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CORDIS Results Pack on

circular economy

A thematic collection of innovative EU-funded research results

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Innovative solutions for industrial and urban waste management

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Contents

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 and recover more of their precious materials and energy within a circular economy approach. This Results Pack examines nine EU-funded projects that will help transform our economy and society and decouple economic growth from environmental impacts.

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 and climate change. But this discarded material also represents a valuable resource, which can be retained in the economy by embracing a more circular economy approach.

A commitment to waste reduction

The projects support the new political priorities of the von der Leyen Commission as set out in the European Green Deal. They make an important contribution to the implementation of the new Circular Economy Action Plan and the European Strategy for Plastics in a Circular Economy.

In addition, the Waste Framework Directive establishes the basic concepts related to waste management, defining waste, recycling and recovery. The revised legislative framework on waste, which entered into force in July 2018, sets clear targets for the reduction of waste and establishes an ambitious and credible long-term path for waste management and recycling.

The EU is thus committed to implementing the principles of the waste management hierarchy, which promotes the prevention of waste, its reuse and recycling. This requires the development and deployment of eco-innovative solutions and resource-efficient products, processes and services.

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 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 not only for the photovoltaic but also for 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. Waste4Think used information and communication technologies to improve all stages of the waste value chain, adopting a global approach focused on citizen participation to move towards a circular economy and build more sustainable, eco-friendly cities.

CIRC-PACK developed numerous innovations to support a circular cradle-to-cradle economy within the plastic packaging value chain. FORCE worked to minimise the leakage of materials from the linear economy and towards a circular economy with a focus on plastic, wood, WEEE and biowaste & food waste in four European cities. Finally, DECISIVE created new decentralised solutions for biowaste management.

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 for the textile and chemical industries by producing 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 not recovered from the waste stream are lost.

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

The project used innovative technologies covering the whole textile value chain. 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. Researchers are now scaling up the most promising chemical hydrolysis methods for obtaining new raw materials for producing biodegradable plastics.

Polyamide (PA) and polyethylene terephthalate (PET) recovery processes were also trialled to produce new plastics and chemicals. Researchers turned PET degradation into a more eco-friendly and cost-efficient process. The high-quality chemical terephthalic acid is suitable for industrial use and could serve as a secondary raw material for plastic packaging. Another recovered chemical, ethylene glycol, could potentially be used as a defrosting agent.

A holistic approach to textile recycling and reuse

Industrial symbiosis is the process by which waste or by-products of an industrial process become the raw materials for another. "The chemical and textile industries can both benefit from utilising secondary textile streams. Low-grade textile fibres recycled into new chemical products get a new life instead of being thrown away or incinerated," notes the technical project coordinator Aleksandra Lobnik.

Low-grade textile fibres recycled into new chemical products get a new life instead of being landfilled or incinerated.

"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 on the market," explains Lobnik. What's more, although much is invested in plastic-to-textile, textile-to-textile and textile-to-chemical innovation, there is no easy solution for mechanical recycling.

RESYNTEX put into practice a holistic approach to address the fragmented nature of textile waste processing. 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 into the process.

Textiles in Europe's circular economy

Reducing the environmental impact from textile production and consumption, while maintaining economic and social benefits, calls for a systemic change towards circularity. In 2020, EURATEX, a partner in the project, published a position paper with recommendations for the Extended Producer Responsibility (EPR) policy debate as it felt the problem with most EPRs is that they were designed for linear economy models.

RESYNTEX is in line with EURATEX recommendations for boosting broader sustainability across the textile value chain. Its sustainable recycling and chemical processes unlock the value of post-consumer textiles and create a tipping point for a closed-loop textile industry.

The pilot plant in Slovenia is still up and running. Consortium members strive to improve and upgrade the RESYNTEX process.

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.

© Caroline Morizure, EFP

The European built environment is responsible for a considerable amount of energy consumption, total greenhouse gas 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-of-life option in mind, buildings end up being demolished, or require complex and expensive renovation work, thereby generating considerable waste. The EU-funded BAMB project fostered a paradigm shift where materials, components and buildings are conceived and evaluated based on effective circularity requirements.

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 in construction and refurbishment.

At the core of this design approach are transformation capacity – the ability to transform building spaces to meet new requirements; and reuse potential – the ability to reuse elements and components without causing any damage. Project partners are developing new software that will assess the transformation capacity and reuse potential of buildings and elements.

Materials passports

The Materials Passports developed by BAMB acts as a one-stop shop for material information supporting circular decision making. The Material Passport Framework has inspired and guided the development of different product data initiatives such as the Product Circularity Data Sheet Initiative developed by the Luxemburg Ministry of Economy.

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 assessing new and existing buildings' resource productivity, based upon material selection and design decisions.

The newly developed software platform helps users to evaluate the impact of alternative solutions, optimising performance measures like reuse potential and transformation capacity through the different phases of the building's life cycle.

Pilot experiences and feedback

The 'Build Reversible in Conception' building is a sustainable, scalable and reversible construction developed entirely by young trainees in Brussels. It has been assembled and disassembled for three consecutive years. Each transformation has been accompanied by a change in function: from an office (2018) to a shop (2019) and eventually an acoustic laboratory (2020).

On the Vrije Universiteit Brussel (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 New Office Building pilot project in Essen has been built close to Zeche Zollverein, a former coal mine industrial complex. Focusing on cradle-to-cradle design approaches, the new office building will host over 200 high-quality office spaces and a rooftop garden.

In Bosnia and Herzegovina, the Green Design Centre is envisioned as a location that will be showcasing principles of circular buildings. It will be part of a new innovation park in Mostar that will integrate different aspects of sustainable living such as urban farming, windmills, open workplaces for disabled children and an open expo.

"Pilot projects and prototyping demonstrated the BAMB tools and methodologies can prevent 75-90 % of all waste generated and raw materials used over several building transformations," concludes project coordinator Caroline Henrotay.

Pilot projects and prototyping demonstrated that BAMB tools and methodologies can prevent 75-90 % of all waste generated and raw materials used over several building transformations.

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, paving the way to a more sustainable PV industry and circular economy.

According to the EU's Directive on waste electrical and electronic equipment (WEEE), by the end of 2018, 85 % of PV waste was to be recovered and 80 % prepared for reuse and recycled.

The Horizon 2020 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), silicon (Si) and silver (Ag) materials for PV and other applications.

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 focused mainly on a PV production value chain, thus demonstrating the cross-sectoral industrial symbiosis with closed-loop processes." Industrial symbiosis describes a network of diverse organisations for fostering eco-innovation and long-term culture change and improving business and technical processes. CABRISS developed

this process by providing raw materials as feedstocks for other industries, like Si waste for the metallurgy industry.

Valuable materials from PV waste

Researchers used three different sources of PV waste in the project. The first involved waste from end-of-life panels while 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.

The result is WEEE legislation compliant recycling of PV wastes, increasing yield and quality of recovered materials, including silicon, indium, silver and high-quality undamaged glass.

Project partners used laser technology to open the thin-film PV 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.

The expertise generated in CABRISS has inspired a new wire-based delamination technology that is particularly effective for bi-facial modules and avoids shredding. This new technology will be developed from 2021 under the auspices of the newly funded EU project PHOTORAMA, with some former CABRISS partners.

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

Benefits for the circularity of the PV industry

CABRISS triggered a new way of thinking about the PV industry by considering this market in a circular way. "The PV market does not only consist of selling PV modules: the market for secondary raw materials and for equipment to recover materials is also fundamental for the economy and the planet," explains Luc Federzoni, an expert at the French Alternative Energies and Atomic Energy Commission.

More recently, by combining the results of CABRISS with the EU-funded CICUSOL project, it became obvious that the scientific community should also investigate the 'second' life of PV modules. Some new projects have been launched recently in Europe on this topic that promise to create jobs and added value for Europe. This new ecosystem will contribute to a reduction in the impact of PV on the planet and increase the circularity of this industry.

PROJECT
CABRISS – Implementation of a CirculAr economy Based on Recycled, reused and recovered Indium, Silicon and Silver materials for photovoltaic and other applications

COORDINATED BY
French Alternative Energies and Atomic Energy Commission (CEA) in France

FUNDED UNDER
H2020

CORDIS FACTSHEET
cordis.europa.eu/project/id/641972

PROJECT WEBSITE
spire2030.eu/cabriss/

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 secondary 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 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.

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 the 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 a 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 a regional, national and international levels. In parallel, the FISSAC project website provides free access to the FISSAC IT platform to facilitate networking and decision-making.

PROJECT
FISSAC – Fostering Industrial Symbiosis for a Sustainable Resource Intensive Industry across the extended Construction Value Chain

COORDINATED BY
ACCIONA Construction SA in Spain

FUNDED UNDER
H2020

CORDIS FACTSHEET
cordis.europa.eu/project/id/642154

PROJECT WEBSITE
fissacproject.eu/en/

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 Raquel Giner Borrull 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.

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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 they each have different economies and social sensitivities, they all share 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 require their and social economy actors' active collaboration, also seeking in the medium term the social and labour insertion of these people in the reuse preparation activity itself."

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 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.

The solutions developed in URBANREC will contribute to the reduction of the use of fossil resources, enhancing reuse and turning waste material into raw material, thus contributing also to a 10-20 % reduction of CO_2 emissions.

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 the 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.

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.

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 ongoing story

As part of its efforts to promote a major transformation of existing waste management models, Waste4Think has developed the holistic WESTE (Waste Environmental, Social, Technical and Economic data assessment) methodology (see Deusto Social Impact Briefings 2017. This can be applied to compare the sustainability levels of waste management services and also monitor implemented actions. To this end, the Waste4Think-Suite has been developed over the open-source platform FIWARE to collect and manage all the information around waste management provided by different IoT and Internet of humans systems.

An inspiring and colourful Story Map offers an in-depth look at this model. True to the project's commitment to engage

© Joao Dinis

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/

Closing the loop protects the environment and enhances sustainability

A linear plastics life cycle from virgin natural resources to product incineration or landfill puts pressure on the environment. Novel biomaterials and recycling-and-recovery processes and tools will preserve resources, reduce emissions and minimise plastics pollution on land and in the sea.

Global plastics production has increased tremendously over the last 50 years. By 2050, it could account for 20 % of global oil consumption. Increasing production and use, particularly of single-use plastics, has led to increasing plastic waste generation, the majority of which is still incinerated or discarded.

In Europe, packaging applications represented 39.9 % of the total plastics demand and the largest application field for the plastics industry in 2018. The EU-funded CIRC-PACK project will help us make ends meet, literally, with numerous innovations to support a circular cradle-to-cradle economy within the plastic packaging value chain. Success was guaranteed with a consortium of partners from every stage of the value chain.

We developed breakthrough biodegradable plastics using alternative bio-based raw materials and eco-friendly packaging designs adapted to these plastics to improve collection and recycling. The materials and designs were supported by our new technologies and methods to increase recyclability and enable a robust after-use plastic economy.

From nature to nature

Rigid plastics like those used in plastic bottles generally consist of a single material. This facilitates recycling tremendously. Multilayer plastic films, a non-recyclable combination of plastic materials or multi-material products such as plastic-coated cardboard are a different story. They are usually incinerated or landfilled, a roadblock to achieving a circular plastics economy. Thanks to CIRC-PACK, this is all changing for the better. CIRC-PACK project coordinator and Technology Project Manager Aitana Saez de Guinoa Vilaplana of CIRCE explains: "We developed breakthrough biodegradable plastics using alternative bio-based raw materials and eco-friendly packaging designs adapted to these plastics to improve collection and recycling. The materials and designs were supported by our new technologies and methods to increase recyclability and enable a robust after-use plastic economy."

Circling the wagons, protecting our environment

CIRC-PACK's biodegradable and compostable biomaterials were demonstrated in plastic bags, flexible packaging for hygiene products, coffee capsules, shampoo bottles, and food trays and films. A life-cycle assessment demonstrated that the new biopolymers reduced the fossil resource scarcity indicator by about 20 %, water consumption 6-40 % and global warming potential 14-50 % when used in the targeted applications.

Applying ecodesign principles to multilayer films for sealing food trays spurred design of a bio-based and compostable mono-material plastic layer as an attractive alternative to current non-recyclable multilayer films. A multi-material box for powdered detergent replaces conventional polyester film lamination with a biopolymer dispersion coating that keeps the cardboard recycling process flowing without hindrance.

The innovative materials and packaging were complemented with new methods and technologies to increase recyclability and enable a robust after-use plastic economy. Saez de Guinoa expands: "In the automotive sector, closed-loop recycling and reuse of scrap to produce new car components reduced the use of virgin polypropylene by about 20 %." Diaper recycling yielded plastic for tertiary packaging and cellulose for the biopolymer sector.

Real-time monitoring during extrusion of the recycled materials enabled adaptation of operating parameters to optimise final properties, overcoming many challenges related to the heterogeneity of post-consumer plastic waste. A 'circular packaging ecodesign tool' has been launched to help packaging manufacturers and designers improve the circularity and recyclability of packaging.

Saez de Guinoa summarises: "The brand owners can use the innovations to provide more sustainable products to their consumers. The recycling systems benefit from the elimination of 'problematic' formats like multilayers and multi-materials. Finally, the environment benefits from the lower impact of all solutions developed in CIRC-PACK." A circle is indeed a simple and beautiful thing.

PROJECT
CIRC-PACK - Towards circular economy in the plastic packaging value chain

COORDINATED BY
CIRCE in Spain

FUNDED UNDER
H2020

CORDIS FACTSHEET
cordis.europa.eu/project/id/730423

PROJECT WEBSITE
circpack.eu/home/

Four European cities successfully put circular economy principles into action

Managing waste more efficiently and sustainably will move us from a linear to a circular economy. Recover, reuse, repair and recycle have been put into action across Europe.

In densely populated cities, it is very difficult to achieve the EU target of preparing for re-use / recycling 60 % of municipal waste by 2030. Towards this goal, four European cities – Copenhagen, Genoa, Hamburg and Lisbon – engaged in participatory value chain-based partnerships within the EU funded FORCE project to enhance circularity in the management of plastic waste, waste from electrical and electronic equipment (WEEE), biowaste and wood waste. "We have seen that knowing the needs in the value chain improves reuse and recycling," notes Mette Skovgaard, FORCE project coordinator.

Copenhagen simplified the collection plastic scheme and the collection rate increased by 30 %.

Separate collection high on the agenda for plastics and WEEE

In Copenhagen, FORCE set up collection schemes for household plastic waste and encouraged citizens to separate more plastic waste. "When Copenhagen simplified the collection scheme, the collection rate increased by 30 %," explains Skovgaard. Several sorting and recycling tests for post-consumer plastics were also conducted. Results showed that polypropylene (PP) and high-density polyethylene (HDPE) could be collected from residual waste, sorted and reprocessed into secondary raw materials with properties and value similar to raw materials derived from source separated PP and HDPE plastics.

In Hamburg, the objective was to raise public awareness on WEEE reduction and avoidance. FORCE introduced an innovative decision support tool, CYCEL, to observe the WEEE market and inform citizens about reselling, repairing, recycling and donation possibilities. The CYCEL website gets about 500 visitors daily and around 80 visitors per day search for the sales value of their devices. Moreover, pre-checking of the devices received at the city's recycling stations to ensure they work before transferred to a second-hand shop resulted in the reduction of non-functioning devices by 10-20 %.

Circularity gaining significant strides in wood waste and surplus food

Italy has a high rate of wood recycling, especially in the panel boards sector. To improve and integrate existing wood waste management and test new sustainable practices, FORCE redesigned the collection schemes for four types of wood waste. Additionally, the Genoa residents operated the reuse

© City of Copenhagen

centre 'Surpluse', allowing locals to donate furniture and large electrical and electronic equipment for repair. The centre also sells second-hand items. Around 3 tonnes of bulky wood waste were collected, repaired and redistributed.

Lisbon undertook a pilot project developing the web app LISBOA ZERO for the reduction of organic waste at its source, in which the food products produced and near the end of their life cycle can be redirected to new channels and platforms. An objective was to identify the quantities and diversity of food sources and food waste and assess the number of saved meals, saved costs and CO_2 emissions. Of the 76 food donors who signed up to the app, the estimated benefits were 1.6 million recovered meals, 800 tonnes of food waste avoided, and 3 400 tonnes of CO_2 emissions avoided.

Circular economy in the hands of European citizens

Project outcomes revealed citizens' willingness to partake in a circular economy, for example, by repairing, reselling, recycling or donating their electrical products or furniture. Many activities were initiated by FORCE but now are operated by local volunteers. As Skovgaard notes, "many people are reluctant to throw away

We have seen that knowing the needs in the value chain improves reuse and recycling.

items that have a reuse potential, and they are keen to minimise the material leakage."

FORCE project set out to minimise material leakage from the linear economy and pave the way to circularity. Partnerships resulted in the successful creation of viable, eco-innovative solutions. Their adoption by other cities will ensure the competitiveness of the European circular economy and green growth.

PROJECT
FORCE – Cities Cooperating for Circular Economy

COORDINATED BY
City of Copenhagen in Denmark

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Localised circular economies for urban biowaste recycling could have global impact

Increasing urbanisation is increasing cities' needs for energy and food yet much of a city's food ends up as waste. EU research has closed this loop by locally and sustainably turning waste into energy and organic products for urban farming.

People in cities produce a lot of solid waste and, unfortunately, the amount of waste each person generates is increasing even faster than the number of people in cities is, creating a snowballing problem. Organic waste accounts for more than 34 % of municipal solid waste in Europe. The EU-funded DECISIVE project developed decentralised solutions for biowaste management that produce local energy and organic products including fertilisers and biopesticides for use in urban or peri-urban farms.

Small solutions with out-sized impact

"Urban biowaste – which is mainly food waste – is both a challenge for waste management and an opportunity due to the energy and agronomic potential of its high organic matter content. DECISIVE implemented two key technologies for decentralised valorisation of biowaste exploiting this potential," says Anne Trémier of the French National Research Institute for Agriculture, Food and Environment (INRAE) and DECISIVE project coordinator.

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Anaerobic digestion of organic matter via microorganisms produces a methane-rich biogas that can be used to meet heating or electricity needs. DECISIVE's microscale digester concept uses little energy and water and is simple enough for a lay person to operate. The remaining solid organic matter is valorised using solid substrate fermentation (SSF), an aerobic process also harnessed by composting. SSF creates a waste recycling loop and requires less water

DECISIVE explored a completely new concept for sustainable development of communities. Decentralised and local urban biowaste valorisation, organised as a network, reduces the impact of waste collection (road traffic and environmental emissions) by promoting new collection solutions (green mobility). It promotes local food production using organic fertilisers from biowaste. Finally, it creates jobs for biowaste collection and treatment and local farming.

than conventional industrial fermentation processes. With it, DECISIVE produced an organic fertiliser and a biopesticide for vegetables. A pilot at the Agricultural High School of Ecully-Dardilly (website in French) in Lyon is valorising food waste from local restaurants and canteens to support the school's urban vegetable farm.

Technology with a turbobooster for successful launch

"To make the most of these technologies, DECISIVE has created a decision support tool targeting communities, design offices and waste facilities' operators that is freely available on the project website," adds Trémier. For a selected biowaste management system, it quantifies relative transport intensity and matter and energy recovery. It then produces an environmental assessment including impact on climate change and toxicity as well as an economic assessment of the costs. A social assessment of the required waste supplier(s), labour and space and a regulatory requirements analysis are also outlined. The tool also assists in planning the best location for microscale treatment and linked waste collection loops in a given area.

A circular economy for urban biowaste

DECISIVE has attracted the interest of communities, citizens' associations, private waste organisations and the EC itself, which referenced one of DECISIVE's publications in its Brief on food waste in the EU.

Trémier concludes: "DECISIVE explored a completely new concept for sustainable development of communities. Decentralised and local urban biowaste valorisation, organised as a network, reduces the impact of waste collection (road traffic and environmental emissions) by promoting new collection solutions (green mobility). It promotes local food production using organic fertilisers from biowaste. Finally, it creates jobs for biowaste collection and treatment and local farming."

With organic waste accounting for almost half of all municipal solid waste globally, DECISIVE's digesters could soon be cranking out energy and organic products supporting greener cities, literally and metaphorically.

PROJECT
DECISIVE – A DECentralIzed management Scheme for Innovative Valorization of urban biowastE

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