

EDITORIAL

Welcome to the first issue of the CINDERELA project newsletter.

CINDERELA is a demonstration project with a strong application focus and ambition to make urban construction sector more resource efficient. To address this issue CINDERELA will deliver a business model accompanied by technological solutions and a pool of knowledge that will enable the use of locally/regionally available secondary raw materials recovered from waste streams available in urban and semi-urban areas in construction applications.

With our newsletters we would like to provide you with the updates on the project development including the advancements in building a circular economy business model for the construction sector, the development and testing of novel construction products based on secondary raw materials and technologies for manufacturing of these products. We will also present an overview of our demo activities related to the validation of the CINDERELA solutions in real environments.

In this issue we would like to give you an overview of the CINDERELA business model concept and first steps towards its development using a Material Flow Analysis tool to identify and valorise waste streams with a potential of secondary raw materials recovery to be used for construction purposes. We would also like to present to you the demo cases that are planned to be implemented to test the CINDERELA outcomes in real conditions.

This newsletter also serves to invite you to join the CINDERELA stakeholder community.

The subscription provides you with a number of opportunities including:

- ★ being first to be updated on CINDERELA developments and events via periodical communications and through our newsletters released twice a year,
- ★ getting notifications on the release of our reports and findings,
- ★ being in the communication loop to have a say and provide feedback on our work

Interested? Visit www.cinderela.eu for registration and info on our project.

CINDERELA Team

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CINDERELA in Brief

CINDERELA (New Circular Economy Business Model for More Sustainable Urban Construction) is a large-scale demonstration project implemented under the flagship of the Horizon 2020 EU Programme. The objective for the project is to design and demonstrate under real conditions **a circular economy business model dedicated to the urban construction sector called CinderCEBM**. The model will enable production of construction products using Secondary Raw Materials (SRM) recovered from different waste types available in urban and semi-urban areas and their application in urban construction services in a technically feasible and economically viable way. The SRM based construction materials will include manufactured aggregates, soil and building composites.

The project aims to:

- ★ create new business opportunities for construction industry and SMEs based on a resourceful use of available materials locally/regionally,
- ★ provide evidence-based knowledge on the enabling framework conditions for design, production and use of SRM based construction materials,
- ★ help build confidence in innovative SRM based construction materials by providing reliable test data on their performance based on testing protocols in line with the construction sector requirements,
- ★ mobilise stakeholders and resources for circular economy implementation in the construction sector on local/regional level.

To achieve these objectives, CINDERELA will investigate and valorise the potential of waste streams available in urban and semi-urban areas, develop and test new SRM based construction



What can CINDERELA offer to stakeholders?

For construction entrepreneurs CINDERELA will:

- ★ provide a business model enabling the use of locally/regionally available materials recovered from urban waste streams as input materials for manufacturing and applying green construction materials,
- ★ demonstrate and promote the values of applying this model towards stakeholders and decision makers as a tool for implementing the circular economy concept in the construction sector and local/regional economies,
- ★ provide a pool of knowledge on best practices and market relevant information on the use of SRM based construction materials in urban construction projects.

For waste stream holders and waste processing companies CINDERELA will:

- ★ provide new, more resourceful options for managing waste streams,
- ★ create an interactive platform for match-making of the waste stream users and other potential business partners as a companion tool facilitating the implementation of the business model,
- ★ develop characteristics of certain waste streams and their valorisation as input material for construction applications.

For regional/local authorities CINDERELA will:

- ★ provide solutions for achieving the circular economy objectives at a local/regional level by a better management of resources recovered from urban waste streams in urban construction works.

For governmental bodies CINDERELA will:

- ★ provide policy guidelines on facilitating circular economy business models and stimulating a circular construction sector in general to validate their innovation and environmental added value for specific applications.

For standardisation/certification bodies CINDERELA will:

- ★ define specifications on the performance of SRM based construction materials,
- ★ define new ways of testing these materials based on the Environmental Technologies Verification scheme to prove their environmental added value in relation to fitness for purpose.

For research bodies CINDERELA will:

- ★ provide a collection of research results on sustainable construction materials and applications of urban waste streams,
- ★ provide inspirations for new research in this area.

materials and their manufacturing technologies and demonstrate their applications in real urban construction projects. The business model to be developed will serve as an enabler of economic opportunities based on these concepts together with a digital knowledge and cooperation platform facilitating its implementation in regions and cities. The sustainability aspects of the business model will be validated with the environmental, economic and social assessment through the whole lifecycle (LCA, LCC and S-LCA).

CINDERELA has an ambition to reduce the environmental impacts along the construction value and supply chain by 20%. It will also help increase the competitiveness of construction companies by providing an opportunity to make their services more sustainable. This will happen by providing real environment tested solutions for reducing virgin material exploitation and converting wastes to products.



CINDERELA project facts

Project duration:	June 2018 - May 2022 (48 months)
Total Project budget:	7 635 365.25 €
Project Coordinator:	Slovenian National Building and Civil Engineering Institute (ZAG)
Project website:	www.cinderela.eu



CinderCEBM – a circular business model for urban construction

At the heart of the CINDERELA project is a product driven business model, in short CinderCEBM. The CinderCEBM is to enable turning unused waste into SRM that can be applied in the construction sector.

New value chains

Setting up new waste-to-products flows requires new business practices. CinderCEBM can be adapted by new or existing construction entrepreneurs to create a business that contributes to a circular construction sector.

The main business practice will involve collecting waste, its processing for recovery of materials or use in full as SRM, and finally their application for manufacturing construction products fit for purpose. All supported by LCA studies and relevant certification. As such, current manufacturers of construction materials are the main target of the CinderCEBM.

Sustainable values

By changing the current practices in urban waste management and consumption patterns of the construction sector, CinderCEBM is intended to deliver economic, environmental and social values to a broad scope of stakeholders and actors along the supply and value chains.

The economic value will be created for construction entrepreneurs by potential costs reduction of manufacturing construction materials thanks to full or partial substitution of virgin materials by cheaper, quality SRM available locally/regionally.

Economic value will also be created for waste holders currently dumping the waste, and the value that comes with it, when it could become an asset.

CinderCEBM will provide environmental values to the urban construction sector by improving its environmental performance in terms of reduction of resource consumption, generation of waste and equivalent CO₂ emissions. For local and regional authorities, the environmental values of CinderCEBM will be the use of resources and locations, that are currently associated with waste, for better purposes. Finally, in terms of social values provided by CinderCEBM, growth in job opportunities should be mentioned.

CinderOSS: a one-stop-shop to support the business model

CinderCEBM focuses on a product-driven business which involves ongoing learning about users and new techniques to develop better products and facilitating their implementation. For that purpose CINDERELA will offer a digital tool in a form of a one-stop-shop (CinderOSS).

CinderOSS will act as a knowledge hub for construction companies interested in implementing the CinderCEBM. To cover a large variety of topics, CinderOSS will be divided into four modules:

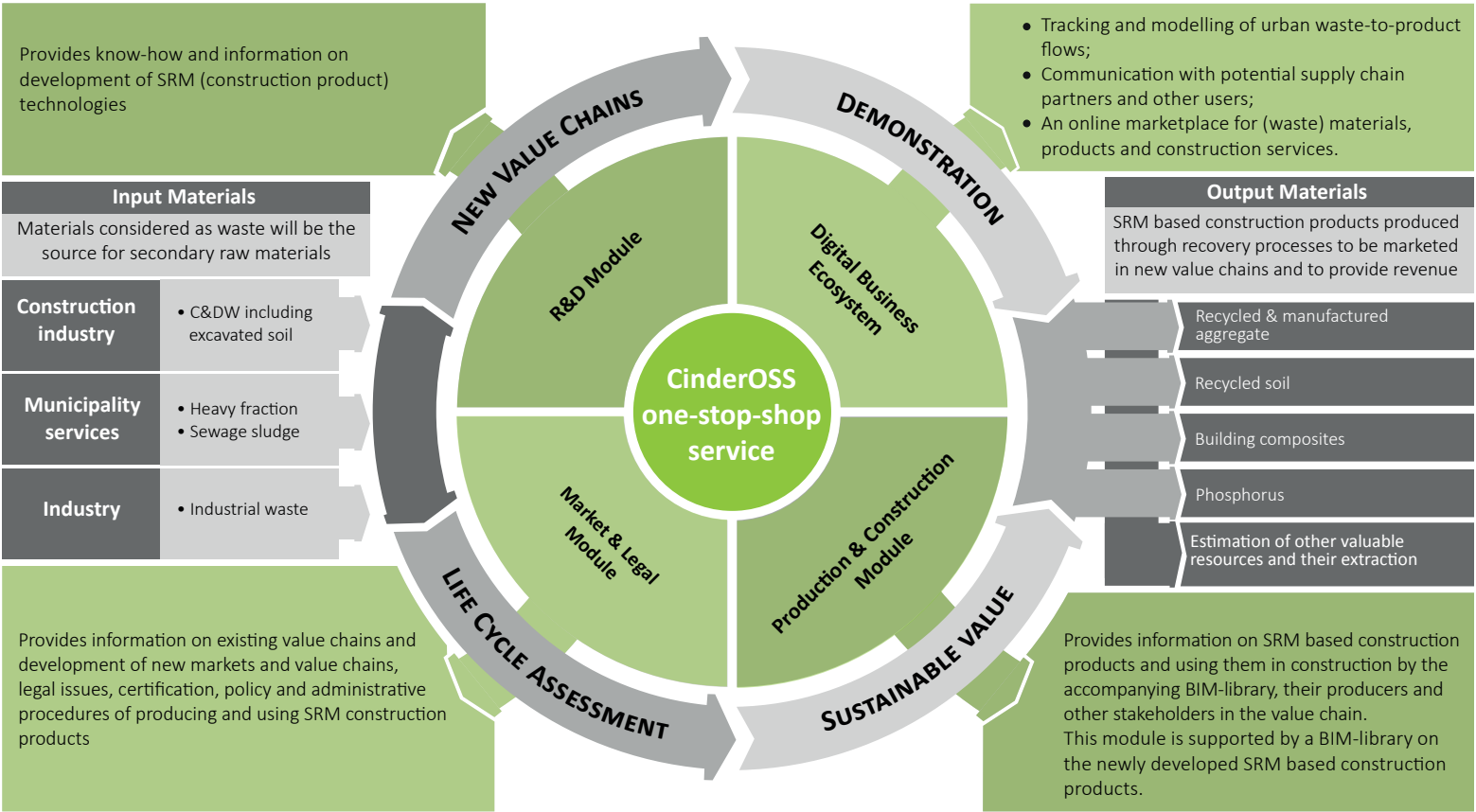
- ★ **production & construction module** that provides information on SRM based construction products' characteristics (also in the form of a BIM-libraries), where to get these products and how to use them;
- ★ **research & development module** which will collect new knowledge on current and future development of SRM (construction product) technologies;
- ★ **market & legal module** that builds market and legal information provided in the CEBM with certification, administrative procedures and specific knowledge on the economic environment of the EU-28 countries;
- ★ **the CINDERELA Digital Business Ecosystem** that facilitates tracking and selling of waste and resources and match-making for business partners.

Demonstration

Both the business model and the digital platform will be developed and tested in real environments using a series of pilots and large-scale demos involving production and testing of SRM based construction materials and their implementation in real world construction projects.

Testing and validation activities with the involvement of stakeholders will ensure that the business model is operational in real conditions and CinderOSS provides useful and market relevant support needed to enable this model.

CINDERELA Circular Economy Business Model (CinderCEBM)



CinderCEBM will be designed to function in urban and semi-urban areas. These areas generate large quantities of different waste types available locally and at hand, potentially of use for the model. However, they need to be properly identified and valorised.

One of the first objectives of CINDERELA is to identify and assess the waste streams generated in urban and semi-urban areas in terms of availability and potential for delivering quality SRMs in relevant amounts that can be of use for manufacturing construction materials. For that purpose a Material Flow Analysis (MFA) will be carried out in six different European regions: Spain, Slovenia, Croatia, Poland, Italy and the Netherlands. The analysis will be carried out based on several steps aimed at providing input data including identification of waste streams of interest, entities generating them, their location and quantities.

Step 1: Selection of waste streams

The first step in this process is the selection of the waste streams to be assessed. CINDERELA partners have selected the European Waste Codes (EWC) that will be studied in the MFA, based on their broad experience in construction recycling and bibliographic research. As a result, the CINDERELA EWC list has been issued, containing waste streams from:

- ★ thermal processes such as slags and sludges;
- ★ construction and demolition such as concrete, bricks, tiles and ceramics;
- ★ waste packaging such as plastic, glass, textile packaging;
- ★ waste management facilities such as heavy fraction or sludges and;
- ★ municipal wastes such as wood and glass.



Metallurgical slag

© photo ZAG

Step 2: Waste data acquisition

The second step for MFA involves acquisition of accurate data from the local, regional and national administrations on the different collected wastes.

First observations show that there are great differences in the waste data obtained from the six European regions studied in CINDERELA. Despite the fact that the EU Member States are obliged to carry out appropriate registers, some countries have data resources available and accessible in formats enabling an easy and correct quantification and classification of wastes from different streams, while others have not. Accessible and accurate data on waste generation are crucial for the analysis and assessment of the waste streams as sources of SRM for the purpose of the business model.

Step 3: Combining waste data with economic activity

As a third step in the analysis, the waste streams are combined with the economic activities that generate them. For that purpose, a mapping tool is used that combines a list of the NACE (Nomenclature des Activités Économiques dans la Communauté Européenne) codes of the economic activities with the waste types encoded using the European Waste Codes (EWC).

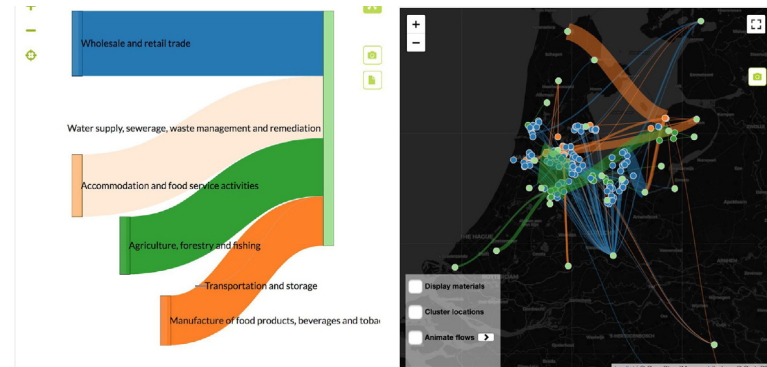
Finally, with the help of the ORBIS database including data on the companies, a list with the geolocated actors that produce the waste streams in each of the six studied regions is compiled.

Step 4: Visualisation

Material Flow Analysis works best when translated into images. Therefore, for each of the test regions all data (i.e. stocks and flows) will be graphically represented with the help of a Geodesign Decision Support Environment (GDSE) tool developed under the H2020 project REPAIR (Resource Management in Peri-urban AREas: Going Beyond Urban Metabolism, <http://h2020repair.eu/>).

Depending on the needs, the use of GDSE tool allows to apply different criteria on the visualised waste streams such as: quantity (i.e. the amount of waste produced); quality (i.e. composition and characteristics of specific waste products); treatment (i.e. destination of the waste produced: landfilled, incinerated, recycled); economic; actor-specific; and geo-specific, etc.

The two images below present what will be the outcome of the GDSE tool: on the left-side a Sankey diagram illustrating the quantities for 4 specific waste-flows from production to treatment, whereas the image on the right-side shows the specific locations and itineraries of these flows on a map.



These criteria allow to investigate different opportunities for the handling of waste generated in the region in view of material recovery for construction applications. They will also help identifying the SRM for further lab testing related to construction products manufacturing, to be performed later in the project. Moreover, the tool will also serve to select the most promising SRM produced in the region and to make an in-depth analysis of their potential for manufacturing new products and establishing new value chains for the needs of the circular economy business model for urban construction.

What and where will be demonstrated in CINDERELA

Slovenia:

- ★ Demo on extraction of phosphorous from sewage sludge in Maribor
- ★ Modular and mobile pilot plant for recycled aggregates, manufactured aggregates, recycled soil, building composites
- ★ Demo revitalisation of degraded area for construction use with the use of SRM based materials
- ★ BIM supported demo construction of a utility building made of green concrete
- ★ Demo on road construction with SRM based materials

The Netherlands, Italy:

Simulation of operational environment for CinderCEBM



Spain:

- ★ Pilot plant for recycled aggregates, bricks, manufactured aggregates, recycled soil, building composites
- ★ Demo revitalisation of an old industrial park area with the use of SRM based materials
- ★ Demo construction of a utility building made of green concrete and other recycled materials
- ★ BIM supported demo construction of an access road to the industrial park

Croatia:

- ★ Modular and mobile pilot plant for recycled aggregates, manufactured aggregates, recycled soil, building composites
- ★ BIM supported demo revitalisation of a degraded area with the use of SRM based materials
- ★ Demo construction of a fence and walls for separation units made of green concrete
- ★ Demo construction of an industrial road

Poland:

Simulation of operational environment for CinderCEBM

Testing in real environments: CINDERELA Demos

One of the central activities of the project is to demonstrate in a large scale the newly developed circular economy business model CinderCEBM and the one-stop-shop CinderOSS service enabling their maturation and successful implementation.

This will be done through demonstrations of CinderCEBM and CinderOSS service in six different functional environments, i.e. Slovenia, Croatia, Spain, Italy, Poland and the Netherlands.

While actual demonstration of construction with SRM based materials will be implemented in Slovenia, Croatia and Spain, testing of CinderCEBM and CinderOSS will also be carried out in the Netherlands (one of the most advanced countries in recycling in EU), Poland and Italy.

Through this the basic conditions for the implementation of a business model such as the prices of waste handling and of SRMs, the availability of materials, non-technological barriers and incentives, will be checked.

Demo 1: Extraction of valuable materials - phosphorous extraction

State-of-the art:

There is no harmonised approach across Europe for sludge treatment. Different approaches, listed from the least favourable to the most favourable BAT approach, include: landfilling, incineration, extraction of phosphorus after incineration and extraction of phosphorus before incineration. The latter approach is usually implemented in centralised wastewater treatment plants (or up the chain), as a measure to reduce the operational and maintenance costs of the utility by preventing the clogging of the wastewater collection and treatment infrastructure with struvite. However, the approach is not wide-spread, because the (new) P-product is relatively new to the market and poses problems for utilities in terms of storage valorisation and market uptake.

CINDERELA approach:

CINDERELA project is building on recently established house-level, street-level and municipality-level pilots of struvite extraction in Amsterdam. These technologies produce struvite of different qualities that find different market applications (food and non-food product manufacturing, agriculture). For the purpose of CINDERELA, the house-level pilot from Amsterdam will be re-conceptualised and constructed in Maribor in order to demonstrate extraction of phosphorus - a critical raw material from the black water entering the wastewater system, which after the treatment ends as sewage sludge.



Phosphorus recovered as struvite
(Source: GENOCOV research group, Universitat Autònoma de Barcelona, <http://www.genocov.com/>)

Main results:

- ★ a large-scale demonstration of phosphorous extraction through struvite production from black water from an office building with approximately 200 population equivalents;
- ★ model of a business case for struvite recovery and valorisation, applicable in other EU countries.

Demo 2: Pilot production of SRM based construction products

State-of-the art:

Some recycled materials such as construction and demolition waste, a few types of manufactured aggregates, i.e. slag aggregate and foundry sand have already been partly used in some European countries in construction, though in relatively small quantities and mainly for low grade applications. The potential of many other materials from municipal waste treatment, especially numerous industrial waste, sewage sludge and inert heavy fraction from municipal waste still remains unused, in particular when taking into consideration their immense possibilities in terms of mass flows and synergic effects for production of new construction composites.

CINDERELA approach:

Pilot production demonstrations will comprise utilisation of the identified waste streams, such as construction and demolition waste, excavated soil, industrial wastes, sewage sludge and inert heavy fraction from municipal waste for production of SRM based construction products. Wastes will be handed over by polluters and treated with a different combination of physical (mainly grinding, mixing and sewing), chemical (hydraulic/pozzolanic remediation) and biological technologies. The specific combination of technologies used for each product will vary with regard to waste availability, its composition and intended end-use of the product. The pilot demonstration plant will be both modular and mobile. The recovery process will produce four types of construction products: recycled aggregates, manufactured aggregates, recycled soil and building composites. The use of all these materials will be demonstrated in large-scale construction demonstration as described below in DEMO 3. Additionally, new ways of production of SRM based construction products via 3D printing will be demonstrated in Marineterrein Amsterdam (The Netherlands).



Recycled aggregates

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Main results:

- ★ a modular and mobile pilot production plant for recycled and manufactured aggregates, recycled soils and building composites at NIGRAD facility in Dogoše, Maribor (Slovenia);
- ★ a modular and mobile pilot production for recycled and manufactured aggregates and building composites in Umag (Croatia);
- ★ a pilot production of recycled and manufactured aggregates, recycled soils and building composites at linked party of AEDHE, CTC Servicios and pilot production of bricks at their subcontractor;
- ★ a pilot 3D printing production of urban furniture.

Demo 3: Large-scale demonstrations of construction with SRM based construction products

Demo 3A: Revitalisation of a degraded area

State-of-the art:

There are numerous degraded sites in each European city as a consequence of industrial activities, which were moved in the 20th century from the urban to semi-urban areas. As properties, these sites are often of little if no value and thus are not attractive for investors. In addition, they may pose threat to the environment due to potential contamination of soil or hazardous waste.



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CINDERELA approach:

The idea behind CINDERELA project is to revitalise such degraded urban areas for use as construction land. In the case when immobilisation of hazardous waste will be needed, mixing with pozzolanic/hydraulic additives will be performed. The main SRM based construction products used for revitalisation will include recycled aggregates, manufactured aggregates, building composites and recycled soils.

Main results:

- ★ revitalisation of degraded area with building composites and recycled soil in Dogoše, Maribor (Slovenia);
- ★ revitalisation of degraded area in Umag (Croatia) supported by BIM;
- ★ revitalisation of an old industrial park in the degraded area in Madrid-Henares (Spain).

Demo 3B: Construction of small facilities

State-of-the art:

There are two main reasons that cause low interest in applying SRM based construction products for buildings. First is that most of the designers are focused on energy efficiency and rarely on materials efficiency of buildings. The other reason is the fact that most of voluminous wastes are preferred to be recycled for geotechnical works where large quantities of materials can be used.

CINDERELA approach:

The CINDERELA approach will demonstrate the use of recycled materials also for high demanding applications (i.e. medium to high-strength concrete). The main SRM based construction products here will be green concrete and mortar finishes made of recycled/manufactured aggregates and alternative binders, recycled aggregates (e.g. glass) for insulation, recycled aggregates for green roofs, reused roof materials and building furniture (windows, doors, etc).



Visualisation of the CINDERELA green concrete building

©NIGRAD

Main results:

- ★ a small demonstration building made of green concrete and other SRM based construction materials at NIGRAD's production site in Dogoše in Maribor (Slovenia) supported with the use of BIM;
- ★ a fence made of green concrete, which will surround the degraded area in Umag (Croatia) and walls for separation units;
- ★ a small facility on the site of the degraded area in Madrid-Henares (Spain), which will be used as an access control to the industrial area;
- ★ additionally a small-scale demo will be developed for the construction of the facility by 3D printing.

Demo 3C: Road construction

State-of-the art:

Road construction and rehabilitation has one of the largest potential for using large quantities of SRM based construction products. They can be used as unbound or hydraulically bound materials for the subbase and base course or as aggregate for surface course (either in asphalt or concrete). Nevertheless, the real application of SRM based construction materials is often hindered by the lack of appropriate legislation as well as due to the lack of interest of investors including even large national public investors.

CINDERELA approach:

CINDERELA will demonstrate three road construction pilots using alternative materials for subbase and base courses as well as surface course.



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Main results:

- ★ 400 m long road section with width of 8 m with side banks constructed at Dogoše site in Maribor (Slovenia);
- ★ an industrial road of 200 m in length and 8.0 m width in Umag (Croatia);
- ★ 500 m long and 6 m wide access road to a degraded area in an old industrial park in Madrid-Henares (Spain).



SAVE the date

CINDERELA: Establishing a New Circular Economy Business Model for More Sustainable Urban Construction

A three-day initial conference and stakeholder workshops

22 - 24 May 2019, Delft, the Netherlands

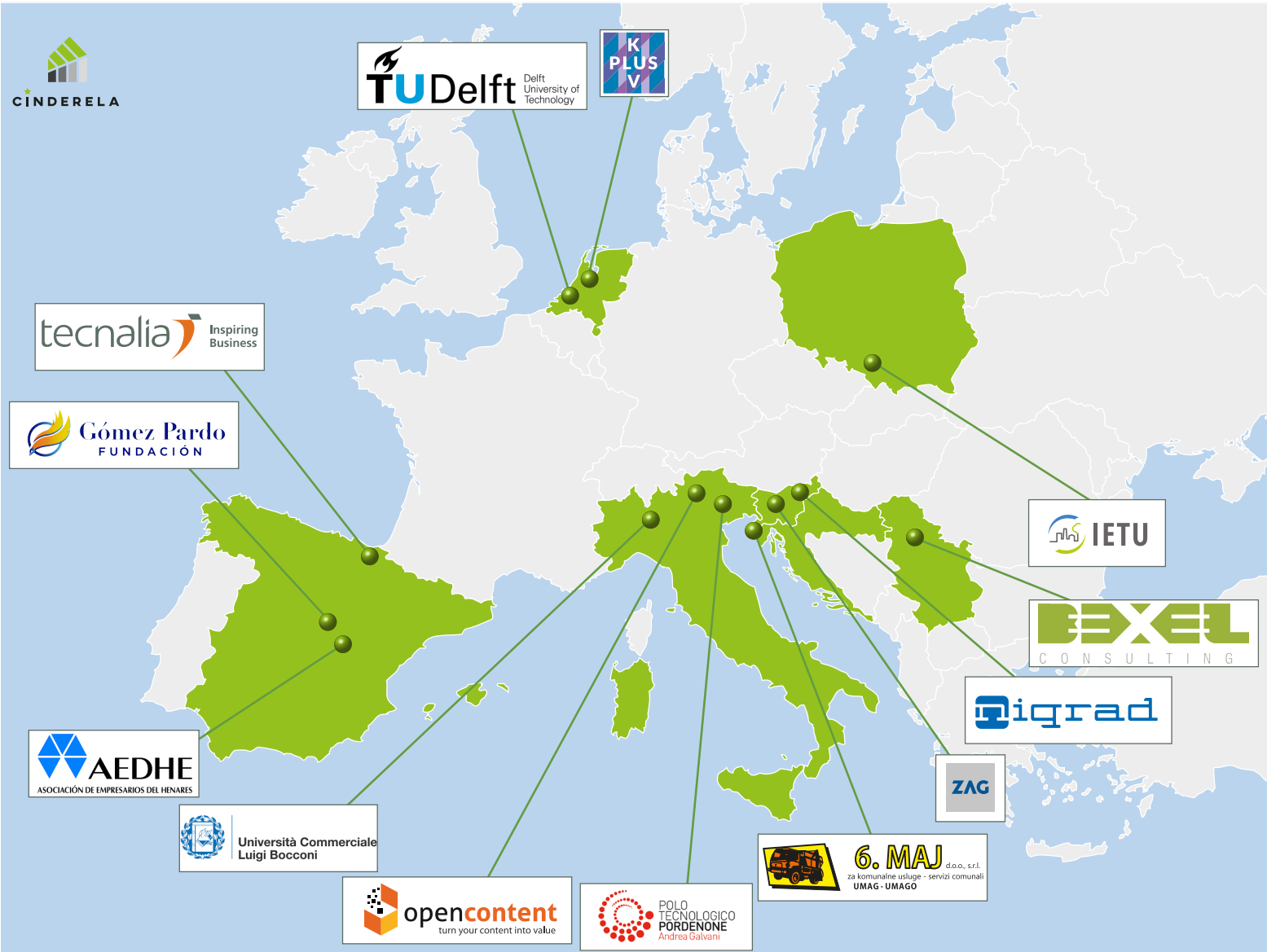


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TU Delft and AMS Institute as leading organisers and the CINDERELA project team invite all stakeholders interested in making urban construction sector more sustainable to take part in our event that will be held at the premises of the Delft University of Technology in Delft, the Netherlands on 22-24 May 2019. During a three-day event the CINDERELA partners would like to share and discuss with the stakeholders their ideas about the circular economy business model (CinderCEBM) and the accompanying platform (CinderOSS) as well as present the initial project results.

To conclude, all involved parties will have the opportunity to visit an inspiring example of sustainable resource management in the Amsterdam Metropolitan Area, showcasing Dutch innovative waste practices towards a more circular economy. More info soon on CINDERELA website.

Don't want to miss the opportunity to participate? Register yourself to the CINDERELA stakeholder community via www.cinderela.eu to receive updates.



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