

Disclaimer: This document does not present a draft of the Green Deal call to be part of the Horizon 2020 work programme update, nor any future position of the European Commission. It aims to support the development of the call and its content is subject to change.

Title: Building and renovating in an energy and resource efficient way

Specific Challenge: With rising focus on the building sector (e.g. the ‘renovation wave’ initiative of the European Green Deal) in view of the full decarbonisation by 2050, the built environment remains a strategic domain for R&I. The priority is the design and construction of new or retrofitting of existing buildings as zero-emission/zero-pollution, positive energy powerhouses within sustainable green neighbourhoods (districts). There are two major components of this transition. **Firstly**, a transition in design and construction of buildings to reduce their embodied emissions and to increase the energy efficiency of their operation; also the retrofitting of existing buildings to increase their efficiency. **Secondly**, a transition to energy positive buildings (producing electricity, covering their heating and cooling needs and contributing to the grid stability) with sustainable, renewable energy technologies. These two components are closely linked, since greater building efficiency can reduce demand for heating and cooling and allow a greater range of zero emission technologies to become viable. It also means, reducing demand through effective building designs (incorporating thermal design and orientation), including those that are adapted to their local environments (climatic conditions) and use. The multiplication of such buildings allows the creation of green neighbourhood “living labs” (including social housing and non-residential buildings such as hospitals, schools, public buildings, commercial buildings etc.) with additional urban functionalities (e.g. shared EV charging facilities).

Scope: Proposals are expected to deliver large-scale, real-life demonstrations of promising technology and social innovations based on:

- Scalability design of green, positive energy neighbourhoods well embedded in the spatial, economic, technical, environmental, regulatory and social context of the demonstration sites.
- Energy and resource efficient, seamless industrial construction/renovation workflows from design through to offsite manufacturing, installation and post-construction monitoring:
 - With recycling/reuse of construction materials (or industrial by-products) or reduction of the amount of materials and components, in order to reduce the embodied energy of buildings;

- Proving high replicability, reduced maintenance costs and long-term performance as well as and socio-environmental performance (e.g. air quality/natural ventilation, natural lighting, etc.);
 - Minimizing disruption for building occupants and the time spent on site;
 - Delivering post-construction / renovation monitoring of operational energy performance, durability of the construction/renovation components.
- Sustainable and highly energy-efficient building designs (incorporating thermal design and orientation), adapted to local environments and climatic conditions; active-passive solutions for the building envelope, with:
 - Digital methods of design and construction (e.g. building information modelling);
 - Innovative and more energy efficient Building Integrated Photovoltaics (BIPV) converting structural elements/surfaces (e.g. facades, windows, roofs, etc.) into electricity-producing surfaces while satisfying building functions in addition to architectural and aesthetic considerations.
- Innovative and more energy efficient RES electricity generation in the buildings and at district level combined with urban service facilities (e.g. charging facilities) and highly energy efficient and cost effective RES heating and cooling solutions:
 - PV (BAPV where BIPV is not an option);
 - Reversible heat pumps with refrigerants, which are not greenhouse gases, or less developed clean heating options such as hydrogen.
- Energy storage systems (e.g. using second life batteries from electric vehicles) without limiting the use of living space (e.g. neighbourhood optimized storage including management systems for optimal integration, flexibility and interoperability with the grid).
- Highly energy-efficient building operation at reduced maintenance costs and long-term performance with the help of digital technologies for monitoring yield, energy system flexibility (matching demand to generation) and “peak shaving” at neighbourhood scale, as well as digital solutions to increase energy efficiency of building systems’ and appliances’ secure operation ensuring optimal comfort for users:
 - Optimal dynamic matching of on-site renewable energy generation and building consumption;
 - Smart home services, advanced automated controls, i.e., smart meters, smart water control, smart EV charging, smart elevators, smart security etc.; understanding the occupants preferred usage of the building and harmonise the buildings’ interaction with its occupants;
 - Integration between building energy management systems / building automation control systems, renewable electricity/energy generation, storage, urban service facilities and the grid;
 - Potential for local flexibility to be aggregated and bundled; possibility to trade and commoditise energy flexibility creating new services and revenue streams for building owners/tenants;

- Citizen awareness raising, as well as, education and training for sustainability, conducive to competences and positive behaviour/good habits for a resource efficient and environmentally respectful energy use.
- Coordination on standards and regulatory aspects for efficiency of buildings and HVAC technologies.

The objective is to test, in view of scaling up and wide replication, those innovations across the whole value chain (from planning and design through manufacture and construction to end use including all relevant players, governance and financing institutions, planners, owners, architects, engineers, contractors, facility managers, tenants, etc.). Consequently adapt this value chain to new operation patterns resulting from the innovations (new business models and services, new usages, changed behaviour). The validation of the market and consumer uptake potential should be carried out in the form of real life “living-labs” and under regulatory conditions that are open to innovation. For this purpose, the project will set up (or use existing) innovation clusters in several different parts of Europe, where relevant with a link to other initiatives (e.g. R&I partnerships). Such innovation clusters need to include the local/regional/national value chain(s) able to demonstrate, evaluate and ultimately replicate the innovative solutions in different environment and market conditions, with due consideration of social, business and policy drivers. This will also ensure the validation of the innovations for different building types - residential (e.g. social housing) and non-residential (e.g. hospitals, schools, public buildings) - and various climatic zones.

Proposals are expected to bring the technologies from TRL 5 to TRL 7 at the end of the project.

Expected Impact: when compared to state of the art the innovative developed solutions are expected to bring the impacts listed below:

- Primary energy savings triggered by the project (in GWh/year);
- Investments in sustainable energy triggered by the project (in million Euro);
- High energy performance (nearly zero-energy level within the meaning of Directive 2010/31/EU) / positive energy buildings;
- Reduction of greenhouse gas emissions towards zero (in tCO₂-eq/year) for the total life-cycle compared to current situation shown through cradle to cradle Life Cycle Assessment;
- Reduction of the embodied energy in buildings by 50 % without concessions with respect to energy consumption and comfort;
- Reduction of air pollutants towards zero (in kg/year) for the total life-cycle compared to current situation shown through cradle to cradle Life Cycle Assessment;
- Demonstration of high potential for replicability using new or existing innovation clusters incorporating the whole value chain;
- Shortened construction/retrofitting time and cost by at least 30%, in order to allow market uptake and social affordability;

- Improved final indoor environment quality by at least 30% and reduction of dust and noise during retrofitting by at least 30%, leading to higher rate of users' satisfaction;
- Contribute to the development and implementation of zero-GHG approaches in the building sector.

Relevant indicators and metrics, with baseline values, should be clearly stated in the proposal.

Type of Action: Innovation Action (IA)