

SOLAR PANEL RECYCLING & EPR

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NEWMOA webinar
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LEADING THE WORLD'S
SUSTAINABLE ENERGY FUTURE





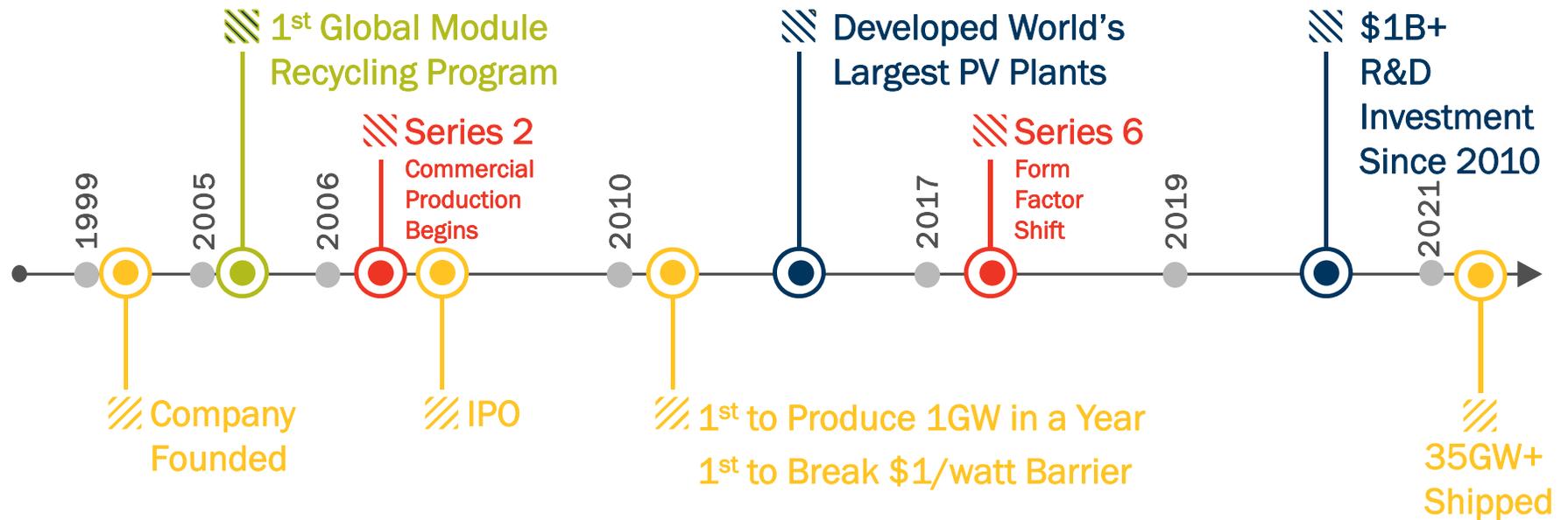
INTRODUCTION TO FIRST SOLAR



THE WESTERN HEMISPHERE'S LARGEST SOLAR MANUFACTURER

- Differentiated thin film technology designed and developed in America
- Higher lifetime energy, with lower levelized cost of electricity (LCOE)
- Financially stable with industry leading bankability
- Lowest carbon PV technology and lowest life cycle environmental footprint

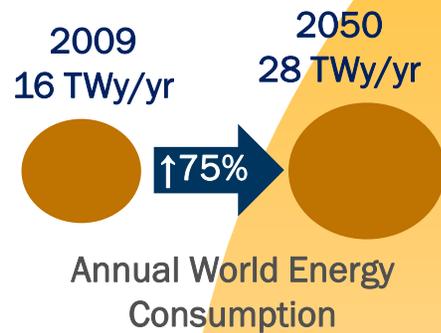
20+ YEARS OF INNOVATION



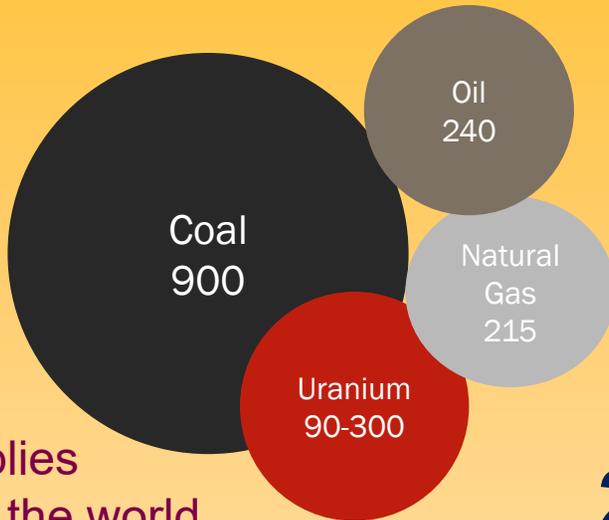


SOLAR ENERGY RESOURCE NEXUS

SOLAR RESOURCE IS VERY ABUNDANT ...



Fossil Fuel Reserves (TWy)



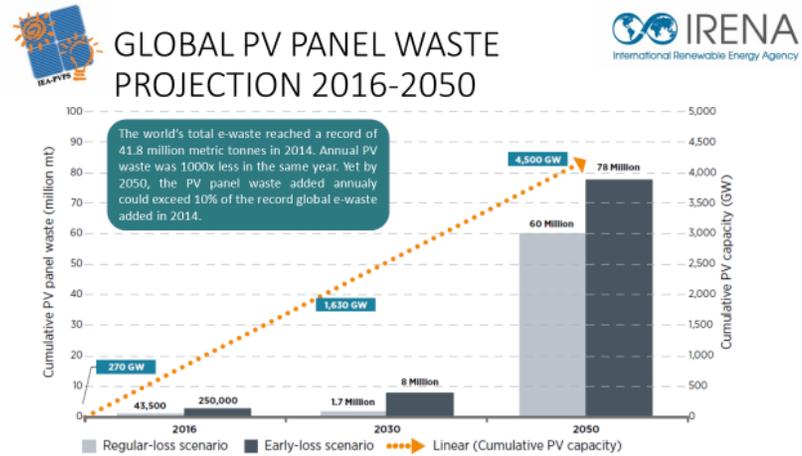
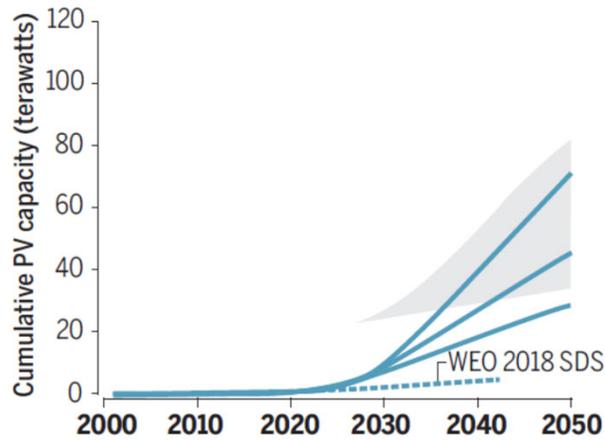
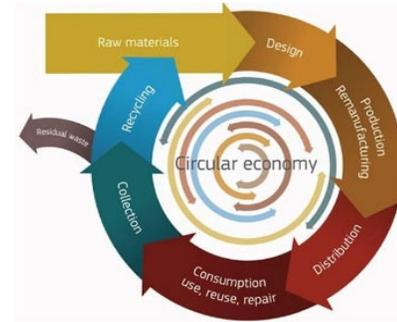
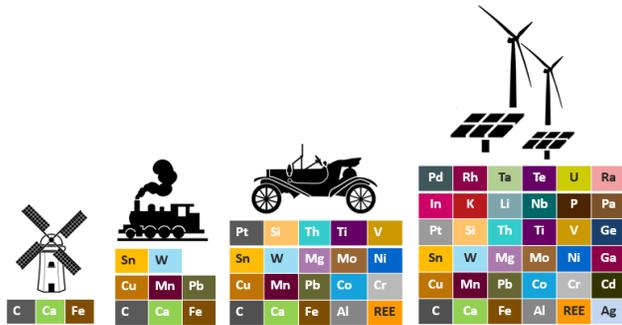
Renewables per Year



Solar
23,000 TW/y

Every hour, the sun supplies enough energy to power the world for an entire year

Source: R. Perez et al, "Renewable Energy Our Solar Future"



CIRCULARITY IS A PRE-REQUISITE FOR TERAWATT-SCALE PHOTOVOLTAICS

A SHORT HISTORY OF PV RECYCLING



1st global PV recycling program in the industry



Ökopol Study



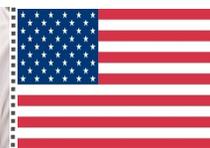
PV Cycle Industry Initiative



EU WEEE Directive



PV Recycling Treatment Standard (EN50625)



U.S. Industry Program



Sustainability Leadership Standard

2005

2007

2012

2017

2018

2019



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

- the Web www.firstsolar.com/recycling
- telephone: 1.800.456.8939 (North American Toll free) +800.433.3133* (International Freephone)
- *For more details on dating codes please visit First Solar's website.
- email: recycling@firstsolar.com

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 módulos solar. Por favor, no elimine de cualquier modo los residuos de este producto antes de ponerse en contacto con First Solar.

La First Solar recoge gratuitamente cuando modulos solares en la oficina del reparto de facturacion. Non getti via questo prodotto prima di aver contattato la First Solar.

First Solar assura gratuitamente la collecte et le recyclage de ce module solaire de manière écologique et responsable. 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 επεξεργασία της παρωπούς βολαιών, πληροφώντας την απαίτηση του προϊόντος, με αποσυνθήκευση πρώτο πρώτο επικοινωνήστε με τη First Solar.

First Solar. www.firstsolar.com

STUDY ON THE DEVELOPMENT OF A TAKE BACK AND RECOVERY SYSTEM FOR PHOTOVOLTAIC PRODUCTS

FUNDED BY BMU
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November 2007



CENELEC

EUROPEAN STANDARD
NORME EUROPEENNE
EUROPAISCHE NORM

FINAL DRAFT
FprEN 50625-2-4

May 2017

English Version
Collection, logistics & treatment requirements for WEEE - Part 2-4: Treatment requirements for photovoltaic panels

Requisitos de colecta, logística y tratamiento para los residuos de equipamiento electrónico de desecho (WEEE). Parte 2-4: Requisitos de tratamiento para paneles fotovoltaicos



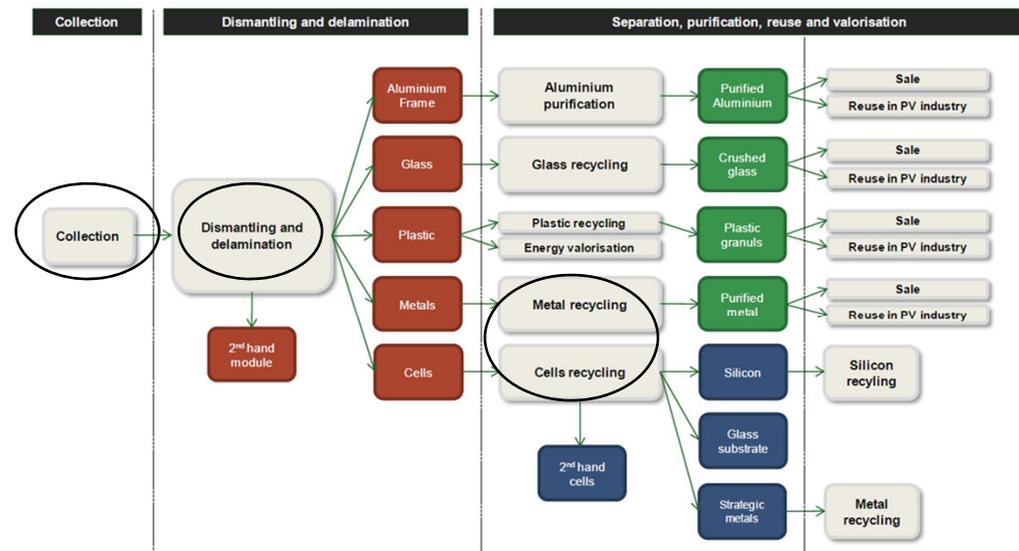


RECYCLING PROCESS AND END MARKETS

KEY TECHNICAL CHALLENGES TO RECYCLING

- Delamination
 - Efficient encapsulant (e.g., EVA) removal
- Collection reverse logistics
 - Waste classification
 - Transport
- High value recycling
 - Need PV-specific recycling standards

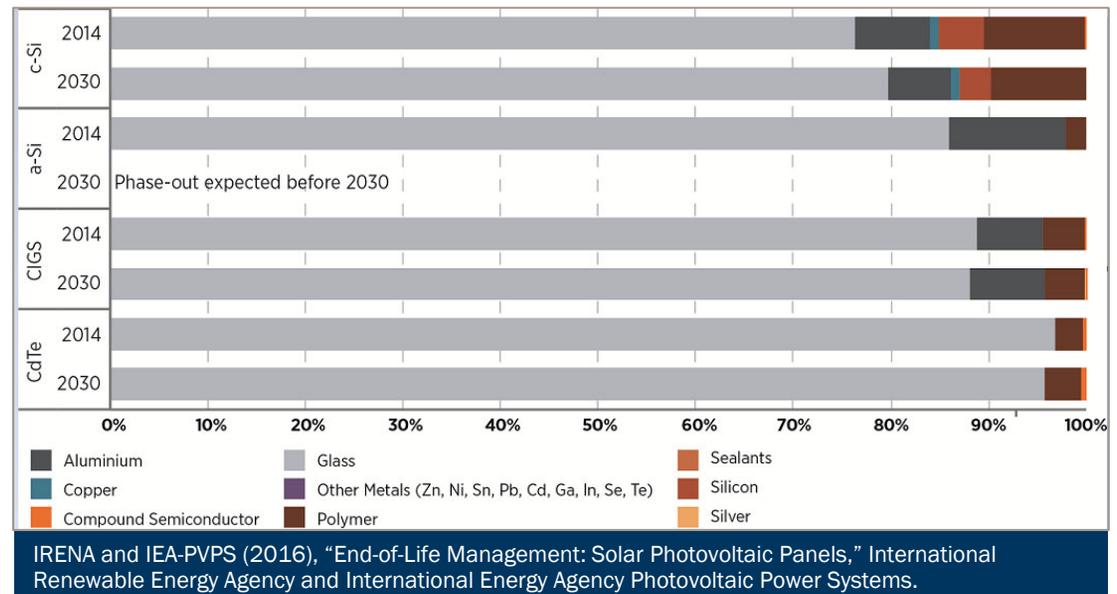
Exhibit 1: Photovoltaic Module Recycling Value Chain



Source : RECORD / ENEA Consulting

BENEFITS OF HIGH-VALUE RECYCLING

- PV modules consist of glass, aluminum, copper, and semiconductor materials that can be successfully recovered and reused
- By weight, more than 80% of a PV module is glass and aluminum
- High-value recycling recovers environmentally sensitive, valuable and energy-intensive materials
- Recoverable value could exceed \$15bn by 2050 (IRENA & IEA PVPS, 2016)



Maximizes resource recovery and increases the sustainability of PV.

FULLY INTEGRATED RESPONSIBLE PRODUCT LIFE CYCLE APPROACH

Material Sourcing



Converting mining byproducts into a stable semiconductor

Product Design



Designed for high-value recycling

Manufacturing



Manufacturing with less energy, water, and GHG emissions

Product Use



Faster CO₂ reductions and greater return on energy invested

High-Value Recycling



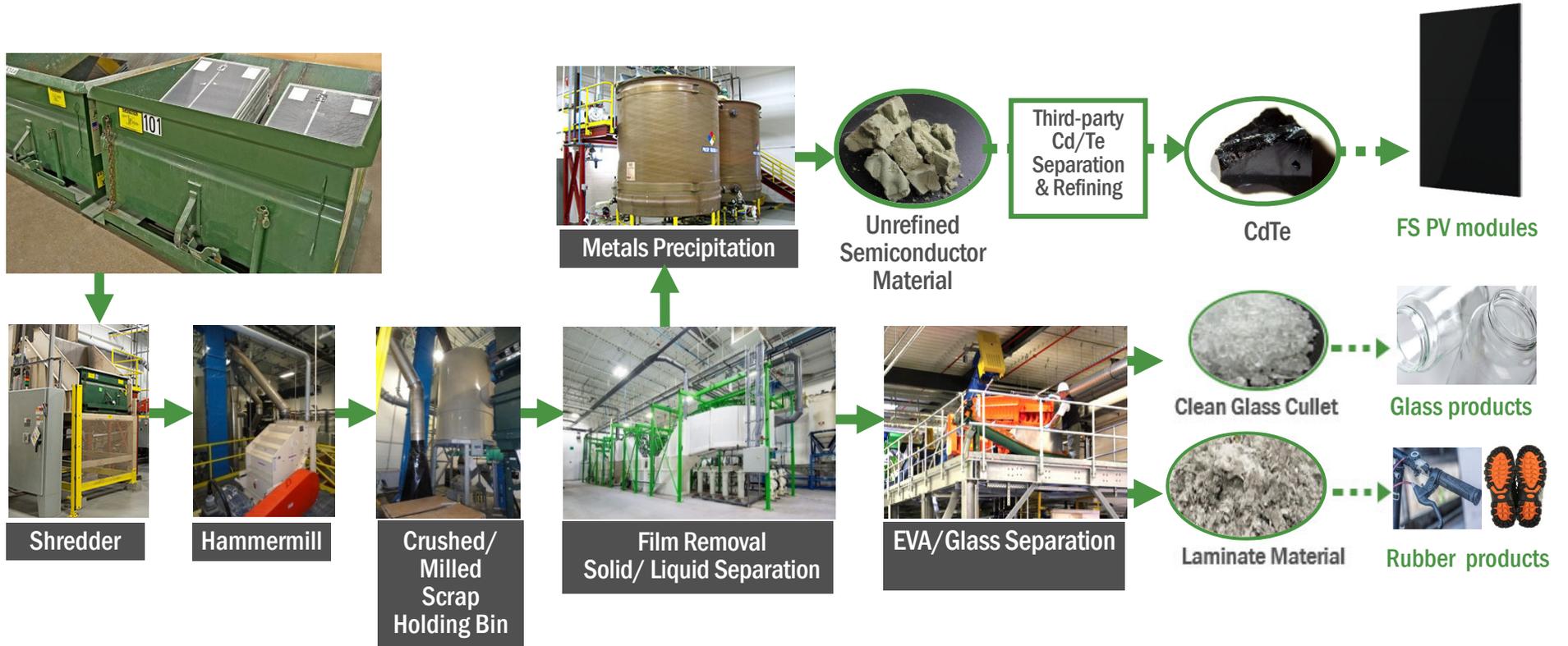
Recovering over 90% of materials at end-of-life for new PV modules

INDUSTRY-LEADING PV RECYCLING SERVICES

- Established 1st global PV module recycling program in the industry
- 10y+ experience operating PV recycling facilities in Germany, Malaysia, Vietnam and the U.S. with ~200,000MT recycled
- Proven and scalable technology to accommodate future high volumes (global capacity of 2 million modules)
- Recovering over 90% of semiconductor materials and approximately 90% of glass for reuse
- Continuously improving processes and technology and reducing operational costs



FIRST SOLAR'S MODULE RECYCLING PROCESS



+ 90% Recycling of Semiconductor Material and ~ 90% Recycling of Glass

CIRCULAR ECONOMY: BEYOND WASTE

TYPICAL RECYCLING RATES



AUTOMOTIVE

~75%



INFORMATION TECHNOLOGY

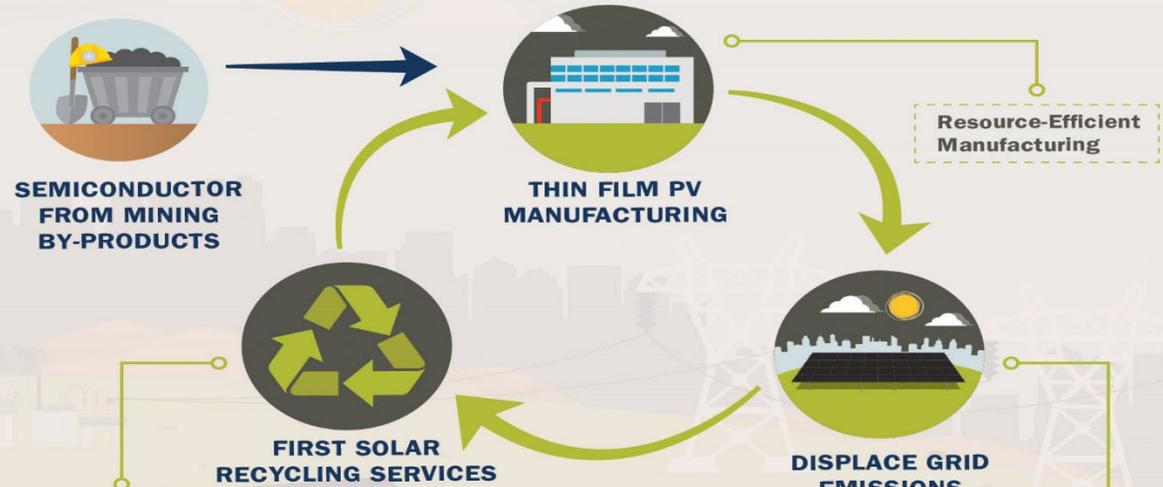
~45%



FIRST SOLAR MODULES

~90%

THE VALUE LOOP



90% RECOVERY RATE

| | | |
|--|---|---|
| <p>GLASS: Used to make glass products</p> | <p>ENCAPSULANT: Used to make rubber products</p> | |
| <p>SEMICONDUCTOR: Reused to produce First Solar modules</p> | | |
| <p>1Kg Of CdTe Semiconductor</p> | <p>40x Times it can be recycled</p> | <p>1,230 years Years It can generate electricity</p> |

25+
Years of
Deployment



FIRSTSOLAR.COM/SUSTAINABILITY



LEADING THE WORLD'S
SUSTAINABLE ENERGY FUTURE