CORDIS Results Pack on circular economy
A thematic collection of innovative EU-funded research results

Innovative solutions for industrial and urban waste management

November 2019
Editorial

Today’s ‘take-make-dispose’ economic model is wasteful and unsustainable. Businesses, research institutes and NGOs are therefore exploring ways to reuse products or their components via the circular economy and restore more of their precious materials and energy. This Results Pack examines six EU-funded projects that will help transform our economy and society and decouple industrial growth from environmental impacts.

The projects are very much in line with the strategy and priorities put forward by the new European Commission President, Ursula von der Leyen, for the European Green Deal and the New Circular Economy Action Plan. These will focus on sustainable resource use, especially in resource-intensive and high impact sectors such as textiles and construction.

Europe’s growing prosperity has resulted in the extraction and use of more resources, thereby producing more waste. Currently, an average citizen generates around 5 tonnes of waste, of which only a limited amount is recycled, most of the remainder is landfilled or incinerated.

The challenge of managing increasing quantities of waste, particularly from growing urban areas, represents a significant cost to society and puts pressure on the natural environment. But this discarded material also represents a valuable resource, which can be exploited by embracing a more circular economy that reduces waste and allows for the continual use of resources. This will help to conserve Europe’s environment and to protect society from the impacts of climate change.

A commitment to waste reduction

Boosting eco-innovative solutions in this way complies with the EU’s Communication on a Road Map to a Resource Efficient Europe which outlines how Europe’s economy can be transformed into a more sustainable one and proposes ways to increase resource productivity and decouple economic growth from resource use and its environmental impact. In addition, the Waste Framework Directive establishes the basic concepts related to waste management, defining waste, recycling and recovery.

The EU is thus committed to implementing the principles of the waste management hierarchy, which promotes the prevention of waste, its reuse and recycling and its energy recovery. This requires eco-innovative solutions and resource-efficient products, processes and services like the urban metabolism model, which analyses the flow of energy and materials within cities.

New approaches

In this CORDIS Results Pack we showcase innovative solutions proposed by projects funded by the EU through the Horizon 2020 programme that promote waste reduction and improved resource efficiency in the textile, construction, photovoltaic, steel industry, bulky and urban waste sectors.

The initiatives focused on Industrial Symbiosis, which is key driver for enabling the next step in a circular economy with a significant reduction in Green House Gas emissions, as well as its contribution to reaching a climate neutral economy by 2050 (zero emissions/zero waste), in line with the political guidelines of the von der Leyen Commission.

The RESYNTEX project tackled textile waste by creating a new circular economy concept that transforms it into feedstock for the chemical and textile industries. Another project, BAMB, is reducing construction and demolition waste through a new standardised circular way of designing buildings, enabling the construction sector to recover, repair and reuse building materials.

Meanwhile, CABRISS developed a circular economy for not only the photovoltaic, but also the electronic and glass industries, to form new business opportunities through the recovery of high-value materials. FISSAC demonstrates a new paradigm built on an innovative industrial symbiosis model with a zero-waste approach to the construction and demolition value chain.

Then we have URBANREC that designed an innovative bulky waste management system to enhance waste prevention and encourage new forms of waste treatment to obtain high added-value recycled products. Finally, Waste4Think used information and communication technologies to improve all stages of the waste value chain, adapting a global approach focused on citizen participation to move towards a circular economy and build more sustainable, eco-friendly cities.
Discarded textile now a raw material for the chemical and textile industries

Not enough textile waste is recycled across Europe. To tackle this, the RESYNTEX project created a new circular economy model for the textile and chemical industries, by recovering secondary raw materials from unwearable textile waste.

The EU textile industry generates waste estimated at 16 million tonnes per year. Around two-thirds of this waste is thrown in landfills or incinerated, with a high environmental impact and at great cost. Valuable resources held within the waste are also lost.

RESYNTEX is changing this with its innovative pilot project – a textile recycling plant – which recycles 100 tonnes of waste per year. This pilot installation in Slovenia transforms textile waste into secondary raw materials for the chemical and textile industries, creating circularity and reducing environmental impacts.

The project also extracted resources and chemicals from textile waste and recycled them. It used innovative technologies covering the whole textile value chain, where the sorted textile waste is chemically treated to extract resources such as protein-based fibres to be used for producing wood panel adhesives, and cellulosic fibres for producing bioethanol. Polyamide (PA) and polyester (PET) recovery was also carried out to produce new chemicals and plastics.

A holistic approach to textile recycling and reuse

Industrial symbiosis is the process by which waste or by-products of one industrial process become the raw materials...
for another. Materials can thus be used more sustainably and contribute to the business model. “Together with the chemical industry, the textile industry can benefit from utilising secondary textile streams, which results in industrial symbiosis. Low-grade textile fibres recycled into new chemical products get a new life instead of being thrown away or incinerated,” notes project technical coordinator Aleksandra Lobnik.

Although companies spend much on textile recycling and reuse technologies, current solutions involve a number of challenges. “Recycling fibres and converting them into high-value feedstock requires precise sorting as 50% of textiles are made from blended fibres. Technologies handling mixed fibres are not readily available,” explains Lobnik. “What’s more, although much is invested in plastic-to-textile, textile-to-textile or textile-to-chemical innovation, there is no easy solution within mechanical recycling.”

RESYNTEX put into practice a holistic approach to address the fragmented nature of textile waste processing via novel chemical pathways. It demonstrated automated fibre-sorting technology that yields approximately 85% clean textile material of very high purity (99%). The technology sorts fibre by composition and is complemented by the use of near-infrared-spectroscopy technology.

Project partners integrated the automated sorting process with the most promising chemical and enzymatic processes for extracting protein and cellulose-based natural fibres as well as PA and PET fibres. Liquid and solid waste treatment and water recycling technologies were also integrated in the process.

**Implementation of EU directives**

Waste management is undergoing significant changes in the EU. In 2015, the EC adopted an action plan to help accelerate Europe’s transition towards a circular economy. The action plan sets out measures to ‘close the loop’ of product lifecycles: from production and consumption to waste management and the market for secondary raw materials.

Several documents suggest amendments of waste-related directives. Textile waste is not directly addressed but the landfill directive should be amended so that the fraction of municipal solid waste to be landfilled is restricted to 10% by 2030. This boosts activities to divert waste (including textile waste) from landfill to incineration or recycling.

RESYNTEX is changing the environmental landscape of the textile industry in Europe. Its proposed sustainable recycling and chemical processes unlock the value of post-consumer textiles and create a tipping point for a closed-loop textile industry.

**PROJECT**

**RESYNTEX - A new circular economy concept: from textile waste towards chemical and textile industries feedstock**

**COORDINATED BY**

SOEX Group in Germany

**FUNDED UNDER**

H2020

**CORDIS FACTSHEET**

cordis.europa.eu/project/id/641942

**PROJECT WEBSITE**

resyntex.eu/
New integrated tools help the building sector move to a circular economy

Buildings constructed or refurbished with reversible design techniques create increased value in a sector where sustainability is under the spotlight. More value means less waste – the EU-funded BAMB project worked on ways to drive a systemic shift towards sustainable building.

The European built environment is responsible for a considerable amount of our energy consumption, total Green House Gas (GHG) emissions, resource extraction and waste production.

One of the principal causes of this is poor building design, coupled with the traditional linear economic model of produce-use-dispose. With only one end-use in mind, following economic or social change, buildings often end up vacant. This in turn leads to demolition, or complex and expensive renovation or repurposing work, generating considerable waste.

The EU-funded BAMB project fostered a paradigm shift where materials, components and buildings are evaluated and conceived by considering the requirements of effective circularity. This approach goes beyond the limited and linear life-cycle analysis approaches currently used in the tools and methodologies in the building sector.

Design protocol for flexible and transformable buildings

Project partners developed a Reversible Building Design Protocol that enables different stakeholders in the construction value chain to implement reversible design strategies and approaches in construction and refurbishing activities.

At the core of this design approach is: transformation capacity – the ability to transform building spaces to meet new requirements; and reuse potential – the ability to reuse elements and components. Reversible Building Design enables resource efficient repair, reuse and recovery of building materials, products and components since different layers such as floors, windows, electric cords, ventilation, inner walls can be accessed without damaging other parts of the building and components can easily be removed or replaced. It can also be used to design flexible and easily transformable buildings.

Tool for circular building assessment

Project partners also developed a prototype Circular Building Assessment tool. The decision-making tool is built on a methodology for the assessment of new and existing buildings’ resource productivity, based upon material selection and design decisions. The methodology’s integration in a newly developed (BIM compatible) software platform could aid users in making better choices for circularity. The platform helps users to see the impact of alternative solutions, optimising performance measures like reuse potential and transformation capacity through the different phases of the building’s life cycle (design, construction, management & maintenance, refurbishing, dismantling).

Pilot experiences and feedback

In Brussels, a new module called ‘Build Reversible in Conception’ consisting of a wooden frame structure and prefabricated wall, floor and roof systems was built, dismantled, reconstructed and...
transformed two times. The sustainable and reversible teaching module is part of an education centre enabling teachers, students and construction product producers to investigate the implementation of circular economy and reversible building design principles in practice.

On the Free University of Brussels-VUB campus, what once used to be a student house has now become the Circular Retrofit Lab. Eight student rooms were renovated using demountable, adaptable and reusable building solutions, creating as little demolition waste as possible.

In Heerlen, Netherlands, the project consortium developed the Green Transformable Building Lab around a multifunctional and reversible steel frame filled with interchangeable, independent and reversible floor, façade and roof elements.

The demonstrators proved that an existing structure can be transformed for a different function (for example, a dissemination space, a co-working space, and an eco-guesthouse) while aspiring for flexibility and circularity in the future. Also, the waste generated by changing functions of a building can be significantly reduced through the use of upgradable modular and exchangeable components. “Pilot projects and prototyping demonstrated the BAMB tools and methodologies can prevent 75–90% of all waste generated and raw materials used over at least four building transformations,” concludes project coordinator Caroline Henrotay.

**PROJECT**

 **BAMB – Buildings as Material Banks:**
Integrating Materials Passports with Reversible Building Design to Optimise Circular Industrial Value Chains

**COORDINATED BY**

Brussels Environment in Belgium

**FUNDED UNDER**

H2020

**CORDIS FACTSHEET**

cordis.europa.eu/project/id/642384

**PROJECT WEBSITE**

bamb2020.eu/
Recycling of photovoltaic waste boosts circular economy

An EU-funded initiative has developed methods for recovering valuable materials from photovoltaic (PV) waste such as silicon (Si) for reuse in the industry.

According to the EU’s Waste Electrical and Electronic Equipment (WEEE) Directive, 85% of PV waste must be recovered and 80% recycled and reused, by 2018.

The Horizon2020 CABRISS project helped to transform the legal obligations under the WEEE directive into new business opportunities by pioneering a circular economy based on recycled, reused and recovered indium (In), Si and silver (Ag) materials for PV and other applications.

Supported by SPIRE (Sustainable process industry through resource and energy efficiency), the consortium comprised 11 companies and 5 research institutes from 9 EU countries working in a public-private partnership.

According to project coordinator David Pelletier: “CABRISS focuses mainly on a photovoltaic production value chain, thus demonstrating the cross-sectorial industrial symbiosis with closed-loop processes.” Industrial symbiosis describes a network of diverse organisations for fostering eco-innovation, long-term culture change, and improving business and technical processes. CABRISS developed this process by providing raw materials as feed stocks for other industries.

Valuable materials from PV waste

Researchers used three different sources of PV waste in the project. The first involved a novel technique for delaminating and recovering all high-value materials like Ag, In, Si and high-purity...
glass from PV end-of life thin film and Si-based PV modules. The second comprised solid waste from PV production, consisting of a mixture of broken Si wafers and cells. The final source consisted of dry Si powder PV production waste, known as kerf, recovered from material lost during the cutting process.

Project partners used laser technology to open the thin-film photovoltaic modules without damage, resulting in higher value for the recycled glass. “For Si-based PV modules, an innovative and water-based technology was developed, which unlike conventional shredding technologies does not break glass, resulting in the collection of all materials in Si PV modules,” says Pelletier.

Economically efficient and environmentally friendly

This approach paved the way for high-value, high-yield recycling of PV modules (thin film and silicon) with economically efficient recovery of all reusable materials. “The result is WEEE-compliant recycling of PV wastes, increasing yield and quality of recovered materials, including silicon, indium, silver, and high-quality undamaged glass,” Pelletier explains.

Furthermore, researchers tested innovative cost-effective methods for the extraction and the recovery of Ag and Si. They also demonstrated the possibility of purifying the recovered Si from broken wafers and cells to solar-grade (5N-grade) by pyro- and hydro- metallurgical processes for a direct reuse in the PV industry. “Refining of silicon kerf has already led to metallurgical silicon grades of 3N to 4N,” claims Pelletier.

CABRIS benefits society by avoiding the environmental impact of landfilling PV waste and the high energy invested in producing virgin Si that has not been used before in manufacturing. It also reduces the environmental impact of the recycling process itself by optimising recycling procedures according to results of the life cycle analysis. “In addition, reports on good practices of waste traceability between PV manufacturers/ PV recyclers will help to improve recyclability opportunities and collection efficiency,” Pelletier points out.
A novel cloud-based platform helps industries minimise waste and enhance sustainability

Industrial symbiosis, much like its natural counterpart, is a mutually beneficial relationship where the waste or surplus of one member is used by another. It is the cornerstone of a sustainable economy, and FISSAC tools could foster its expansion throughout Europe and beyond.

A circular economy in which resources and energy are recycled or recovered rather than moving linearly from use to waste to disposal is based on the industrial symbiosis concept. The ambitious EU-funded FISSAC project set out to accelerate the transition to a circular economy in the construction sector.

Project members worked on a decision-making tool to evaluate the life cycle considerations of materials and processes along with a networking tool for identifying and establishing symbiotic partnerships. According to project coordinators Blanca Juez and Daniel Hiniesto, "The overall objective of FISSAC was to develop and demonstrate a new paradigm built on an innovative industrial symbiosis model with a zero-waste approach in the resource-intensive industries of the construction value chain."

Valorisation of waste for circular rather than linear processes

FISSAC partners manufactured innovative eco-cement and concrete, ceramic wall tiles, and rubber-wood-polymer composites for decking, cladding and fencing, all at industrial scale. These products utilised different types of second raw materials and techniques based on ecodesign concepts that include life cycle considerations from procurement, manufacture and use to disposal.

Among the materials reclaimed by FISSAC were industrial ladle and electric-arc furnace waste (slag), glass and ceramic waste, aluminium waste, marble slurry, used tires and recycled or virgin wood and plastics.

The eco-cement was also used to make novel green precast concrete elements such as pavement and so-called Jersey walls or barriers that separate lanes of traffic. Autoclaved aerated concrete (AAC) wall blocks were produced from ceramic waste and furnace slags.

As Juez and Hiniesto explain, "Five different case studies are showcasing how the new solutions developed can be actually implemented. Running in parallel, several living labs have taken place in different countries, focusing also on non-technical barriers and social acceptance as key factors needed to implement symbiotic processes." The focus of FISSAC is ensuring sustainability of their circular economy concepts by accounting for environmental, economic and social factors.
Putting information and resources in the hands of decision-makers

To encourage transition to a circular economy, FISSAC created a user-friendly cloud-based information technology (IT) platform. It facilitates industrial clustering (creation of new symbiotic relationships in a given region) through a geographic information system (GIS)-based marketplace.

Their IT platform supports decision-making through life-cycle analyses of the materials’ flows to determine potential symbioses opportunities. According to Juez and Hiniesto, “Facilities can retrieve information about industrial symbiosis opportunities, perform feasibility assessments and evaluate network performance using environmental, economic and social indicators. They can search for solution providers and contact other facilities through the marketplace.”

Enhancing industrial symbiosis across sectors throughout Europe

FISSAC outcomes are evolving on their own. “New spontaneous synergies between partners and closed-loop actions have emerged during the project. The new networks have enabled more sustainable supply chains and alternative scenarios for the replication of the FISSAC model. We hope FISSAC outcomes will continue to foster industrial symbiosis and contribute to regional sustainable development efforts,” Juez and Hiniesto explain.

To nurture the seed they have planted, the FISSAC team is spreading the word to target groups at the regional, national and international level. In parallel, the FISSAC project website provides free access to the FISSAC IT platform to facilitate networking and decision-making.
EU regions pilot a circular economy approach to bulky waste management

The URBANREC project is working to improve opportunities for recovering waste-stream materials through enhanced management of bulky waste.

This waste stream has many and varied environmental impacts, and poses numerous challenges related to logistics, use and management, explain Dr Raquel Giner Borull and Ana Isabel Crespo Soler, both of URBANREC coordinator AIMPLAS. "Other challenges are the lack of stringent regulation, and the lack of market outcomes due to, amongst others, the inexistence of cost-effective valorisation methods," they add.

Bulky waste management across a diverse European space

Bulky waste management is regulated and organised in all the project’s demonstration countries: Belgium, Spain, Poland and Turkey. While each have different economies and social sensitivities, they have a common goal to improve their bulky waste management.

The Flemish Region in Belgium is the territory that has one of the most developed collection schemes in Europe, recording several successes in advancing reuse and recycling (to obtain high added value products) of bulky waste. Flanders encompasses a well-organised network of reuse centres and shops and has implemented a landfill ban on recyclable and incinerable waste.

In Valencia (Spain), “it is common for people with a limited livelihood to have a means of subsistence in the sale of scrap metal,” the coordinators report. While this is usually tolerated by the municipalities, it creates difficulties in implementing an approach to the reuse or recycling of materials in the affected civic amenity sites (CASs). “The project has helped in Valencia to make visible and quantify the impact of the problem before our mayors, so that we can acquire their active collaboration, also seeking in the medium term the social and labour insertion of these people in the reuse preparation activity itself.”

The solutions developed in URBANREC will contribute to the reduction of the use of fossil resources, enhancing reuse and turning a waste material into raw material, thus contributing also to a 10-20% reduction of CO₂ emissions.
Warsaw (Poland) is currently implementing new rules for selective collection of municipal waste. Here, it is important to ensure conditions allowing for proper waste segregation – in the context of the activities on reuse or recycling of bulky waste – to obtain products and materials of appropriate quality.

There is little specific regulation addressing bulky waste in Izmir (Turkey). However, new legal and practical steps are being taken towards its improved management. Project activities and results could, for example, help with arrangements for CASs still being constructed throughout the country.

Inspiring a basis for future legislation

To date, URBANREC’s most relevant achievements include knowledge transfer and experimentation, collection for the purpose of recycling and educational programmes customised to citizens’ needs. “The solutions developed in URBANREC will contribute to the reduction of the use of fossil resources, enhancing reuse and turning a waste material into raw material, thus contributing also to a 10-20 % reduction of CO$_2$ emissions,” Giner Borrull and Crespo Soler enthuse. Finally, a guide has been prepared to implement URBANREC management at EU level where 15 project recommendations to improve the EU framework related to bulky waste will be included.

Local authorities involved in the project are committed to considering its results as a basis for future legislation as well as reuse/recycling incentives in the framework of their competences. Commenting on the long-term impact of URBANREC, the coordinators believe this “should be a reduction of the total number of bulky waste and their better management through effective reuse and non-reusable items recycling (thanks to selective collection and an extensive network of CASs).”

**PROJECT**

URBANREC - New approaches for the valorisation of URBAN bulky waste into high added value RECycled products

**COORDINATED BY**

AIMPLAS - Technological Institute of Plastics in Spain

**FUNDED UNDER**

H2020

**CORDIS FACTSHEET**

cordis.europa.eu/project/id/690103

**PROJECT WEBSITE**

urbanrec-project.eu/
Eco-innovative solutions valorise waste

The old phrase “waste not, want not” is gaining new traction thanks to EU-funded research driving the circular use of resources. A multinational team is actively doing its part with the delivery of new waste management solutions.

There are limits to the ongoing use of many of our natural environment’s resources. In this context, the Waste4Think project is advancing eco-innovative solutions that will guard against resource depletion and also support new routes of waste valorisation, mainly biowaste and nappies.

In the Waste4Think milestones video, coordinator Ainhoa Alonso states: “Waste4Think proposes a new paradigm for waste management systems moving from the traditionalist waste management schemes towards more circular strategies, transforming waste into an opportunity for new products and services.” To realise this, the team is developing and piloting 20 eco-innovative solutions encompassing the entire waste value chain.

Putting thought into action

The project’s many and varied eco-solutions are being demonstrated in the urban areas of Halandri (Greece), Zamudio (Spain), Seveso (Italy) and Cascais (Portugal). These pilot sites have different social, demographic and geographic features and represent different levels of industrialisation.

Importantly, the four cities also have distinct realities regarding waste management. Among them, Halandri and Seveso claim two ends of the ‘urban waste sorted’ spectrum, with the latter tallying 70 % and the former a mere 11 %.
Waste4Think solutions thus follow different approaches to achieve the same goal of increasing sorted waste. For the Spanish (30%) and Italian sites, this is being done through implementation of economic instruments and social actions. In Portugal (30%), efforts target optimisation of waste collection to reduce the environmental impact of collection works. On the Greek side, actions include defining an advanced waste collection system and exploitation of biowaste.

On the last point, Alonso notes: “We have consolidated the collection of two new fractions in the case of Halandri for biowaste to produce a new product – FORBI [food residue biomass] – that is used to produce biogas to fuel the trucks to collect this fraction, closed in the loop.” A second innovative solution is a new treatment plant for nappies valorisation. This will be used to produce biogas as well as to recover polymers from the nappies.

An inspiring and colourful Story Map offers an in-depth look at this model. True to the project’s commitment to engage citizens, it also takes viewers through the various tools, apps and materials helping to realise the shift to a circular economy.

As project work progresses, expected impacts are a 20% increase in waste sorting, 10% savings in management costs, and a reduction in waste generation by 8% and greenhouse gas emissions by 10%. Ultimately, project partners also envision a virtual city that integrates all Waste4Think solutions.

**PROJECT**

Waste4Think - Moving Towards Life-Cycle Thinking by Integrating Advanced Waste Management Systems

**COORDINATED BY**

Fundación Deusto in Spain

**FUNDED UNDER**

H2020

**CORDIS FACTSHEET**

cordis.europa.eu/project/id/688995

**PROJECT WEBSITE**

waste4think.eu/
RESULTS PACK ON CREATING PATHWAYS TO SUSTAINABILITY

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