Agenzia nazionale per le nuove tecnologie, l'energia e lo sviluppo economico sostenibile

9-Tech

PARSIVAL pv PAnels Recycling to create Silicon VALue chain

Supported by eit RawMaterials Connecting matters

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Recycling of silicon recovered from end-of-life PV panels by 9-Tech treatment plant, for application in lithium-ion batteries

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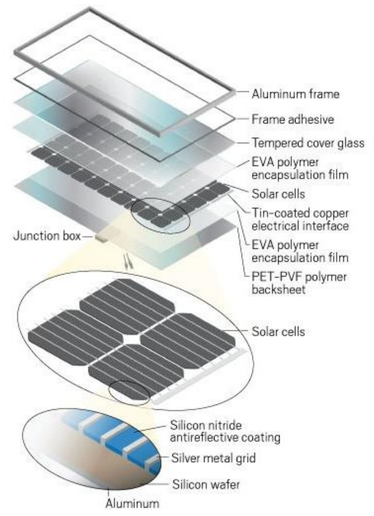
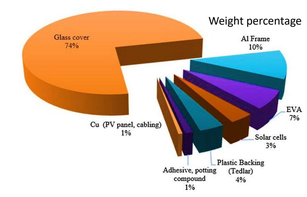
Abstract

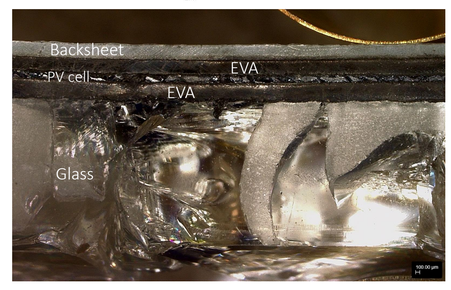
The growing demand for recycling of end-of-life photovoltaic panels (EoL PVs) calls for significant efforts to be dedicated in the development of efficient technologies both for recovering all the valuable materials contained in PV panels (backsheet, aluminum, glass, copper, silver, silicon PV cells) [1-5] and for finding final market for these materials. In addition, the recent inclusion of silicon- as well as of copper - into the EU list of critical materials [6] makes the recovery and recycling of these elements strongly encouraged. PARSIVAL, a project founded by EIT Raw Materials, addresses this challenge by advancing the establishment of a circular PV value chain in Apulia and Extremadura regions. These are RIS areas characterized by intensive installation of PV panels, where a large amount of photovoltaic waste will be generated in the next 15 years (around 300k tons in Apulia, 380k tons in Extremandura). It has been predicted that the worldwide solar PV waste could unlock between 1.7 and 8 million tonnes of raw materials (as plastics and Si, Ag, Cu, Al) and other valuable components by 2030, rising further to about 78 million tons by 2050 [7]. PV cells mainly contain silicon that is regarded as promising anode material for the next generation of lithium-ion batteries (LiBs) because of its high theoretical specific capacity. However, when silicon is used during lithium storage, a huge volume expansion (~300%) appears, involving progressive fragmentation and loss of active material, resulting in a rapid decrease of the accumulated capacity. Various solutions have been proposed to deal with the volumetric variation during battery charge-discharge cycles, including nanosized silicon that exhibits excellent properties due to its large specific surface area, rapid transport of electrons and Li^+, and great volume buffering capacity [8-13].

Since October 2022, 9-Tech is performing at pilot scale a thermo-mechanical recycling process to recover from EoL-PVs: glass, aluminium frame, copper ribbons, junction box and PV cells. In the frame of PARSIVAL project, 9-Tech provided to ENEA laboratories small samples of recovered silicon cell fragments, untreated or treated with NaOH and HNO_3 in order to eliminate aluminium rear-contact and/or silver conductive fingers, respectively. The material is under studying by ENEA in order to be used as active material to completely or partially replace graphite for the realization of anodes in LiBs.

Structure and composition of a PV panel

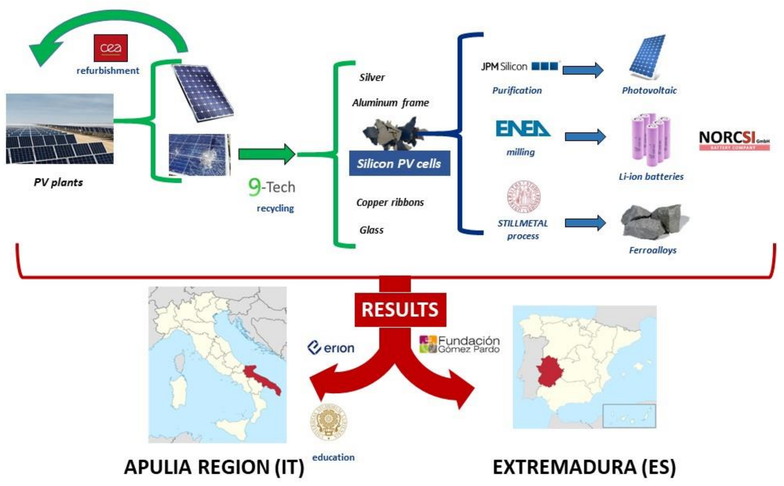






Aim Of The PARSIVAL Project

Study of three different applications in order to create a value chain for recovered Si: material for LiB anodes, silicon-based ferroalloys, new PV cells



ENEA contribution

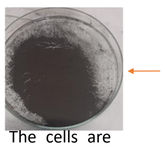

EoL

9-Tech thermo-mechanical process to recover glass, aluminium frame, copper ribbons, junction box and PV cells

Chemical process on PV cells with NaOH and HNO_3 to separate Al and Ag

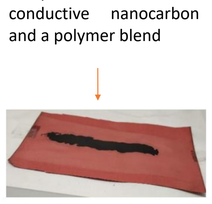

Frements of PV cells


The cells are ground to µm


The cells are ground to nm


Structural and morphological characterization


The powder is mixed with conductive nanocarbon and a polymer blend


The slurry is deposited on Cu substrate


The anode is cut


The battery is assembled in glove-box

ENEA treats the recovered Si-cells in order to obtain sub-micrometric silicon powder to be used in batteries and NorcSI will validate the applications introducing the powder in batteries.
ENEA works on the preparation of nano-silicon obtained from silicon powder recovered from EoL PVs treatment performed by 9-Tech. The powder is opportunely treated though a process which has been developed by ENEA researches, involving grinding and sieving steps.

Partners of the Project

9-Tech	coordination; feasibility study to implement its own recycling in Apulia; supply of the recovered Si/Al cells to study the three applications
ENEA	Research on a treatment process to make recovered Si suitable for LIBs
CEA	Support to the feasibility study for the implementation of a PV panel treatment plant in the Apulia to repair and reuse EoL modules
ERION	Analysis of PV installations in Apulia and forecast of PV waste streams; contribution to the feasibility study in the implementation of a PV reprocessing/recycling plant in Apulia
JPM SILICON	Validating purification processes to make recovered Si suitable for new PVs
FUNDECION GOMEZ PARDO	Study to apply the results of the project in Extremadura
Univ. degli Studi Padova	Research on a treatment process to produce silicon-based ferroalloys; training and dissemination
Univ. degli studi Salento	Higher education and dissemination initiatives in Apulia on the topic of recycling
NorcSI	Construction and validation of anodes and batteries using Si recovered

References

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