

# Recycling of photovoltaic waste boosts circular economy

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

According to the EU's Waste Electrical and Electronic Equipment (WEEE) Directive, 85 percent of PV waste must be recovered and 80 percent 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 is 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 direct reuse in the PV industry. "Refining of silicon kerf has already led to metallurgical silicon grades of 3N to 4N," claims Pelletier.

CABRISS 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.

Provided by CORDIS

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