



EUROPEAN COMMISSION
EUROPEAN HEALTH AND DIGITAL EXECUTIVE AGENCY

HADEA.B – Digital, Industry and Space
B.03 – Industry

GENERAL PROJECT REVIEW CONSOLIDATED REPORT

Grant agreement (GA) number:	723582
Project¹ Acronym:	VEEP
Project title:	Cost-Effective Recycling of CDW in High Added Value Energy Efficient Prefabricated Concrete Components for Massive Retrofitting of our Built Environment
Type of action:	RIA
Start date of the project:	01/10/2016
Duration of the project:	54
Name of primary coordinator contact and organisation:	Anna PARABOSCHI (RINA-C)
Period covered by the report:	from 01/04/2019 to 31/03/2021
Periodic report/Reporting period number:	Final
Date of first submission of the periodic report (if applicable):	09/06/2021
Amendments (latest AMD concerning description of the action)²	05/08/2020 (AMD-723582-34)
Date of meeting with consortium (if applicable):	06/05/2021
Name of project officer:	Eleftherios BOURDAKIS
Name(s) of monitors:	– Kyriacos NEOCLEOUS • K & P Neocleous Techniki Ltd • CYPRUS UNIVERSITY OF TECHNOLOGY CUT • USFD

¹ ‘Project’ means the same thing as ‘action’.

² Only amendments to the description of the action (DoA; AT21) are relevant for general project reviews since they always have to be carried out against the latest version of the DoA

1. Overall assessment

1. Overall assessment
Project has fully achieved its objectives and milestones for the period.
2. Significant results linked to dissemination, exploitation and impact potential
<p>Project has delivered exceptional results with significant immediate or potential impact (even if not all objectives mentioned in the Annex 1 to the GA were achieved).</p> <p>The project results will contribute to the work-program impact, such as resource efficiency and reduction of carbon emissions. Additional environmental impacts will arise from the future commercial exploitation of the project results, including the improved ADR & HAS equipment, the two VEEP precast concrete elements and aerogel materials, containing high amounts of high-grade recycled Construction and Demolition Waste.</p>
3. General comments
<p>The beneficiaries have undertaken a range of project activities, including further development and laboratory testing of the precast concrete elements, construction and monitoring of the full-scale demonstration pilots in the Netherlands and Spain, upscaling LCA/LCCA studies for Netherlands and Spain, business modelling and planning, as well as development of exploitation plans for the 10 project results.</p> <p>The project work contributed to the expected impacts, described in the DoA, and is also expected to contribute to three European Policy Objectives and Strategies (i.e. EU Construction and Demolition Waste Management Protocol and European Green Deal, Clean energy for all Europeans, and An economy that works for people).</p> <p>The project work also included a range of dissemination and communication activities, including scientific publications, non-scientific publications and production of material suitable for social media and multimedia, participation and organisation of dissemination events. Due to the covid-19 travel restrictions, some of these activities were organised online. The final publishable version of some of the scientific publications has been uploaded on the project website and/or Zenodo, and this could potentially lead to copyright/legal issues with the publishers of these scientific papers.</p> <p>The project progress followed the objectives and work plan as specified in the DoA, with some deviations caused by technical issues (such as material preparation required for prototyping preparation and the upscaling pilot activities) as well as by the travel and lockdown restrictions of the COVID-19 health pandemic.</p> <p>The work carried out during the final reporting period also considered the comments and recommendations made at the previous periodic review of the project.</p> <p>The project activities have demonstrated the mutual interaction and dependence of individual project tasks. Despite the delivery of exceptional results, the project participants could have elaborated further issues relating to the upscaling LCA/LCCA studies, the demonstration results acquired at the two pilot sites as well as the manufacturing of the precast concrete elements, and the exploitation/commercialisation of the project results (e.g. internal IPR agreements). Furthermore, the data generated and collated by the project must be properly archived in a certified repository that can provide both open and restricted access to the data.</p>
4. Recommendations concerning the period covered by the report
<p>WP4:</p> <ul style="list-style-type: none">- Finite element non-linear static analysis was performed to simulate the global behaviour (performance) of the PCE in resisting wind and seismic actions. The ANSYS software was used for this purpose due to the availability of a license and technical expertise. However, there are other FEA software that would have been more appropriate for the non-linear FEA of reinforced concrete elements.- The dynamic thermal simulations were performed for a 4-storey building, while it would have been more appropriate if these simulations were carried out for buildings with different volumes. <p>WP5:</p> <ul style="list-style-type: none">- The equipment used for heating and cooling of the pilot demonstration projects was not appropriate, since the portable conditioning unit did not always achieve a stable internal temperature.- The discrepancies observed between the theoretical and measured U-values of the precast elements indicated that

the design & manufacturing process of the PCEs may require further development to achieve the thermal efficiency theoretically targeted for the two elements.

WP6:

- Although the VEEP and Business-as-Usual panels are considered to be equivalent in terms of maintenance and repair, the LCA/LCCA (of upscaling the VEEP solutions in the Netherlands and Spain) should have thoroughly analysed the USE phase of the panels. The actual energy efficiency provided by each panel should have been elaborated further in this phase, since the demonstration pilot results indicated that the actual thermal efficiency of the VEEP panels is lower than anticipated. Furthermore, all EoL options should have been considered by the LCA/LCCA, even if some EoL technologies/options are currently not commercially viable/available.

- The environmental impacts achieved by VEEP's optimised aerogel production process should have been clarified further. It was indicated that the manufacture phase of the aerogel materials (with a 40% reduction in energy consumption) has negligible benefits on the LCA impacts (up to 0.5%). However, the final periodic technical report states (in section 1.3) that, by considering the material preparation phases, the aerogel production can contribute to more than 60% to the LCA results of these phases (reduction of roughly 25 kg CO₂ is possible by considering the improvements in the aerogel production process).

WP7:

- Following the final review meeting, the project beneficiaries have outlined (for all Exploitable Results) the practical steps needed to proceed with the commercial exploitation as well as the additional RTD work required to increase their TRL. However, an implementation schedule is also needed for these actions.

- Cash flow analysis should have also considered discount rates that are more representative of the current economic status of Europe/World and not just consider the rates recommended by the European Commission for the period 2014-2020.

- Internal IPR agreements are also required for all 10 Exploitable Results of the project.

WP8:

- The data collated and/or generated within the project must be properly archived in a certified repository that can provide both open and restricted access to the project data.

5. Recommendations concerning future work, if applicable

Not applicable as this is the final reporting period.

2. Objectives and workplan

1. Is the progress reported in line with objectives and work plan as specified in the DoA? If there are significant deviations, please comment.	Yes
<p>The reported progress of the project was inline with the objectives and the work-plan, described in the DoA. However, in terms of schedule, the project has reported delays in completing some of the activities planned in the DoA; these included the prototyping preparation and testing as well as the scaling up activities at pilot level. These delays were caused by technical issues (such as material preparation) but also by the on-going COVID-19 health pandemic.</p>	
2. Are the objectives of the project still scientifically and /or technologically relevant?	Yes
<p>Objectives were still scientifically and technological relevant and this has been demonstrated by the content of the submitted deliverable reports.</p>	
3. Are the critical implementation risks and mitigation actions described in the DoA still relevant?	Yes
<p>The risk and mitigation actions described in the DoA were still relevant for the final reporting period. There were 22 foreseen risks, but not any unforeseen risks, although the COVID-19 health pandemic was as an unforeseen critical risk. Mitigation measures were applied for all foreseen risks; and 5 of these risks materialised.</p>	
4. Have the pilots/case studies started to showcase innovative results as described in the DoA?	Yes
<p>The beneficiaries used the improved ADR and HAS equipment to recycle high-grade materials from CDW. These materials were then used for the full-scale production of the two types of VEEP's precast concrete elements (PCEs) as well as aerogel materials that were used to thermally insulate the VEEP PCEs.</p> <p>The actual performance of the VEEP precast concrete elements and aerogel materials was assessed at the two demonstration sites (one in the Netherlands and one in Spain). It is worth noting that the actual thermal insulating performance of the VEEP PCEs was lower than expected. Consequently, the project beneficiaries have undertaken additional experimental tests to evaluate the reasons for the lower thermal insulating performance and a number of recommendations were made to improve the PCEs thermal insulating performance.</p>	
5. Have the ethics deliverables due for the current period been adequately addressed and approved?	Not applicable
<p>N/A</p>	
6. Have the comments and recommendations from previous project reviews been taken into account?	Yes
<p>The project beneficiaries have considered the comments and recommendations from the previous reviews of the project as well as from the final periodic review meeting.</p>	

3. Impact

1. Does the work carried out contribute to the expected impacts detailed in the DoA?	Yes
<p>The work of the VEEP project has contributed to the following expected impacts, described in the DoA:</p> <ul style="list-style-type: none"> - Utilization of high amounts of recycled CDW in precast concrete elements and aerogel materials. The target of using 75% CDW in the VEEP precast concrete elements was achieved. - Reduction in embodied energy and in carbon emissions as well as in the use of primary resources. - Cost reductions through the production and use of the VEEP PCEs. - Development of high grade recycled materials and precast concrete elements with comparable performance and durability with existing building products that are available in the market. - High replication potential of the solutions obtained. - Promotion of Life cycle assessment. 	
2. Does the work carried out follow the plan detailed in the DoA to enhance innovation capacity, create new markets opportunities, strengthen competitiveness and growth of companies, address issues related to climate change or the environment, address industrial and/or societal needs at regional level or bring other important benefits for society? Give information on the relevant innovation activities carried out (prototypes, testing activities, standards, clinical trials) and/or new product, service, reference materials, process or method (to be) launched to the market, if any.	Yes
<p>The activities of the VEEP project performed at the final reporting period, focused mainly on actions that enhance the innovation capacity of the beneficiaries.</p> <p>The following are the main innovation activities carried out during the final reporting period.</p> <ul style="list-style-type: none"> - Testing of the precast concrete elements for acoustics, thermal insulation, fire resistance/reaction, and durability properties. - Further development of the precast concrete elements used in the full-scale demonstration pilots. - Construction and monitoring of the full-scale demonstration pilots in the Netherlands and Spain. - Contribution to standardization to support the use of recycled concrete waste for cement production. - Upscaling LCA/ LCCA studies for the Netherlands and Spain. <p>The work carried out also promotes the reuse/recycling of CDW materials, reduction of energy use and carbon emissions, and this work therefore addresses issues relating to climate crisis and the environment, including energy efficiency of the European building stock.</p> <p>The development of the VEEP precast concrete elements also targets the needs of the construction industry in developing innovative precast concrete elements that can also be used for the thermal insulation of buildings.</p> <p>The project beneficiaries also plan to proceed with the commercialisation of two of the exploitable results.</p>	
3. Does the work carried out contribute towards European policy objectives and strategies and have an impact on policy making?	Yes
<p>The work carried out by the project is expected to contribute to the following European Policy Objectives and Strategies.</p> <ul style="list-style-type: none"> - EU Construction and Demolition Waste Management Protocol and European Green Deal: by promoting resource efficiency in precast concrete elements that can also be used for the thermal insulation of buildings. - Clean energy for all Europeans: by developing precast concrete elements that contribute to the energy efficiency of the European building stock. - An economy that works for people: by developing new innovative products and services that can lead to job creation and boosting of investments. <p>Thus, with the continuing engagement of the project beneficiaries with policy makers (even after the project completion), the work of the VEEP project can have a positive impact on EU policy making.</p>	
4. Does (or will) the work carried out have an impact on SMEs?	Yes
<p>The work carried out by the project beneficiaries has demonstrated the potential of high-grade recycling of CDW in</p>	

precast concrete elements. This will therefore benefit the large number of European SMEs operating in the sectors of CDW and the production/supply/installation of precast concrete elements.

5. Have the beneficiaries reached gender balance at all levels of personnel assigned to the action? If not, have the reasons been explained in the periodic report?

Yes

Overall, 59 women have participated (at different levels) in the project activities. The following key roles were covered by female members of staff: Project Coordinator, Project Financial Coordinator, Leaders of four Work Packages (WP4, 6, 7, and 8), Communication Manager, Exploitation Manager as well as Task Leaders.

4. Implementation

1. Has the project been efficiently and effectively managed?	Yes
Despite the restrictions experienced by the Covid-19 health pandemic, the project continued to be managed efficiently and effectively by an experienced team of professionals, which led to the successful completion of the project.	
2. Is the management of the project in line with the obligations of beneficiaries (including ethics and security requirements, risk and innovation management if applicable)?	Yes
The consortium fulfilled all its project management obligations, including for risk and innovation management. A series of deliverables were submitted to describe the range of activities carried out for this purpose; this is also demonstrated by the results achieved by the project beneficiaries.	
3. Is the contribution of each beneficiary in line with the work committed in the DoA? (applicable only to multibeneficiary projects)	Yes
Each project beneficiary has contributed to the project activities as described in the DoA; the project did not report any deviations with regards to this matter.	
4. Have the beneficiaries disseminated project results (foreground) in scientific publications as planned in the DoA (including the deposition of publications in open access repositories)? Do they include a reference to EU funding?	Yes
<p>The project has produced 14 peer-reviewed scientific publications; this number has exceeded the target set by the project beneficiaries.</p> <p>All the scientific publications included reference to EU funding and they are available in the Zenodo repository and/or in Gold access.</p> <p>However, the final publishable version of some of these scientific publications has been uploaded on the project website and/or Zenodo, and this could potentially lead to copyright/legal issues with the publishers of these scientific papers (e.g. ELSEVIER).</p>	
5. Have the beneficiaries disseminated and communicated project activities and results by other means than scientific publications (social media, press-release, the project web site, video/film, etc) as planned in the DoA? Do they include a reference to EU funding?	Yes
<p>Project results were disseminated through the project website, newsletters, flyers, and video that are also available on youtube. Reference to EU funding is included in all the dissemination material developed by the project.</p> <p>The project also maintained accounts on Twitter and LinkedIn; with the former receiving great interest.</p>	
6. Has the plan for the exploitation and dissemination of the results (if required) been updated and implemented as described in the DoA, in particular as regards intellectual property rights? Is it appropriate?	Yes
<p>The dissemination activities of the project, which included networking with sister projects, exceeded the performance indicators set by the project beneficiaries.</p> <p>Furthermore, the project identified 10 exploitable results and two patent applications were filed as a result of the project activities (one of the patents has already been granted). However, by the end of the project, the beneficiaries did not proceed with the internal IPR agreements, required to utilise further the project results.</p>	
7. Has the data management plan (DMP) (if required) been updated and implemented? Is it appropriate?	Partially
There was no need to update the DMP of the project. The public reports and publications of the project are available on the Zenodo repository. However, the project beneficiaries must ensure that this plan is fully implemented in terms of properly archiving (in open as well as restricted access certified repositories) all the data collated and/or generated by the project.	

8. Have the proposed institutional changes been appropriately promoted?	Not applicable
Not applicable to this type of action.	

5. Resources

1. Were the resources used as described in the DoA and were they necessary to achieve its objectives? If there are deviations from planned budget, have they been satisfactorily explained? Have they been used in a manner consistent with the principle of sound financial management (in particular economy, efficiency and effectiveness)?	Yes
<p>The project has reported some deviations in the use of resources. In WPs 3 to 9, project beneficiaries have reported an overspending in Person-Months, for which justifications have been provided. Furthermore, the total financial resources (i.e. for the entire project duration) requested by the project are higher than those planned in the DoA (additional requested amount: 143,336.87 Euro).</p> <p>Some dissemination activities (e.g. VEEP Final Event, VEEP Replication Workshop) and the last 4 General Assemblies of the project were carried out online, due to the travel restrictions of the ongoing COVID-19 pandemic.</p>	

Expert opinion on deliverables

Deliverable number	Deliverable name	Status	Comments
D4.5	Development and optimization of the novel PCEs	Accepted	Deliverable submitted late by 7 months due to delays experienced in the material preparation that subsequently delayed prototyping preparation and testing.
D5.2	Report on the demonstration of cost-effective sustainable aerogels based on water-glass precursors from silica-rich C&DW recycled materials	Accepted	The report of this deliverable was submitted 5 months later than planned; this was due to technical issues experienced during the scaling up of the pilot activities (e.g. manufacturing of the 7cm aerogel panels).
D5.3	Report on the demonstration of advanced manufacturing processes for new sustainable energy efficient precast concrete elements	Accepted	The report of this deliverable was submitted on March 2020 instead of November 2019. This is because the production of the precast concrete elements was affected by the delays experienced at the design phase.
D5.4	Report on the installation and operational phase of PCEs under real climatic conditions	Accepted	Report has also tacked the comments made at the final review of the project. Therefore, the revised version of the deliverable must be uploaded on VEEP's PMON (EC's participant portal).
D5.5	Report on the End-of-Life Phase of the novel VEEP PCEs, mainly focused on reuse and recyclability for the new solutions	Accepted	<p>Report submitted end of April 2021, i.e. 2 months late.</p> <p>New aerogel material was not produced (and characterized) from the ultrafines recycled from the VEEP precast elements. This is because the properties of the ultra-fines, recycled from the VEEP PCEs, were similar to the properties of the recycled material originally used to produce the VEEP aerogels.</p> <p>The report of this deliverable has been revised following the final review meeting of the project.</p>
D6.3	LCA and LCC report on implementing VEEP innovations for the Netherlands	Accepted	<p>Upscaling of the proposed solutions for the building stock in the Netherlands up to 2050, indicated potential costs savings as well as GHG mitigation.</p> <p>The report of this deliverable has been revised following the final review meeting of the project.</p>
D6.4	LCA and LCC report on implementing VEEP innovations for Spain	Accepted	<p>Upscaling of the proposed solutions for the building stock in Spain, indicated potential costs savings as well as GHG mitigation.</p> <p>The report of this deliverable has been revised following the final review meeting of the project.</p>
D6.5	Short report on recommendations highlighting the most remarkable environmental and economic benefits from the VEEP solutions	Accepted	A series of technical recommendations are provided to improve the LCA/LCC of the developed VEEP products.

Deliverable number	Deliverable name	Status	Comments
			The report of this deliverable has been revised following the final review meeting of the project.
D7.2	Business model for the new practice	Accepted	Most VEEP participants are interested in further research activities instead of commercialising all the exploitable results of the projects. The project will only evaluate business patterns only for two project results: ADR+HAS technology and the precast panels.
D7.3	Assessment of the VEEP solution's international replication potential	Accepted	Deliverable was submitted prior to the Replication Workshop, thus the Replication outcomes are not included in this report.
D7.4	Business plans for the new technologies/processes and products	Accepted	This comprehensive report was submitted 6 months later than planned.
D7.5	Final exploitation action plan	Accepted	<p>10 exploitable results have been identified and characterised; BFMULO matrixes were also prepared. The deliverable also outlines the practical steps needed to proceed with the ER's exploitation as well as the RTD work required to achieve a higher TRL.</p> <p>The deliverable has been revised following the final review meeting of the project.</p>
D7.6	Report on the contribution to the standardization system	Accepted	Participants carried out a range of activities aiming to accelerate the acceptance and the use of the recycled materials and precast concrete elements produced by the project.
D8.8	Final communication and dissemination report	Accepted	Current deliverable is an update of deliverable 8.5.
D9.5	Short Interim Management Reports 4	Accepted	Report described the progress of the project.
D9.6	Short Interim Management Reports 5	Accepted	Report described the project progress.

Expert opinion on milestones

Milestone number	Milestone name	Achieved	Comments
MS4	Novel precast concrete elements (PCEs) containing >75% by weight of C&DW recycled materials	Yes	Milestone achieved 8 months later than anticipated due to late submission of D4.5
MS5	Closed-loop approach demonstration of the VEEP solutions	Yes	Milestone achieved 2 months later than planned; this was due to the late submission of D5.5
MS6	Integrated environmental and economic life cycle assessment	Yes	Milestone achieved on time.
MS7	Defined exploitation strategy for the VEEP solutions	Yes	Milestone achieved on time.