



Dimbach, Germany (1.4 MW); Blitzstrom / Beck Energy

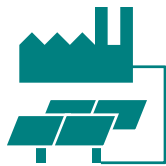
## Overview of First Solar's Module Collection and Recycling Program

Lisa Krueger, Vice President – Sustainable Development





## ● First Solar Introduction



Founded in 1999, a market leader in utility scale commercial and industrial photovoltaic (PV) systems



Approximately 1.2 gigawatt (GW) production capacity operating or announced



World's lowest cost solar module manufacturer

- \$0.93/W, breaking the \$1 per watt price barrier in the fourth quarter of 2008



World's largest thin film solar module manufacturer; 2<sup>nd</sup> largest PV manufacturer



PV industry's first pre-funded collection and recycling program





## First Solar Mission

To create **enduring value** by enabling a world powered by **clean, affordable solar electricity**

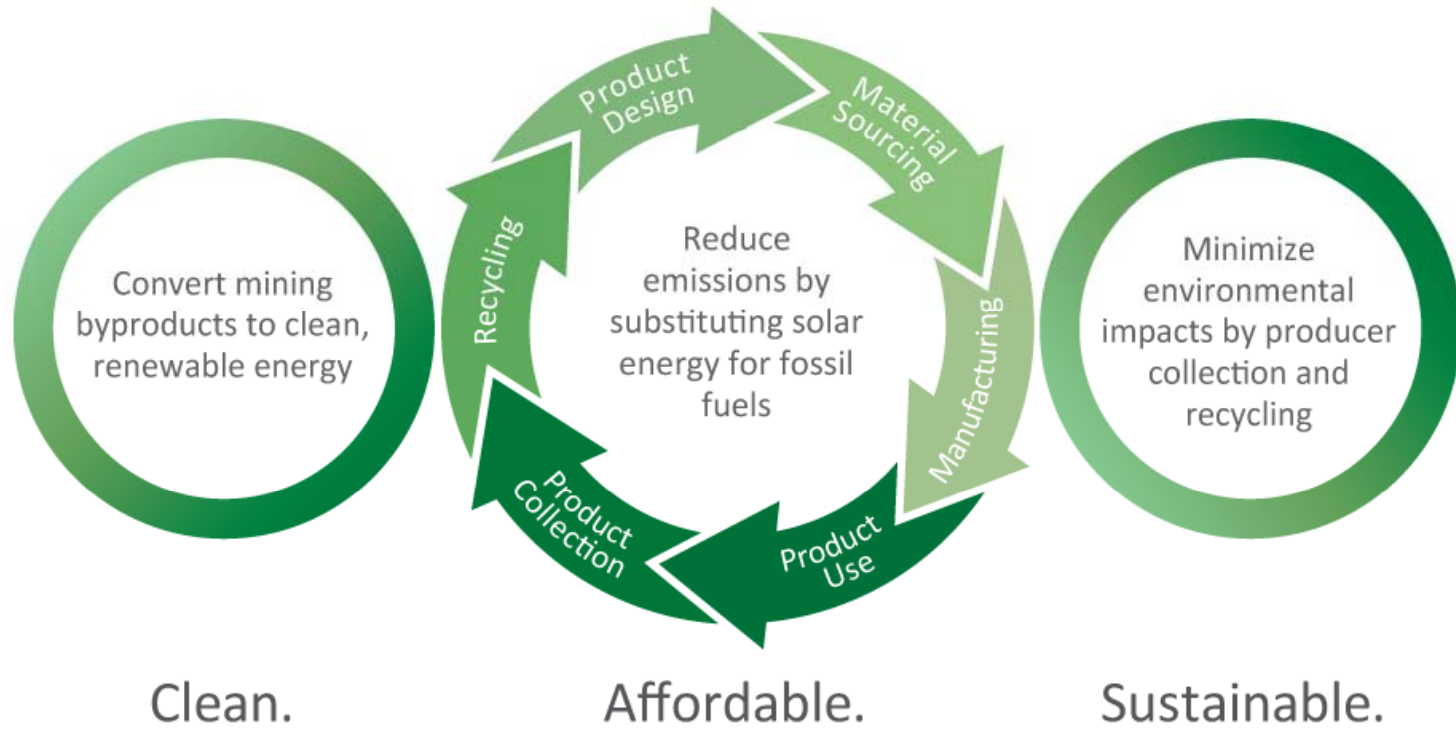
**clean + affordable = sustainable**





## ● First Solar's Commitment to the Environment

Life Cycle Management and Extended Producer Responsibility





## ● Environmental Responsibility

First Solar's Commitment to Extended Producer Responsibility



Extended Producer Responsibility (EPR) requires companies to take responsibility for the impacts of their products: from the materials used in manufacturing to product recycling.



## ● Module Collection and Recycling Program





## ● Module Collection & Recycling Program



- Designed to create a truly sustainable energy supply by combining affordable solar modules with a product life cycle management approach.
- Collection program is designed to maximize collection rates and minimize disposal as municipal waste.
- Recycling program is designed to maximize amount of material recycled.
- Financing is designed to ensure that the collection and recycling program is free of cost to end-users and is protected from the insolvency of First Solar.





## ● Module Collection & Recycling Program



- Module agreements specify that when taken out of service, modules will be processed under First Solar's Collection & Recycling Program or an alternative program that First Solar agrees is at least as protective of the environment.
- Estimated future costs of collecting and recycling at the end time of module sale.
- First Solar will provide packaging and will also collect and transport the modules to processing centers where substantially all components will be treated and processed for recycling.
- Module owners simply have to dismantle and package the modules in accordance with First Solar instructions.





## ● Module Collection & Recycling Process

### Initiate Collection

- Anyone in possession of a First Solar module may request collection at any time via either:

- the Web

[www.firstsolar.com/recycling](http://www.firstsolar.com/recycling)

- by phone

**International Freephone:**

**+ 800.433.32.333**

**Toll free (North America):**

**+1.866.456.8938**



First Solar provides free of charge collection and environmentally responsible recycling of this solar module product. Please do not dispose of this product in any manner before contacting First Solar at:

Toll free (North America): **1.866.456.8938**

International Freephone: **+ 800 433 32 333**

OR

**[www.firstsolar.com/recycling](http://www.firstsolar.com/recycling)**

First Solar bietet für dieses Solarmodul die Möglichkeit zur kostenlosen Rücknahme und umweltgerechten Wiederverwertung. Bitte kontaktieren Sie First Solar, bevor Sie das Produkt entsorgen.

First Solar ofrece gratuitamente la recogida y el reciclaje responsable con el medio ambiente de este producto de módulo solar. Por favor, no elimine de cualquier modo los residuos de este producto antes de ponerse en contacto con First Solar.

La First Solar raccoglie gratuitamente questo modulo solare e lo ricicla nel rispetto dell'ambiente. Non getti via questo prodotto prima di aver contattato la First Solar.

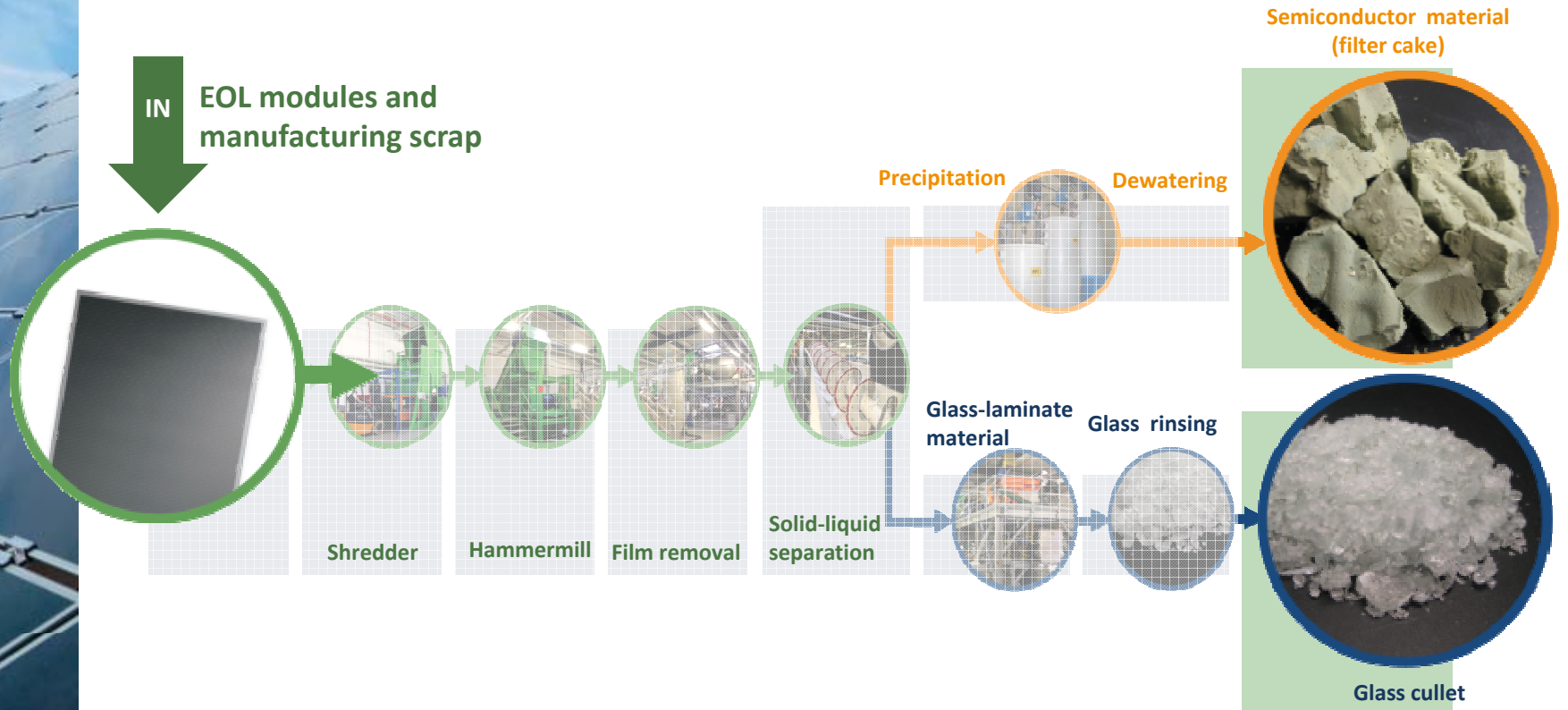
First Solar assure gratuitement la collecte et le recyclage de manière écologique et responsable de ce module solaire. Merci de ne pas vous débarrasser de ce produit de quelque façon que ce soit avant d'avoir contacté First Solar.

First Solar παρέχει δωρεάν συλλογή και περιβαλλοντολογικά υπεύθυνη ανακύκλωση της παρούσας ηλιακής μονάδας. Αποφύγετε την απόρριψη του προϊόντος με οποιονδήποτε τρόπο προτού επικοινωνήσετε με τη First Solar.



**[www.firstsolar.com](http://www.firstsolar.com)**

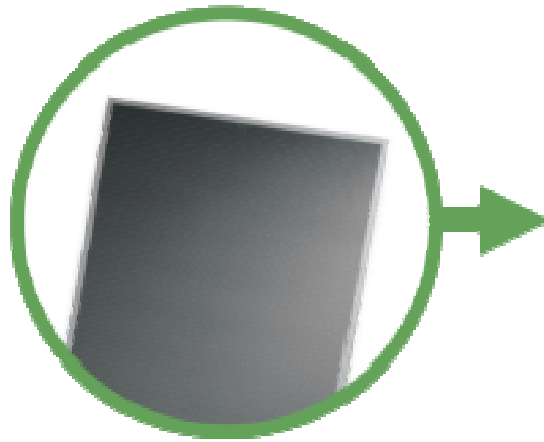
# ● First Solar Recycling Process



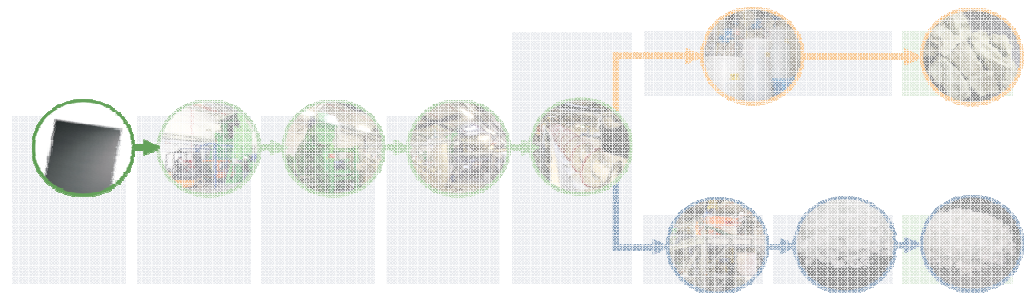


## ● Module Recycling Process

### Collection



- First Solar provides packing materials and collects waste modules upon customer request.
- Once at First Solar's recycling plant, the modules are collected in hoppers and loaded by forklift into a shredder.



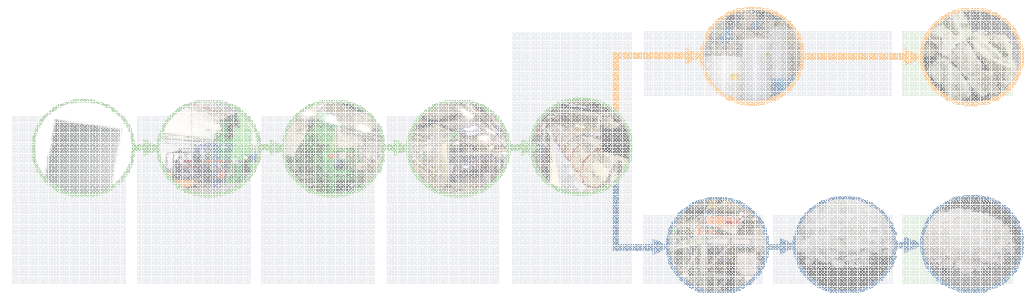


## ● Module Recycling Process

### Aspiration System



- Used for dust control in all dry parts of the recycling process
- Equipped with pre-filters and high efficiency particulate air filters (HEPA) which are 99.95% efficient.
- Collected dust and filters are disposed of in an environmentally safe manner.



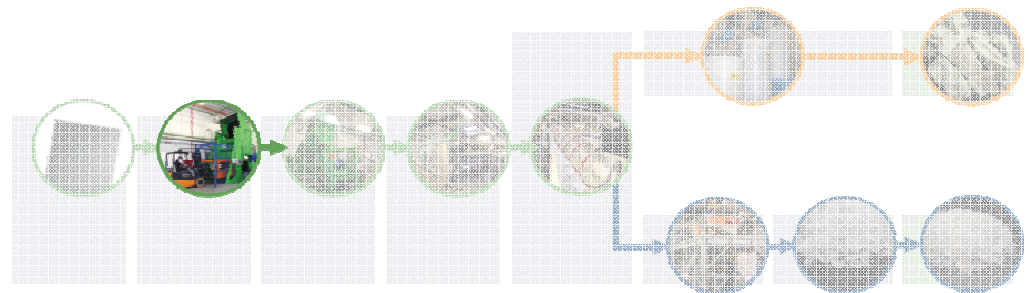


## ● Module Recycling Process

### Shredder



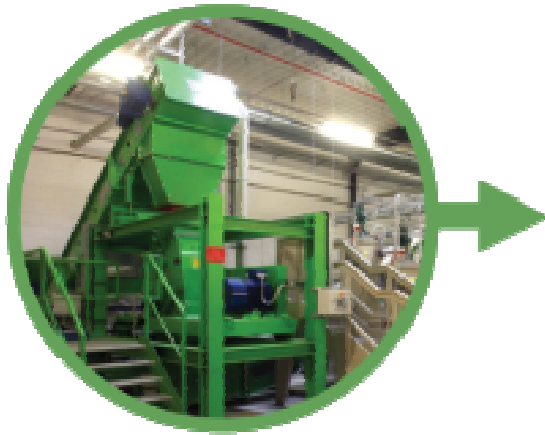
- The modules are reduced in size in a two step process.
- Step one uses a shredder to break the modules into large pieces.



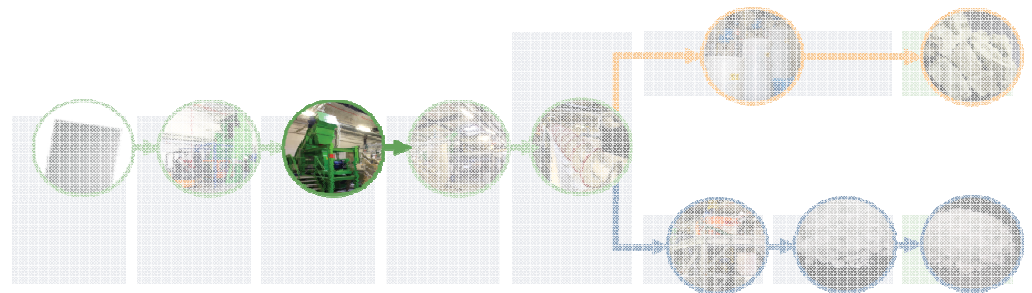


## ● Module Recycling Process

### Hammermill



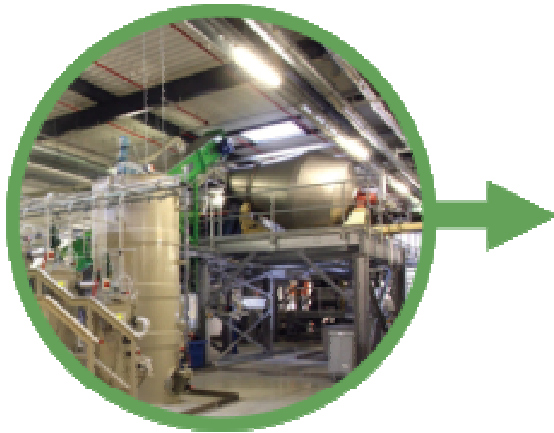
In step two, the hammermill crushes the glass further into approximately 4-5mm pieces, small enough to ensure the lamination bond is broken.



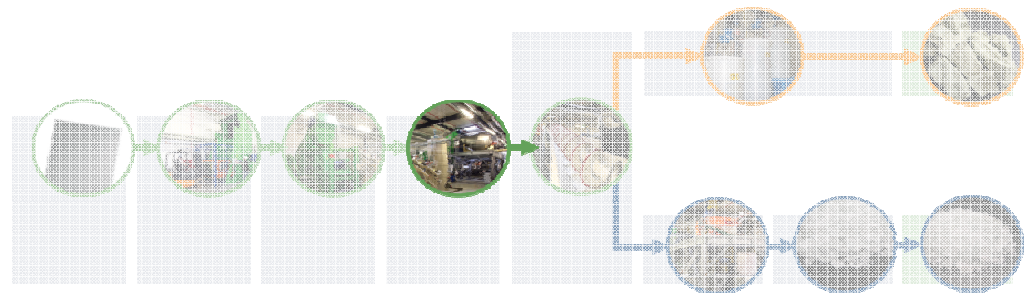


## ● Module Recycling Process

### Film Removal



The semiconductor films are removed by the addition of acid and peroxide in a slowly rotating, stainless steel drum.



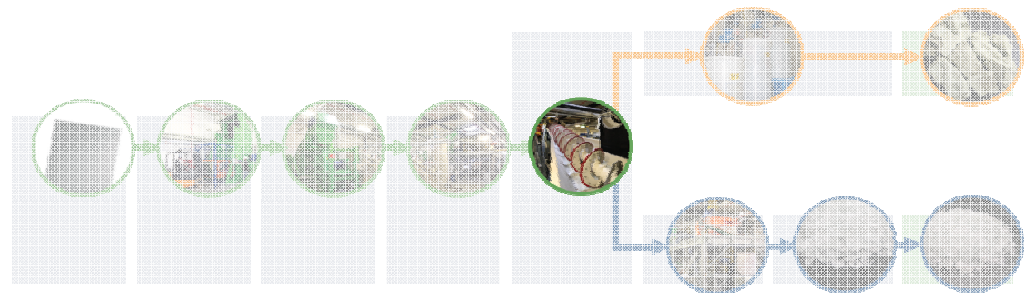


## ● Module Recycling Process

### Solid-Liquid Separation



- The drum is slowly emptied into a classifier where glass materials are separated from liquids.
- A rotating screw conveys the glass up an incline, leaving the liquids behind.





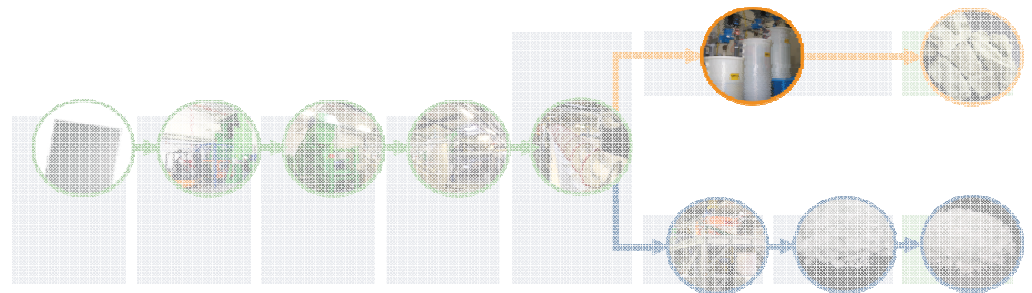


## ● Module Recycling Process

### Precipitation



- The metal-rich liquids are pumped to the precipitation unit.
- The metal compounds are precipitated in three stages at increasing pH.



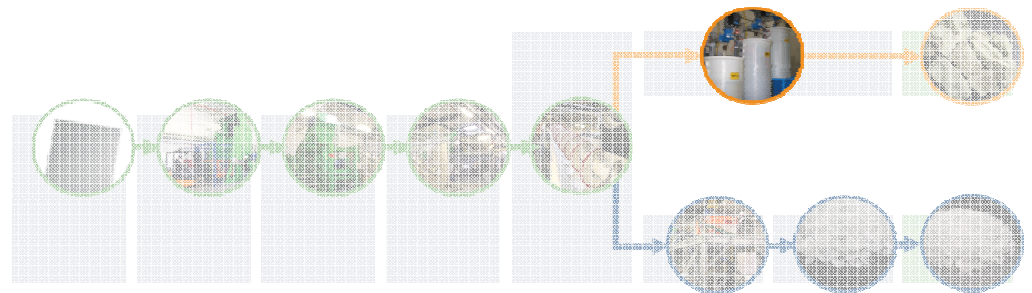


## ● Module Recycling Process

### Dewater



- The precipitated materials are concentrated in a thickening tank.
- Resulting metal-rich filter cake is packaged for processing by a third party

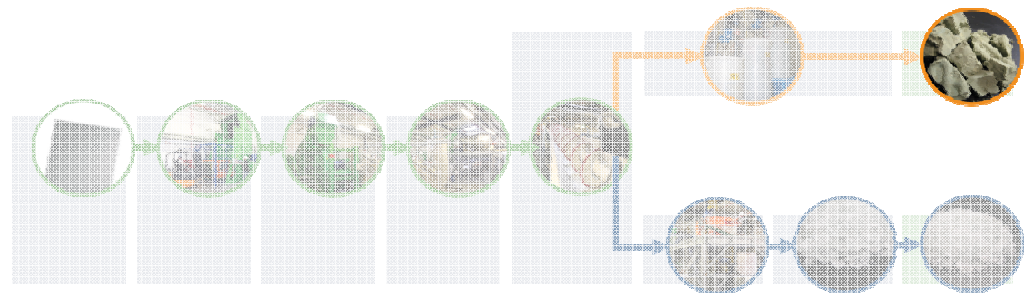




- **Module Recycling Process**  
Metal-Rich Filter Cake



**Results:** ~95% recycling of semiconductor material for use in new modules.



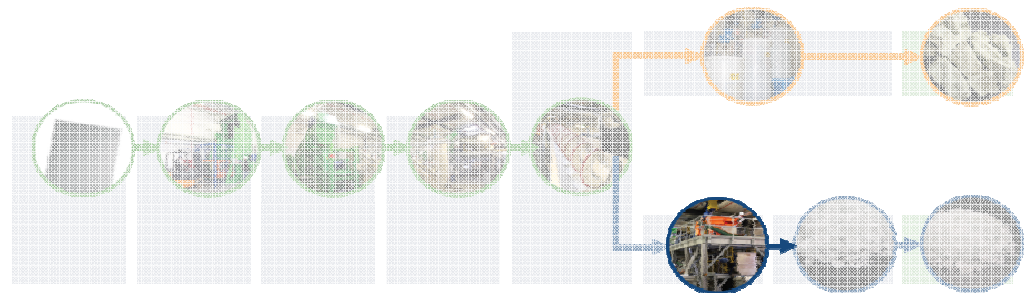


## ● Module Recycling Process

### Glass-Laminate Material



A vibrating screen separates the glass from the larger pieces of laminate material



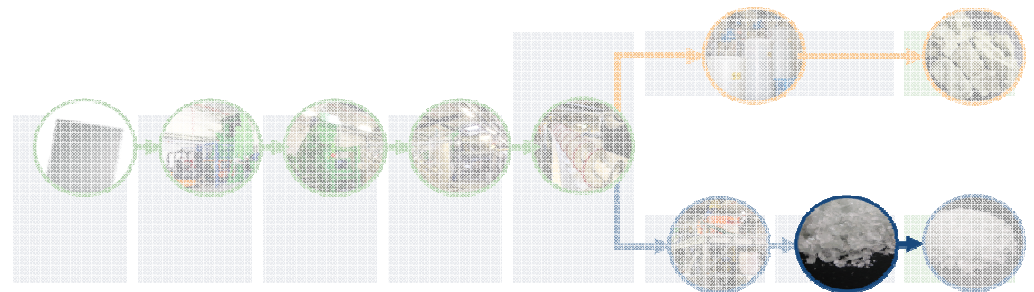


## ● Module Recycling Process

### Glass Rinse



- Rinsed to remove any residual semiconductor films that physically remain on the glass.
- Cleaned glass is packaged for recycling.



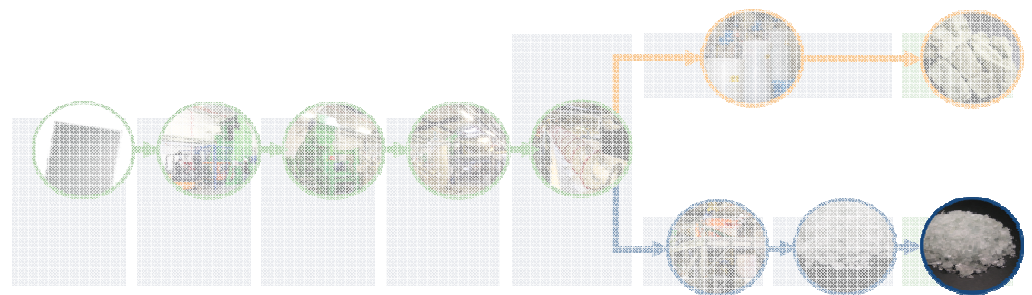


## ● Module Recycling Process

### Clean Glass



**Results:** ~90% recycling of glass for use in new glass products.





## ● Product Recovery and Quality



- Approximately 90% of the module weight is recovered; most of this is glass.
  - Glass will be reused in a new glass product



- Estimated recovery of Te and Cd is 95%
  - Te and Cd will be purified by a third party for reuse in First Solar modules.

All First Solar manufacturing sites have commercial scale recycling facilities.

**First Solar is continually looking at ways to optimize it's Module Collection and Recycling Program.**



## ● Program Funding

- First Solar provides module collection and recycling at no additional cost to anyone in possession of a First Solar module.
- First Solar pre-funds 100% of estimated collection and recycling costs at the time of module sale.
- Funds are invested in a restricted investment account to be used solely for collection and recycling.
- Program, including adequacy of funds, is audited by an external third party auditor annually.







## ● Program Funding

- First Solar has established a trust structure to protect the restricted investment account funds from the potential insolvency of First Solar.
- 'Claims' to access the funds may only be made by a 3<sup>rd</sup> party trustee.
- Reviewed periodically and adjustments made as necessary to ensure the provision of free module collection and recycling to anyone in possession of a First Solar module.



*First Solar...making sustainable attainable.*



## ● First Solar's Module Collection and Recycling Program



- First Solar has the solar industry's first comprehensive pre-funded module collection and recycling program.
- Our program was designed as part of our environmental philosophy and commitment to extended producer responsibility.
- Our program is designed to be:
  - Unconditional
  - Free of cost (e.g. at no additional costs – part of our product offering)
  - Protected from the insolvency of First Solar
  - Minimize the environmental impacts of module disposal by encouraging a high collection rate and recycling rate



First Solar...Enabling a World Powered  
by Clean, Affordable Solar Electricity