (e.g. cultural heritage). Finally, they may not provide adequate additional benefit from the user perspective to motivate the replacement of the existing solutions.

2.3 Addressing the challenges: the B4P intervention logic

Addressing these challenges, the partnership will accelerate people-centric innovation in the built environment¹ that drives the transition towards a sustainable society and economy, relying on the active engagement of its partners and a European network of Innovation Clusters. The built environment refers to all types of buildings and housing assets, as well as infrastructures in its broad inception (encompassing district heating and energy infrastructures, water supply and sanitation, flood defense, all types of transport infrastructures, etc.).

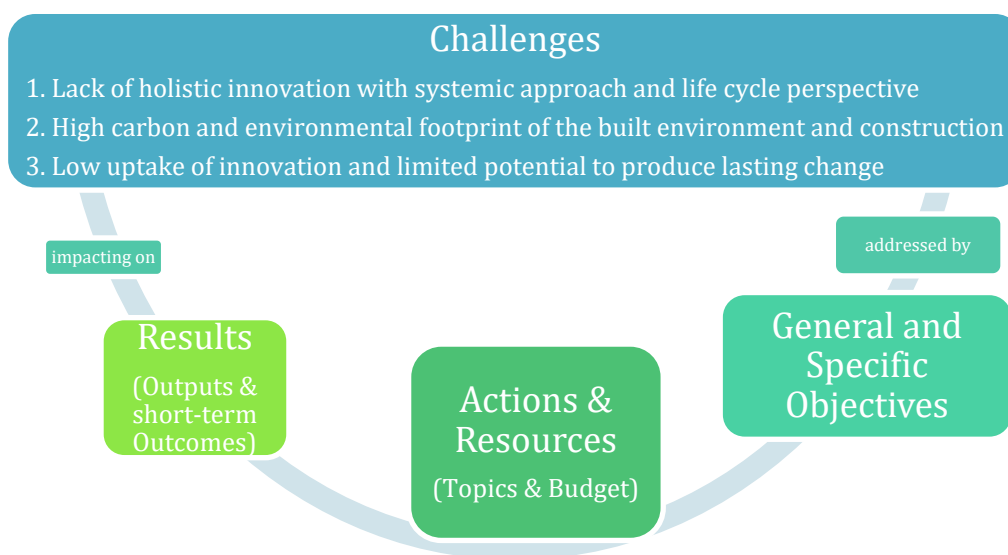
In order to tackle the challenges, the partnership will pursue **three General Objectives**: 1) “Scientific” to generate holistic innovation towards sustainability; 2) “Economic” to revitalise the sector through decarbonisation and sustainability transition; and 3) “Societal” to induce lasting behavioural change towards sustainable living. These will be implemented throughout **seven Specific Objectives**:

- A. Develop holistic solutions in a systemic approach
- B. Demonstrate overall performance in the life-cycle perspective
- C. Demonstrate clean energy transition potential
- D. Demonstrate sector decarbonisation pathways
- E. Demonstrate sustainable, circular business and value chain
- F. Demonstrate affordability and cost-effectiveness
- G. Demonstrate no trade-offs on economy, comfort, health, functions, cultural heritage

The strategic research and innovation agenda (SRIA) sets out the **action and resources (topics and budget)** that must be supported under the partnership, in order to achieve the partnership objectives.

This support will help producing:

- **Outputs**, understood as **results** or deliverables of funding activities
- **Outcomes**, understood as **short-term impacts** directly triggered by the intervention within the programme duration



¹

3. Specific Objectives: which resources and actions are required?

The following section will describe the different specific objectives and which research topics will be necessary to support these, in order to reach expected outcomes and outputs.

3.1 Specific Objective A: Develop holistic solutions with a systemic approach

Developing holistic solutions that break “technological silos” in the built environment will allow

- achievement of substantial energy or resource efficiency gains triggered by systemic innovation for application in the built environment (**Outcome 1**)
- increased economic activity for the actors integrating the systemic innovation solutions and a shift to mainstreaming life cycle costing approaches (**Outcome 2**)

Outcome 1: achievement of substantial energy or resource efficiency gains triggered by systemic innovation for application in the built environment

Resources and actions should focus on breakthrough systemic and integration-ready (packaged) solutions, cost-effective multi-functional and/or prefabricated holistic renovation packages, integrating both energy efficiency (EE) and renewable energy solutions (RES). This should also include lean construction tools, protocols and methodologies for deep energy renovation as well as resilience analysis.

This Specific Objective should be pursued by also investing in innovative measures, business models, and facilitating management schemes to accelerate and scale up the adoption of innovative technology packages with energy performance contracts (including commissioning).

Holistic solutions for the built environment also require better integration of building & transport infrastructure with the energy grid and city networks (e.g. water). Innovation should focus on cross-sectoral planning and management for a sustainable built environment - including district-level energy planning - as well as multi-modal transport hubs and urban mobility infrastructure.

Finally, actions should focus on innovative decision-making tools able to scale-up green procurement, smart financing initiatives (e.g. green mortgages), as well as integrated business models (e.g. One Stop Shop) to make them easily accessible and affordable for all EU citizens.

List of resources and actions (see Annex 4.1, Resources and Actions: R&I topics)

R&I Topic number	Title
1	Cost-effective multi-functional and/or prefabricated holistic renovation packages, integrating EE and RES
2	Demonstrating integrated technology packages with performance guarantees

3	Smart-grid ready and smart-network ready buildings, acting as active utility nodes
4	Multi-modal transport hubs and urban mobility infrastructure
39	Green procurement and new business models for renovation supported by decision-making tools

Outcome 2: Increased economic activity for the actors integrating the systemic innovation solutions and a shift to mainstreaming life cycle costing approaches.

Developing holistic solutions in a systemic approach also means re-thinking the built environment into a life-cycle perspective. For this reason, RDI projects should focus on certified future sustainable and durable construction, innovative products and systems, including re-used and recycled materials. This would entail investing resources and actions into novel and multifunctional products and systems with an improved life cycle and low CO2 footprint as well as move towards more harmonisation at EU level of the process of technical quality control, standardisation and certification of durable innovative products.

Innovation should also focus on new standards/models for building design with a life cycle & circular approach, also taking into consideration adaptation to climate change. This would help to integrate LCA and EU Level(s) indicators into Green Public Procurement as well as to develop multicriteria decision-making tools for investments which will deliver a full, positive environmental impact.

A holistic built environment also requires a better standardization framework for data, models, exchange protocols, for testing methods for innovative materials and products to tackle certification barriers in Europe. Similar considerations should be made for new public and private procurement approaches supporting the implementation of innovation and the performance-based contractual approach.

Holistic solutions for buildings and infrastructure also mean a better integration of users' needs into the built environment. For this reason, the SRIA proposes to invest resources into R&I projects which focus on:

- New design of buildings, infrastructure, multimodal hubs and public spaces for accessibility and inclusiveness;
- Solutions for the ageing population, including new care services from home, better accessibility of the built environment and public spaces with seamless living and mobility patterns, the deployment of age-friendly low-cost solutions and ICT-based functions;
- Solutions to foster dynamic and participative urban planning for sustainable buildings (e.g. scaling up the use of digital systems to involve stakeholders and citizens in participative urban planning & design).

Finally, financial stimulus will be crucial to make holistic renovation a reality. For this reason, R&I projects should focus on

- better understanding of existing barriers at end user level;
- to identify trigger points for deep renovation and to seize financial incentives in a way that they can drive the decision to undergo deep renovation;
- developing financing and incentive mechanisms created and tested on local scales to make renovation affordable and to make technical as well as financial support easily accessible.

List of resources and actions (see Annex 4.1, Resources and Actions: R&I topics)

R&I Topic number	Title
5	Certified future sustainable and durable construction, innovative products and systems, including re-used and recycled materials
6	Tools to facilitate a life cycle-based approach that fosters alignment with EU Level(s) framework indicators
12	New design of buildings, infrastructure, multimodal hubs and public spaces for accessibility and inclusiveness
13	Solutions for the ageing population, including new services from home
14	Solutions to foster dynamic and participative urban planning for sustainable buildings
21	Standardisation framework and progressive regulation
22	New public and private procurement approaches supporting the implementation of innovation and the performance-based contractual approach
23	Lifecycle-based asset management and holistic approach of buildings and infrastructures
40	Financing schemes and business models for holistic renovation services (energy, accessibility, comfort)

3.2 Specific Objective B: Demonstrate overall performance in the life-cycle perspective

Demonstrating the overall performance in the life-cycle perspective will:

- Increase the overall impact of built environment innovative solutions on environment and climate – decreasing carbon footprint and increasing carbon handprint (**Outcome 3**)
- Increase the resilience of the built environment to protect and enhance social, environmental and economic value in the future (**Outcome 4**)

Outcome 3: Increase the overall impact of built environment innovative solutions on environment and climate – decreasing carbon footprint and increasing carbon handprint

Better innovative solutions for environment and climate will be crucial to achieve the environmental protection goals of the European Union, enshrined in the EU Green Deal.

First, this means investing resources and action into more sustainable buildings with reduced embodied energy/carbon and high performance to reduce the life cycle trade-offs. This would entail R&I projects aimed at developing low embodied carbon products and solutions for the production of new and traditional construction materials as well as new design and construction techniques using less materials. These need to address not only new buildings but also contribute to the deep renovation of Europe's huge building stock - as intended by the Renovation Wave.

It is crucial to focus resources and action on a better integration of construction and demolition waste in new constructions (including renovation) and industrial symbiosis. This should entail, for example, demonstration of multiple CDW (Construction & Demolition Waste) reuse, technical and economic instruments to stimulate the integration of CDW (and other waste) business in the construction ecosystem as well as development of routes for certification/standardisation and usage, quality control of materials that incorporate CDW.

As regards the construction site itself, it would be important to focus innovation on methodologies and tools for zero-carbon works – including requirements and business-models supporting the transition to zero-carbon civil works vehicles and protocols.

A sustainable built environment should also be predictive and anticipate future events. For this reason, innovative projects should focus on:

- Designs, materials and solutions to improve resilience, preparedness & responsiveness of the built environment to disruptive events
- Models and digital tools for better-informed decision making on investments and improved risk management for the built environment. This should be developed through better data collection and analytics tools (big data, AI, Machine Learning, BIM) to support decision making and prioritisation of investments (risk assessment, long term prediction).

- Holistic data-based approach, from tendering to the end of life throughout interoperable tools (with BIM, IoT, data analytics, AI) and systems for life cycle management and circular economy, cultural heritage, etc.
- Low-disruptive construction and retrofitting processes using BIM alternative solutions considering costs, energy performance and disruption to users as well as pre-fabrication.

List of resources and actions (see Annex 4.1, Resources and Actions: R&I topics)

R&I Topic number	Title
10	Integration of construction and demolition waste in new constructions and industrial and regional symbiosis
11	More sustainable buildings with reduced embodied energy and high performance to reduce the life cycle trade-offs
18	Low-disruptive construction and retrofitting processes
24	Design, materials and solutions to improve resilience, preparedness & responsiveness of the built environment to disruptive events
26	Models and digital tools for better-informed decision making on investments and improved risk management for the built environment
28	Holistic data-based approach, from tendering to the end of life
31	Big data-based building and infrastructure real-time management, monitoring and maintenance
35	Methodologies and tools for zero-carbon works – including requirements and business-models supporting the transition to zero-carbon civil works vehicles and protocols

Outcome 4 Increase the resilience of the built environment to protect and enhance social, environmental and economic value in the future

The European built environment has a crucial social, environmental and economic value. This requires innovative solutions in order to be future-proof.

In the decision-making phase, the SRIA proposes to focus on models and digital tools for better-informed decision making on investments and improved risk management for the built environment. This should be developed through better data collection and analytics tools (big data, AI, Machine Learning, BIM) to support decision making and prioritisation of investments (risk assessment, long term prediction).

In particular, innovation should focus on new standards/models for building design with a life cycle & circular approach, also taking into consideration adaptation to climate change. This would help to integrate LCA and EU Level(s) indicators into Green Public Procurement as well as develop multicriteria decision-making tools for investments which will include the total environmental impact.

Holistic approaches (e.g. decision-making tools) should be developed for the integration of circular economy and nature-based solutions (NBS) at the scale of building blocks and districts to reintroduce more biodiversity in cities.

In order to develop a future-proof built environment, research and innovation should focus on designs, materials and solutions to improve resilience, preparedness & responsiveness of the built environment (new buildings and existing building stock) to disruptive events. Moreover, actions should be directed towards predictive and integrated maintenance solutions/processes such as modelling of the impact of ageing, natural hazards, man-made threats on the built environment as well as integration of IoT, sensors, automation systems for smart monitoring and automated maintenance.

Similar considerations should be carried out on the development of optimal solutions to adapt existing neighbourhoods to new transport patterns including active travel, the integration of charging infrastructure for e-mobility, and responding to new multimodal, low carbon mobility needs.

Finally, the SRIA believes that the cultural heritage needs a special angle when it comes to innovation. For this reason, resources and actions should focus on innovative solutions for a low carbon, resource efficient and resilient cultural heritage, from prevention and monitoring to maintenance and retrofit.

List of resources and actions (see Annex 4.1, Resources and Actions: R&I topics)

R&I Topic number	Title
6	Tools to facilitate a life cycle-based approach that fosters alignment with EU Level(s) framework indicators
8	Optimal solutions to adapt existing neighbourhoods to new transport patterns
9	New approaches to circular economy (for both technology-based & nature-based solutions)
19	Solutions for a low carbon, resource efficient and resilient cultural heritage, from prevention and monitoring to maintenance and retrofit
24	Design, materials and solutions to improve resilience, preparedness & responsiveness of the built environment to disruptive events
26	Models and digital tools for better-informed decision making on investments and improved risk management for the built environment
37	Predictive and integrated maintenance solutions and processes

3.3 Specific Objective C: Demonstrate clean energy transition potential

By demonstrating the clean energy transition potential of the built environment, it will be possible to achieve:

- Reduced energy demand and consumption, to increase flexibility, to accommodate more renewable energy - this will generate benefits to citizens by paying less operational costs while in parallel increasing the living comfort and reducing the risk of energy poverty (**Outcome 5**)
- Increased local production and job creation, buildings and districts as producers of energy and owners, citizens and communities of the local energy system producing energy and beneficiaries of the energy (local) value chain (**Outcome 6**)
- Energy Transition boost, supply and integrate in the built environment, in a sustainable way, the required supporting network infrastructure for the energy transition, both for stationary and transport sectors (**Outcome 7**)

The decarbonisation of the built environment will firstly depend on better integration of building & transport infrastructure with energy grid and city networks (e.g. water). Innovation should focus on cross-sectoral planning and management for a sustainable built environment - including district-level energy planning - as well as multi-modal transport hubs and urban mobility infrastructure.

Second, the urgently required energy efficiency of the built environment needs innovative solutions at the level of building blocks and districts, including better integration of local renewables. In particular, resources and action should focus on energy sharing platforms and services, micro-grids to share self-produced energy within building blocks, and smart financing/business models for the integration of RES to improve bankability of innovative 100% renewable and self-consumption local projects. Similar attention should be put on holistic approaches (e.g. decision-making tools) for the integration of circular economy and nature-based solutions (NBS) at the scale of building blocks and districts to reintroduce more biodiversity in cities.

However, the decarbonisation of the built environment cannot happen without real participation of the users, involving individual owners and energy communities as beneficiaries and part of the value chain. Prosumers should directly receive value for the produced energy, with more and more real-time based systems and pricing. For this reason, the SRIA proposes to invest resources into solutions for stronger democratic participation, energy citizenship and new energy communities to achieve both reduced and smart energy consumption in the built environment. In particular, this should happen by scaling up the use of digital systems to involve stakeholders and citizens in participative urban planning & design. These should be tools fostering awareness and education of citizens as members of the city community (including the accessibility to cultural heritage via virtual reality, One-stop-shops for the renovation plans at community/urban levels, etc.) and a specific focus should be reserved for solutions enabling a seamless and flexible integration of buildings in to the energy grid as prosumers, taking into account the building users and occupants.

Finally, a user-oriented approach of the built environment needs to focus on innovative solutions for healthier indoor and outdoor environment (air quality, safety, comfort) from building to neighbourhood scale.

List of resources and actions (see Annex 4.1, Resources and Actions: R&I topics)

R&I Topic number	Title
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3	Smart-grid ready and smart-network ready buildings, acting as active utility nodes
4	Multi-modal transport hubs and urban mobility infrastructure
7	Interoperable components for positive energy blocks and districts, including better integration of local renewables (Coordination with DUT)
8	Optimal solutions to adapt existing neighbourhoods to new transport patterns
9	New approaches to circular economy (for both technology-based & nature-based solutions)
14	Solutions to foster dynamic and participative urban planning for sustainable buildings (Coordination with DUT)
15	Solutions for healthier indoor and outdoor environment (air quality, safety, comfort) from building to neighbourhood scale

3.4 Specific Objective D: Demonstrate sector decarbonisation pathways

Demonstrating sector decarbonisation pathways will help transform the built environment as a CO2 sink for the future, through increased deployment of circular and nature-based solutions and effective integration with the bio-economy. **(Outcome 8)**

This should be carried out by investing into new standards/models for building design with a life cycle & circular approach, also taking into consideration adaptation to climate change. This would help to integrate LCA and EU Level (s) indicators into Green Public Procurement, taking into account LCA and the EU Level(s) Framework indicators as well as multicriteria decision-making tools for investments delivering full and positive environmental impact.

Specific attention should also be reserved for solutions for a low carbon, energy and resource efficient and resilient cultural heritage, from prevention and monitoring to maintenance and retrofit.

Finally, monitoring the performance of the built environment in order to take decarbonisation actions. This should be carried out by investing resources and actions into:

- EU-wide open observatory on the existing building stock, database on buildings’ and districts’ energy profiles
- EU-wide open database on the vulnerability of infrastructure and buildings
- Data management platforms, with robust models and data management procedures

List of resources and actions (see Annex 4.1, Resources and Actions: R&I topics)

R&I Topic number	Title
6	Tools to facilitate a life cycle-based approach that foster alignment with EU Level(s) framework indicators
19	Solutions for a low carbon, resource efficient and resilient cultural heritage, from prevention and monitoring to maintenance and retrofit
30	EU-wide open databases and Data Management Platforms on the performance of the built environment

3.5 Specific Objective E: Demonstrate sustainable, circular business and value chain

Demonstrating sustainable, circular business and value chain will help create new business opportunities with reduced risk for investors, opening the supply chain to reused/repared products, re-use/refurbish buildings and infrastructures, demolitions and urban mining (**Outcome 9**)

First, it will be important to invest resources and actions into the development and Integration of approaches for reducing space and materials. This means developing less complex building components, products and systems or systems that can more readily separate components, making them easier to collect and recycle, and more resource efficient, thus contributing to carbon neutrality.

Moreover, it is crucial to focus resources and action on better integration of construction and demolition waste in new constructions; and industrial symbiosis. This should entail, for example, demonstration of multiple CDW (Construction & Demolition Waste) reuse, technical and economic instruments to stimulate the integration of CDW (and other waste) business in the construction ecosystem as well as development of routes for certification/standardisation and usage, quality control of materials that incorporate waste.

In order to green the built environment, private and public demand for sustainable products and services will play a crucial role. For this reason, innovative solutions should be supported in the following fields:

- New public and private procurement approaches supporting the implementation of innovation and the performance-based contractual approach
- Digital innovation in procurement (micro-payments, blockchain based platforms, etc.)
- Models and digital tools for better-informed decision making on investments and improved risk management for the built environment: data collection and analytics tools (big data, AI, Machine Learning, BIM) to support decision making and prioritisation of investments (risk assessment, long term prediction)

Digital solutions can also support and ease the repurpose and re-use of buildings, infrastructure and components throughout the whole lifecycle – including BIM objects for the new building design equally sourced from the product manufacturers and second-hand material dealers. In particular, innovative solutions should concern:

- Life time BIM: tools that support designing out waste through all its perspectives on reuse and recovery, deconstruction/flexible re-use, off-site construction and material optimisation, for resource-efficiency.
- Development of tools and data dictionary/ data bank services to compile information on products at property level based on entire life-cycle support
- Development of BIM protocols and guidelines for sustainable use cases

List of resources and actions (see Annex 4.1, Resources and Actions: R&I topics)

R&I Topic number	Title
10	Integration of construction and demolition waste in new constructions and industrial and regional symbiosis

22	New public and private procurement approaches supporting the implementation of innovation and the performance-based contractual approach
25	New processes, business models and financing mechanisms supporting integration within the construction value chain and with other sectors
26	Models and digital tools for better-informed decision making on investments and improved risk management for the built environment
29	Digital Innovation in procurement
32	Development and Integration of approaches for reducing space and materials
33	Tools to support designing out waste and compiling of information on products at property level based on entire life-cycle support.
34	New value chain-based services for the end user

3.6 Specific Objective F: Demonstrate affordability and cost-effectiveness

The objective of the B4P Partnership is to provide systems and services that will serve the stakeholders, should they be the final users (inhabitants) or the property owners and managers: systems and services must allow to erect or renovate an affordable and feature-adapted built environment for users and inhabitants, whilst ensuring long-term value for building owners, along with increased flows of capital investment and long-term finance into built environment as a sustainability asset (**Outcomes 10 & 11**).

The guarantee of performance of the build assets is having a growing importance, which includes future enhanced EPCs with longer commissioning and condition-based maintenance, technology packages with energy performance contracts (incl. commissioning), and development of EPCs that will work with industrialised solutions for renovating the residential sector, including valorising comfort (Comfort Performance Contracts).

At the same time, the role of Buildings being active nodes in the future local / regional grids as prosumers taking into account the building users and occupants should deliver more added value (both to users and owners), as well as the interrelations between buildings, public spaces transport infrastructures to improve easiness of move, accessibility and inclusiveness. In a 2nd step, the transformation towards smart built assets should lead to an active & adaptive (at level of the envelope, the equipment, in-built renewables, etc.) built environment 'acting' or reacting based on users' preferences, physiological parameters, contextual situations, etc. while being safer and healthier built assets. These built assets should integrate in a near future a new generation of advanced solutions for smart and responsive buildings exploiting an improved knowledge of user experience, implementing as such a concept of 'Building as a service'. Eventually, our future built assets (buildings and infrastructures) should be more prepared to the expected disruptive events in the future (and in particular those being consequences of the climate change): this means new approaches towards resilience (should it be resilience by design or resilience at run-time), as well as new materials and solutions matching future resilience patterns.

To support integration within the construction value chain and with other sectors, new business models and financing mechanisms are required, that should include new market actors as recycling and material handling companies, on-line trading service providers, etc., with new instruments (financing, green procurement, labelling, standards, BREFs & guidelines) to stimulate the integration of CDW (and other waste) business in the construction ecosystem, with better valuation of externalities of waste management and better understanding of local resource streams, with a need to demonstrate and replicate packages of financing and incentive mechanisms created and tested on local scales, to make renovation/adaptation affordable.

As we refer to affordability and cost-effectiveness, digitalisation is going to be a key asset: it's all about Data analytics, global optimisation methods, AI and self-learning algorithms for better-informed decision making on investments as well as enhanced risk management and mitigation. It encompasses the capacity of collecting and providing access to large sets of data through European wide-scale digital observatory on the existing building stock, as well as EU-wide open database on the performance of infrastructures and buildings (in particular public ones), their vulnerability, information based on LCAs and LCCs, etc., and how these data are used for enhanced real-time management, monitoring and maintenance, under various contextual conditions and constraints. Eventually, a new generation of digital tools, systems and applications should support new services for the citizen and the city (transport, health, car parks, waste management), with an enlarged involvement of stakeholders and citizens in monitoring and maintenance of the built assets.

List of resources and actions (see Annex 4.1, Resources and Actions: R&I topics)

R&I Topic number	Title
2	Demonstrating integrated technology packages with performance guarantees
3	Smart-grid ready and smart-network ready buildings, acting as active utility nodes
12	New designs of buildings, infrastructures, multimodal hubs and public spaces for accessibility and inclusiveness
16	Solutions for smart and responsive buildings exploiting an improved knowledge of user experience (Building as a service)
24	Designs, materials and solutions to improve resilience, preparedness & responsiveness of the built environment to disruptive events
25	New processes, business models and financing mechanisms supporting integration within the construction value chain and with other sectors
26	Models and digital tools for better-informed decision making on investments and improved risk management for the built environment
30	EU-wide open databases and Data Management Platforms on the performance of the built environment
31	Big data-based building and infrastructure real-time management, monitoring and maintenance, including cultural heritage
38	Interactive operation and management of city assets

3.7 Specific Objective G: Demonstrate no trade-offs on economy, comfort, health, functions, cultural heritage

Demonstrating no trade-offs on economy, comfort, health, functions, cultural heritage will help be achieved by delivering:

Demonstrated and/or certified built environment with regard to expected or agreed user-centric functions and characteristics **(Outcome 12)**.

Enhanced health and wellbeing through improved indoor and outdoor environment **(Outcome 13)**.

Low carbon, resource efficient, open, accessible and inclusive solutions for conservation and embellishment of cultural heritage, built environment assets **(Outcome 14)**.

In pursuing the transition towards a decarbonised and sustainable built environment it is important to preserve and improve the existing positive attributes. The built environment delivers important functions and provides comfort and cultural heritage. The Built4People partnership will aim to mitigate any negative impacts of the transition on these aspects and to demonstrate that the transition can also go hand in hand with enhancing these aspects. A healthier, more sustainable built environment will bring wellbeing and prosperity to people.

Outcome 12: Demonstrated and/or certified built environment with regard to expected or agreed user-centric functions and characteristics

The partnership will drive improvements in the sector's ability to deliver designed or predicted performance through

- new technologies such as digital tools to improve performance prediction and monitoring before and throughout the life cycle
- new business models such as design for performance approaches and the expanded availability of performance guarantees or performance contracting across key user-centric features such as thermal, acoustic and visual comfort, health impacts and other aspects of the user experience.

It will foster improvements in the availability and uptake of inclusive solutions that serve those with specific needs such as the elderly or those with disabilities.

Outcome 13: Demonstrate enhanced health and wellbeing through improved indoor and outdoor environment

The partnership will support the transition to a built environment that enhances rather than reduces human health through the development of new products and technologies that help avoid release of harmful pollutants or actively reduce their presence in the built environment. The development of new tools to monitor and control the health impacts of built environments will support improved understanding of the effects on people. Fostering novel approaches to design such as biophilic design, nature-based solutions and increased biodiversity and tools and methods to evaluate their impact on human needs will also help achieve this objective. By encouraging regulatory sandboxes to test policy innovations and market models, the partnership will contribute to mass market uptake of these approaches.

Outcome 14: Demonstrate low carbon, resource efficient, open, accessible and inclusive solutions for conservation and embellishment of cultural heritage, built environment assets

The need to decarbonise and transition to a sustainable built environment should not come at the cost of the loss of Europe's cultural heritage and the partnership will foster better understanding and the development of new techniques to achieve sustainability outcomes in cultural heritage assets whilst retaining and enhancing

aesthetic, cultural and economic value. This will be achieved by combining new approaches, techniques and materials for sustainable, culturally sensitive renovations alongside the development and wider deployment of digital monitoring, visualisation and other tools to protect cultural heritage assets from the environment and human impacts such as tourism.

R&I Topic number	Title
2	Demonstrating integrated technology packages with performance guarantees
6	Tools to facilitate a life cycle-based approach that foster alignment with EU Level(s) framework indicators
11	More sustainable buildings with reduced embodied energy and high performance to reduce the life cycle trade-offs
13	Solutions for the ageing population, including new services from home
15	Solutions for healthier indoor and outdoor environment (air quality, safety, comfort) from building to neighbourhood scale
16	Solutions for smart and responsive buildings exploiting an improved knowledge of user experience (Building as a service)
17	Solutions for the sustainable regeneration of urban and rural neighbourhoods
19	Solutions for a low carbon, resource efficient and resilient cultural heritage, from prevention and monitoring to maintenance and retrofit
20	Sustainable renovation for a more open, accessible and inclusive cultural heritage, in a sustainable urban development
21	Standardization framework and progressive regulation
22	New public and private procurement approaches supporting the implementation of innovations and the performance-based contractual approach
24	Designs, materials and solutions to improve resilience, preparedness & responsiveness of the built environment to disruptive events
27	New services for on-site/off site surveillance and monitoring of buildings and infrastructures in construction and in use.
29	Digital Innovation in procurements
30	EU-wide open databases and Data Management Platforms on the performance of the built environment
39	Green procurements and new business models for renovation supported by decision-making tools
40	Financing schemes and business models for holistic renovation services (energy, accessibility, comfort)

4. Annexes

4.1 Resources and actions (R&I topics)

1. Cost-effective multi-functional and/or prefabricated holistic renovation packages integrating EE (energy efficiency) and RES (renewable energy solutions)

State of the art

Prototypes for different types of prefabricated façade systems and adaptable packages (including RES) have been developed and demonstrated in real environment, thereby reaching an average TRL 6.

Topic scope

- ↘ **Industrialised and market-ready modular and scalable turnkey packages for retrofitting, including HVAC and RES** and, for instance:
 - Energy positive glazing for curtain walls and skylight
 - Solutions for energy demand reduction in summer (with e.g. natural, mixed-mode and mechanical ventilation, nature-based solutions, etc.)
 - Passive solutions exploiting natural ventilation and/or solar energy
 - Compact, low cost solutions for (potentially distributed) energy storage at building and district level
 - cost-efficient non-intrusive BIPV elements for both new and renovated buildings
 - Functional, low-cost Building Energy Management Systems for existing buildings, including historical ones, in particular for small and medium size buildings
 - Smart systems embedded in construction elements
- ↘ Prototyping, performance and functional tests as part of the design-for-assembly (and disassembly) process, before mass production and implementation
- ↘ **Lean construction tools, protocols** and methodologies for deep energy renovation, including prefabrication or 3D printing allowing both mass production and customization, with a focus on **suitability for SMEs**
- ↘ Analysis of the value chain, of life cycle costs and values for optimisation of the business case including definition of potential market and related players
- ↘ Deep renovation solutions include **an analysis of the positive economic, social and environmental impacts including resilience** of the renovated building/infrastructure against major disruptive events, such as flooding, heat waves, accidental fires and/or other climate-driven events and/or earthquakes

Nature of activities required

Integration & demo (scaling up and industrialisation) – **IA 2021-2022**

Framework (socio economic studies, standardization) – **CSA 2023-2024**

Linked outputs

- 1.1 Breakthrough systemic and integration-ready (packaged) solutions for more sustainable buildings or infrastructure across the whole life cycle, including embodied and operational impacts

Budget (M€)

75

2. Demonstrating integrated technology packages with performance guarantees

State of the art

Projects to make innovations work with EPC business models, make them accessible to SMEs, and attractive for the residential sector

Topic scope

- ↘ Measures to **accelerate and scale up the adoption of innovative technology packages with energy performance contracts** (incl. commissioning)
- ↘ Development of business models that suit new industrialised design and production methods, including **enhanced EPCs with longer and continuous commissioning and condition-based maintenance** to replace maintenance contracts
- ↘ Development of **EPCs and facility management schemes that work with industrialised solutions for renovating the residential sector**, valorising both energy efficiency and flexibility (through demand response) – integrating all factors (building envelope, equipment & systems, energy storage...) – and valorising indoor environmental quality (IEQ Performance Contracts)

Nature of activities required

Framework (business models) – **IA - CSA**

2021-2024 (CSA kept for 2023-2024 and merged with the CSA Topic 1)

Linked outputs

- 1.2 Comprehensive and validated methodologies and tools for the assessment of the built environment (as an integrated system of systems) performance in terms of resource efficiency
- 11.2 Demonstrated and replicated set of financing and incentive mechanisms and packages created and tested on local scales, to make renovation/adaptation affordable and with proved RoI
- 12.3 Advanced tools and guidance to improve smart readiness in the built environment
- 13.3 Methodologies and tools for sustainability-integrated performance contracting for the built environment

Budget (M€)

20

3. Smart-grid ready and smart-network ready buildings, acting as active utility nodes in smart communities

State of the art

Solutions have been piloted for smart-grid ready buildings (with e.g. demand response, on-site RES optimisation)

Topic scope

- ↳ **Solutions enabling a seamless and flexible integration of buildings to the energy grid as flexible prosumers and data providers**, taking into account the building users and occupants' wellbeing and health
- ↳ Solutions enabling a **better integration of buildings to the city networks**, in particular **water and wastewater**, to encourage the local re-use of water and waste heat, as well as an optimised management of wastewater and rainwater (solve sanitary issues, economic competitiveness of solutions, standardisation)
- ↳ **Integration of BIM with energy modelling** and monitoring during O&M phase and simulation at building level and district level also enabling model calibration and definition of optimal management strategies

Nature of activities required

Integration & demo (scaling up, industrialisation) – **IA 2021-2022**

Framework (business models, standards) – **CSA 2023-2024**

Linked outputs

- 1.3 Integrated and cross-sectoral planning and management for sustainable built environment, including district-level energy planning
- 5.2 Smart products and energy management systems for more flexible demand. Solutions for additional flexibility on the demand side, including demand response and local storage.
- 6.1 Guidance and business models (demonstrations/pilots) integrating individual owners and energy communities as beneficiaries and part of the value chain. Prosumers should directly receive value for the produced energy, with more and more real-time based systems and pricing.
- 6.3 Market and regulatory ready solutions for micro-grid to share self-produced energy within blocks buildings
- 10.2 Solutions for smart and responsive buildings exploiting an improved knowledge of user experience (Building as a Service)

Budget (M€)

35

4. Multi-modal transport hubs and urban mobility infrastructures

State of the art

Pilot experimentations (e.g. projects like HighLite, +CitiesXChange, SEAM4US).

Topic scope

- ↘ **Integrated design and operation** of future ground and underground transportation infrastructures that take into account environmental impacts (air quality, noise, vibrations, etc.) and safety challenges related to energy storage.
- ↘ **Industrialised construction processes** for the development of future multimodal transport hubs, minimizing the disruptions and impacts to the urban activity and environment
- ↘ **ICT tools for mobility optimization (with lifecycle approach)**, with smart control between the electricity grid and transport grid
- ↘ **Business models for low-cost deployment of EV charging points** in all office, commercial and multitenant residential buildings

Nature of activities required

R&D – RIA 2023-2024

Integration & demo (scaling up, industrialisation) – IA 2025-2027

Framework (business models) – CSA 2025-2027

Linked outputs

- 1.3 Integrated and cross-sectoral planning and management for sustainable built environment, including district-level energy planning
- 5.3 Sector integration solutions arising from electric mobility, integrating the charging point and the battery of the vehicles in the local power system.
- 7.1 Evidence-based guidance and demonstration of built environment solutions to create the infrastructure and support business cases for the private sector as e.g. recycling, electrification, district energy, transport and storage of CO₂, refilling stations for H₂, charging stations for electric cars, energy storage

Budget (M€)

30

5. Certified innovative sustainable and durable construction products and systems, including re-used and recycled materials

State of the art

RDI projects have so far focussed on developing advanced insulation materials and nanotechnology-based materials, as well as reducing the embodied energy of more traditional materials (e.g. concrete) thanks to the integration of by-products. The missing standards and lack of market acceptance of new products and systems is often a bottleneck in the innovation process.

Topic scope

- ↘ Development of a **common EU procedure to fast-track the process of technical quality control, standardization and certification without compromising health and safety requirements** of new innovative materials and components
- ↘ **Product labelling according to lifecycle performance**, including CO₂ footprint (with cradle to cradle approach) and durability/service life, and preventing “hidden” ecological/social impacts and aligned with or going beyond EU Level(s) framework indicators.
- ↘ **Novel and multifunctional products and systems with improved life cycle and low CO2 footprint**, long service life, lightweight, self-sensing and self-healing, designed for (in situ) enhancement, re-use and/or easily recyclable, with enhanced properties needed for fire resilience, anti-microbial properties and moisture control
- ↘ **Novel bio-based coatings, paint formulations, safe surface modifications, wood-based insulation & composite materials and active structures** (e.g. filters) to reduce carbon footprint, simultaneously creating a healthy environment for people
- ↘ Protocol (and the related label) for the **non-destructive evaluation of reusable components** Innovative waste-based functional materials (for example geopolymers, nanocomposites, bio-materials, etc.) with novel properties such as self-monitoring, self-healing, self-protecting against corrosion construction etc.
- ↘ **Low carbon and durable solutions for new construction, retrofitting, repair and strengthening**, including cultural heritage (traditional materials, bio-based, locally sourced, or innovative materials compatible with traditional materials)

Nature of activities required

R&D – RIA 2021-2022

Integration & demo (scaling up, industrialisation) – IA 2023-2024

Linked outputs

2.1 Certified, industrialised and market-ready multifunctional (passive & active) prefabricated turnkey packages (component or system)

Budget (M€)

75

6. Tools to facilitate a life cycle-based approach that foster alignment with EU Level(s) framework indicators

State of the art

- *Prototypes of materials developed with a life cycle approach with demonstration on single buildings*
- *Recommendations for a harmonised LCA methodology*

Topic scope

- ↳ **New standards/models for building design with life cycle & circular approach**, which also account for **summer/winter comfort** (with e.g. effective natural, mixed-mode or mechanical ventilation) and integrates data on future climate conditions and risks for **adaptation to climate change**
- ↳ Improvement of the **integration of holistic building assessments in Green Public Procurements**, with e.g. building certification to stimulate circular economy) that takes into account LCA and human health, wellbeing and safety and integrates the EU Level(s) Framework indicators
- ↳ **Rich (i.e. semantic-based) and open datasets for LCA** in the construction sector, with clear methodologies and multicriteria techniques (including reference service life of buildings and their components, end of life scenarios)
- ↳ **Digital representation** including 3D geometry, performance and all material properties required for LCA modelling
- ↳ **Multicriteria decision-making tools for investments** including full environmental impact (LCA/LCC/LCT/LCSA), with CO₂ reduction as a leading principle
- ↳ Definition of reliable **methods for evaluation of energy efficiency packages costs, risks and related building real estate value**, including residual value at the end of the cycle
- ↳ Improvement of the **understanding of user-interactions (considered as part of the asset life-cycle with asset transformation, change of use, etc.) with the built environment and public spaces** (design choice, behaviour, long-term well-being)

Nature of activities required

Framework (standards, economic studies) – IA - CSA

2021-2022, 2023-2024

Linked outputs

- 2.3 Demonstrated new optimal circular value chains through construction & supply-chain clusters and living labs
- 4.2 New standards and tools to integrate data on future climate conditions and risks (adaptation to climate change) into all aspects of decision making along the built environment value chain.
- 4.3 Rich and open datasets for LCA in the construction sector, with clear methodologies and guidance for applying multicriteria decision-making techniques (such as reference service life of buildings and their components, end of life scenarios)
- 8.1 BIM-based solutions providing a GHG compass over the overall life-cycle of the building / infrastructure
- 8.4 Digital tools to raise awareness on GHG impact and on reduction pathways for all stakeholders, from companies to citizen, through public authorities and contractors
- 12.3 Advanced tools and guidance to improve smart readiness in the built environment

Budget (M€)

55

7. Interoperable components for positive energy blocks and districts, including optimised integration of local renewables and storage systems

State of the art

- *Pilots for dynamic exchange of energy (heat, electricity) between buildings*
- *Pilots of Energy Hub, Virtual Power Plants, microgrids*

Topic scope

- ↳ **Energy sharing platforms and services**, connected to local (virtual) energy markets, including demand response, EV integration, RES integration at building to district scale
- ↳ Modular, versatile, flexible and standardised solutions, well integrated to the local environment, buildings and cultural heritage, for **energy generation at district level**, including BIPV, locally available renewable heat sources and waste heat, by harvesting all available energy flows and using energy cascading, addressing fire safety challenges of the wide-spread use of these systems
- ↳ **Market and regulatory ready solutions for micro-grid** to share self-produced energy within blocks buildings
- ↳ **Smart financing and new business models for the integration of RES** (e.g. shared ownership, energy communities, crowd funding, peer-to-peer lending, energy supply as a service), including raising awareness and building up skills in the construction value chain so that integration of innovative RES components are better understood and generalised by white & blue collar workers
- ↳ Capacity building and **cooperation between building/facility managers, thermal energy and electricity stakeholders**, including utilities, DSO, smart service providers at building cluster to city scale, to facilitate cooperative projects
- ↳ **Pilot Credit Facility** to improve bankability of innovative 100% renewable and self-consumption local energy communities

Nature of activities required

R&D - **RIA2023-2024**

Integration & demo (scaling up, industrialisation, business models, training) – **IA 2024-2025**

Linked outputs

- 5.1 Solutions for stronger democratic participation, energy citizenship and new energy communities => Smart energy consumption in the built environment
- 6.2 Energy management systems and storage solutions for positive energy buildings and retrofits supporting grid flexibility and coupling solutions for electricity and heating.
- 7.2 Smart financing and new business models for the integration of RES (e.g. shared ownership, energy communities), and interactions with built environment networks - including raising awareness and building up skills in the construction and supply value chain

Budget (M€)

60

8. Optimal solutions to adapt existing neighbourhoods to new transport patterns

State of the art

New mobility patterns and clean transport are being tested by Smart Cities projects, including e-mobility, traffic fluidisation.

Topic scope

- ↳ **New technologies for the adaptation of the built environment to new transport options**, including active travel and the integration of charging infrastructure for e-mobility
- ↳ **Decision support tools** supporting the development of robust adaptation strategies for neighbourhoods (including the supporting geostructures) to adapt them to multimodal, low carbon mobility needs

of activities required

Integration & demo (scaling up & industrialisation) **IA**

Framework (business models, policy) **IA**

CSA

2023-2024, 2025-2027

Linked outputs

- 4.2 New standards and tools to integrate data on future climate conditions and risks (adaptation to climate change) into all aspects of decision making along the built environment value chain.
- 5.3 Sector integration solutions arising from electric mobility, integrating the charging point and the battery of the vehicles in the local power system.
- 7.1 Evidence-based guidance and demonstration of built environment solutions to create the infrastructure and support business cases for the private sector as e.g. recycling, electrification, district energy, transport and storage of CO₂, refilling stations for H₂, charging stations for electric cars, energy storage

Budget (M€)

75

9. New reliable and robust approaches to circular economy (for both technology-based & nature-based solutions)

State of the art

- *Prototypes of bio-based materials and NBS with demonstration on single buildings.*

Topic scope

Holistic approaches for the integration of circular economy and nature-based solutions (NBS) at the scale of building blocks and districts:

- ↳ NBS in cities (**green spaces, water systems, buffering materials, innovative heating and cooling networks allowing to cope with heat rejection into outdoor air**) to **reduce the heat island issue** and improve heat control
- ↳ NBS and **green corridors** to reintroduce **more biodiversity in cities**
- ↳ Validated and replicable approaches and **decision-making tools for the implementation of NBS** (valuation of overall impacts, including on biodiversity) at building and district scale
- ↳ Solutions for the **integration of agrifood production**, by-products valorisation and waste utilisation within the built environment
- ↳ New approaches (methodologies, tools, KPIs) towards **circular economy practices for buildings and infrastructures** (materials re-use, high quality recycling of components and equipment, etc.) **with LCA considerations.**

Nature of activities required

R&D RIA

Integration & demo (scaling up & industrialisation) IA

Framework (business models, policy)

IA & Large-scale pilots

2023-2024, 2025-2027

Linked outputs

- 4.1 Designs, materials and solutions to improve resilience, preparedness & responsiveness of the built environment to disruptive events
- 6.2 Energy management systems and storage solutions for positive energy buildings and retrofits supporting grid flexibility and coupling solutions for electricity and heating.
- 6.4 Market and regulatory ready solutions to harness local heat sources, e.g. from excess heat, for close-by buildings and districts

Budget (M€)

70

10. Integration of construction and demolition waste in new constructions and industrial symbiosis

State of the art

- *Prototypes of materials with reduced embodied energy thanks to the integration of waste and other secondary materials*
- *Prototypes of novel wood-based material solutions (enhancing circular economy) with reduced embodied energy providing simultaneously good air quality*

Topic scope

- ↳ Optimised approach for **selective demolition** and definition of drivers and approaches for **design for disassembly**
- ↳ Demonstration of multiple **Construction & Demolition Waste (CDW) and industrial waste (IW) reuse technical and economic viability** at regional level (CDW / IW streams, protocols and guidelines), with e.g. exchange platforms and services
- ↳ **New instruments** (financing, green procurement, labelling, standards, BREFs & guidelines) **to stimulate the integration of CDW, IW and other waste business in the construction ecosystem**, with better valuation of the externalities of waste management and better understanding of local resource streams
- ↳ Improved **reuse of CDW / IW fines**
- ↳ **Modelling of performance and ageing** of materials that incorporate waste
- ↳ **CDW / IW quality control** (esp. with regard to unwanted contamination)
- ↳ **Routes for certification/ standardisation and usage** of materials and construction systems that incorporate waste
- ↳ **Innovative routes to recycle/upcycle waste and residue streams from one industry into raw material for the others**, e.g. use of other sectors' by-products (e.g. steel slag) for the production of new construction materials (e.g. cement or other eco-materials (e.g. geopolymers))
- ↳ **CO2 capture and thermic activation processes**
- ↳ Routes for **certification/ standardisation and usage of materials and construction systems** that incorporate waste
- ↳ **Validation at real scale of industrial symbiosis strategies** to be applied in the construction sector

Nature of activities required

Integration & demo (scaling up & industrialisation, business models) **IA & Large-scale pilots**
2021-2022, 2023-2024

Linked outputs

- 3.1 Novel and multifunctional materials with improved life cycle, along with material labelling according to lifecycle performance
- 9.1 Frameworks for multiple CDW (Construction & Demolition Waste) reuse technical and economic viability at regional level (CDW streams, protocols and guidelines), with e.g. exchange platforms and services

Budget (M€)

60

11. More sustainable and regenerative buildings with reduced embodied energy / carbon and high performance to reduce the life cycle trade-offs

State of the art

- *Prototypes of materials integrating waste and residues*
- *Prototypes of enhanced materials (e.g. concrete) with reduced embodied energy and/or life cycle cost*

Topic scope

- ↳ **Low embodied carbon products and solutions, including those that are locally sourced and bio-based** with low carbon impact and capturing/ storing CO₂. **Modelling** of their insulating, cooling, acoustic and hygrometric performance and ageing. **Mechanisation** of their application.
- ↳ New design and construction techniques using **less materials** (lightweighting)
- ↳ **New design** and manufacturing techniques for **innovative prefabs and multifunctional materials** (including recycled materials such as CDW / IW), with large-scale demonstration of performance (energy, durability, protection and resilience against fire including wild fires) using a full life cycle perspective and addressing design for deconstruction
- ↳ **Advanced multifunctional materials and components with optimal recycling and re-using potential** (e.g. through new designs enabling the re-use)
- ↳ Advanced construction techniques that **enable repairing and re-use** (e.g., advanced mechanical joinery)
- ↳ **New routes for the low energy production of traditional materials** (e.g. glass, steel, cement, ceramics), with energy auditing of production processes as part of the overall energy performance assessment (i.e. to account for the embodied energy in the final carbon footprint)
- ↳ **New systems and tools of structural health monitoring**, allowing rapid diagnosis of the structure, reducing cost of repair, retrofitting and strengthening and **increasing component and building service life**

Nature of activities required

Integration & demo (scaling up & industrialisation) **IA**

Framework (business models, policy)

IA & Large-scale pilots

2021-2022, 2023-2024

Linked outputs

- 3.1 Novel and multifunctional materials with improved life cycle, along with material labelling according to lifecycle performance
- 14.1 Low carbon and durable materials, component packages and standardised solutions (well integrated to the local environment) for retrofitting cultural heritage (low tech, bio-based, locally sourced, or innovative materials compatible with traditional materials)

Budget (M€)

50

12. New, viable designs of buildings, infrastructures, multimodal hubs and public spaces for accessibility and inclusiveness

State of the art

- *Can be merged in the future with topic on design?*

Topic scope

- ↳ **Optimal locations** (position, access, minimal disruption in the urban plans,...) for transport assets for accessibility and inclusiveness (for passenger and freight activities)
- ↳ design of infrastructures to **improve the access to different types of facilities and amenities**, and reduce the commuting time (environmental insertion approach)
- ↳ **holistic platforms for sharing services** including transport services

Nature of activities required

R&D - RIA

2023-2024

Linked outputs

- 2.2 Sets of proven cost-effective, market-ready packages delivering buildings and infrastructure which are aligned to long term EU and global sustainability goals
- 7.1 Evidence-based guidance and demonstration of built environment solutions to create the infrastructure and support business cases for the private sector as e.g. recycling, electrification, district energy, transport and storage of CO2, refilling stations for H2, charging stations for electric cars, energy storage
- 10.3 Building solutions, along with business models and investment/economic decision tools, to support multifunctional buildings optimising multi-usage and space as a service-oriented solution

Budget (M€)

30

13. Solutions for the ageing population, including smart services from home

State of the art

- *Ongoing development of a certification framework related to ageing at home*
- *Numerous development projects on robotics-based and sensor/IT based solutions to prolong autonomy at home*

Topic scope

- ↳ Development of **new services from home**, based on the integration of functionalities within the built environment (surveillance and monitoring of elderly, provision of health treatments, interactions, logistical support, etc. fully GDPR compliant)
- ↳ **Better accessibility of the built environment and public spaces with seamless living and mobility patterns** (i.e. continuum of uses)
- ↳ Facilitating the deployment of low-cost solutions to adapt building features, integrated appliances and structure of existing buildings to the evolving needs of the occupants.
- ↳ Ensure the highest level of fire safety and encourage the use of fire resilient materials and systems in buildings occupied by elderly people so that to reduce their exposure to fire risks.
- ↳ Scaling up of **KPIs and certification framework for age-friendliness** of built environment, taking into account its potential to evolve
- ↳ **Reference measurement of wellbeing** in the built environment
- ↳ Integration of **ICT-based functions** in the built environment to better involve the elderly
Tools to assess and monitor the **progressive implementation of age-friendliness criteria** in local/national regulatory environments

Nature of activities required

Framework, Integration & demo - **IA & Large-scale pilots**

2021-2022, 2023-2024

Linked outputs

- 2.2 Sets of proven cost-effective, market-ready packages delivering buildings and infrastructure which are aligned to long term EU and global sustainability goals
- 13.2 Tools and guidance to measure and evaluate building and system performance against key public health metrics and key social and cultural value indicators

Budget (M€)

30

14. Solutions to foster dynamic and participative urban planning for sustainable buildings and communities

State of the art

- *Applicable findings from social sciences and REX from urban planning projects to involve citizen and manage co-creation processes,*
- *IT tools developed to manage participative processes*
- *IT tools available for awareness and education purposes (virtual, augmented reality)*

Topic scope

- ↳ **Scale up the use of digital systems** and social sciences findings to involve stakeholders and citizens in participative urban planning & design
- ↳ Scale up the **use of tools fostering awareness and education of citizens** as members of the city community (including the accessibility to Cultural Heritage via virtual reality, etc.)
- ↳ Scale up of initiatives such as One-Stop-Shop (in particular all-inclusive OSSs) increasing awareness raising and participatory actions towards renovation plans at community/urban levels
- ↳ Improvement of the understanding on the needs of the different building sector segments at local level to foster dynamic (avoid free riders).

Nature of activities required

R&D – RIA

Integration & demonstration / framework – IA & Large-scale pilots

2023-2024

Linked outputs

- 2.4 Evidence-based policy recommendations, guidance and best-practice to EU and Member States towards flexible policy objectives and regulatory frameworks
- 5.1 Solutions for stronger democratic participation, energy citizenship and new energy communities => Smart energy consumption in the built environment

Budget (M€)

70

15. Solutions for healthier indoor and outdoor environment (air quality, safety, thermal and audio-visual comfort) from building to neighbourhood scale

State of the art

Numerous ongoing technology developments, at diverse maturity stages

Topic scope

- ↘ **Active/passive solutions improving acoustical, thermal and hygrometric comfort**, natural and artificial **light**, minimizing vibrations and electro-magnetic fields, providing **pollutants monitoring and filtration** (e.g. filtering of smokes from biomass heating) enabling optimal visual access to outdoor and biophilic solutions
- ↘ Develop continuous **low-cost IAQ monitoring** to support building management strategies and optimise control algorithms
- ↘ Develop **comprehensive evaluation approach** for the indoor environmental quality optimising user perception, the interaction with the outdoor environment and enabling the optimal building envelope and HVAC integrated control.
- ↘ **Fire resilient solutions** to prevent the adverse effects a building fire can have on the environment (air and water pollution, carbon emissions etc).
- ↘ **Specific solutions for wildland-urban interface when it comes to fire risks:** e.g. keeping enough distances between buildings and the natural environment to ensure that fire does not spread from the environment to buildings and vice versa.
- ↘ **Self-cleaning**, self-healing, anti-slip and anti-fouling solutions
- ↘ New products and solutions that **diminish urban heat island effect**, including revegetation, and related **certification systems**, as well as innovative heating and cooling networks allowing to cope with heat dissipation “lost” into outdoor air
- ↘ **Revegetation and use of NBS** as a support to biodiversity (technical solutions and new governance) and resilience (e.g. heavy rains) (“renaturing cities” concepts) → AZ: should be part of this topic too, considering healthy aspects.
- ↘ Regulatory sandboxes to test regulatory innovations and market models (such as dynamic tariffs in a specific territory and DHC operator operate in balancing market) and the interconnection of electricity and heating markets at local level

Nature of activities required

R&D / Integration – RIA

2021-2024

Demo – IA

2025-2027

Linked outputs

- 6.4 Market and regulatory ready solutions to harness local heat sources, e.g. from excess heat, for close-by buildings and districts
- 13.1 Materials, products and designs that demonstrably improve key public health metrics

Budget (M€)

70

16. Solutions for smart and responsive buildings exploiting an improved knowledge of user experience (Building as a service)

State of the art

Numerous ongoing technology developments, at diverse maturity stages. Integration mainly at demo level so far.

- *Ongoing EU work on Smart Readiness Indicator for Buildings*
- *Postpone*
- *Needs reformulation*

Topic scope

- ↘ **Data analytics and self-learning algorithms based on users' preferences and physiological parameters**
- ↘ **Active and adaptative skins** (energy neutral solutions)
- ↘ **Sensors and actuators embedded** in the built environment; Smart and responsive thermostats
- ↘ **Real time comfort measurements**

Nature of activities required

Integration & demo (scaling up, industrialisation) – IA

2022-2024

Linked outputs

- 10.2 Solutions for smart and responsive buildings exploiting an improved knowledge of user experience (Building as a Service)
- 13.1 Materials, products and designs that demonstrably improve key public health metrics
- 13.2 Tools and guidance to measure and evaluate building and system performance against key public health metrics and key social and cultural value indicators

Budget (M€)

40

17. Solutions for the sustainable regeneration of urban and rural neighbourhoods

State of the art

- Numerous ongoing research and tests regarding regeneration strategies

Topic scope

- ↳ New urban development and **'smart growth' models for sustainable living**
- ↳ **New evidence-based strategies and digital tools to foster integrated urban transformation consistent with climate neutrality**
- ↳ New approaches to provide a **better connectivity and a new dynamism to rural and peri-urban areas** (“smart villages”)
- ↳ Novel strategies to **increase well-being and economic prosperity** of citizens in a climate neutral built environment.
- ↳ Approaches to promote smart infrastructure planning to increase connectivity
- ↳ Socio-economic studies to better understand and quantify the **potential of rural revitalisation through rebuilding with traditional and natural local material and nature-based solutions.**
- ↳ Business models for the development of green jobs and circular building solutions (e.g. local resources used as construction materials, ancestral building techniques, etc)
- ↳ *For participative urban planning see R&I 2.1*

Nature of activities required

R&D – RIA

2021-2022

Integration & demo (scaling up, industrialisation) – IA

2021-2022

Framework (business models, socio-economic studies) - – CSA

2023-2025

Linked outputs

- 13.2 Tools and guidance to measure and evaluate building and system performance against key public health metrics and key social and cultural value indicators
- 14.4 New technologies to allow an increase accessibility and inclusiveness of cultural assets and sites for all (3D modelling, virtual reality, augmented reality), along with innovative approaches to foster a better understanding by citizens of cultural heritage and its sociocultural value

Budget (M€)

50

18. Low-disruptive construction and retrofitting processes

State of the art

-

Topic scope

- ↘ Use of **nD BIM** (from 3D to 7D) with what-if scenarios and analysis of alternative solutions considering costs, energy performance, overall product and system performance (fire safety, acoustics, etc.) and disruption to users
- ↘ Low disruptive and cost-effective construction processes using **pre-fabrication**
- ↘ **Develop interoperable and standardised BIM environments** as an easily accessible building data repository, including simulation results and data collected by monitoring systems

Nature of activities required

R&D RIA

Integration & demo (scaling up & industrialisation) IA

Framework (business models)

IA & Large-scale pilots

2021-2022, 2023-2024, 2025-2027

Linked outputs

- 3.3 Solutions for anticipating (estimate / compute) and recording the future requirements for deconstructions and re-use of built assets (e.g. relocation loads, thermal insulation, re-use and reparability of components).

Budget (M€)

60

19. Solutions for a low carbon, resource efficient and resilient cultural heritage, from prevention and monitoring to maintenance and retrofit

State of the art

Ongoing R&D projects investigating solutions dedicated to cultural heritage (including industrial and technological heritage) restoration, where appropriate, and preservation

Topic scope

- ↳ Strategies and tools for the **adaptation of cultural heritage to new uses** when no longer serving the original functions, while maintaining its cultural value
- ↳ Solutions to **apply energy efficiency and RES** in historical buildings maintaining their heritage values, improving comfort and reducing management and costs
- ↳ **Novel materials, techniques and design codes** to improve structural safety, proper conservation and permanent maintenance of cultural heritage (including industrial and modern heritage), **with minimal intervention**
- ↳ Recovery and adaptation of **historic construction techniques and materials** for sustainable restoration
- ↳ **Cost-efficient retrofitting solutions** for historic buildings to reduce the risk of cultural heritage loss while lowering the maintenance costs – including **application of RES in historical buildings** maintaining their heritage values (e.g. artistic, historic, social and scientific).
- ↳ **New eco-design approaches for heritage maintenance**, monitoring and retrofitting (including LCA and BIM) and tools for **predictive maintenance** and preventative conservation tailored to cultural heritage specificities;
- ↳ Sustainable solutions and **novel materials, construction systems, techniques and design codes provide for improved resilience, durability and safety** (including fire safety and resilience) of historical buildings
- ↳ Strategies to **secure long-term provision and quality assurance** of heritage relevant materials (eg open source database of **heritage relevant materials**)
- ↳ More extensive **protection, safeguarding, preservation and valorisation strategies** of cultural heritage (e.g. as a mitigator of social pressures in multicultural environments)

Nature of activities required

R&D RIA

Integration & demo (scaling up & industrialisation) IA

2021-2022, **2023-2024, 2025-2027**

Linked outputs

- 4.1 Designs, materials and solutions to improve resilience, preparedness & responsiveness of the built environment to disruptive events
- 8.1 BIM-based solutions providing a GHG compass over the overall life-cycle of the building / infrastructure
- 14.1 Low carbon and durable materials, component packages and standardised solutions (well integrated to the local environment) for retrofitting cultural heritage (low tech, bio-based, locally sourced, or innovative materials compatible with traditional materials)
- 14.2 Strategies and tools for the adaptation of cultural heritage to long-term current and new uses while maintaining its cultural value, including sustainable solutions for improved resilience, durability and safety of historical assets and new business models for private/ end-user investment in cultural heritage for a better preservation and restoration of cultural BE assets

Budget (M€)

30

20. Sustainable renovation for a more open, accessible and inclusive cultural heritage, in a sustainable urban development

State of the art

- *Market available ICT technologies*
- *Numerous ongoing projects related to cultural heritage (including historical, industrial, technological and scientific heritage) apps*

Topic scope

- ↳ **Sustainable renovation solutions** to preserve cultural heritage assets with minimum environmental impact
- ↳ Provide the **highest level of fire safety** during maintenance and renovation works.
- ↳ Use of **ICT technologies** to allow **increase accessibility and inclusiveness** of cultural sites (3D modelling, virtual reality, augmented reality),
- ↳ **New cultural contents, services and 3D digital (and VR) reconstruction** of cultural assets for public access, as well as proposals for hybrid use (digital combined with physical solutions)
- ↳ **“Open sites”** to citizens/tourists enabling a better understanding of interventions for the safeguarding of the built heritage.
- ↳ Approaches to foster a better understanding by citizens of cultural heritage and its **sociocultural value**
- ↳ Strategies for sustainable renewal and operation of cultural heritage assets
- ↳ **Sustainable tourism strategies** at local, regional, national and transnational level, increasing local economic development, while respecting and improving citizen’s way of life
- ↳ Development of **monitoring campaigns** to measure the influence of over-tourism in the interior climate of built heritage

Nature of activities required

Integration & demo (scaling up, industrialisation) – **IA**

2021-2023

Socio-economic studies - **CSA**

2023-2025

Linked outputs

- 11.1 Socio economic studies to understand barriers at end user level for demand and investment, along proven marketing and awareness raising campaigns
- 14.4 New technologies to allow an increase accessibility and inclusiveness of cultural assets and sites for all (3D modelling, virtual reality, augmented reality), along with innovative approaches to foster a better understanding by citizens of cultural heritage and its sociocultural value

Budget (M€)

55

21. Standardisation framework and progressive regulation

State of the art

Complex standardization frameworks in the overall construction processes, but framework missing on data exchange.

- *Regarding data: Open standards are so far poorly adopted, and proprietary data formats and languages still dominate the market.*

Topic scope

- ↳ Develop and generalise a **standardisation framework for data, models, exchange protocols**, for testing and calculation methods for innovative materials, products and construction systems
- ↳ Tackle certification barriers in Europe (**transferability, interoperability, mutual recognition of certificates**).
- ↳ Scale up approaches for the **progressive implementation of regulation** with prior local tests with early adopters (implementation of regulatory sandboxes).

Nature of activities required

Framework - IA & Large-scale pilots

2023-2024

Linked outputs

- 2.4 Evidence-based policy recommendations, guidance and best-practice to EU and Member States towards flexible policy objectives and regulatory frameworks
- 12.1 Innovative solutions for technical quality control, standardization and certification of innovative materials, components and integrated BE

Budget (M€)

40

22. New public and private procurement approaches supporting the implementation of innovations and the performance-based contractual approach

State of the art

- *Guidelines and tools on Procurement of Innovation (EC; SCI on sustainable construction (ICLEI; EAFIP) and performance-based contracts*

Topic scope

- ↳ Improvement of the **performance of public procurement process** (speed of handling the process for instance with AI evaluation, increase quality, timing, efficiency).
- ↳ Approaches to **open up the market** for innovative technical, financial solutions and business models.

Nature of activities required

Framework – IA & Large-scale pilots

2023-2024

Linked outputs

- 2.5 Evidence-based innovation investment schemes and tools towards built environment owners and users to assess innovation integration business case and profitability
- 9.1 Frameworks for multiple CDW (Construction & Demolition Waste) reuse technical and economic viability at regional level (CDW streams, protocols and guidelines), with e.g. exchange platforms and services
- 13.3 Methodologies and tools for sustainability-integrated performance contracting for the built environment

Budget (M€)

30

23. Lifecycle-based asset management and holistic approach of buildings and infrastructures

State of the art

Ongoing initiatives for common framework for LCA-based Asset Management, focused on transport infrastructures

Topic scope

- ↳ **New risk management tools and approaches**, including new governance systems and **collaboration with the insurance industry and financiers**.
- ↳ **Asset management and life cycle approaches** to optimise costs of resilience (eg to climate and environmental factors, fire etc) of buildings and (transport) infrastructure networks
- ↳ Develop holistic approach of buildings and infrastructures by **linking with other networks** (district heating, water supply and sanitation, flood defence, transport and energy infrastructures)
- ↳ Develop “Circular by design” approach and tools

Nature of activities required

R&D – RIA

2023-2024, 2025-2027

Linked outputs

2.6 Tools for life cycle costing approach to evaluate the business case for innovative sustainable and circular solutions

Budget (M€)

25

24. Designs, materials and solutions to improve resilience, preparedness & responsiveness of the built environment to disruptive events

State of the art

Numerous ongoing projects addressing resilient cities

Topic scope

- ✎ **Europe-wide assessment methodologies, tools and metrics**, including numerical models, **to determine risks associated to climate change** (droughts, forest and urban fires, flooding, etc.) and to determine the resilience of the built environment to climate-related and other threats
- ✎ **Advanced, enhanceable materials and technologies** to combat the effects of Global Warming (increased cooling demand, heat island effects, etc.), and for increased durability, resilience and adaptability of buildings and infrastructures, including their foundations.
- ✎ **Monitoring and early warning systems**; mitigation strategies;
- ✎ **Real Time monitoring** and control systems for transport networks (standardization and technologies e.g. instrumented vehicles): digital resilience (cybersecurity; mitigation for uninterrupted service)
- ✎ Integration of **contingency planning** within urban planning
- ✎ **BIM and interoperable tools for monitoring, detection of critical situations**, support to reaction processes, evacuation of people and first responders
- ✎ Designing and documenting the **Fire Safety design in the planning phase by using BIM**
- ✎ **(Process) Methodologies, framework and tools for swift and safe resettlement of populations**
- ✎ **Self-sensing and adaptable materials**, structures and components with **embedded sensors and actuators**, durability and calibration of these sensors and actuators.
- ✎ **Integrated solutions for the design and/or renovation** of buildings, infrastructures and urban spaces aimed at **improving their safety and resilience** to natural disruptive events such as earthquakes and other seismic influences, floods, heat waves, extreme climatic events, fire and to combat the heat island effect. This should also include the design of ecosystem services to be provided by buildings and infrastructures.

Nature of activities required

R&D RIA

Integration & demo (scaling up & industrialisation) IA

2021-2022, 2023-2024

Linked outputs

- 3.3 Solutions for anticipating (estimate / compute) and recording the future requirements for deconstructions and re-use of built assets (e.g. relocation loads, thermal insulation, re-use and reparability of components).
- 4.2 New standards and tools to integrate data on future climate conditions and risks (adaptation to climate change) into all aspects of decision making along the built environment value chain.
- 10.1 New standards and tools to integrate data on future climate conditions and risks (adaptation to climate change) into all aspects of decision making along the built environment value chain.
- 14.2 Strategies and tools for the adaptation of cultural heritage to long-term current and new uses while maintaining its cultural value, including sustainable solutions for improved resilience, durability and safety of historical assets and new business models for private/ end-user investment in cultural heritage for a better preservation and restoration of cultural BE assets

Budget (M€)

45

25. Effective new processes, business models and financing mechanisms supporting integration within the construction value chain and with other sectors

State of the art

-

Topic scope

- ↳ **Supply chain integration tools** (platforms)
- ↳ **One-stop shops concepts** on B2B and B2C (re-use, renovation, recyclable materials...)

Nature of activities required

Integration & demo IA

Integration **2023-2025**

Linked outputs

- 9.2 Support for new market actors as recycling and material handling companies (including urban mining companies), on-line trading service providers, etc., with new instruments (financing, green procurement, labelling, standards, BREs & guidelines) to stimulate the integration of CDW (and other waste) business in the construction ecosystem, with better valuation of externalities of waste management and better understanding of local resource streams
- 11.2 Demonstrated and replicated set of financing and incentive mechanisms and packages created and tested on local scales, to make renovation/adaptation affordable and with proved RoI

Budget (M€)

35

26. Models and digital tools for better-informed decision making on investments and improved risk management for the built environment

State of the art

- Existing documents / plans (/ frameworks e.g. Worldbank, OECD) on Infrastructure Prioritization and governance
- Available data analytics and AI tools for analysis and predictions, not specific applications to construction
- Prototypes of decision-making tools, but running on partial datasets

Topic scope

- ↳ **Data collection and analytics tools** (big data, AI, Machine Learning) to support decision making and prioritisation on investments (risk assessment, long term prediction) and include fire risk into assessments.
- ↳ **ICT, data collection, analytical tools and AI algorithms for decision-making** on investment in the built environment (risk assessment, long term predictions etc) taking a whole life cycle approach
- ↳ **BIM-based digital tools** for renovation optimisation and investment de-risking
- ↳ New / improved models **linking material performance, durability and service life with CAPEX and OPEX.**
- ↳ Methodological approach for **single owner or multi-owner building stock transformation** with the aim to define priorities and identify technological solutions

Nature of activities required

R&D RIA

Integration & demo (scaling up & industrialisation) IA

Framework (business models, policy)

IA, CSA & Large-scale pilots

2021-2022, 2023-2024

Linked outputs

- 3.2 Tools and methodologies to simplify the holistic assessment of environmental and social impacts of materials, components and processes during the design and delivery stages of built environment projects.
- 4.1 Designs, materials and solutions to improve resilience, preparedness & responsiveness of the built environment to disruptive events
- 4.4 Tools and guidance to support, and to demonstrate the value of, wider deployment of social impact tracking and ESG reporting for all actors in the built environment value chain.
- 9.3 Digital solutions that support and ease the repurpose and re-use of buildings, infrastructure and components throughout the whole lifecycle (Reusable BIM) – including BIM objects for the new building design equally sourced from the product manufacturers and second-hand material dealers
- 11.3 Tools to streamline ESG reporting and disclosure of performance on investments in built environment assets at portfolio level

Budget (M€)

95

27. Effective new services for on-site/off site surveillance and monitoring of buildings and infrastructures in construction and in use

State of the art

-

Topic scope

- ↘ Integrate the use of **robots, drones, sensors, IoT, sensorised components** to develop new on-site processes and services, including **safety, surveillance and quality control and integration with BIM**
- ↘ Risk and observational based design and maintenance, for a better understanding of the behaviour of resilient infrastructure (including the supporting geo-structures)
- ↘ New approaches, tools, sensors and algorithms to **speed up the quality controls for the reception of the building works** and processes and minimise downtime

Nature of activities required

R&D – RIA

Integration & demo (scaling up, industrialisation) – IA

2023-2024

Linked outputs

12.1 Innovative solutions for technical quality control, standardization and certification of innovative materials, components and integrated BE

Budget (M€)

40

28. Holistic data-based approach, from tendering to the end of life

State of the art

- *Prototypes of decision-making tool for planning*
- *BIM-Based quality check*
Marketplaces bringing together building owners and SMEs

Topic scope

- ↳ **Interoperable tools** (with BIM, IoT, data analytics, AI) and systems along the value chain
- ↳ **BIM-based marketplace** bringing together all the stakeholders
- ↳ **BIM adaptation for life cycle management and circular economy**, including the tracking of building materials, data collection, storage and processing models/tools on materials and compounds to predict durability, facilitate reuse and recycling
- ↳ **BIM adaptation** and roll-out for **cultural heritage, Digital twin** of cultural assets
Supporting activities for the widespread adoption of BIM (guidelines for BIM implementation at scale, contribution to standards, sharing of knowledge and experience)

Nature of activities required

R&D RIA

Integration & demo (scaling up & industrialisation) IA

Framework (business models)

IA & Large-scale pilots

2021-2022, 2023-2024

Linked outputs

- 3.2 Tools and methodologies to simplify the holistic assessment of environmental and social impacts of materials, components and processes during the design and delivery stages of built environment projects.
- 9.3 Digital solutions that support and ease the repurpose and re-use of buildings, infrastructure and components throughout the whole lifecycle (Reusable BIM) – including BIM objects for the new building design equally sourced from the product manufacturers and second-hand material dealers
- 14.3 New eco-design standards/requirements for heritage maintenance and retrofitting (including LCA and BIM)

Budget (M€)

75

29. Digital innovation in performance-based procurements

Note: this topic could be merged in other procurement topics and be developed in those projects.

State of the art

- *Pilot initiatives at EU and regional scale to validate new schemes for procurement of innovations*
- *Smart contracts and blockchain approaches at prototype scale*

Topic scope

- ↳ **Micro-payments**, automated payments with **smart contracts**
- ↳ **Blockchain based platform/ marketplace**

Nature of activities required

R&D - RIA

Integration & demo IA

2023-2024

Linked outputs

- 9.3 Digital solutions that support and ease the repurpose and re-use of buildings, infrastructure and components throughout the whole lifecycle (Reusable BIM) – including BIM objects for the new building design equally sourced from the product manufacturers and second-hand material dealers
- 13.3 Methodologies and tools for sustainability-integrated performance contracting for the built environment

Budget (M€)

75

30. EU-wide open databases and Data Management Platforms on the performance of the built environment

State of the art

- *Access to data is today complex and fragmented*
- *Variety of platforms/ data repository and format used (providing aggregated data)*
- *Proposition of common data frameworks*

Topic scope

- ↳ EU-wide **open observatory on the existing building stock**, database on buildings and districts energy profiles
- ↳ EU-wide **open database on the vulnerability of infrastructures and buildings**
- ↳ **Data management platforms**, with robust models and data management procedures
- ↳ EU-wide **open platform for collecting and sharing information about accidental fires**, their causes, casualties, economic, societal, and environmental damages

Nature of activities required

R&D RIA

Integration & demo (scaling up & industrialisation) IA

Framework (business models, policy)

IA

CSA

2023-2024

Linked outputs

- 8.3 Development and measures to accelerate and scale up the adoption of digital certification (such as Energy Performance Certificates) with longer commissioning and condition-based maintenance to replace maintenance contracts
- 11.3 Tools to streamline ESG reporting and disclosure of performance on investments in built environment assets at portfolio level
- 12.3 Advanced tools and guidance to improve smart readiness in the built environment
- 13.2 Tools and guidance to measure and evaluate building and system performance against key public health metrics and key social and cultural value indicators
- 14.2 Strategies and tools for the adaptation of cultural heritage to long-term current and new uses while maintaining its cultural value, including sustainable solutions for improved resilience, durability and safety of historical assets and new business models for private/ end-user investment in cultural heritage for a better preservation and restoration of cultural BE assets

Budget (M€)

60

31. Big data-based building and infrastructure real-time management, monitoring and maintenance,

State of the art

- *Prototypes of Digital Twins*
- *BIM used in the planning and construction phase but not in operation/maintenance*
- *No full interoperability between software, sensors, etc. (e.g. IFC standard not fully functional)*

Topic scope

- ↳ **Real-time Digital Twins** to reduce the performance gap, **BIM platforms**
- ↳ **Artificial Intelligence** for optimised building control, Smart Grid integration (Demand Response), risk-based (subsoil) condition assessment and predictive maintenance, fault detection, robotic devices for monitoring, integrated with BIM
- ↳ **Improvement/validation of sensor integration into materials and structures** to improve the accuracy and reliability of monitoring systems
- ↳ **High-resolution calibration of physics-based models with big-data** (to better describe flexibility, energy performance, human behaviour, and comfort)
- ↳ **Interoperable, plug& play and robust ICT systems** for asset management including eg self-monitoring and/or biomimetic structures

Nature of activities required

R&D RIA

Integration & demo (scaling up & industrialisation) IA

Framework (business models)

IA & Large-scale pilots

2021-2022, 2023-2024, 2025-2027

Linked outputs

- 3.2 Tools and methodologies to simplify the holistic assessment of environmental and social impacts of materials, components and processes during the design and delivery stages of built environment projects.
- 11.3 Tools to streamline ESG reporting and disclosure of performance on investments in built environment assets at portfolio level
- 14.3 New eco-design standards/requirements for heritage maintenance and retrofitting (including LCA and BIM)

Budget (M€)

80

32. Development and Integration of approaches for reducing space and materials

State of the art

- *Scattered concepts testing and implementation lacking measurement of impact and an overall integration of different reduce perspectives.*

Topic scope

- ↳ Multiuse, space as a service, design with more durability, flexibility for conversion, design out waste, development of less complex building components products and systems.
- ↳ Less complex product and materials in future buildings --- easier to collect, separate and recycle, and more resource efficient contributing to the carbon neutrality. As example monomaterial structures: e.g. PLA fibres + PLA polymers together, or cellulose polymers + cellulose fibres.
- ↳ Approaches and solutions that decrease the complexity of products and systems, minimising numbers of different materials and reducing the usage of components with permanently joined layers of different materials
- ↳ Building components with durability and performance, less complex materials, less layers - monomaterials.
- ↳ Lego Building – modular construction.

Nature of activities required

RIA targeting the development of monomaterials and respective integration on components.

2023 - 2024

Demo targeting to measure impacts and collect evidence for replication – IA

2024 – 2027

Linked outputs

- 9.2 Support for new market actors as recycling and material handling companies (including urban mining companies), on-line trading service providers, etc., with new instruments (financing, green procurement, labelling, standards, BREs & guidelines) to stimulate the integration of CDW (and other waste) business in the construction ecosystem, with better valuation of externalities of waste management and better understanding of local resource streams

Budget (M€)

40

33. Tools to support designing out waste and compile information on products at property level based on all life-cycle support.

State of the art

- *In line with logbook*
- *Could fit in it*

Topic scope

- ↘ **Life time BIM:** tools for support designing out waste through all its perspectives on reuse and recovery, deconstruction/flexible re-use, off-site construction and materials optimization, for resource-efficiency.
- ↘ Development of **tools and data dictionary/ data bank services** to compile information on products at property level based on all life-cycle support including formats and standards as e.g. new Product information (with property data) structures, based on data-format standards (IFD).
- ↘ Development of **BIM protocols and guidelines for sustainable use cases** based on process standards (IDM) and development of semantic standards (IFC, CityGML etc.) for strengthening open interoperable approaches of information management in EU countries

Nature of activities required

RIA

2024 – 2027

Linked outputs

- 9.3 Digital solutions that support and ease the repurpose and re-use of buildings, infrastructure and components throughout the whole lifecycle (Reusable BIM) – including BIM objects for the new building design equally sourced from the product manufacturers and second-hand material dealers

Budget (M€)

30

34. New value chain-based services for the end user

State of the art

Topic scope

- ↳ Enabling **real-time services** – relying on built environment (public and private) data, and acting as data providers and support for data generation for people everyday activities
- ↳ **New skills & services especially on the critical layers missing:** product modelling, digitalisation, testing and certification. Data mining (as providers to 1-stop-shop), One-stop-shop service to the waste (renovation and demolition projects). Actions should target piloting & scale up as well as to create cooperation between research and business through Innovation ecosystems.
- ↳ Optimisation of the **integration of the value chain for energy efficient solutions** implementation in new and existing buildings

Nature of activities required

IA

2023-2024

Linked outputs

- 9.5 New services (including also from new start-ups) with people-in-value-chain perspective services.
Enabling real-time services – relying on buildings and infrastructure data, and acting as data providers and support for data generation for people everyday activities

Budget (M€)

15

35. Methodologies and tools for zero-carbon works – including requirements and business-models supporting the transition to zero- carbon civil works vehicles and protocols

State of the art

-

Topic scope

- ↳ Development and demonstration of **fossil free & carbon neutral construction vehicles and equipment** and integration with portable RES and battery storage technologies vehicles / machines / machinery / equipment, resolving safety challenges of these systems, especially when used at wide-scale
- ↳ New tools and data to improve the **quantification of environmental impacts of construction and demolition** phases and benefits of zero carbon construction sites
- ↳ Demonstrate **feasibility and business case for investment** in conversion of existing equipment to fossil free technologies

Nature of activities required

R&D RIA

Integration & demo (scaling up & industrialisation) IA

2021-2024

Linked outputs

- 3.5 Methodologies and tools for zero-carbon works – including requirements and business-models supporting the transition to zero- carbon civil works vehicles and protocols

Budget (M€)

30

36. Strengthening European Cross-Border Value Chains for innovation uptake in sustainable built environment

State of the art

-

Topic scope

- ↳ Link up the concept of Construction Innovation Cluster with regional/national innovation hubs and clusters to improve collaboration,
- ↳ Reinforce specialisation and advanced expertise for Cross-Border Value Chains and offer the best possible R&I support to all actors of the European Construction ecosystem, and in particular for SMEs and mid-caps everywhere in Europe, as well as their stakeholders and clients.
- ↳ The action will include putting in place a long-term network structure for those clusters, along with an appropriate governance, and with the intention to focus and nurture public investments that would serve several regions of Europe. It will also support the organisation of supporting dissemination (including workshops, conferences, industrial fora, dissemination material, etc.) and the development of a organisation and business model for collaboration among these clusters.

For this support action, a close cooperation with the ECTP network of National Technology Platforms and cross-border/cross-sectoral clusters, as well as with the WGBC European network is anticipated.

Nature of activities required

CSA

2021-2022

Linked outputs

-

Budget (M€)

3

37. Predictive and integrated maintenance and facility management solutions and processes

State of the art

- *Prediction models with limited reliability*
- *On the shelf technology for real time monitoring*
- *Several ongoing EU R&D projects for predictive maintenance tools, not specific to construction or built environment*

Topic scope

- ↘ **Modelling of the impact of ageing, natural hazards, man-made threats, climate change** on the built environment and identification of future needs (e.g. cooling); on the built environment; prediction of performances over whole life cycle, potential for reparability.
- ↘ Integration of **IoT, sensors, automation systems for smart monitoring** and automated maintenance in manufacturing processes and in the built environment
- ↘ **Non-destructive diagnosis**: development and validation of an integrated, robust and non-destructive evaluation system (e.g. integration of different type of non-destructive techniques – *ultrasounds, infrared cameras*, etc.) to be calibrated and correlated to destructive test.

Nature of activities required

R&D RIA

Integration & demo (scaling up & industrialisation) IA

2023-2024, 2025-2027

Linked outputs

- 4.2 New standards and tools to integrate data on future climate conditions and risks (adaptation to climate change) into all aspects of decision making along the built environment value chain.
- 10.1 Products designed to survive harsh conditions / disruptive events in several lifecycles

Budget (M€)

40

38. Interactive operation and management of city assets

State of the art

-

Topic scope

Use of **digital tools and apps** to:

- ↳ support **new services for the citizen and the city** (transport, health, car parks, waste management)
- involve stakeholders and citizens in energy and performance monitoring and maintenance of buildings**

Nature of activities required

Integration & demo (scaling up & industrialisation) **IA & large-scale pilots**

Framework (business models)

IA

2023-2024

Linked outputs

10.2 Solutions for smart and responsive buildings exploiting an improved knowledge of user experience (Building as a Service)

Budget (M€)

30

LIFE PROGRAM

39. Green procurements and new business models for renovation supported by decision-making tools

State of the art

Holistic and integrated business models (in particular One Stop Shop, Energy Performance Contracting) and smart financing initiatives (e.g. green mortgages, third party financing) have been successfully demonstrated but their uptake and replication are slow and the perception of investment risk remains high.

Topic scope

- ↳ New green procurements to accelerate deep renovation of buildings and matching with renewable electricity and heating and cooling supply for optimal efficiency and cost-optimisation, as well as the renovation/ adaptation of infrastructures to new transport solutions. Applications for low cost social housing regeneration
- ↳ Scale-up of integrated user-centred renovation services involving all relevant stakeholders in the value chain (design, financing, suppliers, contractors, owners, utilities, etc.)
- ↳ Tools based on digital twins to secure renovation investments by reducing the performance gap and lowering the investment risk
- ↳ Socio-economic studies to better understand and quantify the non-financial co-benefits of renovation for buildings and infrastructure (social e.g. health, comfort, well-being, productivity, and environmental) and develop multi-vectoral Cost Benefit Analysis. Integrating the EU's Level(s) framework indicators.
- ↳ New contractual models for commissioning and to extend the developer/ contractor responsibility for long-term efficiency
- ↳ District decision-making tool for assessing the energy performance and planning renovation at district scale, using for instance cadastral data and locally available energy sources

Nature of activities required

Integration & demo (scaling up) – IA

2021-2022

Framework (socio economic studies, business models) – CSA

2023-2024

Linked outputs

- 1.4 National implementation plans for the EU Sustainable Finance Action plan and the EU Green Taxonomy for buildings
- 11.1 Socio economic studies to understand barriers at end user level for demand and investment, along proven marketing and awareness raising campaigns
- 11.2 Demonstrated and replicated set of financing and incentive mechanisms and packages created and tested on local scales, to make renovation/adaptation affordable and with proved RoI
- 12.2 Socio-economic valuation methods for buildings and infrastructures renovation
- 13.3 Methodologies and tools for sustainability-integrated performance contracting for the built environment

Budget (M€)

50

40. Financing schemes and business models for holistic renovation services (energy, accessibility, comfort)

State of the art

Diverse innovative financing mechanisms have already been developed and are implemented across Europe.

Topic scope

- ↳ Enhancement and replication of the different financing and incentive mechanisms created and tested on local scales, to **make renovation affordable**
- ↳ Socio economic studies to **understand barriers at end user level and financial incentives that can drive decision to renovate** - including better understanding on how to tailor financial incentives to the different segments of the building sector, prioritising those more likely to trigger renovation decision.
- ↳ Targeted **marketing and awareness raising campaigns**
- ↳ Develop specific financial tools for multi-apartments buildings and district-level renovation coupled with development and use of local renewables

Nature of activities required

Framework – IA & Large-scale pilots

2023-2024, 2025-2027

Linked outputs

- 2.5 Evidence-based innovation investment schemes and tools towards built environment owners and users to assess innovation integration business case and profitability
- 11.1 Socio economic studies to understand barriers at end user level for demand and investment, along proven marketing and awareness raising campaigns
- 12.2 Socio-economic valuation methods for buildings and infrastructures renovation

Budget (M€)

40

4.2 Budget summary

BUDGET SUMMARY – Horizon Europe

#	Topic	Relevance to other clusters (% budget share)	Cluster 5 relevance (% budget share)	Partners contribution (M€/%) <i>RIA & CSA: 100%</i> <i>IA: 70% for industry</i>	Budget (%€)	Budget (M€)	OUTPUT Links	Activity Type ²
1	Cost-effective multi-functional and/or prefabricated holistic renovation packages, integrating RES	25 (C4)	75	12.5	4.1	75	1.1	IA, CSA
2	Demonstrating integrated technology packages with performance guarantees		100	3	1.1	20	1.2, 5.4, 11.2, 12.3, 13.3	IA, CSA
3	Smart-grid ready and smart-network ready buildings, acting as active utility nodes		100	5.5	1.9	35	1.3, 5.2, 5.4, 6.1, 6.3, 10.2	IA, CSA
4	Multi-modal transport hubs and urban mobility infrastructures		100	3	1.6	30	1.3, 5.3, 7.1	RIA, IA, CSA,
5	Certified future sustainable and durable construction innovative products and systems, including re-used and recycled materials	50 (C4)	50	7	4.1	75	2.1	RIA, IA,
6	Tools to facilitate a life cycle-based approach that foster alignment with EU Level(s) framework indicators	25 (C4)	75	9	3.0	55	2.3, 4.2, 4.3, 8.1, 8.4, 12.3	IA, CSA
7	Interoperable components for positive energy blocks and districts, including a better integration of local renewables <i>(Coordination with DUT)</i>		100	6	3.3	60	5.1, 6.2, 7.2	RIA, IA,

² RIA = Research and Innovation Action; IA = Innovation Action; CSA = Coordination and Support Action

8	Optimal solutions to adapt existing neighbourhoods to new transport patterns		100	12.5	4.1	75	4.2, 5.3, 7.1	IA, CSA
9	New approaches to circular economy (for both technology-based & nature-based solutions)	50 (C4, C6)	50	12	3.8	70	4.1, 6.2, 6.4	IA,
10	Integration of construction and demolition waste in new constructions and industrial and regional symbiosis	50 (C4)	50	8	3.3	60	3.1, 9.1	IA, Pilots,
11	More sustainable buildings with reduced embodied energy and high performance to reduce the life cycle trades-off	25 (C4, C6)	75	9	2.7	50	3.1, 14.1	IA, Pilots,
12	New designs of buildings, infrastructures, multimodal hubs and public spaces for accessibility and inclusiveness		100		1.6	30	2.2, 7.1, 10.3	RIA
13	Solutions for the ageing population, including new services from home	50 (C2)	50	5.5	1.6	30	2.2, 13.2	IA, Pilots
14	Solutions to foster dynamic and participative urban planning for sustainable buildings <i>(Coordination with DUT)</i>	50 (C2)	50	9	3.8	70	2.4, 5.1	IA, Pilots
15	Solutions for healthier indoor and outdoor environment (air quality, safety, comfort) from building to neighbourhood scale	50 (C4, C6)	50	9	3.8	70	6.4, 13.1	RIA, IA
16	Solutions for smart and responsive buildings exploiting an improved knowledge of user experience (Building as a service)	25(C4)	75	7	2.2	40	10.2, 13.1, 13.2	IA
17	Solutions for the sustainable regeneration of urban and rural neighbourhoods	25 (C6)	75	9	2.7	50	13.2, 14.4	IA, CSA

	(Coordination with DUT)							
18	Low-disruptive construction and retrofitting processes	75 (C4)	25	9	3.3	60	3.3	RIA, IA, Pilots
19	Solutions for a low carbon, resource efficient and resilient cultural heritage, from prevention and monitoring to maintenance and retrofit	25 (C2)	75	3.5	1.6	30	4.1, 8.1, 14.1, 14.2	RIA, IA
20	Sustainable renovation for a more open, accessible and inclusive cultural heritage, in a sustainable urban development	75 (C4, C2)	25	8	3.0	55	11.1, 14.4	IA, CSA
21	Standardization framework and progressive regulation	50 (C4)	50	7	2.2	40	2.4, 12.1	IA, Pilots
22	New public and private procurement approaches supporting the implementation of innovations and the performance-based contractual approach	75 (C4)	25	5.5	1.6	30	2.5, 9.1, 13.3	IA, pilots
23	Lifecycle-based asset management and holistic approach of buildings and infrastructures	75 (C4)	25		1.4	25	2.6	RIA
24	Designs, materials and solutions to improve resilience, preparedness & responsiveness of the built environment to disruptive events	50 (C4, C6)	50	4.5	2.5	45	3.3, 4.2, 10.1, 14.2	RIA, IA
25	New processes, business models and financing mechanisms supporting integration within the construction value chain and with other sectors	100 (C4)		6	1.9	35	9.2, 11.2	IA
26	Models and digital tools for better-informed decision making on investments and improved risk management for the built environment	75 (C4)	25	4.5	5.2	95	3.2, 4.1, 4.4, 9.3, 11.3	IA, RIA, Pilots

27	New services for on-site/off site surveillance and monitoring of buildings and infrastructures in construction and in use.	75 (C4)	25	4.5	2.2	40	12.1	IA
28	Holistic data-based approach, from tendering to the end of life	75 (C4)	25	9	4.1	75	3.2, 9.3, 14.3	RIA, IA, Pilot
29	Digital Innovation in procurements	75 (C4)	25	8	4.1	75	9.3, 13.3	RIA, IA
30	EU-wide open databases and Data Management Platforms on the performance of the built environment	25 (C4)	75	5.5	3.3	60	8.3, 11.3, 12.3, 13.2, 14.2	RIA, IA, CSA
31	Big data-based building and infrastructure real-time management, monitoring and maintenance	75 (C4)	25	7.5	4.4	80	3.2, 11.3, 14.3	RIA, IA, Pilot
32	Development and Integration of approaches for reducing space and materials	75 (C4, C6)	25	4.5	2.2	40	9.2	RIA, IA
33	Tools to support designing out waste and compile information on products at property level based on all life-cycle support.	75 (C4, C6)	25		1.6	30	9.3	RIA
34	New value chain-based services for the end user	75 (C4)	25	3	0.8	15	9.5	IA
35	Methodologies and tools for zero-carbon works – including requirements and business-models supporting the transition to zero- carbon civil works vehicles and protocols	25 (C4)	75	3	1.6	30	3.5	RIA, IA
36	Strengthening European Cross-Border Value Chains for innovation uptake in sustainable built environment		100		0.2	3		CSA
37	Predictive and integrated maintenance solutions and processes	100 (C4)		4.5	2.2	40	4.2, 10.1	RIA, IA

38	Interactive operation and management of city assets	50 (C4)	50	5.5	1.6	30	10.2	IA, Pilots
TOTAL		≈45%	≈55%	230M (13%)	100%	1828M		

Figure 2: Research and Innovation topics and budget allocation

BUDGET SUMMARY – LIFE

#	Topic	Budget (%€)	Budget (M€)	OUTPUT Links	Activity Type ³
39	Green procurements and new business models for renovation supported by decision-making tools	4.9	40	1.4, 11.1, 11.2, 12.2, 13.3	IA, CSA
40	Financing schemes and business models for holistic renovation services (energy, accessibility, comfort)	1.6	40	2.5, 11.1, 12.2	IA, Pilots

³ RIA = Research and Innovation Action; IA = Innovation Action; CSA = Coordination and Support Action

4.3 Partnership specific objectives, outcomes, outputs and topics

Specific Objective A: Develop holistic solutions in a systemic approach

Outcome 1 Substantial **energy or resource efficiency gains** triggered by systemic innovations for application in the built environment

- Output 1.1 Breakthrough **systemic and integration-ready (packaged) solutions** for more sustainable buildings or infrastructure across the whole life cycle, including embodied and operational impacts

1	Cost-effective multi-functional and/or prefabricated holistic renovation packages, integrating RES
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- Output 1.2 Comprehensive and **validated methodologies and tools for the assessment** of the built environment (as an integrated system of systems) performance in terms of resource efficiency

2	Demonstrating integrated technology packages with performance guarantees
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- Output 1.3 Integrated and **cross-sectoral planning and management** for sustainable built environment, including district-level energy planning

3	Smart-grid ready and smart-network ready buildings, acting as active utility nodes
4	Multi-modal transport hubs and urban mobility infrastructures

- Output 1.4 **National implementation plans** for the EU Sustainable Finance Action plan and the EU Green Taxonomy for buildings

39	Green procurements and new business models for renovation supported by decision-making tools
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Outcome 2 **Increased economic activity** for the actors integrating the systemic innovation solutions and a **shift to mainstreaming life cycle costing approaches.**

- Output 2.1 **Certified, industrialised and market-ready multifunctional (passive & active) prefabricated turnkey packages** (component or system)

5	Certified future sustainable and durable construction innovative products and systems, including re-used and recycled materials
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- Output 2.2 **Sets of proven cost-effective, market-ready packages** delivering buildings and infrastructure which are aligned to long term EU and global sustainability goals

12	New designs of buildings, infrastructures, multimodal hubs and public spaces for accessibility and inclusiveness
13	Solutions for the ageing population, including new services from home

- Output 2.3 **Demonstrated new optimal circular value chains** through construction & supply-chain clusters and living labs

6	Tools to facilitate a life cycle-based approach that foster alignment with EU Level(s) framework indicators
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- Output 2.4 **Evidence-based policy recommendations, guidance and best-practice** to EU and Member States towards flexible policy objectives and regulatory frameworks

14	Solutions to foster dynamic and participative urban planning for sustainable buildings (Coordination with DUT)
21	Standardization framework and progressive regulation

- Output 2.5 **Evidence-based innovation investment schemes** and tools towards built environment owners and users to assess innovation integration business case and profitability

22	New public and private procurement approaches supporting the implementation of innovations and the performance-based contractual approach
40	Financing schemes and business models for holistic renovation services (energy, accessibility, comfort)

- Output 2.6 **Tools for life cycle costing approach** to evaluate the business case for innovative sustainable and circular solutions

23	Lifecycle-based asset management and holistic approach of buildings and infrastructures
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Specific Objective B: Demonstrate **overall performance in the life-cycle perspective**

Outcome 3 Increase the overall impact of built environment innovative solutions on environment and climate – **decreasing carbon footprint and increasing carbon handprint**

- Output 3.1 Novel and **multifunctional materials** with improved life cycle, along with material **labelling according to lifecycle performance**

10	Integration of construction and demolition waste in new constructions and industrial and regional symbiosis
11	More sustainable buildings with reduced embodied energy and high performance to reduce the life cycle trades-off

- Output 3.2 **Tools and methodologies to simplify the holistic assessment of environmental and social impacts** of materials, components and processes during the design and delivery stages of built environment projects.

26	Models and digital tools for better-informed decision making on investments and improved risk management for the built environment
28	Holistic data-based approach, from tendering to the end of life
31	Big data-based building and infrastructure real-time management, monitoring and maintenance

- Output 3.3 Solutions for anticipating (estimate / compute) and recording the future requirements for **deconstructions and re-use of built assets** (e.g. relocation loads, thermal insulation, re-use and reparability of components).

18	Low-disruptive construction and retrofitting processes
24	Designs, materials and solutions to improve resilience, preparedness & responsiveness of the built environment to disruptive events

- Output 3.4 Protocols and associated **tools for testing and certification of materials and components for reuse with non-destructive or minimum invasive testing.**

- Output 3.5 **Methodologies and tools for zero-carbon works** – including requirements and business-models supporting the transition to zero- carbon civil works vehicles and protocols

35	Methodologies and tools for zero-carbon works – including requirements and business-models supporting the transition to zero- carbon civil works vehicles and protocols
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Outcome 4 Increase the **resilience of the built environment** to protect and enhance social, environmental and economic value in the future

- Output 4.1 **Designs, materials and solutions to improve resilience, preparedness & responsiveness** of the built environment to disruptive events

9	<i>New approaches to circular economy (for both technology-based & nature-based solutions)</i>
19	<i>Solutions for a low carbon, resource efficient and resilient cultural heritage, from prevention and monitoring to maintenance and retrofit</i>
26	<i>Models and digital tools for better-informed decision making on investments and improved risk management for the built environment</i>

- Output 4.2 **New standards and tools to integrate data on future climate conditions and risks (adaptation to climate change)** into all aspects of decision making along the built environment value chain.

6	Tools to facilitate a life cycle-based approach that foster alignment with EU Level(s) framework indicators
8	Optimal solutions to adapt existing neighbourhoods to new transport patterns
24	Designs, materials and solutions to improve resilience, preparedness & responsiveness of the built environment to disruptive events
37	Predictive and integrated maintenance solutions and processes

- Output 4.3 **Rich and open datasets for LCA in the construction sector**, with clear methodologies and guidance for applying multicriteria decision-making techniques (such as reference service life of buildings and their components, end of life scenarios)

6	Tools to facilitate a life cycle-based approach that foster alignment with EU Level(s) framework indicators
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- Output 4.4 **Tools and guidance to support**, and to demonstrate the value of, wider deployment of social impact tracking and **ESG reporting** for all actors in the built environment value chain.

26	Models and digital tools for better-informed decision making on investments and improved risk management for the built environment
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Specific Objective C: Demonstrate **clean energy transition potential**

Outcome 5 Energy demand **reduce consumption, increase flexibility** to accommodate more renewables, give the benefit to citizens by paying less, reduce energy poverty

- Output 5.1 Solutions for stronger **democratic participation, energy citizenship and new energy communities => Smart energy consumption in the built environment**

7	Interoperable components for positive energy blocks and districts, including a better integration of local renewables (Coordination with DUT)
14	Solutions to foster dynamic and participative urban planning for sustainable buildings (Coordination with DUT)

- Output 5.2 **Smart products and energy management systems for more flexible demand**. Solutions for additional flexibility on the demand side, including demand response and local storage.

3	Smart-grid ready and smart-network ready buildings, acting as active utility nodes
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- Output 5.3 **Sector integration solutions arising from electric mobility**, integrating the charging point and the battery of the vehicles in the local power system.

4	Multi-modal transport hubs and urban mobility infrastructures
8	Optimal solutions to adapt existing neighbourhoods to new transport patterns

Outcome 6 Increased **local production buildings and districts** as producers of energy and owners, citizens and communities of the local energy system producing energy and beneficiaries of the energy (local) value chain.

- Output 6.1 Guidance and business models (demonstrations/pilots) **integrating individual owners and energy communities as beneficiaries and part of the value chain**. Prosumers should directly receive value for the produced energy, with more and more real-time based systems and pricing.

3	Smart-grid ready and smart-network ready buildings, acting as active utility nodes
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- ~~Output 8.1 BIM based solutions providing a GHG compass over the overall life cycle of the building / infrastructure~~
- Output 6.2 **Energy management systems and storage solutions** for positive energy buildings and retrofits supporting grid flexibility and coupling solutions for electricity and heating.

7	Interoperable components for positive energy blocks and districts, including a better integration of local renewables (Coordination with DUT)
9	New approaches to circular economy (for both technology-based & nature-based solutions)

- Output 6.3 **Market and regulatory ready solutions for micro-grid to share self-produced energy** within blocks buildings

3	Smart-grid ready and smart-network ready buildings, acting as active utility nodes
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- Output 6.4 Market and regulatory ready solutions to **harness local heat sources**, e.g. from excess heat, for close-by buildings and districts

9	New approaches to circular economy (for both technology-based & nature-based solutions)
15	Solutions for healthier indoor and outdoor environment (air quality, safety, comfort) from building to neighbourhood scale

Outcome 7 Energy Transition boost, supply and integrate in the built environment, in a sustainable way, the **needed supporting network infrastructure for the energy transition**, both for stationary and transport sectors.

- Output 7.1 Evidence-based guidance and demonstration of **built environment solutions to create the infrastructure and support business cases for the private sector** as e.g. recycling, electrification, district energy, transport and storage of CO₂, refilling stations for H₂, charging stations for electric cars, energy storage

4	Multi-modal transport hubs and urban mobility infrastructures
8	Optimal solutions to adapt existing neighbourhoods to new transport patterns
12	New designs of buildings, infrastructures, multimodal hubs and public spaces for accessibility and inclusiveness

- Output 7.2 **Smart financing and new business models for the integration of RES** (e.g. shared ownership, energy communities), and interactions with built environment networks - including raising awareness and building up skills in the construction and supply value chain

7	Interoperable components for positive energy blocks and districts, including a better integration of local renewables (Coordination with DUT)
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Specific Objective D: Demonstrate **sector decarbonisation pathways**

Outcome 8 Towards **built environment as a CO₂ sink** for the future through increased deployment of circular and nature-based solutions and effective integration with the bio-economy

- Output 8.1 **BIM-based solutions providing a GHG compass** over the overall life-cycle of the building / infrastructure

6	Tools to facilitate a life cycle-based approach that foster alignment with EU Level(s) framework indicators
19	Solutions for a low carbon, resource efficient and resilient cultural heritage, from prevention and monitoring to maintenance and retrofit

- Output 8.2 Large-scale demonstrators of multi-usage & dynamic buildings and infrastructures showing **deep reconfiguration capabilities**
- Output 8.3 Development and measures to accelerate and scale up the **adoption of digital certification (such as Energy Performance Certificates)** with longer commissioning and condition-based maintenance to replace maintenance contracts

30	EU-wide open databases and Data Management Platforms on the performance of the built environment
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- Output 8.4 **Digital tools to raise awareness on GHG impact and on reduction pathways for all stakeholders**, from companies to citizen, through public authorities and contractors

6	Tools to facilitate a life cycle-based approach that foster alignment with EU Level(s) framework indicators
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Specific Objective E: Demonstrate **sustainable, circular business and value chain**

Outcome 9 **New business opportunities with reduced risk** for investors, opening the supply chain to Reduce/reused/repared products, reuse/refurbish buildings and infrastructures, demolitions and urban mining. (product manufacturers, re-certification, deconstruction, trading, space multiuse – space as a service, etc.).

- Output 9.1 Frameworks for **multiple CDW (Construction & Demolition Waste) reuse** technical and economic viability at regional level (CDW streams, protocols and guidelines), with e.g. exchange platforms and services

10	Integration of construction and demolition waste in new constructions and industrial and regional symbiosis
22	New public and private procurement approaches supporting the implementation of innovations and the performance-based contractual approach

- Output 9.2 Support for new market actors as recycling and material handling companies (including urban mining companies), on-line trading service providers, etc., with new instruments (financing, green procurement, labelling, standards, **BREFs Best Available Techniques reference documents** & guidelines) to **stimulate the integration of CDW (and other waste) business in the construction ecosystem**, with better valuation of externalities of waste management and better understanding of local resource streams

25	New processes, business models and financing mechanisms supporting integration within the construction value chain and with other sectors
32	Development and Integration of approaches for reducing space and materials

- Output 9.3 Digital solutions that support and ease the **repurpose and re-use of buildings, infrastructure and components** throughout the whole lifecycle (**Reusable BIM**) – including BIM objects for the new building design equally sourced from the product manufacturers and second-hand material dealers

26	Models and digital tools for better-informed decision making on investments and improved risk management for the built environment
29	Digital Innovation in procurements
33	Tools to support designing out waste and compile information on products at property level based on all life-cycle support.

- Output 9.4 **Sector coupling** – for instance innovative routes to recycle/upcycle waste and residue streams from one industry to the other (e.g. use by-products for producing new construction materials).
- Output 9.5 New services (including also from new start-ups) with **people-in-value-chain perspective services**. Enabling real-time services – relying on **buildings and infrastructure data**, and acting as data providers and support for data generation for people everyday activities

34	New value chain-based services for the end user
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Specific Objective F: Demonstrate **affordability and cost-effectiveness**

Outcome 10 **Affordable and feature-adapted built environment** for users and inhabitants

- Output 10.1 **Products designed to survive harsh conditions** / disruptive events in several lifecycles

24	Designs, materials and solutions to improve resilience, preparedness & responsiveness of the built environment to disruptive events
37	Predictive and integrated maintenance solutions and processes

- Output 10.2 Solutions for **smart and responsive buildings exploiting** an improved knowledge of user experience (Building as a Service)

3	Smart-grid ready and smart-network ready buildings, acting as active utility nodes
16	Solutions for smart and responsive buildings exploiting an improved knowledge of user experience (Building as a service)
38	Interactive operation and management of city assets

- Output 10.3 Building solutions, along with business models and investment/economic decision tools, to support **multifunctional buildings optimising** multi-usage and space as a service-oriented solution

12	New designs of buildings, infrastructures, multimodal hubs and public spaces for accessibility and inclusiveness
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Outcome 11 **Value for building owners, and increased flow of capital investment and long-term finance into built environment as a sustainability asset**

- Output 11.1 **Socio economic studies** to understand barriers at end user level for demand and investment, along proven marketing and awareness raising campaigns

20	Sustainable renovation for a more open, accessible and inclusive cultural heritage, in a sustainable urban development
39	Green procurements and new business models for renovation supported by decision-making tools
40	Financing schemes and business models for holistic renovation services (energy, accessibility, comfort)

- Output 11.2 Demonstrated and replicated **set of financing and incentive mechanisms** and packages created and tested on local scales, **to make renovation/adaptation affordable** and with proved ROI

2	Demonstrating integrated technology packages with performance guarantees
25	New processes, business models and financing mechanisms supporting integration within the construction value chain and with other sectors
39	Green procurements and new business models for renovation supported by decision-making tools

- Output 11.3 Tools to **streamline ESG reporting and disclosure of performance on investments** in built environment assets at portfolio level

26	Models and digital tools for better-informed decision making on investments and improved risk management for the built environment
30	EU-wide open databases and Data Management Platforms on the performance of the built environment
31	Big data-based building and infrastructure real-time management, monitoring and maintenance

Specific Objective G: Demonstrate **no trade-offs on economic, comfort, functions, cultural heritage**

Outcome 12 Demonstrated and/or certified built environment with regard to **expected or agreed user-centric functions and characteristics**

- Output 12.1 Innovative solutions for **technical quality control, standardization and certification of innovative materials, components and integrated BE**

21	Standardization framework and progressive regulation
27	New services for on-site/off site surveillance and monitoring of buildings and infrastructures in construction and in use.

- Output 12.2 **Socio-economic valuation methods** for buildings and infrastructures renovation

39	Green procurements and new business models for renovation supported by decision-making tools
40	Financing schemes and business models for holistic renovation services (energy, accessibility, comfort)

- Output 12.3 Advanced **tools and guidance to improve smart readiness in the built environment**

2	Demonstrating integrated technology packages with performance guarantees
6	Tools to facilitate a life cycle-based approach that foster alignment with EU Level(s) framework indicators
30	EU-wide open databases and Data Management Platforms on the performance of the built environment

Outcome 13 Demonstrate **enhanced health and wellbeing** through improved indoor and outdoor environment

- Output 13.1 Materials, products and designs that demonstrably **improve key public health metrics**

15	Solutions for healthier indoor and outdoor environment (air quality, safety, comfort) from building to neighbourhood scale
16	Solutions for smart and responsive buildings exploiting an improved knowledge of user experience (Building as a service)

- Output 13.2 Tools and guidance to **measure and evaluate building and system performance against key public health metrics** and key social and cultural value indicators

13	Solutions for the ageing population, including new services from home
16	Solutions for smart and responsive buildings exploiting an improved knowledge of user experience (Building as a service)
17	Solutions for the sustainable regeneration of urban and rural neighbourhoods (Coordination with DUT)
30	EU-wide open databases and Data Management Platforms on the performance of the built environment

- Output 13.3 Methodologies and tools for **sustainability-integrated performance contracting** for the built environment

2	Demonstrating integrated technology packages with performance guarantees
22	New public and private procurement approaches supporting the implementation of innovations and the performance-based contractual approach
29	Digital Innovation in procurements
39	Green procurements and new business models for renovation supported by decision-making tools

Outcome 14 Demonstrate low carbon, resource efficient, open, accessible and inclusive solutions for conservation and embellishment of cultural heritage built environment assets

- Output 14.1 **Low carbon and durable materials, component packages** and standardised solutions (well integrated to the local environment) **for retrofitting cultural heritage** (low tech, bio-based, locally sourced, or innovative materials compatible with traditional materials)

11	More sustainable buildings with reduced embodied energy and high performance to reduce the life cycle trades-off
19	Solutions for a low carbon, resource efficient and resilient cultural heritage, from prevention and monitoring to maintenance and retrofit

- Output 14.2 **Strategies and tools for the adaptation of cultural heritage** to long-term current and new uses while maintaining its cultural value, including sustainable solutions for improved resilience, durability and safety of historical assets and new business models for private/ end-user investment in cultural heritage for a better preservation and restoration of cultural BE assets

19	Solutions for a low carbon, resource efficient and resilient cultural heritage, from prevention and monitoring to maintenance and retrofit
24	Designs, materials and solutions to improve resilience, preparedness & responsiveness of the built environment to disruptive events
30	EU-wide open databases and Data Management Platforms on the performance of the built environment

- Output 14.3 **New eco-design standards/requirements for heritage maintenance and retrofitting** (including LCA and BIM)

19	Solutions for a low carbon, resource efficient and resilient cultural heritage, from prevention and monitoring to maintenance and retrofit
24	Designs, materials and solutions to improve resilience, preparedness & responsiveness of the built environment to disruptive events
30	EU-wide open databases and Data Management Platforms on the performance of the built environment

- Output 14.4 New technologies to **allow an increase accessibility and inclusiveness of cultural assets and sites for all** (3D modelling, virtual reality, augmented reality), along with innovative approaches to foster a better understanding by citizens of cultural heritage and its sociocultural value

20	Sustainable renovation for a more open, accessible and inclusive cultural heritage, in a sustainable urban development
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