

Environment, Climate Change and Low Carbon Economy Programme

*'Environment Programme'*

*European Economic Area (EEA) Financial Mechanism 2014-2021*

Final Report

September 20<sup>th</sup> 2023

**12\_CALL#2 - CIRCULAR ECOBIM**

*Accordingly, with the Articles 25.2.j) and 29.4 of the 'Applicants Guide for Financing of Projects Supported by Environment, Climate Change and Low Carbon Economy Programme'*

[https://www.eeaqrants.gov.pt/media/2994/applicants-guide-for-financing-eea-grants\\_environment-projects\\_28112019.pdf](https://www.eeaqrants.gov.pt/media/2994/applicants-guide-for-financing-eea-grants_environment-projects_28112019.pdf)

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## 1. Detailed description

This report summarizes the work carried out in the project Circular EcoBIM between August, 2020, and December 30, 2022. During the project, the following activities were developed:

1. Circular EcoBIM Platform Specifications;
2. Development of the Circular EcoBIM database;
3. Development of the Circular EcoBIM platform;
4. Demonstration;
5. Dissemination and exploitation.

The work carried out by the promoter and the partners is described by activity in sections 1.1 to 1.6. An overview of tasks that were carried out during the reporting period can be seen in Table 1.

*Table 1. Synthesis of status of relevant tasks during the reporting period*

Activity	Task	Current status	Notes
1	Literature review	Completed	-
	Technical specification of criteria for design for disassembly and circularity indicators	Completed	-
	Technical specification of the BIM/LCA integration	Completed	
	Technical specification of the circularity tool for Level 1 and 2	Completed	-
	Technical specification of the circularity tool for Level 3	Completed	-
	Technical specification of GUI and digital twin interface	Completed	-
	Adaptation of circularity tools to be in line with new national and European legislation	Completed	
	Technical implementation of the circularity plugin	Completed	
	Technical implementation of the LCA plugin	Completed	
	Technical implementation of the digital twin application	Completed	
	Technical implementation of the database	Completed	
2	Data collection <sup>1</sup>	Completed	-

<sup>1</sup> “Data collection” in the sense of identifying relevant data sources. However, the actual data compilation in the required format takes place under “Filling out of product data sheets” and “Data organization and characterization”, which are still under way within Activity 2.

Activity	Task	Current status	Notes
	SWOT analysis for database architecture and management	Completed	-
	Definition of the product data template (PDT)	Completed	-
	Filling out of product data sheets	Completed	PDS were filled for each material of two case studies
	Analysis of national construction types	Completed	Study to support the creation of building archetypes
	Data organization and characterization	Completed	Data collection and organization focused on building archetypes and EoL treatments.
	Setup of relational database in SQL	Completed	
3	Parametrization of the Life Cycle calculations	Completed	
	Flow chart for programming of circularity tool for Level 1 and 2 (plugin)	Completed	
	Flow chart for programming of circularity tool for Level 3	Completed	
	Development of user interface	Completed	
4	Digitization of Lisbon archetype	Completed	
	Digitization of new residential house	Completed	Provided by ATREM
	Digitization of Herdade do Pinheiro	Completed	
	Material Flow Analysis (MFA)	Completed	MFA was developed for Herdade do Pinheiro.
	Demonstration of the Circular EcoBIM platform	Completed	The plugins were demonstrated with the Lisbon Archetype, ATREM New Residential House and Herdade do Pinheiro.
	Project presentation events	Completed	The first webinar was held in December 2020, the second webinar was held on June 23 <sup>rd</sup> 2021 and the third webinar was held on February 16 <sup>th</sup> 2022. The final event was held on October 3 <sup>rd</sup> (in hybrid format, in Lisbon and on Zoom).
5	Dissemination in scientific conferences	Completed	Although completed in the duration of the project, further dissemination in conferences will be pursued.
	Website	Completed	Website exists and is updated with continuous communication.
	Social media	Completed	Continuous communication on the project's Twitter account and other social media accounts.
	Project video	Completed	The project video was premiered during the third webinar on 16.02.2022 and was uploaded to the project's Youtube channel.

Activity	Task	Current status	Notes
	Podcasts	Completed	The project consortium has decided to produce podcasts instead of oral and written communications, which were originally defined as a target for Activity 5.

## 1.1 Activity 1 “Circular EcoBIM Platform Specifications”

### 1.1.1 Specification of objectives, tasks and role of each partner

During this activity, the theoretical specifications of the Circular EcoBIM platform<sup>2</sup> and all its components were defined. The technical implementation and programming of the plugins and database was carried out in the context of Activity 2 and 3. To provide a better understanding of the different tasks of the project, hereafter a description of the Circular EcoBIM platform.

The Circular EcoBIM platform comprises different circularity tools:

- One software plugin for the existing BIM software Revit that allows performing a life cycle assessment (LCA) of the construction and renovation of a project design corresponding to Levels 1 and 2 of the EU Level(s) framework. IST – CERIS is responsible for the definition of this plugin. CentralBIM is responsible for the programming of this plugin.
- One software plugin for the existing BIM software Revit that allows analysing the circularity potential for the construction and renovation of a project design corresponding to Levels 1 and 2 of the EU Level(s) framework. IST – IN+ is responsible for the development of this plugin. CentralBIM is responsible for the programming of this plugin.
- One software application using a digital twin that provides an interface to enable the visualization and interaction with the BIM model and the environmental performance in a digital environment. Information is synchronized between the BIM software and the database, which allows the building manager to access all project data, rather than having to browse through multiple data sources. CentralBIM is responsible for the development for the definition and programming of this tool.

In addition, the Circular EcoBIM platform consists of the following components:

- A database that collects information about the environmental performance and circularity potential of construction materials. 3drivers is responsible for the definition and conceptual development of the database. CentralBIM is responsible for the implementation of the database software component.

<sup>2</sup> In the scope of the Circular EcoBIM, the platform should be understood as a set of software and a surrounding ecosystem of resources for a given purpose, i.e. it is not strict definition of a IT platform which consists in the hardware and software in which other applications are run.

- A product data template (PDT) that allows organizing and directing the collection of data for the specific application of the remaining tools of Circular EcoBIM. Due to complex parallel development of two plugins and one digital twin tool, each responsible entity (IST – CERIS, IST – IN+, CentralBIM) defines their own PDT for their respective plugin/tool. Then, 3drivers is responsible for integrating the parameters from all PDTs to define one common platform PDT. Once a PDT is filled with product data, it is called a product data sheet (PDS). The PDS are then direct input for the database (and part of Activity 2). IST and 3drivers are responsible for the development of the PDT. 3drivers is responsible for compiling PDS.

### 1.1.2 Summary of activities

Activity 1 was conducted since the beginning of the project until April 2022 (Reporting period No. 7). During the project, the following activities were developed:

- In the first stage of this activity, a literature review was conducted by 3drivers and IN+ (IST) which focused on the possible criteria and properties for the platform and its application. The definition of the platform architecture was proposed by CERIS (IST) and supported by CentralBIM and IN+ (IST) and analysed by 3drivers. Additionally, the consortium discussed and specified the innovation potential of the platform by deciding to focus on the End-of-life stage of buildings and building elements.
- To integrate LEVEL(s), the focus was on the indicators 1.2 Life cycle Global Warming Potential, 2.1 Bill of quantities, material, life spans, 2.2 Construction and demolition waste and materials, and 2.4 Design for deconstruction, reuse and recycling.
- The definition of the product data templates (PDT) for the data structure was an iterative process. Several characteristics were discussed, tested, and analysed until reaching the final stable version, which refers to specific construction products, includes material composition and environmental impacts.
- A parameterization for calculating the LCA and Circularity in the scope of BIM was conducted by synthesizing the criteria and parameters that must be considered.
- The organization of the parameter structure coming from the BIM model was analysed, to combine the needs of implementing the functionalities, the data to be introduced by the user, the data for calculation, with the parameters to be created or already existing in the BIM model.
- The building automated characterization (BAC) workflow for the Circularity plugin was developed.
- The user interface of the platform was outlined.
- The development of the Graphic User Interface (GUI) for Circularity Plugin.

## 1.2 Activity 2 “Development of Circular EcoBIM database”

### 1.2.1 *Specification of objectives, tasks and role of each partner*

The objective of this activity was the development of a database that provides the required information for the different developed tools of the project. A relational database was developed, which contains the required information for the LCA plugin, the circularity plugin (programmed in C#), and the digital twin application. During the reporting period, an additional effort was made to develop another circularity tool (programmed in Dynamo for Revit) to allow a wider uptake of circularity analysis of buildings. For this last tool, a simplified tabular database, with selected information from the relational database, was required. 3drivers was responsible for this activity, with support from IST - CERIS and CentralBIM for the gathering of information.

### 1.2.2 *Summary of activities*

Activity 2 started earlier than scheduled and ran until the end of the project (Oct. 2020 to Dec. 2022). The following activities were developed in the context of this activity:

- Discussions to define the content of the database were held at the beginning of the project that resulted in the strategy of collecting and storing three types of information in the database: i) characterization of existing building types that can help to fill in the gaps, ii) specific life cycle inventories of materials and processes for the Portuguese construction sector and iii) final mid-point indicators for construction products from existing national and international databases.
- A SWOT analysis of the database was performed to identify the major challenges.
- Development of the structure of the relational database: i) identification of the relevant parameter for the plugins and ii) development of an entity-relationship diagram based on those parameters as a basis for the structure of the database
- Continuous analysis and development of data exchange between database and the plugins to improve the structure of the database, namely by implementing search conditions to correctly implement Circularity and LCA methodologies.
- Development of building archetypes with typical construction elements for the building sector in Portugal to populate the database for existing buildings from 1900 to the present.
- Development and conduction of a survey to C&D Waste Management Operators in Portugal to identify specific material recycling efficiencies and develop the EoL treatments for the database.
- Data collection and upload in the online database:
  - Collection of product data sheets (PDS) and all the associated data for two of the case studies of the project: i) Lisbon Archetype and ii) ATREM New Construction House.
  - Collection and upload of data for the ATREM case study used in Circularity Plugin in Dynamo tool for Revit.

- Selection and collection of information in tabular format for circularity tool, programmed in Dynamo for Revit.
- Database implementation: i) Set up of the database final structure in *phpMyAdmin*; ii) Analysis of methods and procedures to guarantee the correct implementation of database structure in *mysql*, and iii) Establishing remote access to ensure the tools can communicate with the database locally and remotely.
- The quantity of BIM objects analysed during the circularity assessment were 82 in total: 28 in the Lisbon Archetype and 54 in the New Building case study provided by Atelier dos Remédios.
- OpenLCA Collaboration Server, a server application was installed to enable sharing of information in a consolidated LCA database and allow third-party access.

### 1.3 Activity 3 “Development of the Circular EcoBIM platform”

#### 1.3.1 *Specification of objectives, tasks and role of each partner*

The objective of this activity consists in the software development of the two circularity tools and in the software development of the Digital Twin Platform. The goal is to have a practical and user-friendly software platform to support environmental circularity, during construction and building renovation.

IST is responsible for the software implementation of the circularity and LCA tools for Levels 1 and 2. CentralBIM is responsible for the software development of the Digital Twin Application tool for Level 3 and graphical user interface.

#### 1.3.2 *Summary of activities*

This activity took place between December 2020 and December 2022. The following tasks were developed under this activity:

- Development of the LCA plugin:
  - Development of analytical models for plugin functionalities: Streamlined LCA, complete LCA, Level(s) use stage energy performance, Carbon Footprint, Level(s) Global Warming Potential, or Cost.
- Development of the Circularity Plugin C#:
  - Characterization and DfD specifications
  - Implementation of the building automated characterisation (BAC) for the assessment of circularity in existing buildings.
- Development of the Circularity Tool for Revit - A lighter and easier circularity tool (programmed in Dynamo for Revit) was developed using the same circularity



methodology to allow a wider uptake of circularity analysis of buildings<sup>3</sup>. The tool is open access, and it is available on GitHub, under the CircularEcoBIM Repository<sup>4</sup>:

- Definition of prerequisites for plugin use and data preparation.
- Development and testing of three scripts within Dynamo tool: Assigning data; Measuring Circularity; Visualizing Results
- Development and testing of Dynamo plugin outputs: Circularity indicators, summary report in excel, 3d visualization.
  
- Development of the Digital Twin Application in Unity:
  - Detailed specifications were developed. The integration of map visualization technology and BIM software was initiated. Some functionalities inherent to the interaction of maps in Unity were implemented, with the integration and visualization/identification of buildings according to their circularity, and the respective programming functions and methods, maps and BIM models.
  - Creation of features to access/edit the external database and access BIM model database, to interact with 3D BIM model representation.
  - GUI with focus on the management of treatment entities and the routing of elements/materials at the end of life.
  - Development of exporting/importing Digital Twin methodologies from Revit to Unity. With focus on getting an adequate Digital Twin working on Unity, some improvements were carried out to include the needed data, in terms of materials type and fields inherits to the Revit model.
  - Workflow procedure for EoL treatments for elements and materials feature.
- Continuous addressing of bugs and development of improved versions of all the plugins.

## 1.4 Activity 4 “Demonstration”

### 1.4.1 *Specification of objectives, tasks and role of each partner*

Different buildings and building projects represent the case studies for the demonstration phase:

- i. A new building project, provided by Atelier dos Remédios, for the development of the LCA plugin for Levels 1 and 2;
- ii. An existing historic building in the city of Lisbon, provided by IN+ from previous research work, for the development of the circularity plugin for Levels 1 and 2;

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<sup>3</sup> The tool was developed by an external party. Please refer to section 1.6.2 of this report to the service procurement tender

<sup>4</sup> The repository can be consulted here: <https://github.com/CircularEcoBIM/CircularityTool4Revit>

- iii. A new site development in Herdade do Pinheirinho in the Grândola municipality, provided by Potential Sketch, for the development of the circularity tool for Levels 1 and 2, as well as for the material flow analysis (MFA) and the digital twin application.
- iv. The new site development in Matinha in the city of Lisbon, provided by Potential Sketch, will not be further developed as the project has come to a halt because the required building permits from the Lisbon municipality have not been issued.

IST digitized the new project by ATREM and the historic building in Lisbon in Autodesk's Revit software.

CentralBIM digitized Herdade do Pinheirinho and Braço de Prata projects in Autodesk's Revit software. However, due to time and resource constraints, the development of the digital twin application was shifted to Herdade do Pinheiro, which was already modelled at a much higher detail than Braço de Prata. Both case studies were provided by Potential Sketch.

A material flow analysis focusing on the EoL phase, i.e., production of construction and demolition waste, was developed by 3drivers for a showcase building of Herdade do Pinheirinho.

The lessons learned during the demonstration phase have helped to improve other outputs, namely the plugins and digital twin application, and to improve the development of the two construction projects managed by Potential Sketch.

#### 1.4.2 *Summary of activities*

This activity started earlier than scheduled and was conducted throughout the entire duration of the project, between August 2020 and December 2022, during which the different case studies were developed as follows:

- Herdade do Pinheirinho was surveyed with GPS, laser scanning and other means. Strategic points were placed for later connection of the obtained point clouds and their georeferencing. The respective processing, alignment, minimization of errors and georeferencing of all information related to the point clouds from the survey were carried out.
- Digitization of Braço de Prata was carried out through: i) The survey (laser scan) of one apartment and the respective entire building floor and ii) The processing of the point cloud and georeferencing according to the execution phases.
- The historic building in Lisbon was fully described as an archetype by IST IN+.
- LCA plugin was tested by IST CERIS with the archetype case study, which was originally used for the development of the Circularity plugin in Dynamo by IST IN+- The results from the test of the LCA plugin with the new building case study, provided by Atelier dos Remédios.
- Circularity plugin in Dynamo was tested by IST IN+ with the new building case study, provided by Atelier dos Remédios, which was originally used for the development of the LCA plugin by IST CERIS.

- The Circularity plugin and the Digital Twin application were developed and tested with the Herdade do Pinheiro case study.
- A Material flow analysis (MFA) focused on the EoL phase was developed by 3drivers for Herdade do Pinheirinho:
  - Bill of quantities and Bill of Materials (BoQ/BoM) were extracted from the BIM architectural and structural models of Herdade do Pinheirinho and were analysed and reorganized by Brand Layers and materials.
  - Environmental Product Declarations (EPD) were selected for 4 possible design scenarios (circular scenarios vs. business-as-usual scenario), which were needed to quantify the necessary indicators for the realization of the actual MFA, based on the study and analysis of the architectural mood boards of the case study.
  - Material inflows and outflows were quantified and qualified and the results were visualised through Sankey diagrams.

## 1.5 Activity 5 “Dissemination and exploitation”

### 1.5.1 Specification of objectives, tasks and role of each partner

The aim of the dissemination and exploitation was to communicate and build upon the activities of the project and to ensure stakeholder engagement from different areas. 3drivers, as the coordinator of the project, was also responsible for the development and dissemination of information and results of the project, counting with the support of the project partners.

### 1.5.2 Summary of activities

This activity was conducted throughout the entire duration of the project. The following tasks were developed:

- The project’s website ([www.circularecobim.eu](http://www.circularecobim.eu)), online since March 2021, had 1647 visits during the entire reporting period (please refer to Annex 5.1);
- A promoting video of the project<sup>5</sup> was released in February 2022.
- Webinars:
  - 1<sup>st</sup> Webinar<sup>6</sup>, December 10<sup>th</sup> 2021: Presentation of the project, its objectives, and the expected outputs;
  - 2<sup>nd</sup> Webinar<sup>7</sup>, June 23<sup>rd</sup> 2021: Progress of the project;
  - 3<sup>rd</sup> Webinar<sup>8</sup>, February 16<sup>th</sup> 2022: Progress of the project.
- Conference papers:

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<sup>5</sup> Portuguese version: <https://www.youtube.com/watch?v=xtLcdmX7bdE&t=11s>; English version: <https://www.youtube.com/watch?v=ZJ-oLPqPpCc>

<sup>6</sup> <https://www.youtube.com/watch?v=HWOHmuYaB0U>

<sup>7</sup> <https://www.youtube.com/watch?v=ysvCcMrEv1Y&t=288s>

<sup>8</sup> <https://www.youtube.com/watch?v=gLiUyLqq4Mc>

- Teresa Ferreira presented a paper at the PT BIM conference in Braga, Portugal, from 4<sup>th</sup> - 6<sup>th</sup> of May 2022. The paper with the title “Integração de Metodologias de Avaliação do ciclo de vida em Ferramentas BIM” is published open access<sup>9</sup>.
- Teresa Ferreira and Joana Fernandes presented one paper each, at the CESB22 conference in Prague, Czech Republic, 4<sup>th</sup> - 6<sup>th</sup> July, 2022: “Integrated sustainability assessment using BIM” and “Advancing Circular Economy in the Existing Building Stock: a methodology to support building characterisation for sustainable refurbishment design”;
- Teresa Ferreira from IST CERIS submitted and presented the paper “BIM-based LCA tool: Simulation of different scenarios applied to a Case Study” at the ECPPM2022 conference in Trondheim, Norway, 14<sup>th</sup> - 16<sup>th</sup> September 2022;
- Verena Göswein from 3drivers presented a paper at the SBE Berlin conference in Berlin, Germany from 20<sup>th</sup> - 23<sup>rd</sup> of September 2022. The paper called “Bridging the Gap – A database tool for BIM-based circularity assessment” is published open access<sup>10</sup>;
- Presentations of the Circular EcoBIM project:
  - International Society for Industrial Ecology (ISIE), June 21<sup>st</sup>, 2021: “Improving building circularity through BIM/LCA integration” was presented by Teresa Ferreira. The recorded session can be accessed through the YouTube channel from the ISIE<sup>11</sup>.
  - Mariale Moreno from 3drivers presented in an event organized by Resourcify<sup>12</sup>, that took place on March 30<sup>th</sup>, 2022, and disseminated goals and intermediate steps of the project;
  - Teresa Ferreira presented in the Webinar “Como beneficiar da I&D no setor AEC através da Descarbonização” that took place on the 5<sup>th</sup> of April 2022 in Instituto Superior Técnico;
  - Maria Teresa Ferreira from IST CERIS presented the work developed in a Workshop from the Athena project in ISCTE on 2<sup>nd</sup> of June 2022: “Integrated Sustainability Assessment Using BIM - The Level(s) LCA plugin”;
  - Joana Fernandes from IST IN+ presented a project summary in an event workshop organized by Atlantic Technological University (Ireland), that took place on the 11<sup>th</sup> of October 2022, and disseminated goals and intermediate steps of the Circular EcoBIM project. The recorded video can be downloaded from Google Drive<sup>13</sup>;
- Final event of the project took place on October, 3<sup>rd</sup> 2022. It was held in a hybrid format: in-person at Heden<sup>14</sup>, Santa Apolónia in Lisbon, and online on Zoom. The technical

<sup>9</sup> Link to paper by Ferreira et al.: <https://doi.org/10.21814/uminho.ed.32.46>

<sup>10</sup> Link to paper by Göswein et al.: <https://iopscience.iop.org/article/10.1088/1755-1315/1078/1/012099/meta>

<sup>11</sup> <https://www.youtube.com/watch?v=16GwgfnlL3Q>

<sup>12</sup> <https://go.resourcify.com/en/webinar-circular-economy-technology>

<sup>13</sup> [https://drive.google.com/file/d/1bumn8Qx0suCTxbB6npyZX\\_m76JA\\_A9Ev/view?usp=sharing](https://drive.google.com/file/d/1bumn8Qx0suCTxbB6npyZX_m76JA_A9Ev/view?usp=sharing)

<sup>14</sup> Link to the photos of the final event:

<https://drive.google.com/drive/folders/1gOopsvjNllkg4E0gy1LAW8WMffU6Ddob>

outputs of the project were presented by different members of the consortium and followed by a round table discussion. The recording was uploaded to the project's Youtube channel<sup>15</sup>;

- As the project consortium has decided to produce podcasts instead of oral and written communications, a miniseries podcast was developed and released during 2022. There were 4 episodes in which a member of the consortium was interviewed alongside an expert on the following topics:
  - Episode 1: the topic “Design for circular construction” was discussed by Joana Fernandes from IST IN+ and Prof. Dr. Danielle Densley-Tingley from the University of Sheffield;
  - Episode 2: the topic “Metrics for circular construction” was discussed by Prof. Dr. Rolf André Bohne and Dr. Eirik Resch from NTNU;
  - Episode 3: the topic “Policy and circular construction” was discussed by António Lorena from 3drivers and Agathe Kuhn from Longevity Partners;
  - Episode 4: the topic “Putting circular construction into practice” was discussed by Luís Cabecinha from Potential Sketch and Laura Moreira from Tellus.

Episodes 1-3 were recorded in English and moderated by Dr. Verena Göswein from 3drivers, while Episode 4 was recorded in Portuguese and moderated by Ana Mestre from 3drivers. The recordings of the podcasts took place in June and were then edited and uploaded to YouTube<sup>16</sup> including captions in English and Portuguese. In addition, a Spotify account for the project was created<sup>17</sup>, which also hosts the four podcast episodes. The transcripts, in English and Portuguese, of all four episodes can be found on the project website<sup>18</sup>.

The final reports of the activities will be uploaded on the website of the project.

## 1.6 Project management and coordination

### 1.6.1 *Specification of objectives, tasks and role of each partner*

This activity ensures that the project's objectives are achieved on time and within the budget and that the use of resources and communication between partners is carried out effectively. This includes supervision activities, the administration and financial management of the project, preparation of required administrative information and contact with the funding agencies. As promoter of the project, 3drivers is responsible for this activity.

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<sup>15</sup> Recording of the final event: <https://www.youtube.com/watch?v=x8e4mBZxp-s>

<sup>16</sup> YouTube recordings of [Episode 1](#), [Episode 2](#), [Episode 3](#), and [Episode 4](#)

<sup>17</sup> Podcasts on Spotify:

<https://open.spotify.com/show/4Y3Wi9eLQ96sEEX7G0cZ87?si=470722d13b4e46cf>

<sup>18</sup> Project website library: <https://circularecobim.eu/library/>

### 1.6.2 Summary of activities

3drivers organized and moderated regular consortium meetings. During the project, several consortium meetings took place. Each meeting had a different agenda depending on the current topics at those times. Moreover, various bilateral and other meetings were organized by 3drivers and attended by different project partners. The goal of these meetings was to align the partners' work for a systematic and efficient project development.

In November and December, the following meetings took place:

- 2022/11/02 – Consortium meeting: Plan deliverables and final tasks of the project (Please refer to Annex 6.1);
- 2022/11/22 – Internal meeting to discuss Demonstration Final Report (Please refer to Annex 6.2).

A list of attendees in all the meetings held since the beginning of the project can be found in Annex 6.3.

Furthermore, the promoter was also responsible for the acquisition of services in the context of the project. During the project, there were two acquisitions:

- Programming of a Circularity Tool for Autodesk Revit developed in Dynamo under Activity 3 - Platform Development;
- LCA Collaboration Server under Activity 2 - Database.

To comply with EEA Grants rules on service acquisition, it was necessary to make a tender to select the best candidate to program and develop the tool according to the established goals by the Consortium members.

## 2 Results achieved

Table 2 presents the results obtained during the project and compare them with the targets defined for the project indicators.

Table 2. Project results indicators

Activity	Project Indicator	Unit	Target	Total achieved results
1	Number of reports	number	2	2
1	Number of filled in Product Data sheets <sup>19</sup>	number	20	50
2	Number of reports	number	2	2
2	Number of BIM objects with circularity indicators	number	50	82 <sup>2021</sup>
3	Number of reports	number	2	2
3	Software	number	1	3
4	Number of reports with environmental and economic benefits	number	1	1
4	Number of buildings with Circular EcoBIM	number	2	3
5	Website visitors	number	1500	1647
5	Events organized	number	4+1	4+1 <sup>22</sup>
5	Events participants	number	400	275
5	Communications (oral and written)	number	10	16
5	Newsletter subscribers <sup>23</sup>	number	100	0

The final deliverables of the project are the following:

- Final Report of the Platform Specifications;
- Final report of the Database Development;
- Final report of the Platform Development;

<sup>19</sup> This indicator was carried out in activity 2

<sup>20</sup> After completion of the BIM model for the Lisbon archetype, the BIM objects were counted and amounted to 28 (please refer to Interim Report No.7)

<sup>21</sup> When applying the ATREM House as a case study for the circularity plugin, 54 BIM objects were counted (please refer to Interim Report No.8)

<sup>22</sup> The participation in the Industrial Ecology Day was not planned for. Therefore, the total number of organized events will be minimum five at the end of the project, i.e. four webinars/seminars and the IE Day session

<sup>23</sup> This indicator was carried out through four podcasts.

- Report with environmental and economic benefits (Demonstration Final Report);

The final deliverables were already submitted to the Funding Agency on 30.12.2022 and are annexed to this report. Furthermore, they will be published on the website of the project.

Table 3 presents the schedule of each activity, the verification sources for each of the activity's indicators and the deliverables developed under each activity.

Table 3. Activities to report

ID	Activity	Start	End	Status	Indicator	Target	Verification source	Deliverables
1	Platform Specifications	2020-08-17	2022-04-30	Completed	Number of product data sheets	20	Reports No. 4, 6, 7, 8.; Publicly available database	Interim report of the Platform Specifications;
					Number of reports	2	Publicly available reports	Final report of the platform specifications
2	Development of the database	2020-10-01	2022-12-31	Completed	Number of reports	2	Publicly available reports	<u>Interim report of the database development;</u>
					Number of BIM objects with circularity indicators	50	Publicly available database; Publicly available reports	Final report of the database development
3	Platform development	2020-12-01	2022-12-31	Completed	Number of reports	2	Publicly available reports	Interim report of the platform development; Final report of the platform development
					Software	1	Internal records (with evidences)	-
4	Demonstration	2020-08-17	2022-12-31	Completed	Number of reports	1	Publicly available report	Report with environmental and economic benefits (Demonstration final report)
					Number of buildings with Circular EcoBIM	2	Publicly available report	
5	Dissemination and exploitation	2020-08-17	2022-12-31	Completed	Website visitors	1500	Website analytics	Dissemination and exploitation report
					Events organized	4	Website	



					Events participants	400	Internal records (with evidences)	
					Communications (oral and written)	10	Internal records (with evidences)	
					Newsletters <sup>24</sup>	100	YouTube, Spotify, Website analytics	

<sup>24</sup> This indicator will be carried out through four podcasts as mentioned in section 1.5.

### 3 Description of costs and financial impact assessment

Table 4 presents a summary of the expenses associated with the project's execution.

Table 4: Description of project's financial execution

Activity/Partner	Planned budget	Project execution	
<b>0. Project management</b>			
3drivers	22 845,00 €	26 930,40 €	+18%
<b>Total</b>	<b>22 845,00 €</b>	<b>26 930,40 €</b>	<b>+18%</b>
<b>1. Circular EcoBIM Platform Specifications</b>			
3drivers	9 922,50 €	10 046,19 €	+1%
Central BIM	20 916,00 €	22 487,00 €	+8%
Atelier dos Remédios	4 725,00 €	- €	-100%
IST	30 162,70 €	32 700,55 €	+8%
NTNU	8 507,43 €	2 979,00 €	-65%
<b>Total</b>	<b>74 233,62 €</b>	<b>68 212,75 €</b>	<b>-8%</b>
<b>2. Circular EcoBIM database</b>			
3drivers	59 112,50 €	57 066,74 €	-3%
Central BIM	31 374,00 €	29 829,34 €	-5%
IST	20 061,66 €	18 801,98 €	-6%
NTNU	17 014,85 €	8 373,61 €	-51%
<b>Total</b>	<b>127 563,01 €</b>	<b>114 071,67 €</b>	<b>-11%</b>
<b>3. Platform Development</b>			
3drivers	17 500,47 €	17 122,63 €	-2%
Central BIM	37 599,20 €	42 151,27 €	+12%
IST	10 054,23 €	13 018,80 €	+29%
NTNU	10 007,43 €	5 674,52 €	-43%
<b>Total</b>	<b>75 161,33 €</b>	<b>77 967,23 €</b>	<b>+4%</b>
<b>4. Demonstration</b>			
Potential Sketch	9 922,50 €	9 573,77 €	-4%
3drivers	14 553,00 €	11 473,69 €	-21%
Central BIM	61 099,20 €	61 984,10 €	+1%
Atelier dos Remédios	3 756,38 €	4 054,72 €	+8%
IST	27 069,08 €	22 953,03 €	-15%
NTNU	18 514,85 €	9 771,74 €	-47%
<b>Total</b>	<b>134 915,01 €</b>	<b>119 811,04 €</b>	<b>-11%</b>
<b>5. Dissemination and exploitation</b>			
Potential Sketch	1 653,75 €	1 739,49 €	+5%
3drivers	24 222,64 €	30 400,81 €	+26%
Central BIM	4 183,20 €	6 567,79 €	+57%
IST	20 061,66 €	20 052,05 €	-0%
NTNU	8 507,43 €	5 585,15 €	-34%
<b>Total</b>	<b>58 628,67 €</b>	<b>64 345,29 €</b>	<b>+10%</b>
Indirect costs	93 214,28 €	88 468,28 €	-5%
<b>Total costs</b>	<b>586 560,93</b>	<b>559 806,66</b>	<b>-5%</b>
Execution rate (%)		95%	

## 4 Description of the Project's contribution to achieving the overall objectives of EEA Grants and the 'Environment Programme'

As the project reached its conclusion, one can describe the contribution of Circular EcoBIM to the EEA Grants and the targets of the 'Environment Programme'. The project contributed to all priority areas of the call:

A. Development and implementation of construction projects demonstrative of the economic and environmental benefits, of concepts that assume zero waste, of energy efficiency and material productivity: This priority was achieved through the demonstration phase, namely with the publication of the results from the benefits assessment of applying the Circular EcoBIM platform to the three case studies of the project.

B. Projects that promote the performance and environmental profile of materials, components and products developed in Portugal, including buildings, through the application and promotion of innovative methodologies and technologies: this priority was achieved by the development of the Circular EcoBIM platform itself, in particular of the building environmental assessment that allow obtaining Circularity indicators and indicators from the European Commission Level(s) framework. Moreover, the integration of national and international EPDs in the building model contributes to the environmental profile of the materials, components and products.

C. Projects promoting business-to-business cooperation for building and demolition waste reduction: This priority was achieved through the implementation of the MFA-based methodology, which helped to identify CDW prevention opportunities and recycling destinations for all CDW produced throughout the building's life cycle in Herdade do Pinheiro, but also to develop low-carbon and less material intensive scenarios.

The project also fits in with the concrete objectives of the MFEEE 2014-2021 Environment, Climate Change and Low Carbon Economy Program, namely the following objectives / outputs:

- PA11 / Objective 1. Increasing the application of CE principles in specific sectors: The project contributed to the development of a new generation of BIMs that incorporate information on the circularity potential of materials and components and hence the entire building. The integration of circularity concepts into the rapidly growing BIM technology, which is on the way to becoming a common practice in the construction sector, also enhances the growth of the circular economy in this sector;

- Output 1.4. Increasing resource efficiency in the construction sector: The Circular EcoBIM project allows the calculation of aggregate circularity indicators, but also map opportunities for better resource management at different stages of the building life cycle, promoting the prevention of waste and the incorporation of secondary raw materials in the sector itself or in other sectors. Final reports demonstrate the technical gains and the environmental and economic benefits associated with the proposed approaches and therefore contribute to increase the efficiency of the entire sector.

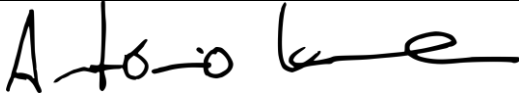
The main objective of the Circular EcoBIM project is also aligned with various national and European backgrounds. The construction sector is identified as one of the most relevant sectors for the circular economy in the Plan of Action for the Circular Economy. Also, in the European context, it is important to highlight the alignment of the Circular EcoBIM project with the EU Construction and Demolition Waste Protocol and Guidelines, namely by addressing the challenges related with CDW identification, deconstruction, high-value recycling and improving waste tracking and monitoring.

Table 5 presents the quantitative contribution of the project to the objectives and targets of the 'Environment Programme' and EEA Grants.

Table 5. Contributions to the outcomes of the programme

	Indicator	Related activity	Contribution of the project to date
<b>PA 11 Objective 1</b>	Use of secondary materials increased in the supported sectors (percentage)	all	<i>Cannot be measured</i>
	Number of jobs created	all	3 All female 30-40 years old
	Construction and demolition waste saved in the supported sectors (percentage)	4	<i>Cannot be measured</i>
<b>Output 1.4</b>	Number of innovative solutions for increased resource efficiency piloted	3	4
	Number of SMEs supported		0
	Number of demonstration buildings constructed	4	0

**Project Promotor**

Name	António Lorena
Date and Signature	
Position	Managing Partner – 3drivers

**Programme Operator – Secretary General for Environment**

Name	Marco Rebelo
Date and Signature	
Position	Secretary General

## Annexes

The following annexes are submitted as separate documents:

Activity 1 “Circular EcoBIM Platform Specifications”

Annex 1.1\_ Platform Specifications Final Report

Activity 2 “Development of Circular EcoBIM database”

Annex 2.1\_ Database Final Report

Activity 3 “Development of the Circular EcoBIM platform”

Annex 3.1\_ Platform Development Final Report Part I

Activity 4 “Demonstration”

Annex 4.1\_ Demonstration Final Report Part I

Activity 5 “Dissemination and exploitation”

Annex 5.1\_ Website Analytics

“Project management and coordination”

Annex 6.1\_ Consortium meeting Slides + screenshots

Annex 6.2\_ Bilateral Meeting Slides

Annex 6.3\_ Meeting log

Annex 6.4.\_ Timeline