MATERIALS SUSTAINABILITY
AN ECTP COMMITTEE

ECTP Materials & Sustainability

FP9 2021-2027 POSITION PAPER

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1. INTRODUCTION

The current EU RTD Framework Program, Horizon 2020, will run until the end of 2020. Discussions and preparations for the next (9^{th}) Framework Program, most likely to cover the period 2021 – 2027 are about to begin.

As part of the European Construction, built environment and energy efficient building Technology Platform ECTP, it is the Material and Sustainability (M&S) Committee's goal to develop a common Vision and Strategic Research Agenda for all construction material stakeholders. This common view will serve as a starting point for future networking and R&D cooperations that will develop solutions helping to overcome societal challenges and to ensure that the construction material sector will, in the long-term, secure its competitiveness and sustainability.

This Position Paper was consequently developed with the purpose to provide insight into those current and upcoming construction material related key-challenges that we strongly believe deserve to be addressed within FP9.

2. SCOPE AND APPROACH

A dedicated working group was set up for the development of this paper. The group was formed from experts coming from industry and academia to ensure that a broad range of competences and experiences was covered.

The first step of the working group towards developing this roadmap was to identify key societal challenges which clearly need to be addressed over the next decade and where innovations in construction materials will make a difference. Climate change, circular economy and resource preservation, competitiveness and economic viability, health and safety, and user comfort are the five key missions that were identified as the main drivers for action.

Chapter 3 of this position paper is on priority topics for FP 9 and is consequently centred on these 5 areas identified. It also addresses an additional mission dedicated to evaluate, to ensure and to valorise the performance of the new material related innovations for sustainable constructions. An FP9 implementation plan for the identified priority topics is suggested in chapter 4 on "Implementation".

The scope of ECTP is continuously evolving, and this is reflected by the scope of this position paper which is no longer limited to buildings: material-related missions for districts and cities are also addressed, as well as for infrastructures and solutions for the energy transitions and other applications.

3. PRIORITY TOPICS FP9 2021-2027

3.1 Climate change

A holistic view along the whole life cycle of construction materials and along the whole value chain needs to be adopted to minimize climate change related impacts. This applies to a broad range of construction materials used in different of applications such as in buildings, cities, infrastructures, energy applications and possibly others.

3.1.1 Reducing embodied energy in construction materials

Embodied energy is the sum of all the energy required to produce any goods, considered as if that energy was incorporated or 'embodied' in the product itself. The production of current construction materials requires high amounts of energy and, together with that, gives rise to significant CO_2 emissions. In fact, the total amount of embodied energy may account for 20% and more of the building's energy use. Reducing embodied energy may therefore significantly reduce the overall environmental impact of the building. Consequently, the reduction of energy demand and emissions in the production of construction materials is of primary importance. This provides opportunities for innovative approaches such as:

- Reduction of CO_2 emissions of traditional construction materials (glass, steel, bituminous binders, cement, composite materials, ceramics and others) by new routes of production and/or low energy demanding production technologies.

- Development of new materials with reduced CO_2 emissions compared with current materials for the same application (example bio- or secondary based raw materials).

3.1.2 Contribution of construction materials to the reduction of energy demand and CO_2 emissions of constructions in use

Energy demand and CO_2 emissions of buildings in use

Decreasing the need for heating and cooling and for repair and maintenance are important levers to reduce energy demand and CO_2 emissions of buildings in use. This can be achieved by engaging into R&D on:

- New high-insulation materials with enhanced durability to be considered in the design phase to ensure superior operational performance along an extended period of life. These materials should be applicable in new buildings and in retrofitting
- Energy capture and storage materials and systems with superior energy storage capacity, and an excellent performance maintain over a large number of charging-discharging cycles (for day-night or seasonal applications). Charging-discharging kinetics including the ability to dispatch should comply with the needs (cooling/heating) of the building to support the implementation of nearly zero-energy houses and plus energy houses.

- New durability enhanced materials for passive cooling applications such as cool envelope solutions suitable for new and existing, even historical, buildings, and able to mitigate global warming through CO_2-eq emission offset.

Fig. 3.1: Lightweight concrete used as high-insulation material with enhanced durability to reduce energy demand and CO_2 emissions of buildings in use.
Source: HeidelbergCement AG / Steffen Fuchs

Performance gap of CO_2 emissions between (building) design and actual performance

In a recent detailed study of 50 non-residential projects and 76 homes, Innovate UK illustrated the huge gap between building design and actual building performance. For non-residential buildings, the carbon emissions were on average 3.8 times higher than designed reaching up to 4.6 times in some cases[1]. As buildings account for 40% of the total energy consumption and are responsible for 36% of greenhouse gas emissions in Europe it is of highest importance to close this gap. Approaches for achieving this include:

- Certifying materials performance in-use, including increasing demands for environmental products declaration
- New characterization tools able to simulate, and to better predict, building operation behaviour in dynamic boundary conditions, (e.g. with varying temperature, humidity content, solar radiation, etc.).
- Implementing predictive maintenance - using telemetry and analytics to optimize maintenance and performance through the product's and asset's lifecycle

[1] *The Future for Construction Product Manufacturing*, Construction Products Association, October 2016, p.14

Transport related energy demand and CO_2 emissions

Innovative materials are also an important lever to enable transport related solutions with reduced energy demand and CO_2 emissions. Such solutions are enabled by materials:

- Permitting improved energy storage
- Decreasing of energy consumption by reducing the interaction between pavement and vehicles

3.1.3 Materials for the energy transition

Remaining within the goal of limiting global warming to less than 2°C as set forth in the Paris Agreement requires to significantly increase the share of renewable energies, such as of solar-, wind- and geothermal power. Research into construction materials can contribute and accelerate this transition by:

- Enabling the construction of new power plants for harvesting renewable energy in harsh environments (e.g. marine/off-shore environment)
- Increasing the efficiency of new power and industrial plants
- Improving and/or enabling energy transport and distribution on different scale

Fig. 3.2:Powercrete®, a high performance heat conducting concrete used for HV and UHV underground cabling to improve energy transport and distribution
Source: HeidelbergCement AG / Steffen Fuchs

3.2 Circular economy and resource preservation

The European Commission adopted an ambitious new Circular Economy Package in December 2015 to help European businesses and consumers making the transition to a stronger and more circular economy where resources are used in a more sustainable way. The European Construction Technology Platform aims to support the transition towards a more circular economy including resource preservation.

3.2.1 Waste hierarchy and circular economy

J. Cramer[1] recently proposed a useful classification encompassing all possible strategies to favour circular economy. Her 10-R levels shown below suggest a hierarchy from the most ‘circular’ (= refusing) to the least ‘circular’ (= energy recovering) strategy.

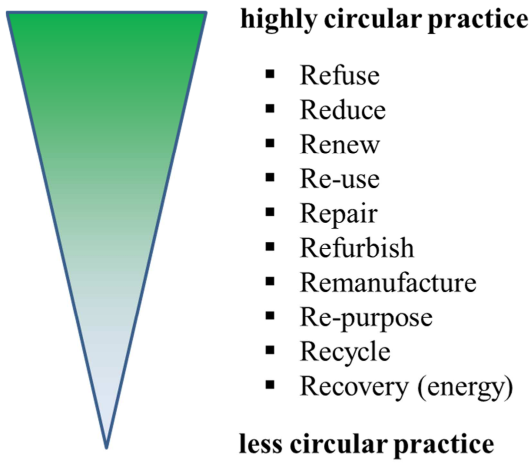

Fig. 3.3: Circularity levels according to J. Cramer[2]

3.2.2 Material research for enhancing circularity and resource preservation

Construction materials are produced in huge amounts (e.g. cement ~4 billion tons and steel ~1.5 billion tons annually) and mostly from non-renewable resources. Applications include buildings, transport- and energy infrastructures. Given the huge amounts of natural resources involved it is very important that an increasing effort is made to align construction material production with circular economy principles. Innovation in resource efficiency needs to start at the design phase of a construction to allow for optimum material recovery and use at the end of the construction’s life. **Material traceability** is an important challenge and may be tackled via implementing digital technologies enabling to tag materials and/or construction parts and to store the data in (open-sourced) databanks.

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[2] J. Cramer: MRA Congres 2016 – De Grenzelose Stad

However, R&D continues to remain important at all levels of the waste hierarchy to ensure making our economy more circular. This includes – depending on the material - R&D on **recycling**, **reuse**, **energy recovery** and **remanufacturing**, e.g.:

- Expanding the scope of recycling from mostly structural materials to other functional categories including insulating- or finishing materials
- Making use of abundant sources of residues, side products, waste and possibly pollutants originating from other industries (e.g. processing wastes, extraction and mining wastes, ashes, sewages, municipal solid wastes and others) as secondary raw materials
- Materials involving the use of industrial CO_2 through carbonation or other chemical processes
- Recycling building materials into a new generation of the same material without loss of functionality (as opposed to traditional processes)
- Handling concrete and demolition waste with mobile, simple and affordable equipment that allow performing local recycling (short circuit).
- Solutions enabling to re-use structural pieces obtained through partial demolition of end-of-life constructions.

3.3 Competitiveness and economic viability

Contrary to many other sectors, the construction industry has not undergone any major disruptive changes during the past 30 years. However, innovation in construction is a powerful lever to secure the sector's competitiveness of tomorrow, and this can be achieved by:

3.3.1 Improving the efficiency of construction materials

The European Commission estimates that 70% of product innovation across all industries is derived from new or improved materials. With approximately one-third of construction cost attributed to construction materials, the scope for applying advanced building materials is considerable. Key R&D topics include the development of:

- Advances on traditional materials and existing characteristics (optimization, recyclability, extended lifetime…)
- New material combinations and multi-functional characteristics (structural foamcrete, fast curing time, crack control…)
- Innovative materials with entirely new functionality (rain-absorbing, temperature management, self-monitoring…)
- Innovative and smart materials adapted for new construction processes (e.g. 3D printing, BIM)
- Simulation tools to support material developments

3.3.2 Maximizing the efficiency of the construction process

Productivity in construction could receive a substantial boost from standardization, modularization and prefabrication, in areas such as:

- Improving image of standardization and potential for individualization
- Handling large prefabricated components in space-constrained construction sites
- (Semi-) automated construction equipment
- Developing new construction technologies (including additive printing)
- Managing digital technologies and big data along the value chain (including BIM).

Developing and applying building materials most economically is another important lever to improve the efficiency of the construction process.

Fig. 3.4: Materials for additive manufacturing in construction
Source: TECNALIA-IAAC

3.3.3 Materials for reducing life cycle costs of constructions

A key factor for maintaining and improving competitiveness of the European construction materials industry is to reduce life cycle costs. This can be achieved via engaging R&D on:

- Understanding property-performance correlations
- Extending the concept of smart building to all construction types for efficiency operation and management and improved safety and convenience
- Modeling service life behaviour and improving material durability
- Simulation tools to support reducing life cycle costs

The development of materials contributing to reducing operational and maintenance costs as well as energy harvesting is a major topic for all the construction industry.

3.4 Health & safety

The provision of **healthy and hygienic structures** to live and work is a crucially important issue for the construction sector in the coming years. Much of this relates to the quality of the breathing air and ventilation particularly in offices and residential buildings. The development and application of functionalized covers or envelopes, such as coatings, incorporating shelf-properties, e.g. self- cleaning or with microbiological action for healthcare buildings, is now a reality and significant further innovations in this area are expected over the coming decades. On the other hand, these new materials for construction, conservation, cleaning, etc. could emit VOCs or other harmful substances, especially if they are treated with compounds to meet building requirements (flame retardants, biocides, etc.). This could be a major hindrance for the use of new, nature based or recycled materials.

Considering the impact of materials on environment and health, up to now major efforts have been guided to the reduction of possible influence of hazardous substances and reduction of environmental impact. To avoid introducing new products with unwanted inherent chemical properties or a negative environmental impact to the growing building stock in Europe better information structure of chemical and environmental properties of building materials is required. This needs to be addressed along with the issue of standardized identities of building products in order for the information to follow the actual product from being delivered to the construction site to the final deconstruction and potentially recycling or re-use. The information structure can be an integrated part of emerging BIM- technologies and allow standardised digitalised transfer of information with low cost and high data security.

Beside these aspects, innovative and improved functionalities can be developed and will open new possibilities in the interaction of materials with citizens and nature. Additionally, there is a need of reliable and diffuse sensing systems for specific pollutants (VOCs, dust, particulates, biological and chemical). This includes new monitoring approaches, according to different perspectives and standardisation of sensor technologies. Assessment of health and toxicological impacts of pollutants (single, mixtures and secondary generated) are required and needs to be standardised, in conjunction with improved adaptable HVAC systems in respect of health and comfort aspects and with reduced maintenance needs.

Developments in new technologies (e.g. nano-technology, shelf-functional additives) offer new opportunities for traditional and new building materials. The development and industrial uptake of new functionalities, such as surface active materials, self-healing capacities, sensor technologies, thermal, sealing etc. are still in their infancy. Their further development can play a key role in the issues of health and safety but also improved sustainability and environmental aspects (outdoor and indoor environment).

Multi-functional/smart construction materials can be a support for the **globally aging population**, which more and more desires to live in their houses. Examples can be materials for sight-impaired, internal or external anti-slip paving and easy to clean surfaces. Specific projects in this area are showing promising results. Extensive research and development has been done on photo catalytic self-cleaning but with varying and usually low success rates in terms of efficiency, durability and cost. Further research is needed on solutions which do effectively work, improve the efficiency, improve the safety and reduce the costs. Further researches should consider not only the improvement of the efficiency, but also the elimination of dangerous intermediates in photocatalytic reactions. In addition, appropriate measurement technologies - id est. sensors/sensor arrays – are required; besides the individual development of both systems, there is a need for the development of a holistic approach combining them.

In addition, **safety in building and infrastructures** (minimal danger or risk of harm related to natural hazards, seismic events, fire, structural ageing, radiation, etc.) should be considered as an important task of future materials, in particular for application and refurbishment interventions in seismic areas (e.g. recent events in central part of Italy) and to mitigate the effect of natural hazards. In order to improve structural functionality and durability, new trends include self-healing materials, to heal damage and corrosion, self-sensing materials to sense moisture ingress, mechanical damage and strain, materials with active response to environmental inputs, multifunctional materials (e.g. multifunctional textile with embedded miniaturized sensor) for structural reinforcement and structural and environmental monitoring purposes. Also, the development of systems and materials for efficient protection (e.g. coatings) from fire is still very important for all types of structures and infrastructures. Protection against radiations is also key in some particular construction (as hospitals), whatever the source (X-ray examinations or cellular phone networks).

Innovation in materials can also significantly improve **safety of workers at the building site**. The building industry in general is characterized as an industry where the number of health implications and accidents due to bad working environment is high (heavy weights, repetitive movements, noise, vibrations etc.). Furthermore, it will be more and more difficult in the future to attract well- trained employees. Therefore, there is an urgent need to improve the working conditions related to the production and construction of buildings and structures. The research needed includes material design and optimization, industrialization and developments in repair and maintenance methods. Many of the risks and accidents associated with construction are related to the management of heavy loads on site. In this sense, some advanced materials have a lot to offer due to their high strength/stiffness to weight ratio compared with conventional materials, enabling reduction in the risk of accidents, injury or death during on-site installation. In this field, improved prefabrication techniques and materials for higher performance of joining technologies will be very interesting.

3.5 User comfort

In developed societies, people spend on average over 90% of their time indoors and most of the remaining time in urban built environments. Therefore, indoor and urban outdoor environment quality is a major impact factor for the health and comfort situation of people, which influences productivity and wellbeing. The following missions were identified:

Fig. 3.5: Passive house part of the Richard-von-Weizsäcker-School in Öhringen with occurrence of discomfort. The school was monitored as case study in the EU project CETIEB(www.cetieb.eu)
Source: V. Stegmaier, Landratsamt Hohenlohekreis

3.5.1 Optimal comfort of living

Due to climate change, there is an increasing risk of overheating in summer periods in indoor and urban outdoor environments. The intelligent use of construction materials in combination with adapted design will help to mitigate this risk and ensure an optimal comfort of living in an energy efficient way. Thermal and hygric comfort levels in the indoor environment are crucial key-factors for comfort and health (e.g. mould).

Fig. 3.6: Full mineral high efficient thermal insulation plaster
Source: quick-mix Gruppe GmbH & Co. KG

There is a need to develop new thermal storage and moisture buffering materials in conjunction with innovative ambient conditioning systems based on new technologies able to stabilize the desired comfort parameters. These material-based solutions have the possibility to control inherently the indoor environment (e.g. thermal comfort, relative humidity, energy storage and provision, and self-cleaning capacity) with reduced costs due to less HVAC installation needs. Special environments and needs like in museums and cultural heritage should be taken into account. In addition to end users comfort, also “well-being” of objects, collections and surfaces is of interest, including reconciliation of “comfort” between human beings and such objects. Smart designed envelop materials in combination with adapted nature based solutions could mitigate heat island effects and discomfort due to air pollution in urban areas.

3.5.2 Well-being in the built environment

Well-being in the built environment is based on well balanced comfort parameters. These need to be actively or passively controlled. Smart materials could enhance the controllability if they ensure tunable properties (adsorption, transport), lower emissions and are able to provide healthier and more comfortable indoor environment; with adaptable behaviour like storage (moisture/ thermal/ energy) or cleaning abilities and enabling passive control. While some manufacturers have introduced dynamically changing properties of material (for example glass changing their light transfer spectrum) the domain of controllable properties is quite unexplored, or quite hidden in the research labs of big material or panel manufacturers. The question of measuring flux of any kind (thermal, humidity, air, chemicals), controlling the transfer properties, adsorption properties of smart materials is an open question which may be driven in the near future by M2M revolution. Also, active noise control has been explored and combination with tuned noise adsorption can be envisioned (tuned damping material).

Fig. 3.7: Tartu Mart Reinik Gymnasium’s football stadium building intended to improve sporting conditions at the gymnasium
Source: OSIRYS demo building (https://osirysproject.eu/) / Tartu municipality

3.5.3 User experience

Human behaviour and perception has an important influence on indoor environment quality (IEQ) and comfort. Therefore, the user and his experience should be in focus of this mission. A special regard should be dedicated to the subjective human IEQ perception comparing with the real IEQ measured. There is a need of reliable and diffuse sensing systems to assess comfort factors (thermo-hygrometric comfort, illumination and noise) as well as performance of smart materials and generate parameters to be used in intelligent control systems. This includes new monitoring approaches, according to different perspectives and standardisation of sensor technologies in conjunction with improved adaptable HVAC systems in respect of health and comfort aspects and with reduced maintenance needs. Development in the Smart Home sector should be taken into account. Innovative solutions will have the potential to penetrate competitive markets such as Europe, Asia and the US.

3.6 Enabling robust and fast innovation in construction

While the socio-economic drivers related to climate change, circular economy, health and safety, competitiveness and user comfort form five missions to channel the (sub)roadmaps for sustainability in construction materials, this sixth mission is focusing on generic approaches enabling to evaluate, ensure and valorise performance of the (new) material related innovations developed for sustainable constructions.

3.6.1 Robust innovation in constructions

Performance validation of new materials for structural and functional reliability of constructions

New construction materials for improved sustainability often include secondary raw materials, new combinations of materials, new processing techniques, etc., which lead to an initially unknown performance. Immediate performance and mechanical properties can be tested with regular testing methods, but the performance in time is less easy to predict in advance. Often standard accelerated aging test methods, monitoring tools and modeling are valid for well-known materials and have been validated over the years through experience in practice. In other words, validated and modeled relations are established between the actual performance test, monitoring and model parameters (performance indicators). For new materials, this knowledge cannot just be transposed without understanding the underlying mechanisms (chemistry, physics…) leading to the performance (evolution) with time [e.g., Provis & van Deventer, 2014[3]]. Key R&D topics in this area are:

- Methodology developments resulting in uniformly applicable characterization approaches for new materials to enable comparison
- New accelerated test methods, monitoring tools and models for performance and service life prediction

[3] Provis, J., van Deventer, J (eds). 2014. Alkali Activated Materials. State-of-the-Art Report. RILEM TC 224-AAM. Springer, Netherlands, 388 p.

Accelerated ageing

Information achieved by standard accelerated aging tests is strongly material dependent and not easy to compare with real aging processes due to the mostly global evaluation methods. There is a need to develop fast and easy to use evaluation methods on a multi scale level with new microscopic techniques. This would speed up the understanding of material related processes and the possibility to predict real aging and performance processes.

Field exposure sites, living labs and mock-ups

Despite the fact that exposure sites and mock-ups are more long-time assessment methods are on the other hand the only evaluation methods reflecting the real environment in which new materials are to be used. There is need to determine procedures how to set the field exposure sites and mock-ups in order to reflect real environment on one hand and to characterize different parameters based on which a fast laboratory evaluation method can be developed. The second challenge is to develop a suitable scale up factor for demonstration of new materials' functionality in real buildings.

Monitoring pilots

Ubiquitous sensing is developing very fast. Therefore, new monitoring techniques with a variety of different cost-effective sensors are available and could be used to evaluate in depth material behaviour in real environments.

Fig. 3.8: Experimental platform located at the French National Institute of Solar Energy (INES) near Chambery / France. The experimental platform is used for testing novel materials and systems, e.g. by the EU funded HOMESKIN project (https://homeskin.net/) in their development of thinner insulation systems and by other EU-funded projects
Source: INES Platform

Performance and service life modeling

Advanced testing and analysis methods in conjunction with advanced monitoring will give the possibility to generate multi scale models and perform simulation of new and established materials to understand in depth performance and behaviour.

3.6.2 Fast innovation in constructions

Performance valorisation of new materials for fast implementation in innovative constructions

Achieving actual uptake by the construction industry of innovative and sustainable construction materials and concepts asks for recognition of current building practices. The acceptance and successful uptake in practice of innovations in constructions often requires adaption of existing design, built, maintain, use and end-of-life practices and as such these should be an integral part of innovation.

This includes taking into account demands and boundary conditions (e.g. economic) of all parties involved including end-users. A systematic approach, including integration of design, material and LCA via extensions of BIM models, is necessary to ensure successful valorisation of innovations in the built environment. Dedicated developments in system engineering applied to specific innovations, demonstrators and pilots are needed to set successful examples for each new development in Materials and Sustainability.

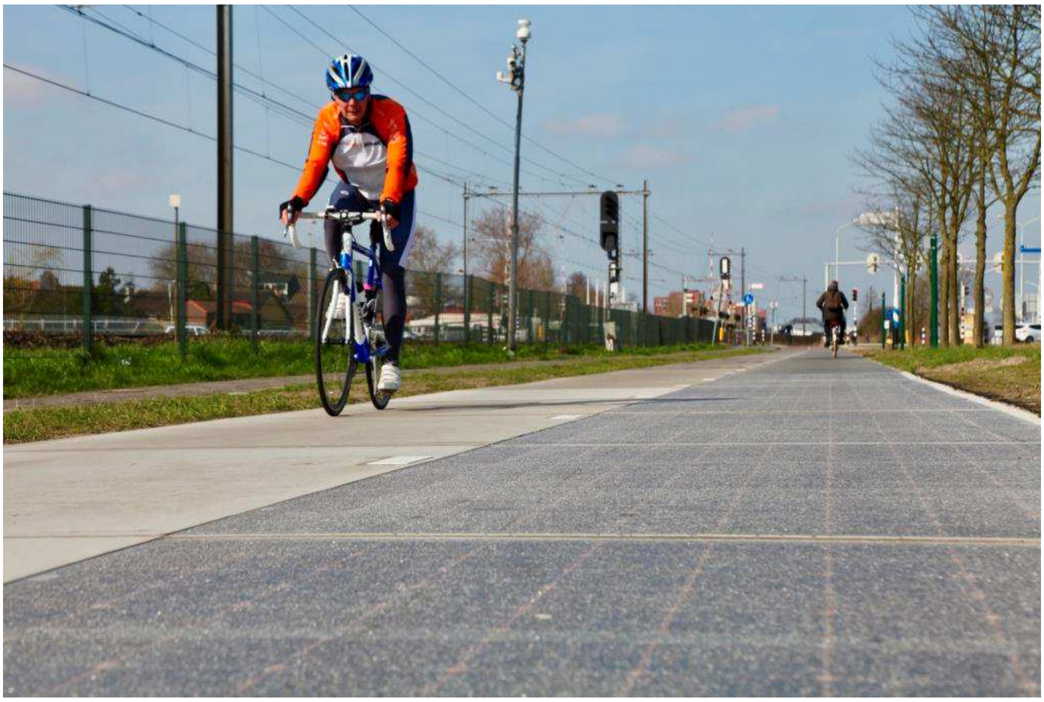

Fig. 3.9: SolaRoad converting sunlight into electricity at Krommenie / The Netherlands
Source: Solaroad www.solaroad.nl

4. IMPLEMENTATION

The proposed implementation plan shown in Table 4.1 targets – in a very efficient way – to provide material related answers to the key societal challenges identified and discussed in this position paper. The related timeline is the result of intense discussions amongst the working group members bringing in a broad range of competences and experiences. It goes without saying that the timeline builds on previous roadmaps, in particular on the multi-annual roadmap for the contractual PPP under Horizon 2020 "Energy-Efficient Buildings" and that it clearly reflects the Commissions' previous and on-going efforts in funding a significant number of successful projects under the current EU RTD Framework Program Horizon 2020.

Table 4.1: Proposed implementation plan

Section	Topics	FP 9 Topic		
		early 2021 - 2022	**mid-term** 2023 - 2025	**later stage** 2026 - 2027
3.1 Climate Change				
	Embodied energy in construction materials			x
	Contribution of construction materials to the reduction of energy demand and CO_2 emissions of constructions in use			
	- Energy demand and CO_2 emissions of buildings in use		x	
	- Performance gap of CO_2 emissions between (building) design and actual performance		x	
	- Transport related energy demand and CO_2 emissions			x
	Materials for the energy transition	x		
3.2 Circular economy and resource preservation				
	Material traceability	x		
	Recycling, re-use, remanufacture and other		x	
3.3 Competitiveness and economic viability				
	Improving the performance of construction materials		x	
	Maximizing the efficiency of the construction process	x		
	Materials for reducing life cycle costs of constructions			x
3.4 Health & Safety				
	Healthy and hygienic structures	x		
	Globally aging population			x
	Safety in building and infrastructures		x	
	Safety of workers at the building site	x		
3.5 User comfort				

	Optimal comfort of living	x		
	Well-being in the built environment			x
	User experience		x	
3.6 Enabling robust and fast innovation in construction industry				
	Performance validation of new materials for structural and functional reliability of constructions			
	- Accelerated ageing	x		
	- Field exposure sites, living labs and mock-ups	x		
	- Monitoring pilots		x	
	- Performance and service life modelling		x	
	Performance valorisation of new materials for fast implementation in innovative constructions			x

5. ANNEX

Mapping relevant H2020 calls and related projects was an important step when developing the implementation timeline for construction material related projects that will help addressing societal key challenges within FP9. The mapping is shown in Table 5.1.

Table 5.1: Mapping of previous H2020 calls and projects relating to construction / construction materials

Section	**Topics**	**Call Reference**	**EeB PPP Project**	**Website**
3.1 Climate Change				
	Embodied energy in construction materials	**H2020-MSCA-RISE-2014**	SUPERCONCRETE	http://www.superconcrete-h2020.unisa.it/
	Contribution of construction materials to the reduction of energy demand and CO_2 emissions of constructions in use	**NMPB-17-2016**	NewSOL	http://cordis.europa.eu/project/rcn/207604_en.html
	- Energy demand and CO_2 emissions of buildings in use	**EeB-01-2016**	1) GELCLAD	https://www.gelclad.eu/
			2) INNOVIP	http://innovip-h2020.eu/
			3) WALL-ACE	https://www.wall-ace.eu/
			4) EENSULATE	http://www.eensulate.eu/
	- Performance gap of CO_2 emissions between (building) design and actual	**EE-02-2015**		
		EeB-05-2017		

	performance			
	- Transport related energy demand and CO_2 emissions			
	Materials for the energy transition			
3.2 Circular economy and resource preservation				
	Solutions favouring resource preservation	**EeB-04-2016**	1) GREEN Instruct	http://www.greeninstruct.eu/
			2) InnoWEE	http://innowee.eu/
			3) RE4	http://www.re4.eu/
			4) VEEP	http://www.veep-project.eu/
		H2020-WASTE-2014	5) FISSAC	http://fissacproject.eu/es/
			6) HISER	http://www.hiserproject.eu/
		H2020-SPIRE-2016	7) Rehap	http://www.rehap.eu/
3.3 Competitiveness and economic viability				
	Improving the performance of construction materials	**NMBP-06-17**	ReSHEALience	
		NMP-19-2015	LORCENIS	https://www.sintef.no/projectweb/lorcenis
		NMBP-35-2017	INNOVACONCRETE	
	Maximizing the efficiency of the construction process	**EeB-03-2014**	1) Built2SPEC	http://built2spec-project.eu/
			2) INSITER	
		H2020-ICT-2016-1	3) HEPHAESTUS	http://www.hephaestus-project.eu/
3.4 Health & Safety				
	Healthy and hygienic structures			
	Globally aging population			
	Safety in building and infrastructures			
	Safety of workers at the building site	**EE-14-2016-2017**		
3.5 User comfort				
	Optimal comfort of living			
	Well-being in the built environment			
	User experience	**EE-07-2016-2017**		
		EE-06-2016-2017		

3.6 Enabling robust and fast innovation in construction industry				
	Performance validation of new materials for structural and functional reliability of constructions	**NMBP-06-2017**		
	- Accelerated ageing			
	- Field exposure sites, living labs and mock-ups			
	- Monitoring pilots			
	- Performance and service life modelling			
	Performance valorisation of new materials for fast implementation in innovative constructions	**EeB-01-2014**	1) BERTIM	http://www.bertim.eu/index.php?lang=en
			2) ECO-BINDER	http://www.ecobinder-project.eu/en/
			3) HOMESKIN	https://homeskin.net/
			4) ISOBIO	http://isobioproject.com/
		EeB-02-2014	1) BRESAER	http://www.bresaer.eu/
			2) E2VENT	http://www.e2vent.eu/