



## SOLAR PANEL RECYCLING SYSTEM

LEADING MANUFACTURER OF MACHINERY AND EQUIPMENT FOR THE RECYCLING OF MONOCRYSTALLINE, POLYCRYSTALLINE, THIN-FILM, MONOFACIAL, AND BIFACIAL SOLAR PANELS



### STOKKERMILLSOLAR

#### SOLAR 200

Power:  
170 Kw

Operating Power:  
80 Kw

Input production:  
1500-2000 Kg-H

#### SOLAR 300

Power:  
280 Kw

Operating Power:  
130 Kw

Input production:  
2500-3000 Kg-H

#### SOLAR 400

Power:  
320 Kw

Operating Power:  
150 Kw

Input production:  
3500-4000 Kg-H

#### SOLAR 500

Power:  
> 320 Kw

Operating Power:  
> 150 Kw

Input production:  
> 4000 Kg-H

The Stokkermill photovoltaic panels recycling line allows the recovery of 99.8 percent by weight of the input material.

There is no need to remove the aluminium frame to proceed with processing

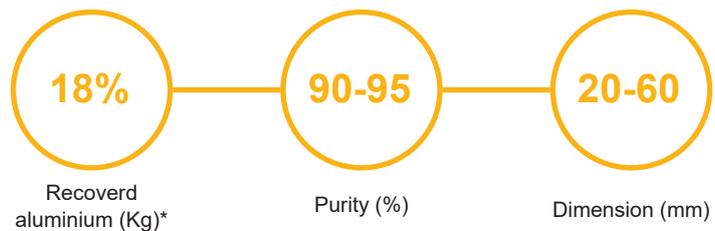
## Aluminum, an infinitely recyclable metal



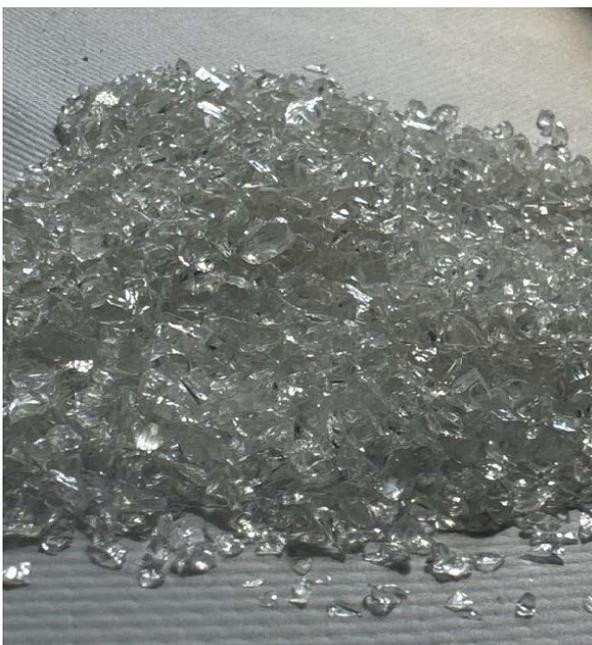
The Stokkermill recycling system does not require the removal of the aluminum frame, drastically reducing the processing time for the panels.

The quality of the output materials is excellent.

The aluminum, for example, will be ready for the furnace, not contaminated, and the correct size for downstream metallurgical processing. The aluminum fraction obtained also meets the requirements to be classified as End of Waste. Maximum material recovery and minimal energy impact.



## Glass, an increasingly valuable resource



The glass resulting from the treatment operations has different grain sizes and qualities.

The larger glass is clean and has a low iron content.

The smaller fraction is still used in the ceramics industry.



\*Value referred to 1 ton

## Silicon, the heart of semiconductors



It is an End-of-Waste fraction with a high silicon concentration, containing traces of silver and other valuable metals that make its recovery through chemical–physical processes economically convenient.

Recovered silicon can be used in several applications: as a deoxidizing agent in steelmaking; in ceramics, refractories, and abrasives; in technical glass and composite materials; refined into metallurgical-grade or polysilicon (when purity is adequate); and reintegrated into the photovoltaic supply chain in closed-loop projects based on secondary silicon.



## Plastic, a source of energy



The polymer backing sheet and the EVA fraction (ethylene vinyl acetate) are recovered at the end of the process.

These fractions are essentially free of glass and other contaminants and have a good calorific value. In special applications, it is possible to reduce the EVA granules to a size of a few millimeters.



\*Value referred to 1 ton

## Copper



Copper is a strategic metal, valuable and easily reusable in industry.

In solar panel recycling, Stokkermill leverages over 20 years of experience in metal separation, using reliable equipment and technologies dedicated to the treatment of conductive fractions.

This allows us to optimize copper recovery and obtain a high-quality final material through a simple and efficient process.

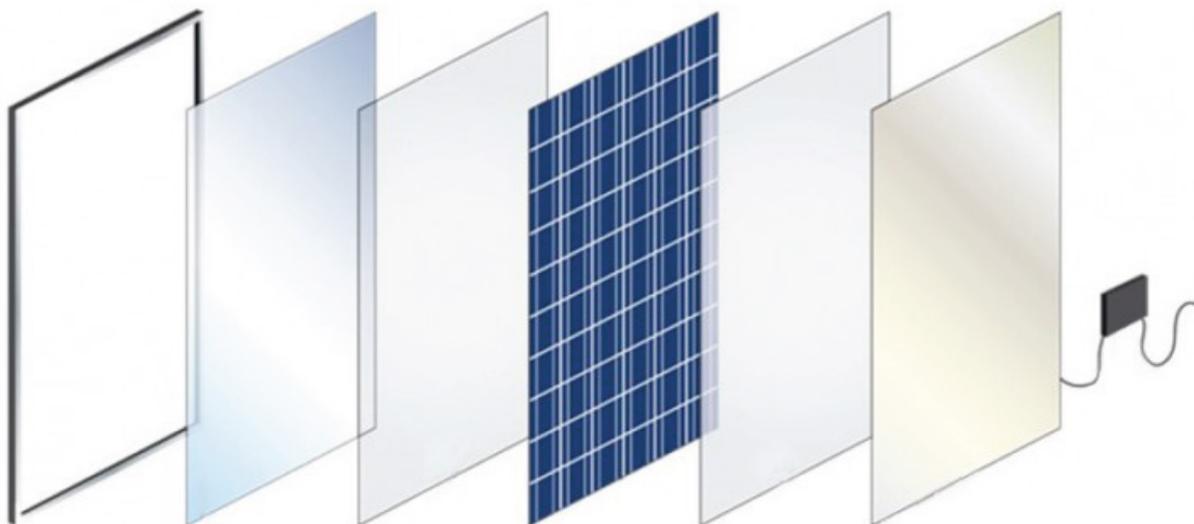
1-2%

Copper  
recovered \*

\*Value referred to 1 ton

Material	Quantity	(weight) %
Glass (external layers)	700 kg	70%
Aluminium (frame)	180 kg	18%
Copper (conductors and connections)	12 kg	1,2%
EVA polymer (encapsulant)	51 kg	5,1%
Back-sheet (PVF)	15 kg	1,5%
Silicon (cells)	90 Kg	8-10 %
Silver	0,6 kg	0,06%
Other metals	4,9 kg	0,49%

## What a panel looks like



<https://amaranzero.it/academy/blog/i-nemici-del-fotovoltaico-parte-2-delaminazione>

**Aluminum frame:** provides a sturdy structure for the photovoltaic panel.

**Tempered glass:** forms the upper panel of the photovoltaic module and has high light transmission properties to allow light to pass through to the cells below.

**Ethylene Vinyl Acetate (EVA):** EVA is a thermoplastic material used to seal and protect the photovoltaic cells inside the panel. It guarantees electrical insulation and protects the cells from moisture and environmental contamination.

**Photovoltaic cell:** this is the heart of the photovoltaic panel, where solar energy is converted into electricity. Cells are usually made from semiconductor materials such as silicon and are designed to capture solar photons and generate electrical current through the photovoltaic effect.

**Junction box:** contains the electrical protection devices and connectors needed to connect the photovoltaic panels.

### ► Complete solutions for solar panel recycling plants: Mod. Solar



<1 kw

Consumption for panel



Only 2

Operators required



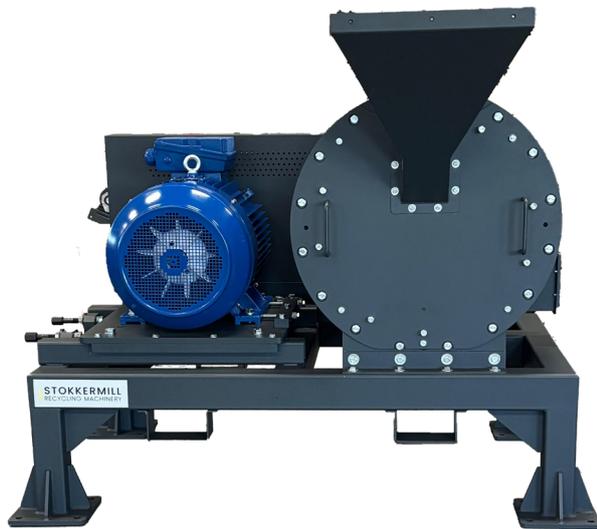
PLC

Electronics

\*One operator for handling and one for controlling the machine

\*managed entirely by a PLC

## The delaminating mill and the recovery of raw materials



XRS Delaminator Secondary delamination

To industrialize the process, the Stokkermill XRS series of delaminating mills has been perfected. These mills are also used for crushing lithium batteries (LIBs), and poly-laminated materials.

Furthermore, the XRS secondary delaminator stands out for its low energy consumption and, despite the abrasive properties of glass, requires extremely limited predictive maintenance in terms of time and cost.

This process allows for correctly separated fractions, ready for final processing operations. The XRS delaminator mill reduces human intervention and related operational risks, as well as drastically reducing panel processing times.

### Technical specifications:

- **Mechanical reduction and separation:** Stokkermill machines reduce and separate panels in a completely mechanical way, eliminating the need for costly chemical/thermal treatments and drastically reducing the environmental footprint.
- **Energy efficiency and maintenance:** the transmission components and other parts are designed to minimize energy consumption and optimize maintenance operations. Thanks to the use of PLCs and monitoring tools, it is possible to accurately adjust and monitor operating parameters and energy consumption.
- **Flexibility in particle size:** the delaminating mill allows for variable particle sizes to be obtained based on the mechanical characteristics of the material.
- **The XRS series of delaminating mills includes three basic models with variable power, flow rates, and sizes.** However, Stokkermill is able to design and manufacture customized solutions specific to the end user's needs.

## RECYCLING PROCESS

Load → Shear → HMS → Separation → Magnetic → MFS → XRS → Final output



### Load

Feeding of panels with or without frames and dosing to the shearing machine. Removal of junction box if present.



### Shear

First volumetric reduction, panel opening, and partial or total detachment of the aluminum frame.



### HMS

Delamination of glass-EVA-cells, release of metals, production of main fractions: coarse/fine glass and aluminum proler.



### Separation

Separation of heavy fractions (glass) and light fractions (EVA, powders, fine glass).



### Magnetic

Removal of ferrous residues using an Overbelt magnetic system.



### Final Output

EOW aluminum dross, coarse/fine glass, glass+EVA mixture, micro-metal residues, and silicon powders.

Your partner in solar panel recycling



Stokkermill Recycling Machinery

For thirty years, we have been innovating and improving technologies for recycling materials, with over 1,000 plants and machines installed in more than 30 countries around the world.

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