Technology Collaboration Programme
by IEA

International Energy Agency
Photovoltaic Power Systems Programme

Task 12 PV Sustainability Activities

PVPS

Advances in Photovoltaic Module Recycling

Literature Review and Update to Empirical Life Cycle Inventory Data and Patent Review

2024

Report IEA-PVPS T12-28:2024

What is IEA PVPS TCP?

The International Energy Agency (IEA), founded in 1974, is an autonomous body within the framework of the Organization for Economic Cooperation and Development (OECD). The Technology Collaboration Programme (TCP) was created with a belief that the future of energy security and sustainability starts with global collaboration. The programme is made up of 6.000 experts across government, academia, and industry dedicated to advancing common research and the application of specific energy technologies.

The IEA Photovoltaic Power Systems Programme (IEA PVPS) is one of the TCP's within the IEA and was established in 1993. The mission of the programme is to "enhance the international collaborative efforts which facilitate the role of photovoltaic solar energy as a cornerstone in the transition to sustainable energy systems." In order to achieve this, the Programme's participants have undertaken a variety of joint research projects in PV power systems applications. The overall programme is headed by an Executive Committee, comprised of one delegate from each country or organisation member, which designates distinct 'Tasks,' that may be research projects or activity areas.

The 25 IEA PVPS participating countries are Australia, Austria, Belgium, Canada, China, Denmark, Finland, France, Germany, Israel, Italy, Japan, Korea, Malaysia, Morocco, the Netherlands, Norway, Portugal, South Africa, Spain, Sweden, Switzerland, Thailand, Turkey, and the United States of America. The European Commission, Solar Power Europe, the Smart Electric Power Alliance, the Solar Energy Industries Association, the Solar Energy Research Institute of Singapore and Enercity SA are also members.

Visit us at www.iea-pvps.org.

What is IEA PVPS Task 12?

Task 12 aims at fostering international collaboration in safety and sustainability that are crucial for assuring that PV grows to levels enabling it to make a major contribution to the needs of the member countries and the world. The overall objectives of Task 12 are to 1. Quantify the environmental profile of PV in comparison to other energy technologies; 2. Investigate end of life management options for PV systems as deployment increases and older systems are decommissioned; 3. Define and address environmental health & safety and other sustainability issues that are important for market growth. The first objective of this task is well served by life cycle assessments (LCAs) that describe the energy-, material-, and emission-flows in all the stages of the life of PV. The second objective is addressed through analysis of including recycling and other circular economy pathways. For the third objective, Task 12 develops methods to quantify risks and opportunities on topics of stakeholder interest.

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COVER PICTURE

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PHOTOVOLTAIC POWER SYSTEMS PROGRAMME

Advances in Photovoltaic Module Recycling

Literature Review and Update to Empirical Life Cycle Inventory Data and Patent Review

IEA PVPS
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LIST OF ABBREVIATIONS

ASEAN	Association of Southeast Asian Nations
BIL	Bipartisan Infrastructure Law
BOS	Balance-of-system
CN	Canada
CNG	Compressed natural gas
CdTe	Cadmium telluride
CIGS	Copper indium gallium selenide
COD	Certificate of destruction
COR	Certificate of recycling
c-Si	Crystalline silicon
DE	Germany
DOE SETO	U.S. Department of Energy Solar Energy Technologies Office
EIT	European Institute of Innovation and Technology
EOL	End of life
EP	European patent
EPO	European Patent Office
EU	European Union
EU PVSEC	European Photovoltaic Solar Energy Conference
EVA	Ethyl vinyl acetate
FE	Ferrous
FR	France
GB	Great Britain
IEA	International Energy Agency
IRA	Inflation Reduction Act
JB	Junction box
JP	Japan
KR	Korea
LCA	Life cycle assessment
LCI	Life cycle inventory
LNG	Liquid natural gas
MORE PV	Materials, Operation, and Recycling of Photovoltaics
MSDS	Material Safety Data Sheets
NF	Non-ferrous

NREL	National Renewable Energy Laboratory
OECD	Organization for Economic Cooperation and Development
PCT	Patent Cooperation Treaty
PV	Photovoltaic
PVPS	Photovoltaic Power Systems Programme
R&D	Research & development
SEIA	Solar Energy Industries Association
SERI R2	Sustainability Electronics Recycling International Responsible Recycling
TCP	Technology Collaboration Programme
US	United States
WEEE	Waste from Electrical and Electronic Equipment
WIPS	Worldwide Intellectual Property Service

EXECUTIVE SUMMARY

Introduction

Global cumulative installed solar photovoltaic (PV) capacity exceeded 1 TW in 2022, and deployment is expected to accelerate over the next decade. With PV industry scale-up there is increasing recognition that the volume of defective, damaged, and spent modules will expand rapidly in the decades ahead. Module management is becoming a pressing concern for owners and operators of solar generation systems. Development and optimization of collection, triage, repair, refurbishment, reuse, and recycling pathways are needed to convert PV materials into assets that contribute to the circular economy and improve environmental responsibility, rather than creating new waste streams.

PV modules that cannot be repaired or refurbished have reached end of life (EOL) and can often be recycled. A 2016-2017 IEA PVPS Task 12 study funded by the National Renewable Energy Laboratory (NREL) and EPRI reviewed PV recycling technologies in Europe, including four commercial glass and metal recyclers that process batches of PV modules on a periodic basis and one pilot-scale recycling process customized for PV modules.[1,2] Heath et al. showed that recovery of high-value materials like silicon and silver at high purity is needed to improve the economics of recycling.[3] New commercial and demonstration-scale recycling options for PV modules have emerged in the past few years, including some that claim to recover silicon and silver. Limited public data are available on recycling processes for pilot or commercial facilities.

The objective of this study was to identify advances in PV recycling technology that have the potential to be affordable, technically feasible, and environmentally responsible. A survey of recyclers, literature review, and patent search identified industry trends and advances in PV recycling processes. Additionally, leading recyclers supplied life cycle inventory (LCI) data and process flow diagrams for facilities that use advanced recycling treatments to separate PV materials with high quality and yield.

Research Overview

The research team identified 177 recyclers and PV recycling equipment manufacturers globally through press releases, existing connections, past studies, and online search. Invitations to participate in the LCI survey were sent to 24 recyclers that are applying best available or new PV recycling technologies on a commercial or pilot scale. A questionnaire was developed to understand current practices and recycling treatments.

Six recyclers provided information and life cycle inventory data. A seventh LCI case was prepared based on a combination of a recycler LCI response and data previously published by

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[1] Life Cycle Inventory of Current Photovoltaic Module Recycling Processes in Europe. IEA PVPS Task 12, IEA PV Power Systems Programme. Report IEA-PVPS Task 12-12:2017. ISBN 978-3-906042-67-1.

[2] *Insights on Photovoltaic Recycling Processes in Europe: A Survey-Based Approach*. EPRI, Palo Alto, CA: 2017. 3002008846.

[3] G.A. Heath, T.J. Silverman, M. Kempe, M. Deceglie, D. Ravikumar, T. Remo, H. Cui, P. Sinha, C. Libby, S. Shaw, K. Komoto, K. Wambach, E. Butler, T. Barnes, and A. Wade, "Research and development priorities for silicon photovoltaic module recycling supporting a circular economy." Nature Energy 5, 502-501 (2020).

Task 12.[4] Whereas only one of five recycling processes in the 2016-2017 IEA PVPS Task 12 report was customized for PV modules, all seven recycling facilities evaluated in the current study are dedicated to treating PV modules.

LCI data were analyzed across the respondents to compare material recovery rate and energy consumption. To facilitate comparison, a consistent system boundary was applied at the point in each process where a cell fraction (including metals) is separated from the glass and polymers. Subsequent steps to recover silicon and metals like silver, as well as purification steps were not included in the side-by-side analysis to facilitate comparison because not all recyclers responding to the LCI survey performed this function. The system boundary was slightly different for First Solar, as intermediate stage LCI data were not available prior to cadmium and tellurium recovery.

The research team also identified relevant patents and literature on the topic of PV recycling. The global patent search identified 456 relevant patents on recycling PV components, processing methods, and recovered materials. The search relied on DEPATISnet[5] and a 2018 IEA PVPS Task 12 report that used the Worldwide Intellectual Property Service (WIPS). The literature search revealed 569 relevant results identified through Scopus, SciFinder, Google, and ResearchGate. Statistical evaluations were carried out to identify trends in patents and literature by year, country, recycling treatment method, organization, author, and so on.

Results

Five European recyclers and First Solar (US) shared data for recycling capacities between 1 000 t/yr to 50 000 t/yr. A seventh LCI case was modelled based on a combination of a recycler LCI response and previously published data.[4]

- First Solar Inc., Tempe, U.S.
- Reiling Glas Recycling GmbH & Co. KG, Marienfeld, Germany
- LuxChemtech GmbH, Freiberg, Germany
- Flaxres GmbH, Dresden, Germany
- ROSI SAS, Grenoble, France
- Envie 2E Aquitane, Saint-Loubès, France and ROSI SAS, Grenoble, France, combined processes (modelled using ROSI LCI response and previously published data[4])
- Tialpi S.r.l., Mottalciata, Italy

Most of the LCI survey results rely on input from companies that are scaling up new technologies. Many data gaps still exist that could not be fully resolved by the data provided or information from the expert interviews. For example, each LCI assumes a significantly different input mix (module type), making direct comparisons challenging. The capacity of the processes varies from 1 000 t/yr (LuxChemtech) to 50 000 t/yr (Reiling), and the amount of material

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[4] R. Frischknecht, K. Komoto, T. Doi 2023, Life Cycle Assessment of Crystalline Silicon Photovoltaic Module Delamination with Hot Knife Technology, IEA PVPS Task 12, International Energy Agency (IEA) PVPS Task 12, Report T12-25:2023. ISBN 978-3-907281-41-3.

[5] DEPATISNET is an online service of the German patent agency (DPMA): https://depatisnet.dpma.de/DepatisNet/depatisnet?window=1&space=main&content=basis&action=basis

processed annually varies from a test batch size of 7.5 t for Flaxres' pilot line to 41 921 t/yr for First Solar's commercial facilities. Some of the data are projections of expected values for facilities under construction, such as for ROSI's pilot plant in Grenoble, whereas data for established facilities represent actual data. One of the LCI cases (Envie & ROSI) is a modelling result based on preliminary data.

Despite these challenges, the results provide useful insights for a variety of recycling approaches at different levels of development and the associated recovery rates and energy consumption.

Material Recovery

Material output was normalized to 100% for each recycler, such that the cumulative material fractions sum to the weight of one module or one ton of input. The percentages for cables, frames, junction boxes, and non-ferrous metals differ between the respondents largely because of differences in the types of modules that were processed. One main difference is glass recovery rates. Tialpi, Reiling, and Flaxres recover similar percentages of glass, and LuxChemtech and ROSI, with and without Envie, can achieve slightly higher glass outputs. First Solar modules are glass-glass construction, resulting in a higher percentage of glass output. There are also differences in the mixed fractions and dust produced in each process. Mechanical processes (such as Reiling's crushing step, Tialpi's use of a blade to remove the glass, and ROSI's mechanical sortation) tend to produce more dust than water-jet and thermal processes. Pyrolysis fully removes the foil fraction, effectively increasing the relative amounts of the other outputs in the two ROSI LCI cases.

Energy Consumption

Energy consumption data were not yet available for the ROSI LCI cases. Reiling and Flaxres are the most efficient in terms of energy consumption. The chemical and water-jet processes developed by LuxChemtech consume a moderate amount of electricity, but it is still more than twice the consumption of Reiling's facility. Tialpi results are in the same energy consumption range as the LuxChemtech process. First Solar's LCI data include recovery of cadmium and tellurium, resulting in higher electricity consumption than the other LCI cases presented.

Recycling Survey and LCI Key Findings

- *Mechanical recycling is still the benchmark.* Mechanical recycling is optimized for costs, capacity, and output but frequently includes some downgrading of material quality. Reiling's improved, pure-mechanical process for silicon-based modules represents a fully commercial, best available technology that sets a benchmark for maturity, cost, and low energy consumption. However, it does not allow recovery of silicon and silver.
- *Innovative technologies offer improved recycling quality.* New technologies in pilot-stage demonstrations offer excellent recycling quality in terms of yield and purity of the fraction and economic value opportunities. Innovative approaches include light pulse treatment, water-jet cleaning, pyrolysis, and chemical treatment. Recyclers have demonstrated full recovery of aluminum frames, cables, junction boxes, interconnectors, silicon, and silver. Envie & ROSI, ROSI, LuxChemtech, Tialpi and Flaxres separate a glass fraction that can offer the flat glass industry a future source of usable cullet as a secondary raw material, saving melting energy. Improving the quality of recovered materials offers upcycling opportunities that can offset the cost of recycling and advance PV circularity.
- *Strong thin-film recycling experience.* First Solar operates a proprietary recycling system for its own thin-film module technology that has achieved over 90% material recovery through continuous process improvements in recent years. Some emerging recycling technologies are expected to be applicable to thin-film modules of any kind,

as well as silicon-based modules, though some additional special treatment might need to be added.

- *Facilities dedicated to PV recycling.* There has been a dramatic shift since the 2016-2017 IEA PVPS Task 12 study in terms of the number of recyclers that accept PV modules and in terms of the development and demonstration of recycling treatments and processes customized for PV modules. The first commercial PV module recycling plants with advanced treatments to separate materials with high quality and yield are being planned and constructed to support the growing supply of end-of-life modules.

Patent and Literature Review Key Findings

Global interest in PV recycling is rising as evidenced by steep increases in publications, patents, and research. The number of publications and patent applications coincides with growth in the global PV market and the introduction of PV waste policies in several regions.

Nearly 80% of patents target recycling processes for silicon-based modules, cell metals, polymers, glass, or devices. Thin-film and emerging technologies comprise the remaining patent space. Patents typically focus on recovering valuable material, toxic materials, or semiconductor materials, though some address glass and polymers. Technical approaches include mechanical, chemical, and thermal treatments, or combinations of treatment methods.

Patent filings and ownership correlate with major production locations and major PV installation markets. Top regions for patent applications are People's Republic of China, United States, South Korea, Japan, and Europe. People's Republic of China owns the most patents with 141, followed by 85 in Japan, 79 in South Korea, 54 in the U.S., and 33 in Germany. Most patents are filed by universities, research institutions, and module manufacturers. There are few applications by recyclers, professional waste treatment companies, and equipment manufacturers because the current waste stream in most regions is still too small to justify significant investments in dedicated recycling technologies.

Published literature is primarily comprised of journal articles and conference papers. PV recycling is viewed as an important topic globally. The U.S. has the most publications, followed by Italy and People's Republic of China, but developing countries and emerging markets like Ghana, South Africa, and Mexico are also publishing papers about PV recycling. Most studies are authored by research institutions and universities, frequently in collaboration with PV manufacturers, equipment providers, and recycling companies. Of the top 25 publishing organizations, only one was a recycler, First Solar. Results for individual leading authors show that U.S. authors hold the most publications, followed by authors in Italy and People's Republic of China. This result follows the same trend as the total number of publications by country.

How to Apply Results

Solar PV system asset owners and operators, as well as utility integrated resource planners can use the knowledge and perspectives in this study to inform module management strategies and enable a circular economy for energy materials as an integral part of the clean energy transition in cooperation with authorities, take back systems and recyclers. Commercial recyclers and researchers within the international solar PV community and related disciplines can use the LCI data to support work that further improves recycling quality and improves economic value. LCI data for PV module recycling can be used by researchers in full life cycle assessments for PV. Identifying gaps in treatment technologies and operating experience also helps in shaping research and development (R&D) priorities.

1 STUDY OVERVIEW

1.1 Introduction

Global cumulative installed solar photovoltaic (PV) capacity exceeded 1 TW in 2022, and deployment is expected to accelerate over the next decade. With PV industry scale-up there is increasing recognition that the volume of defective, damaged, and spent modules will expand rapidly in the decades ahead. Module management is becoming a pressing concern for owners and operators of solar generation systems. Development and optimization of collection, triage, repair, refurbishment, reuse, and recycling pathways are needed to convert PV materials into assets that contribute to the circular economy and improve environmental responsibility, rather than creating new waste streams.

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The objective of this study was to identify advances in PV recycling technology that have the potential to be affordable, technically feasible, and environmentally responsible. A survey of recyclers, literature review, and patent search identified industry trends and advances in PV recycling processes. Additionally, six leading recyclers supplied life cycle inventory (LCI) data for facilities that use advanced recycling treatments to separate PV materials with high quality and yield. A seventh approach, the combined recycling processes of Envie and ROSI, was modelled using LCI data from a recent IEA-PVPS report on the Japanese NPC recycling process.[9,10]

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[6] Life Cycle Inventory of Current Photovoltaic Module Recycling Processes in Europe. IEA PVPS Task 12, IEA PV Power Systems Programme. Report IEA-PVPS Task 12-12:2017. ISBN 978-3-906042-67-1.

[7] *Insights on Photovoltaic Recycling Processes in Europe: A Survey-Based Approach*. EPRI, Palo Alto, CA: 2017. 3002008846.

[8] G.A. Heath, T.J. Silverman, M. Kempe, M. Deceglie, D. Ravikumar, T. Remo, H. Cui, P. Sinha, C. Libby, S. Shaw, K. Komoto, K. Wambach, E. Butler, T. Barnes, and A. Wade, "Research and development priorities for silicon photovoltaic module recycling supporting a circular economy." Nature Energy 5, 502-501 (2020).

[9] R. Frischknecht, K. Komoto, T. Doi 2023, Life Cycle Assessment of Crystalline Silicon Photovoltaic Module Delamination with Hot Knife Technology, IEA PVPS Task 12, International Energy Agency (IEA) PVPS Task 12, Report T12-25:2023. ISBN 978-3-907281-41-3.

[10] Information provided by ROSI

1.2 Survey of Photovoltaic Module Recyclers

This section presents survey results for PV recyclers that process PV modules on a commercial or pilot level. The circular economy has grown significantly since the previous 2016–2017 survey. Several organizations are now involved, although the scale of PV waste streams is still moderate compared to other electronic waste streams worldwide. Significant growth of PV waste streams is expected after 2030 in the major PV markets, which will require construction and scale-up of recycling plants and dedicated-equipment suppliers.

1.3 Approach

The list of recyclers to survey was developed via the following:

- An update of the 2016–2017 survey list of recyclers
- Online research at the following:
  - Enfsolar: https://de.enfsolar.com/directory/service/manufacturers-recycling
  - Google: “PV module recycling” OR “PV panel recycling” OR “Solar module recycling” OR “Solar panel recycling”
  - Bing: “PV module recycling” OR “PV panel recycling” OR “Solar module recycling” OR “Solar panel recycling”
  - Press releases (e.g., PV magazine, international issues)
  - DEPATISnet survey on patent applicants
  - Solar Energy Industries Association (SEIA): www.seia.org
  - Wer liefert was: https://www.wlw.de
  - Stiftung EAR: https://www.stiftung-ear.de
  - List of universal waste companies accepting PV modules in California
  - Participant lists from recycling webinars and workshops as identified
- Expert interviews (e.g., PV CYCLE, Take-e-way, SENS eRecycling, Soren)
- Lists of U.S. recyclers from previous EPRI studies

1.4 Survey Results

The research team identified 177 recyclers or PV recycling equipment manufacturers, whereas the 2016–2017 NREL/EPRI study included about 25 companies.[1] The recyclers mentioned in a recent IEA PVPS Task 12 report have been included in the list of recyclers and equipment manufacturers.[11]

Figure 1 shows the recyclers’ regional distribution, and Table 1, shown on page 16, compares results of the 2022 survey with previous findings and organizations contacted. The results are consistent with PV market growth, growing waste streams, and upcoming legislative frameworks in many countries. As expected, the European PV waste market grew significantly,

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[11] International Energy Agency. Photovoltaic Power Systems Programme. Status of PV Module Recycling in Selected IEA PVPS Task12 Countries. IEA-PVPS-T12-24. 2022. https://iea-pvps.org/wp-content/uploads/2022/09/Report-IEA-PVPS-T12-24_2022_Status-of-PV-Module-Recycling.pdf.

and the European Union's Waste from Electrical and Electronic Equipment (WEEE) Directive further developed collection and waste treatment rules for PV in the last five years. In response, mechanical, thermal, and chemical treatments customized for PV modules have emerged to improve recycling yield and quality.

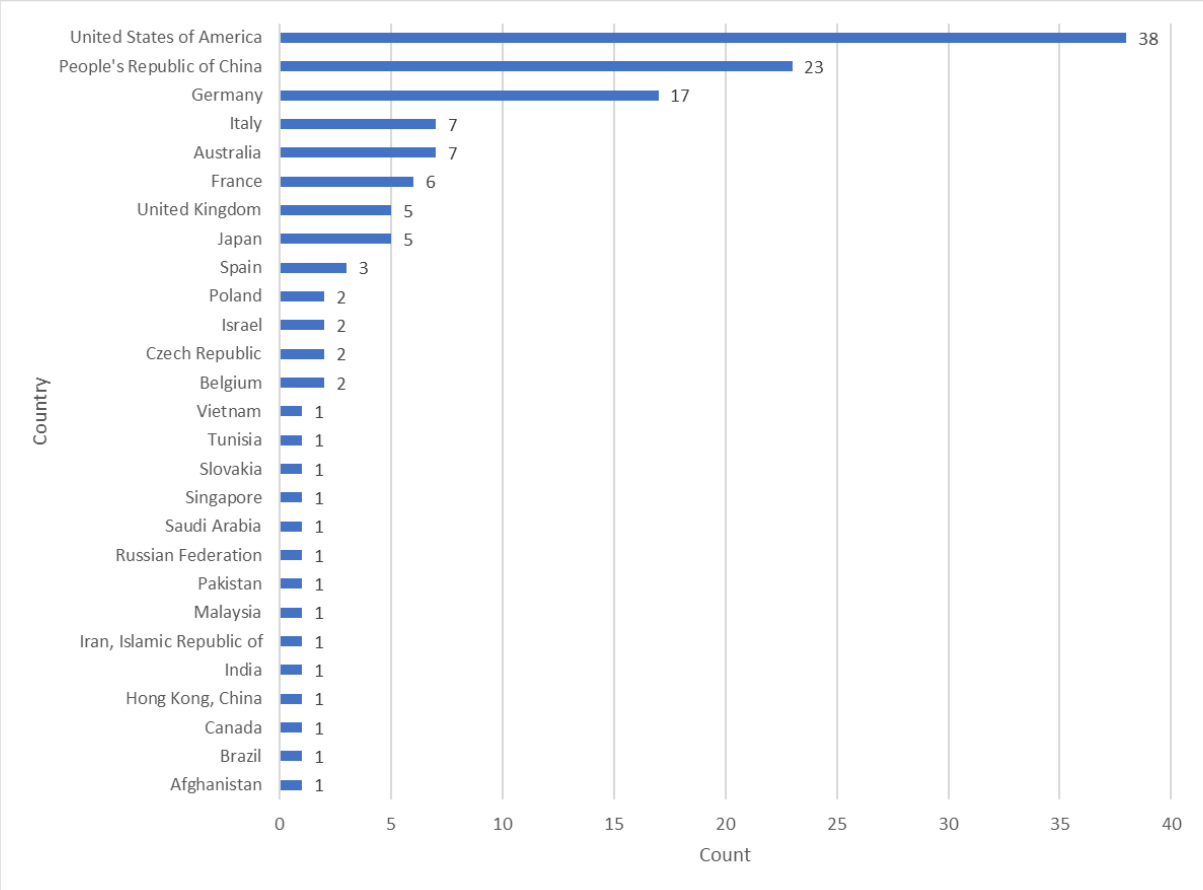


Figure 1: Geographical distribution of recyclers and pilot lines

Table 1: Current and previous results of inquiries to PV module recyclers and recyclers contacted in this study

	2015	2016	2022
Contacts	8 recyclers (1 declined)	16 recyclers (7 declined)	24 (18 did not respond or declined request)
Locations	Belgium: 1 Germany: 6	Australia: 1 Belgium: 1 France: 1 Germany: 8 Italy: 3 Japan: 1 Switzerland: 1	Australia: 2 Belgium: 1 Germany: 5 Italy: 3 Japan: 1 France: 2 United States: 10
Technologies	E-waste recyclers: 2 Laminated glass recyclers: 6	E-waste recyclers: 2 General waste treatment companies: 2 Laminated glass recyclers: 5 Metal recyclers: 2 PV module recyclers (pilot stages): 5	Crushing/mechanical separation: 17 Hot knife: 2 Infrared heating: 1 Light pulse annealing: 2 Pyrolysis: 2
Questionnaires sent to recyclers	7	9	9 (after confirmation of acceptance)
Respondent feedback on questionnaires	7	7	6
Face-to-face or online discussions	3	2	7
Data sets received	2: Anonymous, Germany Exner Trenntechnik, Germany	5: Anonymous, Germany Exner Trenntechnik, Germany (stopped) Maltha, Belgium (stopped) Nike, Italy Sasil (now Tialpi), Italy	6:* First Solar Inc, U.S. Flaxres, Germany LuxChemtech, Germany Reiling, Germany ROSI SAS, France Tialpi, Italy (partial)

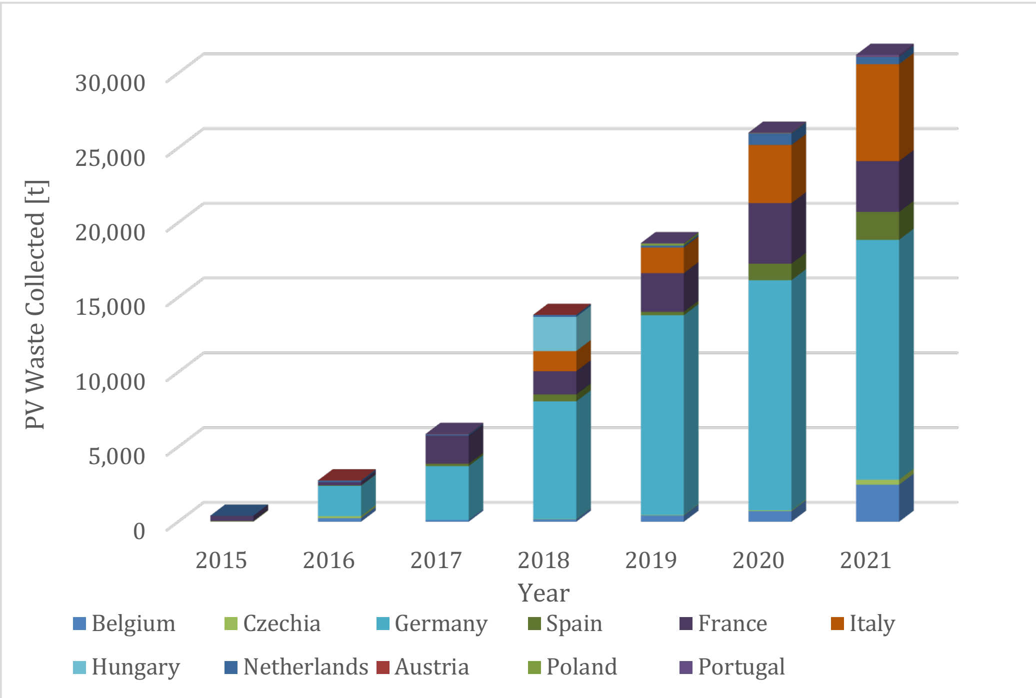
* While not a recycler, NPC provided data to Task 12 in a separate study. These data were used along with the 6 recycler-provided datasets.

The information found during the search for recyclers is not always consistent; some links (including some provided by Enfsolar or SEIA, for example) do not work, and validation is frequently impossible for missing contact links or blocked or non-existent URLs. Though this study identified many recyclers that seem to accept PV modules and PV recycling equipment manufacturers, additional information about the companies is limited. Specifically, details about recycling activities, plant capacities, treatment processes, and outputs are rarely published, and it is unclear whether recyclers also perform waste treatment and disposal or downstream processing. Some of the listed recyclers may actively collect PV waste and some may test the condition of the module, sort modules for reuse or recycling, or perform pre-treatments like cable, frame, or junction box repair or removal. The residual modules are then processed either in-house or by a third party or landfilled. Few details are available in the public domain.

The official Eurostat statistics in Figure 2 illustrate the EU PV recycling market's development. According to the rules set in the WEEE, the member states representing the main PV markets predominantly provide the statistical data. Due to differences in the national transpositions of the WEEE and different reporting practices, the numbers might not be fully consistent. Expert interview results indicated that a huge international market already exists for used modules (decreasing the waste stream) and that not all PV waste may be reported, despite being properly treated. Therefore, the Eurostat statistics may underestimate the waste stream's size.

The first IEA PVPS Task 12 study on PV recycling life cycle inventory was started in 2015 and was continued in 2016 during the early stages of mandatory PV recycling in the EU, which was part of the recast of the WEEE in 2012.[12,13] Collection and recycling of PV modules has been established in the meantime, and the EU member states report annually via Eurostat. An example of the PV waste collection results reported is shown in Figure 2.

Figure 2: PV waste collected in Europe, according to Eurostat 2015–2021[14]



Some of the recyclers have stopped their recycling activities since the 2016–2017 survey, including the following:

- Veolia stopped mechanical treatment activities (which used technology reportedly supplied by La Mia Energia from Italy, EU project PV Morede) in Rousset, France. However, Veolia cooperates with ROSI SAS and Flaxres GmbH, Germany, on the European Institute of Innovation and Technology (EIT) Raw Materials project ReProSolar using flash lamp annealing for PV module separation.

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[12] https://iea-pvps.org/wp-content/uploads/2020/01/LCI_of_Current_European_PV_Recycling_WambachHeath_2017_by_Task_12.pdf.

[13] https://iea-pvps.org/wp-content/uploads/2020/01/Life_Cycle_Assesment_of_Current_Photovoltaic_Module_Recycling_by_Task_12.pdf.

[14] https://ec.europa.eu/eurostat/databrowser/view/ENV_WASELEE__custom_1388102/default/table?lang=en, https://ec.europa.eu/eurostat/databrowser/view/ENV_WASELEEOS__custom_4287260/default/table?lang=en (accessed June 2, 2024.)

- Maltha Groep no longer recycles PV modules. Maltha now concentrates on glass recycling and is therefore still interested in glass cullet processing from PV modules.
- Exner Trenntechnik GmbH was sold to Wilhelm Geiger GmbH & Co. KG group and now concentrates on metal recycling.
- PV CYCLE and Soren also cooperate with the recycler Galloo in Belgium, but the companies did not provide any information.

Many other companies entered the PV waste market in recent years, and the research team identified 177 companies via the sources mentioned above. It can be assumed that several other companies worldwide have started PV recycling activities and that the study's list may not be exhaustive because companies rarely publish their activities internationally. Appendix A, Table A1: Global PV Recyclers has a full list of global PV recyclers.

The team identified 38 U.S. recyclers, though recycling in the United States is not yet mandatory.[15] The recyclers provide few details in published literature or on their company web sites about their activities and the treatment processes they apply. According to expert interview results, there is a range of definitions for PV module recycling. While some recyclers recover over 80% of the material, PV modules are frequently picked up only for cable and frame removal prior to landfill disposal. This could change in the future if recycling costs become competitive with landfill disposal costs and if laws and regulations are implemented. Additionally, the 2022 Bipartisan Infrastructure Law (BIL)[16] designated $10 million to fund research that advances reuse and recycling of solar energy technologies. The Inflation Reduction Act (IRA) of 2022 offered tax credits to spur domestic manufacturing, which could in turn drive recycling demand to treat manufacturing waste streams. In July 2023, the U.S. Department of Energy's Solar Energy Technologies Office (DOE SETO) announced $20 million in funding for Materials, Operation, and Recycling of Photovoltaics (MORE PV) in July 2023, including $8 million of BIL funding.[17] DOE SETO's action plan for PV system end-of-life management[18] established a recycling cost-reduction target of less than $3 USD/module (or less than $150 USD/ton) by 2030 to compete with the cost of U.S. landfill disposal. The action plan also outlines research and development (R&D) priorities.

1.5 Recyclers Contacted

Table 2 presents a detailed list of contacted recyclers. The following criteria were applied during selection:

- Commercial activity with significant market share in a region.
- Best available technology application or innovative recycling processes demonstrated at least at pilot level.
- Potential willingness to support the study.

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[15] Starting July 1, 2025, Washington state will become the first state to require PV module manufacturers to offer and finance PV module take-back and reuse or recycling for products sold within or into the state, as of July 1, 2017.

[16] Bipartisan Infrastructure Law Homepage | Department of Energy.

[17] DOE-FOA-0002985: Materials, Operation, and Recycling of Photovoltaics (MORE PV)

[18] DOE Releases Action Plan For Photovoltaic Systems End-Of-Life Management | Department of Energy.

Of the 26 recyclers contacted for this study, several European and one American recycler responded. Many recyclers were quite reluctant to provide information, and predominantly European waste treatment companies participated. An explanation might be that a mandatory recycling system is already being established in Europe per the WEEE, and Europe has more-mature collection and recycling systems.

Table 2: Participating recyclers

Recycler	Country	Technology	Comment
Reiling	Germany	Mechanical	Commercial, new recycling center under construction
Flaxres	Germany	Light pulse	Pilot, subsequent steps not yet implemented
LuxChemtech	Germany	Water jet, light pulse, chemical	Pilot, not all subsequent steps are implemented yet
First Solar Inc.	Germany; United States; Vietnam; Malaysia	Mechanical and chemical	Recently upgraded recycling in progress in Germany, V4 under development; contact via First Solar Inc., U.S.
ROSI SAS	France	Pyrolysis, mechanical, and chemical	Pilot, under construction
Tialpi	Italy	Thermal, mechanical, and chemical	Pilot plant of 1 000 tons per year in Italy
NPC ~	Japan	Mechanical, hot knife	Equipment manufacturer
~ NPC provided data to Task 12 in a separate study.			

The research team observed increasing activity in PV waste R&D, policy development, and legislative actions in many regions, such as Africa, Asia, Australia, India, Europe, the United States, and South America. This observation was confirmed by the increasing number of publications from these regions (see Literature Search Results section).

2 RESULTS OF THE LIFE CYCLE INVENTORY SURVEY AND ASSOCIATED EXPERT INTERVIEWS

2.1 First Solar Inc., Tempe, U.S.

First Solar is one of the top-ten PV producers, with its CdTe thin-film modules (www.firstsolar.com). First Solar operates four recycling plants worldwide for its own end-of-life products, with a total treatment capacity of about 50 000 tons per year. The plants are in Ohio, Malaysia, Vietnam, and Germany, fully covering First Solar's global recycling demand. The recycling processes applied allow a very high recovery of more than 90%, according to the company's 2022 environmental report. The proprietary recycling process has been continuously improved in recent years.

As shown in Figure 3, First Solar removes the junction box first. Then they shred the laminate and use a hammer mill process to separate the glass from the polymers and semiconductor material. A buffer stores the polymer and semiconductor fraction in separate containers. Then a leaching process using water and chemicals recovers Cd and Te from the glass. These metals precipitate from the solution, such that they can be recovered and further purified by third parties. An evaporator recirculates the water, producing a Na_2SO_4 residue. In a final step, First Solar separates the ethyl vinyl acetate (EVA) from the glass. The polymer is incinerated or landfilled depending on the country, and it can also be used to produce rubber products. Recovered glass is used in the glass industry.

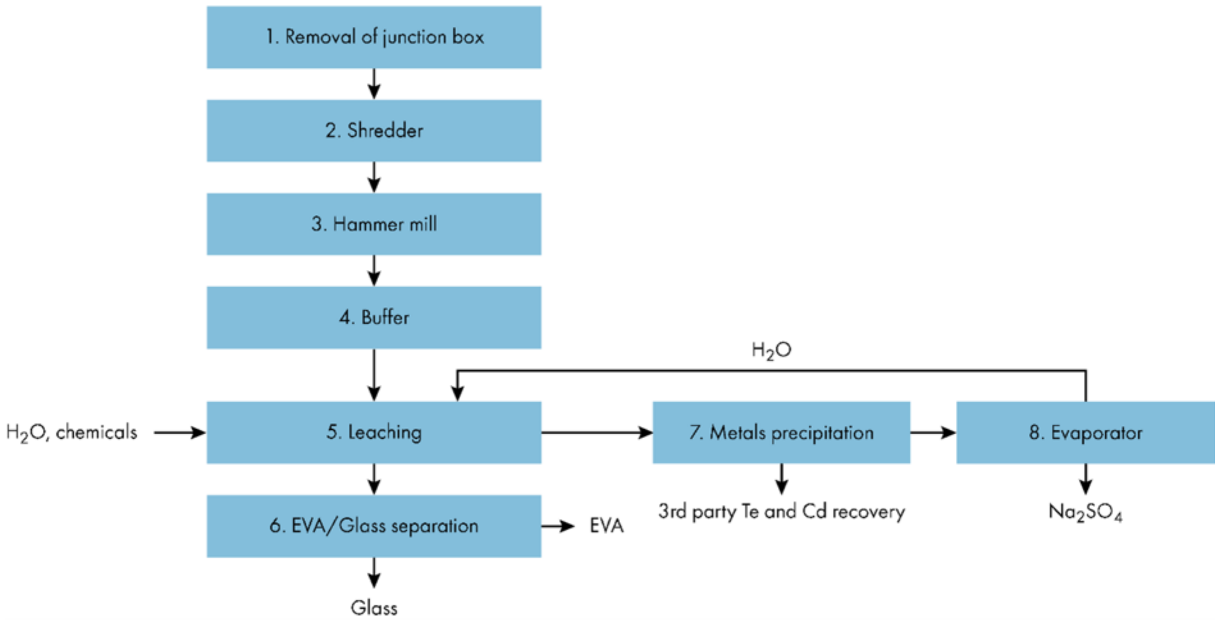

Figure 3: First Solar CdTe module recycling process; all steps 1–8 are included in the LCI comparison except the third party recovery treatments

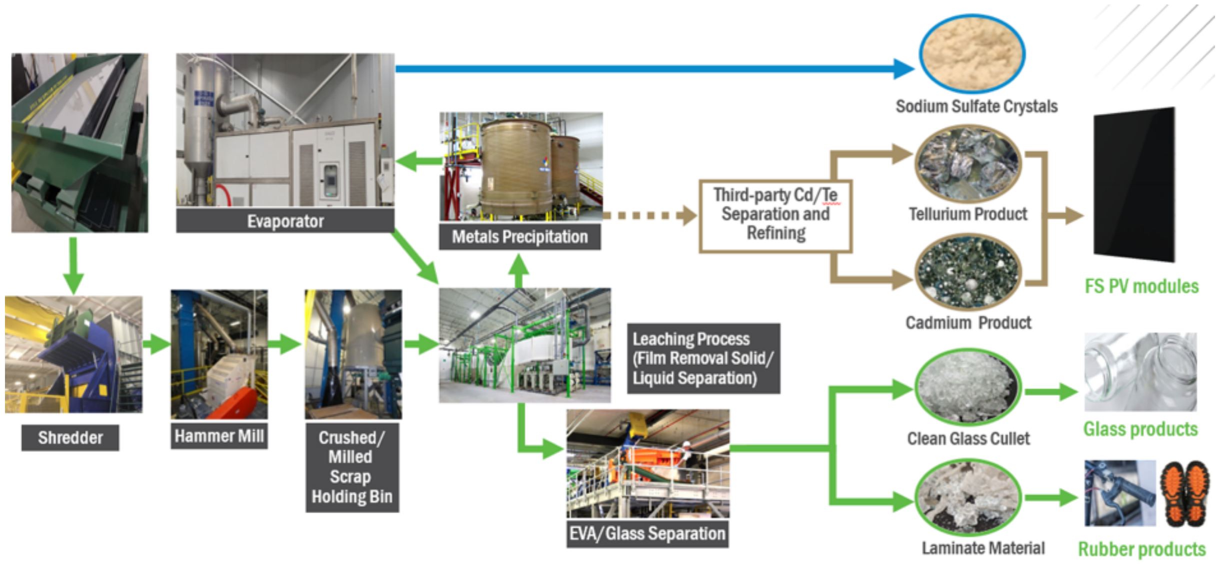

Figure 4: First Solar third-generation recycling technology based on a continuous flow process (Credit: First Solar Inc.)

For knowledge protection reasons, First Solar could not provide detailed data on the subsequent treatment and chemical use.

The LCI data provided show a recycling rate of the output fractions that total about 97.2% relative to the total mass of the input. Deviations in the international reporting systems prevent the outputs from totalling 100%. Table 3 shows the LCI results.

Table 3: LCI results for First Solar's recycling processes based on a 2022 environmental report

Company	First Solar Inc., Perrysburg, USA		
Name	CdTe module recycling		
Time period	2021 with updates from 2022 sustainability report and some LCI data of 2012		
Geography	USA, Malaysia, Vietnam, Germany		
Technology	Mechanical and chemical treatment		
Representativeness			
Date	11/20/2022		
Collection method	Data from recycler		
Comment	Several national and regional electricity mixes, partly from renewables		
		Original values	
Plant	**Unit**	**Amount**	**Comment/reference**
Capacity	t/yr	50 000	Estimates cum. capacity of 4 plants
Type of plant		4 recycling plants	Mechanical and chemical treatment
Location		Several plants	Recycling sites: Perrysburg, Ohio; Kulim, Malaysia; Ho Chi Minh City, Vietnam and Frankfurt/Oder, Germany
Module type processed		CdTe double glass modules	First Solar CdTe modules
Time period		2021	Data from 2022 sustainability report
Mechanical and chemical treatment			
Total input	t/yr	41 921	First Solar CdTe modules

Components/fuels			
Electricity consumption	kWh/t	265	As of 2012 in Frankfurt/Oder, based on IEA-PVPS Task 12 report, table 3.7
CNG/LNG[19]	kWh/t	Not applicable	
Diesel/oil consumption	l/t	Not applicable	
Output			**Specify and indicate utilisation, subsequent treatment**
Cables	%		Not provided, recovered during pre-treatment
Frame	%		Not provided, recovered during pre-treatment
Junction boxes	%		Not provided, recovered during pre-treatment
Semiconductor	%	0.4	Specialized Cd and Te refiner
Metals	%	1.5	Metal recycler
Glass cullet	%	87	Glass manufacturer
Polymer	%	3	Incineration with energy recovery
Polymer	%	5	Rubber material production, landfill or incineration
Other materials	%	0.3	Encapsulant
Other (wastes, emissions)	%	Not applicable	Water, recirculated[20]

2.2 Reiling Glas Recycling GmbH & Co. KG, Marienfeld, Germany

Reiling is a family-owned recycling company that started recycling PV modules around 2010, at the boom of the PV industry in Germany (www.reiling.de). It currently operates four glass-recycling plants where crystalline silicon (c-Si) PV modules are accepted. Reiling also provides logistic services. The plants are located in Marienfeld, Torgau, Osterwedding, and Burgbernheim, Germany. The current capacity is about 10 000 t/yr. A new plant dedicated to recycling crystalline-silicon-based PV modules is located in Münster, with a capacity of 50 000 t/yr. The technology used is based on a mechanical treatment originally used for laminated glass from the building and automotive industries. The treatment plants' free capacities were used to process the PV modules in discrete batches. As the PV waste stream increased, Reiling performed several R&D projects to improve the mechanical treatment process's yield and efficiency. The results are deployed in the new Münster plant that started in 2023. In 2022, Reiling recycled about 4 200 tons of PV modules. The LCI results presented in this report include a simplification of the shredding and separation process by which the aluminum in the frames is extracted automatically after crushing.[21] Reiling succeeded in increasing the yield of glass cullet by 6% compared to 2017 with moderate electrical energy consumption. In Münster, electricity from Reiling's own PV plant is used to operate the recycling process, and modules are tested for reuse (second life) potential. Figure 5 shows the process, and Figure 6 shows an example of the different output fractions obtained.

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[19] Compressed natural gas (CNG) or liquid natural gas (LNG) fuels

[20] The amount of recirculated water used or consumed was not reported.

[21] Before the new process was implemented, the frames and junction boxes had been removed semi-automatically before crushing.

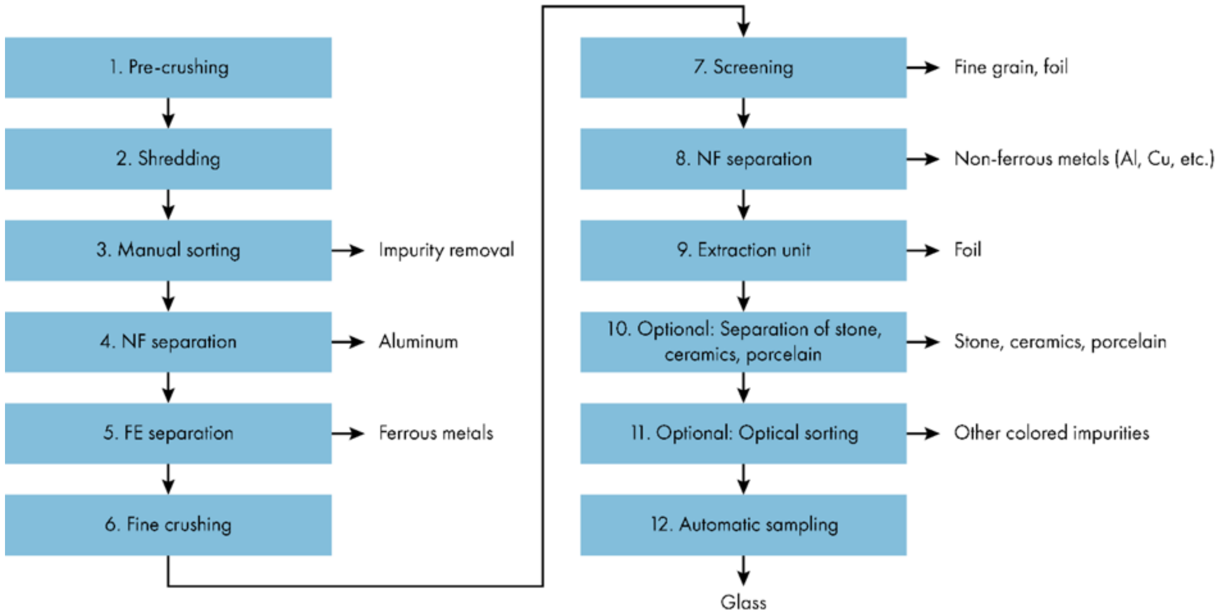


Figure 5: Reiling mechanical recycling process; all steps are included in the LCI comparison

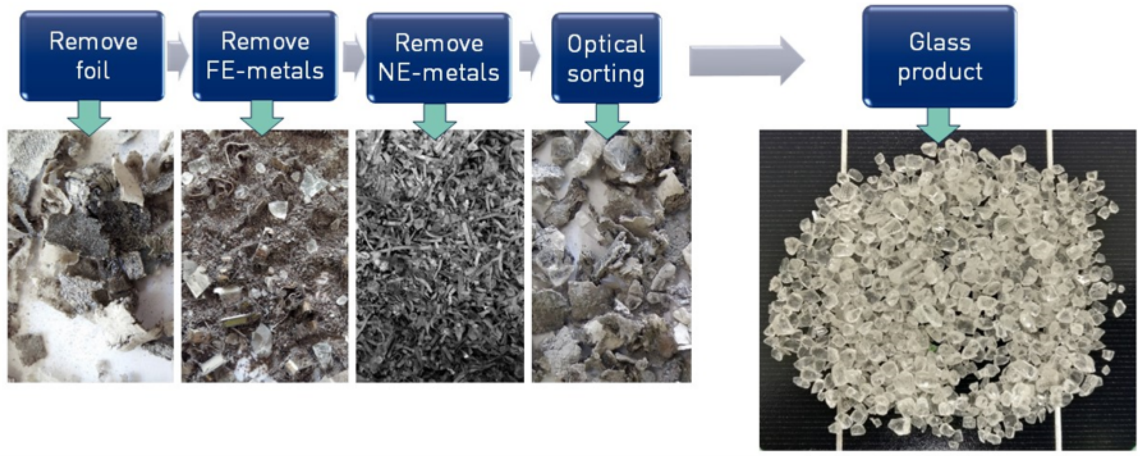


Figure 6: Images of PV module materials at intermediate steps in Reiling's recycling process: foil removal, FE metals removal, NF metals removal, optical sorting, and glass product (Credit: Reiling Group)

After mechanical pre-crushing and shredding steps to extract the aluminum frame, Reiling separates ferrous (FE) metals,[22] such as screws, that may be present from the frames. A fine crushing step then makes the glass and foil more accessible for subsequent screening. Reiling then performs a second separation of non-ferrous (NF) metals,[23] such as Al and Cu from the interconnectors. They then extract the polymer fraction from the glass. Treatments typically performed for other glass-based products (but optional for PV modules) include separation of stone, ceramics, and porcelain and optical sorting, such as x-ray sortation, to remove colored impurities. Reiling performs a final quality check. Cross contamination has been an issue with

[22] Ferrous metals: iron-based alloys

[23] Non-ferrous metals: other metals, such as Al, Sn, Cu, Mg and their alloys

the existing process, and the resulting output fractions are of low purity, sometimes resulting in downcycling.

The company is certified according to Specialist Waste Management Company, DIN ISO 9001:2015, DIN ISO 50001, Declaration of Compliance with the Minimum Wage Act, and so on. A certificate of destruction will be issued on customer's request.

Reiling is one of the top-two PV module recyclers in Germany (along with First Solar) and concentrates on c-Si PV modules and amorphous silicon modules only. Table 4 shows the LCI data for Reiling.

Table 4: LCI data for Reiling's mechanical PV module recycling process

Company	Reiling Glas Recycling GmbH & CO. Kg		
Name	LCI of cryst. Si and ASI - PV module recycling		
Time period	2022		
Geography	Germany		
Technology	Mechanical processing		
Representativeness	Individual real processes discrete batches		
Date	8/31/2022		
Collection method	Data from Reiling Glass Recycling		
Comment	German Electricity mix		
Plant	**Unit**	**Amount**	**Comment/reference**
Capacity	t/yr	10 000	New plant in Münster: approx. 50 000 t/a
Type of plant		Glass recycling plant	New: plant especially for PV-recycling
Location		Marienfeld, Osterwedding Torgau, and Burgbernheim, Germany	
Module type processed		Cryst. Silicon and silicon based thin film	
Time period		2022	
Step 1			**specify, e.g. modules processed**
Total input	t/yr	4 200	New plant in Münster started in 2023, 50 000 t/a
Components/fuels			
Electricity consumption	kWh/t	60	In Münster: The plant is operated completely electrically. Electricity from own PV installation is used.
CNG/LNG	kWh/t	0.36	Forklift
Diesel/oil consumption	l/t	2.5	Wheel loader
Output			**Specify and indicate utilisation, subsequent treatment**
Cables	%	0.65	Cable recycler
Frame	%	11.5	Metal recycler (Al)
Junction boxes	%	0.35	Electronic scrap recycler
Ferrous metals	%	0.2	Metal recycler

Non-ferrous metals	%	1.2	Metal recycler
Polymers/foils	%	14	Incineration
Glass cullet	%	64	Foam glass, glass fiber
Mixture of glass cullet, foil and metals	%	6.6	Other utilization
Dust	%	1.5	Other utilization
Other (wastes, emissions)	%		
Total Output	**%**	**100**	

2.3 LuxChemtech GmbH, Freiberg, Germany

LuxChemtech was founded in 2019 as a successor of Loser Chemie. It operates two facilities in Germany, including its headquarters in Freiberg, Saxony, where it is active in many valuable material recovery areas, such as lithium, indium, gallium, selenium, tellurium, silver, silicon, and so on (www.lc-freiberg.de). The plant is equipped with several blasting units, saws, crushers, mills, and other mechanical processing equipment, universal etching lines, silicon ingot growing furnaces, and an analytical laboratory. The plant is located in the former factory of Sunicon GmbH, a subsidiary of SolarWorld AG, a former manufacturer of PV wafers, cells, and modules.

LuxChemtech performs R&D for PV recycling of any type, including c-Si, copper indium gallium selenide (CIGS), and CdTe. In addition to its chemical recycling facilities, it is building a pilot demonstration plant at its site in Tangermünde, an old Hanse town close to Schwerin in northern Germany. The Tangermünde plant's targeted capacity is about 1 000 t/yr.

A high-pressure water-jet and a light-pulse treatment process are under construction. Figure 7 shows the recycling steps for modules constructed with a single glass plate. LuxChemtech uses a high-pressure water jet to remove the polymers, cells, and metals from the glass plate. This produces very pure glass, which may stay intact during the process. Then they filter polymer material from the water before recirculating the water. The next steps separate non-ferrous metals from the polymers and separate copper from silicon in an etching bath.

The LCI data provided for the water-jet treatment and chemical recovery processes in Table 5 are based on batch processing of several tons of modules of different types and performance measurements in 2022. The Step 1 water-jet process produces a polymer/foil fraction that is 11.13% of the total input by weight. In Step 2, only the polymer/foil fraction is treated. The polymers are separated from the semiconductor materials and metals, and approximately 3.3% of the Step 2 input material by weight is recovered silicon, silver, indium, tin, and copper.

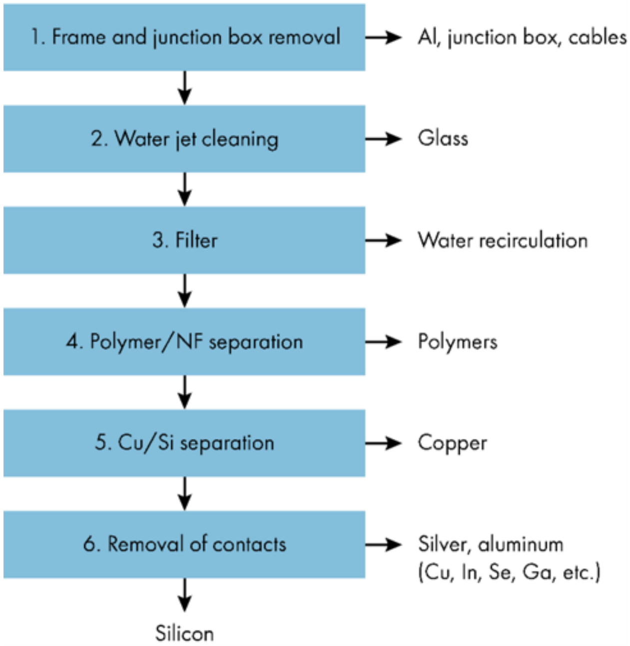


Figure 7: Example of LuxChemtech's water-jet and chemical recycling processes for c-Si PV modules (thin-film recovery indicated in brackets in Step 6); steps 1–5 are included in the LCI comparison

Figure 8: Clean glass cullet collected after water jet treatment (left) and separated polymer fraction with metal and solar cell fragments prior to further recycling (right) (Credit: LuxChemtech GmbH)

For knowledge protection reasons, LuxChemtech did not provide detailed data on the subsequent treatment and chemical use, but the main chemicals in use and consumptions are indicated. The silver in the solar cell fragments is dissolved in acid and then electrolyzed. Table 5 summarizes the results.

Table 5: LCI data for LuxChemtech's water-jet and chemical recovery process

Company	LuxChemtech GmbH		
Name	LCI of PV module recycling		
Time period	2021/22		
Geography	Germany		
Technology	Waterjet treatment and chemical treatment		
Representativeness	Individual real processes in continuous or discrete batches		
Date	10/21/2022		
Collection method	Data from recycler		
Comment	Germany		
Plant	**Unit**	**Amount**	**Comment/reference**
Capacity	t/yr	1 000	Demonstrator
Type of plant			
Location		Tangermünde, Saxony-Anhalt	
Module type processed		Cryst. Silicon	No amorph. Silicon, compound semiconductor modules in similar process steps
Time period		2022/2023	
Step 1			**Water jet cleaning**
Total input	t/yr		Demonstrator, 1 000 tons/year under construction, (100 modules/hour)
Components/fuels			
Electricity consumption	kWh/t	130	Own PV plant, not optimized, 2t/h
Water	m³/t		Recirculated, not disclosed
CNG/LNG	kWh/t	No	Transportation only
Diesel/oil consumption	l/t	No	Transportation only
Output			**Specify and indicate utilisation, subsequent treatment**
Cables	%	0.42	To cable recycler
Frame	%	11.07	90% very pure 10 % with impurities, to Al recycler
Junction boxes	%	0.39	To e-waste recycler
Ferrous metals	%	0	Some with ferrous metals, e.g. back rails from Avancis modules to metal recycler
Non-ferrous metals	%	4.05	Nearly 100% silicon, (indium, tin), silver, see below, 98% used
Polymers/foils	%	11.13	To own mechanical/chemical treatment
Glass cullet	%	72.5	0.5% of total glass amount (100%) as pieces on wires and/or pieces at frame
Mixture of glass cullet, foil and metals	%	0	
Dust, other	%	0.44	To incineration
Other (wastes, emissions)	%		Small amounts of filter cloth
Step 1 Output	**%**	**100**	
Step2			**Chemical and mechanical separation and purification treatment**
Total input	t/yr	120	Polymer fraction from waterjet treatment

Components/fuels			
Electricity consumption	kWh/t		
Chemicals	kg/t		Not disclosed
NaOH	kg/t	2	Maximum amounts, depend on input type
CH3SO3H	kg/t	1	Maximum amounts, depend on input type
HCl	kg/t	1	Maximum amounts, depend on input type
H2O2	kg/t	1	Maximum amounts, depend on input type
CNG/LNG	kWh/t		Transportation only
Diesel/oil consumption	l/t		Transportation only
Output			**Yield Assumption 90%**
Non-ferrous metals	%	0.027	Silver to metal recycler, indium, tin to metal recycler
Copper	%	0.45	Interconnectors for metallurgy
Silicon	%	2.826	Battery electrodes, sputter targets, metallurgy
Other semiconductors		0	Depending on module type In, Ga, Se, Te, Cd to metal recycler
Polymers/foils	%	0	Incineration, recycling planned for 2025+
Dust			
Other (wastes, emissions)	%	0.5	Depending on input quality, waste water purification, auxiliary materials, sludge disposal[24]

LuxChemtech also has access to the light-pulse technology used to separate thin-film PV modules with glass/glass construction and expects similar results to the ones Flaxres reported achieving with its proprietary technology (see Flaxres technology details in next section). LuxChemtech successfully began separating thin-film modules with a pulsed laser scanner and now also utilizes tube lamp light-pulse technology for c-Si modules.

2.4 Flaxres GmbH, Dresden, Germany

Flaxres is a young company founded in 2017 to develop a mobile and sustainable process for separating composite materials such as PV modules (www.flaxres.com). Flaxres's large-scale flashing unit FLAXTHOR® exposes the solar module to one or more very short, high-intensity light pulses to heat light absorbing material layers to enable delamination. Flaxres's web page describes the process as follows: "The light travels through the transparent glass and polymer layer and is then converted into thermal energy by the light-absorbing layer (e.g., silicon wafer). The photovoltaic cells heat up in less than a small fraction of one second. Thermal treatment of the boundary layers results to separation of the material. With the help of preceding and subsequent process steps, the photovoltaic module is separated into glass, aluminum, polymers, silicon with silver, junction box with cable and bus bars." Flaxres states on its web page: "The glass is very clean and can be easily recycled as flat glass, the aluminum and copper can be used by aluminum or copper manufacturers. The solar cell fragments can be processed by 3rd parties to recover silver, and silicon." In these other treatment processes (for example, LuxChemtech's), silver, silicon, and even aluminum compounds from the aluminum metallization are recovered. The polymers can be incinerated, landfilled, or recycled,

[24] The amount of recirculated water used or consumed in the water-jet process was not reported.

depending on the legal framework. Figure 9 shows the process, and Figure 10 shows the Flaxres pilot line. Flaxres will offer a mobile line on a truck for PV recycling service.

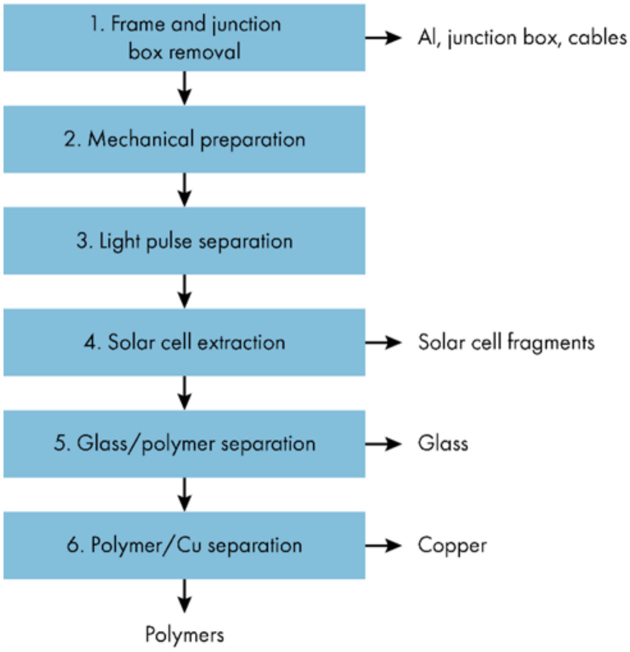


Figure 9: Flaxres's pilot process scheme for c-Si PV modules; all steps are included in the LCI comparison

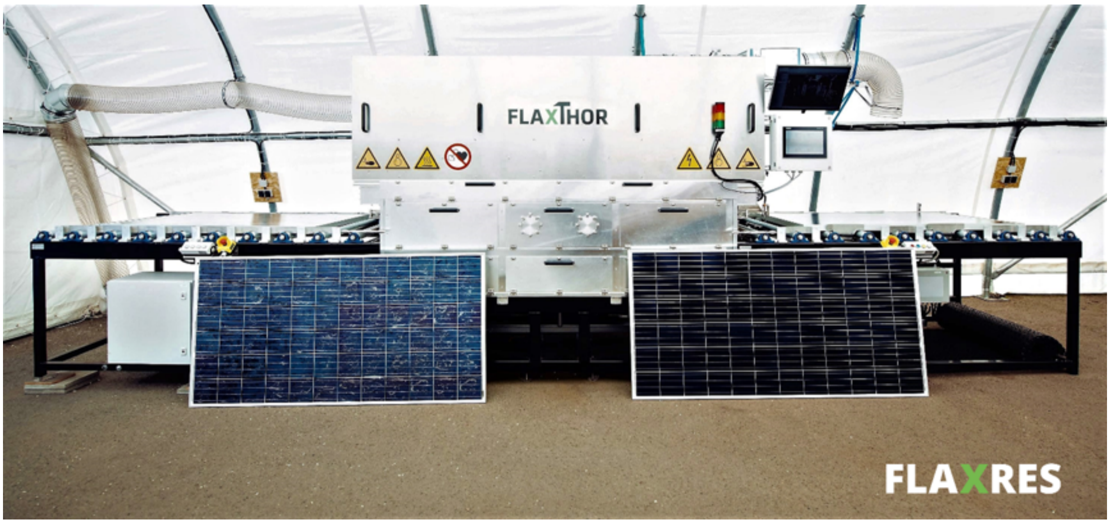


Figure 10: Flaxres light pulse PV recycling pilot line (Credit: Flaxres GmbH)

The light–pulse process is also successfully applied to separate thin-film modules, such as CdTe, CIGS, or other non-PV applications.

The LCI data provided by Flaxres is based on a mass test of 7.5 tons carried out in 2022, which is representative for the pilot process implemented. Table 6 shows the results.

Table 6: Flaxres's LCI results from a mass test in its pilot line in 2022

Company	FLAXRES GmbH, Blumenstr. 80, 01307 Dresden

Name	LCI of PV module recycling		
Time period	2022		
Geography	Germany		
Technology	Light pulse technology		
Representativeness	Individual real processes in continuous or discrete batches		
Date	10/10/2022		
Collection method	Data from recycler		
Comment	National Electricity mix (please modify if needed)		
Mass test			
Input			
Total input	t	7.5	Silicon based modules, mass test
Components/fuels			
Electricity consumption	kWh	<1.0	Overall consumption per solar panel
CNG/LNG	kWh/t	0	
Diesel/oil consumption	l/t	0	Only for equipment transportation > mobile equipment (2 trucks)
Output [weight %]			**Specify and indicate utilisation, subsequent treatment**
Cables	%	1	
Frame	%	17	
Junction boxes	%	1	
Ferrous metals	%		
Non-ferrous metals	%	3	Silicon wafer
Polymers/foils + bus bars	%	12	Includes silicon residues; target is to separate polymers by wind sifter
Glass cullet	%	66	
Mixture of glass cullet, foil and metals	%		
Dust	%		Negligible
Other (wastes, emissions)	%		Negligible
Output [kg]			**Specify and indicate utilisation, subsequent treatment**
Cables	t	0.075	
Frame	t	1.284	
Junction boxes	t	0.075	
Ferrous metals	t		
Non-ferrous metals	t	0.219	Silicon wafer
Polymers/foils + bus bars	t	0.897	Includes silicon residues; target is to separate polymers by wind sifter
Glass cullet	t	4.902	
Mixture of glass cullet, foil and metals	t		
Dust	t		Negligible
Other (wastes, emissions)	t		Negligible

2.5 ROSI SAS, Grenoble, France

ROSI is a French startup company founded in 2017 that focuses on recovering silicon, as suggested by its slogan, "**R**eturn **o**f **Si**licon." The company states on its homepage (www.rosi-solar.com): "ROSI is a company offering innovative solutions for recycling and revalorization of raw materials in the photovoltaic industry. Its technologies allow to recover high purity silicon and other metals currently lost during the production of photovoltaic cells and at the end-of-life of solar panels." Its two main activities are silicon kerf recovery and c-Si PV module recycling.

ROSI partners with Soren (France's PV take-back system, a PV CYCLE successor) and collaborates with Envie to provide high-value recycling in France. In Spring 2023, ROSI put a PV recycling plant in operation close to Grenoble, France, which uses a batch pyrolysis process and a proprietary silicon and silver recovery process. Data from Envie are not included in the LCI data for ROSI. A pre-treatment at Envie is not a pre-requisite of ROSI's process. ROSI can fully treat both any end-of-life crystalline silicon PV module or partially separated module.

Figure 11 shows ROSI's process sequence for treating full modules.

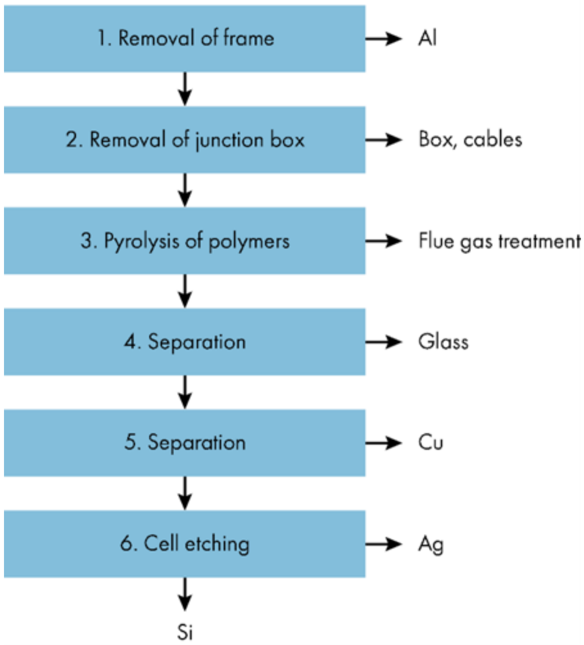


Figure 11: ROSI's PV module recycling process, including pyrolysis and chemical treatment; steps 1–5 are included in the LCI data comparison

Table 7 lists the LCI data for ROSI's full module 6-step treatment process. After frame, junction box, and cable removal, ROSI performs pyrolysis of the polymers. The flue gas is treated with an afterburner to make sure the combustible gases resulting from pyrolysis undergo complete combustion (such as transforming carbon monoxide to carbon dioxide). The gases after the afterburner are then washed by a wet scrubber before eventually being discharged into the atmosphere. The scrubber captures pollutants by absorption including acid gases of the HF type (due to the presence of fluorine in the backsheet). The pyrolysis of the polymers gives easy access to high-quality and high-yield glass, metals, and solar cell fragments. High quality clean glass cullets are obtained after pyrolysis. The copper interconnectors and solar cell fragments can be separated using existing mechanical separation technology, such as screening or sortation by density. ROSI developed a process to detach the silver fingers and pads from the broken cell fragments using a soft chemical etching process that was not disclosed. The reported outputs are typical compositions, and some values may not agree. For example, "Cell fragments: Silicon cell with aluminum paste and silver finger" in Table 7 has a value of 3.4%, whereas the silicon and silver outputs from the chemical treatment step are 2.78% and 0.07%, respectively, which only totals 2.85%. The absence of aluminum may explain the discrepancy, along with potential yield losses during processing, such as etching of silicon or incomplete recovery of silver. The silicon obtained is 99.999 – 99.9999% pure (5-6N). The energy consumption shown in the table includes fuel for the heaters and electricity for chemical treatment. Electricity consumed during junction box and cable removal and for fans and controls during pyrolysis is not included, as it has not yet been measured.

Table 7: ROSI's pilot process with steps for cable, junction box, and frame removal, pyrolysis, and chemical treatment to recover silver and 5-6N silicon

Company			
Name	ROSI SAS, Grenoble, France		
Time period	2022/23		
Geography	France		
Technology			
Representativeness	Individual real processes in continuous or discrete batches (please enter right information)		
Date	02.11.2022		
Collection method	Data from recycler		
Comment	French Electricity mix		
Plant	**Unit**	**Amount**	**Comment/reference**
Capacity	t/yr	3 000	Input: full module with Al frame and JB
Type of plant			
Location		La Mure, FR	
Module type processed		Crystalline silicon	
Time period		Nov-22	Operation from Q1 2023 on
Step 1 - Removal JB and cable			
Total input	t/yr	3 000	Full module with Al frame and junction box
Components/fuels			
Electricity consumption	kWh/t		Not disclosed
Output			**Specify and indicate utilisation, subsequent treatment**
Cables	%	0.85	To cable recycler
Frame	%	7.79	To Al recycler
Junction boxes	%	4.3	To e-waste recycler
Ferrous metals	%	0	To metal recycler
Non-ferrous metals	%	0	Aluminum frame and cable
Module without Al frame JB and cable	%	87.06	
Step 2 - Pyrolysis			
Total input	t/yr	2611.8	Full module with glass, without aluminum frame and junction box
Components/fuels			
Electricity consumption	kWh/t		Not disclosed, fans and controls
Chemicals	kg/t		Not disclosed
Propane	MWh/t	1.73	
Output			**Specify and indicate utilisation, subsequent treatment**
Cables	%	0	Already removed before pyrolysis

Frame	%	0	Already removed before pyrolysis
Junction boxes	%	0	Already removed before pyrolysis
Ferrous metals	%	0	
Non-ferrous metals	%	0.87	Copper ribbon, send to next refiner if needed
Polymers/foils	%	0	Polymers are pyrolyzed
Glass cullet	%	71.42	
Mixture of glass cullet, foil and metals	%		
Cell fragments	%	3.4	Silicon cell with aluminum paste and silver finger
Dust	%	0	In sludge cake
Other (wastes, emissions)	%	2	2wt% of PV input end up as sludge cake
	t/t	1.47	H2O
	t/t	0.26	CO2
Step3 - Chemical treatment			
Total input	t/yr	102	Cell fragments
Components/fuels			
Electricity consumption	kWh/t	27.6	
Chemicals	kg/t		Not disclosed
Water	m³/t		Not disclosed
Output			**Specify and indicate utilisation, subsequent treatment**
Non-ferrous metals	%	2.78	Silicon
	%	0.07	Silver
Other (wastes, emissions)	kg/t	19.5	Mineral waste

2.6 Envie 2E Aquitane, Saint-Loubès, France and ROSI SAS, Grenoble, France, Combined Processes

Envie 2E Aquitane started a new PV module recycling line in Saint-Loubès, France, in October 2022 serving the collection system operated by Soren. They accept any non-bent crystalline silicon PV module with a single and intact glass pane. Within Soren's take-back system the modules are presorted according to these criteria. Double glass modules, highly bent modules, and modules with broken glass are collected separately and transported to other recyclers, such as ROSI. Additionally, Envie partially processes deformed modules or ones with broken glass and removes the junction boxes and frames.[25] The residual output is collected separately and processed elsewhere. These modules, therefore, are not included in the combined process LCI data presented in this section. ROSI is capable of processing heavily damaged modules using the full recycling process described in Section 2.5.

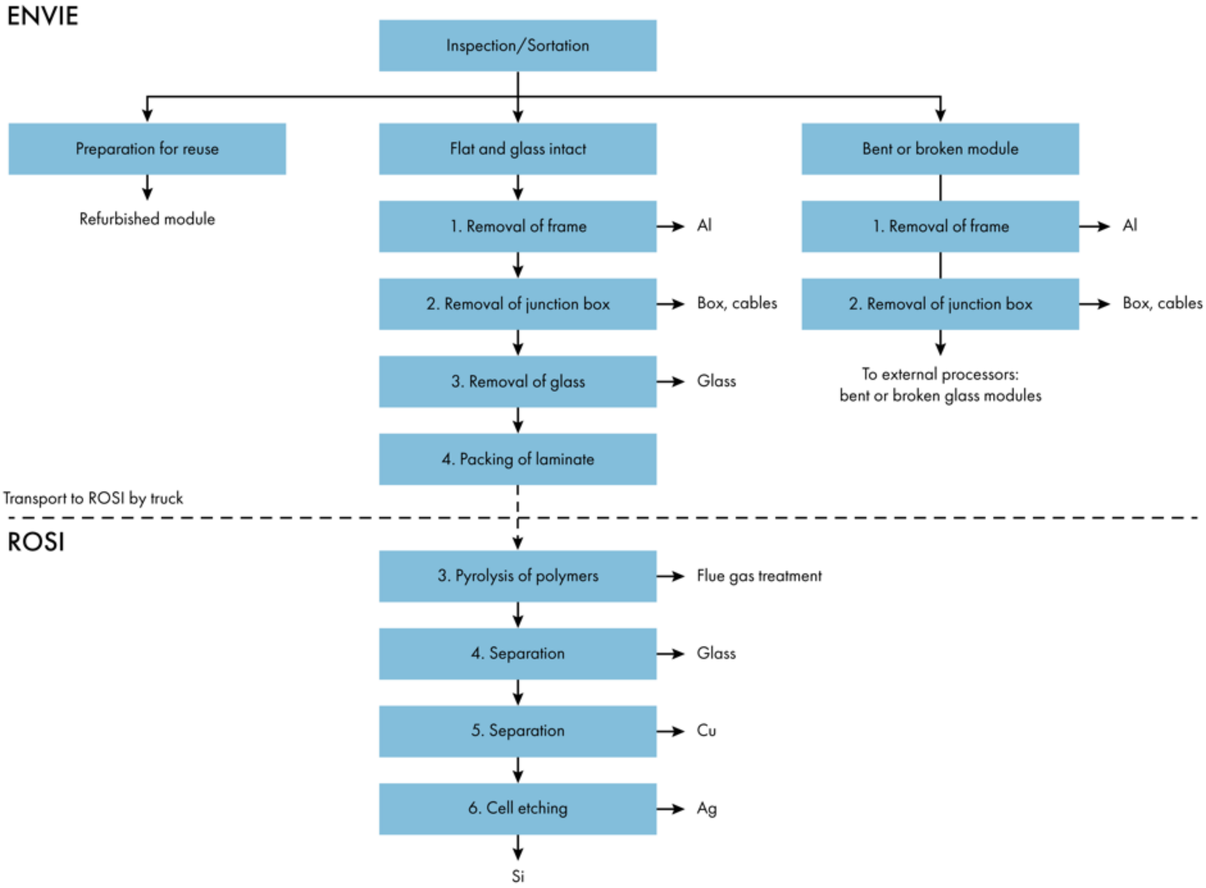
Envie treats up to 3 000 tons per year of c-Si PV modules with NPC equipment from Japan. Details of the NPC process and the equipment are presented in a recent IEA-PVPS Task 12 report.[9] In Envie's process, the modules pass an incoming inspection and sortation (modules in good condition are further tested for potential reuse, e.g., electroluminescence, sun

[25] Information provided by ROSI

simulator current-voltage curves, high potential isolation[26]). Envie's target is to prepare around 5% of the input modules for reuse.[27] Modules accepted for reuse form the first sortation class shown in Figure 12.

The second sortation class is comprised of modules with intact glass and no more than moderate deformation. These modules are treated with the NPC process by removal of junction boxes, cables, and frames. The front glass is cut-off by applying the hot blade technology. The polymer part of the module laminate with copper interconnectors and solar cells is packed and transferred to ROSI by truck (representing about 15% of the overall input module weight, according to ROSI[27]). The other outputs are further treated by glass, electronic scrap, and metal recyclers. The combination of Envie's and ROSI's treatment steps is shown in Figure 12. The laminates from Envie enter ROSI's process in ROSI's Step 3, "Pyrolysis of polymers" (shown in Figure 11 in Section 2.5).

The third sortation class is comprised of modules with broken glass and severe deformation. The junction box and the frames may be removed by Envie, and the rest is processed by third parties that were not disclosed.



[26] Wet leakage testing, such as what is performed on representative samples during certification tests, is not performed on all modules due to the high cost. Instead, high voltage isolation testing is performed to confirm that the module has sufficient insulation resistance at the rated operating voltage.

[27] According to information provided by Soren, France

Figure 12: Envie's process (with NPC technology) and subsequent treatment at ROSI (Section 2.5); the LCI data of NPC[9] and steps 3–5 of ROSI's process are included in the LCI model

Envie did not participate in the survey, therefore the LCI results are modelled with data obtained from press releases[28,29] and the LCI report about NPC technology.[9] It is assumed that Envie's processes are carried out like the ones described in the NPC report.

The polymer/foil output fraction is estimated to be 15% of the input module weight. This material is packed, e.g., on pallets, and transported to ROSI for further treatment. The transport distance is 688 km. An average diesel consumption of 35 litres per 100 km for trucks carrying a 25-ton load is assumed, which is equivalent to 1.4 litres diesel per ton of laminate per 100 km.

The material mass allocation table in the NPC report is modified in this report to be consistent with the data reported by ROSI. The results are shown in Table 8.

Table 8: Allocation table for input modules according to NPC report[9] (referred to as Table 3.1. and 3.5) and "Envie" data used in the combined Envie & ROSI process)

		Service	Glass	Aluminum	Copper	Laminate	Sum
Current study	**Envie & ROSI Output (2.5) (1t module input)**	**1**	**0.7147**	**0.0779**	**0.0085**	**0.15**	
LCI values of NPC study[9]	NPC Table 3.1	1	0.692	0.146	0.009	0.14	
Infra-structure	Table 3.5 for 1kg output	8.54E-01	8.54E-03	8.54E-01	1.20E+00	3.42E-02	
Envie	*Table 3.1 for 1 kg module*	*8.54E-01*	*6.10E-03*	*6.65E-02*	*1.02E-02*	*5.13E-03*	*9.42E-01*
Electricity	NPC Table 3.5 for 1kg output	2.99E-02	2.99E-04	2.99E-02	4.19E-02	1.20E-03	
Envie	*Table 3.1 for 1 kg module*	*2.99E-02*	*2.14E-04*	*2.33E-03*	*3.56E-04*	*1.80E-04*	*3.30E-02*
Chromium steel 18/8	Table 3.5 for 1kg output	6.92E-05	6.92E-07	6.92E-05	9.60E-05	2.77E-06	
Envie	*Table 3.1 for 1 kg module*	*0.00E+00*	*4.95E-07*	*5.39E-06*	*8.16E-07*	*4.16E-07*	*7.12E-06*
Waste	Table 3.5 for 1kg output	1.36E-02	1.36E-04	1.36E-02	1.91E-02	5.45E-04	
Envie	*Table 3.1 for 1 kg module*	*1.36E-02*	*9.72E-05*	*1.06E-03*	*1.62E-04*	*8.18E-05*	*1.50E-02*
Transport average	Table 3.5 for 1kg output	8.54E-01	8.54E-03	8.54E-01	1.20E+00	3.42E-02	
Envie	*Table 3.1 for 1 kg module*	*8.54E-01*	*6.10E-03*	*6.65E-02*	*1.02E-02*	*5.13E-03*	*9.42E-01*

28 https://www.envie.org/magasin-reseau-envie/envie-aquitaine-2e-saint-loubes-1/

29 https://rreuse.org/unique-site-for-the-re-use-of-solar-panels-launched-in-gironde-by-envie-and-soren/

The LCI data Table 9 for Envie's process steps are based on the NPC LCI data, and the subsequent treatments at ROSI are listed in Table 10. Similar to ROSI's LCI data in Table 7, the reported outputs in Table 10 are typical compositions, and some values may not agree.

Table 9: Modelled Envie LCI data with functional unit of 1 t of module input and data taken from the recent IEA PVPS Task 12 report[9]

Company			
Name	Envie 2E Aquitaine, Saint-Loubès, France		
Time period	2022/2023 - Start Oct 2022		
Geography	France		
Technology			
Representativeness	Process by NPC, Japan		
Date	08/27/2023		
Collection method	Data from online publications and press releases and IEA-PVPS Task12		
Comment	French Electricity mix (please modify if needed)		
Plant	**Unit**	**Amount**	**Comment/Reference**
Capacity	t/yr	4 000	Input: full module with Al frame and junction box (JB)
Type of plant			
Location		Saint-Loubès, FR	
Module type processed		crystalline silicon	
Time period		2022/2023	
Step 1 Test for reuse			
Total input	t/yr	3 000	
For reuse	t/yr	150	Currently 5% target
Sortation for NPC treatment		2 850	NPC treatment, assumption: 15% to Rosi after processing, as of NPC report
Components/fuels			
Water	m³		Not disclosed
Electricity consumption	kWh/t		Not disclosed
Output			
Module for NPC process	%	95	Bend or broken glass share not disclosed and not included
Step 2 - Removal of cable, junction box and frame			
Total input	t/yr	2 850	Full module with Al frame and junction box
Components/fuels			
Electricity consumption	kWh/t	2.32921	Frame
Electricity consumption	kWh/t	0.35615	J-box, cables
Electricity consumption	kWh/t	21.54594	Glass
Electricity consumption	kWh/t	0.18	Laminate with interconnectors and cells
Consumables (18/8 steel)	t	5.39E-06	Frame
Consumables (18/8 steel)	t	8.24E-07	J-box, cables
Consumables (18/8 steel)	t	4.99E-07	Glass
Consumables (18/8 steel)	t	4.16E-07	Laminate with interconnectors and cells
Waste	t	1.06E-03	Frame
Waste	t	1.62E-04	J-box, cables
Waste	t	9.80E-05	Glass
Waste	t	8.18E-05	Laminate with interconnectors and cells
Transport	tkm	6.65E-03	Frame
Transport	tkm	1.02E-03	J-box, cables

Transport	tkm	6.15E-04	Glass
Transport	tkm	8.54E-01	Laminate with interconnectors and cells
Output			
Cables	%	0.85	To cable recycler
Frame	%	7.79	To Al recycler
Junction boxes	%	4.3	To e-waste recycler
Ferrous metals	%	0	To metal recycler
Non-ferrous metals	%	0	
Module without Al frame	%	87.06	
Step 3 - Hot Knife			
Total input	t/yr	2481.21	Full module with glass, without aluminium frame and junction box
Components/fuels			
Electricity consumption	kWh/t	0	Not disclosed, fans and controls
Output			
Cables	%	0	
Frame	%	0	
Junction boxes	%	0	
Ferrous metals	%	0	
Non-ferrous metals	%	0	
Polymers/foils	%	0	
Glass cullet	%	72.06	To glass company after cleaning
Laminate: foil and metals	%	15.0	To Rosi
Laminate	t/yr	427.50	For transport to Rosi
Step 4 - Transport to Rosi			
Total input	t/yr	427.5	Laminate
Transport distance		688	km
Components/fuels			
Diesel	l	4 118	1.4 l per ton load and 100 km, 25 t truck, 10.4 kWh/l
Diesel	kWh	42 824	
Pallets	pieces	855	Estimated: about 0.5 tons/pallet
Stretch foil			Not disclosed
Tension strip			Not disclosed

Table 10: Modelled ROSI data (Section 2.5) with laminate input in the pyrolysis (Step 3) after pretreatment at Envie

Company			
Name	ROSI SAS Grenoble, France		
Time period	2022/2023		
Geography	France		
Technology			
Representativeness	Individual real processes in discrete batches		
Date	08/11/2023, With IEA NPC and Envie data of 30.07.2023		
Collection method	Data from recycler and Publications		
Comment	French Electricity mix (please modify if needed)		
Plant	**Unit**	**Amount**	**Comment/Reference**
Capacity	t/yr	428	Input: laminate without frame, JB and glass, equivalent to 2850 t/yr of full modules
Type of plant			
Location		Saint-Honoré, FR	

Module type processed		crystalline silicon, laminates w/o glass	
Time period		March 2023	Operation from Q1 2023 on
Step 1 - Pyrolysis			
Total input	t/yr	428	Input: laminates without glass, equivalent to 2850 t/y of full modules entering to NPC machine at Envie site
Components/fuels			
Electricity consumption	kWh/t	0	Not disclosed, fans and controls
Chemicals	kg/t		Not disclosed
Propane	MWh/t full module treatment	1.73	Estimated value, still includes glass heating as in full process
Output			**Specify and indicate utilisation, subsequent treatment**
Cables	%	0	Already removed at Envie
Frame	%	0	Already removed at Envie
Junction boxes	%	0	Already removed at Envie
Ferrous metals	%	0	Already removed at Envie
Non-ferrous metals	%	0.85	Copper ribbon, send to next refiner if needed
Polymers/foils	%	0	Polymers are pyrolyzed
Glass cullet	%		Already removed at Envie
Mixture of glass cullet, foil and metals	%		Not applicable
Cell fragments	%	3.18	Silicon cell with aluminium paste and silver finger
Dust	t/yr		Not disclosed
Other (wastes, emissions)	t/yr		Not disclosed
Step 2 - Chemical treatment			
Total input	t/yr	90.63	Cell fragments
Components/fuels			
Electricity consumption	kWh/t full module treatment	27.6	
Chemicals	kg/t		Not disclosed
Water	m^3/t		Not disclosed
Output			
Non-ferrous metals	%	3.11	Silicon
	%	0.07	Silver
Other (wastes, emissions)	kg/t	19.5	Mineral waste
Waste water			Not disclosed

The process to produce the laminate fraction processed at Envie results in a fine-grained solar cell residue after pyrolysis at ROSI. The fine fragments are difficult to recycle and require modification of the mechanical separation and chemical recovery of silicon and silver, creating additional recycling costs with potential impact on yield and quality.

2.7 Tialpi S.r.l., Mottalciata, Italy

Tialpi is located in the Piedmont region of northern Italy. Its predecessor, FRELP, participated in the first IEA PVPS Task 12 LCI study in 2016-2017 (https://www.frelp.info/). Tialpi has built a pilot plant with a capacity of about 3 000 tons per year if operated continuously (three shifts/day) to recycle up to about 97% of the module mass, broken down as follows:

- 15% aluminum
- 60% high-quality glass, cullet size 2–10 mm
- 5% secondary-quality glass, cullet size 0.1–2 mm
- 10% plastics, including backsheet
- 7% silicon, copper, and silver (mixture to be separated in Steps 3 and 4 under development)

Tialpi first removes the frames, cables, and junction box. Then they use a blade to cut off the glass like NPC does, but they heat the full module via infrared lights to 140–212°F (60–100°C) while the blade stays about room temperature. The process can be used for single-pane modules with intact or broken glass with a throughput of 1 t/hr. After being cut, the glass is crushed and collected in two qualities, high-quality cullet (0.08–0.39 in. [2–10 mm]) and fines (<0.08 in. [<2 mm]) with higher impurity levels. Tialpi then treats the foils with liquid nitrogen before heating the materials and performing sieving and electrostatic separation to extract glass residues and copper. The company's targets describe the following phases:

- Phase 1: Recovery of aluminum; recovery of high-purity, low-iron glass
- Phase 2: Separation of silicon
- Phase 3 (under development): Acidic leaching to enhance silicon quality (99% purity)
- Phase 4 (under development): Electrolysis for copper and silver recovery

Tialpi expects a total energy consumption of 50–250 kWh per ton input of end-of-life modules. Figure 13 presents the process scheme including Steps 5 and 6 (representing Phases 3 and 4), which are still under development. The preliminary data are based on an interim solution, in which silicon and EVA are sent to an aluminum production facility as an additive, and the backsheet is blended with other plastic. In this case, the total energy consumption is about 136 kWh/t. Further refinement steps under development comprise removal of polymer residues by pyrolysis, electrostatic separation and etching of the solar cells with nitric acid to recover high-purity silicon and, finally, electrolysis to recover silver and copper. Since Phases 3 and 4 are still under development, the preliminary (research) life cycle inventory data for Steps 5 and 6 are not shown in this study but the process steps are indicated in Figure 13.

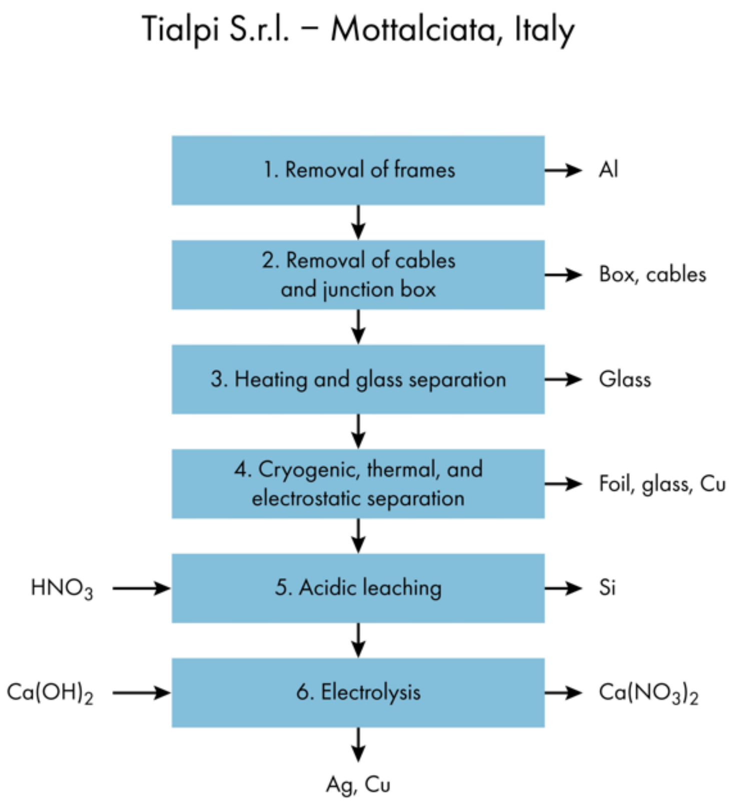


Figure 13: Tialpi process scheme for its 3 000 tons/year pilot plant; steps 1–4 are included in the LCI, and 5 and 6 are under development

Table 11 lists the LCI data for Tialpi's 1 000 ton/year (single-shift operation) pilot line and the former single-shift "FRELP by Sun" pilot line. The process includes the following three steps:

1. Box, cable, and frame removal
2. Glass removal
3. Separation of EVA, silicon, and metals from polymer backsheet

Table 11: LCI data for Tialpi's process, presenting results from FRELP by Sun project

Company	TIALPI SRL, Mottalciata (Biella) - ITALY		
Name	LCI of PV module recycling		
Time period	Start in May 2022		
Geography	Italy		
Technology	Patent for first phase FRELP BY SUN process and for specific machine to detach glass		
Representativeness	Individual real processes in continuous process		
Date	5/1/2022		
Collection method	Data from recycler		
Comment	Italian electricity mix		
Plant	**Unit**	**Amount**	**Comment/reference**
Capacity	t/yr each shift	1 000	Total capacity 3 000 tons/year
Type of plant			Automatic

Location			Mottalciata
Module type processed		Cryst. Silicon	Mono and polycristalline silicon modules
Time period		2021/22	
Step 1	**According to FRELP BY SUN project**		
Total input	t/yr	1 000	Patented process as described project “FRELP BY SUN”
Components/fuels			
Electricity consumption	kWh/t	136	Electric energy coming from PV panels on the roof of the factory
CNG/LNG	kWh/t	0	
Diesel/oil consumption	l/t	0	
Output			
Cables	%	1	Copper recovery, external
Frame	%	15	Aluminium recovery, external
Junction boxes	%	1	Recovery of metals, external
Ferrous metals	%	0	
Non-ferrous metals	%	0	
Polymers/foils	%	14	
Glass cullet	%	65	EoW for first quality glass
Mixture of glass cullet, foil and metals	%	3	Recycled by other company
Dust	%	0	
Other (wastes, emissions)	%	1	Waste disposal
Step2	**Patented process that includes the following technologies: cut the single PV cell (155x155 mm); cryogenic treatment of the cells in order to have a different thermic dilatation; detachment of the wafer (silicon + EVA) from the backsheet (multilayer plastic)**		
Total input	t/yr	500	(From 3000 tons of panels)
			Single cells (wafer + backsheet)
Components/fuels			
Electricity consumption	kWh/t	100	
Nitrogen consumption	kg/kg	0.5	Kg of nitrogen for kg of cells
CNG/LNG	kWh/t	0	
Diesel/oil consumption	l/t	0	
Output	**Wafer (silicon + EVA) utilized in the aluminium furnace as additive; multilayer backsheet utilized in the pressed plastic compound mixed with other plastics**		
Cables	%	0	
Frame	%	0	
Junction boxes	%	0	
Ferrous metals	%	0	
Non-ferrous metals	%	55	Silicon + EVA for aluminum furnace
Polymers/foils	%	35	Multilayer plastic as backsheet
Glass cullet	%	0	
Mixture of glass cullet, foil and metals	%	5	Waste from wafer detachment

Dust		0	
Other (wastes, emissions)	%	5	Powder from cutting cells

2.8 Discussion of LCI Results

The LCI survey results mostly rely on input from companies that are scaling up new technologies that target value-preserving, high-quality, and high-yield recycling processes. Many data gaps still exist that could not be fully resolved by the data provided or information from the expert interviews.

Comparing the LCI data across the six respondents and the modelled Envie & ROSI combined process is challenging for several reasons:

- Process scale and throughput: The capacity of the processes varies from 1 000 t/yr to 50 000 t/yr. The amount of material processed annually varies from a test batch size of 7.5 t for Flaxres' pilot line to 41 921 t/yr for First Solar's commercial facilities.
- Variations in the type of modules processed at each facility result in differences in the metrics and values reported. Data for six of the seven facilities is for c-Si modules, however, c-Si module composition varies across different manufacturers, models, vintage, and so on. The seventh facility, First Solar, processes CdTe modules.
- Data for facilities under construction or in the ramp-up phase, such as for ROSI's pilot plant in Grenoble, are projections of expected values, whereas data for established facilities represent actual data. One of the LCI cases is a modelling result based on Envie's application of the commercial NPC process and preliminary data from ROSI.
- LCI data for some respondents is not based on their entire recycling process. For example, data for Tialpi only includes removal of the glass and separation of the backsheet, though they have investigated the full process sequence through to the electrolysis of silver from the chemical treatment of the solar cells.

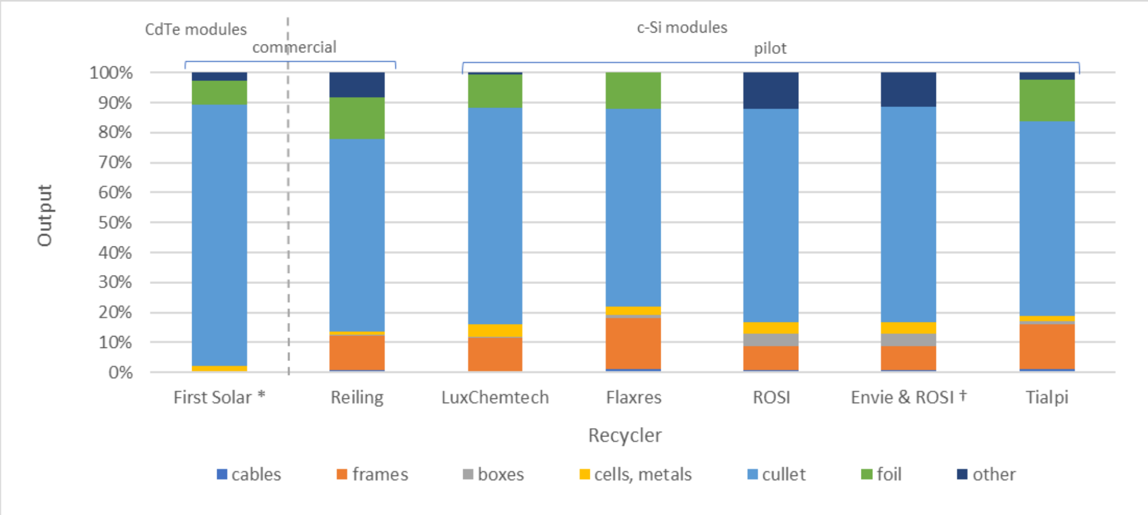
Despite these challenges, the results provide useful insights for a variety of recycling approaches at different levels of development and the associated recovery rates and energy consumption. Table 12 (on the following page) contains a summary of LCI data. To facilitate comparison, a consistent system boundary is applied at the point in each process where a cell fraction (including metals) is separated from the glass and polymers. Subsequent steps to recover silicon and metals like silver, as well as purification steps are not included in the summary LCI table to facilitate comparison. The system boundary is slightly different for First Solar, as intermediate stage LCI data are not available prior to cadmium and tellurium recovery. The percentages for cables, frame, junction boxes, and non-ferrous metals in the lower portion of Table 12 differ between the respondents largely because of differences in the types of modules that were processed. There are significant differences in the glass recovered. Tialpi, Reiling, and Flaxres have a similar percentage of the glass output, and LuxChemtech and ROSI, with and without Envie, can achieve slightly higher glass outputs. First Solar modules are glass-glass construction, resulting in a higher percentage (87%) of glass output.

Table 12: Comparison of LCI results

Company		First Solar*	Reiling	LuxChemtech	Flaxres	ROSI	Envie & ROSI	Tialpi
	Unit	**Amount**	**Amount**	**Amount**	**Amount**	**Amount**	**Amount**	**Amount**
Capacity	t/yr	50 000	50 000	1 000	1 000	3 000	3 000	3 000
Type of plant		4 recycling plants					2 plants, subsequent treatment	Automatic
Location		Multiple	Marienfeld, other, Germany	Tangermünde, Germany	Dresden, Germany	La Mure, France	Saint-Loubès & La Mure, France	Mottalciata (Biella), Italy
Module		CdTe	c-Si	c-Si	c-Si	c-Si	c-Si	c-Si
Time period		2021	2022/2023	2022/2023	2022	Nov-22	2022/23	2021/22
Annual Throughput								
Total input	t/yr	41 921	1 000	1 000	7	3 000	2 850	1 000
Process steps included		1–8, Figure 3	1–12, Figure 5	1–5, Figure 7	1–6, Figure 9	1–5, Figure 11	NPC (see [9]) & ROSI 3–5, Figure 12	1–4, Figure 13
Components/fuels								
Electricity	kWh/t	265	60	130	50	n.d.	52	136
CNG/LNG	kWh/t	Not applicable	0.36	No	n.d.	n.d.	n.d.	0
Diesel/oil consumption	l/t	Not applicable	2.5	No	n.d.	n.d.	15	0
Output								
Cables	%	Not provided	0.65	0.42	1	0.85	0.89	1
Frame	%	Not provided	11.5	11.1	17	7.79	7.79	15
Junction boxes	%	Not provided	0.35	0.39	1	4.3	4.3	1
Ferrous metals	%	0.4	0.2	0		0	0	0
Non-ferrous metals	%	1.5	1.2	4.05	3	0.87	4.27	0
Polymers/foils	%	8	14	11.1	12	0	0	14
Glass cullet	%	87	64	72.5	66	71.4	72.1	65
Mixture of glass cullet, foil and metals	%		6.6	0		3.4	0	3
Dust	%		1.5	0.44		0	0	0
Other	%	0.3				2	2	1
Total Output	**%**	97.2	100	100	100	90.6	91.3	100

* First Solar LCI data for CdTe module recycling includes process steps to recover cadmium and tellurium, whereas the system boundary for the other recyclers is at the point where a cell fraction (including metals) is separated from the glass and polymers.

Figure 14 presents a comparison of material recovery for the six respondents and the modelled Envie & ROSI combined processes based on the Table 12 data. Each process assumes a significantly different input mix (module type). The y-axis is normalized to 100% for each recycler, such that the cumulative material fractions sum to the weight of one module or one ton of input. All of the respondents recover the frame (except First Solar because their modules do not have frames), cables, and junction boxes, but these contributions vary based on the type of module processed. The foils are more similar, but "other" materials (shown in dark blue in Figure 14), vary between respondents. For example, Reiling's mechanical crushing process produces a mixed fraction and large amounts of dust. ROSI's mechanical sortation also produces some dust. In Tialpi's mechanical processes, the glass is not fully removed from the polymer, producing some dust and mixed fractions. LuxChemtech removes the glass cullet and foil in a way that produces hardly any dust or foil. In ROSI's process, the foil fraction is fully pyrolyzed, which effectively increases the relative amounts of the other outputs. The pyrolyzed polymers are represented in the "other" fraction together with some dust in the graph. Lead is present in small concentrations in the solder alloy covering the Cu interconnectors. Therefore, some lead is collected in the Cu fraction and treated in Cu production. Trace amounts of lead also may be present as PbO glass frit on the solar cells. In some recycling processes lead may be precipitated from the waste chemical and water treatment streams for disposal, but this detail was not reported by the recyclers in this study.



* First Solar LCI data includes recovery of cadmium and tellurium, whereas the system boundary for the other recyclers is at the point where a cell fraction (including metals) is separated from the glass and polymers.

† Envie uses NPC's commercial process, but the combined Envie & ROSI process is considered a pilot.

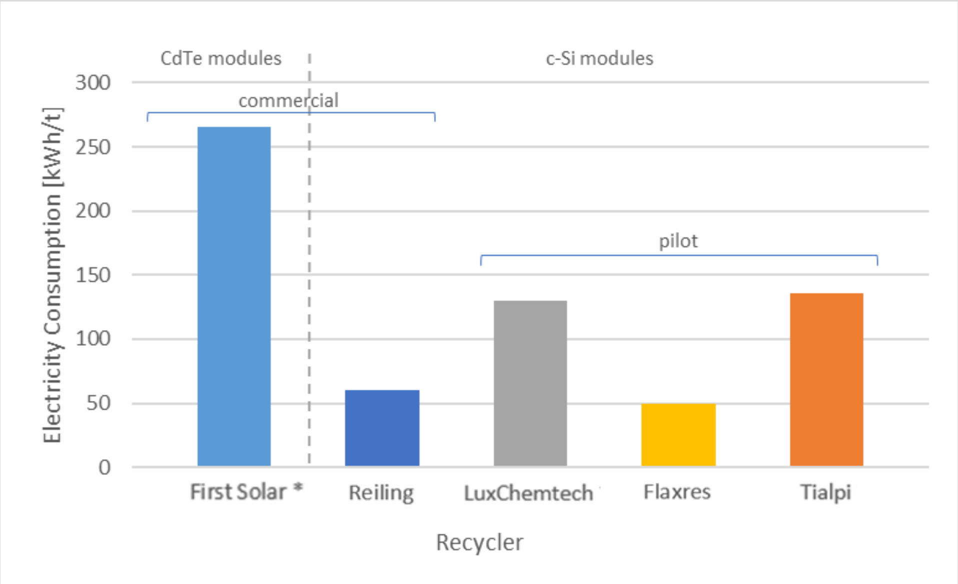
Figure 14: Relative output composition for 7 recyclers using significantly different input mixes (module type). The system boundary is the point in the process where a cell fraction (including metals) is separated from the glass and polymers. Table 12 indicates the process steps included in the LCI comparison.

Table 13 summarizes available information about silicon and silver recovery for each of the respondents.

Table 13: Recovery of silicon and silver

Technology	Silicon	Silver	Comment
First Solar	N/A	N/A	
Reiling	--	--	Not currently able to recover
LuxChemtech	Yes	Yes	Nearly 100% silicon, (indium, tin), silver
Flaxres	--	--	Flaxres currently partners with third parties to recover silicon and silver and is actively developing this capability
ROSI	Yes	Yes	Recovered silicon has 5-6N purity
Envie & ROSI	Yes	Yes	Recovered silicon has 5-6N purity
Tialpi	Yes	Yes	Silicon and silver recovery process is under development

Figure 15 compares energy consumption for all respondents except ROSI and Envie & ROSI, because ROSI does not yet have data available. Processes vary in the number of steps, additional chemical treatments, and consumption of fossil fuel. Reiling and Flaxres are the most efficient in terms of energy consumption. The chemical and water-jet processes developed by LuxChemtech consume a moderate amount of electricity, but it is still more than twice the consumption of Reiling's facility. Tialpi results are in the same energy consumption range as the LuxChemtech process, if only Phases 1 and 2 of Tialpi's pilot process are included. Tialpi would likely have the highest energy consumption if all recycling steps under development in Phases 3 and 4—such as polymer decomposition; copper, silicon, and silver recycling; and silver winning by electrolysis—were included. First Solar's LCI data includes recovery of cadmium and tellurium, which explains the higher electricity consumption.



* First Solar LCI data includes recovery of cadmium and tellurium, whereas the system boundary for the other recyclers is at the point where a cell fraction (including metals) is separated from the glass and polymers.

Figure 15: Electricity consumption of the different recycling processes, except ROSI and Envie & ROSI. The system boundary is the point in the process where a cell fraction (including metals) is separated from the glass and polymers. Table 12 indicates the process steps included in the LCI comparison.

2.8.1 Quality of Recovered Materials

In addition to the recovery rate of a recycling process, the quality of the recovered materials is important to the economics of recycling. Higher purity materials can be sold into higher value markets, potentially offsetting the cost of recycling. While the recycler survey focused on LCI data, a few recyclers shared information about material quality. For example, First Solar relies on a third party to purify recovered Cd and Te for reuse in manufacturing new CdTe modules. In Reiling's past batch processing of modules, they had cross contamination issues, sometimes resulting in low purity output fractions and material downcycling. Information is not yet available for the dedicated PV facility that was commissioned in 2023. LuxChemtech stated that the water-jet process produces high-purity glass, which may stay intact. Similarly, Flaxres reported that the glass produced with the light pulse delamination process is very clean and can be recycled as flat glass. ROSI is the only recycler to quantify the quality of recovered material. The company reported that the recovered silicon has 5-6N purity. In the combined process with Envie, a fine-grained solar cell residue was observed after pyrolysis. The fine fragments potentially impact quality unless the mechanical separation and chemical recovery of silicon and silver can be modified. Tialpi currently is able to produce high-quality cullet (0.08–0.39 in. [2–10 mm]). The company is working on an acidic leaching process that would enhance silicon quality to 99% purity and electrolysis for copper and silver recovery. All recyclers have outlets for the material fractions, including downcycling in some cases.

Few PV recyclers publish material quality today. As the PV recycling industry matures, output stream quality may determine which recyclers are profitable. In the meantime, there is R&D value in collecting measurable data on quality, and this is a gap that could be addressed in future studies.

2.8.2 Technology Development Trends

For c-Si module technology, Reiling's improved, pure-mechanical recycling process represents a fully commercial, best available technology and sets a benchmark for maturity, costs, and low energy consumption. Though the glass yields were significantly improved compared to the reported yields in the 2016-2017 study, the output streams currently do not allow silicon and silver recovery because much of the silicon and silver is encapsulated in the polymers, which are incinerated for energetic use. The glass quality could be slightly improved, thus approaching the limits of what is feasible with pure mechanical separation technology.

All other processes presented in this study target value-preserving recycling through full recovery of aluminum frames, cables, junction boxes, interconnectors, silicon, and silver, combining high yields with high-quality output fractions. For example, the Envie & ROSI, ROSI, LuxChemtech, Tialpi and Flaxres processes separate a glass fraction that can offer the flat glass industry a future source of usable cullet as a secondary raw material, saving melting energy. All new processes show that it is feasible to achieve more ambitious PV module recycling targets than the prevailing laws in the EU, which currently require an 80% recycling rate. However, recovery of copper, silicon and silver in high quality and yield requires significant investments in dedicated PV module recycling technologies that combine thermal, physical, and chemical treatment of the modules.

As First Solar operates a proprietary recycling system for its own thin-film CdTe module technology, it is challenging to compare with the recycling processes for c-Si module technology. With over 90% material recovery, First Solar's recycling process is a good example of a value-preserving thin-film module recycling process. New emerging recycling technologies are expected to be applicable to thin-film modules of any kind, as well as c-Si modules, though some additional special treatment might need to be added.

With the mandatory PV recycling system in place, European companies have started to invest in modern recycling plants customized for PV modules. Other countries are expected to follow soon by setting up waste policies and appropriate legislative measures. This trend can be observed through the rapidly increasing number of worldwide treatment facilities and the large annual number of patents and publications found.

Compared with the results of the previous 2016-2017 IEA PVPS LCI study,[1] the recycling processes have been better optimised for yield, quality, and economics. Though the waste streams are still moderate, new companies entered the recycling market with pilot lines and processes dedicated to PV modules in the past six years, including innovative ideas like light pulse treatment, water-jet cleaning, pyrolysis, and chemical treatment and many combinations of these treatment methods. Mechanical treatment is still the dominant technology with significant improvement in separation technology optimizing the economics of the process.

3 PATENT AND LITERATURE SURVEY

This section of the report summarizes the patents and scientific literature on recycling PV or module components as of the end of August 2022. The project includes scientific literature as found in Scopus, Elsevier's abstract and citation database, covering publications about PV and PV material recycling from 1991 on.

3.1 Approach

The research team pursued four methods to identify relevant patents and literature on the topic of PV recycling. Specific information sources, search methods, and queries are described.

3.1.1 Global Patent Search Review via DEPATISnet

Query:

BI=(recycling) AND (BI=(photovoltaic (L) panel) OR BI=(photovoltaic (L) module) OR BI=(solar (L) panel) OR BI=(solar (L) module) date: 07/30/2022

The patent search covered worldwide patent applications from 1990 through the first half of 2022. The query returned 5 380 patents. These were filtered for duplicate numbers, refined, and further analyzed by applying patent class searches in combination with the initial results. The research team finally identified 353 patents that were used for further analyses. The patent list was consolidated with the findings of IEA PVPS Task 12 described below, for a total of 456 patent applications.

3.1.2 Global Patent Search Review by IEA PVPS Task 12, 2018[30]

The team conducted the patent search using the online Worldwide Intellectual Property Service (WIPS). The date range used was January 6, 1976, through December 9, 2016. Countries covered: European patent (EP), Denmark (DE), France (FR), Great Britain (GB), United States (US), Canada (CN), Japan (JP), Korea (KR), and the Patent Cooperation Treaty (PCT). The initial search in WIPS resulted in 6 465 patents. After screening, 178 effective patents directly related to PV recycling were identified. The analysis focused on targeted components, processing method, and recovered materials.

The results are attached in Appendix A, Table A2: PV Recycling Patents.

3.1.3 Literature Review of Commercial and Pilot PV Recycling Plant Suppliers of Dedicated Equipment via Scopus (Elsevier)

The team conducted the literature search using Scopus with the queries:

TITLE-ABS-KEY-AUTH((“PV” OR “photovoltaic”) AND (“module” OR “panel”) AND (“recycling” OR “recovery” OR “reclaim”))

and

TITLE-ABS-KEY-AUTH((“PV” OR “photovoltaic”) AND (“module” OR “panel”) AND (“recycling” OR “recovery” OR “reclaim”)) AND (SUBJAREA(CENG OR CHEM OR COMP OR EART OR

[30] K. Komoto, J.-S. Lee, J. Zhang, D. Ravikumar, P. Sinha, A. Wade, and G. Heath, End-of-Life Management of Photovoltaic Panels: Trends in PV Module Recycling Technologies. IEA PVPS Task 12, International Energy Agency Power Systems Programme. Report IEA-PVPS T12-10:2018. 2018.

ENER OR ENGI OR ENVI OR MATE OR MATH OR PHYS)) OR SUBJAREA(BUSI OR DECI OR ECON OR SOCI) AND (LIMIT-TO (SUBJAREA,"ENGI") OR LIMIT-TO (SUBJAREA,"ENER") OR LIMIT-TO (SUBJAREA,"ENVI") OR LIMIT-TO (SUBJAREA,"MATE") OR LIMIT-TO (SUBJAREA,"CENG") OR LIMIT-TO (SUBJAREA,"CHEM") OR LIMIT-TO (SUBJAREA,"SOCI") OR LIMIT-TO (SUBJAREA,"BUSI") OR LIMIT-TO (SUBJAREA,"ECON")) AND (LIMIT-TO (LANGUAGE,"English") OR LIMIT-TO (LANGUAGE,"German") OR LIMIT-TO (LANGUAGE,"French") OR LIMIT-TO (LANGUAGE,"Italian"))

The query returned 1 077 hits, which were refined by removing all publications dealing with other topics, such as water purification, desalination, and so on. The results are attached in Appendix A, Table A3: PV Recycling Literature. The statistical evaluation was carried out with the full set of hits.

The query was supplemented with a Google literature search about PV recycling and a survey via ResearchGate. Links to YouTube videos about PV recycling processes were also added.

3.1.4 Literature Review of Commercial and Pilot PV Recycling Plant and Suppliers of Dedicated Equipment via SciFinder (CAS)

The team conducted a SciFinder search as a complementary survey with the same query as above. The team downloaded 500 results. New valid results were extracted and added to the table of Scopus literature attached in Appendix A, Table A3: PV Recycling Literature.

3.2 Patent Search Results

Most patents found target recycling processes for c-Si panels, cell metals, polymers, glass, or devices (Figure 16). A smaller number explicitly address recycling CdTe or CIGS and its components. Emerging cell technologies, such as perovskites, organic photovoltaic, or dye-sensitized cells, are not well represented yet (Table 14).

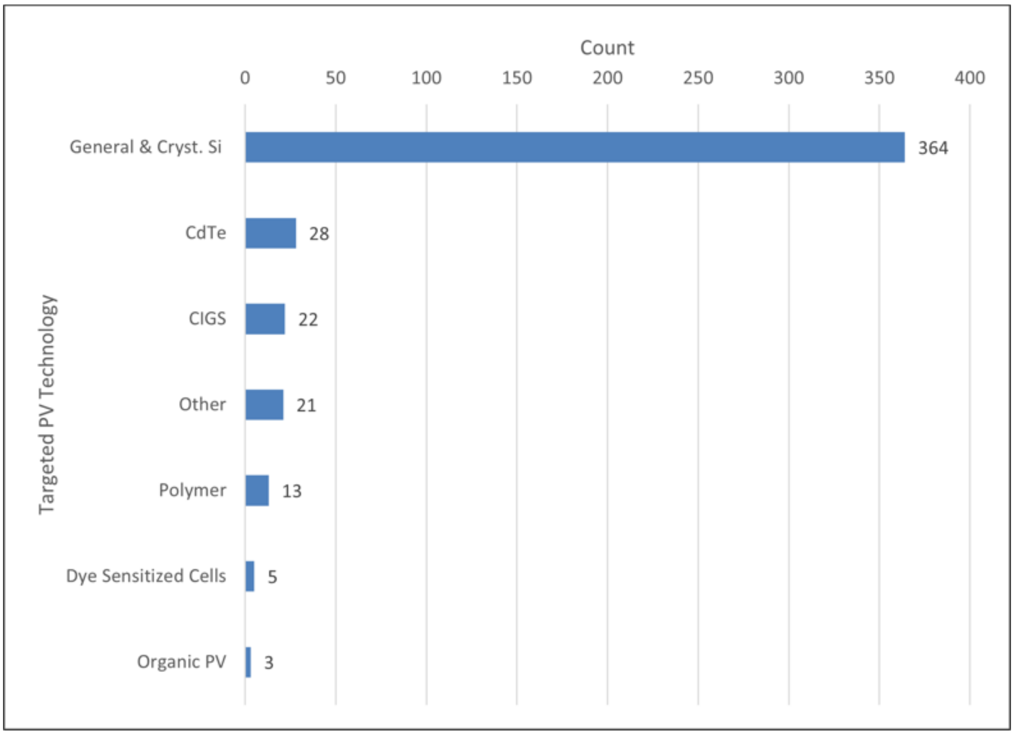


Figure 16: Number of recycling patent applications by PV technology

Table 14: Patent applications by targeted technology

Targeted PV Technology	Count	Share
General and c-Si	364	79.8%
CdTe	28	6.1%
CIGS	22	4.8%
Other	21	4.6%
Polymer	13	2.9%
Dye-sensitized cells	5	1.1%
Organic PV	3	0.7%

Producers of silicon-based solar cells and modules or their business partners frequently also develop thin-film technologies, e.g., modules using perovskite-silicon tandem solar cells. A number of PV manufacturers, equipment suppliers, polymer or glass companies, and research institutions developing c-Si technologies are actively involved in the development of recycling solutions for modules and their components.

Most patents aim at recovering valuable or toxic materials and semiconductor materials, some focus on glass, and some focus on polymers. A large variety of patented techniques (Table 15 and Table 16) combine several technical approaches, such as the following:

- Mechanical treatments, such as cutting, shredding, grinding, blasting, and so on.
- Thermal measures, such as pyrolysis, incineration, and hydrothermal or polymer melting.
- Chemical treatment with solvents, such as water vapor, supercritical CO_2, ionic liquids, salt melts, limonene, microemulsions, and so on.
- Treatments complemented by reactive chemicals to remove layers and recover materials of interest, such as alkaline (NaOH, KOH with or without alcohol), HNO_3, H_2SO_4/H_2O_2, methane sulfonic acid, and so on.
- Other: electrodynamic fragmentation, laser, or flash lamp annealing.

Table 15: Treatment methods applied to c-Si modules

Treatment	Share of Patents
Mechanical	40%
Thermal	15%
Chemical	19%
Combination	25%

Table 16: Treatment methods applied to thin-film compound modules

Treatment	Share of Patents
Mechanical	7%
Thermal	9%

Chemical	7%
Electrochemical	4%
Optical	9%
Combination	64%

According to the IEA survey, 128 patents addressed c-Si modules, with 45% of them targeting module separation. Many patents focused on recovering module components like frames, junction boxes or intact glass panes rather than recovering materials like cullet, polymers, copper, silicon, and silver (Table 15).

The results for thin-film compounds predominantly aimed at high-value recovery of materials, including several treatment steps from module separation to material recovery. Table 16 lists the main treatment methods applied.

For both technologies, the first treatment steps remove frames and terminal boxes. The methods listed in Table 15 and Table 16 are applied accordingly in subsequent process steps.

The number of publications and patent applications clearly indicates that interest has increased with the annual growth of the global PV market and the introduction of PV waste policies in several regions (Figure 17). Increasing production, the introduction of waste policies (in EU in 2012), the publication of the first studies on expected PV module waste streams (e.g., by IEA-PVPS Task12 and IRENA in 2016), potential material supply shortages, and eco-friendly design rules initiated a worldwide discussion on end-of-life waste treatment and valuable-material recovery. Many universities and institutes started research on module recycling and recycling equipment designs partly in cooperation with module manufacturers. The share of patent applicants is therefore dominated by those organizations; recyclers and equipment manufacturers rarely filed for patents previously.

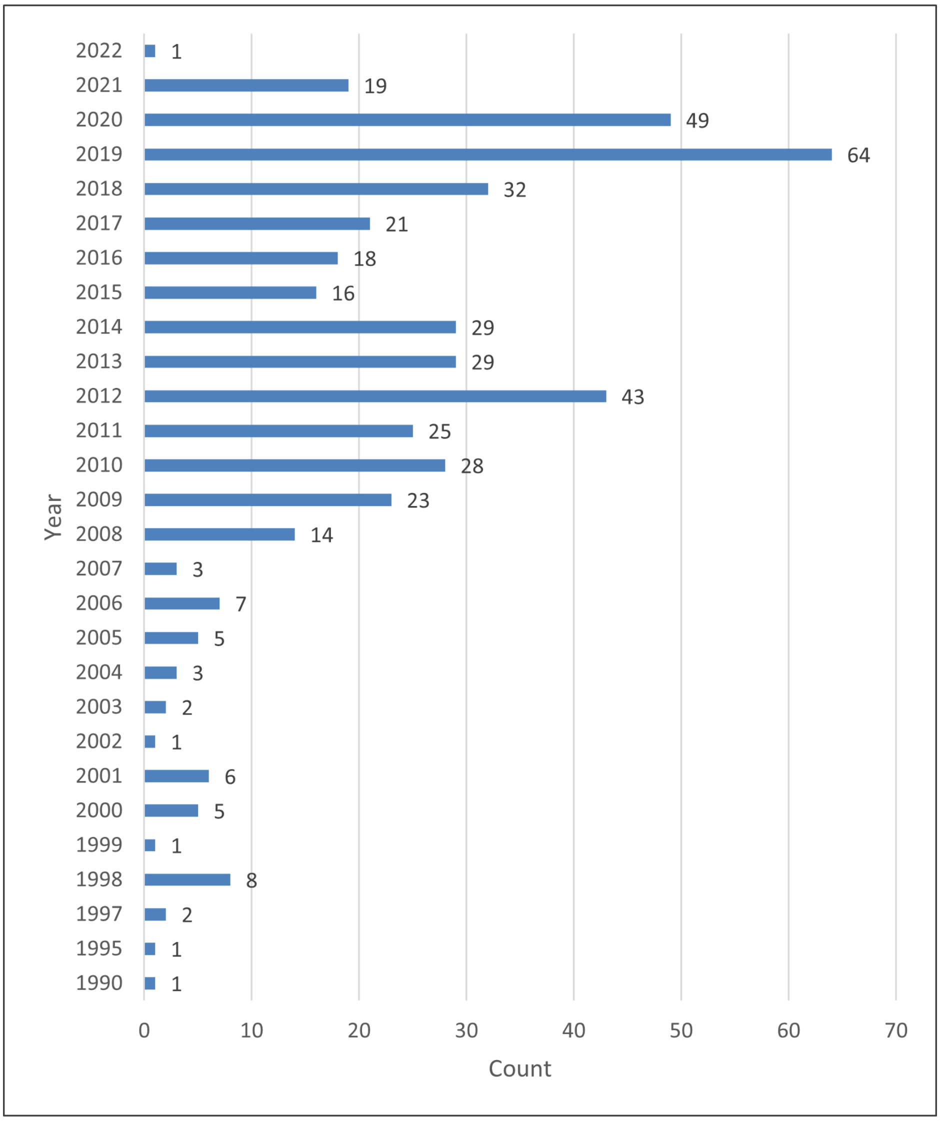


Figure 17: Annual distribution of recycling patent applications

Recyclers' interest is still moderate for the small waste streams reported today, hardly justifying a significant investment into dedicated treatment facilities.

Figure 18 shows the number of PV recycling patents per country. The graph may have some redundancy because some entities have applied for the same patents in several countries. In Europe, national patents frequently are discontinued once a European Patent Office (EPO) application has been awarded. For this reason, applications originating in individual EU member states can be added to the number of European patents when considering broader economic regions. In this case, the top-five regions are People's Republic of China, the United States, Korea, Japan, and EU.

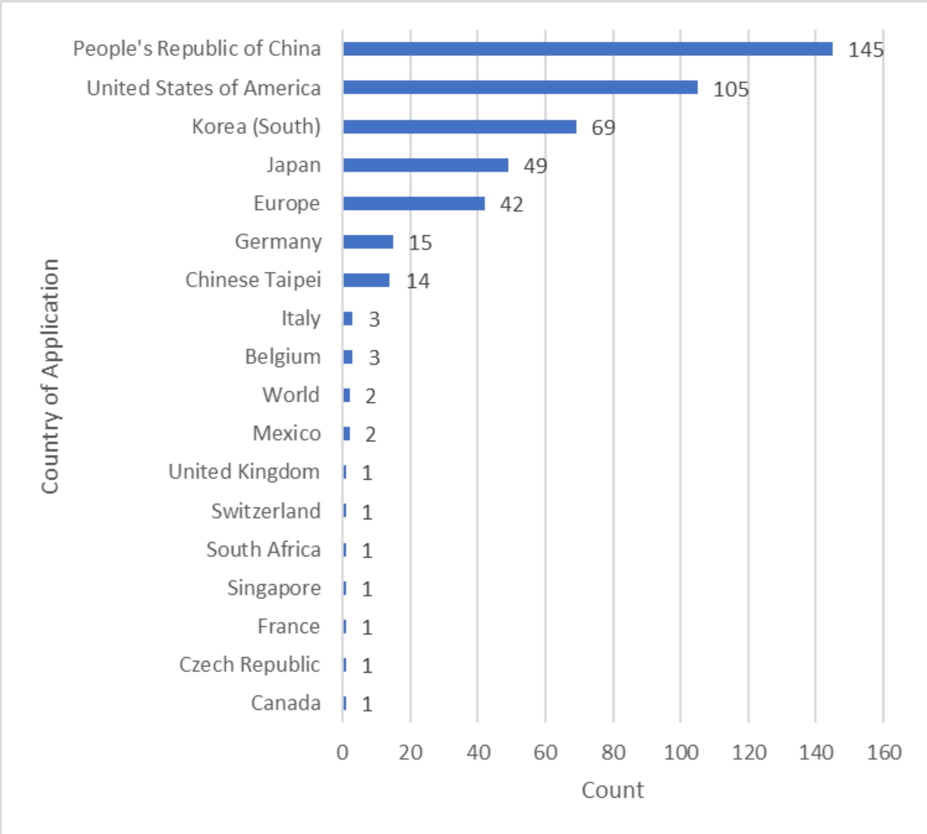


Figure 18: Geographical distribution of recycling patent applications

The patent search (Figure 19) revealed that organizations located in People's Republic of China own the most patents, followed by Japan, Korea, the United States, and Germany.

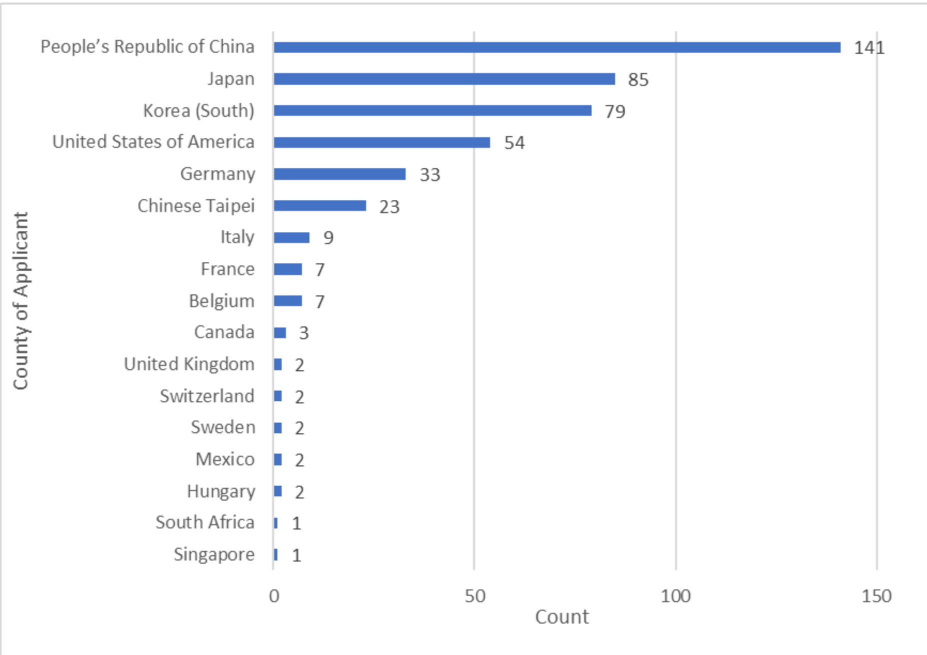


Figure 19: Geographical distribution of recycling patent owners

The results shown in Figure 19 clearly indicate that the patents are filed in major production locations and main installation markets. The owners are predominantly PV producers or suppliers and research institutions, but rarely professional waste treatment companies.

Figure 20 presents the number of patent applications by organization. Top ranking is the Korea Institute of Energy Research, which closely collaborates with companies such as Samsung and LG. Second ranking is Suzhou Goldway Technologies Co Ltd, known for developing PV-deframing equipment. Third on the list is First Solar, with its proprietary recycling technology for CdTe modules. Next is Yingli, an integrated PV manufacturer. The next three companies are in Japan: Tattori Resource Recycling manufactures the foam glass "Alpha," NPC manufactures PV production and recycling equipment, and Daikin Industries produces heat pumps, air conditioning systems, and fluorochemicals (the latter relevant for PV).

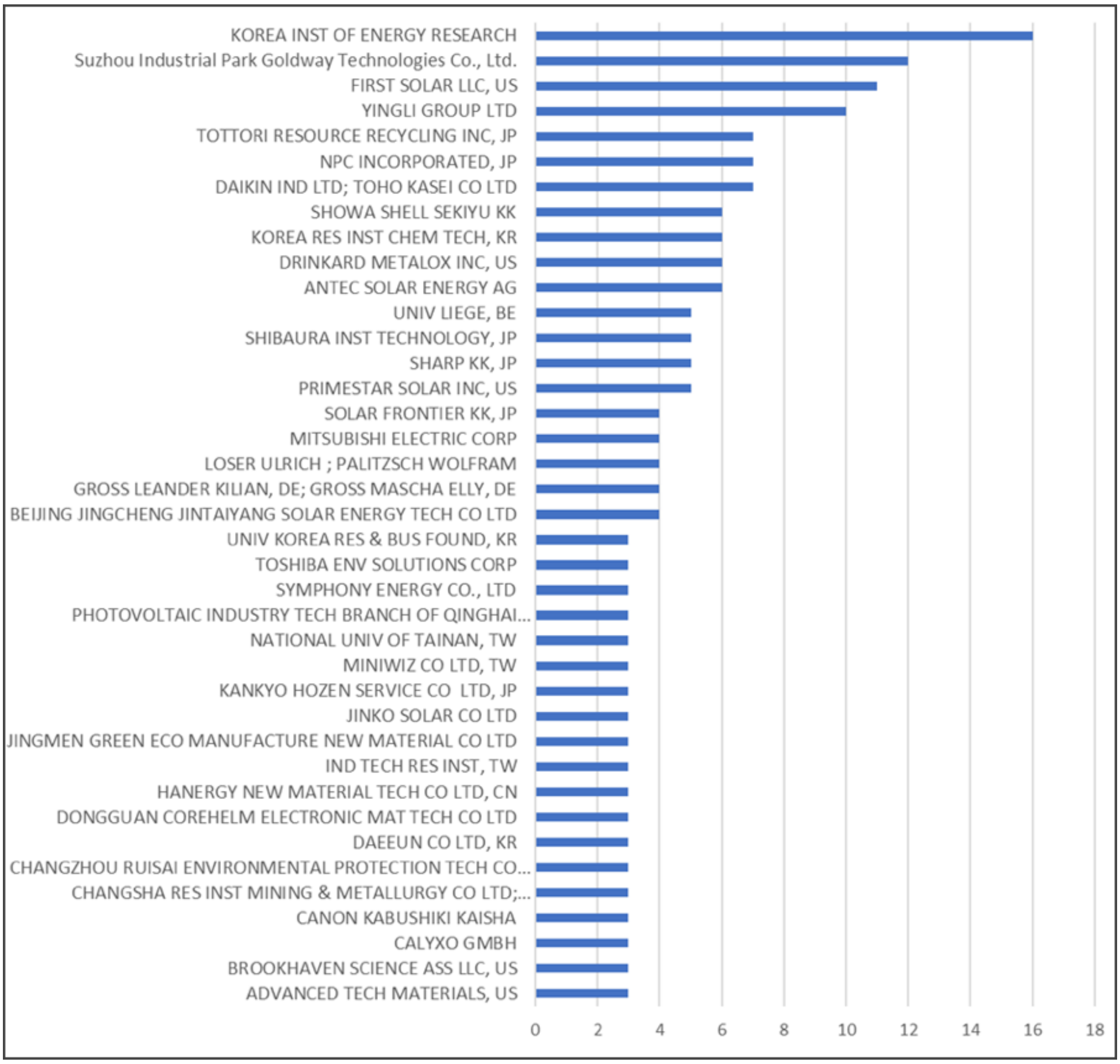


Figure 20: Number of patent applications by organizations

A reason that few patents are filed by professional waste treatment companies is that the current waste stream isn't sizable enough to justify significant investments in dedicated recycling technologies. Additionally, appropriate legal frameworks are lacking and are currently insufficient to encourage high-value recycling.

3.3 Literature Search Results

The research team conducted the literature search using Scopus to perform the following queries:

TITLE-ABS-KEY-AUTH((“PV” OR “photovoltaic”) AND (“module” OR “panel”) AND (“recycling” OR “recovery” OR “reclaim”))

The search resulted in more than 10 000 hits. Therefore, the query was modified as follows:

TITLE-ABS-KEY-AUTH((“PV” OR “photovoltaic”) AND (“module” OR “panel”) AND (“recycling” OR “recovery” OR “reclaim”)) AND (SUBJAREA(CENG OR CHEM OR COMP OR EART OR ENER OR ENGI OR ENVI OR MATE OR MATH OR PHYS)) OR SUBJAREA(BUSI OR DECI OR ECON OR SOCI) AND (LIMIT-TO (SUBJAREA,”ENGI”) OR LIMIT-TO (SUBJAREA,”ENER”) OR LIMIT-TO (SUBJAREA,”ENVI”) OR LIMIT-TO (SUBJAREA,”MATE”) OR LIMIT-TO (SUBJAREA,”CENG”) OR LIMIT-TO (SUBJAREA,”CHEM”) OR LIMIT-TO (SUBJAREA,”SOCI”) OR LIMIT-TO (SUBJAREA,”BUSI”) OR LIMIT-TO (SUBJAREA,”ECON”)) AND (LIMIT-TO (LANGUAGE,”English”) OR LIMIT-TO (LANGUAGE,”German”) OR LIMIT-TO (LANGUAGE,”French”) OR LIMIT-TO (LANGUAGE,”Italian”))

The query returned 1 077 documents on all aspects of recycling, including technology development, policy analysis, technoeconomic analysis, and life cycle assessment. After screening query results from all sources, 569 results relevant to PV recycling remained. These results are reasonably consistent with other recent literature searches. For example, a recent critical review paper that addressed circular economies for solar PV modules identified 1 349 journal publications and 408 government reports, but only 181 passed all screening stages.[31] That study did not limit search results by geography but did exclude results written in languages other than English. Examples of differences between literature searches may include use of different databases and search terms and application of filters to screen for language and subject area. The date the search is performed is also a factor in the quantity of search results, given the growing number of publications on this topic. Figure 21 shows the analysis.

[31] Heath, Garvin A., Dwarakanath Ravikumar, Brianna Hansen, and Elaine Kupets. “A Critical Review of the Circular Economy for Lithium-Ion Batteries and Photovoltaic Modules – Status, Challenges, and Opportunities.” Journal of the Air & Waste Management Association 72, no. 6 (June 3, 2022): 478–539. https://doi.org/10.1080/10962247.2022.2068878.

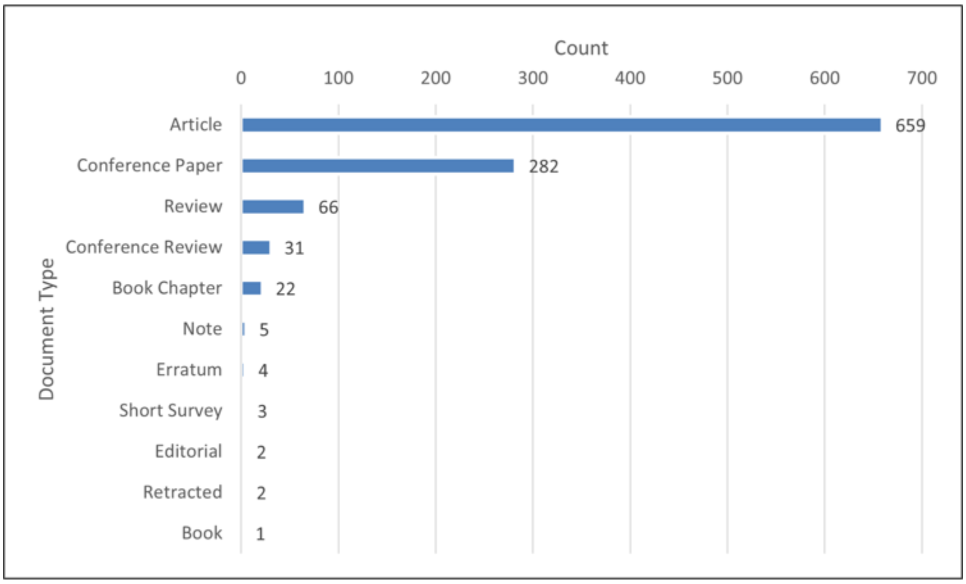


Figure 21: Scopus literature search results by document type

A ranking of information sources by number of results returned is led by IEEE conference proceedings, Solar Energy Materials and Solar Cells, and Renewable and Sustainable Energy Reviews. Notably, the query used in the Scopus and SciFinder literature searches did not identify the Association of Southeast Asian Nations (ASEAN) or European Photovoltaic Solar Energy Conference (EU PVSEC) in the results. Figure 22 shows other leading sources.

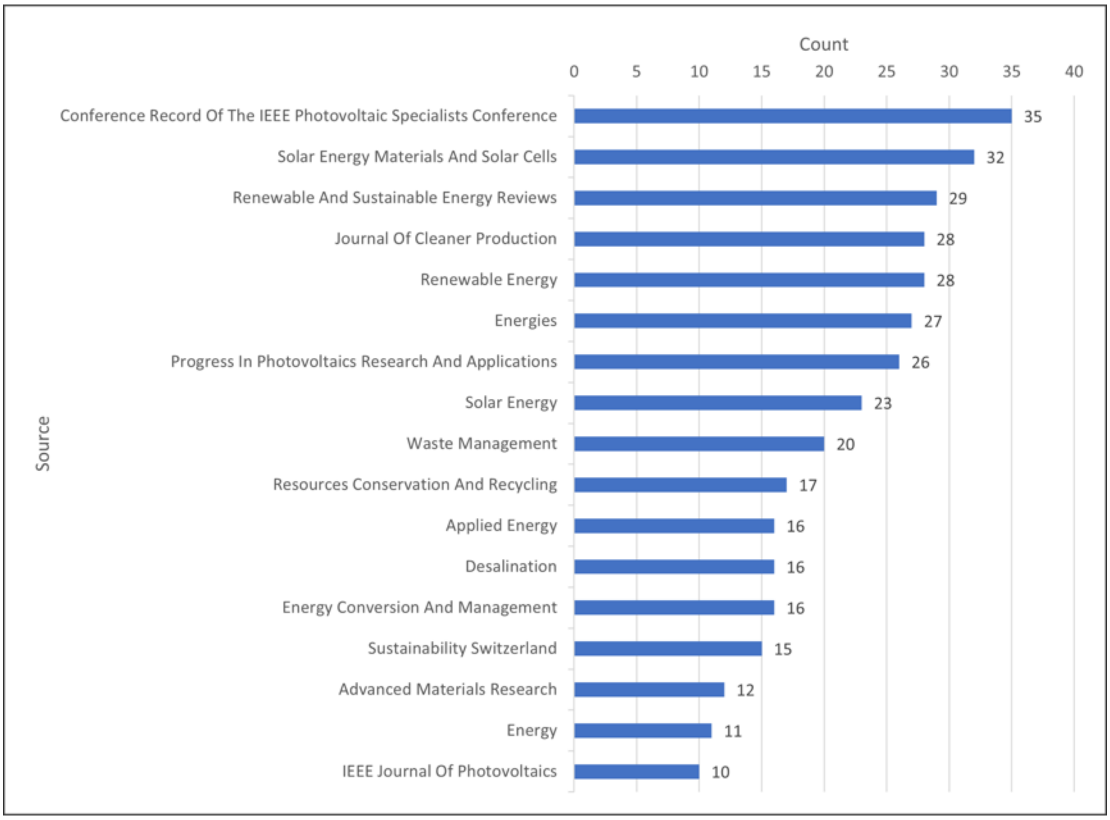


Figure 22: List of top literature sources with at least 10 publications in total (Note: The Scopus and SciFinder result lists did not identify ASEAN or EU PVSEC.)

Figure 23 shows the number of annual publications from 1981 to 2022. The number of publications has ascended steeply since 2010. This correlates with the number of newly installed PV capacities and the WEEE discussions and implementation in Europe. Many countries are considering PV waste policies, and research interest is high.

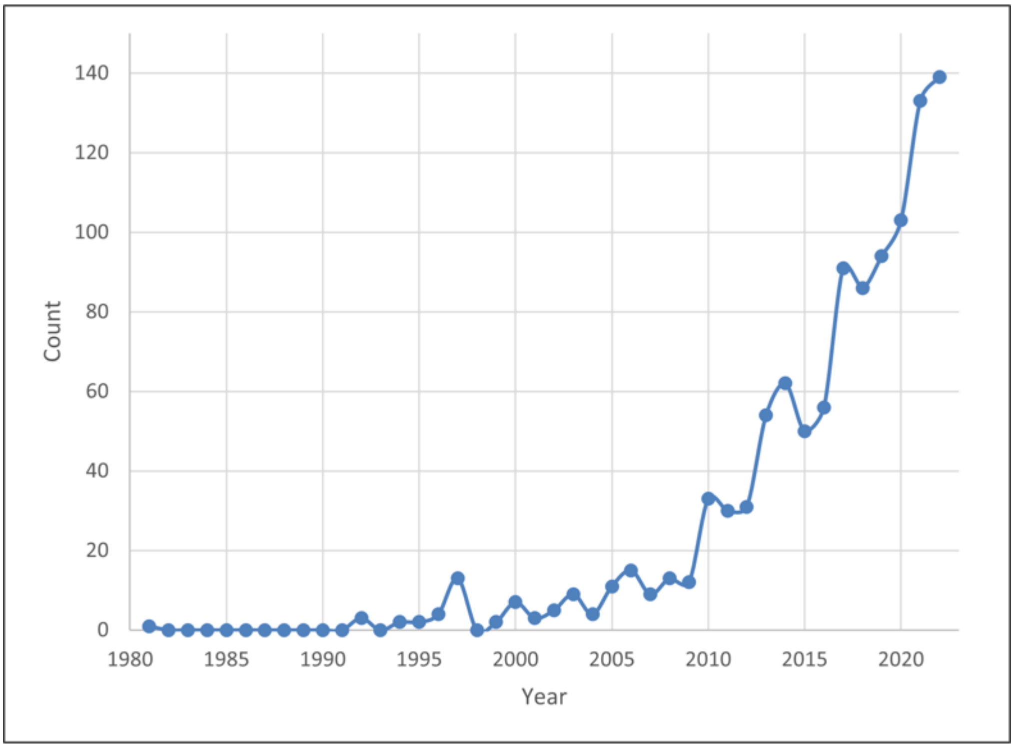


Figure 23: Number of annual publications about PV recycling

Figure 24 presents the authors with the most publications (at least five) found in the Scopus search. Most of the authors' affiliations are research institutes and universities. Of the top 25 publishing organizations, only one was a company—First Solar, United States (Figure 25). The author list of publications selected for download evidences that institutes and universities frequently cooperate with PV manufacturing companies, equipment manufacturers, and recycling companies.

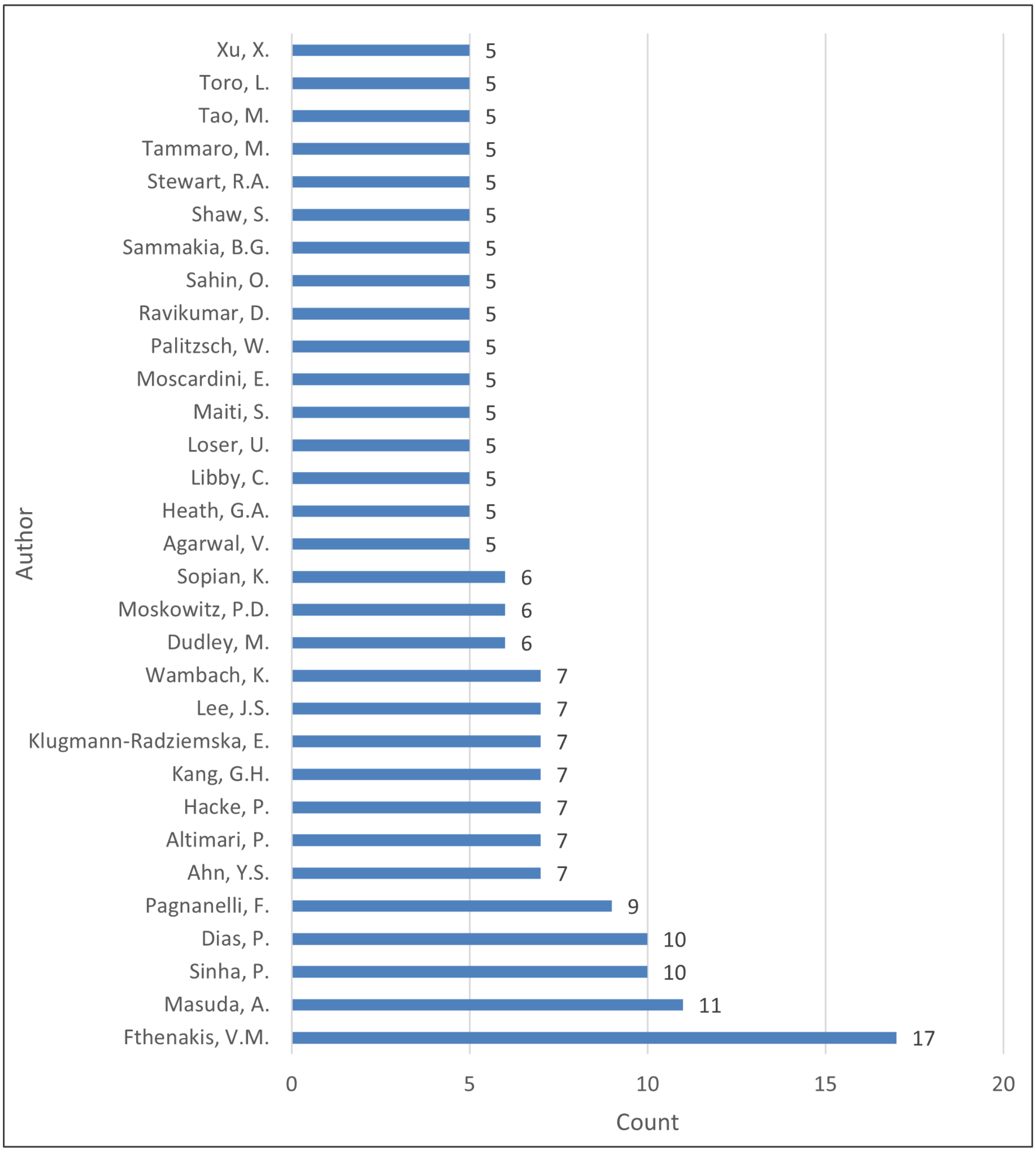


Figure 24: Authors with most publications (at least five) about PV recycling

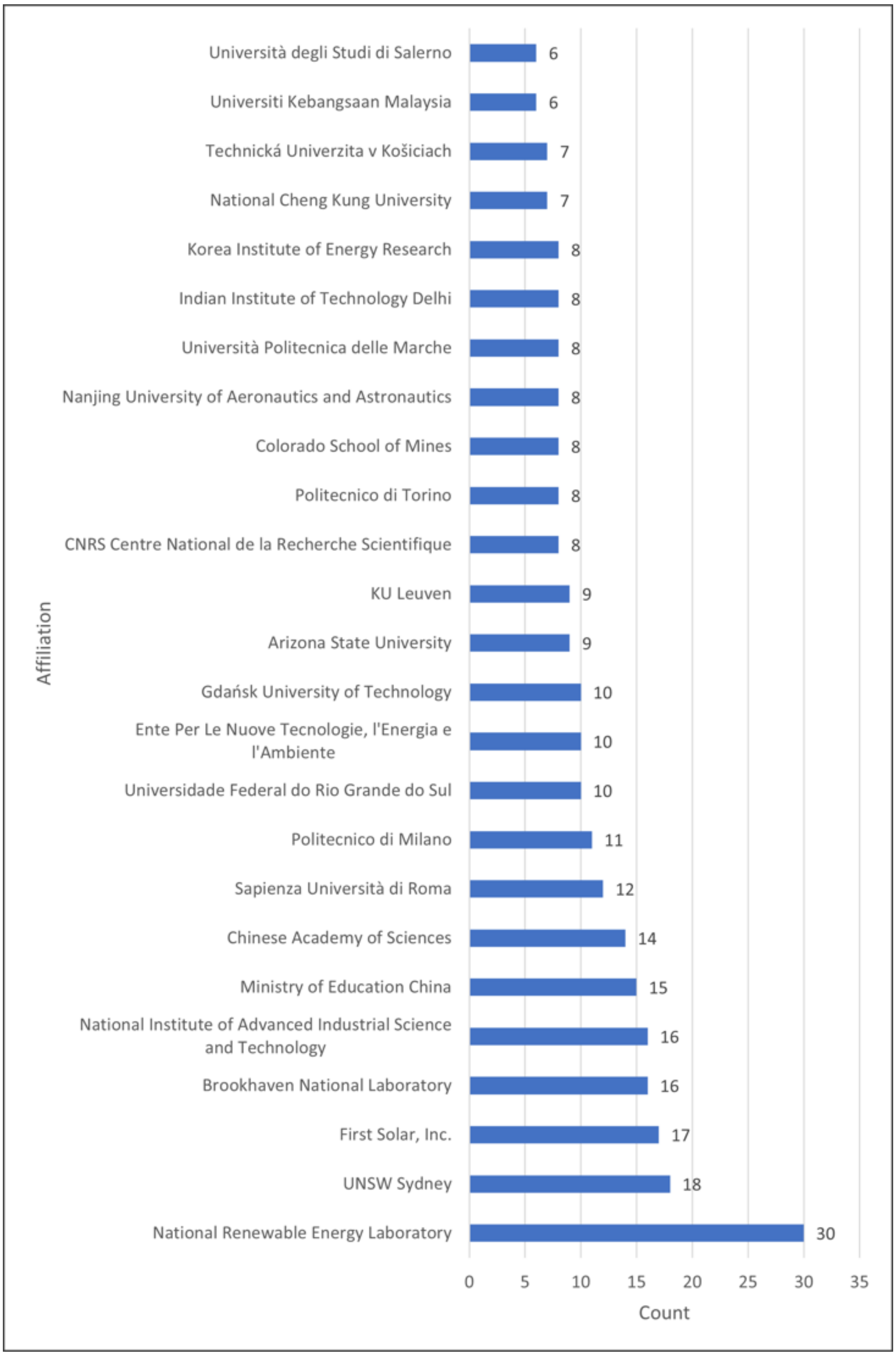


Figure 25: International organizations with most publications (more than five)

The authors with the most publications were from the United States, followed by Italy and the country with the most publications, People's Republic of China. The list of top countries and economies does not correlate with the major PV production regions or with the major markets. PV recycling has obviously been identified as a global and important topic. This can be confirmed by publications such as those in Table 17, found using Scopus (see also Appendix A, Table A3: PV Recycling Literature). The selection of publications gives an overview of the different demands and conditions in various industrialized, emerging, and developing countries and economies. The PV waste topic is discussed not only in the leading production countries and markets (e.g., EU, United States, People's Republic of China, Japan, South Korea, Australia) but also in countries such as Ghana, Nigeria, South Africa, and Mexico. Further activities are found, for example, in India, Chile, and Vietnam. This breadth of interest can also be seen in the number of publications from a country, region, or economy, as Figure 26 presents.

Table 17: List of publications targeting regional PV waste treatment systems and policies

Author		Title	Year	Scopus Code
Liu C., et al.	CN	Employing benefit-sharing to motivate stakeholders' efficient investment in waste photovoltaic module recycling	2022	2-s2.0-85123929279
Zhang L., Chang S., Wang Q., Zhou D.	CN	Is subsidy needed for waste PV modules recycling in China? A system dynamics simulation	2022	2-s2.0-85125119028
Zhang L., Chang S., Wang Q., Zhou D.	CN	Projection of Waste Photovoltaic Modules in China Considering Multiple Scenarios	2022	2-s2.0-85134795621
Heath G.A., et al.	US	A critical review of the circular economy for lithium-ion batteries and photovoltaic modules–status, challenges, and opportunities	2022	2-s2.0-85131528047
Li Y., et al.	CN	Conception and policy implications of photovoltaic modules end-of-life management in China	2021	2-s2.0-85088008346
Powicki C., Libby C., Shaw S.	US	Review of Decommissioning Plans for Large-Scale Solar Plants	2021	2-s2.0-85115942059
Murakami S., et al.	JP	Potential impact of consumer intention on generation of waste photovoltaic panels: A case study for Tokyo	2021	2-s2.0-85115718963
Ogbonnaya C., Turan A., Abeykoon C.	GB	Novel thermodynamic efficiency indices for choosing an optimal location for large-scale photovoltaic power generation	2020	2-s2.0-85075854073
Xi Z.-Z., Song Z.-C., Guo Y.-G., Wu X.	CN	Progress and prospects of recovery of spent photovoltaic module	2020	2-s2.0-85088092172
Liu C., Zhang Q., Wang H.	CN	Cost-benefit analysis of waste photovoltaic module recycling in China	2020	2-s2.0-85091328816
Salim H.K et al.	AU	Systems approach to end-of-life management of residential photovoltaic panels and battery energy storage system in Australia	2020	2-s2.0-85088989342
Li Y., et al.	CN	Study on the optimal deployment for Photovoltaic components recycle in China	2019	2-s2.0-85063911737
Nair S., et al.	IN	'Roshini'-Developing a DIY Rural Solar Light: Utilizing Products at End-of-Life (EoL) Stage	2019	2-s2.0-85061792648
Mahmoudi S., Huda N., Behnia M.	AU	Photovoltaic waste assessment: Forecasting and screening of emerging waste in Australia	2019	2-s2.0-85064315779
Kim H., Park H.	KO	PV waste management at the crossroads of circular economy and energy transition: The case of South Korea	2018	2-s2.0-85054519504
Domínguez A., Geyer R.	US	Photovoltaic waste assessment in Mexico	2017	2-s2.0-85028420985
Chenvidhya D., et al.	TH	PV industry growth and module reliability in Thailand	2015	2-s2.0-84951188892
Lin K.-L., et al.	TW	Recycling solar panel waste glass sintered as glass-ceramics	2012	2-s2.0-84867746575

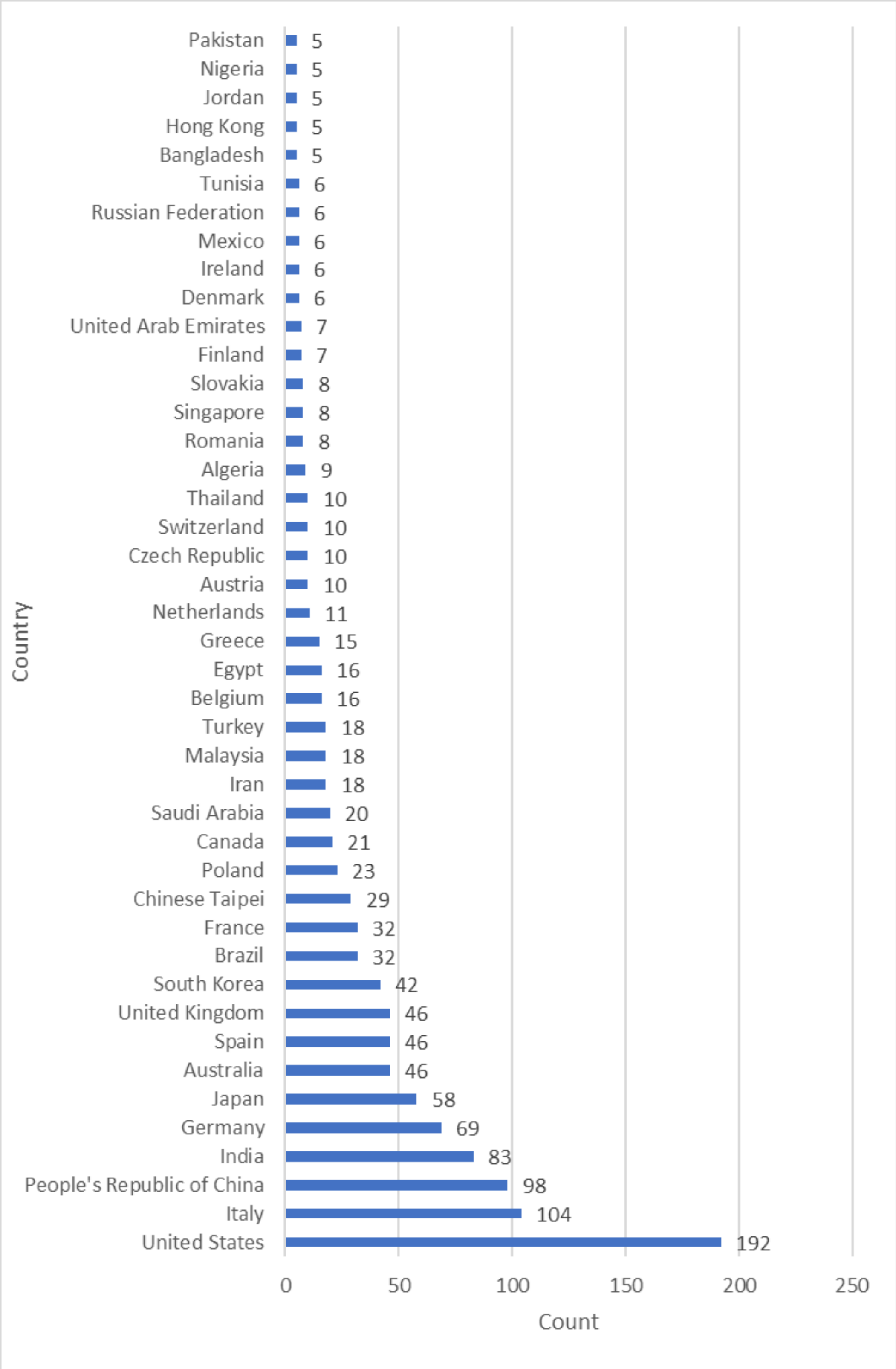


Figure 26: Countries, regions, and economies with the most publications (at least 10 publications)

Similar to what was observed in the patent space, most publications have been submitted by researchers from institutes and research organizations; waste treatment companies are rarely involved. Details about current commercial recycling processes can rarely be found, except from First Solar. Some recyclers provide general descriptions on their web pages, some with links to YouTube videos. “Appendix C: Example Recycling Videos,” lists examples.

4 CONCLUSIONS

This report identifies worldwide research on PV recycling with a broad approach to separating components and recovering valuable materials or purifying the products. These activities include developing tools for handling and automatically removing frames and junction boxes and separating glass from polymers. This is accomplished predominantly through mechanical treatments and modern recycling process technologies that combine several types of crushers and mills, sieves, vibrating tables, aeraulic sortation, sensor-based sortation, eddy current separators, optical sortation, X-ray sortation, and more. Mechanical treatment remains the most common approach because existing shredding facilities can be easily adapted to recycle PV modules. However, the outputs of mechanical processing are usually not very pure and better yields of high-quality materials or critical raw materials, especially for silicon and silver, should be targeted for better economic and environmental performance. In advanced recycling processes customized for PV modules, the mechanical steps are combined with various pyrometallurgical or chemical treatments to extract and recycle semiconductors and metals. New developments include electrodynamic fragmentation, laser or light-pulse annealing, and green chemistry approaches. Improving the quality of recovered materials offers upcycling opportunities that can offset the cost of recycling and advance PV circularity.

Most processes are still under development or in a pilot stage, except for several mechanical process technologies for c-Si modules and First Solar’s recycling plants in the United States, Vietnam, Malaysia, and Germany for CdTe modules.

Commercial processes today rely predominantly on mechanical treatment, which has a wide quality range in execution. It spans from frame and cable removal with landfill disposal of the module laminate to sophisticated mechanical treatment of the entire module. Full mechanical treatment is carried out with process technologies for metal, e-waste, or laminated-glass separation. Existing lines’ free capacities are used to treat PV panels collected in batches. Since it is not optimized for PV modules, there is frequently some downgrading of recovered material quality.

An increase in the waste stream can be observed in regions such as People’s Republic of China, Europe, the United States, India, and others. First commercial plants for PV module recycling are planned or under construction. These plants cover all technical combinations, including thermal, mechanical, and chemical treatments to separate the materials in high quality and yields to support the growing supply of end-of-life modules. Many new technologies in pilot stage offer excellent recycling quality (with both: high yields and purity of the fraction) and economic value opportunities. Recyclers and equipment manufacturers in Japan, People’s Republic of China, Europe, and the United States have started to provide solutions for waste PV modules, including companies such as Reiling, ROSI, NPC, La Mia Energia, ImpulsTec, LuxChemtech, and many others.

Trends in global publications, patents, and research activities suggest a steep increase in PV recycling interest. While most work is focused on recycling current PV technologies, innovative recycling approaches are also under development for next-generation PV. Limited information about capacity, technologies, and output results are available for most commercial recycling facilities, as well as those under development. In this study, five European recyclers and First Solar, a US company with four global locations, shared LCI data for processes ranging from 1 000 t/yr (LuxChemtech) to 50 000 t/yr (Reiling). These six companies are scaling up innovative technologies to improve the economic value of recycling through improvements in yield and quality.

APPENDIX A: PV RECYCLING RESULTS

Full results of the recycler survey and patent and literature search are presented. Please see Table A-1 for a list of global PV recyclers, Table A-2 for a list of PV recycling patents, and Table A-3 for results of the PV recycling literature review.

Table A-1: Global PV Recyclers

Recycler Name	Country	Zip	City	Street	URL
Etavolt Pte. Ltd.	Singapore	637141	Singapore	1 Cleantech Loop #06-04 Cleantech One	Home (etavolt.com)
Henan Minguan Trade UK Ltd alias Panoramic Resources	United Kingdom	SE7 7QU	London	260 Woolwich Road	www.solar2recycle.com
3R Recycling	United States of America				http://3r-recycling-cincinnati.com/
Aerisoul Metal & Energy Corp. s.r.o., AMEC	Slovakia	936 01	Šahy	Lesná 1863	https://aerisoul.com/solar-panel-recycling/
Aurinka PV	Spain				
Buhck/Take-e-way	Germany		Hamburg		
Canadian Solar Inc.	China				
Cascade Eco Minerals LLC	United States of America	MO 64804	Joplin	2401 E 32nd St. Ste. 10 PMB 344	Solar Panel Recycling | Cascade Eco Minerals
Chungbuk Technopark	Korea (South)		Chungbuk		
Cleanlites Recycling	United States of America		Mason, Michigan	PO Box 212	https://cleanlites.com/
Closed Loop Refining And Recovery, Inc.	United States of America		Phoenix		http://www.clrrusa.com
cmc Recycling	United States of America	Tx 75039	Irving	6565 N. MacArthur Blvd., suite 800	Home | Commercial Metals Company (cmcrecycling.com)
COMET	Belgium		Chatelet & Obourg (Mons)	Rivage de Boubier 25	https://www.cometgroup.be
Cyber Recycling & Disposal Pty Ltd	Australia		Perth	32 Bannick Ct, Canning Vale WA 6155,	Commercial Solar Panel Recycling in Perth | Solar Panel Disposal in Adelaide | Solar Panel Recycling in Darwin (cyberrecycling.com.au)

Table A-1: Global PV Recyclers

Recycler Name	Country	Zip	City	Street	URL
Darfon	Tunisia				
Dongyuan New Energy Technology	Viet Nam				
DR Deutsche Recycling Service GmbH	Germany	50968	Köln	Bonner Straße 484 – 486	www.deutsche-recycling.de
Dynamic Lifecycle Innovation, Wisconsin Headquarters:	United States of America	WI 54650	Onalaska	N5549 County Rd Z	Dynamic Lifecycle Innovations | Materials Lifecycle Solutions (thinkdynamic.com)
Echo Environmental, LLC	United States of America	TX 75006	Carollton (Dallas)	2101 W Belt Line Rd	echoenvironmental.com
ECO PV	Italy				
Ecoadvance	Japan		Iga, Mie		
Econecol, Inc.	Japan		Fujinomiya, Shizuoka		
EcoTech Recycling	United States of America		Port of Kalama, WA		Ecotech Recycles
Eggersman GmbH	Germany	33790	Halle (Westf.)	Ravenna-Park 2	www.eggersmann-recyclingtechnology.com
Eiki Shoji	Japan				
Elecsome Pty.Ltd, Ojas Group	Australia	Victoria 3195	Braeside	Unit 2,24 Canterbury Rd,	Elecsome Solar Upcycling - Elecsome
Electronic Recycling & IT Asset Disposition Services	United States of America				https://eridirect.com/
ENGIE My Power SAS Service Clients	France	92400	Courbevoie	place Samuel de Champlain	https://mypower.engie.fr/energie-solaire/conseils/recyclage-panneau-photovoltaique.html
Envaris	Germany	13627	Berlin	Friedrich-Olbricht-Damm 62	Recycling & Entsorgung – envaris.de
Envie 2E Aquitaine	France				
ENVIE 2E Midi-Pyrénées	France		Portet sur Garonne		
EUROPEAN RECYCLING PLATFORM ESPAÑA, ERP ESPAÑA S.L.U.	Spain	28003	Madrid	C/ Raimundo Fernández Villaverde nº 61, Planta 8ª, Centro Izquierda	
Experia Solution Srl	Italy	35013	Cittadella (Padova) Italy	Via Postumia di Levante, 8	Experia Solution - Second-Hand PV Machines & Consulting
FabTech Enterprises, Inc.	United States of America	AZ 85297	Gilbert	596 E Germann Rd Suite 104	Recycle - Fabtech Enterprises

Table A-1: Global PV Recyclers

Recycler Name	Country	Zip	City	Street	URL
First Solar, Inc.	United States of America	OH	Perysburg		
First Solar, Inc.	Germany				
First Solar, Inc.	Malaysia				
Flaxres	Germany		Dresden		www.flaxres.com
Galloo in Halluin	France		Halluin		
Geltz Umwelttechnologie GmbH	Germany	75417	Mühlacker	Kerschensteinerstr. 6	www.geltz.de
Good Sun	United States of America				https://www.goodsun.life/
Green Century Electronics Recycling	United States of America				https://greencenturyonline.net/
Green Clean Solar	United States of America	GA 30068	Marietta	1205 Johnson Ferry Road, Suite 136-164	https://www.greenclean-solar.com/
Green Lights Recycling Inc.	United States of America	MN 55449-4423	Blaine	10040 Davenport St NE	https://www.glrnow.com/
Greenflow?	United States of America				
H I RABAYASH I METAL Co., Ltd.	Japan		Okayama, Okayama		
H&H Pro Limited	United Kingdom	HA1 1BD	Harrow, Middlesex	79 College Road	https://www.hnhpro.co.uk
Hakuto Total Recycle System Co., Ltd.	Japan		Tottori, Tottori		
Hamada Co., Ltd.	Japan		Minato, Tokyo & Takatsuki Osaka		
Hanwha Group? Hanwha Solar One Schanghei	China				
Harita Metal Co., Ltd.	Japan		Takaoka, Toyama		
Henan Honest Heavy Machinery Co., Ltd	China				
Hensel Recycling GmbH	Germany	63743	Aschaffenburg	Mühlweg 1	www.hensel-recycling.com

Table A-1: Global PV Recyclers

Recycler Name	Country	Zip	City	Street	URL
IBA	Hong Kong, SAR China				
ILM Highland	United Kingdom	IV17 0XS	Alness	Unit 1G, Teaninich Industrial Estate	www.ilmhighland.co.uk
Immark AG	Switzerland	CH-8105	Regensdorf, ZH	Bahnstrasse 142	www.immark.ch
ImpulsTec GmbH	Germany	01445	Radebeul	Wilhelm-Eichler-Straße 34	
Infoactiv Group PTY LTD	Australia	VIC 3126	Canterbury	G03 313 Canterbury Road	https://ecoactiv.com.au
INTERCO TRADING, INC.	United States of America	Il 62060	Madison	10 FOX INDUSTRIAL DRIVE	Interco Recycles Solar Panels - Interco (intercotradingco.com)
JA Solar Co., Ltd.	China				
Jamko Sp. z o.o.	Poland	36-060	Głogów Małopolski	ul. Rudolfa Menerki 13b	Photovoltaic Wholesaler| JAMKO
JFE Bars & Shapes Corporation	Japan		Kurashiki, Okayama		
Jiangsu Juxin Energy Silicon Technology Co., Ltd.	China	225000	Yangzhou, Jiangsu	No. 0178, Industrial Park, South Yangtze River	Jiangsu Juxin Energy Silicon Industry Technology Co., Ltd.: monokristalline 125 Zellen, polykristalline 156 Zellen, Solarsiliziumwafer (11467.com)
Jingke Energy Co., Ltd.	China				
Kaneshiro Sangyou	Japan		Matsuyama, Ehime		
Kangai	Japan		Kurashiki, Okayama		
Kankyo Hozen Service Co., Ltd.	Japan		Oshu, Iwate		
Kankyo Tsushin Yuso	Japan		Ushiku, Ibaraki		
Kinki Denden Yuso, Ltd.	Japan		Neyagawa, Osaka		
KRD Global Group	Poland				
Kunshan Chencan Scrap Material Recycle	China				
Kunshan Crystal Still Sun New Energy Technology	China				
KWB Planreal AG	Switzerland	CH-9443	Widnau	Ringstrasse 4	www.kwbplanreal.ch
Kyusyuhokusei Co., Ltd.	Japan		Kobayashi, Miyazaki		
La Mia Energia s.c.ar.l.	Italy	03043	Cassino (FR)	Via Cerro Antico s.n.c.	Our Treatment Plants (lamiaenergia.eu)

Table A-1: Global PV Recyclers

Recycler Name	Country	Zip	City	Street	URL
Lotus Energy Recycling	Australia		Melbourne		
LuxChemTech	Germany	09599	Freiberg	Alfred-Lange-Str. 18	
LONGi Green Energy Technology Co., Ltd.	China		Xi'an Shaanxi	No.8369 Shangyuan Road, Economic And Technological Development Zone	www.longi.com
LZY Solar	China				
Matec, Inc.	Japan		Ishikari, Hokkaido		
Mitsuba-Shigen Co., Ltd.	Japan		Towada, Aomori		
Mitsubishi Electric	United States of America				https://www.mitsubishielectricsolar.com/
Mitsukaido Sangyo	Japan		Joso, Ibaraki		
Moriya	Japan		Higasine, Yamagata		
MOTIVE ENERGY, INC. (Power Solutions)	United States of America	CA 92801	ANAHEIM	125 E. COMMERCIAL STREET	
MTKN Consulting Group	Japan	104-0061	Tokyo	Re-energy Labo. Ginza, Okuno Building 701, 1-9-8 Ginza, Chuo- ku	https://mtkn.group
Mujin New Energy Technology	China				
Nike* S.r.l.	Italy				
Nisso Metallochemical Co., Ltd.	Japan		Fukushima (Taito, Tokyo)		
NovaTec Recycling	United States of America				
NPC	Japan				
NPC Incorporated	Japan		Matsuyama, Ehime		
Okaishi Construction Co., Ltd	Japan	701-0213	Okayama-ken	293-1, Okayama-shi	www.kousai-k.co.jp
PV Industries Pty. Ltd.	Australia		Sidney, NSW		https://www.pvindustries.com.au
PV Recycling	China				
R3-tech	China		Wan Chai Hong Kong	300 Lockhart Road	http://r3-tech.com/

Table A-1: Global PV Recyclers

Recycler Name	Country	Zip	City	Street	URL
Reclaim PV Recycling Pty Ltd	Australia		Lonsdale (South Australia)		www.reclaimpv.com
Reclaim PV Recycling Pty Ltd	Australia		Brisbane, Lonsdale (plant9		www.reclaimpv.com
Reclite SA Pty Ltd	Saudi Arabia	1401	Germiston	Unit 1, 1400 16 Indianapolis Blvd, Gosforth Park	www.reclite.co.za
Recma SC	Belgium	4100	Seraing (Wallonia)	Rue du Téris 4	https://www.recma.be/recyclage/panneaux-photovolta%C3%AFques/
Recubyl	France				
Recycle Solar Technologies Ltd.	United Kingdom	DN15 7PA	Scunthorpe, North Lincolnshire	82 Oswald Road	
RECYCLE SOLAR UK	United Kingdom	DN161BD	Scunthorpe	Woodhouse Road	https://www.recyclesolar.co.uk/
RECYCLE SOLAR UK	Iran, Islamic Republic of				
Recycle Tech Co., Ltd.	Japan		Kitakyushu, Fukuoka		
Recycle Tech Japan	Japan		Nagoya, Aichi		
Recycle Technologies, Inc.	United States of America	WI 53186	Waukesha	1480 N Springdale Rd,	
Recycle1234	United States of America	CA 94587	Union City	33548 Central Avenue	https://recycle1234.com
RecyclePVSolar	United States of America	Nevada	Reno/Sparks		
Reiling GmbH & Co. KG	Germany	33428	Marienfeld/Harsewinkel	Bussemasstr. 49	www.reiling.de
Reiling GmbH & Co. KG	Germany		Torgau		
Reiling GmbH & Co. KG	Germany		Münster		
Relightitalia/TREEE	Italy				https://www.relightitalia.it/en/company; https://www.treee.it/
REMA PV Systém	Czech Republic	14000	Praha 4, Krč	Antala Staška 510/38	www.rema.cloud
Re-Tem Corporation	Japan		Ibaraki (Chiyoda, Tokyo)		
Rinovasol	Germany				
ROSI SAS	France		Grenoble		www.rosi.com

Table A-1: Global PV Recyclers

Recycler Name	Country	Zip	City	Street	URL
ROTH International GmbH	Germany	92637	Weiden	Hohenstaufenstraße 58	
S.C.	Poland				
Sasil	Italy				
SB Energy	France				
SDIC Yellow River Hydropower Development Co., Ltd.	China				
Seinan Corporation	Japan		Hirosaki, Aomori		
Shanghai FeiHang International Trade Co., Ltd.	China		Kunshan, Jiangsu	No. 556 Qingyang Road, Development Zone	https://www.pvrecycle.cn
Sharp Corp	Japan				
Shirakawa Syouten	Japan		Koriyama, Fukushima		
SiC Processing (Deutschland) GmbH	Germany		Bautzen		
Silcontel	Israel	27230	Haifa	Haarmonim 25	Contact Us - Silcontel (silcontel-ltd.com)
Silicon Specialists	United States of America				https://www.siliconspecialists.com/
Sinopower Holding (Hong Kong) Co. Ltd.	China		Shatin, New Territories	Room 17-18, 23/F, Metropolis Plaza, 2 On Yiu Street	https://www.sinopowersolar.com.hk/
SOFIES	India		Bangalore		
Solar German Cells GmbH	Germany		Leipzig		
SOLAR MATERIALS GmbH	Germany	39114	Magdeburg	Paul-Ecke-Straße 4	https://solar-materials.com/
Solar Professionals (KGM Services Pty Ltd)	Australia		Wagga Wagga		
Solar Recovery Corporation	Australia		Melbourne		
Solar Recycling Experts LLC	United States of America	CA 93561	Tehachapi		solarrecyclingexperts.com/
Solar Sun's Recycling					
SolarCycle	United States of America				SOLARCYCLE | Full Solar Panel Recycling Services

Table A-1: Global PV Recyclers

Recycler Name	Country	Zip	City	Street	URL
Solarsilicon Recycling Services dba SRS	United States of America		Ventura, CA		www.solarsilicon.com
Solucciona Energia	Spain	28702	San Sebastian de los Reyes, Madrid	Calle Jose Hierro 6	www.solucciona.com
Sunada Co., Ltd.	Japan		Higashi-hiroshima, Hiroshima		
SunPlan GmbH	Germany	84574	Taufkirchen	Rieder 2	www.sunplan.de
Sunpower Corp	United States of America				
SunR	Brazil	13283-200	Vinhedo/SP	Av. dos Pinheiros 719, João XXIII	www.sunr.com.br
Sunset Renewable Asset Management Inc.	Canada				www.sunsetrenewables.com
Surplus Service	United States of America	CA 94539	Fremont	3090 Osgood Ct	https://surplusservice.com
Suzhou Jingshang Solar New Energy Technology	China				
Suzhou Jingshang Sunshine New Energy Technology	China				
Suzhou Minlai Photovoltaic New Energy Co., Ltd.	China		Kunshan, Jiangsu	No. 1128, Beimen Road	www.xumin188.com
Suzhou RZJ New Energy Technology	China				
Suzhou Shangyunda	China				
Takaryo Corporation	Japan		Minamisoma, Fukushima		
TBF Computing Inc	United States of America				https://www.desktopdisposal.com/solarpanel.php
TG Companies	United States of America				https://www.tg-companies.com/
The Retrofit Companies	United States of America				https://retrofitcompanies.com/

Table A-1: Global PV Recyclers

Recycler Name	Country	Zip	City	Street	URL
Tokyo Power Technology, Ltd.	Japan		Koto, Tokyo		
Toshiba Environmental Solutions Corporation	Japan		Yokohama Kanagawa		
Total Green Recycling	Australia	WA 6986	Welshpool DC	PO Box 711	https://www.totalgreenrecycling.com.au/
Trillio	Italy				
Trina Solar	China				
Um-Welt-Japan Co., Ltd	Japan		Yorii, Saitama		
United Electronic Recycling	United States of America	TX 75019	Coppell, Texas	505 Airline Dr	https://unitedelectronicrecycling.com
United Scrap Metal	United States of America	IL 60804	Cicero	1545 South Cicero Avenue	
VEOLIA	France		Rousset (Bouches-du-Rhône		
We Recycle Solar, Inc.	United States of America	AZ 85016	STE 300 Phoenix	4742 N 24th St	Solar Panel Recycling & Disposal Company - We Recycle Solar
WonKwang S&T	Korea (South)		Incheon		
Yancheng Kefa Renewable Material Recycling	China				
Yellow River Upstream Hydropower Development Co, Ltd.	China				
Yingli Energy Co.	China				
Yiwu Shopolo Import and Export Co., Ltd.	China		Yiwu City, Zheiyang Province	2106#, Futian Mansion A	
Yiwu Shopolo Import and Export Co., Ltd.	Afghanistan		Kabul		
Yiwu Shopolo Import and Export Co., Ltd.	Pakistan				
Yiwu Shopolo Import and Export Co., Ltd.	Russian Federation				
Yoonjin Tech	Korea (South)		Gyeongbuk		
Tialpi S.r.l.	Italy	13874	Mattalciata Bi	km. 3.200 Strada St. N	
Yousolar Srl	Italy	36022	Cassola, VI	Via A. Ferrarin, 14	www.yousolar.it

Table A-1: Global PV Recyclers

Recycler Name	Country	Zip	City	Street	URL
Yuepeng New Energy	China				
ZEEP Technology, LLC	United States of America	MA	South Hadley		

Table A-2: PV Recycling Patents

PV Type	Country of Applicant	Country	Publication NO	Date	IPC-classes	Inventor	Applicant	Title	Document
CSI	Korea (South)	Korea (South)	KR000102258669B1	10.06.2019				[EN] ECO RECYCLING SYSTEM OF UNUSABLE SOLAR MODULE	https://depatisnet.dpma.de/DepatisNet/depatisnet?action=pdf&docid=KR000102258669B1&xxxfull=1
CSI	Korea (South)	Korea (South)	KR000102250482B1	29.03.2019	B02C 23/08			[EN] RECYCLING METHOD FOR UNUSABLE SOLAR MODULE	https://depatisnet.dpma.de/DepatisNet/depatisnet?action=pdf&docid=KR000102250482B1&xxxfull=1
CSI	Korea (South)	Korea (South)	KR000102315051B1	18.02.2019	B02C 17/18, C01B 21/068			[EN] RECYCLING PROCESS OF WASTE PHOTOVOLTAIC MODULE	https://depatisnet.dpma.de/DepatisNet/depatisnet?action=pdf&docid=KR000102315051B1&xxxfull=1
CSI	Korea (South)	Korea (South)	KR000102207445B1	01.02.2019	C22B 4/00			[EN] RECYCLING METHOD FOR SPENT SOLAR MODULE USING PYROMETALLURGY	https://depatisnet.dpma.de/DepatisNet/depatisnet?action=pdf&docid=KR000102207445B1&xxxfull=1
CSI	Korea (South)	Korea (South)	KR000102112145B1	21.09.2018				[EN] A Removing Device of Unusable Solar Module and A Recycling System of Unusable Solar Module Having the Same	https://depatisnet.dpma.de/DepatisNet/depatisnet?action=pdf&docid=KR000102112145B1&xxxfull=1
CSI	Korea (South)	Korea (South)	KR000101986837B1	26.09.2017	B02C 18/22, B02C 18/24, B02C 21/00			[EN] A Recycling System of Unusable Solar Module	https://depatisnet.dpma.de/DepatisNet/depatisnet?action=pdf&docid=KR000101986837B1&xxxfull=1
CSI	Korea (South)	Korea (South)	KR000101714496B1	09.12.2014	B09B 3/00			[EN] METHOD FOR RECYCLING SILICON FROM WASTE SOLAR MODULE	https://depatisnet.dpma.de/DepatisNet/depatisnet?action=pdf&docid=KR000101714496B1&xxxfull=1
CSI	Korea (South)	Korea (South)	KR000101490088B1	28.11.2014				[EN] SOLAR CELL RECYCLING JIG FROM WASTE SOLAR MODULES AND SOLAR CELL RECYCLING METHOD FROM WASTE SOLAR MODULES USING THE SAME	https://depatisnet.dpma.de/DepatisNet/depatisnet?action=pdf&docid=KR000101490088B1&xxxfull=1
CSI	Korea (South)	Korea (South)	KR000101409319B1	20.08.2012				[EN] Device for recycling cell from solar module	https://depatisnet.dpma.de/DepatisNet/depatisnet?action=pdf&docid=KR000101409319B1&xxxfull=1
CSI	Korea (South)	Korea (South)	KR000101292052B1	12.10.2011				[EN] RECYCLING SOLAR PANEL MODULE AND MANUFACTURE METHOD THEREOF	https://depatisnet.dpma.de/DepatisNet/depatisnet?action=pdf&docid=KR000101292052B1&xxxfull=1
CSI	Korea (South)	Korea (South)	KR000101207297B1	27.08.2010				[EN] METHOD FOR RECYCLING SILICON FROM WASTE SOLAR MODULE	https://depatisnet.dpma.de/DepatisNet/depatisnet?action=pdf&docid=KR000101207297B1&xxxfull=1
CSI	Italy	Italy	EP000002998038A1	16.09.2015	B09B 5/00, H01L 31/18	AGNOLETTI OLIMPIA, IT; ERCOLE PIETRO, IT; RAMON LODOVICO, IT	SASIL S P A, IT	[DE] VERFAHREN UND VORRICHTUNG ZUM LÖSEN VON GLAS VON EINER MONO- ODER POLYKRISTALLINEN SILICUMHALTIGEN PHOTOVOLTAIKTAFEL [EN] METHOD AND APPARATUS FOR DETACHING GLASS FORM A MONO- OR POLYCRYSTALLINE ...	https://depatisnet.dpma.de/DepatisNet/depatisnet?action=pdf&docid=EP000002998038A1&xxxfull=1
CSI	Korea (South)	Korea (South)	EP000002858125B1	30.09.2014	B32B 38/00, B32B 43/00, H01L 31/048	AHN YOUNG SOO, KR; JANG BO YUN, KR; KANG GI HWAN, KR; KIM JOON SOO, KR; LEE JIN SEOK, KR	KOREA INST ENERGY RES, KR	[DE] VERFAHREN ZUR DEMONTAGE EINES PHOTOVOLTAISCHEN MODULS [EN] METHOD FOR DISASSEMBLING PHOTOVOLTAIC MODULE [FR] PROCÉDÉ POUR DÉMONTER UN MODULE PHOTOVOLTAÏQUE	https://depatisnet.dpma.de/DepatisNet/depatisnet?action=pdf&docid=EP000002858125B1&xxxfull=1
CSI	Korea (South)	Korea (South)	KR000101842224B1	11.11.2016	H01L 31/18, B02C 7/02, H01L 31/042, B02C 7/17	AHN YOUNG SOO, KR; KANG GI HWAN, KR; LEE JIN SEOK, KR	KOREA INST ENERGY RES, KR	[EN] PARTIAL DISMANTLING DEVICE OF PHOTOVOLTAIC MODULE	https://depatisnet.dpma.de/DepatisNet/depatisnet?action=pdf&docid=KR000101842224B1&xxxfull=1
CSI	Korea (South)	Korea (South)	US020200247106A1	12.08.2019	H01L 31/18, H02S 40/34	AHN YOUNG SOO, KR; KANG GI HWAN, KR; LEE JIN SEOK, KR; LEE JUN KYU, KR	KOREA INST ENERGY RES, KR	[EN] DEVICE AND METHOD FOR DISASSEMBLING SOLAR CELL MODULE	https://depatisnet.dpma.de/DepatisNet/depatisnet?action=pdf&docid=US020200247106A1&xxxfull=1
CSI	Korea (South)	Korea (South)	KR000101698002B1	13.08.2015	C22B 15/00	AHN YOUNG SOO, KR; KANG GI HWAN, KR; LEE JIN SEOK, KR; LEE JUN KYU, KR	KOREA ENERGY RESEARCH INST, KR	[EN] Recycling Apparatus and Method of Photovoltaic Module Ribbon	https://depatisnet.dpma.de/DepatisNet/depatisnet?action=pdf&docid=KR000101698002B1&xxxfull=1
CSI	Korea (South)	Korea (South)	KR102022075761A	30.11.2020	B26D 3/06	AHN YOUNG SOO; KANG GI HWAN; LEE JIN SEOK; LEE JUN KYU	KOREA INST ENERGY RES, KR	[EN] APPARATUS AND METHOD FOR RECYCLING SOLAR CELL MODULE	https://depatisnet.dpma.de/DepatisNet/depatisnet?action=pdf&docid=KR102022075761A&xxxfull=1
CSI	Korea (South)	Korea (South)	KR102022013185A	24.07.2020	B03D 3/00, B02C 18/06, B07B 1/04	AHN YOUNG SOO; KANG GI HWAN; LEE JIN SEOK; LEE JUN KYU	KOREA INST ENERGY RES, KR	[EN] COMPONENT SEPARATION DEVICE AND METHOD FOR SOLAR MODULE RECYCLING	https://depatisnet.dpma.de/DepatisNet/depatisnet?action=pdf&docid=KR102022013185A&xxxfull=1
CSI	Korea (South)	United States of America	US020180133720A1	09.11.2017	B02C 23/10, B02C 4/02, B02C 23/38, B02C 25/00, H01L 31/18	AHN YOUNG-SOO, KR; KANG GI-HWAN, KR; LEE JIN-SEOK, KR	KOREA INST ENERGY RES, KR	[EN] PARTIAL DISMANTLING DEVICE OF PHOTOVOLTAIC MODULE	https://depatisnet.dpma.de/DepatisNet/depatisnet?action=pdf&docid=US020180133720A1&xxxfull=1
CSI	Korea (South)	China	CN000108067497A	13.11.2017	B09B 5/00, B02C 23/14, H01L 31/042	AHN YOUNG-SOO; KANG GI-HWAN; LEE JIN-SEOK	KOREA INST ENERGY RES	[EN] PARTIAL DISMANTLING DEVICE OF PHOTOVOLTAIC MODULE	https://depatisnet.dpma.de/DepatisNet/depatisnet?action=pdf&docid=CN000108067497A&xxxfull=1

Table A-2: PV Recycling Patents

PV Type	Country of Applicant	Country	Publication NO	Date	IPC-classes	Inventor	Applicant	Title	Document
CSI	Japan	Japan	JP002003142714A	07.11.2001	B09B 5/00, B09B 3/00	AMANO KOJI	TOKYO ELECTRIC POWER CO	[EN] METHOD AND DEVICE FOR SEPARATING ELEMENT OF SOLAR BATTERY MODULE AND METHOD FOR MANUFACTURING SOLAR BATTERY MODULE	https://depatisnet.dpma.de/DepatisNet/depatisnet?action=pdf&docid=JP002003142714A&xxxfull=1
CDTE	United States of America	United States of America	WO002011137268A1	29.04.2011	C25C 1/22, C22B 61/00, C22B 17/00, C22B 7/00, C22B 3/12	ANDRESEN PETER LOUIS, US; CAI WEI, CN; HUANG QUNJIAN, CN; SUN YONGWEI, CN; ZHANG CHENGQUIAN, CN; ZHANG JUNGANG, CN	ANDRESEN PETER LOUIS, US; CAI WEI, CN; GEN ELECTRIC, US; HUANG QUNJIAN, CN; SUN YONGWEI, CN; ZHANG CHENGQUIAN, CN; ZHANG JUNGANG, CN	[EN] METHOD FOR RECOVERING TELLURIUM FROM MODULE COMPRISING CADMIUM TELLURIDE [FR] PROCÉDÉ DE RÉCUPÉRATION DE TELLURE À PARTIR D'UN MODULE COMPRENANT DU TELLURURE DE CADMIUM	https://depatisnet.dpma.de/DepatisNet/depatisnet?action=pdf&docid=WO002011137268A1&xxxfull=1
CSI	United States of America	United States of America	US000006063995A	16.07.1998		ANISIMOV IGOR IVANOVICH, US; BOHLAND JOHN RAPHAEL, US	FIRST SOLAR LLC, US	[EN] Recycling silicon photovoltaic modules	https://depatisnet.dpma.de/DepatisNet/depatisnet?action=pdf&docid=US000006063995A&xxxfull=1
TF	United States of America	United States of America	US000006391165B1	17.05.2000	B01D 24/00, C22B 3/00, C22B 1/00, B02C 13/00	ANISIMOV IGOR IVANOVICH, US; BOHLAND JOHN RAPHAEL, US; DAPKUS TODD JAMES, US; KAMM KRISTIN DANIELLE, US; SASALA RICHARD ANTHONY, US; SMIGIELSKI KEN ALAN, US	FIRST SOLAR LLC, US	[EN] Reclaiming metallic material from an article comprising a non-metallic friable substrate	https://depatisnet.dpma.de/DepatisNet/depatisnet?action=pdf&docid=US000006391165B1&xxxfull=1
TF	United States of America	United States of America	US000006129779A	12.05.1998		ANISIMOV IGOR IVANOVICH, US; BOHLAND JOHN RAPHAEL, US; DAPKUS TODD JAMES, US; KAMM KRISTIN DANIELLE, US; SASALA RICHARD ANTHONY, US; SMIGIELSKI KEN ALAN, US	FIRST SOLAR LLC, US	[EN] Reclaiming metallic material from an article comprising a non-metallic friable substrate	https://depatisnet.dpma.de/DepatisNet/depatisnet?action=pdf&docid=US000006129779A&xxxfull=1
CSI	Korea (South)	Korea (South)	KR102021083123A	26.12.2019	H01L 31/18	AREUM PARK; GYECHOON PARK; YUNSU JUN	UNIV NAT MOKPO IND ACAD COOP GROUP, KR; WONKWANG ELEC CO, KR	[EN] SOLAR PANEL RECYCLING SYSTEM AND METHOD	https://depatisnet.dpma.de/DepatisNet/depatisnet?action=pdf&docid=KR102021083123A&xxxfull=1
CSI	France	United States of America	US020180257267A1	02.09.2016	B32B 43/00, C08J 11/06	AYMONIER CYRIL, FR; SLOSTOWSKI CÉDRIC, FR	CENTRE NAT RECH SCIENT, FR	[EN] METHOD AND DEVICE FOR DISMANTLING MULTILAYER SYSTEMS INCLUDING AT LEAST ONE ORGANIC COMPONENT	https://depatisnet.dpma.de/DepatisNet/depatisnet?action=pdf&docid=US020180257267A1&xxxfull=1
DSC	Korea (South)	Korea (South)	KR102013049983A	07.11.2011	H01L 31/18	BAE HO GI, KR; CHO JU YEOL, KR; YANG HWI CHAN, KR	DONGJIN SEMICHEM CO LTD, KR	[EN] METHOD FOR RECYCLING DYE OF DYE-SENSITIZED SOLAR CELL	https://depatisnet.dpma.de/DepatisNet/depatisnet?action=pdf&docid=KR102013049983A&xxxfull=1
DSC	Korea (South)	Korea (South)	WO002013069929A1	02.11.2012	H01L 31/18	BAE HO-GI, KR; CHO JU-YEOL, KR; YANG HWI-CHAN, KR	DONGJIN SEMICHEM CO LTD, KR	[EN] METHOD FOR RECYCLING DYE OF DYE-SENSITIZED SOLAR CELL MODULE [FR] PROCÉDÉ DE RECYCLAGE D'UN COLORANT D'UN MODULE DE PHOTOPILE À COLORANT	https://depatisnet.dpma.de/DepatisNet/depatisnet?action=pdf&docid=WO002013069929A1&xxxfull=1
CSI	Korea (South)	Korea (South)	KR000101939493B1	13.09.2017	H01L 31/0216, H01L 31/048, H01L 31/0445	BAE SOO HYUN, KR; KANG YOON MOOK, KR; KIM DONG HWAN, KR; KO JONG WON, KR; LEE JAE SEOK, KR; PARK HYO MIN, KR; PARK SE JIN, KR	UNIV KOREA RES & BUS FOUND, KR	[EN] Solar Cell Module Separation Method For Recycling	https://depatisnet.dpma.de/DepatisNet/depatisnet?action=pdf&docid=KR000101939493B1&xxxfull=1
CSI	Korea (South)	United States of America	US000011104116B2	18.02.2020	B32B 7/12, B32B 9/00, B32B 17/06, H01L 31/048	BAE SOOHYUN, KR; KANG YOON MOOK, KR; KIM DONGHWAN, KR; KO JONG WON, KR; LEE HAE-SEOK, KR; PARK HYOMIN, KR; PARK SE JIN, KR	UNIV KOREA RES & BUS FOUND, KR	[EN] Method for dismantling solar cell module for recycling	https://depatisnet.dpma.de/DepatisNet/depatisnet?action=pdf&docid=US000011104116B2&xxxfull=1
CSI	Korea (South)	United States of America	US020200180295A1	18.02.2020	B32B 9/00, B32B 7/12, H01L 31/048, B32B 17/06	BAE SOOHYUN, KR; KANG YOON MOOK, KR; KIM DONGHWAN, KR; KO JONG WON, KR; LEE HAE-SEOK, KR; PARK HYOMIN, KR; PARK SE JIN, KR	UNIV KOREA RES & BUS FOUND, KR	[EN] METHOD FOR DISMANTLING SOLAR CELL MODULE FOR RECYCLING	https://depatisnet.dpma.de/DepatisNet/depatisnet?action=pdf&docid=US020200180295A1&xxxfull=1
CSI	China	China	CN000110817882A	29.11.2019	C01B 33/037	BAI LIUYANG; FANG ZHENG; LI JIANGONG; WANG YINLING	UNIV HUANGHUAI	[EN] Method for preparing nano silicon powder by utilizing silicon recovered from waste photovoltaic modules	https://depatisnet.dpma.de/DepatisNet/depatisnet?action=pdf&docid=CN000110817882A&xxxfull=1
TF	United States of America	United States of America	US020220135442A1	22.02.2020		BAWENDI MOUNGI, US; BULOVIC VLADIMIR, US; MOODY NICOLE, US; SWARTWOUT RICHARD, US	MASSACHUSETTS INST TECHNOLOGY, US	[EN] THIN-FILMS FOR CAPTURING HEAVY METAL	https://depatisnet.dpma.de/DepatisNet/depatisnet?action=pdf&docid=US020220135442A1&xxxfull=1
CDTE	Germany	European Patent	EP000001187224B1	11.09.2000	C22B 17/02, C22B 11/00	BEIER JUTTA DR, DE; BONNET DIETER DR, DE; CAMPO MANUEL DIEGUEZ DR, DE; GEGENWART RAINER DR, DE	ANTEC SOLAR ENERGY AG, DE	[DE] Recycling-Verfahren für CdTe/CdS-Dünnschichtsolarzellenmodule [EN] Recycling method for CdTe/CdS thin film solar cell modules [FR] Méthode de recyclage pour modules de cellules solaires en couche ...	https://depatisnet.dpma.de/DepatisNet/depatisnet?action=pdf&docid=EP000001187224B1&xxxfull=1
CDTE	Germany	Czech Republic	CZ000000302626B6	07.09.2001	C22B 7/00, H01L 31/18, C22B 11/00	BEIER JUTTA, DE; BONNET DIETER, DE; CAMPO MANUEL DIEGUEZ, DE; GEGENWART RAINER, DE	ANTEC SOLAR GMBH, DE	[EN] Recycling process of solar cell modules, having CdTe/CdS thin film [XX] Zpusob recyklování modulu solárních clánku s tenkým filmem CdTe/CdS	
CDTE	Germany	United States of America	US000006572782B2	24.08.2001	C01B 9/02	BEIER JUTTA, DE; BONNET DIETER, DE; CAMPO MANUEL DIEQUEZ, DE; GEGENWART RAINER, DE	ANTEC SOLAR GMBH, DE	[EN] Process for recycling CdTe/Cds thin film solar cell modules	https://depatisnet.dpma.de/DepatisNet/depatisnet?action=pdf&docid=US000006572782B2&xxxfull=1

Table A-2: PV Recycling Patents

PV Type	Country of Applicant	Country	Publication NO	Date	IPC-classes	Inventor	Applicant	Title	Document
CDTE	Germany	United States of America	US020020030035A1	24.08.2001		BEIER JUTTA, DE; BONNET DIETER, DE; DIEGUEZ MANUEL, DE; GEGENWART RAINER, DE	BEIER JUTTA; BONNET DIETER; DIEGUEZ MANUEL; GEGENWART RAINER	[EN] Process for recycling CdTe/Cds thin film solar cell modules	https://depatisnet.dpma.de/DepatisNet/depatisnet?action=pdf&docid=US020020030035A1&xxxfull=1
TF	Germany	Germany	DE102013006363A1	12.04.2013	H01L 21/66	Bell, Guido, Dr., 83080, Oberaudorf, DE	Bell, Guido, Dr., 83080, Oberaudorf, DE	[DE] Sensorik für die Unterscheidung von Dünnfilm-Solarmodulen	https://depatisnet.dpma.de/DepatisNet/depatisnet?action=pdf&docid=DE102013006363A1&xxxfull=1
CSI	United States of America	United States of America	US020210159134A1	20.11.2020	C03C 23/00, C03C 21/00, H01L 23/00, C03C 15/00	BELLMAN ROBERT ALAN, US; DUTTA INDRAJIT, US; HSIEH YI-CHENG, US; ONO TOSHIHIKO, US; SMITH NICHOLAS JAMES, US	CORNING INC, US	[EN] RECYCLED GLASS AND GLASS-CERAMIC CARRIER SUSTRATES	https://depatisnet.dpma.de/DepatisNet/depatisnet?action=pdf&docid=US020210159134A1&xxxfull=1
CSI	United States of America	United States of America	WO002021102106A1	19.11.2020	H01L 21/02	BELLMAN ROBERT ALAN, US; DUTTA INDRAJIT, US; HSIEH YI-CHENG, US; ONO TOSHIHIKO, US; SMITH NICHOLAS JAMES, US	CORNING INC, US	[EN] RECYCLED GLASS AND GLASS-CERAMIC CARRIER SUSTRATES [FR] SUBSTRATS DE SUPPORT EN VITROCÉRAMIQUE ET VERRE RECYCLÉS	https://depatisnet.dpma.de/DepatisNet/depatisnet?action=pdf&docid=WO002021102106A1&xxxfull=1
CSI	Germany	Germany	DE102013112004B4	31.10.2013	C01B 33/039, B09B 5/00, B03B 9/06, H01L 21/306	Boger, Thomas, 75417, Mühlacker, DE; Weeber, Peter, 75417, Mühlacker, DE	variata Dorit Lang GmbH & Co. KG, 75417, Mühlacker, DE	[DE] Recycling von Photovoltaikmodulen und/oder Solarmodulen	https://depatisnet.dpma.de/DepatisNet/depatisnet?action=pdf&docid=DE102013112004B4&xxxfull=1
CSI	United States of America	United States of America	US020110186779A1	13.08.2009	C09K 11/66, C01G 11/02, C01B 33/02, C01B 19/04, C01B 19/02, B22F 1/00	BOHLAND JOHN, US; WADE ANDREAS, DE	BOHLAND JOHN; WADE ANDREAS	[EN] PHOTOVOLTAIC MODULE RECYCLING	https://depatisnet.dpma.de/DepatisNet/depatisnet?action=pdf&docid=US020110186779A1&xxxfull=1
CSI	United States of America	United States of America	WO002010019767A1	13.08.2009		BOHLAND JOHN, US; WADE ANDREAS, DE	BOHLAND JOHN, US; CALYXO GMBH, DE; WADE ANDREAS, DE	[EN] PHOTOVOLTAIC MODULE RECYCLING [FR] RECYCLAGE DE MODULES PHOTOVOLTAÏQUES	https://depatisnet.dpma.de/DepatisNet/depatisnet?action=pdf&docid=WO002010019767A1&xxxfull=1
CSI	Belgium	European Patent	EP000003323150A1	01.07.2016		BOSCHINI FRÉDÉRIC, BE; CLOOTS RUDI, BE; SCHRIJNEMAKERS AUDREY, BE	UNIV LIEGE, BE	[DE] VERFAHREN ZUR WIEDERVERWERTUNG FOTOVOLTAISCHER SOLARZELLENMODULE [EN] METHOD FOR RECYCLING PHOTOVOLTAIC SOLAR CELLS MODULE. [FR] PROCÉDÉ DE RECYCLAGE DE MODULE DE CELLULES SOLAIRES PHOTOVOLTAÏQUES	https://depatisnet.dpma.de/DepatisNet/depatisnet?action=pdf&docid=EP000003323150A1&xxxfull=1
CSI	Belgium	United States of America	US020180315884A1	01.07.2016	B32B 43/00	BOSCHINI FRÉDÉRIC, BE; CLOOTS RUDI, BE; SCHRIJNEMAKERS AUDREY, BE	UNIV LIEGE, BE	[EN] METHOD FOR RECYCLING PHOTOVOLTAIC SOLAR CELLS MODULE	https://depatisnet.dpma.de/DepatisNet/depatisnet?action=pdf&docid=US020180315884A1&xxxfull=1
CSI	Belgium	Belgium	WO002017009062A1	01.07.2016		BOSCHINI FRÉDÉRIC, BE; CLOOTS RUDI, BE; SCHRIJNEMAKERS AUDREY, BE	UNIV LIEGE, BE	[EN] METHOD FOR RECYCLING PHOTOVOLTAIC SOLAR CELLS MODULE. [FR] PROCÉDÉ DE RECYCLAGE DE MODULE DE CELLULES SOLAIRES PHOTOVOLTAÏQUES	https://depatisnet.dpma.de/DepatisNet/depatisnet?action=pdf&docid=WO002017009062A1&xxxfull=1
CSI	Belgium	European Patent	EP000003118902A1	15.07.2015		BOSCHINI FRÉDÉRIC, BE; CLOOTS RUDI, BE; SCHRIJNEMAKERS AUDREY, BE	UNIVERSITÉ DE LIÈGE, BE	[DE] VERFAHREN ZUR WIEDERVERWERTUNG FOTOVOLTAISCHER SOLARZELLENMODULE [EN] METHOD FOR RECYCLING PHOTOVOLTAIC SOLAR CELLS MODULE [FR] PROCÉDÉ DE RECYCLAGE DE MODULE À CELLULES SOLAIRES PHOTOVOLTAÏQUES	https://depatisnet.dpma.de/DepatisNet/depatisnet?action=pdf&docid=EP000003118902A1&xxxfull=1
CSI	Belgium	China	CN000107912070A	01.07.2016		BOSCHINI FREDERIC; CLOOTS RUDI; SCHRIJNEMAKERS AUDREY	UNIV LIEGE	[EN] Method For Recycling Photovoltaic Solar Cells Module.	https://depatisnet.dpma.de/DepatisNet/depatisnet?action=pdf&docid=CN000107912070A&xxxfull=1
CSI	France	United States of America	US000008449747B2	25.06.2008		BOULANGER CLOTILDE, FR; DILIBERTO SEBASTIEN, FR; LECLERC NATHALIE, FR; LECUIRE JEAN-MARIE, FR; SEGHIR SAKINA, FR	BOULANGER CLOTILDE, FR; CENTRE NAT RECH SCIENT, FR; DILIBERTO SEBASTIEN, FR; LECLERC NATHALIE, FR; LECUIRE JEAN-MARIE, FR; SEGHIR SAKINA, FR; UNIV LORRAINE, FR	[EN] Method and device for selective cation extraction by electrochemical transfer in solution and applications of said method	https://depatisnet.dpma.de/DepatisNet/depatisnet?action=pdf&docid=US000008449747B2&xxxfull=1
CSI	France	United States of America	US020100252442A1	25.06.2008	C25B 9/10	BOULANGER CLOTILDE, FR; DILIBERTO SEBASTIEN, FR; LECLERC NATHALIE, FR; LECUIRE JEAN-MARIE, FR; SEGHIR SAKINA, FR	CT NAT DE LA RECH SCENTIFIQUE, FR; UNIV PAUL VERLAINE, FR	[EN] METHOD AND DEVICE FOR SELECTIVE CATION EXTRACTION BY ELECTROCHEMICAL TRANSFER IN SOLUTION AND APPLICATIONS OF SAID METHOD	https://depatisnet.dpma.de/DepatisNet/depatisnet?action=pdf&docid=US020100252442A1&xxxfull=1
CSI	United States of America	United States of America	WO002022147522A1	04.01.2022	B09B 3/60, B09B 3/70, B09B 3/80, B09B 5/00, B09B 3/40	BRANDHORST JR, US; ENGEL ULLRICH H, US; LUDWIG CHARLES T, US; ZAVORAL SR, US	CHZ TECH LLC, US	[EN] SYSTEMS AND PROCESS FOR SOLAR PANEL RECYCLING [FR] SYSTÈMES ET PROCÉDÉ DE RECYCLAGE DE PANNEAUX SOLAIRES	https://depatisnet.dpma.de/DepatisNet/depatisnet?action=pdf&docid=WO002022147522A1&xxxfull=1
CSI	United States of America	United States of America	US000008202411B2	19.03.2008	C25C 1/12, C25C 1/08, C25C 1/02, C25C 1/06, C25C 7/02, C25C 1/14, C25C 1/20, C25C 1/18, C25C 1/00, C25C 1/10, C25C 1/16, C25C 1/22	BUSCHMANN WAYNE E, US	BUSCHMANN WAYNE E, US; ELTRON RES & DEV INC, US	[EN] Electrowinning apparatus and process	https://depatisnet.dpma.de/DepatisNet/depatisnet?action=pdf&docid=US000008202411B2&xxxfull=1

Table A-2: PV Recycling Patents

PV Type	Country of Applicant	Country	Publication NO	Date	IPC-classes	Inventor	Applicant	Title	Document
CSI	Germany	Germany	DE000004006738A1	03.03.1990		Büttner, Anton, 7917 Vöhringen, DE	Büttner, Anton, 7917 Vöhringen, DE	[DE] Wiederverwertung (Recycling) von gebrauchten Autoscheiben [EN] Recycling window glass from scrapped vehicles - involves using glass to make solar panels sandwiched between two identical panes	https://depatisnet.dpma.de/DepatisNet/depatisnet?action=pdf&docid=DE000004006738A1&xxxfull=1
CSI	China	China	CN000110538862A	26.09.2019	B09B 5/00, H01L 31/18	CAI XIA; CAO HAIBO; CHEN CHENGJIN; JIANG JIANHUI; KE PO; LU WENHUA; NI ZHICHUN; WU ZHEN; YU CHANG	SUZHOU TALESUN SOLAR TECH CO LTD	[EN] Waste photovoltaic module recycling device and recycling method thereof	https://depatisnet.dpma.de/DepatisNet/depatisnet?action=pdf&docid=CN000110538862A&xxxfull=1
CSI	China	China	CN000110639933A	26.09.2019		CAI XIA; CAO HAIBO; CHEN CHENGJIN; JIANG JIANHUI; KE PO; LU WENHUA; NI ZHICHUN; WU ZHEN; YU CHANG	SUZHOU TALESUN SOLAR TECH CO LTD	[EN] Method and device for recycling waste photovoltaic modules	https://depatisnet.dpma.de/DepatisNet/depatisnet?action=pdf&docid=CN000110639933A&xxxfull=1
CSI	Italy	European Patent	EP000003989296A1	13.10.2021	H01L 31/048	CERCHIER PIETROGIOVANNI, IT; NISATO FRANCESCO, IT; PEZZATO LUCA, IT; TASSINATO GRAZIANO, IT	9 TECH S R L, IT; VENEZIANA ENERGIA RISORSE IDRICHE TERRITORIO AMBIENTE SERVIZI V E R I T A S S P A, IT	[DE] VERFAHREN, ANLAGE UND VORRICHTUNG ZUM RECYCLING VON PHOTOVOLTAISCHEN PANEELEN [EN] METHOD, PLANT AND APPARATUS FOR RECYCLING PHOTOVOLTAIC PANELS [FR] MÉTHODE, INSTALLATION ET APPAREIL POUR LE ...	https://depatisnet.dpma.de/DepatisNet/depatisnet?action=pdf&docid=EP000003989296A1&xxxfull=1
CSI	Italy	European Patent	EP000003993067A1	13.10.2021		CERCHIER PIETROGIOVANNI, IT; NISATO FRANCESCO, IT; PEZZATO LUCA, IT; TASSINATO GRAZIANO, IT	9 TECH S R L, IT; VENEZIANA ENERGIA RISORSE IDRICHE TERRITORIO AMBIENTE SERVIZI V E R I T A S S P A, IT	[DE] VERFAHREN, ANLAGE UND VORRICHTUNG ZUM RECYCLING VON PHOTOVOLTAISCHEN PANEELEN, MIT EINER THERMISCHEN BEHANDLUNG [EN] METHOD, PLANT AND APPARATUS FOR RECYCLING PHOTOVOLTAIC PANELS, COMPRISING IMPLEMENTATION ...	https://depatisnet.dpma.de/DepatisNet/depatisnet?action=pdf&docid=EP000003993067A1&xxxfull=1
CSI	Italy	Italy	WO002019087111A1	31.10.2018	H01L 31/18	CERCHIER PIETROGIOVANNI, IT; ZAMBON ANDREA, IT	UNIV DEGLI STUDI PADOVA, IT	[EN] METHOD AND PLANT FOR RECYCLING PHOTOVOLTAIC PANELS [FR] PROCÉDÉ ET INSTALLATION POUR RECYCLAGE DE PANNEAUX PHOTOVOLTAÏQUES	https://depatisnet.dpma.de/DepatisNet/depatisnet?action=pdf&docid=WO002019087111A1&xxxfull=1
CSI	Mexico	Mexico	MX002014015832A	18.12.2014	F24J 2/38	CHAIT NATAN CORNEJO, MX	INTEPPCO S A DE C V, MX	[EN] AUTOMATED SYSTEM WITH THE USE OF RENEWABLE ENERGIES FOR THE PRODUCTION OF ECOLOGICAL AND SUSTAINABLE SUBSTITUTES FROM RAW MATERIALS BASED ON RECYCLED GLASS AND PROCESS THEREOF. [XX] SISTEMA AUTOMATIZADO ...	
CSI	Taiwan, Republic of China	European Patent	EP000003385048A1	04.04.2018		CHAN KONG-SANG JACKIE, TW; CHANG YA-TING, TW; CHANG YI-CHUN, TW; HSIEH CHIA-CHUN, TW; HSIEH TIAN-JIA, TW; HUANG CHIAN-CHI, TW; LIU TZU-WEI, TW; MUTTINI ENZO-LOUIS, TW	MINIWIZ CO LTD, TW	[DE] MOBILES KUNSTSTOFFRECYCLINGSYSTEM UND VERFAHREN ZU DESSEN VERWENDUNG [EN] MOBILE PLASTIC RECYCLING SYSTEM AND RECYCLING METHOD USING THE SAME [FR] SYSTÈME MOBILE DE RECYCLAGE DE PLASTIQUE ET ...	https://depatisnet.dpma.de/DepatisNet/depatisnet?action=pdf&docid=EP000003385048A1&xxxfull=1
CSI	Taiwan, Republic of China	European Patent	EP000003385048B1	04.04.2018		CHAN KONG-SANG JACKIE, TW; CHANG YA-TING, TW; CHANG YI-CHUN, TW; HSIEH CHIA-CHUN, TW; HSIEH TIAN-JIA, TW; HUANG CHIAN-CHI, TW; LIU TZU-WEI, TW; MUTTINI ENZO-LOUIS, TW	MINIWIZ CO LTD, TW	[DE] MOBILES KUNSTSTOFFRECYCLINGSYSTEM UND VERFAHREN ZU DESSEN VERWENDUNG [EN] MOBILE PLASTIC RECYCLING SYSTEM AND RECYCLING METHOD USING THE SAME [FR] SYSTÈME MOBILE DE RECYCLAGE DE PLASTIQUE ET ...	https://depatisnet.dpma.de/DepatisNet/depatisnet?action=pdf&docid=EP000003385048B1&xxxfull=1
PO	Taiwan, Republic of China	United States of America	US020180290340A1	06.04.2017	B29B 17/02, B29C 39/02, B29C 39/38, B29B 13/00	CHAN KONG-SANG JACKIE, TW; CHANG YA-TING, TW; CHANG YI-CHUN, TW; HSIEH CHIA-CHUN, TW; HSIEH TIAN-JIA, TW; HUANG CHIAN-CHI, TW; LIU TZU-WEI, TW; MUTTINI ENZO-LOUIS, TW	MINIWIZ CO LTD, TW	[EN] MOBILE PLASTIC RECYCLING SYSTEM AND RECYCLING METHOD USING THE SAME	https://depatisnet.dpma.de/DepatisNet/depatisnet?action=pdf&docid=US020180290340A1&xxxfull=1
CSI	China	China	CN000102544239A	07.03.2012		CHAO HOU; HAILIANG ZHOU; SHAOXI HE; SHIYUAN WANG; ZHANYOU WANG	YINGLI GROUP LTD	[EN] Method and device for decomposing and recycling photovoltaic component	https://depatisnet.dpma.de/DepatisNet/depatisnet?action=pdf&docid=CN000102544239A&xxxfull=1
CSI	Taiwan, Republic of China	Taiwan, Republic of China	TW00000M549454U	10.03.2017	B01D 33/06, H01L 31/18	CHEN BO-JUN, TW	JATA TECH CO LTD, TW	[EN] Centrifugal slurry filtering and recycling equipment for solar panel printing slurry and recycling adhesive filtering can	
CSI	Taiwan, Republic of China	Taiwan, Republic of China	TW000202015821A	19.10.2018		CHEN DENG-YAO, TW; FU YAO-XIAN, TW; HONG JIA-CONG, TW; LIN SHI-REN, TW; LIU ZHEN-CHENG, TW; YE SHU-FEN, TW	NATIONAL UNIV OF TAINAN, TW	[EN] Recycling method of solar cell module capable of obtaining more complete adhesive layers to be beneficial for following recycling and reuse	
CSI	Taiwan, Republic of China	Taiwan, Republic of China	TW000202015822A	19.10.2018	B09B 5/00, H02S 99/00	CHEN DENG-YAO, TW; FU YAO-XIAN, TW; HONG JIA-CONG, TW; LIN SHI-REN, TW; LIU ZHEN-CHENG, TW; YE SHU-FEN, TW	NATIONAL UNIV OF TAINAN, TW	[EN] Method for recycling solar cell modules wherein the solar cell module includes a solar cell panel, a light-transmissive cover plate, a back plate, and two laminate layers	

Table A-2: PV Recycling Patents

PV Type	Country of Applicant	Country	Publication NO	Date	IPC-classes	Inventor	Applicant	Title	Document
CSI	Taiwan, Republic of China	Taiwan, Republic of China	TW000202017200A	19.10.2018	B09B 3/00, E04D 13/18	CHEN DENG-YAO, TW; FU YAO-XIAN, TW; HONG JIA-CONG, TW; LIN SHI-REN, TW; LIU ZHEN-CHENG, TW; YE SHU-FEN, TW	NATIONAL UNIV OF TAINAN, TW	[EN] Method for recycling solar cell module which can separate the glue layers from the back panel, the glass plate and the solar cell panel by reducing the viscosity between different materials under ...	
CSI	Taiwan, Republic of China	Taiwan, Republic of China	TW000202015823A	30.10.2018		CHEN DI-YUN, TW; ZHENG XIAN-ZHANG, TW	CHEN DI-YUN, TW; ZHENG XIAN-ZHANG, TW	[EN] Punching method suitable for recycling a tempered glass of a solar photovoltaic module	
CSI	Taiwan, Republic of China	Taiwan, Republic of China	TW00000M550668U	24.07.2017	E04D 13/18	CHEN DI-YUN, TW; ZHENG XIAN-ZHANG, TW	CHEN DI-YUN, TW; ZHENG XIAN-ZHANG, TW	[EN] Solar photovoltaic module recycling equipment	
CSI	China	China	CN000105750297A	22.02.2016	B09B 5/00	CHEN HUAIZHI; HU GUOBO; NIE HAITAO; WANG GANG; ZHANG RENYOU	CHENGDU ZHENZHONG ELECTRIC CO	[EN] Solar cell panel recycling device	https://depatisnet.dpma.de/DepatisNet/depatisnet?action=pdf&docid=CN000105750297A&xxxfull=1
CSI	United States of America	United States of America	US020220048012A1	13.08.2021	B01J 21/04, C10G 1/10, C10G 1/04, B01J 21/06, B01J 21/16, B01J 23/04, C10B 57/06, B01J 29/072, B01J 35/00, C10B 3/02, C10B 7/00, C10B 27/06, C10B 53/00, B01J 23/745	CHEN HUANG-CHUAN, TW; CHEN KUAN-HSIN, TW; CHEN KUAN-TA, TW; CHEN KUAN-YU, TW; HUANG CHIEN-FA, TW; WANG YI-YU, TW	CHEN KUAN HSIN, TW; CHEN KUAN TA, TW; CHEN KUAN YU, TW; HUANG CHIEN FA, TW	[EN] CATALYST, PYROLYSIS DEVICE AND PYROLYSIS METHOD	https://depatisnet.dpma.de/DepatisNet/depatisnet?action=pdf&docid=US020220048012A1&xxxfull=1
CSI	China	China	CN000209322513U	13.12.2018		CHEN JIE	HANGZHOU BOYANG SOLAR ENERGY TECH CO LTD	[EN] Solar cell panel processing waste liquid recycling system	https://depatisnet.dpma.de/DepatisNet/depatisnet?action=pdf&docid=CN000209322513U&xxxfull=1
CSI	China	China	CN000112133791A	27.09.2020	H01L 21/67	CHEN KETONG; HU KAI; LI LEI; SUN XIAOYU; TU JIELEI; YU SHOUZHE; ZHANG WEINAN	UNIV YUNNAN	[EN] Method for recycling photovoltaic module	https://depatisnet.dpma.de/DepatisNet/depatisnet?action=pdf&docid=CN000112133791A&xxxfull=1
CSI	China	China	CN000108262332A	02.01.2018	B09B 5/00, B29C 47/92	CHEN KUN	ZHONGTIAN PHOTOVOLTAIC MAT CO LTD	[EN] Pollution-free recycling method for photovoltaic module	https://depatisnet.dpma.de/DepatisNet/depatisnet?action=pdf&docid=CN000108262332A&xxxfull=1
CSI	Taiwan, Republic of China	China	CN000107425094A	07.06.2017	H01L 31/049	CHEN KUN; LIAO JIE; LIU XIANG'AN; MAO YI; SUN WANNAN; WANG QIANG; WANG TONGXIN; WANG YANNING; YAO YUANYI	ZHONGTIAN PHOTOVOLTAIC MAT CO LTD	[EN] Harmless processing method of insulation backboard for scrapped crystalline silicon photovoltaic module	https://depatisnet.dpma.de/DepatisNet/depatisnet?action=pdf&docid=CN000107425094A&xxxfull=1
CSI	China	China	CN000213102329U	13.08.2020	B02C 23/00	CHEN LONGBAO	ZHANGPU MINGNENG PHOTOELECTRIC TECH CO LTD	[EN] Waste treatment device for solar photovoltaic panel production	https://depatisnet.dpma.de/DepatisNet/depatisnet?action=pdf&docid=CN000213102329U&xxxfull=1
CSI	China	China	CN000109530394A	19.11.2018	B09B 5/00	CHEN LU; LI DUNXIN; LI YIJUN; LI YISHENG; LIU DEFENG; WANG YING	YINGKOU JINCHEN MACHINERY CO LTD	[EN] TPT backboard, EVA/ battery piece and glass disassembly and recovery method and device	https://depatisnet.dpma.de/DepatisNet/depatisnet?action=pdf&docid=CN000109530394A&xxxfull=1
PO	China	China	CN000114248369A	16.05.2017	H01L 31/049, B29B 17/04, B29B 17/02	CHEN MEIXIANG; LUO SHUIYUAN; QU BO; TAK DONG-HYUN; ZENG GE	QUANZHOU TEACHING UNIV	[EN] Recycling method of solar backboard material	https://depatisnet.dpma.de/DepatisNet/depatisnet?action=pdf&docid=CN000114248369A&xxxfull=1
CSI	China	China	CN000212442508U	09.05.2020	B26D 7/06, B26F 3/12	CHEN RUIBIN; DUAN CHUNYAN; LIN CANHUI; LIU JIAPING; OUYANG PING; TAN JIANBIN; ZHANG WENCHAO	FOSHAN POLYTECHNIC	[EN] Photovoltaic module disassembling and recycling system	https://depatisnet.dpma.de/DepatisNet/depatisnet?action=pdf&docid=CN000212442508U&xxxfull=1
PO	China	China	CN000114012936A	10.11.2021	B29B 17/04	CHEN SHAOYUN; QU BO; WANG RUI; ZHUO DONGXIAN	UNIV QUANZHOU NORMAL	[EN] Method for separating and recycling leftover materials of composite EVA (Ethylene Vinyl Acetate) adhesive film of solar back panel based on low-temperature grinding method	https://depatisnet.dpma.de/DepatisNet/depatisnet?action=pdf&docid=CN000114012936A&xxxfull=1
CIGS	Taiwan, Republic of China	United States of America	US000011374144B2	23.10.2020	H01L 31/0224, H01L 31/032, H01L 31/0445, B09B 3/80, B32B 43/00, C01G 3/02, C01G 15/00	CHEN WEI-SHENG, TW; CHENG TZU-MING, TW; CHUEH YU-LUN, TW; LAI CHIH-HUANG, TW; LIU FAN-WEI, TW	UNIV NAT TSING HUA, TW	[EN] Method for recovering resource from CIGS thin-film solar cell	https://depatisnet.dpma.de/DepatisNet/depatisnet?action=pdf&docid=US000011374144B2&xxxfull=1
CIGS	Taiwan, Republic of China	United States of America	US020220052220A1	23.10.2020	H01L 31/0445, B09B 3/00, H01L 31/032, H01L 31/0224, C01G 15/00, C01G 3/02, B32B 43/00	CHEN WEI-SHENG, TW; CHENG TZU-MING, TW; CHUEH YU-LUN, TW; LAI CHIH-HUANG, TW; LIU FAN-WEI, TW	UNIV NAT TSING HUA, TW	[EN] METHOD FOR RECOVERING RESOURCE FROM CIGS THIN-FILM SOLAR CELL	https://depatisnet.dpma.de/DepatisNet/depatisnet?action=pdf&docid=US020220052220A1&xxxfull=1
CSI	China	China	CN000110491969A	12.08.2019	B09B 3/00	CHEN YAN; DU JUAN; LEI MINGYU; LI DEYIN; LU GANG; MA JICHAO; MA YUNFENG; YANG ZHENYING; YANG ZIQI; ZHANG GUO; ZHENG LU	PHOTOVOLTAIC INDUSTRY TECH BRANCH OF QINGHAI HUANGHE HYDROPOWER DEVELOPMENT CO LTD	[EN] Crystalline silicon photovoltaic module recovery method and device	https://depatisnet.dpma.de/DepatisNet/depatisnet?action=pdf&docid=CN000110491969A&xxxfull=1

Table A-2: PV Recycling Patents

PV Type	Country of Applicant	Country	Publication NO	Date	IPC-classes	Inventor	Applicant	Title	Document
CSI	China	China	CN000210296400U	12.08.2019	B09B 3/00	CHEN YAN; DU JUAN; LEI MINGYU; LI DEYIN; LU GANG; MA JICHAO; MA YUNFENG; YANG ZHENYING; YANG ZIQI; ZHANG GUO; ZHENG LU	PHOTOVOLTAIC INDUSTRY TECH BRANCH OF QINGHAI HUANGHE HYDROPOWER DEVELOPMENT CO LTD	[EN] Recovery device of crystalline silicon photovoltaic module	https://depatisnet.dpma.de/DepatisNet/depatisnet?action=pdf&docid=CN000210296400U&xxxfull=1
CSI	China	China	CN000113732013A	27.08.2021	B01J 19/12, B09B 5/00, H01M 4/36, H01M 10/0525, H01M 4/62, H01M 4/583, H01M 4/38	CHEN ZHENGJIE; LI SHAOYUAN; LIAO QIJUN; MA WENHUI; WEI KUIXIAN; WU DANDAN; XI FENGSHUO	UNIV KUNMING SCIENCE & TECH	[EN] Microwave catalytic treatment method for waste photovoltaic module and silicon-carbon composite material obtained by microwave catalytic treatment method	https://depatisnet.dpma.de/DepatisNet/depatisnet?action=pdf&docid=CN000113732013A&xxxfull=1
CSI	Taiwan, Republic of China	Taiwan, Republic of China	TW000202108255A	21.08.2019	B09B 5/00, H02S 99/00	CHEN ZHI-BIN, TW; HONG JIA-CONG, TW; HUANG SHI-MING, TW; LIN SHI-REN, TW	ACON GREENERGY TECHNOLOGY CO LTD, TW; ACON HOLDING INC, TW	[EN] Solar cell module recycling method breaks and decomposes interface molecule bonding of gluing layer between back plate and cover plate so as to reduce stickiness	
CSI	China	China	CN000110571306A	12.09.2019	B09B 5/00, B09B 3/00, H01L 31/20	CHEN ZHIJUN; DONG GUOYI; LAI WEIDONG; LI XINJUAN; LI YINGYE; LIU YING; MA CHAO; WU CUIGU; WU MENGMENG; YUAN BEIHAI	PHOENIX VALLEY ZERO CARBON DEVELOPMENT RES INSTITUTE HEBEI PROVINCE; YINGLI SOLAR CHINA CO LTD	[EN] Photovoltaic module recycling method and system	https://depatisnet.dpma.de/DepatisNet/depatisnet?action=pdf&docid=CN000110571306A&xxxfull=1
CSI	China	China	CN000102654927A	10.05.2012		CHENYU CAI; JING BI; JIWEN GAO; KELIN SHEN; YANG GAO; YU CAO	UNIV SHANGHAI DIANJI	[EN] Solar-powered device for paid recycling of waste cells	https://depatisnet.dpma.de/DepatisNet/depatisnet?action=pdf&docid=CN000102654927A&xxxfull=1
CSI	Korea (South)	Korea (South)	KR102020100298A	18.02.2019	B02C 17/18, C01B 21/068	CHO JAE SUNG; JIN HYUN JU; KIM BO HOON, KR; KIM SOO	SBREM CO LTD, KR	[EN] RECYCLING PROCESS OF WASTE PHOTOVOLTAIC MODULE	https://depatisnet.dpma.de/DepatisNet/depatisnet?action=pdf&docid=KR102020100298A&xxxfull=1
CSI	Korea (South)	Korea (South)	KR102020132236A	16.05.2019	H01L 31/18	CHO JAI YOUNG; LEE JAE KYUNG; PARK A REUM	KOREA ELECTRIC POWER CORP, KR; WONKWANG ELEC CO, KR	[EN] RECYCLING SYSTEM OF SOLAR CELL MODULE AND RECYCLING METHOD OF SOLAR CELL USING THE SAME	https://depatisnet.dpma.de/DepatisNet/depatisnet?action=pdf&docid=KR102020132236A&xxxfull=1
CSI	Korea (South)	Korea (South)	WO002020197231A1	24.03.2020	H01L 31/18	CHO SANGHO, KR; KIM HYONSOO, KR; KIM YOUNGKOOK, KR	NAT UNIV CHONBUK IND COOP FOUND, KR	[EN] SOLAR PANEL RECYCLING APPARATUS AND METHOD [FR] APPAREIL ET PROCÉDÉ DE RECYCLAGE DE PANNEAU SOLAIRE	https://depatisnet.dpma.de/DepatisNet/depatisnet?action=pdf&docid=WO002020197231A1&xxxfull=1
CSI	Korea (South)	Korea (South)	KR000102091346B1	25.03.2019	H01L 31/18	CHO SANGHO; KIM HYON SOO; KIM YOUNG KOOK	NAT UNIV CHONBUK IND COOP FOUND, KR	[EN] Apparatus for recycling Solar panel and method thereof	https://depatisnet.dpma.de/DepatisNet/depatisnet?action=pdf&docid=KR000102091346B1&xxxfull=1
CSI	Korea (South)	Korea (South)	KR102014038829A	21.09.2012	B01D 15/04	CHO YI SAK, KR; EYU JI CHEOL, KR; HAN BYEONG HYEON, KR; KIM MYOUNG SUK, KR; LEE EUL GYU, KR; PAEK A RONG, KR; SEOL TAE JOON, KR; SUN WOO HWAN, KR	JEONG YOUNG CO LTD, KR	[EN] ON-SITE RECYCLING METHOD AND APPARATUS FOR THE HIGH EFFICIENT RECOVERY OF WASTE GENERATION FROM GLASS ETCHING PROCESS AND RECYCLING LIQUID USING THEREOF AND METHOD FOR TREATING SLUDGE	https://depatisnet.dpma.de/DepatisNet/depatisnet?action=pdf&docid=KR102014038829A&xxxfull=1
CSI	Korea (South)	Korea (South)	KR102020128944A	07.05.2019	H01L 31/18, H01L 31/042, B09B 5/00	CHOE JE HAK, KR	CHOE JE HAK, KR	[EN] method of taking to pieces of solar cell module and apparatus for taking to pieces of solar cell module	https://depatisnet.dpma.de/DepatisNet/depatisnet?action=pdf&docid=KR102020128944A&xxxfull=1
CSI	Korea (South)	Korea (South)	KR000101747912B1	16.01.2017	H01L 31/18, H01L 31/036	CHUNG IN SUNG, KR; CHUNG YOUNG CHUL, KR; JUNG YOUNG DOO, KR; KIM SUNG HYUN, KR; YOO KWANG YONG, KR	PRETECH CO LTD, KR	[EN] CRYSTALLINE SILICON UNUSABLE SOLAR MODULE RECYCLING PROCESS METHOD AND SINGLE SYSTEM FOR PERFORMING THE SAME	https://depatisnet.dpma.de/DepatisNet/depatisnet?action=pdf&docid=KR000101747912B1&xxxfull=1
CSI	China	China	WO002014026237A1	16.08.2013	B29B 17/02, B02C 19/00, B02C 25/00, B26F 1/26, B26F 3/00, B29B 17/04	COOKE PHILIP ANDREW, AU	MADDISON MORGAN & BAILEY LTD, CN	[EN] A METHOD FOR PROCESSING A USED MATTRESS, A METHOD FOR COMPRESSING A USED MATTRESS, COMPRESSION APPARATUS FOR COMPRESSING A USED MATTRESS, DECONSTRUCTION APPARATUS FOR DECONSTRUCTING A MATTRESS, ...	https://depatisnet.dpma.de/DepatisNet/depatisnet?action=pdf&docid=WO002014026237A1&xxxfull=1
CSI	France	United States of America	US020200198316A1	28.08.2018	H01L 31/18, H01L 31/048, B26D 3/28, B26D 1/547, B26D 1/00, H02S 40/20	COUSTIER FABRICE, FR; MESSAOUDI PAUL, FR; SERASSET MARION, FR; VELET NICOLAS, FR	COMMISSARIAT ENERGIE ATOMIQUE, FR	[EN] METHOD FOR DISASSEMBLING A PHOTOVOLTAIC MODULE AND ASSOCIATED INSTALLATION	https://depatisnet.dpma.de/DepatisNet/depatisnet?action=pdf&docid=US020200198316A1&xxxfull=1
CSI	France	European Patent	EP000003808862A1	18.10.2019	C22B 7/00, C22B 4/08, H05H 1/00	CRAMER JONATHAN, FR; MORVAN DANIEL, FR; PRIMA FRÉDÉRIC, FR; ROUSSEAU FRÉDÉRIC, FR	CENTRE NAT RECH SCIENT, FR; ECOLE NAT SUPERIEURE DE CHIMIE DE PARIS, FR; PARIS SCIENCES LETTRES QUARTIER LATIN, FR	[DE] BEHANDLUNG EINER ZUSAMMENSETZUNG MIT EINEM PLASMA [EN] TREATMENT OF A COMPOSITION WITH A PLASMA [FR] TRAITEMENT D'UNE COMPOSITION À L'AIDE D'UN PLASMA	https://depatisnet.dpma.de/DepatisNet/depatisnet?action=pdf&docid=EP000003808862A1&xxxfull=1
CSI	China	China	CN000205816119U	26.07.2016	B65B 69/00	CUI ZENGTAO; DING YINGYING; WANG ZHIXIN; ZHANG LINA	REALFORCE POWER CO LTD	[EN] Barreled silica gel recycle device for photovoltaic module	https://depatisnet.dpma.de/DepatisNet/depatisnet?action=pdf&docid=CN000205816119U&xxxfull=1
CDTE	United States of America	United States of America	US000008821711B2	20.06.2012	C25C 1/16, C22B 17/02, C22B 17/00, C01B 19/02, C22B 7/00	DEFILIPPO MAKKO, US; TAYLOR PATRICK, US	COLORADO SCHOOL OF MINES, US; DEFILIPPO MAKKO, US; TAYLOR PATRICK, US	[EN] Process to recycle end of life CDTE modules and manufacturing scrap	https://depatisnet.dpma.de/DepatisNet/depatisnet?action=pdf&docid=US000008821711B2&xxxfull=1

Table A-2: PV Recycling Patents

PV Type	Country of Applicant	Country	Publication NO	Date	IPC-classes	Inventor	Applicant	Title	Document
CDTE	United States of America	United States of America	US020120325676A1	20.06.2012	C22B 5/00, C22B 17/00, C25C 1/16	DEFILIPPO MAKKO, US; TAYLOR PATRICK, US	DEFILIPPO MAKKO, US; TAYLOR PATRICK, US	[EN] PROCESS TO RECYCLE END OF LIFE CDTE MODULES AND MANUFACTURING SCRAP	https://depatisnet.dpma.de/DepatisNet/depatisnet?action=pdf&docid=US020120325676A1&xxxfull=1
CSI	China	China	CN000112662884A	16.12.2020	C22B 7/00	DIAO HONGWEI; WANG WENJING; ZHAO LEI	INST ELECTRICAL ENG CAS	[EN] Method for recycling metallic silver in crystalline silicon heterojunction solar cell	https://depatisnet.dpma.de/DepatisNet/depatisnet?action=pdf&docid=CN000112662884A&xxxfull=1
CDTE	China	China	CN000103866129A	12.03.2014	C01B 19/00, C22B 17/00	DING FAZHU; DONG ZEBIN; GU HONGWEI; PENG XINGYU; QU FEI; WANG HONGYAN; ZHANG TENG	INST ELECTRICAL ENG CAS	[EN] Recycling method of CdTe solar cell module	https://depatisnet.dpma.de/DepatisNet/depatisnet?action=pdf&docid=CN000103866129A&xxxfull=1
CSI	China	China	CN000214812819U	14.05.2021	B07C 5/18, B07C 5/28, B07C 5/38	DING YU'AN	JIANGSU RUINENG TECH CO LTD	[EN] Sorting machine for recycling waste solar cell panels	https://depatisnet.dpma.de/DepatisNet/depatisnet?action=pdf&docid=CN000214812819U&xxxfull=1
CSI	China	China	CN000112058871A	03.09.2020	B09B 5/00	DONG GUOYI; LAI WEIDONG; LIU YING; WU CUIGU; ZHANG HUACHENG; ZHAO YAJUN	UNIV HEBEI	[EN] Equipment and method for disassembling solar cell module	https://depatisnet.dpma.de/DepatisNet/depatisnet?action=pdf&docid=CN000112058871A&xxxfull=1
PO	China	China	CN000211100752U	17.12.2019	H01L 31/18, B23P 19/00	DONG WENLONG; LI JING; LI NING; MU HONGYAN; WANG XINYUE; ZHANG XUEZHEN	BEIJING JINGCHENG JINTAIYANG SOLAR ENERGY TECH CO LTD	[EN] Photovoltaic module backboard stripping device	https://depatisnet.dpma.de/DepatisNet/depatisnet?action=pdf&docid=CN000211100752U&xxxfull=1
CSI	China	China	CN000211515531U	17.12.2019	B01J 6/00	DONG WENLONG; LI JING; LI NING; MU HONGYAN; WANG XINYUE; ZHANG XUEZHEN	BEIJING JINGCHENG JINTAIYANG SOLAR ENERGY TECH CO LTD	[EN] Waste photovoltaic module thermal decomposition equipment	https://depatisnet.dpma.de/DepatisNet/depatisnet?action=pdf&docid=CN000211515531U&xxxfull=1
CSI	China	China	CN000212040811U	17.12.2019	B02C 18/24, B02C 18/12	DONG WENLONG; LI JING; LI NING; MU HONGYAN; WANG XINYUE; ZHANG XUEZHEN	BEIJING JINGCHENG JINTAIYANG SOLAR ENERGY TECH CO LTD	[EN] Waste photovoltaic module crushing device	https://depatisnet.dpma.de/DepatisNet/depatisnet?action=pdf&docid=CN000212040811U&xxxfull=1
CSI	China	China	CN000211102534U	10.12.2019		DONG WENLONG; LI JING; LI NING; MU HONGYAN; WANG XINYUE; ZHANG XUEZHEN	BEIJING JINGCHENG JINTAIYANG SOLAR ENERGY TECH CO LTD	[EN] Automatic frame dismounting machine for photovoltaic module	https://depatisnet.dpma.de/DepatisNet/depatisnet?action=pdf&docid=CN000211102534U&xxxfull=1
CSI	China	China	CN000210192519U	14.11.2019	B65G 13/07	DONG WENLONG; LI JING; LI NING; MU HONGYAN; WANG XINYUE; ZHANG XUEZHEN	BEIJING JINGCHENG JINTAIYANG ENERGY TECH CO LTD	[EN] Photovoltaic module recycling and feeding device	https://depatisnet.dpma.de/DepatisNet/depatisnet?action=pdf&docid=CN000210192519U&xxxfull=1
CDTE	United States of America	United States of America	US000005997718A	16.06.1998	C01G 11/00	DRINKARD JR WILLIAM F, US; GOOZNER ROBERT E, US; LONG MARK O, US	DRINKARD METALOX INC, US	[EN] Recycling of CdTe photovoltaic waste	https://depatisnet.dpma.de/DepatisNet/depatisnet?action=pdf&docid=US000005997718A&xxxfull=1
CIGS	United States of America	United States of America	US000005779877A	12.05.1997	C25C 1/12, C25C 1/24, C21B 15/00	DRINKARD JR WILLIAM F, US; GOOZNER ROBERT E, US; LONG MARK O, US	DRINKARD METALOX INC, US	[EN] Recycling of CIS photovoltaic waste	https://depatisnet.dpma.de/DepatisNet/depatisnet?action=pdf&docid=US000005779877A&xxxfull=1
CDTE	United States of America	United States of America	US000005897685A	12.05.1997		DRINKARD JR WILLIAM F, US; GOOZNER ROBERT E, US; LONG MARK O, US	DRINKARD METALOX INC, US	[EN] Recycling of CdTe photovoltaic waste	https://depatisnet.dpma.de/DepatisNet/depatisnet?action=pdf&docid=US000005897685A&xxxfull=1
CSI	Taiwan, Republic of China	Taiwan, Republic of China	TW000201310665A	16.08.2011	H01L 31/042	DU CHEN-HSUN, TW; WANG TENG-YU, TW	IND TECH RES INST, TW	[EN] Method for recycling photovoltaic cell modules	
CSI	South Africa	South Africa	WO002012114165A1	28.09.2011	C22B 3/18, C22B 11/08	EKSTEEN JACOBUS JOHANNES, ZA; MWASE JAMES MALUMBO, ZA; PETERSEN JOCHEN, ZA	EKSTEEN JACOBUS JOHANNES, ZA; MWASE JAMES MALUMBO, ZA; PETERSEN JOCHEN, ZA; UNIV CAPE TOWN, ZA; WESTERN PLATINUM LTD, ZA	[EN] ENERGY EFFICIENT RECOVERY OF PRECIOUS METALS AND BASE METALS [FR] RÉCUPÉRATION EFFICACE AU PLAN ÉNERGÉTIQUE DE MÉTAUX PRÉCIEUX ET DE MÉTAUX COMMUNS	https://depatisnet.dpma.de/DepatisNet/depatisnet?action=pdf&docid=WO002012114165A1&xxxfull=1
CSI	Germany	European Patent	EP000002380736A1	26.04.2010	B29B 17/02	ERGUEN CENGIZ DR, DE	ERGUEN CENGIZ DR, DE	[DE] Verfahren und Vorrichtung zum Abbau von beschichteten Verglasungen oder von Photovoltaikmodulen [EN] Process and apparatus for disassembly of laminated glazings or photovoltaic modules [FR] Procédé ...	https://depatisnet.dpma.de/DepatisNet/depatisnet?action=pdf&docid=EP000002380736A1&xxxfull=1
CSI	Germany	European Patent	EP000002380736B1	26.04.2010	B29B 17/02	ERGUEN CENGIZ DR, DE	ERGUEN CENGIZ DR, DE	[DE] Verfahren und Vorrichtung zum Abbau von beschichteten Verglasungen oder von Photovoltaikmodulen [EN] Process and apparatus for disassembly of laminated glazings or photovoltaic modules [FR] Procédé ...	https://depatisnet.dpma.de/DepatisNet/depatisnet?action=pdf&docid=EP000002380736B1&xxxfull=1
CSI	United States of America	United States of America	WO002005124892A2	08.06.2005		FAUST TOM, US; HAIMANN RICHARD	FAUST TOM, US	[EN] DEVULCANIZED PHOTOVOLTAIC ROOFING TILES [FR] TUILES DE TOITURES PHOTOVOLTAIQUES REGENEREES	https://depatisnet.dpma.de/DepatisNet/depatisnet?action=pdf&docid=WO002005124892A2&xxxfull=1
CIGS	Canada	United States of America	US000008834818B2	22.11.2011	C22B 3/04, C22B 15/00, C22B 3/26, C22B 3/08, C22B 7/00	FERRON CESARE G, CA	FERRON CESARE G, CA; MOLYCORP MINERALS CANADA ULC, CA	[EN] Treatment of indium gallium alloys and recovery of indium and gallium	https://depatisnet.dpma.de/DepatisNet/depatisnet?action=pdf&docid=US000008834818B2&xxxfull=1
CIGS	Canada	Canada	WO002012068668A1	22.11.2011	C22B 3/04	FERRON CESARE G, CA	FERRON CESARE G, CA; NEO MATERIAL TECHNOLOGIES INC, CA	[EN] TREATMENT OF INDIUM GALLIUM ALLOYS AND RECOVERY OF INDIUM AND GALLIUM [FR] TRAITEMENT D'ALLIAGES D'INDIUM-GALLIUM ET RÉCUPÉRATION D'INDIUM ET DE GALLIUM	https://depatisnet.dpma.de/DepatisNet/depatisnet?action=pdf&docid=WO002012068668A1&xxxfull=1

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PV Type	Country of Applicant	Country	Publication NO	Date	IPC-classes	Inventor	Applicant	Title	Document
CSI	France	France	WO002013041926A1	18.07.2012		FIGUET CHRISTOPHE, FR; GOURDEL CHRISTOPHE, FR	FIGUET CHRISTOPHE, FR; GOURDEL CHRISTOPHE, FR; SOITEC SILICON ON INSULATOR, FR	[EN] METHOD FOR FABRICATING A COMPOSITE STRUCTURE TO BE SEPARATED BY EXFOLIATION [FR] PROCÉDÉ POUR FABRIQUER UNE STRUCTURE COMPOSITE DESTINÉE À ÊTRE SÉPARÉE PAR EXFOLIATION	https://depatisnet.dpma.de/DepatisNet/depatisnet?action=pdf&docid=WO002013041926A1&xxxfull=1
CSI	France	Germany	DE112012003902T5	18.07.2012		Figuet, Christophe, 38920 Crolles, FR; Gourdel, Christophe, Saint Maximin, FR	Soitec, Bernin, FR	[DE] Verfahren zur Herstellung einer durch Ablättern abzutrennenden Verbundstruktur	https://depatisnet.dpma.de/DepatisNet/depatisnet?action=pdf&docid=DE112012003902T5&xxxfull=1
CSI	United States of America	European Patent	EP000001975987A2	31.03.2008	H01L 21/3213, H01L 21/02	FLETCHER KRISTIN A, US; JIANG PING, US; KING MACKENZIE, US; KORZENSKI MICHAEL B, US; MINSEK DAVID W, US; VISINTIN PAMELA M, US	ADVANCED TECH MATERIALS, US	[DE] Verfahren zum Abstreifen von Material zur Wafer-Wiedergewinnung [EN] Methods for stripping material for wafer reclamation [FR] Procédés de décapage de matériau pour réclamation de tranche	https://depatisnet.dpma.de/DepatisNet/depatisnet?action=pdf&docid=EP000001975987A2&xxxfull=1
CSI	United States of America	United States of America	WO002008121952A1	31.03.2008	C09K 8/02, H01L 21/027	FLETCHER KRISTIN A, US; JIANG PING, US; KING MACKENZIE, US; KORZENSKI MICHAEL B, US; MINSEK DAVID W, US; VISINTIN PAMELA M, US	ADVANCED TECH MATERIALS, US; FLETCHER KRISTIN A, US; JIANG PING, US; KING MACKENZIE, US; KORZENSKI MICHAEL B, US; MINSEK DAVID W, US; VISINTIN PAMELA M, US	[EN] METHODS FOR STRIPPING MATERIAL FOR WAFER RECLAMATION [FR] PROCÉDÉS POUR DÉCAPER UN MATÉRIAU POUR RÉCUPÉRATION DE TRANCHE	https://depatisnet.dpma.de/DepatisNet/depatisnet?action=pdf&docid=WO002008121952A1&xxxfull=1
CDTE	United States of America	United States of America	US020060275191A1	31.05.2006		FTHENAKIS VASILIIS M, US; WANG WENMING, US	BROOKHAVEN SCIENCE ASS LLC, US	[EN] SYSTEM AND METHOD FOR SEPARATING TELLURIUM FROM CADMIUM WASTE	https://depatisnet.dpma.de/DepatisNet/depatisnet?action=pdf&docid=US020060275191A1&xxxfull=1
CDTE	United States of America	United States of America	US020100189612A1	08.04.2010	C01B 19/00, B01J 8/02	FTHENAKIS VASILIS, US; WANG WENMING, US	FTHENAKIS VASILIS; WANG WENMING	[EN] SYSTEM AND METHOD FOR SEPARATING TELLURIUM FROM CADMIUM WASTE	https://depatisnet.dpma.de/DepatisNet/depatisnet?action=pdf&docid=US020100189612A1&xxxfull=1
CDTE	United States of America	EP	EP000001888464B1	01.06.2006	C01G 11/02, C22B 61/00, C22B 3/42, C22B 7/00, C22B 17/00, C01G 11/00	FTHENAKIS VASILIS, US; WANG WENMING, US	BROOKHAVEN SCIENCE ASS LLC, US	[DE] HYDROMETALLURGISCHES VERFAHREN ZUM TRENNEN VON TELLUR-ABFALLPRODUKTEN [EN] HYDROMETALLURGICAL METHOD FOR SEPARATING TELLURIUM WASTE [FR] PROCEDE HYDROMETALLURGIQUE DESTINE A LA SEPARATION DES ...	https://depatisnet.dpma.de/DepatisNet/depatisnet?action=pdf&docid=EP000001888464B1&xxxfull=1
CDTE	United States of America	United States of America	WO002006130715A2	01.06.2006		FTHENAKIS VASILIS, US; WANG WENMING, US	BROOKHAVEN SCIENCE ASS LLC, US; FTHENAKIS VASILIS, US; WANG WENMING, US	[EN] SYSTEM AND METHOD FOR SEPARATING TELLURIUM WASTE [FR] SYSTEME ET PROCEDE DESTINES A LA SEPARATION DES DECHETS DE TELLURIUM	https://depatisnet.dpma.de/DepatisNet/depatisnet?action=pdf&docid=WO002006130715A2&xxxfull=1
CSI	China	China	CN000105355709A	16.10.2015		FU SHAOYONG; XIONG ZHEN; ZHOU LU	CHANGZHOU TRINA SOLAR ENERGY	[EN] Glass separation method for crystalline silicon solar cell module	https://depatisnet.dpma.de/DepatisNet/depatisnet?action=pdf&docid=CN000105355709A&xxxfull=1
CSI	Taiwan, Republic of China	Taiwan, Republic of China	TW000202204060A	30.07.2020		FU YAW-SHYAN, TW; HSU KUO-CHIN, TW; HU CHIN-CHIH, TW; HUNG CHIA-TSUNG, TW; KO HAO-WEI, TW; LIN SHI-REN, TW; LIU CHENG-CHEN, TW; MA YI-JUN, TW	ACON GREENERGY TECHNOLOGY CO LTD, TW; ACON HOLDING INC, TW; NATIONAL UNIV OF TAINAN, TW	[EN] Solar cell module mobile recycling system capable of saving the transportation cost and completely recycling the solar cell module without using any fuel	
OPV	United States of America	United States of America	US000009203030B2	21.03.2014	H01L 51/00, H01L 31/04, H01L 31/0224, H01L 51/44, B82Y 10/00	FUENTES-HERNANDEZ CANEK, US; KIPPELEN BERNARD, US; MOON ROBERT, US; YOUNGBLOOD JEFFREY P, US; ZHOU YINHUA, US	GEORGIA TECH RES INST, US; PERDUE RES FOUNDATION, US; PURDUE RESEARCH FOUNDATION, US; US AGRICULTURE, US	[EN] Recyclable organic solar cells on substrates comprising cellulose nanocrystals (CNC)	https://depatisnet.dpma.de/DepatisNet/depatisnet?action=pdf&docid=US000009203030B2&xxxfull=1
CSI	Japan	Japan	JP002016203093A	22.04.2015	H01L 31/042	FUJII NOBUYUKI; NAKA JIRO; NAKAGAWA YASUYUKI	MITSUBISHI ELECTRIC CORP	[EN] RECYCLING APPARATUS AND RECYCLING METHOD OF SOLAR BATTERY PANEL	https://depatisnet.dpma.de/DepatisNet/depatisnet?action=pdf&docid=JP002016203093A&xxxfull=1
CSI	Japan	Japan	JP002016036756A	06.08.2014	B09B 5/00, H02S 30/10	FUJITA KOUJI	DOWA ECO SYSTEM CO LTD	[EN] RECYCLING METHOD OF SOLAR CELL MODULE	https://depatisnet.dpma.de/DepatisNet/depatisnet?action=pdf&docid=JP002016036756A&xxxfull=1
CSI	Japan	Japan	JP002000269535A	13.01.2000	E04D 13/18, H01L 31/04, E04D 3/40	FUKAE KIMITOSHI; ITOYAMA SEIKI; MAKITA HIDEHISA; SASAOKA MAKOTO; SHIOMI SATORU	CANON KK	[EN] SOLAR BATTERY MODULE AND POWER GENERATING DEVICE AND METHOD FOR SEPARATING THE SOLAR BATTERY MODULE AND METHOD FOR REPRODUCING THE MODULE	https://depatisnet.dpma.de/DepatisNet/depatisnet?action=pdf&docid=JP002000269535A&xxxfull=1
CSI	Japan	Japan	JP002015229126A	03.06.2014	B09B 5/00, H01L 31/048	FUKAMI TAKUO; NISHIMURA TETSUO	NIHON SUPERIOR CO LTD	[EN] RECYCLING METHOD OF SOLAR BATTERY PANEL	https://depatisnet.dpma.de/DepatisNet/depatisnet?action=pdf&docid=JP002015229126A&xxxfull=1
CSI	Japan	Japan	JP002015217372A	20.05.2014		FUKAMI TAKUO; NISHIMURA TETSUO	NIHON SUPERIOR CO LTD	[EN] REGENERATION METHOD OF SOLAR BATTERY PANEL	https://depatisnet.dpma.de/DepatisNet/depatisnet?action=pdf&docid=JP002015217372A&xxxfull=1
CSI	Japan	European Patent	EP000002241381A1	25.12.2008	C22B 7/00, C22B 15/00, C22B 19/30, C22B 3/46, C25C 7/06, C22B 1/00, C22B 3/04, C22B 58/00	FURUYAMA TOMOYUKI, JP; HOMMA TETSUYA, JP; MORIKAKU AKIHIRO, JP; TANAKA KUMPEI, JP; UBUSAWA TOMOYUKI, JP	SHIBAURA INST TECHNOLOGY, JP	[DE] VERFAHREN ZUR WIEDERVERWERTUNG VON NÜTZLICHEM METALL [EN] METHOD OF RECYCLING USEFUL METAL [FR] PROCÉDÉ DE RECYCLAGE DE MÉTAL UTILE	https://depatisnet.dpma.de/DepatisNet/depatisnet?action=pdf&docid=EP000002241381A1&xxxfull=1

Table A-2: PV Recycling Patents

PV Type	Country of Applicant	Country	Publication NO	Date	IPC-classes	Inventor	Applicant	Title	Document
CSI	Japan	United States of America	US000008317896B2	25.12.2008	B22F 9/04	FURUYAMA TOMOYUKI, JP; HOMMA TETSUYA, JP; MORIKAKU AKIHIRO, JP; TANAKA KUMPEI, JP; UBUSAWA TOMOYUKI, JP	FURUYAMA TOMOYUKI, JP; HOMMA TETSUYA, JP; MORIKAKU AKIHIRO, JP; SHIBAURA INST TECHNOLOGY, JP; TANAKA KUMPEI, JP; UBUSAWA TOMOYUKI, JP	[EN] Method of recycling useful metal	https://depatisnet.dpma.de/DepatisNet/depatisnet?action=pdf&docid=US000008317896B2&xxxfull=1
CSI	United States of America	United States of America	US020110017020A1	25.12.2008		FURUYAMA TOMOYUKI, JP; HOMMA TETSUYA, JP; MORIKAKU AKIHIRO, JP; TANAKA KUMPEI, JP; UBUSAWA TOMOYUKI, JP	SHIBAURA INST TECHNOLOGY, JP	[EN] METHOD OF RECYCLING USEFUL METAL	https://depatisnet.dpma.de/DepatisNet/depatisnet?action=pdf&docid=US020110017020A1&xxxfull=1
CSI	China	China	CN000108839943A	19.07.2018	B65D 71/04	GE XIANPING; GU MINGMING; LU ZHENYU; SUN QUAN; XU JIANMEI; ZHANG YINGBIN	TIANHE LIGHT ENERGY CO LTD; YANCHENG TIANHE GUONENG PHOTOVOLTAIC TECH CO LTD	[EN] Recyclable photovoltaic module packing and transport method, and structural assembly	https://depatisnet.dpma.de/DepatisNet/depatisnet?action=pdf&docid=CN000108839943A&xxxfull=1
CSI	China	China	CN000212760315U	07.09.2020	B09B 5/00, B02C 21/00, B02C 23/14	GONG WENYONG; HAN JINDOU; HE YINFENG; LEI MINGYU; LIAO QIAN; MA CHONGZHEN; MA YUNFENG; WEI CHENJUAN; YANG ZIQI; ZHANG JIANWEN; ZHANG ZHANSHENG; ZHENG LU	CHANGSHA RES INST MINING & METALLURGY CO LTD; PHOTOVOLTAIC INDUSTRY TECH BRANCH OF QINGHAI HUANGHE HYDROPOWER DEVELOPMENT CO LTD; QINGHAI HUANGHE HYDROPOWER DEV CO LTD; SPIC HUANGHE HYDROPOWER DEV CO LTD; YELLOW RIVER HYDROPOWER PHOTOVOLTAIC IND TECH CO LTD	[EN] Recovery device of broken glass photovoltaic module	https://depatisnet.dpma.de/DepatisNet/depatisnet?action=pdf&docid=CN000212760315U&xxxfull=1
CSI	Italy	European Patent	EP000002997169B1	09.05.2014	B03B 9/06, C22B 7/00, C22B 17/00	GRANATA GIUSEPPE, IT; MOSCARDINI EMANUELA, IT; PAGNANELLI FRANCESCA, IT; TORO LUIGI, IT	ECO RECYCLING S R L, IT; GA ENERGY S P A, IT	[DE] VERFAHREN ZUR BEHANDLUNG VON AUSGESCHALTETEN PV-MODULEN [EN] PROCESS FOR TREATING SPENT PHOTOVOLTAIC PANELS [FR] PROCÉDÉ DE TRAITEMENT DES PANNEAUX PHOTOVOLTAÏQUES USAGÉS	https://depatisnet.dpma.de/DepatisNet/depatisnet?action=pdf&docid=EP000002997169B1&xxxfull=1
CSI	Italy	Italy	WO002014184816A1	09.05.2014	C22B 7/00, B03B 9/06, C22B 17/00	GRANATA GIUSEPPE, IT; MOSCARDINI EMANUELA, IT; PAGNANELLI FRANCESCA, IT; TORO LUIGI, IT	ECO RECYCLING S R L, IT	[EN] PROCESS FOR TREATING SPENT PHOTOVOLTAIC PANELS [FR] PROCÉDÉ DE TRAITEMENT DES PANNEAUX PHOTOVOLTAÏQUES USAGÉS	https://depatisnet.dpma.de/DepatisNet/depatisnet?action=pdf&docid=WO002014184816A1&xxxfull=1
PO	Belgium	Belgium	WO002022069435A1	28.09.2021	C07C 21/20, H01L 21/00	GROEBER CHRISTIAN, DE; KANG JOO-HEE, FR; PITTROFF MICHAEL, DE; REVELANT DENIS, FR	SOLVAY, BE	[EN] A PROCESS FOR THE PURIFICATION OF FLUORINATED OLEFINS [FR] PROCÉDÉ DE PURIFICATION D'OLÉFINES FLUORÉES	https://depatisnet.dpma.de/DepatisNet/depatisnet?action=pdf&docid=WO002022069435A1&xxxfull=1
CSI	Germany	European Patent	EP000003469635B1	25.01.2018		GROSS HARALD, DE	GROSS LEANDER KILIAN, DE; GROSS MASCHA ELLY, DE	[DE] VERFAHREN UND VORRICHTUNG ZUM TRENNEN VERSCHIEDENER MATERIALSCHICHTEN EINES VERBUNDBAUTEILS [EN] METHOD AND DEVICE FOR SEPARATING DIFFERENT MATERIAL LAYERS OF A COMPOSITE COMPONENT [FR] PROCÉDÉ ...	https://depatisnet.dpma.de/DepatisNet/depatisnet?action=pdf&docid=EP000003469635B1&xxxfull=1
CSI	Germany	United States of America	US000010786982B2	25.01.2018	B32B 38/10, H01L 31/048	GROSS HARALD, DE	GROSS LEANDER KILIAN, DE; GROSS MASCHA ELLY, DE	[EN] Method and device for separating different material layers of a composite component	https://depatisnet.dpma.de/DepatisNet/depatisnet?action=pdf&docid=US000010786982B2&xxxfull=1
CSI	Germany	United States of America	US020190308405A1	25.01.2018		GROSS HARALD, DE	GROSS LEANDER KILIAN, DE; GROSS MASCHA ELLY, DE	[EN] METHOD AND DEVICE FOR SEPARATING DIFFERENT MATERIAL LAYERS OF A COMPOSITE COMPONENT	https://depatisnet.dpma.de/DepatisNet/depatisnet?action=pdf&docid=US020190308405A1&xxxfull=1
CSI	Germany	Germany	WO002018137735A1	25.01.2018		GROSS HARALD, DE	GROSS LEANDER KILIAN, DE; GROSS MASCHA ELLY, DE	[DE] VERFAHREN UND VORRICHTUNG ZUM TRENNEN VERSCHIEDENER MATERIALSCHICHTEN EINES VERBUNDBAUTEILS [EN] METHOD AND DEVICE FOR SEPARATING DIFFERENT MATERIAL LAYERS OF A COMPOSITE COMPONENT [FR] PROCÉDÉ ...	https://depatisnet.dpma.de/DepatisNet/depatisnet?action=pdf&docid=WO002018137735A1&xxxfull=1
CSI	China	China	CN000111958352A	07.09.2020	B24B 27/00, B24B 27/033, B24B 55/06, B24B 55/12, H01L 31/049, H01L 31/18	GU XING; HAN JINDOU; HE YINFENG; LEI MINGYU; LIANG HAN; LIU LANG; MA CHONGZHEN; MA YUNFENG; TAO SIYAO; YANG ZIQI; ZHANG ZHANSHENG; ZHENG LU	CHANGSHA RES INST MINING & METALLURGY CO LTD; PHOTOVOLTAIC INDUSTRY TECH BRANCH OF QINGHAI HUANGHE HYDROPOWER DEVELOPMENT CO LTD; QINGHAI HUANGHE HYDROPOWER DEV CO LTD; SPIC HUANGHE HYDROPOWER DEV CO LTD; YELLOW RIVER HYDROPOWER PHOTOVOLTAIC IND TECH CO LTD	[EN] System and method for recycling backboard of photovoltaic module	https://depatisnet.dpma.de/DepatisNet/depatisnet?action=pdf&docid=CN000111958352A&xxxfull=1

Table A-2: PV Recycling Patents

PV Type	Country of Applicant	Country	Publication NO	Date	IPC-classes	Inventor	Applicant	Title	Document
PO	China	China	CN000212399026U	07.09.2020	H01L 31/049, B24B 27/00, B24B 55/12, B24B 55/06, B24B 27/033, H01L 31/18	GU XING; HAN JINDOU; HE YINFENG; LEI MINGYU; LIANG HAN; LIU LANG; MA CHONGZHEN; MA YUNFENG; TAO SIYAO; YANG ZIQI; ZHANG ZHANSHENG; ZHENG LU	CHANGSHA RES INST MINING & METALLURGY CO LTD; PHOTOVOLTAIC INDUSTRY TECH BRANCH OF QINGHAI HUANGHE HYDROPOWER DEVELOPMENT CO LTD; QINGHAI HUANGHE HYDROPOWER DEV CO LTD; SPIC HUANGHE HYDROPOWER DEV CO LTD; YELLOW RIVER HYDROPOWER PHOTOVOLTAIC IND TECH CO LTD	[EN] Backboard recovery system of photovoltaic module	https://depatisnet.dpma.de/DepatisNet/depatisnet?action=pdf&docid=CN000212399026U&xxxfull=1
CSI	China	China	CN000112371256A	04.11.2020	B02C 7/08, C03B 5/00, C03B 3/00, C03B 1/00, B02C 13/20, C03C 1/00	GUO BISHUI	NINGBO AOGE ELECTRONIC TECH CO LTD	[EN] Device for recycling and reproducing surface glass of solar cell panel	https://depatisnet.dpma.de/DepatisNet/depatisnet?action=pdf&docid=CN000112371256A&xxxfull=1
CSI	China	European Patent	EP000004009385A1	26.12.2019		GUO ZHIQIU, CN; JIN YEYI, CN; WANG JUAN, CN	JINKO SOLAR CO LTD, CN; ZHEJIANG JINKO SOLAR CO LTD, CN	[DE] VERFAHREN ZUR HERSTELLUNG EINER PHOTOVOLTAISCHEN ANORDNUNG [EN] FABRICATION METHOD FOR PHOTOVOLTAIC ASSEMBLY [FR] PROCÉDÉ DE FABRICATION D'UN ENSEMBLE PHOTOVOLTAÏQUE	https://depatisnet.dpma.de/DepatisNet/depatisnet?action=pdf&docid=EP000004009385A1&xxxfull=1
CSI	China	China	CN000110841786A	27.11.2019	B07B 1/46, H01L 31/18	GUO ZHIQIU; HU JIANGUAN; JIN HAO; LIU LIFANG	JINKO SOLAR CO LTD; JINKO SOLAR HOLDING CO LTD	[EN] Waste photovoltaic module recycling method	https://depatisnet.dpma.de/DepatisNet/depatisnet?action=pdf&docid=CN000110841786A&xxxfull=1
CSI	Korea (South)	Korea (South)	KR000102185429B1	29.01.2020	H01L 31/18	HAN JAE HAK; KIM SUNG JI; LEE CHEOL SONG; SONG KI TAEK, KR	DAEEUN CO LTD, KR	[EN] A Disassembling System of Unusable Solar Module	https://depatisnet.dpma.de/DepatisNet/depatisnet?action=pdf&docid=KR000102185429B1&xxxfull=1
CSI	Korea (South)	Korea (South)	KR102013039535A	12.10.2011	H01L 31/18	HAN JONG WOK, KR; JEONG YEONG SIK, KR	HAN JONG WOK, KR; JEONG YEONG SIK, KR	[EN] RECYCLING SOLAR PANEL MODULE AND MANUFACTURE METHOD THEREOF	https://depatisnet.dpma.de/DepatisNet/depatisnet?action=pdf&docid=KR102013039535A&xxxfull=1
CSI	Korea (South)	Korea (South)	KR102013060708A	30.11.2011	H01L 31/04, B03B 9/06, B09B 5/00	HAN KYU WON, KR; LEE GANG WOO, KR; LEE JAE JEONG, KR; MOON DONG HYUN, KR; SHIN HYUNG JOON, KR	YOOSUNG CO LTD, KR	[EN] RECYCLING METHOD OF PHOTOVOLTAIC WASTE FACILITY	https://depatisnet.dpma.de/DepatisNet/depatisnet?action=pdf&docid=KR102013060708A&xxxfull=1
CSI	Japan	European Patent	EP000003782744A1	05.04.2019	H01L 31/042, B29B 17/02	HARADA HIDEKI, JP; SAKAI NORIYUKI, JP	SOLAR FRONTIER KK, JP	[DE] SOLARZELLENMODULRECYCLINGVERFAHREN UND RECYCLINGVORRICHTUNG [EN] SOLAR CELL MODULE RECYCLING METHOD AND RECYCLING DEVICE [FR] PROCÉDÉ DE RECYCLAGE DE MODULE DE CELLULE SOLAIRE ET DISPOSITIF DE ...	https://depatisnet.dpma.de/DepatisNet/depatisnet?action=pdf&docid=EP000003782744A1&xxxfull=1
CSI	Japan	United States of America	US020210162729A1	05.04.2019	H01L 31/18, H01L 31/048, B09B 3/00	HARADA HIDEKI, JP; SAKAI NORIYUKI, JP	SOLAR FRONTIER KK, JP	[EN] SOLAR CELL MODULE RECYCLING METHOD AND RECYCLING DEVICE	https://depatisnet.dpma.de/DepatisNet/depatisnet?action=pdf&docid=US020210162729A1&xxxfull=1
CSI	Japan	Japan	WO002019203026A1	05.04.2019	B29B 17/02, H01L 31/042	HARADA HIDEKI, JP; SAKAI NORIYUKI, JP	SOLAR FRONTIER KK, JP	[EN] SOLAR CELL MODULE RECYCLING METHOD AND RECYCLING DEVICE [FR] PROCÉDÉ DE RECYCLAGE DE MODULE DE CELLULE SOLAIRE ET DISPOSITIF DE RECYCLAGE	https://depatisnet.dpma.de/DepatisNet/depatisnet?action=pdf&docid=WO002019203026A1&xxxfull=1
CSI	Japan	China	CN000112703066A	05.04.2019	B29B 17/02, H01L 31/042	HARADA HIDEKI; SAKAI NORIYUKI	SOLAR FRONTIER KK	[EN] SOLAR CELL MODULE RECYCLING METHOD AND RECYCLING DEVICE	https://depatisnet.dpma.de/DepatisNet/depatisnet?action=pdf&docid=CN000112703066A&xxxfull=1
TF	Japan	United States of America	US000008668157B2	16.12.2011	B24B 1/00	HASHIMOTO SATOSHI, JP; INOUE SATOSHI, JP; KAWATO SHINICHI, JP; SONODA TOHRU, JP	HASHIMOTO SATOSHI, JP; INOUE SATOSHI, JP; KAWATO SHINICHI, JP; SHARP KK, JP; SONODA TOHRU, JP	[EN] Method of recovering film-forming material	https://depatisnet.dpma.de/DepatisNet/depatisnet?action=pdf&docid=US000008668157B2&xxxfull=1
TF	Japan	United States of America	US020130292501A1	16.12.2011		HASHIMOTO SATOSHI, JP; INOUE SATOSHI, JP; KAWATO SHINICHI, JP; SONODA TOHRU, JP	HASHIMOTO SATOSHI, JP; INOUE SATOSHI, JP; KAWATO SHINICHI, JP; SHARP KK, JP; SONODA TOHRU, JP	[EN] METHOD OF RECOVERING FILM-FORMING MATERIAL	https://depatisnet.dpma.de/DepatisNet/depatisnet?action=pdf&docid=US020130292501A1&xxxfull=1
CSI	Switzerland	Switzerland	WO002019138154A1	28.12.2018		HASHMI GHUFRAN SYED, FI; MARTINEAU DAVID, CH; MYLLYMÄKI TEEMU, FI	AALTO KORKEAKOULUSAEAETIOE SR, FI; SOLARONIX S A, CH	[EN] METHOD FOR REFURBISHING OF CARBON BASED PEROVSKITE SOLAR CELLS (CPSCS) AND MODULES VIA RECYCLING OF ACTIVE MATERIALS [FR] PROCÉDÉ PERMETTANT DE REMETTRE À NEUF DES CELLULES SOLAIRES À PÉROVSKITE ...	https://depatisnet.dpma.de/DepatisNet/depatisnet?action=pdf&docid=WO002019138154A1&xxxfull=1
CSI	United Kingdom	United States of America	US020070021039A1	13.07.2006	B24C 3/00, B24C 5/04	HASLETT BASIL, GB	HASLETT BASIL	[EN] GLASS ETCHING	https://depatisnet.dpma.de/DepatisNet/depatisnet?action=pdf&docid=US020070021039A1&xxxfull=1
CSI	United Kingdom	United Kingdom	WO002007009579A1	03.07.2006	B24C 9/00, B24C 1/04, B24C 7/00	HASLETT BASIL, GB	HASLETT BASIL, GB	[EN] ABRASIVE BLASTING OF GLASS [FR] DECAPAGE PAR PROJECTION D'ABRASIF DE VERRE	https://depatisnet.dpma.de/DepatisNet/depatisnet?action=pdf&docid=WO002007009579A1&xxxfull=1

Table A-2: PV Recycling Patents

PV Type	Country of Applicant	Country	Publication NO	Date	IPC-classes	Inventor	Applicant	Title	Document
CSI	Japan	European Patent	EP000003178562A1	28.10.2016		HATA YUICHI, JP; MATSUDA GENICHIRO, JP; NAMIHIRA TAKAO, JP; UTUMI SYOUGO, JP	PANASONIC CORP, JP	[DE] OBJEKTDEMONTAGEVERFAHREN UND DEMONTAGEVORRICHTUNG [EN] OBJECT DISASSEMBLY METHOD AND DISASSEMBLY DEVICE [FR] PROCÉDÉ DE DÉMONTAGE D'OBJET ET DISPOSITIF DE DÉMONTAGE	https://depatisnet.dpma.de/DepatisNet/depatisnet?action=pdf&docid=EP000003178562A1&xxxfull=1
CSI	Japan	European Patent	EP000003178562B1	28.10.2016		HATA YUICHI, JP; MATSUDA GENICHIRO, JP; NAMIHIRA TAKAO, JP; UTUMI SYOUGO, JP	PANASONIC CORP, JP	[DE] OBJEKTDEMONTAGEVERFAHREN UND DEMONTAGEVORRICHTUNG [EN] OBJECT DISASSEMBLY METHOD AND DISASSEMBLY DEVICE [FR] PROCÉDÉ DE DÉMONTAGE D'OBJET ET DISPOSITIF DE DÉMONTAGE	https://depatisnet.dpma.de/DepatisNet/depatisnet?action=pdf&docid=EP000003178562B1&xxxfull=1
CSI	Japan	European Patent	EP000003352227A1	16.09.2016	B09B 3/00, B09B 5/00	HAYASHI YOSHIAKI, JP; KAWANISHI TAKANORI, JP; MOTOJI TOSHIROU, JP; SUMI KAZUHIRO, JP	DAIKIN IND LTD, JP; TOHO KASEI CO LTD, JP	[DE] RECYCLINGVERFAHREN FÜR SOLARBATTERIEMODUL [EN] RECYCLING METHOD FOR SOLAR BATTERY MODULE [FR] PROCÉDÉ DE RECYCLAGE POUR MODULE DE BATTERIE SOLAIRE	https://depatisnet.dpma.de/DepatisNet/depatisnet?action=pdf&docid=EP000003352227A1&xxxfull=1
CSI	Japan	European Patent	EP000003352227A4	16.09.2016	H01L 31/049, H01L 31/042, C08L 23/08, C08J 11/06, H01L 31/18, B29B 17/02, B32B 38/10, B32B 43/00, B09B 5/00	HAYASHI YOSHIAKI, JP; KAWANISHI TAKANORI, JP; MOTOJI TOSHIROU, JP; SUMI KAZUHIRO, JP	DAIKIN IND LTD, JP; TOHO KASEI CO LTD, JP	[DE] RECYCLINGVERFAHREN FÜR SOLARBATTERIEMODUL [EN] RECYCLING METHOD FOR SOLAR BATTERY MODULE [FR] PROCÉDÉ DE RECYCLAGE POUR MODULE DE BATTERIE SOLAIRE	https://depatisnet.dpma.de/DepatisNet/depatisnet?action=pdf&docid=EP000003352227A4&xxxfull=1
CSI	Japan	European Patent	EP000003352227B1	16.09.2016	B32B 38/10, B29B 17/02, B09B 5/00, H01L 31/18, H01L 31/049, H01L 31/048, H01L 31/042, C08L 23/08, C08J 11/06, B32B 43/00	HAYASHI YOSHIAKI, JP; KAWANISHI TAKANORI, JP; MOTOJI TOSHIROU, JP; SUMI KAZUHIRO, JP	DAIKIN IND LTD, JP; TOHO KASEI CO LTD, JP	[DE] RECYCLINGVERFAHREN FÜR SOLARBATTERIEMODUL [EN] RECYCLING METHOD FOR SOLAR BATTERY MODULE [FR] PROCÉDÉ DE RECYCLAGE POUR MODULE DE BATTERIE SOLAIRE	https://depatisnet.dpma.de/DepatisNet/depatisnet?action=pdf&docid=EP000003352227B1&xxxfull=1
CSI	Japan	United States of America	US000010388812B2	16.09.2016	H01L 31/18, H01L 31/042, H01L 31/049, B09B 3/00, C08L 23/08, B09B 5/00, C08J 11/06, B29B 17/02, B32B 38/10	HAYASHI YOSHIAKI, JP; KAWANISHI TAKANORI, JP; MOTOJI TOSHIROU, JP; SUMI KAZUHIRO, JP	DAIKIN IND LTD, JP; TOHO KASEI CO LTD, JP	[EN] Method of recycling solar cell module	https://depatisnet.dpma.de/DepatisNet/depatisnet?action=pdf&docid=US000010388812B2&xxxfull=1
CSI	Japan	United States of America	US020180254364A1	16.09.2016	B09B 5/00, C08L 23/08, H01L 31/18, B09B 3/00	HAYASHI YOSHIAKI, JP; KAWANISHI TAKANORI, JP; MOTOJI TOSHIROU, JP; SUMI KAZUHIRO, JP	DAIKIN IND LTD, JP; TOHO KASEI CO LTD, JP	[EN] METHOD OF RECYCLING SOLAR CELL MODULE	https://depatisnet.dpma.de/DepatisNet/depatisnet?action=pdf&docid=US020180254364A1&xxxfull=1
CSI	Japan	Japan	WO002017047802A1	16.09.2016	B09B 5/00, B09B 3/00	HAYASHI YOSHIAKI, JP; KAWANISHI TAKANORI, JP; MOTOJI TOSHIROU; SUMI KAZUHIRO, JP	DAIKIN IND LTD, JP; TOHO KASEI CO LTD, JP	[EN] RECYCLING METHOD FOR SOLAR BATTERY MODULE [FR] PROCÉDÉ DE RECYCLAGE POUR MODULE DE BATTERIE SOLAIRE	https://depatisnet.dpma.de/DepatisNet/depatisnet?action=pdf&docid=WO002017047802A1&xxxfull=1
CSI	Japan	China	CN000108352418A	16.09.2016	B09B 5/00, B09B 3/00	HAYASHI YOSHIAKI; KAWANISHI TAKANORI; MOTOJI TOSHIROU; SUMI KAZUHIRO	DAIKIN IND LTD; TOHO KASEI CO LTD	[EN] RECYCLING METHOD FOR SOLAR BATTERY MODULE	https://depatisnet.dpma.de/DepatisNet/depatisnet?action=pdf&docid=CN000108352418A&xxxfull=1
CSI	China	China	CN000108015096A	12.12.2017	B09B 5/00	HE FENGQIN; ZHANG ZHI; ZHENG LU	PHOTOVOLTAIC INDUSTRY TECH BRANCH COMPANY HUANGHE HYDROPOWER DEVELOPMENT CO LTD	[EN] Reagent-assisted disintegration recycling method for photovoltaic module	https://depatisnet.dpma.de/DepatisNet/depatisnet?action=pdf&docid=CN000108015096A&xxxfull=1
CSI	China	China	CN000113976597A	02.11.2021	H01L 31/18, B09B 3/70, B09B 101/00	HE LONGGUAN; LUO JIAN; WANG XIAOLIANG	XUANJIN SHANGHAI ENVIRONMENTAL TECH CO LTD	[EN] Low-energy-consumption method for separating and recycling all parts in photovoltaic module	https://depatisnet.dpma.de/DepatisNet/depatisnet?action=pdf&docid=CN000113976597A&xxxfull=1
CSI	China	China	CN000113617799A	04.08.2021	B09B 5/00, B02C 23/14	HE LONGGUAN; LUO JIAN; WANG XIAOLIANG	XUANJIN SHANGHAI ENVIRONMENTAL TECH CO LTD	[EN] Photovoltaic module separation recovery method	https://depatisnet.dpma.de/DepatisNet/depatisnet?action=pdf&docid=CN000113617799A&xxxfull=1
CSI	China	China	CN000212069643U	13.02.2020	B08B 3/02, H02S 40/10	HE QUANJUN	SICHUAN FUYILIAN INF TECH CO LTD	[EN] Cleaning equipment for photovoltaic panel recycling	https://depatisnet.dpma.de/DepatisNet/depatisnet?action=pdf&docid=CN000212069643U&xxxfull=1
CSI	Switzerland	United States of America	US020120270475A1	08.10.2009	B24B 7/22, B24B 7/02, B24B 1/00	HOFER ADOLF, CH; SUTER PASCAL, CH	HOFER ADOLF, CH; KOMAX HOLDING AG, CH; SUTER PASCAL, CH	[EN] APPARATUS AND METHOD FOR DECOATING SOLAR MODULES	https://depatisnet.dpma.de/DepatisNet/depatisnet?action=pdf&docid=US020120270475A1&xxxfull=1
CSI	Taiwan, Republic of China	Korea (South)	KR102022048836A	13.10.2020	F23G 5/033, F23G 5/44, H02S 10/00, F23G 5/00, B01D 46/00	HONG KOOK SUN, KR	HONG KOOK SUN, KR	[EN] RECYCLING SYSTEM FOR SOLAR CELL PANEL	https://depatisnet.dpma.de/DepatisNet/depatisnet?action=pdf&docid=KR102022048836A&xxxfull=1
CSI	Taiwan, Republic of China	United States of America	US020220094299A1	28.12.2020	H02S 99/00	HSIEH NENG-WEN, TW; LI CHIN-YUEH, TW; LIN CHIH-LUNG, TW; SUNG MU-HSI, TW; WANG TENG-YU, TW	IND TECH RES INST, TW	[EN] DISMANTLING DEVICE FOR FRAME OF PV MODULE	https://depatisnet.dpma.de/DepatisNet/depatisnet?action=pdf&docid=US020220094299A1&xxxfull=1
TF	United States of America	United States of America	WO002010017160A2	04.08.2009	H01L 21/027, G03F 7/42	HSU ROBERT MING-ANN; KORZENSKI MICHAEL B, US; TANG LILLIAN CHING-HSUAN	ADVANCED TECH MATERIALS, US; ATMI TAIWAN CO LTD; HSU ROBERT MING-ANN; KORZENSKI MICHAEL B, US; TANG LILLIAN CHING-HSUAN	[EN] ENVIRONMENTALLY FRIENDLY POLYMER STRIPPING COMPOSITIONS [FR] COMPOSITIONS POLYMÈRES DÉCAPANTES ÉCOLOGIQUES	https://depatisnet.dpma.de/DepatisNet/depatisnet?action=pdf&docid=WO002010017160A2&xxxfull=1

Table A-2: PV Recycling Patents

PV Type	Country of Applicant	Country	Publication NO	Date	IPC-classes	Inventor	Applicant	Title	Document
CSI	China	China	CN000111804697A	12.06.2020	B23K 26/362, B32B 43/00, B09B 5/00	HUANG GUOPING; JIANG YASHUAI; LI JINGNAN; SUN GUAN; YAN XUN; ZHUANG HAO	CECEP SOLAR ENERGY TECHNOLOGY ZHENJIANG CO LTD	[EN] Photovoltaic module recycling method based on laser etching pre-deadhesion technique and post stripping device thereof	https://depatisnet.dpma.de/DepatisNet/depatisnet?action=pdf&docid=CN000111804697A&xxxfull=1
CSI	China	China	CN000211801385U	02.01.2020	B02C 18/16, B01D 47/02, B02C 23/16, B08B 15/04	HUANG SHIZHI; YAN JIERONG; ZHANG BAOZHEN	FUJIAN DEHUA JIEBAO CERAM CO LTD	[EN] Material recovery device for ceramic faceplate production	https://depatisnet.dpma.de/DepatisNet/depatisnet?action=pdf&docid=CN000211801385U&xxxfull=1
CSI	United States of America	United States of America	US000010385421B2	14.05.2018	C22B 3/00, C22B 15/00, C22B 25/06, C01B 33/037, C01B 33/02	HUANG WEN-HSI, US; TAO MENG, US	HUANG WEN HSI, US; TAO MENG, US; UNIV ARIZONA STATE, US	[EN] Recovery of valuable or toxic metals from silicon solar cells	https://depatisnet.dpma.de/DepatisNet/depatisnet?action=pdf&docid=US000010385421B2&xxxfull=1
CSI	United States of America	United States of America	US020180291477A1	14.05.2018	C22B 25/06, C01B 33/037, C22B 3/00, C22B 15/00	HUANG WEN-HSI, US; TAO MENG, US	HUANG WEN HSI, US; TAO MENG, US	[EN] RECOVERY OF VALUABLE OR TOXIC METALS FROM SILICON SOLAR CELLS	https://depatisnet.dpma.de/DepatisNet/depatisnet?action=pdf&docid=US020180291477A1&xxxfull=1
CSI	United States of America	United States of America	WO002017100443A1	08.12.2016	B03B 1/04	HUANG WEN-HSI, US; TAO MENG, US	UNIV ARIZONA STATE, US	[EN] RECOVERY OF VALUABLE OR TOXIC METALS FROM SILICON SOLAR CELLS [FR] RÉCUPÉRATION DE MÉTAUX PRÉCIEUX OU TOXIQUES À PARTIR DE CELLULES SOLAIRES AU SILICIUM	https://depatisnet.dpma.de/DepatisNet/depatisnet?action=pdf&docid=WO002017100443A1&xxxfull=1
CSI	China	China	CN000108823411A	11.06.2018	C22B 5/16, C10L 3/00, C01B 33/021, C01B 33/12	HUANG ZHE; QIN BAOJIA; QIU RONGLIANG; RUAN JUJUN	UNIV SUN YAT SEN	[EN] Method for recycling metal and energy gas from waste solar panel	https://depatisnet.dpma.de/DepatisNet/depatisnet?action=pdf&docid=CN000108823411A&xxxfull=1
CSI	European Patent	European Patent	EP000003838400A1	17.12.2019	H01L 31/04, B01J 20/26, B01J 20/30	HUCKABA ARON, CH; NAZEERUDDIN MOHAMMAD KHAJA, CH; QUEEN WENDY LEE, CH; SUN DANIEL TEAV, CH; SUTANDO ALBERTUS ADRIAN, ID	ECOLE POLYTECHNIQUE FED DE LAUSANNE EPFL EPFL TTO, CH	[DE] PEROWSKIT-SOLARZELLE MIT ADSORPTIONSMATERIAL ZUR ADSORPTION VON TOXISCHEN MATERIALIEN [EN] PEROVSKITE SOLAR CELL PROVIDED WITH AN ADSORBENT MATERIAL FOR ADSORBING TOXIC MATERIALS [FR] CELLULE ...	https://depatisnet.dpma.de/DepatisNet/depatisnet?action=pdf&docid=EP000003838400A1&xxxfull=1
CSI	Taiwan, Republic of China	United States of America	US020120312747A1	12.06.2011	B01D 61/08	IANG JR-JUNG, TW	IANG JR-JUNG, TW	[EN] METHOD AND APPARATUS FOR RECYCLING AND TREATING WASTES OF SILICON WAFER CUTTING AND POLISHING PROCESSES	https://depatisnet.dpma.de/DepatisNet/depatisnet?action=pdf&docid=US020120312747A1&xxxfull=1
CSI	Japan	Japan	JP002018086651A	07.12.2017	B02C 19/10	IBARADA NAOKI; KURIHARA KOJI; OGASAWARA SHINOBU; TSUBOI NOBUYUKI; TSUSHIMA TAKUYA	MITSUBISHI ELECTRIC CORP	[EN] SOLAR BATTERY MODULE RECYCLING METHOD AND SOLAR BATTERY MODULE RECYCLING DEVICE	https://depatisnet.dpma.de/DepatisNet/depatisnet?action=pdf&docid=JP002018086651A&xxxfull=1
CSI	Japan	Japan	JP002018086651A	07.12.2017	B02C 19/10	IBARADA NAOKI; KURIHARA KOJI; OGASAWARA SHINOBU; TSUBOI NOBUYUKI; TSUSHIMA TAKUYA	MITSUBISHI ELECTRIC CORP	[EN] SOLAR BATTERY MODULE RECYCLING METHOD AND SOLAR BATTERY MODULE RECYCLING DEVICE	https://depatisnet.dpma.de/DepatisNet/depatisnet?action=pdf&docid=JP002018086651A&xxxfull=1
CSI	Japan	Japan	JP002020126990A	05.02.2019		IGARASHI GORO	IGARASHI GORO	[EN] METHOD OF RECYCLING PHOTOELECTRIC CONVERSION LAYER	https://depatisnet.dpma.de/DepatisNet/depatisnet?action=pdf&docid=JP002020126990A&xxxfull=1
CSI	Japan	Japan	JP002019030861A	07.08.2017	B01J 20/20, B01J 20/34	IGARASHI GORO	IGARASHI GORO	[EN] RECYCLING METHOD OF PHOTOVOLTAIC POWER GENERATION MODULE USING DRY DISTILLATION	https://depatisnet.dpma.de/DepatisNet/depatisnet?action=pdf&docid=JP002019030861A&xxxfull=1
CSI	Japan	Japan	JP002018140353A	28.02.2017	B09B 3/00	IMOO MAKOTO; ONO HIROYA; OTOMO YUICHI; SAGAE MITSURU; WADA NAOYA	AC CO LTD; KINKI KOGYO; MICRON METAL CO LTD; R2 SOLUTION LLC	[EN] GLASS MEMBER SEPARATION METHOD AND GLASS MEMBER SEPARATION SYSTEM	https://depatisnet.dpma.de/DepatisNet/depatisnet?action=pdf&docid=JP002018140353A&xxxfull=1
CSI	Korea (South)	Korea (South)	KR000102199179B1	02.06.2020	B09B 5/00	JEONG SEONG DAE; KIM JEONG YUN; LEE SEUNGIL	RESET COMPANY CO LTD, KR	[EN] AUTOMATIC FLAKING APPARATUS FOR PHOTOVOLTAIC PANEL	https://depatisnet.dpma.de/DepatisNet/depatisnet?action=pdf&docid=KR000102199179B1&xxxfull=1
CSI	Korea (South)	Japan	JP002021190676A	11.08.2020	B09B 5/00, B09B 3/00	JEONG SEONG DAE; KIM JONG YUN; LEE SEUNG-IL	RESETCOMPANY CO LTD	[EN] AUTOMATED PEELING DEVICE FOR SOLAR PANEL	https://depatisnet.dpma.de/DepatisNet/depatisnet?action=pdf&docid=JP002021190676A&xxxfull=1
CSI	China	China	CN000105312303A	21.04.2015	B09B 5/00	JI ZHICHAO	CHANGZHOU TRINA SOLAR ENERGY	[EN] No-damage recycling method for photovoltaic module	https://depatisnet.dpma.de/DepatisNet/depatisnet?action=pdf&docid=CN000105312303A&xxxfull=1
CSI	China	China	CN000209810908U	29.04.2019	B23P 19/04	JIANG GENSHEN	JIANGSU JINGBAO ENERGY ENG CO LTD	[EN] Solar panel recycling device	https://depatisnet.dpma.de/DepatisNet/depatisnet?action=pdf&docid=CN000209810908U&xxxfull=1
CSI	China	China	CN000108346715A	09.02.2018		JIANG LIANGXING; LAI YANQING; LI JIE; LIU FANGYANG; LIU YEXIANG	UNIV CENTRAL SOUTH	[EN] Recycling method for silicon solar cell	https://depatisnet.dpma.de/DepatisNet/depatisnet?action=pdf&docid=CN000108346715A&xxxfull=1
CSI	Korea (South)	United States of America	US000010847324B2	24.10.2016	B08B 3/08, G01R 31/26, H01G 9/20, H01L 21/00, H01L 21/66, H01L 31/032, H01L 31/18, H01L 51/00, H01L 51/42, H01L 51/44, C25B 15/00, H01L 31/0256, C11D 1/58	JIN YOUNG UN, KR; JUNG HYUN SUK, KR; KIM BYEONG JO, KR; KIM DONG HOE, KR; KWON SEUNG LEE, KR; LEE DONG GEON, KR; PARK SO YEON, KR	GLOBAL FRONTIER CENTER FOR MULTISCALE ENERGY, KR; GLOBAL FRONTIER CT MULTISCALE ENERGY SYSTEMS, KR; RES & BUSINESS FOUNDATION SUNGYUNKWAN, KR; RESEARCH & BUSINESS FOUND SUNGKYUNKWAN UNIV, KR	[EN] Method for recycling perovskite-based photoelectric conversion element	https://depatisnet.dpma.de/DepatisNet/depatisnet?action=pdf&docid=US000010847324B2&xxxfull=1

Table A-2: PV Recycling Patents

PV Type	Country of Applicant	Country	Publication NO	Date	IPC-classes	Inventor	Applicant	Title	Document
CSI	Korea (South)	United States of America	US020180308642A1	24.10.2016	B08B 3/08, H01L 51/44	JIN YOUNG UN, KR; JUNG HYUN SUK, KR; KIM BYEONG JO, KR; KIM DONG HOE, KR; KWON SEUNG LEE, KR; LEE DONG GEON, KR; PARK SO YEON, KR	GLOBAL FRONTIER CT MULTISCALE ENERGY SYSTEMS, KR; RESRARCH & BUSINESS FOUNDATION SUNGKYUNKWAN UNIV, KR	[EN] METHOD FOR RECYCLING PEROVSKITE-BASED PHOTOELECTRIC CONVERSION ELEMENT	https://depatisnet.dpma.de/DepatisNet/depatisnet?action=pdf&docid=US020180308642A1&xxxfull=1
CSI	Korea (South)	Korea (South)	KR102015101525A	26.02.2014	H01L 31/18	JUNG BYUNG JO, KR; KIM JIN HYOK, KR; LEE HAK SOO, KR; PARK NO CHANG, KR; SEO DONG HWAN, KR	KOREA INTERFACIAL SCIENCE AND ENGINEERING INST, KR	[EN] THE RECYCLING METHOD OF SOLAR BATTERY CELL	https://depatisnet.dpma.de/DepatisNet/depatisnet?action=pdf&docid=KR102015101525A&xxxfull=1
TF	Korea (South)	Korea (South)	KR000101916637B1	17.07.2018	H01L 31/18	JUNG SUNG HUN; KANG JI HOON; PARK SUN OK	CNI CO LTD, KR	[EN] Apparatus for manufacturing thin silicon solar cell module	https://depatisnet.dpma.de/DepatisNet/depatisnet?action=pdf&docid=KR000101916637B1&xxxfull=1
CSI	Japan	Japan	JP002016203061A	17.04.2015	H01L 31/042, B09B 5/00	KADO TOMOHIKO; MIYOSHI SHINJI; NAKANOWATARI YUYA; SUGA YUICHIRO; TAKIMOTO YUKIO; WATANABE MAKOTO; YANAI TOSHIYUKI	NPC INC	[EN] RECYCLING APPARATUS OF SOLAR BATTERY MODULE	https://depatisnet.dpma.de/DepatisNet/depatisnet?action=pdf&docid=JP002016203061A&xxxfull=1
CSI	Japan	European Patent	EP000003281972A1	08.04.2016	B09B 3/00, H01L 31/048	KAMO TOHRU, JP	AIST, JP	[DE] VERFAHREN ZUR SOLUBILISIERUNG VON VERNETZTEM EVA UND VERFAHREN ZUR RÜCKGEWINNUNG DES ROHSTOFFS AUS GEBRAUCHTER SOLARZELLE DURCH ANWENDUNG DES SOLUBILISIERUNGSVERFAHRENS [EN] METHOD FOR SOLUBILIZING ...	https://depatisnet.dpma.de/DepatisNet/depatisnet?action=pdf&docid=EP000003281972A1&xxxfull=1
CSI	Japan	Japan	JP002016190177A	31.03.2015	B09B 3/00	KANEKO MASAHIKO; MIZUGUCHI HITOSHI; TAKAHASHI HIROO	UNIV SHINSHU	[EN] METHOD FOR RECOVERING VALUABLE MATERIAL FROM SOLAR BATTERY PANEL AND PROCESSING DEVICE FOR RECOVERING THE SAME	https://depatisnet.dpma.de/DepatisNet/depatisnet?action=pdf&docid=JP002016190177A&xxxfull=1
CSI	Japan	Japan	JP002004042033A	16.05.2003	B09B 5/00, H01L 31/04	KANESHIRO TSUNEO; SHIMAMURA YORIFUMI; YAMAUCHI KIYOSHI	KAWATETSU TECHNO RES KK; SHIMAMURA BIIMU KK	[EN] METHOD OF RECOVERING SILICON WAFER AND TEMPERED GLASS FROM SOLAR BATTERY MODULE	https://depatisnet.dpma.de/DepatisNet/depatisnet?action=pdf&docid=JP002004042033A&xxxfull=1
CSI	Korea (South)	Korea (South)	KR102020080618A	27.12.2018	E04D 1/34, H02S 20/24, H02S 20/25, H01L 31/042	KANG GEON MIN, KR; KANG SEON HEUI; PARK KWANG WOO; YANG JU SUK	KANG GEON MIN, KR	[EN] Manufacturing method of loop filler for environmentally friendly solar panel installation and loop filler for environmentally friendly solar panel installation	https://depatisnet.dpma.de/DepatisNet/depatisnet?action=pdf&docid=KR102020080618A&xxxfull=1
PO	Belgium	Belgium	WO002022069434A1	28.09.2021	H01L 21/00, C07C 21/20	KANG JOO-HEE, FR; PERIN ERIC, FR; PITTROFF MICHAEL, DE; REVELANT DENIS, FR	SOLVAY, BE	[EN] A PROCESS FOR THE PURIFICATION OF FLUORINATED OLEFINS IN GAS PHASE [FR] PROCÉDÉ DE PURIFICATION D'OLÉFINES FLUORÉES EN PHASE GAZEUSE	https://depatisnet.dpma.de/DepatisNet/depatisnet?action=pdf&docid=WO002022069434A1&xxxfull=1
CSI	Korea (South)	Korea (South)	KR000101256574B1	14.11.2011	B09B 5/00, H01L 31/042	KANG SUK MIN, KR; RYU HO JIN, KR	KOREA RES INST CHEM TECH, KR	[EN] METHOD FOR RECYCLING SILICON FROM WASTE SOLAR MODULE	https://depatisnet.dpma.de/DepatisNet/depatisnet?action=pdf&docid=KR000101256574B1&xxxfull=1
CSI	Korea (South)	Korea (South)	KR102012105330A	15.03.2011	B09B 3/00	KANG SUK MIN, KR; RYU HO JIN, KR	KOREA RES INST CHEM TECH, KR	[EN] METHOD FOR RECYCLING SILICON FROM WASTE SOLAR MODULE	https://depatisnet.dpma.de/DepatisNet/depatisnet?action=pdf&docid=KR102012105330A&xxxfull=1
CSI	Korea (South)	Korea (South)	KR102012041290A	27.08.2010	B09B 3/00	KANG SUK MIN, KR; RYU HO JIN, KR	KOREA RES INST CHEM TECH, KR	[EN] METHOD FOR RECYCLING SILICON FROM WASTE SOLAR MODULE	https://depatisnet.dpma.de/DepatisNet/depatisnet?action=pdf&docid=KR102012041290A&xxxfull=1
CSI	Korea (South)	Korea (South)	KR102012000148A	25.06.2010	B09B 3/00, B09B 5/00	KANG SUK MIN, KR; RYU HO JIN, KR	KOREA RES INST CHEM TECH, KR	[EN] METHOD FOR RECYCLING SILICON FROM WASTE SOLAR MODULE	https://depatisnet.dpma.de/DepatisNet/depatisnet?action=pdf&docid=KR102012000148A&xxxfull=1
CSI	Korea (South)	Korea (South)	KR102011031688A	21.09.2009	F23G 7/00, B01D 11/00	KANG SUK MIN, KR; RYU HO JIN, KR	KOREA RES INST CHEM TECH, KR	[EN] THE SOLAR CELL RECYCLING METHODE FROM THE WASTE SOLAR MODULE	https://depatisnet.dpma.de/DepatisNet/depatisnet?action=pdf&docid=KR102011031688A&xxxfull=1
CSI	Japan	China	CN000111604349A	05.08.2019		KANO KIMITOSHI	KANKYO HOZEN SERVICE CO LTD	[EN] An electrical component recovery device and recycling system for solar cell modules	https://depatisnet.dpma.de/DepatisNet/depatisnet?action=pdf&docid=CN000111604349A&xxxfull=1
CSI	Japan	Korea (South)	KR102020103517A	07.08.2019	H01L 31/02, H01L 31/049	KARINO MASATOSHI	KANKYOHOZEN SERVICE CO LTD, JP	[EN] Electrical member recovery device and Recycling system of the solar cell module	https://depatisnet.dpma.de/DepatisNet/depatisnet?action=pdf&docid=KR102020103517A&xxxfull=1
CSI	Japan	Taiwan, Republic of China	TW000202031378A	06.08.2019	B09B 3/00	KARINO MASATOSHI, JP	KANKYO HOZEN SERVICE CO LTD, JP	[EN] Electrical component recycling device and recycling system for solar cell module including a supply part (20), a brush roller (40) and a pressing means (50)	
CSI	Germany	European Patent	EP000003140093B1	30.04.2015	C08J 7/02, C08J 11/04, B29L 31/00, B29K 105/26, B29K 29/00	KERNBAUM SEBASTIAN, DE; LOVIS FLORIAN, DE; SEIBT HORST, DE	SAPERATEC GMBH, DE	[DE] VERFAHREN UND VORRICHTUNG ZUR WIEDERVERWERTUNG VON VERBUNDGLAS [EN] METHOD AND APPARATUS FOR RECYCLING LAMINATED GLASS [FR] PROCÉDÉ ET APPAREIL DE RECYCLAGE DU VERRE FEUILLETÉ	https://depatisnet.dpma.de/DepatisNet/depatisnet?action=pdf&docid=EP000003140093B1&xxxfull=1

Table A-2: PV Recycling Patents

PV Type	Country of Applicant	Country	Publication NO	Date	IPC-classes	Inventor	Applicant	Title	Document
TF	Germany	United States of America	US020200238679A1	13.04.2020	B01J 8/00, C09K 13/02, H01L 31/042, C08J 11/08, C08J 11/06, B03B 9/06, C09K 13/00	KERNBAUM SEBASTIAN, DE; SEIBT HORST, DE	SAPERATEC GMBH, DE	[EN] FACILITY FOR SEPARATING LAYERS IN MULTILAYER SYSTEMS	https://depatisnet.dpma.de/DepatisNet/depatisnet?action=pdf&docid=US020200238679A1&xxxfull=1
CSI	Germany	United States of America	US020160214368A1	22.03.2016		KERNBAUM SEBASTIAN, DE; SEIBT HORST, DE	KERNBAUM SEBASTIAN, DE; SEIBT HORST, DE	[EN] Method For Separating Multilayer Systems	https://depatisnet.dpma.de/DepatisNet/depatisnet?action=pdf&docid=US020160214368A1&xxxfull=1
TF	United States of America	United States of America	US020200282432A1	22.05.2020	B02C 23/38, B02C 21/00, B02C 23/10	KHADILKAR CHANDRASHEKHAR S, US	OWENS BROCKWAY GLASS CONTAINER, US	[EN] Obtaining Cullet from Thin Film Solar Modules	https://depatisnet.dpma.de/DepatisNet/depatisnet?action=pdf&docid=US020200282432A1&xxxfull=1
TF	United States of America	United States of America	US000010688535B1	10.01.2018	B02C 21/00, B02C 23/38, B07C 5/342, H01L 31/048, H01L 31/02, H01L 31/0296, H01L 31/0445	KHADILKAR CHANDRASHEKHAR S, US	OWENS BROCKWAY GLASS CONTAINER, US	[EN] Obtaining cullet from thin film solar modules	https://depatisnet.dpma.de/DepatisNet/depatisnet?action=pdf&docid=US000010688535B1&xxxfull=1
CSI	Korea (South)	Korea (South)	KR102021148684A	01.06.2020	B09B 5/00	KIM HYON SOO, KR	DYNAMIC IND, KR	[EN] Cracked glass separation apparatus from recycling solar panel	https://depatisnet.dpma.de/DepatisNet/depatisnet?action=pdf&docid=KR102021148684A&xxxfull=1
CSI	Korea (South)	Korea (South)	KR102016069643A	09.12.2014	B09B 3/00	KIM JAE IL, KR	LTD PARTNERSHIP JUAN ENERGY, KR	[EN] METHOD FOR RECYCLING SILICON FROM WASTE SOLAR MODULE	https://depatisnet.dpma.de/DepatisNet/depatisnet?action=pdf&docid=KR102016069643A&xxxfull=1
CSI	Korea (South)	Korea (South)	KR102020034100A	21.09.2018		KIM JONG HYUN; LEE CHEOL SONG; SONG KI TAEK, KR	DAEEUN CO LTD, KR	[EN] A Removing Device of Unusable Solar Module and A Recycling System of Unusable Solar Module Having the Same	https://depatisnet.dpma.de/DepatisNet/depatisnet?action=pdf&docid=KR102020034100A&xxxfull=1
CSI	Korea (South)	Korea (South)	KR102021071267A	06.12.2019	B07C 5/34, B07C 5/36, G06Q 50/10	KIM SEONG IL, KR	INFINITY ENERGY CO LTD, KR	[EN] Solar Power Smart Waist Sorting System Through Recognition of Recycling Mark And Method Thereof	https://depatisnet.dpma.de/DepatisNet/depatisnet?action=pdf&docid=KR102021071267A&xxxfull=1
CSI	United States of America	United States of America	US020220184939A1	14.06.2021	B65G 1/02, H02S 99/00	KIM TAESUNG, US	KIM TAESUNG, US	[EN] METHODS AND SYSTEMS FOR RECYCLING END-OF-LIFE PHOTOVOLTAIC MODULES	https://depatisnet.dpma.de/DepatisNet/depatisnet?action=pdf&docid=US020220184939A1&xxxfull=1
CSI	Korea (South)	Korea (South)	KR102014025003A	20.08.2012		KIM YOUNG JIN, KR; LEE JAE RYEONG, KR	KNU INDUSTRY COOPERATION FOUND, KR	[EN] DEVICE FOR RECYCLING CELL FROM SOLAR MODULE	https://depatisnet.dpma.de/DepatisNet/depatisnet?action=pdf&docid=KR102014025003A&xxxfull=1
CSI	Korea (South)	Korea (South)	KR000102154030B1	16.04.2019	H02S 10/00, B65G 13/02	KIM YOUNG KOOK, KR	KIM YOUNG KOOK, KR	[EN] Apparatus for recycling solar cell module	https://depatisnet.dpma.de/DepatisNet/depatisnet?action=pdf&docid=KR000102154030B1&xxxfull=1
CSI	Japan	Japan	JP002014104406A	27.11.2012	B09B 3/00	KIMURA MASANORI	YOKOHAMA YUSHI KOGYO KK	[EN] SOLAR CELL MODULE RECYCLING METHOD	https://depatisnet.dpma.de/DepatisNet/depatisnet?action=pdf&docid=JP002014104406A&xxxfull=1
CDTE	Hungary	United States of America	US000010683565B2	16.04.2018	H01L 31/0296, C22B 7/00, C22B 3/00, H01L 31/042	KISS ZOLTAN J, HU	KISS ZOLTAN J, HU	[EN] Method of reclaiming cadmium and tellurium from CdTe for CdTe photovoltaic modules	https://depatisnet.dpma.de/DepatisNet/depatisnet?action=pdf&docid=US000010683565B2&xxxfull=1
CDTE	Hungary	United States of America	US020190316224A1	16.04.2018	H01L 31/0296, C22B 7/00, H01L 31/042	KISS ZOLTAN J, HU	KISS ZOLTAN J, HU	[EN] METHOD OF RECLAIMING CADMIUM AND TELLURIUM FROM CDTE FOR CDTE PHOTOVOLTAIC MODULES	https://depatisnet.dpma.de/DepatisNet/depatisnet?action=pdf&docid=US020190316224A1&xxxfull=1
CSI	Germany	Germany	DE102008049004B3	25.09.2008		Konrad, Benjamin, Dipl.-Ing. (FH), 01139 Dresden, DE; Werzner, Kristin, Dipl.-Ing., 09600 Oberschöna, DE	Sunicon AG, 09599 Freiberg, DE	[DE] Spaltsieb [EN] Device for separating mixture of glass breakage and cell breakage i.e. silicon broken wafer, during recycling of old solar module, has rods that together with counter wall form ...	https://depatisnet.dpma.de/DepatisNet/depatisnet?action=pdf&docid=DE102008049004B3&xxxfull=1
CSI	Japan	Japan	JP002011173099A	25.02.2010	B09B 5/00, H01L 31/042	KUSHIYA KATSUMI	SHOWA SHELL SEKIYU	[EN] METHOD OF RECYCLING SOLAR CELL MODULE	https://depatisnet.dpma.de/DepatisNet/depatisnet?action=pdf&docid=JP002011173099A&xxxfull=1
CIGS	Japan	European Patent	EP000001830411A1	22.12.2005	H01L 31/048	KUSHIYA KATSUMI, JP; TANAKA MANABU, JP	SHOWA SHELL SEKIYU, JP	[DE] DÜNNFILM-SOLARZELLENMODUL AUF CIS-BASIS, VERFAHREN ZU SEINER HERSTELLUNG UND VERFAHREN ZUM TRENNEN EINES SOLARZELLENMODULS [EN] CIS BASED THIN FILM SOLAR CELL MODULE, METHOD FOR PRODUCING THE ...	https://depatisnet.dpma.de/DepatisNet/depatisnet?action=pdf&docid=EP000001830411A1&xxxfull=1
CIGS	Japan	United States of America	US020080105294A1	22.12.2005	H01L 51/48, B32B 38/10, B32B 37/12	KUSHIYA KATSUMI, JP; TANAKA MANABU, JP	SHOWA SHELL SEKIYU, JP	[EN] Cis Type Thin-Film Photovoltaic Module, Process for Producing the Photovoltaic Module, and Method of Separating the Module	https://depatisnet.dpma.de/DepatisNet/depatisnet?action=pdf&docid=US020080105294A1&xxxfull=1
CIGS	Japan	Japan	WO002008102457A1	22.02.2007	H01L 31/032	KUSHIYA KATSUMI; OKAZAWA TADASHI	KUSHIYA KATSUMI; OKAZAWA TADASHI; SHOWA SHELL SEKIYU, JP	[EN] METHOD OF RECOVERING CONSTITUENT MEMBER OF CIS TYPE THIN-FILM SOLAR CELL MODULE [FR] PROCÉDÉ DE RÉCUPÉRATION D'ÉLÉMENTS CONSTITUTIFS D'UN MODULE DE CELLULE SOLAIRE EN COUCHES MINCES DE TYPE CIS	https://depatisnet.dpma.de/DepatisNet/depatisnet?action=pdf&docid=WO002008102457A1&xxxfull=1

Table A-2: PV Recycling Patents

PV Type	Country of Applicant	Country	Publication NO	Date	IPC-classes	Inventor	Applicant	Title	Document
CIGS	Japan	Japan	JP002006179626A	22.12.2004	H01L 31/042	KUSHIYA KATSUMI; TANAKA MANABU	SHOWA SHELL SEKIYU	[EN] CIS SYSTEM THIN FILM SOLAR CELL MODULE, AND ITS MANUFACTURING METHOD AND SEPARATION METHOD	https://depatisnet.dpma.de/DepatisNet/depatisnet?action=pdf&docid=JP002006179626A&xxxfull=1
CSI	Korea (South)	Korea (South)	KR102020095749A	01.02.2019	C22B 4/00	KYOUNGKEUN YOO	KOREA MARITIME UNIV IND ACAD, KR	[EN] RECYCLING METHOD FOR SPENT SOLAR MODULE USING PYROMETALLURGY	https://depatisnet.dpma.de/DepatisNet/depatisnet?action=pdf&docid=KR102020095749A&xxxfull=1
CSI	China	China	CN000113857216A	29.09.2021	H01L 31/18	LAI DENGGUO; WANG YIN; XU XINHAI	INST URBAN ENVIRONMENT CAS	[EN] Method for recycling waste photovoltaic module	https://depatisnet.dpma.de/DepatisNet/depatisnet?action=pdf&docid=CN000113857216A&xxxfull=1
CSI	China	China	CN000110624936A	27.09.2019	B09B 5/00	LAI DENGGUO; WANG YIN; XU XINHAI	INST URBAN ENVIRONMENT CAS	[EN] Waste photovoltaic module dismounting method capable of realizing silicon slice integral recycling	https://depatisnet.dpma.de/DepatisNet/depatisnet?action=pdf&docid=CN000110624936A&xxxfull=1
CSI	Korea (South)	Korea (South)	KR102020114634A	29.03.2019	B02C 23/08	LEE JONG JO, KR	KUMKANG ENG CORP, KR	[EN] RECYCLING METHOD FOR UNUSABLE SOLAR MODULE	https://depatisnet.dpma.de/DepatisNet/depatisnet?action=pdf&docid=KR102020114634A&xxxfull=1
CSI	Korea (South)	Korea (South)	KR000102283519B1	17.08.2020	H02S 10/00	LEE KYOUNG HEE; SUE BO SUNG; SUE YONG GYO	DAEWON GLOBAL SYSTEM INTEGRATION CO LTD, KR; IL SUNG TECH CO LTD, KR	[EN] Crushing and Recovery Unit for Dry Recycling of Solar Waste Module	https://depatisnet.dpma.de/DepatisNet/depatisnet?action=pdf&docid=KR000102283519B1&xxxfull=1
CSI	Korea (South)	United States of America	US020220194842A1	23.12.2020	B32B 43/00, C03C 12/02, C09D 5/33, B08B 7/00, B09B 3/00	LEE YONG SU, KR	LEE YONG SU, KR	[EN] WASTE GLASS RECOVERY METHOD FOR MANUFACTURING GLASS BEAD	https://depatisnet.dpma.de/DepatisNet/depatisnet?action=pdf&docid=US020220194842A1&xxxfull=1
CSI	China	China	CN000209739889U	14.11.2018	B65F 1/16	LI FENG; REN HUAIZHI	SUOLING ELECTRIC CO LTD	[EN] Solar article recovery device	https://depatisnet.dpma.de/DepatisNet/depatisnet?action=pdf&docid=CN000209739889U&xxxfull=1
TF	China	China	CN000110016566A	17.05.2019	C22B 58/00	LI GUANFU; WANG DING; WANG HAOJIE; WANG LEI; YU SHUKUI	UNIV HOHAI CHANGZHOU	[EN] Method for recycling indium in waste photovoltaic module	https://depatisnet.dpma.de/DepatisNet/depatisnet?action=pdf&docid=CN000110016566A&xxxfull=1
CSI	China	China	CN000113231434A	02.04.2021	B09B 5/00	LI HAIPENG; SU BOJIE; ZHANG XUE	CHINA QUALITY CERTIFICATION CENTER	[EN] Crystalline silicon photovoltaic module recycling method	https://depatisnet.dpma.de/DepatisNet/depatisnet?action=pdf&docid=CN000113231434A&xxxfull=1
CSI	China	China	CN000113245341A	02.04.2021	C22B 7/00	LI HAIPENG; SU BOJIE; ZHANG XUE	CHINA QUALITY CERTIFICATION CENTER	[EN] Method for recycling Metal Wrap Through (MWT) crystalline silicon photovoltaic module	https://depatisnet.dpma.de/DepatisNet/depatisnet?action=pdf&docid=CN000113245341A&xxxfull=1
CSI	China	China	CN000215089127U	28.06.2021	B08B 3/02, H01L 31/18, B08B 5/04	LI JINGTAO; WANG NANA; ZHAI WEI; ZHU JIANPING	ZHONGXIN CHUNXING NEW ENERGY POWER SUZHOU CO LTD	[EN] Movable photovoltaic module disassembling and recycling device	https://depatisnet.dpma.de/DepatisNet/depatisnet?action=pdf&docid=CN000215089127U&xxxfull=1
CSI	China	China	CN000113713891A	28.08.2021	B03B 5/40, B08B 1/00, B02C 23/02, B02C 23/14, B03B 11/00, B08B 1/04, B65G 15/58, B65G 47/22, H01L 31/18	LI JINYU	LI JINYU	[EN] Solar cell waste recycling and re-preparing treatment process	https://depatisnet.dpma.de/DepatisNet/depatisnet?action=pdf&docid=CN000113713891A&xxxfull=1
CSI	China	China	CN000111957715A	23.07.2020		LI LINGXUAN; WANG ZHIQIANG; WU LEI; XIE ZI'AO; YUE CHENGZHI; ZHANG XIANGTAI; ZHANG YUHUI	UNIV QINGHAI	[EN] Technology for recycling waste crystalline silicon solar cell module	https://depatisnet.dpma.de/DepatisNet/depatisnet?action=pdf&docid=CN000111957715A&xxxfull=1
OPV	China	China	EP000003576162A1	24.10.2018	H01L 31/0392, B29B 17/02	LI SHENGCHUN, CN; SUN GANG, CN; TAN MINGLIANG, CN	HANERGY NEW MATERIAL TECH CO LTD, CN	[DE] VERFAHREN ZUM TRENNEN EINES ORGANISCHEN FILMS EINES SOLARZELLENMODULS UND RECYCLINGVERFAHREN [EN] METHOD FOR SEPARATING AN ORGANIC FILM OF A SOLAR CELL MODULE AND METHOD FOR RECYCLING [FR] PROCÉDÉ ...	https://depatisnet.dpma.de/DepatisNet/depatisnet?action=pdf&docid=EP000003576162A1&xxxfull=1
OPV	China	United States of America	US020190371957A1	23.10.2018	H01L 31/024, H01L 31/0445, B32B 43/00	LI SHENGCHUN, CN; SUN GANG, CN; TAN MINGLIANG, CN	HANERGY NEW MATERIAL TECH CO LTD, CN	[EN] Separation Method of Organic Film Module of Solar Cell Module and Recycling Method	https://depatisnet.dpma.de/DepatisNet/depatisnet?action=pdf&docid=US020190371957A1&xxxfull=1
CSI	China	China	CN000107876129A	18.11.2017	B30B 9/30, H01M 10/54	LI WENHAO; QI XIAOYUN; YUE ZHIBAO	YUE ZHIBAO	[EN] Waste garbage recycling processing equipment for production of solar panel components	https://depatisnet.dpma.de/DepatisNet/depatisnet?action=pdf&docid=CN000107876129A&xxxfull=1
PO	Singapore	Singapore	WO002017184079A1	19.04.2017	H01L 31/048, B32B 43/00	LI XIAODONG, SG; LU YANRU, SG; YIN XI JIANG, SG	SINGAPORE POLYTECHNIC, SG	[EN] METHOD AND APPARATUS FOR SEPARATING A COMPONENT FROM A THERMOSET POLYMER ADHERED TO THE COMPONENT [FR] PROCÉDÉ ET APPAREIL POUR SÉPARER UN COMPOSANT À PARTIR D'UN POLYMÈRE THERMODURCI ADHÉRANT ...	https://depatisnet.dpma.de/DepatisNet/depatisnet?action=pdf&docid=WO002017184079A1&xxxfull=1
CSI	Taiwan, Republic of China	Taiwan, Republic of China	TW00000M595572U	18.02.2020	B09B 3/00, B26D 7/01	LIAO JI-BIN, TW; LIN CONG-XIN, TW; ZHANG WEN-JUN, TW; ZHANG ZONG-WEI, TW	GET GREEN ENERGY CORP LTD, TW; MACTECH CORP, TW	[EN] Pre-cutting device of solar panel recycling apparatus	

Table A-2: PV Recycling Patents

PV Type	Country of Applicant	Country	Publication NO	Date	IPC-classes	Inventor	Applicant	Title	Document
CSI	Taiwan, Republic of China	Taiwan, Republic of China	TW000202132171A	18.02.2020	B09B 3/00	LIAO JI-BIN, TW; LIN CONG-XIN, TW; ZHANG WEN-JUN, TW; ZHANG ZONG-WEI, TW	GET GREEN ENERGY CORP LTD, TW; MACTECH CORP, TW	[EN] Solar panel recycling apparatus and solar panel recycling method capable of recycling wasted solar panels	
CSI	Taiwan, Republic of China	United States of America	US020210138520A1	16.10.2020	B09B 5/00	LIN CHIH-LUNG, TW; WANG CHENG CHUAN, TW; WANG TENG-YU, TW	IND TECH RES INST, TW	[EN] RECYCLE APPARATUS FOR PHOTOVOLTAIC MODULE	https://depatisnet.dpma.de/DepatisNet/depatisnet?action=pdf&docid=US020210138520A1&xxxfull=1
CSI	China	China	CN000212085168U	30.03.2020	B02C 4/42, B02C 4/28, B08B 15/04, B02C 4/08, B01D 50/00	LIN XIUZAI	LIN XIUZAI	[EN] Waste garbage recycling device for solar cell panel assembly production	https://depatisnet.dpma.de/DepatisNet/depatisnet?action=pdf&docid=CN000212085168U&xxxfull=1
CSI	China	China	CN000216015407U	28.10.2021	B09B 3/40	LIU DEJUN; WANG CAIXIA; WU YAO; YAN SHUAI; ZHAO XIAOXIA; ZONG JUN	LIMITED COMPANY OF STATE ELECTRICITY PROJECT GROUP INSTITUTE OF SCIENCE AND TECH	[EN] Photovoltaic module recovery equipment	https://depatisnet.dpma.de/DepatisNet/depatisnet?action=pdf&docid=CN000216015407U&xxxfull=1
CSI	China	China	WO002017113755A1	18.07.2016	B09B 5/00	LIU JIAN, CN; SU GUANXIAN, CN	COREHELM ELECTRONIC MAT CO LTD, CN	[EN] METHOD FOR RECYCLING CRYSTALLINE SILICON SOLAR CELL ASSEMBLIES [FR] PROCÉDÉ DE RECYCLAGE D'ENSEMBLES DE CELLULES SOLAIRES EN SILICIUM CRISTALLIN	https://depatisnet.dpma.de/DepatisNet/depatisnet?action=pdf&docid=WO002017113755A1&xxxfull=1
CSI	China	China	CN000105618461A	31.12.2015	B09B 5/00	LIU JIAN; SU GUANXIAN	DONGGUAN COREHELM ELECTRONIC MAT TECH CO LTD	[EN] Method for recycling crystalline silicon solar cell module	https://depatisnet.dpma.de/DepatisNet/depatisnet?action=pdf&docid=CN000105618461A&xxxfull=1
CSI	China	China	CN000106391655A	27.09.2016		LIU JIAN; YAN SHAOJIE; ZHANG XIAOFEI	DONGGUAN COREHELM ELECTRONIC MAT TECH CO LTD	[EN] Invalid crystalline silicon photovoltaic module recycling cracking furnace	https://depatisnet.dpma.de/DepatisNet/depatisnet?action=pdf&docid=CN000106391655A&xxxfull=1
CSI	China	China	CN000210041739U	28.06.2019	H01L 31/048	LIU JIANGFENG; LU XIAOMAN; XU YINGCHUN; ZI WEI	UNIV XINYANG NORMAL	[EN] Easy-to-recycle photovoltaic module	https://depatisnet.dpma.de/DepatisNet/depatisnet?action=pdf&docid=CN000210041739U&xxxfull=1
CSI	China	China	CN000211027352U	03.12.2019	B08B 13/00, B32B 38/10, B08B 1/00	LIU SHENGQIANG; ZHUANG HULIANG	CHANGZHOU RUISAI ENVIRONMENTAL PROTECTION TECH CO LTD	[EN] Aluminum frame cleaning machine for recycling scrapped photovoltaic module	https://depatisnet.dpma.de/DepatisNet/depatisnet?action=pdf&docid=CN000211027352U&xxxfull=1
CSI	Japan	European Patent	EP000003412363A1	29.03.2018		MATSUDA GENICHIRO, JP; SUZUKI NORIYUKI, JP; UTUMI SYOUGO, JP; YOSHIOKA AKIO, JP	PANASONIC IP MAN CO LTD, JP	[DE] VORRICHTUNG ZUM ZERLEGEN EINES PLATTENFÖRMIGEN GEGENSTANDES [EN] PLATE-SHAPED ARTICLE DISASSEMBLING DEVICE [FR] DISPOSITIF DE DÉMONTAGE D'UN ARTICLE EN FORME DE PLAQUE	https://depatisnet.dpma.de/DepatisNet/depatisnet?action=pdf&docid=EP000003412363A1&xxxfull=1
CSI	Japan	European Patent	EP000003412363B1	29.03.2018		MATSUDA GENICHIRO, JP; SUZUKI NORIYUKI, JP; UTUMI SYOUGO, JP; YOSHIOKA AKIO, JP	PANASONIC IP MAN CO LTD, JP	[DE] VORRICHTUNG ZUM ZERLEGEN EINES PLATTENFÖRMIGEN GEGENSTANDES [EN] PLATE-SHAPED ARTICLE DISASSEMBLING DEVICE [FR] DISPOSITIF DE DÉMONTAGE D'UN ARTICLE EN FORME DE PLAQUE	https://depatisnet.dpma.de/DepatisNet/depatisnet?action=pdf&docid=EP000003412363B1&xxxfull=1
CSI	Japan	Japan	JP002009272654A	19.08.2009	G06K 19/07, G06K 19/06, G06K 19/00	MATSUKAWA TOMONORI	SHARP KK	[EN] SOLAR CELL MODULE, AND RECYCLING METHOD OF SOLAR CELL MODULE	https://depatisnet.dpma.de/DepatisNet/depatisnet?action=pdf&docid=JP002009272654A&xxxfull=1
CSI	Japan	Taiwan, Republic of China	TW000202033286A	11.03.2019	B09B 5/00, H01L 31/042	MATSUMOTO KENJI, JP; TAKIMOTO YUKIO, JP; YAUCHI TOSHIYUKI, JP	NPC INCORPORATED, JP	[EN] Recycling apparatus of solar cell module capable of reliably and easily peeling and separating an accidentally broken glass substrate from other materials	
CSI	Japan	European Patent	EP000003936245A1	06.03.2019	H01L 31/048, B09B 5/00	MATSUMOTO KENJI, JP; TAKIMOTO YUKIO, JP; YAUCHI TOSHIYUKI, JP	NPC INCORPORATED, JP	[DE] RECYCLING-VORRICHTUNG FÜR SOLARZELLENMODUL [EN] RECYCLING APPARATUS FOR SOLAR CELL MODULE [FR] APPAREIL DE RECYCLAGE POUR MODULE DE CELLULE SOLAIRE	https://depatisnet.dpma.de/DepatisNet/depatisnet?action=pdf&docid=EP000003936245A1&xxxfull=1
CSI	Japan	United States of America	US020220140175A1	06.03.2019	H01L 31/048, B09B 3/35	MATSUMOTO KENJI, JP; TAKIMOTO YUKIO, JP; YAUCHI TOSHIYUKI, JP	NPC INCORPORATED, JP	[EN] RECYCLING APPARATUS FOR SOLAR CELL MODULE	https://depatisnet.dpma.de/DepatisNet/depatisnet?action=pdf&docid=US020220140175A1&xxxfull=1
CSI	Japan	Japan	WO002020179002A1	06.03.2019	H01L 31/048, B09B 5/00	MATSUMOTO KENJI, JP; TAKIMOTO YUKIO, JP; YAUCHI TOSHIYUKI, JP	NPC INCORPORATED, JP	[EN] RECYCLING APPARATUS FOR SOLAR CELL MODULE [FR] APPAREIL DE RECYCLAGE POUR MODULE DE CELLULE SOLAIRE	https://depatisnet.dpma.de/DepatisNet/depatisnet?action=pdf&docid=WO002020179002A1&xxxfull=1
CSI	Japan	Japan	JP002019069428A	11.10.2017	B26D 7/06, B09B 5/00, B26D 3/28, B26D 7/02, H01L 31/042	MATSUMOTO KENJI; TAKIMOTO YUKIO; YANAI TOSHIYUKI	NPC INC	[EN] RECYCLING APPARATUS OF SOLAR CELL MODULE	https://depatisnet.dpma.de/DepatisNet/depatisnet?action=pdf&docid=JP002019069428A&xxxfull=1
CSI	United States of America	United States of America	US020140251820A1	06.03.2014	C25B 1/00, C01B 19/00	MAYS TIM, US; OMOFOMA MATTHEW, US; WANG WENMING, US	FIRST SOLAR INC, US	[EN] METHOD OF RECOVERING A METAL FROM A SOLUTION	https://depatisnet.dpma.de/DepatisNet/depatisnet?action=pdf&docid=US020140251820A1&xxxfull=1
CSI	Japan	European Patent	EP000003834955A1	19.07.2019	C08J 11/12, H01L 31/04, H01L 31/042	MINABE YUICHIRO, JP; SASAI MASARU, JP	TOKUYAMA CORP, JP	[DE] VERFAHREN ZUR RÜCKGEWINNUNG VON WERTVOLLEN OBJEKTEN AUS SOLARZELLENMODULEN [EN] METHOD FOR RECOVERING VALUABLE OBJECT FROM SOLAR CELL MODULE [FR] PROCÉDÉ DE RÉCUPÉRATION D'OBJET DE VALEUR À PARTIR ...	https://depatisnet.dpma.de/DepatisNet/depatisnet?action=pdf&docid=EP000003834955A1&xxxfull=1
CSI	Japan	United States of America	US020210305450A1	19.07.2019	C08J 11/12	MINABE YUICHIRO, JP; SASAI MASARU, JP	TOKUYAMA CORP, JP	[EN] Method of Recovering Valuable Materials from Photovoltaic Module	https://depatisnet.dpma.de/DepatisNet/depatisnet?action=pdf&docid=US020210305450A1&xxxfull=1

Table A-2: PV Recycling Patents

PV Type	Country of Applicant	Country	Publication NO	Date	IPC-classes	Inventor	Applicant	Title	Document
CSI	Japan	Japan	WO002022065479A1	27.09.2021	H01L 31/048, B24C 11/00, B24C 1/00, B02C 17/20, B02C 19/00	MIYAKO TAKERU, JP	SINTOKOGIO LTD, JP	[EN] METHOD FOR RECYCLING SOLAR PANEL, AND DEVICE FOR RECYCLING SOLAR PANEL [FR] PROCÉDÉ DE RECYCLAGE DE PANNEAU SOLAIRE, ET DISPOSITIF DE RECYCLAGE DE PANNEAU SOLAIRE	https://depatisnet.dpma.de/DepatisNet/depatisnet?action=pdf&docid=WO002022065479A1&xxxfull=1
CSI	Japan	Japan	WO002018096716A1	07.06.2017	H01L 31/042, B09B 3/00	MIYOSHI SHINJI, JP; MONDO TOMOHIKO, JP; TAKIMOTO YUKIO, JP; WATANABE SHIN, JP	NPC INCORPORATED, JP	[EN] SOLAR CELL MODULE RECYCLING APPARATUS [FR] APPAREIL DE RECYCLAGE DE MODULE DE CELLULE SOLAIRE	https://depatisnet.dpma.de/DepatisNet/depatisnet?action=pdf&docid=WO002018096716A1&xxxfull=1
CSI	Japan	Japan	JP002021151634A	24.03.2020	B09B 3/00	MOROSAWA YASUHIRO; OKADA KOICHI; SEGAWA NOBORU; SHIMURA NAOHIKO; TAKEDA SHINJI; TAKIZAWA TAKASHI	TOSHIBA ENV SOLUTIONS CORP	[EN] REPROCESSING METHOD OF GLASS SHEET USED IN SOLAR BATTERY PANEL AND RECYCLING METHOD OF SOLAR BATTERY PANEL	https://depatisnet.dpma.de/DepatisNet/depatisnet?action=pdf&docid=JP002021151634A&xxxfull=1
CSI	Japan	Japan	JP002019205982A	30.05.2018	H02S 40/00	MOROSAWA YASUHIRO; SEGAWA NOBORU	TOSHIBA ENV SOLUTIONS CORP	[EN] RECYCLING METHOD OF SOLAR CELL MODULE AND RECYCLING DEVICE USED FOR THE SAME	https://depatisnet.dpma.de/DepatisNet/depatisnet?action=pdf&docid=JP002019205982A&xxxfull=1
CSI	Japan	Japan	JP002018020267A	01.08.2016	B09B 5/00, H01L 31/042	MOROSAWA YASUHIRO; SEGAWA NOBORU	TOSHIBA ENV SOLUTIONS CORP	[EN] RECYCLING METHOD OF SOLAR CELL MODULE	https://depatisnet.dpma.de/DepatisNet/depatisnet?action=pdf&docid=JP002018020267A&xxxfull=1
CSI	United States of America	United States of America	US000009214353B2	26.02.2013	B23K 26/00, B23K 26/06, B23K 26/08, B23K 26/30, H01L 21/268, H01L 21/304, H01L 31/18, H01L 25/065, H01L 33/00	MOSLEHI MEHRDAD M, US; RANA VIRENDA V, US; SEUTTER SEAN, US; TAMILMANI SUBRAMANIAN, US; YONEHARA TAKAO, US	SOLEXEL INC, US	[EN] Systems and methods for laser splitting and device layer transfer	https://depatisnet.dpma.de/DepatisNet/depatisnet?action=pdf&docid=US000009214353B2&xxxfull=1
CSI	United States of America	United States of America	US000008448318B2	13.08.2010		MURPHY STEPHEN P, US	FIRST SOLAR INC, US; MURPHY STEPHEN P, US	[EN] Removal tool	https://depatisnet.dpma.de/DepatisNet/depatisnet?action=pdf&docid=US000008448318B2&xxxfull=1
CSI	Japan	United States of America	US020210053868A1	10.11.2020	C03C 1/00, C03B 19/08, B09B 3/00	NAKANO SHIGENORI, JP; TANAKA HIROKI, JP	TOTTORI RESOURCE RECYCLING INC, JP	[EN] METHOD FOR RECYCLING SOLAR CELL MODULE GLASS	https://depatisnet.dpma.de/DepatisNet/depatisnet?action=pdf&docid=US020210053868A1&xxxfull=1
CSI	European Patent	European Patent	EP000003623349A1	21.09.2018	C03C 11/00, B09B 3/00	NAKANO SHIGENORI, JP; TANAKA HIROKI, JP	TOTTORI RESOURCE RECYCLING INC, JP	[DE] VERFAHREN ZUM RECYCLING VON SOLARZELLENMODULGLAS [EN] METHOD FOR RECYCLING SOLAR CELL MODULE GLASS [FR] PROCÉDÉ DE RECYCLAGE DE VERRE DE MODULE PHOTOVOLTAÏQUE	https://depatisnet.dpma.de/DepatisNet/depatisnet?action=pdf&docid=EP000003623349A1&xxxfull=1
CSI	European Patent	European Patent	EP000003623349A4	21.09.2018	C03B 1/00, B09B 3/00, C03C 11/00	NAKANO SHIGENORI, JP; TANAKA HIROKI, JP	TOTTORI RESOURCE RECYCLING INC, JP	[DE] RECYCLING-VERFAHREN FÜR SOLARZELLENMODULGLAS [EN] METHOD FOR RECYCLING SOLAR CELL MODULE GLASS [FR] PROCÉDÉ DE RECYCLAGE DE VERRE DE MODULE PHOTOVOLTAÏQUE	https://depatisnet.dpma.de/DepatisNet/depatisnet?action=pdf&docid=EP000003623349A4&xxxfull=1
CSI	Japan	United States of America	US000010865137B2	21.09.2018	C03B 19/08, C03C 1/00, B09B 3/00	NAKANO SHIGENORI, JP; TANAKA HIROKI, JP	TOTTORI RESOURCE RECYCLING INC, JP	[EN] Method for recycling solar cell module glass	https://depatisnet.dpma.de/DepatisNet/depatisnet?action=pdf&docid=US000010865137B2&xxxfull=1
CSI	Japan	United States of America	US020200148585A1	21.09.2018	C03C 1/00, B09B 3/00, C03B 19/08	NAKANO SHIGENORI, JP; TANAKA HIROKI, JP	TOTTORI RESOURCE RECYCLING INC, JP	[EN] METHOD FOR RECYCLING SOLAR CELL MODULE GLASS	https://depatisnet.dpma.de/DepatisNet/depatisnet?action=pdf&docid=US020200148585A1&xxxfull=1
CSI	Japan	Japan	WO002019065489A1	21.09.2018	B09B 3/00, C03C 11/00	NAKANO SHIGENORI, JP; TANAKA HIROKI, JP	TOTTORI RESOURCE RECYCLING INC, JP	[EN] METHOD FOR RECYCLING SOLAR CELL MODULE GLASS [FR] PROCÉDÉ DE RECYCLAGE DE VERRE DE MODULE PHOTOVOLTAÏQUE	https://depatisnet.dpma.de/DepatisNet/depatisnet?action=pdf&docid=WO002019065489A1&xxxfull=1
CSI	Japan	China	CN000111094196A	21.09.2018	B09B 3/00, C03C 11/00	NAKANO SHIGENORI; TANAKA HIROKI	TOTTORI RESOURCE RECYCLING INC	[EN] METHOD FOR RECYCLING SOLAR CELL MODULE GLASS	https://depatisnet.dpma.de/DepatisNet/depatisnet?action=pdf&docid=CN000111094196A&xxxfull=1
PO	Japan	Japan	JP002019207900A	30.09.2016	B32B 27/20, B32B 27/36	NAKATANI TOSHIHIRO	FUJIFILM CORP	[EN] BACK SHEET FOR SOLAR CELL, MANUFACTURING METHOD OF THE SAME, SOLAR CELL MODULE, AND RECYCLING METHOD OF THE SAME	https://depatisnet.dpma.de/DepatisNet/depatisnet?action=pdf&docid=JP002019207900A&xxxfull=1
CSI	Mexico	Mexico	MX000000362827B	18.12.2014	B03B 9/04, G05B 19/045, C04B 14/22	NATAN CORNEJO CHAIT, MX	INTEPPCO S A DE C V, MX	[EN] AUTOMATED SYSTEM WITH THE USE OF RENEWABLE ENERGIES FOR THE PRODUCTION OF ECOLOGICAL AND SUSTAINABLE SUBSTITUTES FROM RAW MATERIALS BASED ON RECYCLED GLASS AND PROCESS THEREOF. [XX] SISTEMA AUTOMATIZADO ...	
CSI	United States of America	United States of America	US020110083972A1	08.10.2010	C25B 9/00	OJEBUOBOH FUNSHO K, US; WANG WENMING, US	FIRST SOLAR INC, US	[EN] ELECTROCHEMICAL METHOD AND APPARATUS FOR REMOVING COATING FROM A SUBSTRATE	https://depatisnet.dpma.de/DepatisNet/depatisnet?action=pdf&docid=US020110083972A1&xxxfull=1

Table A-2: PV Recycling Patents

PV Type	Country of Applicant	Country	Publication NO	Date	IPC-classes	Inventor	Applicant	Title	Document
CSI	United States of America	United States of America	WO002011044340A1	07.10.2010		OJEBUOBOH FUNSHO K, US; WANG WENMING, US	FIRST SOLAR INC, US; OJEBUOBOH FUNSHO K, US; WANG WENMING, US	[EN] ELECTROCHEMICAL METHOD AND APPARATUS FOR REMOVING COATING FROM A SUBSTRATE [FR] PROCÉDÉ ÉLECTROCHIMIQUE ET APPAREIL PERMETTANT D'ÉLIMINER UN REVÊTEMENT D'UN SUBSTRAT	https://depatisnet.dpma.de/DepatisNet/depatisnet?action=pdf&docid=WO002011044340A1&xxxfull=1
CSI	Italy	European Patent	EP000003242754B1	08.01.2016	B32B 43/00, B29C 45/16, B29B 17/02, B09B 5/00, H01L 31/18	OMIZZOLO FABRIZIO, IT	OMIZZOLO GIACOMO, IT	[DE] VERFAHREN UND VORRICHTUNG ZUR ENTSORGUNG VON FOTOVOLTAIKMODULEN [EN] METHOD AND APPARATUS FOR THE DISPOSAL OF PHOTOVOLTAIC PANELS [FR] PROCÉDÉ ET APPAREIL D'ÉLIMINATION DE PANNEAUX PHOTOVOLTAÏQUES	https://depatisnet.dpma.de/DepatisNet/depatisnet?action=pdf&docid=EP000003242754B1&xxxfull=1
CSI	Korea (South)	Korea (South)	KR102020141215A	10.06.2019		PAIK JONG MYUNG	APEC CO LTD, KR	[EN] ECO RECYCLING SYSTEM OF UNUSABLE SOLAR MODULE	https://depatisnet.dpma.de/DepatisNet/depatisnet?action=pdf&docid=KR102020141215A&xxxfull=1
TF	Germany	Germany	DE102008058530A1	21.11.2008	B03B 7/00, B03B 9/00, B09B 3/00, B09B 5/00, H01L 31/18, B29B 17/02	Palitzsch, Wolfram, Dr., 09599 Freiberg, DE	Loser, Ulrich, 09661 Striegistal, DE; Palitzsch, Wolfram, Dr., 09599 Freiberg, DE	[DE] Technisches Verfahren zum Recycling von Dünnschichtsolarzellenmodulen [EN] Method for recycling a thin layer solar module during simultaneous recovering of recyclable material, by loading photovoltaic ...	https://depatisnet.dpma.de/DepatisNet/depatisnet?action=pdf&docid=DE102008058530A1&xxxfull=1
CSI	China	European Patent	EP000002281310B1	19.05.2009	H01L 31/032	PALM JÖRG, DE	CNBM BENGBU DESIGN & RES INSTITUTE FOR GLASS INDUSTRY CO LTD, CN	[DE] SCHICHTSYSTEM FÜR SOLARZELLEN [EN] LAYER SYSTEM FOR SOLAR CELLS [FR] SYSTÈME MULTICOUCHE POUR CELLULES SOLAIRES	https://depatisnet.dpma.de/DepatisNet/depatisnet?action=pdf&docid=EP000002281310B1&xxxfull=1
CSI	Korea (South)	Korea (South)	KR000102145043B1	19.05.2020	H02S 20/30, G02B 5/08, G02B 3/00, G02B 1/14, C09J 201/00, C09J 7/22	PARK DOO SUNG; PARK KI JU, KR	SMART POWER CO LTD, KR	[EN] Recycling Solar Module with Rod Convex Lens	https://depatisnet.dpma.de/DepatisNet/depatisnet?action=pdf&docid=KR000102145043B1&xxxfull=1
CSI	Korea (South)	Korea (South)	KR102021033638A	19.09.2019		PARK JONG GAB, KR	PARK JONG GAB, KR	[EN] Solar Panel recycle System	https://depatisnet.dpma.de/DepatisNet/depatisnet?action=pdf&docid=KR102021033638A&xxxfull=1
CSI	Korea (South)	Korea (South)	KR102022026695A	26.08.2020	H02S 10/00, B07B 9/00, B07B 1/28	PARK SE WOOK; SUE BO SUNG; SUE YONG GYU	DAEWON GLOBAL SYSTEM INTEGRATION CO LTD, KR; IL SUNG TECH CO LTD, KR	[EN] Crushing and Recovery System for Dry Recycling of Solar Waste Module	https://depatisnet.dpma.de/DepatisNet/depatisnet?action=pdf&docid=KR102022026695A&xxxfull=1
CSI	Italy	Italy	WO002013057035A1	11.10.2012	B02C 4/08	PASIN ANDREA, IT	COMPTON S R L, IT; PASIN ANDREA, IT	[EN] A METHOD AND MACHINE TO ASSIST RECYCLING OF PHOTOVOLTAIC PANELS [FR] PROCÉDÉ ET MACHINE PERMETTANT DE FACILITER LE RECYCLAGE DE PANNEAUX SOLAIRES PHOTOVOLTAÏQUES	https://depatisnet.dpma.de/DepatisNet/depatisnet?action=pdf&docid=WO002013057035A1&xxxfull=1
CDTE	United States of America	United States of America	US000008187555B2	15.12.2009		PAVOL MARK JEFFREY, US; RATHWEG CHRISTOPHER, US; REED MAX WILLIAM, US	PAVOL MARK JEFFREY, US; PRIMESTAR SOLAR INC, US; RATHWEG CHRISTOPHER, US; REED MAX WILLIAM, US	[EN] System for cadmium telluride (CdTe) reclamation in a vapor deposition conveyor assembly	https://depatisnet.dpma.de/DepatisNet/depatisnet?action=pdf&docid=US000008187555B2&xxxfull=1
CDTE	United States of America	United States of America	US020110142746A1	15.12.2009	C23C 16/54	PAVOL MARK JEFFREY, US; RATHWEG CHRISTOPHER, US; REED MAX WILLIAM, US	PRIMESTAR SOLAR INC, US	[EN] SYSTEM AND PROCESS FOR CADMIUM TELLURIDE (CdTe) RECLAMATION IN A VAPOR DEPOSITION CONVEYOR ASSEMBLY	https://depatisnet.dpma.de/DepatisNet/depatisnet?action=pdf&docid=US020110142746A1&xxxfull=1
CSI	China	China	CN000111069234A	18.12.2019	B02C 1/14, B09B 5/00	PENG YE	XUZHOU BAFANG NETWORK TECH CO LTD	[EN] Copper wire recovery equipment and method for photovoltaic solar panel recycling	https://depatisnet.dpma.de/DepatisNet/depatisnet?action=pdf&docid=CN000111069234A&xxxfull=1
CDTE	United States of America	United States of America	US000008404177B2	31.10.2011	C23C 16/06, B01D 7/00	RATHWEG CHRISTOPHER, US	PRIMESTAR SOLAR INC, US; RATHWEG CHRISTOPHER, US	[EN] System for recovery of cadmium telluride (CdTe) from system components used in the manufacture of photovoltaic (PV) modules	https://depatisnet.dpma.de/DepatisNet/depatisnet?action=pdf&docid=US000008404177B2&xxxfull=1
CDTE	United States of America	United States of America	US020120045374A1	31.10.2011		RATHWEG CHRISTOPHER, US	PRIMESTAR SOLAR INC, US; RATHWEG CHRISTOPHER, US	[EN] SYSTEM FOR RECOVERY OF CADMIUM TELLURIDE (CdTe) FROM SYSTEM COMPONENTS USED IN THE MANUFACTURE OF PHOTOVOLTAIC (PV) MODULES	https://depatisnet.dpma.de/DepatisNet/depatisnet?action=pdf&docid=US020120045374A1&xxxfull=1
CDTE	United States of America	United States of America	US000008048194B2	16.12.2009		RATHWEG CHRISTOPHER, US	PRIMESTAR SOLAR INC, US	[EN] System and process for recovery of cadmium telluride (CdTe) from system components used in the manufacture of photovoltaic (PV) modules	https://depatisnet.dpma.de/DepatisNet/depatisnet?action=pdf&docid=US000008048194B2&xxxfull=1
CDTE	United States of America	United States of America	US020110138964A1	16.12.2009	B01L 7/00	RATHWEG CHRISTOPHER, US	PRIMESTAR SOLAR INC, US	[EN] SYSTEM AND PROCESS FOR RECOVERY OF CADMIUM TELLURIDE (CdTe) FROM SYSTEM COMPONENTS USED IN THE MANUFACTURE OF PHOTOVOLTAIC (PV) MODULES	https://depatisnet.dpma.de/DepatisNet/depatisnet?action=pdf&docid=US020110138964A1&xxxfull=1
TF	United States of America	United States of America	WO002011075416A1	10.12.2010		REED JAMES D, US; WANG WENMING, US	FIRST SOLAR INC, US; REED JAMES D, US; WANG WENMING, US	[EN] FILM REMOVAL [FR] ELIMINATION DE FILM	https://depatisnet.dpma.de/DepatisNet/depatisnet?action=pdf&docid=WO002011075416A1&xxxfull=1

Table A-2: PV Recycling Patents

PV Type	Country of Applicant	Country	Publication NO	Date	IPC-classes	Inventor	Applicant	Title	Document
CSI	Italy	European Patent	EP000003089825B1	18.12.2014	B02C 21/00, B02C 21/02, B02C 23/14, B09B 3/00, B29B 17/02, B02C 13/04, B29B 17/04, B09B 5/00, B29L 7/00	REGGI RENATO, IT	LA MIA ENERGIA SCARL, IT	[DE] DE-MONTAGESYSTEM FÜR EIN FOTOVOLTAIKMODUL ZUR VERWERTUNG VON AUSGANGSMATERIALIEN [EN] DE-ASSEMBLING SYSTEM FOR A PHOTOVOLTAIC PANEL ENABLING SALVAGE OF ORIGINAL MATERIALS [FR] SYSTÈME DE DÉMONTAGE ...	https://depatisnet.dpma.de/DepatisNet/depatisnet?action=pdf&docid=EP000003089825B1&xxxfull=1
CSI	Japan	Japan	JP002019209219A	30.05.2018	B29B 17/02, B09B 1/00, H02S 40/00	SAGAE MITSURU	MICRON METAL CO LTD	[EN] TRANSPARENT COVER LAYER SEPARATION/COLLECTION METHOD AND TRANSPARENT COVER LAYER SEPARATION/COLLECTION DEVICE	https://depatisnet.dpma.de/DepatisNet/depatisnet?action=pdf&docid=JP002019209219A&xxxfull=1
CSI	Japan	Japan	JP002015110201A	06.12.2013	H01L 31/042, B09B 5/00	SAKAMOTO JUNICHI; TAKAHASHI MOTOO; UTSUNOMIYA KEIICHIRO	MITSUBISHI ELECTRIC CORP	[EN] SOLAR BATTERY MODULE RECYCLING METHOD	https://depatisnet.dpma.de/DepatisNet/depatisnet?action=pdf&docid=JP002015110201A&xxxfull=1
TF	Germany	United States of America	US020090308535A1	08.06.2009		SCHMIEDER FRANK, DE; WAGNER UWE, DE	SCHMIEDER FRANK; WAGNER UWE	[EN] Method for Recycling Thin-Film Solar Cell Modules	https://depatisnet.dpma.de/DepatisNet/depatisnet?action=pdf&docid=US020090308535A1&xxxfull=1
TF	Germany	Japan	JP002009302533A	04.06.2009		SCHMIEDER FRANK; WAGNER UWE	JENOPTIK AUTOMATISIERUNGSTECH	[EN] METHOD FOR RECYCLING THIN-FILM SOLAR CELL MODULE	https://depatisnet.dpma.de/DepatisNet/depatisnet?action=pdf&docid=JP002009302533A&xxxfull=1
CSI	Japan	Japan	JP002014054593A	12.09.2012	B09B 5/00, H01L 31/042	SEGAWA NOBORU	TERUMU KK	[EN] RECYCLING APPARATUS AND RECYCLE METHOD FOR SOLAR BATTERY PANEL	https://depatisnet.dpma.de/DepatisNet/depatisnet?action=pdf&docid=JP002014054593A&xxxfull=1
CSI	China	China	CN000209929333U	30.07.2019	H01L 31/00	SHI JUNFENG; WANG MENG; WANG YONGWEI; WEI CHUNYAN; ZHU JIE	SUZHOU RIYIXIN ELECTRONIC TECH CO LTD	[EN] Movable photovoltaic module disassembling and recycling device	https://depatisnet.dpma.de/DepatisNet/depatisnet?action=pdf&docid=CN000209929333U&xxxfull=1
CSI	China	China	CN000102500602A	07.11.2011	B09B 5/00, H01L 31/18	SHIYUAN WANG	YINGLI GROUP LTD	[EN] Equipment and method for recycling photovoltaic module	https://depatisnet.dpma.de/DepatisNet/depatisnet?action=pdf&docid=CN000102500602A&xxxfull=1
CSI	Korea (South)	Korea (South)	KR102019035112A	26.09.2017	B02C 21/00, B02C 18/24, B02C 18/22	SONG KI TAEK, KR	DAEEUN CO LTD, KR	[EN] A Recycling System of Unusable Solar Module	https://depatisnet.dpma.de/DepatisNet/depatisnet?action=pdf&docid=KR102019035112A&xxxfull=1
CSI	China	China	CN000106801143A	22.01.2017	C22B 11/00, C01B 33/037	SU GUANXIAN; ZHANG XIAOFEI	COREHELM ELECTRONIC TECH CO LTD	[EN] Method for recycling silver of waste solar cell panel	https://depatisnet.dpma.de/DepatisNet/depatisnet?action=pdf&docid=CN000106801143A&xxxfull=1
CSI	China	China	CN000106629738A	12.01.2017	C01F 7/02, C22B 7/00, C22B 11/00, C25C 1/20, H01L 31/18	SU GUANXIAN; ZHANG XIAOFEI	DONGGUAN COREHELM ELECTRONIC MAT TECH CO LTD	[EN] Method of extracting silver from crystalline silicon solar panel	https://depatisnet.dpma.de/DepatisNet/depatisnet?action=pdf&docid=CN000106629738A&xxxfull=1
CSI	China	China	CN000110964907A	28.09.2018	C22B 11/00, C22B 21/00	SU TAOGUI; XU KAIHUA; YI QINGPING; YU SHUNWEN; ZHANG YUNHE; ZHENG HONGWEI	JINGMEN GREEN ECO MANUFACTURE NEW MATERIAL CO LTD	[EN] Recycling and reusing method of waste photovoltaic module	https://depatisnet.dpma.de/DepatisNet/depatisnet?action=pdf&docid=CN000110964907A&xxxfull=1
CSI	China	China	CN000110964908A	28.09.2018	C22B 11/00, C22B 1/00, C22B 21/00	SU TAOGUI; XU KAIHUA; YI QINGPING; YU SHUNWEN; ZHANG YUNHE; ZHENG HONGWEI	JINGMEN GREEN ECO MANUFACTURE NEW MATERIAL CO LTD	[EN] Recycling method of photovoltaic module	https://depatisnet.dpma.de/DepatisNet/depatisnet?action=pdf&docid=CN000110964908A&xxxfull=1
CSI	China	China	CN000110964909A	28.09.2018	C22B 21/00, C22B 1/00, C22B 11/00	SU TAOGUI; XU KAIHUA; YI QINGPING; YU SHUNWEN; ZHANG YUNHE; ZHENG HONGWEI	JINGMEN GREEN ECO MANUFACTURE NEW MATERIAL CO LTD	[EN] Recycling method of waste photovoltaic module	https://depatisnet.dpma.de/DepatisNet/depatisnet?action=pdf&docid=CN000110964909A&xxxfull=1
PO	Japan	United States of America	US020200181354A1	11.12.2018	B29B 17/02	TACHIBANA TAKASHI, JP	EARTHRECYCLE CO LTD, JP	[EN] SEPARATION AND COLLECTION APPARATUS OF PLASTIC-BASED COMPLEX WASTE	https://depatisnet.dpma.de/DepatisNet/depatisnet?action=pdf&docid=US020200181354A1&xxxfull=1
CSI	China	China	CN000113560745A	28.07.2021	B23K 26/70, B23K 26/142, B23K 101/36	TANG HENG; YAO QIN; ZHANG KAI	SHANGHAI SDO ENERGY TECH CO LTD	[EN] Method for recycling photovoltaic cell module	https://depatisnet.dpma.de/DepatisNet/depatisnet?action=pdf&docid=CN000113560745A&xxxfull=1
CSI	China	China	CN000112794054A	26.01.2021	B65F 1/14, B65G 47/34	TAO MINGQING	HANGZHOU SHIYAN TRADING CO LTD	[EN] Quick classifying and recycling equipment for photovoltaic panel	https://depatisnet.dpma.de/DepatisNet/depatisnet?action=pdf&docid=CN000112794054A&xxxfull=1
CSI	China	China	CN000111064429A	06.03.2020		THE INVENTOR HAS WAIVED THE RIGHT TO BE MENTIONED	ZHUJI LUOXING NEW ENERGY TECH CO LTD	[EN] Recyclable and foldable solar power generation equipment	https://depatisnet.dpma.de/DepatisNet/depatisnet?action=pdf&docid=CN000111064429A&xxxfull=1
CSI	Japan	Japan	JP002017006839A	19.06.2015	H01L 31/042	TODA TOSHIHIKO; YAMAZAKI AKITO	ECO ASSIST KK	[EN] SOLAR PANEL RECYCLING APPARATUS	https://depatisnet.dpma.de/DepatisNet/depatisnet?action=pdf&docid=JP002017006839A&xxxfull=1
CSI	Japan	United States of America	US020080276988A1	16.07.2008		UMEMOTO AKIMASA, JP	SHARP KK, JP	[EN] METHOD FOR REGENERATING PHOTOVOLTAIC MODULE AND PHOTOVOLTAIC MODULE	https://depatisnet.dpma.de/DepatisNet/depatisnet?action=pdf&docid=US020080276988A1&xxxfull=1
CSI	Japan	United States of America	US020040003840A1	05.06.2003		UMEMOTO AKIMASA, JP	SHARP KK, JP	[EN] Method for regenerating photovoltaic module and photovoltaic module	https://depatisnet.dpma.de/DepatisNet/depatisnet?action=pdf&docid=US020040003840A1&xxxfull=1

Table A-2: PV Recycling Patents

PV Type	Country of Applicant	Country	Publication NO	Date	IPC-classes	Inventor	Applicant	Title	Document
PO	United States of America	United States of America	WO002007056019A2	31.10.2006	C23D 17/00, C23G 1/00	VERHAVERBEKE STEVEN, US	APPLIED MATERIALS INC, US	[EN] STRIPPING AND CLEANING OF ORGANIC-CONTAINING MATERIALS FROM ELECTRONIC DEVICE SUBSTRATE SURFACES [FR] ELIMINATION DE MATERIAUX CONTENANT DES MATIERES ORGANIQUES DES SURFACES DE SUBSTRATS DE DISPOSITIFS ...	https://depatisnet.dpma.de/DepatisNet/depatisnet?action=pdf&docid=WO002007056019A2&xxxfull=1
PO	United States of America	United States of America	US020080000497A1	30.06.2006	C23F 1/00	VERHAVERBEKE STEVEN, US	APPLIED MATERIALS INC	[EN] Removal of organic-containing layers from large surface areas	https://depatisnet.dpma.de/DepatisNet/depatisnet?action=pdf&docid=US020080000497A1&xxxfull=1
CIGS	China	China	CN000106319222A	28.06.2015	C01B 19/00, C22B 15/00, C22B 58/00	WANG GUAN; WU GUOFA	HANERGY NEW MAT TECH CO LTD	[EN] Copper-indium-gallium-selenium photovoltaic module recycling method	https://depatisnet.dpma.de/DepatisNet/depatisnet?action=pdf&docid=CN000106319222A&xxxfull=1
CSI	China	China	CN000212143878U	09.01.2020	B09B 5/00	WANG LULU; ZHANG XIAOYONG; ZHU XIANRAN	INST THERMAL POWER GENERATION TECH CHINA DATANG CORP SCI & TECH RES INST	[EN] System for treating waste photovoltaic cell panel by using plasma technology	https://depatisnet.dpma.de/DepatisNet/depatisnet?action=pdf&docid=CN000212143878U&xxxfull=1
CSI	China	China	CN000102500602B	07.11.2011	H01L 31/18, B09B 5/00	WANG SHIYUAN	YINGLI GROUP LTD	[EN] Equipment and method for recycling photovoltaic module	https://depatisnet.dpma.de/DepatisNet/depatisnet?action=pdf&docid=CN000102500602B&xxxfull=1
CSI	China	China	CN000211757562U	24.04.2020		WANG TIHU; ZONG BING	ASIA SILICON QINGHAI CO LTD; QINGHAI YAGUI SILICON MATERIAL ENGINEERING TECH CO LTD	[EN] Waste solar photovoltaic module and plate comprising same	https://depatisnet.dpma.de/DepatisNet/depatisnet?action=pdf&docid=CN000211757562U&xxxfull=1
CSI	China	China	CN000110125138A	25.04.2019		WANG TIHU; ZONG BING	ASIA SILICON QINGHAI CO LTD; QINGHAI ASIA SILICON MATERIAL ENGINEERING TECH CO LTD	[EN] Recycling method of waste solar photovoltaic module	https://depatisnet.dpma.de/DepatisNet/depatisnet?action=pdf&docid=CN000110125138A&xxxfull=1
PO	China	China	CN000114181448A	28.10.2021	C08L 23/06, C22B 7/00, C08J 11/08, C08J 11/06, C08J 11/00, C01B 33/037, C08K 5/14, C08K 3/18	WANG YAKUN	TIANJIN JINYU PLASTIC PRODUCT CO LTD	[EN] Low-temperature EVA (Ethylene Vinyl Acetate), preparation method and method for recycling resources by utilizing low-temperature EVA	https://depatisnet.dpma.de/DepatisNet/depatisnet?action=pdf&docid=CN000114181448A&xxxfull=1
CSI	China	China	CN000112886920A	22.01.2021	F24S 25/70, F24S 25/632, H02S 20/00, B08B 3/04	WU XIAOZHEN	WU XIAOZHEN	[EN] Clean energy recycling device and using method thereof	https://depatisnet.dpma.de/DepatisNet/depatisnet?action=pdf&docid=CN000112886920A&xxxfull=1
CSI	China	China	CN000109037378A	06.08.2018	H02S 40/10, H02S 50/00	XIA RONGHUA	SHANGHAI JINGXIA NEW ENERGY TECH CO LTD	[EN] A manufacturing method of a recoverable solar panel for photovoltaic power generation	https://depatisnet.dpma.de/DepatisNet/depatisnet?action=pdf&docid=CN000109037378A&xxxfull=1
CSI	China	China	CN000208895907U	20.06.2018		XIE YANQI; XU ZHONGXING; ZHUANG HULIANG	CHANGZHOU RECY ENVIRONMENTAL PROTECTION TECH CO LTD	[EN] Nozzle for recycling photovoltaic panel	https://depatisnet.dpma.de/DepatisNet/depatisnet?action=pdf&docid=CN000208895907U&xxxfull=1
CSI	China	China	CN000210971644U	05.12.2019	B65B 35/24, B65B 35/18, B65B 57/20	XU ZHONGXING; ZHUANG HULIANG	CHANGZHOU RUISAI ENVIRONMENTAL PROTECTION TECH CO LTD	[EN] Quantitative weighing packer for recycling battery pieces of scrapped photovoltaic module	https://depatisnet.dpma.de/DepatisNet/depatisnet?action=pdf&docid=CN000210971644U&xxxfull=1
CSI	China	China	CN000210972240U	05.12.2019	B65D 85/86, F16F 15/04, B65D 81/07, B65D 81/05	XU ZHONGXING; ZHUANG HULIANG	CHANGZHOU RUISAI ENVIRONMENTAL PROTECTION TECH CO LTD	[EN] Scrapped photovoltaic module recycling, transporting and fixing bracket with damping function	https://depatisnet.dpma.de/DepatisNet/depatisnet?action=pdf&docid=CN000210972240U&xxxfull=1
CSI	Japan	Japan	JP002005311178A	23.04.2004	B09B 3/00	YAMASHITA KATSUYA	SHARP KK	[EN] EXTRACTION METHOD OF SOLAR CELL BOARD MATERIAL, REGENERATING METHOD OF SOLAR CELL, AND FORMATION METHOD OF INGOT FOR SOLAR CELL	https://depatisnet.dpma.de/DepatisNet/depatisnet?action=pdf&docid=JP002005311178A&xxxfull=1
CIGS	Japan	European Patent	EP000002752493A1	09.02.2012	C02F 3/34	YAMASHITA MITSUO, JP	SHIBAURA INST TECHNOLOGY, JP	[DE] VERFAHREN ZUR GEWINNUNG VON SELEN [EN] METHOD FOR RECOVERING SELENIUM [FR] PROCÉDÉ DE RÉCUPÉRATION DE SÉLÉNIUM	https://depatisnet.dpma.de/DepatisNet/depatisnet?action=pdf&docid=EP000002752493A1&xxxfull=1
CIGS	Japan	European Patent	EP000002752493B1	09.02.2012	C02F 3/00, C02F 3/34, C12R 1/38, C02F 101/10	YAMASHITA MITSUO, JP	SHIBAURA INST TECH, JP	[DE] VERFAHREN ZUR GEWINNUNG VON SELEN [EN] METHOD FOR RECOVERING SELENIUM [FR] PROCÉDÉ DE RÉCUPÉRATION DE SÉLÉNIUM	https://depatisnet.dpma.de/DepatisNet/depatisnet?action=pdf&docid=EP000002752493B1&xxxfull=1
CIGS	Japan	United States of America	US020140302578A1	09.02.2012		YAMASHITA MITSUO, JP	SHIBAURA INST TECHNOLOGY, JP; YAMASHITA MITSUO, JP	[EN] METHOD FOR RECOVERING SELENIUM	https://depatisnet.dpma.de/DepatisNet/depatisnet?action=pdf&docid=US020140302578A1&xxxfull=1
CSI	China	China	CN000112140173A	25.09.2020	B02C 23/00, B02C 21/00, B02C 19/16, B02C 1/14, B26D 5/08	ZHANG QI	PUJIANG PINGGUI CABINET ELECTRONIC TECH CO LTD	[EN] Cutting-off and crushing recovery device for solar panels	https://depatisnet.dpma.de/DepatisNet/depatisnet?action=pdf&docid=CN000112140173A&xxxfull=1
CSI	China	China	CN000111952688A	21.08.2020	B09B 3/00, B09B 5/00	ZHANG XIAO	YONGKANG RENYIELECTRONIC SCIENCE AND TECH CO LTD	[EN] Solar cell recycling and separating device	https://depatisnet.dpma.de/DepatisNet/depatisnet?action=pdf&docid=CN000111952688A&xxxfull=1
CSI	Taiwan, Republic of China	Taiwan, Republic of China	TW000201338884A	30.03.2012	E04D 13/18	ZHAO CHONG-REN, TW	FEI BEI KE ENVIRONMENTAL TECHNOLOGY CO LTD, TW	[EN] Environmentally friendly face brick using recycled waste photovoltaic module	
CSI	China	China	CN 101126131A	10/4/2006			MENGLONG MO	Method for reclaiming solar battery thin splinter or IC splinter	

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PV Type	Country of Applicant	Country	Publication NO	Date	IPC-classes	Inventor	Applicant	Title	Document
CSI	Japan	European Patent	EP 0935295A2	2/5/1999			CANON KABUSHIKI KAISHA	Semiconductor device, solar cell module and methods for their dismantlement	
CSI	China	China	CN 101217169A	12/27/2007			JIANGYIN JETION SCIENCE AND TECHNOLOGY CO., LTD.	A reworking method on degraded products after the printing of crystal silicon solar battery	
CSI	Germany	European Patent	EP 0893250A1	7/20/1998			Wambach, Karsten Dr.	Method for separating the components of a laminated glazing	
TF	Taiwan, Republic of China	China	CN 101562212A	4/18/2008			CONTREL TECHNOLOGY CO LTD	Method for recycling transparent conducting glass substrate of solar cell	
CSI	Korea (South)	United States of America	US 2015-0090406A1	10/1/2014			KOREA INSTITUTE OF ENERGY RESEARCH	METHOD FOR DISASSEMBLING PHOTOVOLTAIC MODULE	
CSI	China	China	CN 101719529A	11/17/2009			GUANGDONG GOLDEN GLASS TECHNOL	Method for recovering crystalline silicon cell plate in double-glass solar cell assembly with PVB interbed	
CSI	Germany	United States of America	US 2011-0186779A1	8/13/2009			CALYXO GMBH	PHOTOVOLTAIC MODULE RECYCLING	
CSI	China	China	CN 102343352A	7/26/2010			BYD Co., Ltd.	Recovery method for solar silicon slice	
CSI	Japan	United States of America	US 2005-0000560A1	6/28/2004			Canon Kabushiki Kaisha	Semiconductor device, solar cell module, and methods for their dismantlement	
CSI	China	China	CN 102354677A	11/7/2011			Yingli Group Ltd.	Solar module decomposing equipment and rotary clamp thereof	
CSI	United States of America	United States of America	US 6063995A	7/16/1998			First Solar, LLC	Recycling silicon photovoltaic modules	
CSI	China	China	CN 102419605A	11/7/2011			Yingli Group Ltd.	Heating temperature control device and photovoltaic module decomposition and recovery equipment provided with same	
CSI	China	China	CN 102437244A	12/13/2011			Suzhou Industrial Park Goldway Technologies Co., Ltd.	Frame disassembling system of solar cell	
CSI	China	China	CN 102509717A	11/7/2011			Yingli Group Ltd.	Solar battery recovery decomposition device and its rotation balance disk	
CSI	China	China	CN 102634800A	4/21/2012			Hunan Redsolar Photoelectric Technology Co., Ltd.	Washing method of washing-difficult reworked piece of crystalline silicon solar battery	
CSI	China	China	CN 102842648A	8/12/2012			Anyang Phoenix Photovoltaic Technology Co., Ltd.	Method for carrying out desilvering processing on waste solar cell slice	
CSI	China	China	CN 102851506A	8/12/2012			Anyang Phoenix Photovoltaic Technology Co., Ltd.	Method for extracting and recovering silver from waste solar cell	
CSI	China	China	CN 201893366U	12/1/2010			TIANWEI NEW ENERGY HOLDINGS CO | TIANWEI NEW ENERGY CHENGDU PV MODULE CO LTD | BAODING TIANWEI GROUP CO LTD	Tool for dismantling frame of crystalline silicon solar battery component	
CSI	China	China	CN 102931290A	11/27/2012			Bailida Solar Energy Co., Ltd.	Polycrystalline silicon solar cell reworking method without damaging suede	
CSI	China	China	CN 103165731A	12/13/2011			Suzhou Industrial Park Goldway Technologies Co., Ltd.	Solar cell frame dismantling system	
CSI	China	China	CN 103165732A	12/13/2011			Suzhou Industrial Park Goldway Technologies Co., Ltd.	Solar cell frame dismantling system	
CSI	China	China	CN 103165733A	12/13/2011			Suzhou Industrial Park Goldway Technologies Co., Ltd.	Solar cell frame dismantling system	
CSI	China	China	CN 103165734A	12/13/2011			Suzhou Industrial Park Goldway Technologies Co., Ltd.	Solar cell frame dismantling system	
CSI	China	China	CN 103165735A	12/13/2011			Suzhou Industrial Park Goldway Technologies Co., Ltd.	Solar cell frame dismantling system	
CSI	China	China	CN 103165736A	12/13/2011			Suzhou Industrial Park Goldway Technologies Co., Ltd.	Solar cell frame dismantling system	
CSI	China	China	CN 103165737A	12/13/2011			Suzhou Industrial Park Goldway Technologies Co., Ltd.	Solar cell frame dismantling system	
CSI	China	China	CN 103165738A	12/13/2011			Suzhou Industrial Park Goldway Technologies Co., Ltd.	Solar cell frame dismantling system	
CSI	China	China	CN 103165739A	12/13/2011			Suzhou Industrial Park Goldway Technologies Co., Ltd.	Solar cell frame dismantling system	
CSI	China	China	CN 103165740A	12/13/2011			Suzhou Industrial Park Goldway Technologies Co., Ltd.	Solar cell frame dismantling method	

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PV Type	Country of Applicant	Country	Publication NO	Date	IPC-classes	Inventor	Applicant	Title	Document
CSI	China	China	CN 103165741A	12/13/2011			Suzhou Industrial Park Goldway Technologies Co., Ltd.	Solar cell frame dismantling system	
CSI	China	China	CN 103337563A	7/15/2013			SHANDONG LINUO SOLAR POWER HOL	Method for reworking defective printing piece of crystalline silicon solar cell	
CSI	China	China	CN 103779441A	11/13/2013			HENAN INST SCIENCE & TECH	Cleaning recovery treatment process of solar cell sheet	
CSI	China	China	CN 103920698A	5/8/2014			LIU JINGYANG	Method for recycling resources in waste crystal solar silicon cell piece in classified mode	
CSI	China	China	CN 104167462A	5/16/2013			WUXI SUNTECH POWER CO LTD	Poorly printed solar battery reworking method	
CSI	China	China	CN 202103080U	6/15/2011			LEYE PHOTOVOLTAIC CO.,LTD.	Solar cell panel frame dismounting machine	
CSI	China	China	CN 104368958A	9/26/2014			SUZHOU SUNCOME SOLAR SCIENCE & TECHNOLOGY CO LTD	Photovoltaic module dismantling clamp	
CSI	China	China	CN 202307807U	11/1/2011			NINGBO XINYOU PHOTOVOLTAICS INDUSTRY CO LTD	Recycling system for waste silicon solar cell	
CSI	China	China	CN 104716225A	12/17/2013			JINKO SOLAR CO LTD	Silicon cell recycling method	
CSI	China	China	CN 202315994U	11/7/2011			YINGLI GROUP LTD	Solar battery assembly decomposing equipment and automatic material-transporting double-shaft bevelment crushing device thereof	
CSI	China	China	CN 202307849U	11/7/2011			YINGLI GROUP LTD	Solar cell recovery and decomposition equipment and rotary balance disc thereof	
CSI	China	China	CN 202285230U	11/7/2011			YINGLI GROUP LTD	Solar battery component disassembly equipment and rotary fixture thereof	
CSI	China	China	CN 202332932U	11/28/2011			JETION SOLAR CHINA CO LTD	Tool for disassembling aluminum section of photovoltaic component	
CSI	China	China	CN 202384377U	12/8/2011			JETION SOLAR CHINA CO LTD	Frame disassembling machine used for disassembling frame of solar battery pack	
CSI	China	China	CN 202616274U	4/9/2012			CEEG SHANGHAI SOLAR SCI & TECH	Apparatus for disassembling photovoltaic assembly	
CSI	China	China	CN 202977513U	12/13/2012			QINHUANGDAO XINMEIYUAN CONTROLLED EQUIPMENT CO LTD	Solar cell panel long edge frame dismantler	
CSI	China	China	CN 203031219U	12/12/2012			TAITONG TAIZHOU IND CO LTD	Simple solar photovoltaic module frame dismantling device	
CSI	China	China	CN 203288629U	12/14/2012			QINHUANGDAO XINMEIYUAN CONTROLLED EQUIPMENT CO LTD	Solar cell panel short edge frame dismantler	
CSI	China	China	CN 203600179U	11/14/2013			FUYU ENERGY SCIENCE & TECHNOLOGY KUNSHAN CO LTD | HON HAI PREC IND CO LTD	Photovoltaic module dismounting device	
CSI	China	China	CN 203617327U	12/9/2013			BAODING TIANWEI YINGLI NEW ENERGY CO LTD	Device for detaching solar cell assembly side frame	
CSI	China	China	CN 204011460U	8/8/2014			TITAN PV CO LTD	Auxiliary tool for frame detachment of photovoltaic assembly	
CSI	China	China	CN 204148829U	8/8/2014			TITAN PV CO LTD	Auxiliary tool for dismounting photovoltaic assembly frame	
CSI	China	China	CN 204167343U	11/11/2014			YINGLI SOLAR CHINA CO LTD	Solar cell frame detaching tool	
CSI	China	China	CN 204206092U	11/20/2014			TONGWEI SOLAR HEFEI CO LTD	A used for crystalline silicon solar cell assembly of the frame removal tool	
CSI	China	China	CN 204235474U	10/18/2014			URUMQI TUOHUANGZHE INFORMATION TECHNOLOGY CO LTD	Photovoltaic component frame remove table	
CSI	Germany	Germany	DE19541074A1	11/3/1995			SIEMENS SOLAR GMBH	Recycling solar cells or modules of silicon@ and silicon alloys	
CSI	Germany	Germany	DE19541074C	11/3/1995			SIEMENS SOLAR GMBH	Recycling of solar modules and - cells from silicon and its alloys	
CSI	Germany	Germany	DE102007034441A1	7/20/2007			LOSER ULRICH ; PALITZSCH WOLFRAM	Method for removing front and rear side contacts of solar cells, involves processing solar cells with aqueous, sour metallic salt	

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CSI	Germany	Germany	DE102012018548A1	9/20/2012			Technische Universität Bergakademie Freiberg	Recycling disused solar modules and solar cells, comprises separating cell breakage having silicon from starting materials, and treating the breakage with chloromethane/dichloromethane and hydrogen in the presence of catalyst	
CSI	Germany	Germany	DE102013112004A1	10/31/2013			variata Dorit Lang GmbH & Co. KG	Recycling of photovoltaic module and/or solar modules	
CSI	Japan	Japan	JP 2007-134358A	11/8/2005			KYOWA HAKKO CHEMICAL CO LTD	METHOD FOR RECOVERING SOLAR BATTERY CELL AND/OR REINFORCED GLASS FROM SOLAR CELL MODULE	
CSI	Japan	Japan	JP 2007-180063A	12/26/2005			KYOCERA CORP	DISASSEMBLING METHOD OF SOLAR CELL MODULE	
CSI	Japan	Japan	JP 2009-214058A	3/12/2008			SHARP CORP	DISASSEMBLING METHOD OF SOLAR CELL MODULE	
CSI	Japan	Japan	JP 2014-094321A	11/7/2012			TORAY FINE CHEMICALS CO LTD	METHOD OF DISINTEGRATING SOLAR CELL MODULE	
CSI	Japan	Japan	JP 2014-104406A	11/27/2012			YOKOHAMA YUSHI KOGYO KK	SOLAR CELL MODULE RECYCLING METHOD	
CSI	Japan	Japan	JP 2014-108375A	11/30/2012			SHINRYO CORP	METHOD OF RECOVERING CONSTITUENT MATERIAL OF SOLAR CELL ELEMENT	
CSI	Japan	Japan	JP 2014-116363A	12/6/2012			SHINRYO CORP	SOLAR CELL MODULE DISMANTLING APPARATUS	
CSI	Korea (South)	Korea (South)	JP 2015-071162A	10/1/2014			KOREA INST OF ENERGY RESEARCH	METHOD FOR DISASSEMBLING PHOTOVOLTAIC MODULE	
CSI	Korea (South)	Korea (South)	KR 1584174B1	5/16/2014			KOREA INST OF ENERGY RESEARCH	METHOD OF COLLECTING SOLAR CELL	
CSI	Korea (South)	Korea (South)	KR 1539528B1	2/20/2014			Kumoh National Institute of Technology	A method for recovering silver from the waste solar cell	
CSI	Korea (South)	Korea (South)	KR 2015-0039005A	10/1/2013			KOREA INST OF ENERGY RESEARCH	METHOD FOR RECOVERYING METAL OF SOLAR CELL	
CSI	Korea (South)	Korea (South)	KR 1486803B1	10/1/2013			KOREA INST OF ENERGY RESEARCH	METHOD FOR DISASSEMBLING SOLAR CELL MODULE	
CSI	Korea (South)	Korea (South)	KR 2015-0039006A	10/1/2013			KOREA INST OF ENERGY RESEARCH	Apparatus and Method for Recovery of Metal of Photovoltaic Module	
CSI	Korea (South)	Korea (South)	KR 1509086B1	10/1/2013			KOREA INST OF ENERGY RESEARCH	METHOD FOR RECOVERYING METAL OF SOLAR CELL	
CSI	Korea (South)	Korea (South)	KR 2015-0039010A	10/1/2013			KOREA INST OF ENERGY RESEARCH	METHOD FOR DISASSEMBLING SOLAR CELL MODULE	
CSI	Korea (South)	Korea (South)	KR 2014-00250032	8/20/2012			Kangwon National University	Device for recycling cell from solar module	
CSI	Korea (South)	Korea (South)	KR 2013-0104794A	3/15/2012			SYMPHONY ENERGY CO., LTD	APPARATUS FOR DISMANTLING WASTE SOLAR MODULE THERMALLY	
CSI	Korea (South)	Korea (South)	KR 2011-0069962A	12/18/2009			Korea Research Institute of Chemical Technology	METHODE FOR RECYCLING SILICON FROM WASTE SOLAR CELL	
CSI	Korea (South)	Korea (South)	KR 2013-0095915A	2/21/2012			SYMPHONY ENERGY CO., LTD	APPARATUS FOR DISASSEMBLING SOLAR MODULE FRAME	
CSI	Korea (South)	Korea (South)	KR 2011-0106953A	3/24/2010			LEE, HYUN-JOO | GU, SOO-JIN	Recovery Method of High-purified poly Silicon from a waste solar wafer	
CSI	Korea (South)	Korea (South)	KR 2013-0080950A	1/6/2012			SYMPHONY ENERGY CO., LTD	METHOD FOR DISMANTLING ECO-FRIENDLY WASTE SOLAR MODULE	
CdTe	Germany	United States of America	US 2002-0030035A1	8/24/2001			ANTEC SOLAR GMBH	Process for recycling CdTe/Cds thin film solar cell modules	
CIGS	Canada	United States of America	US 2014-0065037A1	11/22/2011			MOLYCORP MINERALS CANADA ULC	TREATMENT OF INDIUM GALLIUM ALLOYS AND RECOVERY OF INDIUM AND GALLIUM	
CIGS	Sweden	United States of America	US 2014-0341799A1	12/14/2012			MIDSUMMER AB	RECYCLING OF COPPER INDIUM GALLIUM DISELENIDE	
CdTe	United States of America	United States of America	US 6391165B1	5/17/2000			First Solar, LLC	Reclaiming metallic material from an article comprising a non-metallic friable substrate	
CIGS	United States of America	United States of America	US 5997718A	6/16/1998			Drinkard Metalox, Inc.	Recycling of CdTe photovoltaic waste	
CdTe	United States of America	United States of America	US 6129779A	5/12/1998			First Solar, LLC	Reclaiming metallic material from an article comprising a non-metallic friable substrate	

Table A-2: PV Recycling Patents

PV Type	Country of Applicant	Country	Publication NO	Date	IPC-classes	Inventor	Applicant	Title	Document
CdTe	United States of America	United States of America	US 5897685A	5/12/1997			Drinkard Metalox, Inc.	Recycling of CdTe photovoltaic waste	
CIGS	United States of America	United States of America	US 5779877A	5/12/1997			Drinkard Metalox, Inc.	Recycling of CIS photovoltaic waste	
CIGS	China	China	CN 103199148A	1/9/2012			Shenzhen GEM High-Tech Co., Ltd.	Method for recycling gallium, indium and germanium from wasted thin-film solar cells	
CIGS	Japan	Japan	JP 2004-186547A	12/5/2002			SHOWA SHELL SEKIYU KK	METHOD FOR RECOVERING COMPONENT OF CIS THIN-FILM SOLAR CELL MODULE	
CIGS	Japan	Japan	JP 2007-059793A	8/26/2005			SHOWA SHELL SEKIYU KK	METHOD OF RECOVERING STRUCTURAL COMPONENT OF CIS SYSTEM THIN FILM SOLAR CELL MODULE	
CIGS	Japan	Japan	JP 2014-079667A	10/13/2012			MIYAZAKI PREFECTURE | NISHINIHON ENVIRONMENTAL TECHNOLOGICAL RESEACH CO LTD	METHOD OF RECOVERING VALUABLES FROM CIS THIN FILM SOLAR CELL	
CdTe	Germany	Japan	JP 2002-164558A	9/4/2001			ANTEC SOLAR GMBH	REPRODUCTION METHOD OF CdTe/CdS THIN FILM SOLAR CELL MODULE	
TF	Germany	Korea (South)	KR 2009-0129944A	6/4/2009			JENOPTIK Automatisierungstechnik GmbH	Recycling process for thin film solar cell modules	
CIGS	Sweden	Sweden	WO 2013-089630A1	12/14/2012			MIDSUMMER AB	RECYCLING OF COPPER INDIUM GALLIUM DISELENIDE	
CdTe	Germany	Germany	DE50012431B1	9/11/2000			ANTEC SOLAR ENERGY AG	Recycling procedure for CdTe/CD thin section solar cell modules	
TF	Germany	Germany	DE102008058530A1	11/21/2008			LOSER ULRICH ; PALITZSCH WOLFRAM	Method for recycling a thin layer solar module during simultaneous recovering of recyclable material, by loading photovoltaic	
TF	Germany	Germany	DE102013009586A1	6/9/2013			Loser, Ulrich, 04741, Roßwein, DE ; Palitzsch, Wolfram, 09599, Freiberg, DE	Hydrometallurgisches Verfahren zur Rückgewinnung von III-V-, II-VI- oder I-III-VI2- Verbindungshalbleitermaterialien aus High-Tech- bzw, Green-Tech-Abfällen, bzw. Elektro- und Elektronikabfällen	
DSC	United States of America	United States of America	US2014-0202517A	3/21/2014			Georgia Tech Research Corporation	Recyclable Organic Solar Cells On Substrates Comprising Cellulose Nanocrystals (CNC)	
TF	China	China	CN 101562212A	4/1/2008			Contrel Semiconductor Technology Co Ltd	Method for recycling transparent conducting glass substrate of solar cell	
DSC	Korea (South)	Korea (South)	KR2013-0049983A	11/7/2011			Dongjin Semichem Co., Ltd.	Method for Recycling Dye of Dye-Sensitized Solar Cel	
DSC	Korea (South)	Korea (South)	WO 2013069929A	11/7/2011			DONGJIN SEMICHEM CO., LTD.	METHOD FOR RECYCLING DYE OF DYE-SENSITIZED SOLAR CELL MODULE	

Table A-3: PV Recycling Literature Review

Authors	Title	Year	Source Title	Volume	Issue	Art. No.	Page Start	Page End	DOI	Link	Affiliations	ISSN	ISBN	CODEN	Document Type	Publication Stage	Open Access	Source	EID
Yue Y., Zhuo Y., Li Q., Shen Y.	Experimental and numerical study of extracting silver from end-of-life c-Si photovoltaic solar cells in rotating systems	2022	Resources, Conservation and Recycling	186		106548			10.1016/j.resconrec.2022.106548	https://www.scopus.com/inward/record.uri?eid=2-s2.0-85134582338&doi=10.1016%2fj.resconrec.2022.106548&partnerID=40&md5=1c207d6b3d18ac928ae4f7191d283e44	School of Chemical Engineering, University of New South Wales, Sydney, NSW 2052, Australia	09213449		RCREE	Article	Final		Scopus	2-s2.0-85134582338
El-Khawad L., Bartkowiak D., Kümmerer K.	Improving the end-of-life management of solar panels in Germany	2022	Renewable and Sustainable Energy Reviews	168		112678			10.1016/j.rser.2022.112678	https://www.scopus.com/inward/record.uri?eid=2-s2.0-85133910890&doi=10.1016%2fj.rser.2022.112678&partnerID=40&md5=5f2e6ed2f4b438740cd0bd2c52148e06	Leuphana Universität Lueneburg, Universitätsallee 1, Lüneburg, 21335, Germany; Institute of Sustainable and Environmental Chemistry, Leuphana Universität Lueneburg, Universitätsallee 1, Lüneburg, 21335, Germany; International Sustainable Chemistry Collaborative Centre (ISC3), Research & Education Hub, Germany	13640321		RSERF	Review	Final		Scopus	2-s2.0-85133910890
Qin B., Lin M., Xu Z., Ruan J.	Preparing ultra-thin glass from waste glass containing impurities of household waste by the combined technology of in-situ deposition and vacuum pyrolysis	2022	Resources, Conservation and Recycling	185		106451			10.1016/j.resconrec.2022.106451	https://www.scopus.com/inward/record.uri?eid=2-s2.0-85132542124&doi=10.1016%2fj.resconrec.2022.106451&partnerID=40&md5=ff29ca7bc689f551af23fe610c5712e2	Guangdong Provincial Key Laboratory of Environmental Pollution Control and Remediation Technology, School of Environmental Science and Engineering, Sun Yat-Sen University, 135 Xingang Xi Road, Guangzhou, 510275, China; School of Environmental Science and Engineering, Shanghai Jiao Tong University, 800 Dongchuan RoadShanghai 200240, China	09213449		RCREE	Article	Final		Scopus	2-s2.0-85132542124
Li K., Wang Z., Liu C., Wang D., Li G., Chen X., Qian G., Hu K.	A green method to separate different layers in photovoltaic modules by using DMPU as a separation agent	2022	Solar Energy Materials and Solar Cells	245		111870			10.1016/j.solmat.2022.111870	https://www.scopus.com/inward/record.uri?eid=2-s2.0-85133250993&doi=10.1016%2fj.solmat.2022.111870&partnerID=40&md5=e95de5384b45a938aa646119cd5f4c5f	Ganjiang Innovation Academy, Chinese Academy of Sciences, Ganzhou, 341007, China; Key Laboratory of Green Process and Engineering, National Engineering Research Center of Green Recycling for Strategic Metal Resources, Institute of Process Engineering, Chinese Academy of Sciences, Beijing, 100190, China; Nanchang University, Nanchang, 330031, China; Zhejiang Jinko Solar Co., Ltd., Zhejiang314400, China	09270248		SEMCE	Article	Final		Scopus	2-s2.0-85133250993
Prasad D.S., Sanjana B., Kiran D.S., Srinivasa Kumar P.P., Ratheesh R.	Process optimization studies of essential parameters in the organic solvent method for the recycling of waste crystalline silicon photovoltaic modules	2022	Solar Energy Materials and Solar Cells	245		111850			10.1016/j.solmat.2022.111850	https://www.scopus.com/inward/record.uri?eid=2-s2.0-85132890806&doi=10.1016%2fj.solmat.2022.111850&partnerID=40&md5=ed770ddd1ed6876079fdc332fff3d81a	Centre for Materials for Electronics Technology (C-MET), IDA Phase-III, Cherlapally, Hyderabad, India	09270248		SEMCE	Article	Final		Scopus	2-s2.0-85132890806
Zhang L., Chang S., Wang Q., Zhou D.	Projection of Waste Photovoltaic Modules in China Considering Multiple Scenarios	2022	Sustainable Production and Consumption	33			412	424	10.1016/j.spc.2022.07.012	https://www.scopus.com/inward/record.uri?eid=2-s2.0-85134795621&doi=10.1016%2fj.spc.2022.07.012&partnerID=40&md5=a3be149bbaa4e41f3992cd129abd94d9	College of Economics and Management, Nanjing University of Aeronautics and Astronautics, Nanjing, 211106, China; Research Centre for Soft Energy Science, Nanjing University of Aeronautics and Astronautics, Nanjing, 211106, China	23525509			Article	Final		Scopus	2-s2.0-85134795621
Belançon M.P., Sandrini M., Tonholi F., Herculano L.S., Dias G.S.	Towards long term sustainability of c-Si solar panels: The environmental benefits of glass sheet recovery	2022	Renewable Energy Focus	42			206	210	10.1016/j.ref.2022.06.009	https://www.scopus.com/inward/record.uri?eid=2-s2.0-85134340371&doi=10.1016%2fj.ref.2022.06.009&partnerID=40&md5=c78696bc2c7992126b30fc79f1280cbb	Universidade Tecnológica Federal do Paraná (UTFPR), Câmpus Pato Branco, Brazil; Universidade Tecnológica Federal do Paraná (UTFPR), Câmpus Medianeira, Brazil; Universidade Estadual de Maringá (UEM), Departamento de Física, Brazil	17550084			Article	Final	All Open Access, Green	Scopus	2-s2.0-85134340371
Molano J.C., Xing K., Majewski P., Huang B.	A holistic reverse logistics planning framework for end-of-life PV panel collection system design	2022	Journal of Environmental Management	317		115331			10.1016/j.jenvman.2022.115331	https://www.scopus.com/inward/record.uri?eid=2-s2.0-85130888777&doi=10.1016%2fj.jenvman.2022.115331&partnerID=40&md5=6c0bc259699762f5ae9913cc9845ead1	UniSA STEM, University of South Australia, Mawson Lakes, SA 5095, Australia; Future Industry Institute, University of South Australia, Mawson Lakes, SA 5095, Australia; School of Energy and Power Engineering, Changsha University of Science and Technology, Hunan, Changsha, 410114, China	03014797		JEVMA	Article	Final		Scopus	2-s2.0-85130888777
Granata G., Altimari P., Pagnanelli F., De Greef J.	Recycling of solar photovoltaic panels: Techno-economic assessment in waste management perspective	2022	Journal of Cleaner Production	363		132384			10.1016/j.jclepro.2022.132384	https://www.scopus.com/inward/record.uri?eid=2-s2.0-85131444526&doi=10.1016%2fj.jclepro.2022.132384&partnerID=40&md5=acae1c123a568d837e58e79b851cd4d4	Department of Chemical Engineering, KU Leuven, Celestijnenlaan 200F, Heverlee, Leuven 3001, Belgium; Department of Materials Engineering, KU Leuven, Kasteelpark Arenberg 44, Heverlee, Leuven 3001, Belgium; Department of Chemistry, Sapienza University of Rome, Piazzale Aldo Moro 5, Rome, 00185, Italy	09596526		JCROE	Article	Final		Scopus	2-s2.0-85131444526
Zhang C., Jiang J., Ma E., Zhang L., Bai J., Wang J., Bu Y., Fan G., Wang R.	Recovery of silver from crystal silicon solar panels in Self-Synthesized choline Chloride-Urea solvents system	2022	Waste Management	150			280	289	10.1016/j.wasman.2022.07.003	https://www.scopus.com/inward/record.uri?eid=2-s2.0-85134765379&doi=10.1016%2fj.wasman.2022.07.003&partnerID=40&md5=e0f2d2688041e49247531ba3057b4d70	School of Resources and Environmental Engineering, Shanghai Polytechnic University, Jinhai Road No. 2360, Pudong New District, Shanghai, 201209, China; Shanghai Collaborative Innovation Centre for WEEE Recycling, Shanghai Polytechnic University, Jinhai Road No. 2360, Pudong New District, Shanghai, 201209, China; Yunlong Bocui Precious Metals Technology Co., Ltd., Dali, 672711, China	0956053X		WAMAE	Article	Final		Scopus	2-s2.0-85134765379
Wang S., Shen Y.	Particle-scale modelling of the pyrolysis of end-of-life solar panel particles in fluidized bed reactors	2022	Resources, Conservation and Recycling	183		106378			10.1016/j.resconrec.2022.106378	https://www.scopus.com/inward/record.uri?eid=2-s2.0-85129531265&doi=10.1016%2fj.resconrec.2022.106378&partnerID=40&md5=a6fa295901511f43b5df3fdcac434f19	School of Chemical Engineering, University of New South Wales, Sydney, NSW 2052, Australia	09213449		RCREE	Article	Final		Scopus	2-s2.0-85129531265
Karpan B., Abdul Raman A.A., Rahim R., Aroua M.K.T., Buthiyappan A.	Carbon Footprint Evaluation of Industrial Wastes Based Solid Fuel in the Context of Its Use in a Cement Plant	2022	Waste and Biomass Valorization	13	8		3723	3735	10.1007/s12649-022-01761-6	https://www.scopus.com/inward/record.uri?eid=2-s2.0-85128598744&doi=10.1007%2fs12649-022-01761-6&partnerID=40&md5=d983e58375a6de3cf3f3e8623cb08cc2	Department of Chemical Engineering, Faculty of Engineering, Universiti of Malaya, Kuala Lumpur, 50603, Malaysia; Centre for Carbon Dioxide Capture and Utilization, School of Science and Technology, Sunway University, 47500 Petaling Jaya, Selangor, Malaysia; Institute of Ocean and Earth Sciences, University of Malaya, C308 Institute for Advanced Studies Building, Kuala Lumpur, 50603, Malaysia	18772641			Article	Final		Scopus	2-s2.0-85128598744

Table A-3: PV Recycling Literature Review

Authors	Title	Year	Source Title	Volume	Issue	Art. No.	Page Start	Page End	DOI	Link	Affiliations	ISSN	ISBN	CODEN	Document Type	Publication Stage	Open Access	Source	EID
van der Heide A., Tous L., Wambach K., Poortmans J., Clyncke J., Voroshazi E.	Towards a successful re-use of decommissioned photovoltaic modules	2022	Progress in Photovoltaics: Research and Applications	30	8		910	920	10.1002/pip.3490	https://www.scopus.com/inward/record.uri?eid=2-s2.0-85117169931&doi=10.1002%2fpip.3490&partnerID=40&md5=9c4e315b9a2d9598ea6d0fb14f81621d	imec (Energyville campus), Genk, Belgium; bifa Umweltinstitut GmbH, Augsburg, Germany; Department ESAT – ELECTA, KU Leuven, Leuven, Belgium; UHasselt, Hasselt, Belgium; PV CYCLE, Brussels, Belgium; CEA-INES, Le Bourget-du-Lac, France	10627995		PPHOE	Article	Final		Scopus	2-s2.0-85117169931
Wikoff H.M., Reese S.B., Reese M.O.	Embodied energy and carbon from the manufacture of cadmium telluride and silicon photovoltaics	2022	Joule	6	7		1710	1725	10.1016/j.joule.2022.06.006	https://www.scopus.com/inward/record.uri?eid=2-s2.0-85134778770&doi=10.1016%2fj.joule.2022.06.006&partnerID=40&md5=76bbb5c9e82e2c3a8c70c321b9b58e7c	National Renewable Energy Laboratory, Golden, CO 80401, United States	25424351			Article	Final		Scopus	2-s2.0-85134778770
Lee K., Cho S.B., Yi J., Chang H.S.	Simplified Recovery Process for Resistive Solder Bond (RSB) Hotspots Caused by Poor Soldering of Crystalline Silicon Photovoltaic Modules Using Resin	2022	Energies	15	13	4623			10.3390/en15134623	https://www.scopus.com/inward/record.uri?eid=2-s2.0-85133305045&doi=10.3390%2fen15134623&partnerID=40&md5=d24bb20bf2c3afe8c1bb44b5b621f79b	Graduate School of Energy Science & Technology, Chungnam National University, Daejoen, 34134, South Korea; College of Information and Communication Engineering, Sungkyunkwan University, Suwon, 16419, South Korea; SK Solar Energy. Co. Ltd., 112 Jangwookjin-ro, Yeondong-myeon, Sejong, 34013, South Korea	19961073			Article	Final	All Open Access, Gold	Scopus	2-s2.0-85133305045
Zhao P., Yang F., Bai Y., Yan G., Sun Z., Zhao H., Zhang B.	Analysis and optimization of the selective crushing process based on high voltage pulse energy	2022	Minerals Engineering	185		107697			10.1016/j.mineng.2022.107697	https://www.scopus.com/inward/record.uri?eid=2-s2.0-85133289430&doi=10.1016%2fj.mineng.2022.107697&partnerID=40&md5=03fae548ec306e1fba4d65f02a6d6aad	Key Laboratory of Coal Processing and Efficient Utilization of Ministry of Education, China University of Mining & Technology, Jiangsu, Xuzhou, 221116, China; School of civil and resource engineering, University of Science & Technology Beijing, Beijing, 100083, China	08926875		MENGE	Article	Final		Scopus	2-s2.0-85133289430
Ko J., Bae S., Park S.J., Park H., Seol J., Kang Y., Lee H.-S., Kim D.	Effective Recycling Method for Silicon Photovoltaic Modules with Electrical Sacrificial Layer	2022	IEEE Journal of Photovoltaics	12	4		999	1004	10.1109/JPHOTOV.2022.3164668	https://www.scopus.com/inward/record.uri?eid=2-s2.0-85129345849&doi=10.1109%2fJPHOTOV.2022.3164668&partnerID=40&md5=daf42e4c9e91a70bb034492ef4b4a56f	Department of Materials Science and Engineering, Korea University, Seoul, 02841, South Korea; Hanwha Q CELLS GmbH, Bitterfeld-Wolfen, 06766, Germany; KU-KIST Green School, Graduate School of Energy Environment Policy and Technology, Korea University, Seoul, 02841, South Korea	21563381			Article	Final		Scopus	2-s2.0-85129345849
Liu F.-W., Cheng T.-M., Chen Y.-J., Yueh K.-C., Tang S.-Y., Wang K., Wu C.-L., Tsai H.-S., Yu Y.-J., Lai C.-H., Chen W.-S., Chueh Y.-L.	High-yield recycling and recovery of copper, indium, and gallium from waste copper indium gallium selenide thin-film solar panels	2022	Solar Energy Materials and Solar Cells	241		111691			10.1016/j.solmat.2022.111691	https://www.scopus.com/inward/record.uri?eid=2-s2.0-85127807953&doi=10.1016%2fj.solmat.2022.111691&partnerID=40&md5=6491efe6a11dc0e5497c5f628627d7b6	Department of Materials Science and Engineering, National Tsing Hua University, No. 101, Section 2, Kuang-Fu Road, Hsinchu, Taiwan; School of Materials Science and Engineering, Georgia Institute of Technology, Atlanta, GA 30332, United States; Department of Resources Engineering, National Cheng Kung University, University Road, No. 1, Tainan, 701, Taiwan; Department of Occupational Safety and Health, Chang Jung Christian University, No.1, Changda Rd, Gueiren District, Tainan City71101, Taiwan; Department of Safety, Health, and Environmental Engineering, National Kaohsiung University of Science and Technology, No. 1, University Road, Yanchao Dist, Kaohsiung City, Taiwan; Laboratory for Space Environment and Physical Sciences, Harbin Institute of Technology, No. 92, West Dazhi Street, Nan Gang District, Harbin, 150001, China; School of Physics, Harbin Institute of Technology, No. 92, West Dazhi Street, Nan Gang District, Harbin, 150001, China; Instrument Center, National Tsing Hua University, Hsinchu, 30013, Taiwan	09270248		SEMCE	Article	Final		Scopus	2-s2.0-85127807953
Khalifa S.A., Mastrorocco B.V., Au D.D., Ovaitt S., Barnes T.M., Carpenter A.C., Baxter J.B.	Dynamic material flow analysis of silicon photovoltaic modules to support a circular economy transition	2022	Progress in Photovoltaics: Research and Applications	30	7		784	805	10.1002/pip.3554	https://www.scopus.com/inward/record.uri?eid=2-s2.0-85127241855&doi=10.1002%2fpip.3554&partnerID=40&md5=4e1f5ae8650d52b7273da3eee022b073	Department of Chemical and Biological Engineering, Drexel University, Philadelphia, PA, United States; National Renewable Energy Laboratory, Golden, CO, United States	10627995		PPHOE	Article	Final		Scopus	2-s2.0-85127241855
Xu X., Lai D., Wang W., Wang Y.	A systematically integrated recycling and upgrading technology for waste crystalline silicon photovoltaic module	2022	Resources, Conservation and Recycling	182		106284			10.1016/j.resconrec.2022.106284	https://www.scopus.com/inward/record.uri?eid=2-s2.0-85126276442&doi=10.1016%2fj.resconrec.2022.106284&partnerID=40&md5=168e64e79b2c15c9355ee0bb8d42e8c6	CAS Key Laboratory of Urban Pollutant Conversion, Institute of Urban Environment, Chinese Academy of Sciences, Xiamen, 361021, China; University of Chinese Academy of Sciences, Beijing, 100049, China; Ningbo (Beilun) Zhongke Haixi Industrial Technology Innovation Center, Ningbo, 315000, China	09213449		RCREE	Article	Final		Scopus	2-s2.0-85126276442
Sabia G., Tammaro M., Cerchier P., Salluzzo A., Brunelli K.	Treatment and management of the effluents generated by hydrometallurgical processes applied to End-of-Life Photovoltaic Panels	2022	Journal of Water Process Engineering	47		102814			10.1016/j.jwpe.2022.102814	https://www.scopus.com/inward/record.uri?eid=2-s2.0-85129498895&doi=10.1016%2fj.jwpe.2022.102814&partnerID=40&md5=bc0a8aa2ee726225f3ece923463f281f	ENEA Italian National Agency for New Technologies, Department for Sustainability, Research Centre of Bologna, Via Martiri di Monte Sole 4, BO, Bologna, 40129, Italy; ENEA Italian National Agency for New Technologies, Department for Sustainability, Research Centre of Portici, P. le E. Fermi 1, NA, Portici, 80055, Italy; Department of Industrial Engineering, University of Padua, Via Marzolo 9, PD, Padua, 35131, Italy	22147144			Article	Final		Scopus	2-s2.0-85129498895
Kastanaki E., Giannis A.	Energy decarbonisation in the European Union: Assessment of photovoltaic waste recycling potential	2022	Renewable Energy	192			1	13	10.1016/j.renene.2022.04.098	https://www.scopus.com/inward/record.uri?eid=2-s2.0-85129433770&doi=10.1016%2fj.renene.2022.04.098&partnerID=40&md5=8ab522d65203ac5f2811e0a192cddd0c	School of Chemical and Environmental Engineering, Technical University of Crete, University Campus, Chania, 73100, Greece	09601481			Article	Final		Scopus	2-s2.0-85129433770

Table A-3: PV Recycling Literature Review

Authors	Title	Year	Source Title	Volume	Issue	Art. No.	Page Start	Page End	DOI	Link	Affiliations	ISSN	ISBN	CODEN	Document Type	Publication Stage	Open Access	Source	EID
Tao M., Click N., Ricci L.	Commentary on Technoeconomic Analysis of High-Value, Crystalline Silicon Photovoltaic Module Recycling Processes [Solar Energy Materials and Solar Cells 238 (2022) 111592]	2022	Solar Energy Materials and Solar Cells	239		111677			10.1016/j.solmat.2022.111677	https://www.scopus.com/inward/record.uri?eid=2-s2.0-85125732939&doi=10.1016%2fj.solmat.2022.111677&partnerID=40&md5=0611a7d9e5ed004e6d59b9d674432174	Engineering Research Center, Arizona State University, 551 East Tyler Mall, Tempe, AZ 85281, United States; TG Companies LLC, 9040 South Rita Road, Tucson, AZ 85747, United States	09270248		SEMCE	Article	Final		Scopus	2-s2.0-85125732939
Liu C., Zhang Q., Zhang M., Wang L., Zhao J.	Employing benefit-sharing to motivate stakeholders' efficient investment in waste photovoltaic module recycling	2022	Sustainable Energy Technologies and Assessments	51		101877			10.1016/j.seta.2021.101877	https://www.scopus.com/inward/record.uri?eid=2-s2.0-85123929279&doi=10.1016%2fj.seta.2021.101877&partnerID=40&md5=96506d6ee6a465efc3253a6e9e2d02b6	College of Economics and Management, Nanjing University of Aeronautics and Astronautics, Nanjing, 210016, China; Research Centre for Soft Energy Science, Nanjing University of Aeronautics and Astronautics, Nanjing, 210016, China	22131388			Article	Final		Scopus	2-s2.0-85123929279
Zhang Z., Yang N., Xi F., Chen X., Li S., Ma W., Lei Y., Deng R.	Purification of silicon from waste photovoltaic cells and its value-added application in lithium-ion batteries	2022	New Journal of Chemistry	46	24		11788	11796	10.1039/d2nj01093c	https://www.scopus.com/inward/record.uri?eid=2-s2.0-85131968548&doi=10.1039%2fd2nj01093c&partnerID=40&md5=c7c5d0867655cb1088c7a0d158339aae	Faculty of Metallurgical and Energy Engineering, State Key Laboratory of Complex Nonferrous Metal Resources Clean Utilization, Kunming University of Science and Technology, Kunming, 650093, China; Silicon Material Industry Research Institution (Innovation Center) of Yunnan Province, Kunming, 650093, China; Xi'an Mingde Institute of Technology, Xi'an, 710000, China; School of Materials Science and Engineering, Yunnan University, Kunming, 650091, China; School of Photovoltaic and Renewable Energy Engineering (SPREE), University of New South Wales, Sydney, 2052, Australia	11440546		NJCHE	Article	Final		Scopus	2-s2.0-85131968548
Cao J., Sim Y., Tan X.Y., Zheng J., Chien S.W., Jia N., Chen K., Tay Y.B., Dong J.-F., Yang L., Ng H.K., Liu H., Tan C.K.I., Xie G., Zhu Q., Li Z., Zhang G., Hu L., Zheng Y., Xu J., Yan Q., Loh X.J., Mathews N., Wu J., Suwardi A.	Upcycling Silicon Photovoltaic Waste into Thermoelectrics	2022	Advanced Materials	34	19	2110518			10.1002/adma.202110518	https://www.scopus.com/inward/record.uri?eid=2-s2.0-85127285038&doi=10.1002%2fadma.202110518&partnerID=40&md5=bb413e0965467c7c05e5ab4ec3cc557f	Agency for Science, Technology and Research, Institute of Materials Research and Engineering, #08-03, 2 Fusionopolis Way, Singapore, 138634, Singapore; Energy Research Institute, Nanyang Technological University (ERI@N), Research Techno Plaza, X-Frontier Block Level 5, 50 Nanyang Drive, Singapore, 637553, Singapore; Singapore-CEA Alliance for Research in Circular Economy (SCARCE), School of Chemical and Biomedical Engineering, 62 Nanyang Drive, Singapore, 637459, Singapore; School of Materials Science and Engineering, Nanyang Technological University, Singapore, 639798, Singapore; School of Mechanical and Aerospace Engineering, Nanyang Technological University, Singapore, 639798, Singapore; Interdisciplinary Graduate School (IGS), Nanyang Technological University, 50 Nanyang Avenue, Singapore, 639798, Singapore; Department of Materials Science and Engineering, National University of Singapore, Singapore, 117575, Singapore; School of Materials Science and Engineering, Hunan University of Science and Technology, Xiangtan, 411201, China; Institute of Sustainability for Chemicals, Energy and Environment (ISCE2), A*STAR, 1 Pesek Road, Jurong Island, Singapore, 627833, Singapore; Institute of High Performance Computing, 1 Fusionopolis Way, Connexis, Singapore, 138632, Singapore; Laboratory for Materials and Structures, Tokyo Institute of Technology, 4259 Nagatsuta, Midori-ku, Kanagawa, Yokohama, 226-8503, Japan; Key Laboratory of Optoelectronic Chemical Materials and Devices, Ministry of Education, Jianghan University, Hubei, Wuhan, 430056, China	09359648		ADVME	Article	Final		Scopus	2-s2.0-85127285038
Briand A., Leybros A., Doucet O., Vite M., Gasmi A., Ruiz J.C., Lamadie F., Grandjean A.	Deformation-induced delamination of photovoltaic modules by foaming ethylene-vinyl acetate with supercritical CO2	2022	Journal of CO2 Utilization	59		101933			10.1016/j.jcou.2022.101933	https://www.scopus.com/inward/record.uri?eid=2-s2.0-85125738085&doi=10.1016%2fj.jcou.2022.101933&partnerID=40&md5=ac98108030655d618bb9d6a0f849c84f	Cea, Des, Isec, Dmrc, Univ Montpellier, Marcoule, France; Univ Grenoble Alpes, Cea, Drt, Liten, Dts, Ines, Univ Grenoble Alpes, Grenoble, F-38 000, France	22129820			Article	Final		Scopus	2-s2.0-85125738085
Zhang L., Chang S., Wang Q., Zhou D.	Is subsidy needed for waste PV modules recycling in China? A system dynamics simulation	2022	Sustainable Production and Consumption	31			152	164	10.1016/j.spc.2022.02.005	https://www.scopus.com/inward/record.uri?eid=2-s2.0-85125119028&doi=10.1016%2fj.spc.2022.02.005&partnerID=40&md5=42ece66421de230b8bae9e73d66e3c94	College of Economics and Management, Nanjing University of Aeronautics and Astronautics, Nanjing, 211106, China; Research Centre for Soft Energy Science, Nanjing University of Aeronautics and Astronautics, Nanjing, 211106, China	23525509			Article	Final		Scopus	2-s2.0-85125119028
Yeo Z.Y., Ling Z.P., Ho J.W., Lim Q.X., So Y.H., Wang S.	Status review and future perspectives on mitigating light-induced degradation on silicon-based solar cells	2022	Renewable and Sustainable Energy Reviews	159		112223			10.1016/j.rser.2022.112223	https://www.scopus.com/inward/record.uri?eid=2-s2.0-85124194399&doi=10.1016%2fj.rser.2022.112223&partnerID=40&md5=8165d945281af4920cc5f773eb97cbca	ERI@N, Research Techno Plaza, X-Frontier Block, Level 5, 50 Nanyang Drive, Singapore637553, Singapore; EtaVolt Pte Ltd, 1 Cleantech Loop, Level 6, Cleantech One, Singapore637141, Singapore; Solar Energy Research Institute of Singapore, 7 Engineering Drive 1, 06-01 Block E3A, Singapore117574, Singapore	13640321		RSERF	Review	Final		Scopus	2-s2.0-85124194399
Cui H., Heath G., Remo T., Ravikumar D., Silverman T., Deceglie M., Kempe M., Engel-Cox J.	Technoeconomic analysis of high-value, crystalline silicon photovoltaic module recycling processes	2022	Solar Energy Materials and Solar Cells	238		111592			10.1016/j.solmat.2022.111592	https://www.scopus.com/inward/record.uri?eid=2-s2.0-85123949546&doi=10.1016%2fj.solmat.2022.111592&partnerID=40&md5=c098372a8c0e3b738ac150f6668217f8	Metallurgical and Materials Engineering, Colorado School of Mines: 1500 Illinois St, Golden, CO 80401, United States; National Renewable Energy Laboratory, 15013 Denver West Parkway, Golden, CO 80401, United States; Joint Institute for Strategic Energy Analysis, Golden, CO, United States	09270248		SEMCE	Article	Final		Scopus	2-s2.0-85123949546

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LI Y., ZHANG Q., WANG G., LU X.	Recycling schemes and supporting policies modeling for photovoltaic modules considering heterogeneous risks	2022	Resources, Conservation and Recycling	180		106165			10.1016/j.resconrec.2022.106165	https://www.scopus.com/inward/record.uri?eid=2-s2.0-85122990749&doi=10.1016%2fj.resconrec.2022.106165&partnerID=40&md5=84b41c89df2858b7654723dbc39a0fbd	School of Environment, State Key Joint Laboratory of Environment Simulation and Pollution Control, Tsinghua University, Haidian, Beijing 100084, China; School of Economics and Management, China University of Petroleum-Beijing, Changping, Beijing 102249, China; School of Economics and Management, North China Electric Power UniversityBeijing 102206, China; Beijing Key Laboratory of New Energy and Low-Carbon Development, (North China Electric Power University), Changping, Beijing 102206, China	09213449		RCREE	Article	Final		Scopus	2-s2.0-85122990749
Liao C.-S., Chuang H.-K.	Determinants of innovative green electronics: An experimental study of eco-friendly laptop computers	2022	Technovation	113		102424			10.1016/j.technovation.2021.102424	https://www.scopus.com/inward/record.uri?eid=2-s2.0-85120623249&doi=10.1016%2fj.technovation.2021.102424&partnerID=40&md5=e191488ec7f094b5291bea4b168da4e4	College of Business, Yango University, No. 99 Denglong Road, Mawei District, Fuzhou Economic & Technological Development Zone, Fujian350015, China; Department of Business Administration, Chihlee University of Technology, No.313, Sec. 1, Wenhua Rd., Banqiao Dist., New Taipei City, 220, Taiwan	01664972		TNVTD	Article	Final		Scopus	2-s2.0-85120623249
Krassowski E., Jaeckel B., Zeller U., Pander M., Schenk P., Hofmueller E., Hanifi H.	Reliability Evaluation of Photovoltaic Modules Fabricated from Treated Solar Cells by Laser-Enhanced Contact Optimization Process	2022	Solar RRL	6	5	2100537			10.1002/solr.202100537	https://www.scopus.com/inward/record.uri?eid=2-s2.0-85118662322&doi=10.1002%2fsolr.202100537&partnerID=40&md5=d2de00e68995bb23201d9c8176afc9f5	Diagnostics and Metrology, Fraunhofer-Center for Silicon-Photovoltaics CSP, Halle, 06120, Germany; Naturwissenschaftliche Fakultät II, Martin Luther University of Halle-Wittenberg, Halle, 06108, Germany; Research and Development, CE Cell Engineering GmbH, Kabelsketal, 06184, Germany; Module and System Reliability, Fraunhofer Institute for Microstructure of Materials and Systems IMWS, Halle, 06120, Germany; Research and Development, Alternative Energy AE Solar, Königsbrunn, 86343, Germany	2367198X			Article	Final		Scopus	2-s2.0-85118662322
Rathore N., Panwar N.L.	Strategic overview of management of future solar photovoltaic panel waste generation in the Indian context	2022	Waste Management and Research	40	5		504	518	10.1177/0734242X211003977	https://www.scopus.com/inward/record.uri?eid=2-s2.0-85104735227&doi=10.1177%2f0734242X211003977&partnerID=40&md5=d8af7d2d22e52310ab04fde4268b75d1	Department of Renewable Energy Engineering, MPUAT, India	0734242X		WMARD	Review	Final	All Open Access, Hybrid Gold, Green	Scopus	2-s2.0-85104735227
Ganesan K., Valderrama C.	Anticipatory life cycle analysis framework for sustainable management of end-of-life crystalline silicon photovoltaic panels	2022	Energy	245		123207			10.1016/j.energy.2022.123207	https://www.scopus.com/inward/record.uri?eid=2-s2.0-85123844005&doi=10.1016%2fj.energy.2022.123207&partnerID=40&md5=ab9043065d652618a9ad2eeb10c611d2	Barcelona School of Industrial Engineering, ETSEIB, UPC·BarcelonaTECH, Spain; Chemical Engineering Department, Universitat Politècnica de Catalunya UPC·BarcelonaTECH, Spain; Barcelona Multi-Scale Science and Engineering Research Center, BarcelonaTECH, Spain	03605442		ENEYD	Article	Final	All Open Access, Hybrid Gold, Green	Scopus	2-s2.0-85123844005
Wang S., Shen Y.	Super-quadric CFD-DEM simulation of chip-like particles flow in a fluidized bed	2022	Chemical Engineering Science	251		117431			10.1016/j.ces.2022.117431	https://www.scopus.com/inward/record.uri?eid=2-s2.0-85123104025&doi=10.1016%2fj.ces.2022.117431&partnerID=40&md5=fe38248f88ed015725e9e9c972bf746e	School of Chemical Engineering, University of New South Wales, Sydney, NSW 2052, Australia	00092509		CESCA	Article	Final		Scopus	2-s2.0-85123104025
Włodarczyk R.	Analysis of the Photovoltaic Waste-Recycling Process in Polish Conditions—A Short Review	2022	Sustainability (Switzerland)	14	8	4739			10.3390/su14084739	https://www.scopus.com/inward/record.uri?eid=2-s2.0-85129150059&doi=10.3390%2fsu14084739&partnerID=40&md5=efc2a23c53ca4578b64ebcce198bb603	Faculty of Infrastructure and Environment, Czestochowa University of Technology, J. H. Dabrowskiego Str. 69, Czestochowa, 42-200, Poland	20711050			Article	Final	All Open Access, Gold	Scopus	2-s2.0-85129150059
Nain P., Kumar A.	A state-of-art review on end-of-life solar photovoltaics	2022	Journal of Cleaner Production	343		130978			10.1016/j.jclepro.2022.130978	https://www.scopus.com/inward/record.uri?eid=2-s2.0-85126106866&doi=10.1016%2fj.jclepro.2022.130978&partnerID=40&md5=550122453ac6b041fa56de8f398712a9	Department of Civil Engineering, Indian Institute of Technology, New Delhi, India	09596526		JCROE	Review	Final		Scopus	2-s2.0-85126106866
Peplow M.	Solar Panels Face Recycling Challenge	2022	ACS Central Science	8	3		299	302	10.1021/acscentsci.2c00214	https://www.scopus.com/inward/record.uri?eid=2-s2.0-85127788110&doi=10.1021%2facscentsci.2c00214&partnerID=40&md5=b25d14c945c28995c9bded9880d6844d		23747943		ACSCI	Article	Final	All Open Access, Green	Scopus	2-s2.0-85127788110
Lim M.S.W., He D., Tiong J.S.M., Hanson S., Yang T.C.-K., Tiong T.J., Pan G.-T., Chong S.	Experimental, economic and life cycle assessments of recycling end-of-life monocrystalline silicon photovoltaic modules	2022	Journal of Cleaner Production	340		130796			10.1016/j.jclepro.2022.130796	https://www.scopus.com/inward/record.uri?eid=2-s2.0-85124235571&doi=10.1016%2fj.jclepro.2022.130796&partnerID=40&md5=9642905b3a1d5936bcc8f7fc6b509cef	Department of Chemical and Environmental Engineering, Faculty of Science and Engineering, University of Nottingham, Broga Road, Selangor43500, Malaysia; Department of Chemical and Environmental Engineering, Faculty of Science and Engineering, University of Nottingham, 199, Taikang East Road, Yinzhou, Zhejiang, Ningbo, 315042, China; Department of Chemical Engineering and Biotechnology, National Taipei University of Technology, No. 1, Section 3, Zhongxiao East Road, Da'an District, Taipei City, 106, Taiwan	09596526		JCROE	Article	Final		Scopus	2-s2.0-85124235571
Ren M., Qian X., Chen Y., Wang T., Zhao Y.	Potential lead toxicity and leakage issues on lead halide perovskite photovoltaics	2022	Journal of Hazardous Materials	426		127848			10.1016/j.jhazmat.2021.127848	https://www.scopus.com/inward/record.uri?eid=2-s2.0-85119914477&doi=10.1016%2fj.jhazmat.2021.127848&partnerID=40&md5=fdac74608917696f31e3df05be1920a8	School of Environmental Science and Engineering, Shanghai Jiao Tong University, 800 Dongchuan Rd., Shanghai, 200240, China	03043894		JHMAD	Review	Final		Scopus	2-s2.0-85119914477
Huber S.T., Steininger K.	Critical sustainability issues in the production of wind and solar electricity generation as well as storage facilities and possible solutions	2022	Journal of Cleaner Production	339		130720			10.1016/j.jclepro.2022.130720	https://www.scopus.com/inward/record.uri?eid=2-s2.0-85123837202&doi=10.1016%2fj.jclepro.2022.130720&partnerID=40&md5=81aeda1dc077a7a137968e8f581c87ba	University of Graz, Wegener Center for Climate and Global Change, Brandhofgasse 5, Graz, 8010, Austria	09596526		JCROE	Article	Final	All Open Access, Hybrid Gold	Scopus	2-s2.0-85123837202
Cai J.	Application of KOH-ethanol Solution in Separation of Waste Photovoltaic Panels	2022	Nature Environment and Pollution Technology	21	1		413	420	10.46488/NEPT.2022.v21i01.049	https://www.scopus.com/inward/record.uri?eid=2-s2.0-85127537475&doi=10.46488%2fNEPT.2022.v21i01.049&partnerID=40&md5=3f5eba4a0e627015a43073abbe22488c	International Department, Shanghai World Foreign Language Middle School, Shanghai200233, China	09726268			Article	Final	All Open Access, Gold	Scopus	2-s2.0-85127537475

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Baiamonte M., Colletti C., Ragonesi A., Gerardi C., Dintcheva N.Tz.	Durability and Performance of Encapsulant Films for Bifacial Heterojunction Photovoltaic Modules	2022	Polymers	14	5	1052			10.3390/polym14051052	https://www.scopus.com/inward/record.uri?eid=2-s2.0-85126318460&doi=10.3390%2fpolym14051052&partnerID=40&md5=69dd1bd9944f37dbe5a9fd330c426759	Dipartimento di Ingegneria, Università di Palermo, Viale delle Scienze, Ed. 6, Palermo, 90128, Italy; 3SUN—Enel Green Power SpA Contrada Blocco Torrazze, Zona Industriale Catania, Catania, 95121, Italy	20734360			Article	Final	All Open Access, Gold, Green	Scopus	2-s2.0-85126318460
Zarzavilla M., Quintero A., Abellán M.A., Serrano F.L., Austin M.C., Tejedor-Flores N.	Comparison of Environmental Impact Assessment Methods in the Assembly and Operation of Photovoltaic Power Plants: A Systematic Review in the Castilla—La Mancha Region	2022	Energies	15	5	1926			10.3390/en15051926	https://www.scopus.com/inward/record.uri?eid=2-s2.0-85126300512&doi=10.3390%2fen15051926&partnerID=40&md5=c288a583b0c81a675126887a49cd4fb0	Grupo de Investigación en Energética y Confort en Edificaciones Bioclimáticas (ECEB), Faculty of Mechanical Engineering, Universidad Tecnológica de Panama, Panama City, 0801, Panama; Escuela Técnica Superior de Ingenieros Agrónomos de Albacete, Universidad Castilla-La Mancha, Albacete, 02071, Spain; Centro de Estudios Multidisciplinarios en Ciencias, Ingeniería y Tecnología (CEMCIT-AIP), Panama City, 0801, Panama; Sistema Nacional de Investigación (SNI), Panama City, 0816, Panama; Centro de Investigaciones Hidráulicas e Hidrotécnicas (CIHH), Universidad Tecnológica de Panamá, Panama City, 0801, Panama	19961073			Article	Final	All Open Access, Gold	Scopus	2-s2.0-85126300512
Kayla Kilgo M., Anctil A., Kennedy M.S., Powell B.A.	Metal leaching from Lithium-ion and Nickel-metal hydride batteries and photovoltaic modules in simulated landfill leachates and municipal solid waste materials	2022	Chemical Engineering Journal	431		133825			10.1016/j.cej.2021.133825	https://www.scopus.com/inward/record.uri?eid=2-s2.0-85121663167&doi=10.1016%2fj.cej.2021.133825&partnerID=40&md5=ef2e4486a0f3bb11dbe5b564fad86c1b	Department of Environmental Engineering and Earth Sciences, Clemson University, Clemson, SC 29634, United States; Department of Civil and Environmental Engineering, Michigan State University, East Lansing, MI 48824, United States; Department of Materials Science and Engineering, Clemson University, Clemson, SC 29634, United States	13858947		CMEJA	Article	Final		Scopus	2-s2.0-85121663167
Li Z., Wu X., Wu S., Gao D., Dong H., Huang F., Hu X., Jen A.K.-Y., Zhu Z.	An effective and economical encapsulation method for trapping lead leakage in rigid and flexible perovskite photovoltaics	2022	Nano Energy	93		106853			10.1016/j.nanoen.2021.106853	https://www.scopus.com/inward/record.uri?eid=2-s2.0-85121440395&doi=10.1016%2fj.nanoen.2021.106853&partnerID=40&md5=0ec994d7936388b99280924f61f09754	Department of Chemistry, City University of Hong Kong, Kowloon, 999077, Hong Kong; Hong Kong Institute for Clean Energy, City University of Hong Kong, Kowloon, 999077, Hong Kong; Department of Materials Science and Engineering, City University of Hong Kong, Kowloon, 999077, Hong Kong; Key Laboratory for Physical Electronics and Devices of the Ministry of Education & Shaanxi Key Lab of Information Photonic Technique, School of Electronic Science and Engineering, Xi'an Jiaotong University, No. 28, Xianning West Road, Xi'an, 710049, China; State Key Lab of Advanced Technology for Materials Synthesis and Processing, Wuhan University of Technology, Wuhan, 430070, China; College of Chemistry, Nanchang University, 999 Xuefu Avenue, Nanchang, 330031, China	22112855			Article	Final		Scopus	2-s2.0-85121440395
Tasnim S.S., Rahman M.M., Hasan M.M., Shammi M., Tareq S.M.	Current challenges and future perspectives of solar-PV cell waste in Bangladesh	2022	Heliyon	8	2	e08970			10.1016/j.heliyon.2022.e08970	https://www.scopus.com/inward/record.uri?eid=2-s2.0-85124754687&doi=10.1016%2fj.heliyon.2022.e08970&partnerID=40&md5=545f68b0bafc5d5197fa6289a6a1b457	Laboratory of Environmental Health and Ecotoxicology, Department of Environmental Sciences, Jahangirnagar University, Dhaka, 1342, Bangladesh; Department of Environmental Sciences, Jahangirnagar University, Dhaka, 1342, Bangladesh; Climate Change Program, Christian Commission for Development in Bangladesh (CCDB), Dhaka, 1216, Bangladesh	24058440			Article	Final	All Open Access, Green	Scopus	2-s2.0-85124754687
Isherwood P.J.M.	Reshaping the Module: The Path to Comprehensive Photovoltaic Panel Recycling	2022	Sustainability (Switzerland)	14	3	1676			10.3390/su14031676	https://www.scopus.com/inward/record.uri?eid=2-s2.0-85124070842&doi=10.3390%2fsu14031676&partnerID=40&md5=2a4f1d9842a8de25cedf820b9e41e06e	Centre for Renewable Energy Systems Technology, Wolfson School, Loughborough University, Loughborough, LE11 3TU, United Kingdom	20711050			Review	Final	All Open Access, Gold, Green	Scopus	2-s2.0-85124070842
Li Z., Wu X., Li B., Zhang S., Gao D., Liu Y., Li X., Zhang N., Hu X., Zhi C., Jen A.K.Y., Zhu Z.	Sulfonated Graphene Aerogels Enable Safe-to-Use Flexible Perovskite Solar Modules	2022	Advanced Energy Materials	12	5	2103236			10.1002/aenm.202103236	https://www.scopus.com/inward/record.uri?eid=2-s2.0-85121544104&doi=10.1002%2faenm.202103236&partnerID=40&md5=f498c75431c6765011653cfcf3196dfc	Department of Chemistry, City University of Hong Kong, Kowloon, 999077, Hong Kong; Department of Materials Science and Engineering, City University of Hong Kong, Kowloon, 999077, Hong Kong; College of Chemistry, Nanchang University, 999 Xuefu Avenue, Nanchang, 330031, China; Department of Materials Science and Engineering, University of Washington, Seattle, WA, United States; Hong Kong Institute for Clean Energy, City University of Hong Kong, Kowloon, 999077, Hong Kong	16146832			Article	Final		Scopus	2-s2.0-85121544104
Daniela-Abigail H.-L., Tariq R., Mekaoui A.E., Bassam A., Vega De Lille M., J Ricalde L., Riech I.	Does recycling solar panels make this renewable resource sustainable? Evidence supported by environmental, economic, and social dimensions	2022	Sustainable Cities and Society	77		103539			10.1016/j.scs.2021.103539	https://www.scopus.com/inward/record.uri?eid=2-s2.0-85119604433&doi=10.1016%2fj.scs.2021.103539&partnerID=40&md5=1bc9467f20f5c23bb90d234f3dca69c0	Facultad de Ingeniería, Universidad Autónoma de Yucatán, Av. Industrias No Contaminantes por Anillo Periférico Norte, Apdo. Postal 150, Cordemex, Mérida, Yucatán, Mexico; Cátedra CONACYT, Centro de Investigaciones Regionales, Unidad de Ciencias Sociales, Universidad Autónoma de Yucatán, Calle 61 número 525 entre 66 y 68, col. Centro, Mérida, Yucatán C.P. 97000, Mexico	22106707			Article	Final		Scopus	2-s2.0-85119604433

Table A-3: PV Recycling Literature Review

Authors	Title	Year	Source Title	Volume	Issue	Art. No.	Page Start	Page End	DOI	Link	Affiliations	ISSN	ISBN	CODEN	Document Type	Publication Stage	Open Access	Source	EID
Talens Peiró L., Martin N., Villalba Méndez G., Madrid-López C.	Integration of raw materials indicators of energy technologies into energy system models	2022	Applied Energy	307		118150			10.1016/j.apenergy.2021.118150	https://www.scopus.com/inward/record.uri?eid=2-s2.0-85118863831&doi=10.1016%2fj.apenergy.2021.118150&partnerID=40&md5=e25a87ffe7232dcfce1ff045570730a5	Sostenipra (2017SGR1683), Institut de Ciència i Tecnologia Ambientals (ICTA-UAB), Universitat Autònoma de Barcelona (Unitat Excelencia Maria de Maetzu MDM CEX2019-000940-M), Cerdanyola del Vallès, Barcelona, 08193, Spain; Department of Chemical, Biological and Environmental Engineering, Catalan Biotechnology Reference Network - XRB, Universitat Autònoma de Barcelona (UAB), Campus UAB, Bellaterra, Barcelona, 08193, Spain	03062619		APEND	Article	Final	All Open Access, Hybrid Gold, Green	Scopus	2-s2.0-85118863831
Nambiraj K.M., Rajkumar K., Sabarinathan P.	A Novel Approach on Reusing Silicon Wafer Kerf Particle as Potential Filler Material in Polymer Composite	2022	Silicon	14	4		1537	1548	10.1007/s12633-021-00951-6	https://www.scopus.com/inward/record.uri?eid=2-s2.0-85100026574&doi=10.1007%2fs12633-021-00951-6&partnerID=40&md5=b7925734861751813c631403e1375e0e	Department of Mechanical Engineering, Sri Sivasubramaniya Nadar College of Engineering, Tamilnadu, Chennai, India	1876990X			Article	Final		Scopus	2-s2.0-85100026574
Ndzibah E., Pinilla-De La Cruz G.A., Shamsuzzoha A.	Collaboration towards value creation for end-of-life solar photovoltaic panel in Ghana	2022	Journal of Cleaner Production	333		129969			10.1016/j.jclepro.2021.129969	https://www.scopus.com/inward/record.uri?eid=2-s2.0-85121673830&doi=10.1016%2fj.jclepro.2021.129969&partnerID=40&md5=364ca3c48993fa9b4a11a59f165c7dfb	School of Technology and Innovations, University of Vaasa, Wolffintie 34, Vaasa, 65200, Finland; VEBIC – Vaasa Energy Business Innovation Centre, School of Technology and Innovations University of Vaasa, Wolffintie 34, Vaasa, 65200, Finland; Digital Economy Research Platform, School of Technology and Innovations, University of Vaasa, Wolffintie 34, Vaasa, 65200, Finland	09596526		JCROE	Article	Final	All Open Access, Hybrid Gold, Green	Scopus	2-s2.0-85121673830
Xanthopoulos P., Bevandić S., Spooren J., Binnemans K., Kukurugya F.	Recovery of copper, zinc and lead from photovoltaic panel residue	2022	RSC Advances	12	4		2351	2360	10.1039/d1ra09268e	https://www.scopus.com/inward/record.uri?eid=2-s2.0-85123907906&doi=10.1039%2fd1ra09268e&partnerID=40&md5=3dee34c89230035064c333d4cfe809a1	KU Leuven, Department of Chemistry, Celestijnenlaan 200F-Box 2404, Heverlee, B-3001, Belgium; KU Leuven, Department of Earth and Environmental Sciences, Celestijnenlaan 200E, Heverlee, B-3001, Belgium; Waste Recycling Technologies, Flemish Institute for Technological Research, VITO N.V., Boerentang 200, Mol, 2400, Belgium	20462069		RSCAC	Article	Final	All Open Access, Gold, Green	Scopus	2-s2.0-85123907906
Ndzibah E., Andrea Pinilla-De La Cruz G., Shamsuzzoha A.	End of life analysis of solar photovoltaic panel: roadmap for developing economies	2022	International Journal of Energy Sector Management	16	1		112	128	10.1108/IJESM-11-2020-0005	https://www.scopus.com/inward/record.uri?eid=2-s2.0-85109808147&doi=10.1108%2fIJESM-11-2020-0005&partnerID=40&md5=83b55d38c6ce48de05b7e9eddcbd68ac	School of Technology and Innovations, University of Vaasa, Vaasa, Finland	17506220			Article	Final	All Open Access, Hybrid Gold, Green	Scopus	2-s2.0-85109808147
Liu Y.-H., Chen Y.-L., Chen Y.-S., Huang S.-M., Huang H.-M., Lin S.-J., Yang C.-Y.	Utilization of Si/SiOx/Al2O3 materials from recycled solar cells for a high-performance lithium-ion battery anode	2022	Green Chemistry						10.1039/d2gc01770a	https://www.scopus.com/inward/record.uri?eid=2-s2.0-85131837731&doi=10.1039%2fd2gc01770a&partnerID=40&md5=ec23db00baf4b87d833e5650e2a04093	Department of Chemical and Materials Engineering, National Central University. No. 300, Zhongda Rd., Zhongli Dist., Taoyuan City, 32001, Taiwan; ACON Greenergy Technology Co. Ltd, No. 28, Ln. 634, Zhongshan N. Rd., Yongkang Dist., Tainan City, 71041, Taiwan; Department of Mechanical Engineering, Chien Hsin University of Science and Technology. No.229, Jianxing Rd., Zhongli Dist., Taoyuan City, 32097, Taiwan	14639262		GRCHF	Article	Article in Press		Scopus	2-s2.0-85131837731
Schichtel B.A., Stevenson E.	Introduction to the A&WMA 2022 critical review: A critical review of circular economy for lithium-ion batteries and photovoltaic modules—status, challenges, and opportunities	2022	Journal of the Air and Waste Management Association	72	6		475	477	10.1080/10962247.2022.2067402	https://www.scopus.com/inward/record.uri?eid=2-s2.0-85131583994&doi=10.1080%2f10962247.2022.2067402&partnerID=40&md5=691b129b76847d0453f24612efaa1d9c	National Park Service Air Resources Division, Lakewood, CO, United States	10962247		JIJME	Editorial	Final	All Open Access, Bronze	Scopus	2-s2.0-85131583994
Heath G.A., Ravikumar D., Hansen B., Kupets E.	A critical review of the circular economy for lithium-ion batteries and photovoltaic modules–status, challenges, and opportunities	2022	Journal of the Air and Waste Management Association	72	6		478	539	10.1080/10962247.2022.2068878	https://www.scopus.com/inward/record.uri?eid=2-s2.0-85131528047&doi=10.1080%2f10962247.2022.2068878&partnerID=40&md5=5a034c176968425219ca85c760daf1a1	Strategic Energy Analysis Center, National Renewable Energy Laboratory, Golden, CO, United States; Joint Institute for Strategic Energy Analysis, Golden, CO, United States	10962247		JIJME	Review	Final	All Open Access, Hybrid Gold, Green	Scopus	2-s2.0-85131528047
Atmaja G.P.S.G., Sambodo N.P., Muflikhun M.A.	A Mini Review on The Recent Progress on The Method of Recycling Lithium-Ion Battery: Pros And Cons In Environmental and Economical Aspect	2022	Journal of Engineering Science and Technology Review	15	1		74	84	10.25103/jestr.151.10	https://www.scopus.com/inward/record.uri?eid=2-s2.0-85131316191&doi=10.25103%2fjestr.151.10&partnerID=40&md5=6724ec969635285abe1c8139161452cb	Mechanical and Industrial Engineering Department, Faculty of Engineering, Universitas Gadjah Mada (UGM), Indonesia; Department of Economics, Faculty of Economics and Business, Universitas Gadjah Mada (UGM), Indonesia; Center for Advanced Manufacturing and Structural Engineering (CAMSE), Faculty of Engineering, Universitas Gadjah Mada (UGM), Indonesia	17919320			Article	Final	All Open Access, Gold	Scopus	2-s2.0-85131316191
Lee S.H., Han K.-Y., Chang H.J.	Properties of passivation layer formed by solution process on flexible CIGS solar cells	2022	Molecular Crystals and Liquid Crystals	734	1		47	62	10.1080/15421406.2021.1972213	https://www.scopus.com/inward/record.uri?eid=2-s2.0-85131187657&doi=10.1080%2f15421406.2021.1972213&partnerID=40&md5=2fdbb947fd0625f90e580f7cb27c8779	Department of Electronics and Electrical Engineering, Dankook University, Yongin-si, South Korea; Department of Display Engineering, Dankook University, Cheonan-si, South Korea	15421406		MCLCD	Article	Final		Scopus	2-s2.0-85131187657
[No author name available]	Construction Research Congress 2022: Infrastructure Sustainability and Resilience - Selected Papers from Construction Research Congress 2022	2022	Construction Research Congress 2022: Infrastructure Sustainability and Resilience - Selected Papers from Construction Research Congress 2022	1-A						https://www.scopus.com/inward/record.uri?eid=2-s2.0-85130335038&partnerID=40&md5=b5cf19136da2bb85c7698806d762baeb			9780784483954		Conference Review	Final		Scopus	2-s2.0-85130335038

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Kamperidis T., Tremouli A., Remoundaki E., Lyberatos G.	Silver Recovery from Wastewater, Simulating the Chemical Extract Originating from a PV Panel Using Microbial Fuel Cell Technology	2022	Waste and Biomass Valorization						10.1007/s12649-022-01793-y	https://www.scopus.com/inward/record.uri?eid=2-s2.0-85130196388&doi=10.1007%2fs12649-022-01793-y&partnerID=40&md5=54cf84972c640ea2ecf32503a7e7f0d2	School of Chemical Engineering, National Technical University of Athens, Heroon Polytechniou 9, Athens, 15780, Greece; School of Mining and Metallurgical Engineering, National Technical University of Athens, Heroon Polytechniou 9, Athens, 15780, Greece; Institute of Chemical Engineering Sciences (ICE-HT), Stadiou Str., Platani, Patras, 26504, Greece	18772641			Article	Article in Press		Scopus	2-s2.0-85130196388
Chávez C., Ramírez J.D., María F.T.L., Otero P., Taco-Vásquez S., Tibanlombo V.	Determination of the Appropriate Number of Photovoltaic Panels for Microgeneration and Self-supply of Final Consumers by Energy Production Estimation via Fuzzy Logic	2022	International Journal on Advanced Science, Engineering and Information Technology	12	2		460	469	10.18517/ijaseit.12.2.15291	https://www.scopus.com/inward/record.uri?eid=2-s2.0-85129294674&doi=10.18517%2fijaseit.12.2.15291&partnerID=40&md5=aec7aa04633c6abd4875ea95db7e71ba	Departamento de Energía Eléctrica, Escuela Politécnica Nacional, Ladrón de Guevara, Quito, E11 253, Ecuador; Departamento de Ingeniería Mecánica, Escuela Politécnica Nacional, Ladrón de Guevara, Quito, E11 253, Ecuador; Departamento de Ingeniería Química, Escuela Politécnica Nacional, Ladrón de Guevara, Quito, E11 253, Ecuador	20885334			Article	Final	All Open Access, Hybrid Gold	Scopus	2-s2.0-85129294674
Dobra T., Thajer F., Wiesinger G., Vollprecht D., Pomberger R.	Selective delamination by milling as a first step in the recycling of photovoltaic modules	2022	Environmental Technology (United Kingdom)						10.1080/09593330.2022.2061380	https://www.scopus.com/inward/record.uri?eid=2-s2.0-85129214453&doi=10.1080%2f09593330.2022.2061380&partnerID=40&md5=07f4679d386f6964b9d5730e978a97d5	Department of Environmental and Energy Process Engineering, Chair of Waste Processing Technology and Waste Management, Montanuniversitaet Leoben, Leoben, Austria; Institute of Production Engineering and Photonic Technologies, TU Wien, Vienna, Austria	09593330		ENVTE	Article	Article in Press	All Open Access, Hybrid Gold	Scopus	2-s2.0-85129214453
Park Y., Kim M.J., Gim U.	Attention! Is Recycling Artificial Neural Network Effective for Maintaining Renewable Energy Efficiency?	2022	2022 IEEE Texas Power and Energy Conference, TPEC 2022						10.1109/TPEC54980.2022.9750784	https://www.scopus.com/inward/record.uri?eid=2-s2.0-85128740816&doi=10.1109%2fTPEC54980.2022.9750784&partnerID=40&md5=0b4d2c920259ef4e11b25545d08ea485	Sk Planet Co., Ltd., Seongnam, South Korea		9781665479028		Conference Paper	Final		Scopus	2-s2.0-85128740816
Theocharis M., Pavlopoulos C., Kousi P., Hatzikioseyian A., Zarkadas I., Tsakiridis P.E., Remoundaki E., Zoumboulakis L., Lyberatos G.	An Integrated Thermal and Hydrometallurgical Process for the Recovery of Silicon and Silver from End-of-Life Crystalline Si Photovoltaic Panels	2022	Waste and Biomass Valorization						10.1007/s12649-022-01754-5	https://www.scopus.com/inward/record.uri?eid=2-s2.0-85127570656&doi=10.1007%2fs12649-022-01754-5&partnerID=40&md5=9a52e1e5fd3ef561b760ef6c7e430db5	School of Mining and Metallurgical Engineering, National Technical University of Athens (NTUA), Heroon Polytechniou 9, Zografou, 15780, Greece; School of Chemical Engineering, National Technical University of Athens (NTUA), Heroon Polytechniou 9, Zografou, 15780, Greece; Polyeco S.A. Headquarters, 16th km of Athens-Korinthos National Road, Aspropyrgos, 19300, Greece	18772641			Article	Article in Press		Scopus	2-s2.0-85127570656
Bartie N., Cobos-Becerra L., Fröhling M., Schlatmann R., Reuter M.	Metallurgical infrastructure and technology criticality: the link between photovoltaics, sustainability, and the metals industry	2022	Mineral Economics						10.1007/s13563-022-00313-7	https://www.scopus.com/inward/record.uri?eid=2-s2.0-85127325485&doi=10.1007%2fs13563-022-00313-7&partnerID=40&md5=bccd5050e0d8db3154544db481857234	Institute of Energy and Process Systems Engineering, Technische Universität Braunschweig, Braunschweig, Germany; Professorship Circular Economy, Technical University of Munich, Straubing, Germany; Helmholtz-Zentrum Berlin für Materialien und Energie, PVcomB, Berlin, Germany; SMS-Group, Eduard-Schloemann-Str. 4, Düsseldorf, 40237, Germany	21912203			Article	Article in Press	All Open Access, Hybrid Gold	Scopus	2-s2.0-85127325485
Urbina A.	Standardization and Regulations for PV Technologies	2022	Green Energy and Technology				249	266	10.1007/978-3-030-91771-5_11	https://www.scopus.com/inward/record.uri?eid=2-s2.0-85125733719&doi=10.1007%2f978-3-030-91771-5_11&partnerID=40&md5=5e07c2feeb47cfab8e3ff0b6b343c57c	Institute for Advanced Materials and Mathematics (INAMAT2) and Department of Sciences, Public University of Navarra (UPNA), Pamplona, Spain	18653529			Book Chapter	Final		Scopus	2-s2.0-85125733719
Urbina A.	Recycling and End of Life of PV Technologies	2022	Green Energy and Technology				199	214	10.1007/978-3-030-91771-5_8	https://www.scopus.com/inward/record.uri?eid=2-s2.0-85125718334&doi=10.1007%2f978-3-030-91771-5_8&partnerID=40&md5=5db14edbfc5d30def0628ab2bcc55822	Institute for Advanced Materials and Mathematics (INAMAT2) and Department of Sciences, Public University of Navarra (UPNA), Pamplona, Spain	18653529			Book Chapter	Final		Scopus	2-s2.0-85125718334
Urbina A.	Scenarios for Solar Electricity at the TeraWatt Scale	2022	Green Energy and Technology				3	17	10.1007/978-3-030-91771-5_1	https://www.scopus.com/inward/record.uri?eid=2-s2.0-85125710337&doi=10.1007%2f978-3-030-91771-5_1&partnerID=40&md5=bb7de4cccfcd0a22a4e8b6ca4894d783	Institute for Advanced Materials and Mathematics (INAMAT2) and Department of Sciences, Public University of Navarra (UPNA), Pamplona, Spain	18653529			Book Chapter	Final		Scopus	2-s2.0-85125710337
Wang S.	Tellurium Recovery—Development of a Novel Hydrometallurgical Process	2022	Minerals, Metals and Materials Series	Part F			225	235	10.1007/978-3-030-92662-5_22	https://www.scopus.com/inward/record.uri?eid=2-s2.0-85125288437&doi=10.1007%2f978-3-030-92662-5_22&partnerID=40&md5=5ba03fb30ddf14f59c06eb52dcb18da5	Coeur Mining Inc., 104 S. Michigan Ave., Chicago, IL, United States	23671181	9783030926618		Conference Paper	Final		Scopus	2-s2.0-85125288437
Flores R., He H., Sinha P., Heath G., Leu P.W., Schoenung J.M.	Environmental Benefits of Closing the Solar Manufacturing and Recycling Loop: Preparation of Solar Manufacturing Inventories	2022	Minerals, Metals and Materials Series				435	448	10.1007/978-3-030-92563-5_45	https://www.scopus.com/inward/record.uri?eid=2-s2.0-85125266945&doi=10.1007%2f978-3-030-92563-5_45&partnerID=40&md5=2e48618edc2e9abb559bc3a603d6679b	Department of Mechanical and Aerospace Engineering, University of California, Irvine, CA 92697, United States; Department of Materials Science and Engineering, University of California, Irvine, CA 92697, United States; First Solar, Tempe, AZ 85281, United States; National Renewable Energy Laboratory, Golden, CO 80401, United States; Department of Industrial Engineering, University of Pittsburgh, Pittsburgh, PA 15260, United States	23671181	9783030925628		Conference Paper	Final		Scopus	2-s2.0-85125266945

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Husain D., Tewari K., Sharma M., Ahmad A., Prakash R.	Ecological Footprint of Multi-silicon Photovoltaic Module Recycling	2022	Environmental Footprints and Eco-Design of Products and Processes				65	82	10.1007/978-981-16-8426-5_3	https://www.scopus.com/inward/record.uri?eid=2-s2.0-85124491208&doi=10.1007%2f978-981-16-8426-5_3&partnerID=40&md5=4e8f4ce3a370e85a5a19ad8915763862	Department of Mechanical Engineering, Maulana Mukhtar Ahmad Nadvi Technical Campus, Maharashtra, Malegaon, India; Department of Mechanical Engineering, National Institute of Technology Sikkim, Sikkim, Ravangla, India; Department of Mechanical Engineering, Malla Reddy Engineering College, Telangana, Hyderabad, India; Faculty of Science and Information Technology, Mianz International College, Male, Maldives; Department of Mechanical Engineering, Motilal Nehru National Institute of Technology Allahabad, Uttar Pradesh, Prayagraj, India	23457651			Book Chapter	Final		Scopus	2-s2.0-85124491208
Nain P., Kumar A.	Understanding manufacturers' and consumers' perspectives towards end-of-life solar photovoltaic waste management and recycling	2022	Environment, Development and Sustainability						10.1007/s10668-022-02136-6	https://www.scopus.com/inward/record.uri?eid=2-s2.0-85123494494&doi=10.1007%2fs10668-022-02136-6&partnerID=40&md5=0b03df5a318a4ef4a3c0573509ce574b	Department of Civil Engineering, Indian Institute of Technology, New Delhi, India	1387585X		EDSNB	Article	Article in Press		Scopus	2-s2.0-85123494494
Chava V.S.N., Sreenivasan S.T.	Material and Process-Related Contaminants in Solar Photovoltaics: Key Issues, and Future Prospects	2022	Energy, Environment, and Sustainability				527	557	10.1007/978-981-16-8367-1_22	https://www.scopus.com/inward/record.uri?eid=2-s2.0-85121391988&doi=10.1007%2f978-981-16-8367-1_22&partnerID=40&md5=196b51e67888c7b55edcae3dd3de3a3c	Department of Chemistry and Biochemistry, The University of Texas at El Paso, 500 W. University Avenue, El Paso, TX 79968, United States	25228366			Book Chapter	Final		Scopus	2-s2.0-85121391988
Dhimish M., Badran G.	Recovery of Photovoltaic Potential-Induced Degradation Utilizing Automatic Indirect Voltage Source	2022	IEEE Transactions on Instrumentation and Measurement	71					10.1109/TIM.2021.3134328	https://www.scopus.com/inward/record.uri?eid=2-s2.0-85121347322&doi=10.1109%2fTIM.2021.3134328&partnerID=40&md5=6207f814de6e1ffe5f47be7e8cfad3f2	Department of Electronic Engineering, University of York, York, YO10 5DD, United Kingdom	00189456		IEIMA	Article	Final	All Open Access, Green	Scopus	2-s2.0-85121347322
Kray D., Bandyopadhyay S., Heuberger L., Weiser D., Muranovic D., Rudert H., Einhaus R.	N.I.C.E.-Wire: Next Generation Robust Eco-Friendly Bifacial PV Modules with High Efficiency	2022	IEEE Journal of Photovoltaics	12	1		38	44	10.1109/JPHOTOV.2021.3124168	https://www.scopus.com/inward/record.uri?eid=2-s2.0-85120056944&doi=10.1109%2fJPHOTOV.2021.3124168&partnerID=40&md5=bf62c75bd82bec6a4f0d787d4e0c52f9	Institute for Energy Systems Technology, University of Applied Sciences Offenburg, Offenburg, 77652, Germany; F.U.R. Wickeltechnologie, Berlin, 10365, Germany; Apollon Solar, Saint-Priest, 69800, France	21563381			Article	Final		Scopus	2-s2.0-85120056944
Li X., Liu H., You J., Diao H., Zhao L., Wang W.	Back EVA recycling from c-Si photovoltaic module without damaging solar cell via laser irradiation followed by mechanical peeling	2022	Waste Management	137			312	318	10.1016/j.wasman.2021.11.024	https://www.scopus.com/inward/record.uri?eid=2-s2.0-85119653286&doi=10.1016%2fj.wasman.2021.11.024&partnerID=40&md5=843f950c3012565d174133acf18f11da	Key Laboratory of Solar Thermal Energy and Photovoltaic System of Chinese Academy of Sciences, Institute of Electrical Engineering, The Chinese Academy of Sciences, Beijing, China; University of Chinese Academy of Sciences, Beijing, China; Dalian National Laboratory for Clean Energy, Dalian, China	0956053X		WAMAE	Article	Final		Scopus	2-s2.0-85119653286
Duran A.S., Atasu A., Van Wassenhove L.N.	Cleaning after solar panels: applying a circular outlook to clean energy research	2022	International Journal of Production Research	60	1		211	230	10.1080/00207543.2021.1990434	https://www.scopus.com/inward/record.uri?eid=2-s2.0-85118432674&doi=10.1080%2f00207543.2021.1990434&partnerID=40&md5=f1b4cd942752f83008607b99d51c56f9	Haskayne School of Business, University of Calgary, Calgary, Canada; Technology and Operations Management Area, INSEAD, Fontainebleau, France	00207543		IJPRB	Article	Final		Scopus	2-s2.0-85118432674
Thomassen G., Dewulf J., Van Passel S.	Prospective material and substance flow analysis of the end-of-life phase of crystalline silicon-based PV modules	2022	Resources, Conservation and Recycling	176		105917			10.1016/j.resconrec.2021.105917	https://www.scopus.com/inward/record.uri?eid=2-s2.0-85116515448&doi=10.1016%2fj.resconrec.2021.105917&partnerID=40&md5=4ec4e577f9abb3082afd036e72b4f21d	Research Group Sustainable Systems Engineering (STEN), Ghent University, Coupure Links 653, Ghent, 9000, Belgium; Department of Engineering Management, University of Antwerp, Prinsstraat 13, Antwerp, 2000, Belgium	09213449		RCREE	Article	Final		Scopus	2-s2.0-85116515448
Briand A., Leybros A., Audoin C., Ruiz J.C., Lamadie F., Grandjean A.	CO2 absorption into a polymer within a multilayer structure: The case of poly(ethylene-co-vinyl acetate) in photovoltaic modules	2022	Journal of Supercritical Fluids	179		105380			10.1016/j.supflu.2021.105380	https://www.scopus.com/inward/record.uri?eid=2-s2.0-85115782024&doi=10.1016%2fj.supflu.2021.105380&partnerID=40&md5=e218ece131f7a3e41205c3417bca5532	CEA, DES, ISEC, DMRC, Univ Montpellier, Marcoule, France; Univ. Grenoble Alpes, CEA, Liten, Campus Ines, Le Bourget du Lac, 73375, France	08968446		JSFLE	Article	Final	All Open Access, Bronze	Scopus	2-s2.0-85115782024
Dobra T., Vollprecht D., Pomberger R.	Thermal delamination of end-of-life crystalline silicon photovoltaic modules	2022	Waste Management and Research	40	1		96	103	10.1177/0734242X211038184	https://www.scopus.com/inward/record.uri?eid=2-s2.0-85113164891&doi=10.1177%2f0734242X211038184&partnerID=40&md5=e4290191caf60fe557b0c73203599014	Department of Environmental and Energy Process Engineering, Chair of Waste Processing Technology and Waste Management, Montanuniversitaet Leoben, Leoben, Austria	0734242X		WMARD	Article	Final	All Open Access, Green	Scopus	2-s2.0-85113164891
Deng R., Dias P.R., Lunardi M.M., Ji J.	A sustainable chemical process to recycle end-of-life silicon solar cells	2021	Green Chemistry	23	24		10157	10167	10.1039/d1gc02263f	https://www.scopus.com/inward/record.uri?eid=2-s2.0-85121648187&doi=10.1039%2fd1gc02263f&partnerID=40&md5=5373c161faacd9330c99046e407a04d3	School of Photovoltaic and Renewable Energy Engineering, University of New South Wales, Sydney, 2052, Australia; LACOR, Universidade Federal Do Rio Grande Do sul (UFRGS), RS, Porto Alegre, Brazil	14639262		GRCHF	Article	Final		Scopus	2-s2.0-85121648187
Peters I.M., Hauch J., Brabec C., Sinha P.	The value of stability in photovoltaics	2021	Joule	5	12		3137	3153	10.1016/j.joule.2021.10.019	https://www.scopus.com/inward/record.uri?eid=2-s2.0-85120979676&doi=10.1016%2fj.joule.2021.10.019&partnerID=40&md5=6e3611ab4ef10fd58cde2978f4bf9e7a	FZ Jülich, Helmholtz-Institut Erlangen-Nürnberg for Renewable Energies, Immerwahrstraße 2, Erlangen, 91058, Germany; Institute of Materials for Electronics and Energy Technology (i-MEET), Department of Materials Science and Engineering, Friedrich-Alexander University Erlangen-Nürnberg, Erlangen, 91058, Germany; First Solar, 350 W Washington St, Suite 600, Tempe, AZ 85281, United States	25424351			Article	Final		Scopus	2-s2.0-85120979676
Kuczyńska-Łażewska A., Klugmann-Radziemska E., Witkowska A.	Recovery of valuable materials and methods for their management when recycling thin-film CdTe photovoltaic modules	2021	Materials	14	24	7836			10.3390/ma14247836	https://www.scopus.com/inward/record.uri?eid=2-s2.0-85121338168&doi=10.3390%2fma14247836&partnerID=40&md5=461e0115b472298c65a85cfba4707fba	Department of Energy Conversion and Storage, Faculty of Chemistry, Gdansk University of Technology, G. Narutowicza Str. 11/12, Gdańsk, PL-80-233, Poland; Institute of Nanotechnology and Materials Engineering, Faculty of Applied Physics and Mathematics, Gdansk University of Technology, G. Narutowicza Str. 11/12, Gdańsk, PL-80-233, Poland	19961944			Article	Final	All Open Access, Gold, Green	Scopus	2-s2.0-85121338168

Table A-3: PV Recycling Literature Review

Authors	Title	Year	Source Title	Volume	Issue	Art. No.	Page Start	Page End	DOI	Link	Affiliations	ISSN	ISBN	CODEN	Document Type	Publication Stage	Open Access	Source	EID
Luo M., Liu F., Zhou Z., Jiang L., Jia M., Lai Y., Li J., Zhang Z.	A comprehensive hydrometallurgical recycling approach for the environmental impact mitigation of EoL solar cells	2021	Journal of Environmental Chemical Engineering	9	6	106830			10.1016/j.jece.2021.106830	https://www.scopus.com/inward/record.uri?eid=2-s2.0-85119675588&doi=10.1016%2fj.jece.2021.106830&partnerID=40&md5=9fabdb2a7608c837af0ecc42e623ac02	School of Metallurgy and Environment, Central South University, Changsha, 410083, China; Hunan Provincial Key Laboratory of Nonferrous Value-added Metallurgy, Central South University, Changsha, 410083, China	22133437			Article	Final		Scopus	2-s2.0-85119675588
Chen B., Fei C., Chen S., Gu H., Xiao X., Huang J.	Recycling lead and transparent conductors from perovskite solar modules	2021	Nature Communications	12	1	5859			10.1038/s41467-021-26121-1	https://www.scopus.com/inward/record.uri?eid=2-s2.0-85116437823&doi=10.1038%2fs41467-021-26121-1&partnerID=40&md5=37cc9a1a36acf84a1adb1fb22bbab600	Department of Applied Physical Sciences, University of North Carolina at Chapel Hill, Chapel Hill, NC 27599, United States	20411723			Article	Final	All Open Access, Gold, Green	Scopus	2-s2.0-85116437823
Salim H., Stewart R.A., Sahin O., Sagstad B., Dudley M.	R3SOLVE: A serious game to support end-of-life rooftop solar panel waste management	2021	Sustainability (Switzerland)	13	22	12418			10.3390/su132212418	https://www.scopus.com/inward/record.uri?eid=2-s2.0-85119197342&doi=10.3390%2fsu132212418&partnerID=40&md5=fe73582ee92aa35938f6fedc6140c3b9	School of Engineering and Built Environment, Griffith University, Southport, QLD 4222, Australia; Cities Research Institute, Griffith University, Southport, QLD 4222, Australia; Griffith Climate Change Response Program, Griffith University, Southport, QLD 4222, Australia; TechCollect NZ, Auckland, 0642, New Zealand	20711050			Article	Final	All Open Access, Gold, Green	Scopus	2-s2.0-85119197342
Huang Y.-H., Shen T.-S.	An article on green firefighting equipment in Taiwan	2021	Sustainability (Switzerland)	13	22	12421			10.3390/su132212421	https://www.scopus.com/inward/record.uri?eid=2-s2.0-85119174936&doi=10.3390%2fsu132212421&partnerID=40&md5=cf78abee0dcbf4b8ba2941d28d7540ba	Department of Fire Science, Central Police University, Taoyuan City, 33304, Taiwan	20711050			Article	Final	All Open Access, Gold, Green	Scopus	2-s2.0-85119174936
Mishra S., Panda S., Akcil A., Dembele S., Agcasulu I.	A review on chemical versus microbial leaching of electronic wastes with emphasis on base metal dissolution	2021	Minerals	11	11	1255			10.3390/min11111255	https://www.scopus.com/inward/record.uri?eid=2-s2.0-85118747935&doi=10.3390%2fmin11111255&partnerID=40&md5=8202c92a980e21116a12a55b2fb132db	Mineral-Metal Recovery and Recycling (MMR&R) Research Group, Mineral Processing Division, Department of Mining Engineering, Suleyman Demirel University, Isparta, TR32260, Turkey	2075163X			Review	Final	All Open Access, Gold, Green	Scopus	2-s2.0-85118747935
Máčalová K., Václavík V., Dvorský T., Figmig R., Charvát J., Lupták M.	The use of glass from photovoltaic panels at the end of their life cycle in cement composites	2021	Materials	14	21	6655			10.3390/ma14216655	https://www.scopus.com/inward/record.uri?eid=2-s2.0-85118714410&doi=10.3390%2fma14216655&partnerID=40&md5=facb30ed2549a4e72187f5e530f212ad	Department of Environmental Engineering, Faculty of Mining and Geology, VSB—Technical University of Ostrava, 17. Listopadu 15/2172, Ostrava, 708 00, Czech Republic; Faculty of Civil Engineering, Institute of Environmental Engineering, Technical University of Kosice, Vysokoskolska 4, Kosice, 04200, Slovakia; Faculty of Materials, Metallurgy and Recycling, Institute of Materials and Quality Engineering, Technical University of Kosice, Kosice, 04200, Slovakia	19961944			Article	Final	All Open Access, Gold, Green	Scopus	2-s2.0-85118714410
Modrzynski C., Blaesing L., Hippmann S., Bertau M., Bloh J.Z., Weidlich C.	Electrochemical Recycling of Photovoltaic Modules to Recover Metals and Silicon Wafers	2021	Chemie-Ingenieur-Technik	93	11		1851	1858	10.1002/cite.202100105	https://www.scopus.com/inward/record.uri?eid=2-s2.0-85115970275&doi=10.1002%2fcite.202100105&partnerID=40&md5=e92e8e9192c042b2fc64535d6944858f	DECHEMA-Forschungsinstitut, Theodor-Heuss-Allee 25, Frankfurt a. M., 60486, Germany; Freiberg University of Mining and Technology, Institute of Chemical Technology, Leipziger Straße 29, Freiberg, 09599, Germany	0009286X		CITEA	Article	Final	All Open Access, Hybrid Gold	Scopus	2-s2.0-85115970275
Zhang C., Ma Q., Cai M., Zhao Z., Xie H., Ning Z., Wang D., Yin H.	Recovery of porous silicon from waste crystalline silicon solar panels for high-performance lithium-ion battery anodes	2021	Waste Management	135			182	189	10.1016/j.wasman.2021.08.037	https://www.scopus.com/inward/record.uri?eid=2-s2.0-85114673224&doi=10.1016%2fj.wasman.2021.08.037&partnerID=40&md5=b8b3ddaca2e05bbde5114b9a54b5bd17	Key Laboratory for Ecological Metallurgy of Multimetallic Mineral of Ministry of Education, School of Metallurgy, Northeastern University, Shenyang, 110819, China; School of Resource and Environmental Science, Wuhan University, Wuhan, 430072, China; Key Laboratory of Data Analytics and Optimization for Smart Industry, Ministry of Education, Northeastern University, Shenyang, 110819, China	0956053X		WAMAE	Article	Final		Scopus	2-s2.0-85114673224
Kokul S.R., Bhowmik S.	Recycling of crystalline silicon photovoltaic solar panel waste to modified composite products	2021	Progress in Rubber, Plastics and Recycling Technology	37	4		327	339	10.1177/14777606211019416	https://www.scopus.com/inward/record.uri?eid=2-s2.0-85107281175&doi=10.1177%2f14777606211019416&partnerID=40&md5=f4fe28b6d1ba7c4a4a90b32b0e368c58	Department of Aerospace Engineering, Amrita School of Engineering, Coimbatore, Amrita Vishwa Vidyapeetham, Coimbatore, India	14777606		PRPRC	Article	Final		Scopus	2-s2.0-85107281175
Mallick A., Visoly-Fisher I.	Pb in halide perovskites for photovoltaics: Reasons for optimism	2021	Materials Advances	2	19		6125	6135	10.1039/d1ma00355k	https://www.scopus.com/inward/record.uri?eid=2-s2.0-85113282830&doi=10.1039%2fd1ma00355k&partnerID=40&md5=961696c04f575fc2d7df785a459c26f5	Department of Solar Energy and Environmental Physics, Swiss Institute for Dryland Environmental and Energy Research, Jacob Blaustein Institutes for Desert Research, Ben-Gurion University of the Negev, Midreshet Ben-Gurion, 8499000, Israel	26335409			Review	Final	All Open Access, Gold	Scopus	2-s2.0-85113282830
Daljit Singh J.K., Molinari G., Bui J., Soltani B., Rajarathnam G.P., Abbas A.	Life cycle analysis of disposed and recycled end-of-life photovoltaic panels in australia	2021	Sustainability (Switzerland)	13	19	11025			10.3390/su131911025	https://www.scopus.com/inward/record.uri?eid=2-s2.0-85116654697&doi=10.3390%2fsu131911025&partnerID=40&md5=600b4899afe712241fe2c32a8b516f68	Waste Transformation Research Hub, School of Chemical and Biomolecular Engineering, The University of Sydney, Sydney, NSW 2006, Australia; Mercularis Pty. Ltd., Sydney, NSW 2145, Australia	20711050			Article	Final	All Open Access, Gold, Green	Scopus	2-s2.0-85116654697
Gao Z., Kong X., Yi J., Yang B., Xu B., Liu D., Wu J., Xiong H.	Vacuum gasification-directional condensation for separation of tellurium from lead anode slime	2021	Metals	11	10	1535			10.3390/met11101535	https://www.scopus.com/inward/record.uri?eid=2-s2.0-85115816751&doi=10.3390%2fmet11101535&partnerID=40&md5=83b7db182fe74ec032c0b5a075f8891d	National Engineering Laboratory of Vacuum Metallurgy, Kunming University of Science and Technology, Kunming, 650093, China; Faculty of Metallurgical and Energy Engineering, Kunming University of Science and Technology, 68 Wenchang Road, Kunming, 650093, China; State Key Laboratory of Complex Nonferrous Metal Resources Clean Utilization, Kunming University of Science and Technology, Kunming, 650093, China	20754701			Article	Final	All Open Access, Gold, Green	Scopus	2-s2.0-85115816751
Murakami S., Yamamoto H., Toyota T.	Potential impact of consumer intention on generation of waste photovoltaic panels: A case study for tokyo	2021	Sustainability (Switzerland)	13	19	10507			10.3390/su131910507	https://www.scopus.com/inward/record.uri?eid=2-s2.0-85115718963&doi=10.3390%2fsu131910507&partnerID=40&md5=0c3e797b184f811007242d16067c8305	Department of Technology Management for Innovation, Graduate School of Engineering, The University of Tokyo, Tokyo, 113-8656, Japan; Department of Systems Innovation, Graduate School of Engineering, The University of Tokyo, Tokyo, 113-8656, Japan	20711050			Article	Final	All Open Access, Gold, Green	Scopus	2-s2.0-85115718963

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Authors	Title	Year	Source Title	Volume	Issue	Art. No.	Page Start	Page End	DOI	Link	Affiliations	ISSN	ISBN	CODEN	Document Type	Publication Stage	Open Access	Source	EID
Börner F., Keith M., Smith D.J., Barry T.L., Neumann T., Klemd R.	Fingerprinting fluid evolution by trace elements in epithermal pyrite, Vatukoula Au-Te deposit, Fiji	2021	Ore Geology Reviews	137		104314			10.1016/j.oregeorev.2021.104314	https://www.scopus.com/inward/record.uri?eid=2-s2.0-85109212547&doi=10.1016%2fj.oregeorev.2021.104314&partnerID=40&md5=51d1b743f5d9df4beba74472d7ea0ba0	GeoZentrum Nordbayern, Friedrich-Alexander-Universität Erlangen-Nürnberg, Erlangen, 91054, Germany; Technische Universität Berlin, Institut für Angewandte Geowissenschaften, Berlin, 10587, Germany; University of Leicester, School of Geography, Geology and the Environment, Leicester, LE1 7RH, United Kingdom	01691368			Article	Final		Scopus	2-s2.0-85109212547
Contreras-Lisperguer R., Muñoz-Cerón E., Aguilera J., de la Casa J.	A set of principles for applying Circular Economy to the PV industry: Modeling a closed-loop material cycle system for crystalline photovoltaic panels	2021	Sustainable Production and Consumption	28			164	179	10.1016/j.spc.2021.03.033	https://www.scopus.com/inward/record.uri?eid=2-s2.0-85104092160&doi=10.1016%2fj.spc.2021.03.033&partnerID=40&md5=8cf9b8022303195f28e6b3ba57be4d39	Natural Resources Division, Energy and Water Unit, United Nations Economic Commission for Latin America and the Caribbean; Department of Graphic Engineering, Design and Project, University of Jaen, IDEA Research Group (Research and Development in Solar Energy); Electronics and Automation Engineering Department. University of Jaen, IDEA Research Group (Research and Development in Solar Energy)	23525509			Article	Final		Scopus	2-s2.0-85104092160
Farrell C., Osman A.I., Harrison J., Vennard A., Murphy A., Doherty R., Russell M., Kumaravel V., Al-Muhtaseb A.H., Zhang X., Abu-Dahrieh J.K., Rooney D.W.	Pyrolysis Kinetic Modeling of a Poly(ethylene-co-vinyl acetate) Encapsulant Found in Waste Photovoltaic Modules	2021	Industrial and Engineering Chemistry Research	60	37		13492	13504	10.1021/acs.iecr.1c01989	https://www.scopus.com/inward/record.uri?eid=2-s2.0-85115656342&doi=10.1021%2facs.iecr.1c01989&partnerID=40&md5=1de072b08372b4dfa32a2def19e0061e	South West College, Cookstown, BT80 8DN, United Kingdom; School of Mechanical and Aerospace Engineering, Queen's University Belfast, Belfast, BT9 5AH, United Kingdom; School of Chemistry and Chemical Engineering, Queen's University Belfast, Belfast, BT9 5AG, United Kingdom; School of Natural and Built Environment, Civil Engineering, Queen's University Belfast, Belfast, BT9 5AG, United Kingdom; Department of Environmental Science, School of Science, Institute of Technology Sligo, Ash Lane, Sligo, F91 YW50, Ireland; Department of Petroleum and Chemical Engineering, College of Engineering, Sultan Qaboos University, Muscat, B1262-900, Oman; Department of Chemical and Process Engineering, James Weir Building, University of Strathclyde Glasgow, Glasgow, G1 1XJ, United Kingdom	08885885		IECRE	Article	Final	All Open Access, Hybrid Gold, Green	Scopus	2-s2.0-85115656342
Pang S., Yan Y., Wang Z., Wang D., Li S., Ma W., Wei K.	Enhanced separation of different layers in photovoltaic panel by microwave field	2021	Solar Energy Materials and Solar Cells	230		111213			10.1016/j.solmat.2021.111213	https://www.scopus.com/inward/record.uri?eid=2-s2.0-85107989347&doi=10.1016%2fj.solmat.2021.111213&partnerID=40&md5=296dfa3e6b36c1c4427a4718c2207ec7	Key Laboratory of Green Process and Engineering, National Engineering Laboratory for Hydrometallurgical Cleaner Production Technology, Institute of Process Engineering, Chinese Academy of Sciences, Beijing, 100190, China; Innovation Academy for Green Manufacture, Chinese Academy of Sciences, Beijing, 100190, China; University of Chinese Academy of Sciences, Beijing, 100039, China; National Engineering Laboratory for Vacuum Metallurgy, Faculty of Metallurgical and Energy Engineering, Kunming University of Science and Technology, Kunming, 650093, China	09270248		SEMCE	Article	Final		Scopus	2-s2.0-85107989347
Forcade G.P., Valdivia C.E., Lu S., Molesky S., Rodriguez A.W., Krich J.J., St-Gelais R., Hinzer K.	Modeling Efficiency of InAs-Based Near-Field Thermophotovoltaic Devices	2021	Proceedings of the International Conference on Numerical Simulation of Optoelectronic Devices, NUSOD	2021-September			53	54	10.1109/NUSOD52207.2021.9541515	https://www.scopus.com/inward/record.uri?eid=2-s2.0-85116312640&doi=10.1109%2fNUSOD52207.2021.9541515&partnerID=40&md5=1b692d34eca2bb52f2ea3cb950b0a69c	University of Ottawa, SUNLAB, Centre for Research in Photonics, Ottawa, ON, Canada; Princeton University, Department of Physics, Princeton, NJ, United States; Princeton University, Department of Electrical and Computer Engineering, Princeton, NJ, United States; University of Ottawa, Department of Physics, Ottawa, ON, Canada; University of Ottawa, Micro and Nano Systems Lab, Ottawa, ON, Canada	21583234	9781665412766		Conference Paper	Final		Scopus	2-s2.0-85116312640
Cerchier P., Brunelli K., Pezzato L., Audoin C., Rakotoniaina J.P., Sessa T., Tammaro M., Sabia G., Attanasio A., Forte C., Nisi A., Suitner H., Dabalà M.	Innovative recycling of end of life silicon pv panels: Resielp	2021	Detritus	16			41	47	10.31025/2611-4135/2021.15118	https://www.scopus.com/inward/record.uri?eid=2-s2.0-85118894913&doi=10.31025%2f2611-4135%2f2021.15118&partnerID=40&md5=cda53a94e52007819d2324d3b7e6499f	Department of Industrial Engineering, University of Padova, via Marzolo 935131, Italy; University Grenoble Alpes, CEA, Liten, Campus Ines, Le Bourget du Lac, 73375, France; Relight, via Lainate 98/100, Rho, 20017, Italy; ENEA, Energy and Sustainable Economic Development, Division Resource Efficiency, Piazzale E. Fermi 1, Naples, 80055, Italy; ENEA, Energy and Sustainable Economic Development, Division Resource Efficiency, via M.M. Sole 4, Bologna, 40129, Italy; CETMA, Diagnistic and Civil Engineering Area, Advanced Materials & Processes Consulting Division, s.s, 7 Appia, Brindisi, 72100, Italy; I.T.O. S.r.l., via Achille Costa 60, Galatone, 73044, Italy; PROJEKTkompetenz.eu GmbH, Franz-Josef-Str. 19/7, Salzsburg, 5020, Austria	26114127			Article	Final	All Open Access, Gold	Scopus	2-s2.0-85118894913
Camargo P.S.S., Domingues A.D.S., Palomero J.P.G., Kasper A.C., Dias P.R., Veit H.M.	Photovoltaic module recycling: Thermal treatment to degrade polymers and concentrate valuable metals	2021	Detritus	16			48	62	10.31025/2611-4135/2021.15119	https://www.scopus.com/inward/record.uri?eid=2-s2.0-85118846785&doi=10.31025%2f2611-4135%2f2021.15119&partnerID=40&md5=7d42a29e8fc60ac009746967b0d7b94e	Department of Materials Engineering, Federal University of Rio Grande do Sul (UFRGS), Av. Bento Gonçalves, 9500, Porto Alegre, RS, 91509-900, Brazil; School of Photovoltaics and Renewable Energy Engineering, University of New South Wales, UNSW, Sydney, NSW 2052, Australia	26114127			Article	Final	All Open Access, Gold	Scopus	2-s2.0-85118846785
Korniejenko K., Kozub B., Bąk A., Balamurugan P., Uthayakumar M., Furtos G.	Tackling the circular economy challenges—composites recycling: Used tyres, wind turbine blades, and solar panels	2021	Journal of Composites Science	5	9	243			10.3390/JCS5090243	https://www.scopus.com/inward/record.uri?eid=2-s2.0-85116970229&doi=10.3390%2fJCS5090243&partnerID=40&md5=edbea8d121dd6292123ac8121c3bda7d	Faculty of Material Engineering and Physics, Cracow University of Technology, Jana Pawła II 37, Cracow, 31-864, Poland; Faculty of Mechanical Engineering, Kalasalingam Academy of Research and Education, Krishnankoil, 626126, India; Raluca Ripan Institute of Research in Chemistry, Babes-Bolyai University, Cluj-Napoca, 400084, Romania	2504477X			Review	Final	All Open Access, Gold	Scopus	2-s2.0-85116970229

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Walzberg J., Carpenter A., Heath G.A.	Role of the social factors in success of solar photovoltaic reuse and recycle programmes	2021	Nature Energy	6	9		913	924	10.1038/s41560-021-00888-5	https://www.scopus.com/inward/record.uri?eid=2-s2.0-85114900990&doi=10.1038%2fs41560-021-00888-5&partnerID=40&md5=95ec5324202a1dccbf24fb74815998a3	National Renewable Energy Laboratory, Golden, CO, United States; Joint Institute for Strategic Energy Analysis, Golden, CO, United States	20587546			Article	Final	All Open Access, Hybrid Gold, Green	Scopus	2-s2.0-85114900990
Padoan F.C.S.M., Schiavi P.G., Belardi G., Altimari P., Rubino A., Pagnanelli F.	Material flux through an innovative recycling process treating different types of end-of-life photovoltaic panels: Demonstration at pilot scale	2021	Energies	14	17	5534			10.3390/en14175534	https://www.scopus.com/inward/record.uri?eid=2-s2.0-85114514732&doi=10.3390%2fen14175534&partnerID=40&md5=487d41c7eeb8edb758545899858e7ef6	Department of Chemistry, Sapienza University of Rome, Piazzale Aldo Moro 5, Rome, 00185, Italy; Department of Physics, Tor Vergata University of Rome, Via della Ricerca Scientifica 1, Rome, 00133, Italy	19961073			Article	Final	All Open Access, Gold, Green	Scopus	2-s2.0-85114514732
Lim S., Imaizumi Y., Mochidzuki K., Koita T., Namihira T., Tokoro C.	Recovery of Silver from Waste Crystalline Silicon Photovoltaic Cells by Wire Explosion	2021	IEEE Transactions on Plasma Science	49	9		2857	2865	10.1109/TPS.2021.3106307	https://www.scopus.com/inward/record.uri?eid=2-s2.0-85113896958&doi=10.1109%2fTPS.2021.3106307&partnerID=40&md5=9bb331741288b8da6ec7f3c50af0a2b2	Waseda Research Institute for Science and Engineering, Waseda University, Shinjuku-ku, Tokyo, 169-8555, Japan; Graduate School of Creative Science and Engineering, Waseda University, Shinjuku-ku, Tokyo, 169-8555, Japan; Retoca Laboratory LLC, Chiba, 274-0824, Japan; Institute of Industrial Nanomaterials, Kumamoto University, Chuo-ku, Kumamoto, 860-8555, Japan; Faculty of Engineering, The University of Tokyo, Bunkyo-Ku, Tokyo, 113-8656, Japan	00933813		ITPSB	Article	Final		Scopus	2-s2.0-85113896958
Tian X., Stranks S.D., You F.	Life cycle assessment of recycling strategies for perovskite photovoltaic modules	2021	Nature Sustainability	4	9		821	829	10.1038/s41893-021-00737-z	https://www.scopus.com/inward/record.uri?eid=2-s2.0-85108641969&doi=10.1038%2fs41893-021-00737-z&partnerID=40&md5=a78d2aa21c7e57c46acf5f8a6fc9a203	Systems Engineering, College of Engineering, Cornell University, Ithaca, NY, United States; Cavendish Laboratory, University of Cambridge, Cambridge, United Kingdom; Department of Chemical Engineering and Biotechnology, University of Cambridge, Cambridge, United Kingdom; Robert Frederick Smith School of Chemical and Biomolecular Engineering, Cornell University, Ithaca, NY, United States; Cornell Atkinson Center for Sustainability, Cornell University, Ithaca, NY, United States	23989629			Article	Final	All Open Access, Green	Scopus	2-s2.0-85108641969
Xu X., Lai D., Wang G., Wang Y.	Nondestructive silicon wafer recovery by a novel method of solvothermal swelling coupled with thermal decomposition	2021	Chemical Engineering Journal	418		129457			10.1016/j.cej.2021.129457	https://www.scopus.com/inward/record.uri?eid=2-s2.0-85103279945&doi=10.1016%2fj.cej.2021.129457&partnerID=40&md5=236716887e24f65eb684945daa5c5aa0	CAS Key Laboratory of Urban Pollutant Conversion, Institute of Urban Environment, Chinese Academy of Sciences, Xiamen, 361021, China; University of Chinese Academy of Sciences, Beijing, 100049, China	13858947		CMEJA	Article	Final		Scopus	2-s2.0-85103279945
Protopapa M.L., Burresi E., Palmisano M., Pesce E., Schioppa M., Capodieci L., Penza M., Sala D.D., Vincenti N., Accili A., Campadello L.	Optical methods to identify end-of-life PV panel structure	2021	Resources, Conservation and Recycling	171		105634			10.1016/j.resconrec.2021.105634	https://www.scopus.com/inward/record.uri?eid=2-s2.0-85110257808&doi=10.1016%2fj.resconrec.2021.105634&partnerID=40&md5=3936df8dc4cc79cddc9de472ea365969	ENEA - Italian National Agency for New Technologies, Energy and the Sustainable Economic Development, Division Sustainable Materials - Brindisi Research Center, S.S. 7 Appia km. 706, Brindisi, 72100, Italy; ERION, Via Messina 38, Milano, 20154, Italy	09213449		RCREE	Article	Final		Scopus	2-s2.0-85110257808
Oteng D., Zuo J., Sharifi E.	A scientometric review of trends in solar photovoltaic waste management research	2021	Solar Energy	224			545	562	10.1016/j.solener.2021.06.036	https://www.scopus.com/inward/record.uri?eid=2-s2.0-85108283921&doi=10.1016%2fj.solener.2021.06.036&partnerID=40&md5=19a6bb362b637448b1f3249f197ea55a	School of Architecture and Built Environment, The University of Adelaide, Adelaide, South Australia, Australia	0038092X		SRENA	Review	Final		Scopus	2-s2.0-85108283921
Jia X., Zhou C., Tang Y., Wang W.	Life cycle assessment on PERC solar modules	2021	Solar Energy Materials and Solar Cells	227		111112			10.1016/j.solmat.2021.111112	https://www.scopus.com/inward/record.uri?eid=2-s2.0-85103958341&doi=10.1016%2fj.solmat.2021.111112&partnerID=40&md5=1ddba700de90555f16e29d9e446db742	The Key Laboratory of Solar Thermal Energy and Photovoltaic System, Institute of Electrical Engineering, Chinese Academy of Science (CAS), Beijing, China; University of Chinese Academy of Sciences (UCAS), Beijing, China; Henan Key Laboratory of Photovoltaic Materials, Henan University, Kaifeng, China	09270248		SEMCE	Article	Final		Scopus	2-s2.0-85103958341
Sharma H.B., Vanapalli K.R., Barnwal V.K., Dubey B., Bhattacharya J.	Evaluation of heavy metal leaching under simulated disposal conditions and formulation of strategies for handling solar panel waste	2021	Science of the Total Environment	780		146645			10.1016/j.scitotenv.2021.146645	https://www.scopus.com/inward/record.uri?eid=2-s2.0-85103408065&doi=10.1016%2fj.scitotenv.2021.146645&partnerID=40&md5=9accfb757ce99720e0920e971e335d2d	Environmental Engineering and Management, Department of Civil Engineering, Indian Institute of Technology Kharagpur, Kharagpur, West Bengal 721302, India; School of Environmental Science and Engineering, Indian Institute of Technology Kharagpur, Kharagpur, West Bengal 721302, India; Department of Mining Engineering, Indian Institute of Technology Kharagpur, Kharagpur, West Bengal 721302, India	00489697		STEVA	Article	Final		Scopus	2-s2.0-85103408065
Araibia H., Boutouchent-Guerfi N., Tazibet S., Boukhemikhem Z., Izri Y.	Identification of the Silica Nanoparticles Appeared in the Slurry Generated during the Sawing Step to Manufacture the Photovoltaic Cells	2021	Silicon	13	8		2763	2769	10.1007/s12633-020-00622-y	https://www.scopus.com/inward/record.uri?eid=2-s2.0-85089175390&doi=10.1007%2fs12633-020-00622-y&partnerID=40&md5=b765fd1c9f42ee73af53656f4732126	Unité d'Enseignement et de Recherche en Chimie Appliquée, Ecole Militaire Polytechnique (EMP), Bordj El-Bahri, Algiers 16111, Algeria; Direction de la Recherche Scientifique et Technique, Académie Militaire de Cherchell, BP 48, Cherchell, Tipaza 42006, Algeria; Croissance Cristalline des semi-Conducteurs et Procédés Métallurgiques (CCPM-03), Centre de Recherche en Technologie des Semi-conducteurs pour l'Energétique (CRTSE), 02 Bd Frantz Fanon BP140, Alger, 7 merveilles, Algiers, 16038, Algeria	1876990X			Article	Final		Scopus	2-s2.0-85089175390
Deng R., Chang N., Lunardi M.M., Dias P., Bilbao J., Ji J., Chong C.M.	Remanufacturing end-of-life silicon photovoltaics: Feasibility and viability analysis	2021	Progress in Photovoltaics: Research and Applications	29	7		760	774	10.1002/pip.3376	https://www.scopus.com/inward/record.uri?eid=2-s2.0-85097014041&doi=10.1002%2fpip.3376&partnerID=40&md5=7ffeb9b746ebcdf53e5b756379ec75d1	School of Photovoltaic and Renewable Energy Engineering, University of New South Wales, Sydney, Australia; Programa de Pós-Graduação em Engenharia de Minas, Metalúrgica e de Materiais, Universidade Federal do Rio Grande do Sul, Porto Alegre, Brazil	10627995		PPHOE	Article	Final		Scopus	2-s2.0-85097014041

Table A-3: PV Recycling Literature Review

Authors	Title	Year	Source Title	Volume	Issue	Art. No.	Page Start	Page End	DOI	Link	Affiliations	ISSN	ISBN	CODEN	Document Type	Publication Stage	Open Access	Source	EID
Ovaitt S., Mirletz H.M., Hegedus A., Gaulding A., Barnes T.	PV Evolution in the light of Circular Economy	2021	Conference Record of the IEEE Photovoltaic Specialists Conference				1570	1575	10.1109/PVSC43889.2021.9518683	https://www.scopus.com/inward/record.uri?eid=2-s2.0-85115970096&doi=10.1109%2fPVSC43889.2021.9518683&partnerID=40&md5=398e926876df9ef32b5c567b8a27f6d2	National Renewable Energy Laboratory, Golden, CO 80401, United States; Colorado School of Mines, Golden, CO 80401, United States; Middlebury College, Middlebury, VT 05753, United States	01608371	9781665419222	CRCND	Conference Paper	Final		Scopus	2-s2.0-85115970096
Walzberg J., Carpenter A., Heath G.A.	Exploring PV circularity by modeling socio-technical dynamics of modules' end-of-life management	2021	Conference Record of the IEEE Photovoltaic Specialists Conference				41	43	10.1109/PVSC43889.2021.9518638	https://www.scopus.com/inward/record.uri?eid=2-s2.0-85115948500&doi=10.1109%2fPVSC43889.2021.9518638&partnerID=40&md5=01ed191cba0336747cb2928f7cd00d6a	Strategic Energy Analysis Center, National Renewable Energy Laboratory, Golden, CO, United States	01608371	9781665419222	CRCND	Conference Paper	Final		Scopus	2-s2.0-85115948500
Bartie N., Cobos-Becerra L., Frohling M., Reuter M.A., Schlatmann R.	Process simulation and digitalization for comprehensive life-cycle sustainability assessment of Silicon photovoltaic systems	2021	Conference Record of the IEEE Photovoltaic Specialists Conference				1244	1249	10.1109/PVSC43889.2021.9518984	https://www.scopus.com/inward/record.uri?eid=2-s2.0-85115944705&doi=10.1109%2fPVSC43889.2021.9518984&partnerID=40&md5=24b53746d274c0b1657d84c4ab4e04ed	Helmholtz Institute Freiberg for Resource Technology, Helmholtz-Zentrum Dresden-Rossendorf, Freiberg, Germany; Helmholtz-Zentrum Berlin für Materialien und Energie, PVcomB, Berlin, Germany; Professorship Circular Economy, Technical University of Munich, Straubing, Germany; Sms Group, Düsseldorf, Germany	01608371	9781665419222	CRCND	Conference Paper	Final		Scopus	2-s2.0-85115944705
Powicki C., Libby C., Shaw S.	Review of Decommissioning Plans for Large-Scale Solar Plants	2021	Conference Record of the IEEE Photovoltaic Specialists Conference				1037	1044	10.1109/PVSC43889.2021.9519000	https://www.scopus.com/inward/record.uri?eid=2-s2.0-85115942059&doi=10.1109%2fPVSC43889.2021.9519000&partnerID=40&md5=b442b311d40cba1a22de2a8fddfa7770	Water Energy Ecology Information Design Services Inc., Brewster, MA 02631, United States; Electric Power Research Institute, Palo Alto, CA 94304, United States	01608371	9781665419222	CRCND	Conference Paper	Final		Scopus	2-s2.0-85115942059
Seo B., Kim J.Y., Chung J.	Overview of global status and challenges for end-of-life crystalline silicon photovoltaic panels: A focus on environmental impacts	2021	Waste Management	128			45	54	10.1016/j.wasman.2021.04.045	https://www.scopus.com/inward/record.uri?eid=2-s2.0-85105541441&doi=10.1016%2fj.wasman.2021.04.045&partnerID=40&md5=5c2e7e70e48760f6507c3583ff570b87	Department of Civil and Environmental Engineering, Seoul National University, Seoul, 151-744, South Korea; Water Cycle Research Center, Korea Institute of Science and Technology, Seoul, 02792, South Korea; Division of Energy and Environmental Technology, KIST School, Korea University of Science and Technology (UST), Seoul, 02792, South Korea	0956053X		WAMAE	Article	Final		Scopus	2-s2.0-85105541441
Mathur D., Gregory R., Hogan E.	Do solar energy systems have a mid-life crisis? Valorising renewables and ignoring waste in regional towns in Australia's Northern Territory	2021	Energy Research and Social Science	76		101934			10.1016/j.erss.2021.101934	https://www.scopus.com/inward/record.uri?eid=2-s2.0-85103726388&doi=10.1016%2fj.erss.2021.101934&partnerID=40&md5=66f010c37a9f981cab630e8d859a74e4	Charles Darwin University, Australia; Regional Development Australia, NT, CADO Office, 55 Todd St Mall, Alice Springs, NT, Australia; Independent Researcher, Australia	22146296			Article	Final	All Open Access, Hybrid Gold	Scopus	2-s2.0-85103726388
Guo J., Liu X., Yu J., Xu C., Wu Y., Pan D., Senthil R.A.	An overview of the comprehensive utilization of silicon-based solid waste related to PV industry	2021	Resources, Conservation and Recycling	169		105450			10.1016/j.resconrec.2021.105450	https://www.scopus.com/inward/record.uri?eid=2-s2.0-85100714547&doi=10.1016%2fj.resconrec.2021.105450&partnerID=40&md5=6a8f421c2673fd7d107a0ab5bf06c51b	Faculty of Materials and Manufacturing, Beijing University of Technology, Beijing, 100124, China; China International Engineering Consulting Corporation, Beijing, 100124, China	09213449		RCREE	Review	Final		Scopus	2-s2.0-85100714547
Yu H., Tong X.	Producer vs. local government: The locational strategy for end-of-life photovoltaic modules recycling in Zhejiang province	2021	Resources, Conservation and Recycling	169		105484			10.1016/j.resconrec.2021.105484	https://www.scopus.com/inward/record.uri?eid=2-s2.0-85100684689&doi=10.1016%2fj.resconrec.2021.105484&partnerID=40&md5=ac04e7ab82e9ae03f03378ad1793b156	College of Urban and Environmental Sciences, Peking University, Beijing, 100871, China	09213449		RCREE	Article	Final		Scopus	2-s2.0-85100684689
Salim H.K., Stewart R.A., Sahin O., Dudley M.	Dynamic modelling of Australian rooftop solar photovoltaic product stewardship transition	2021	Waste Management	127			18	29	10.1016/j.wasman.2021.04.030	https://www.scopus.com/inward/record.uri?eid=2-s2.0-85105695047&doi=10.1016%2fj.wasman.2021.04.030&partnerID=40&md5=d4a188cce03b790047e3dbc1e9fffd2a	School of Engineering and Built Environment, Griffith University, Southport, QLD 4222, Australia; Cities Research Institute, Griffith University, Southport, QLD 4222, Australia; Griffith Climate Change Response Program, Griffith University, Southport, QLD 4222, Australia; Australia and New Zealand Recycling Platform, Auckland, New Zealand	0956053X		WAMAE	Article	Final		Scopus	2-s2.0-85105695047
Ansanelli G., Fiorentino G., Tammaro M., Zucaro A.	A Life Cycle Assessment of a recovery process from End-of-Life Photovoltaic Panels	2021	Applied Energy	290		116727			10.1016/j.apenergy.2021.116727	https://www.scopus.com/inward/record.uri?eid=2-s2.0-85102029476&doi=10.1016%2fj.apenergy.2021.116727&partnerID=40&md5=73b26930832fcbc7d25b2710818d594e	ENEA, Department for Sustainability, Division Resource Efficiency, Research Centre of Portici (NA), Italy	03062619		APEND	Article	Final		Scopus	2-s2.0-85102029476
Sheoran M., Kumar P., Sharma S., Soni A., Sahariya J.	Photovoltaic waste assessment in india and its environmental impact	2021	Journal of Physics: Conference Series	1849	1	012003			10.1088/1742-6596/1849/1/012003	https://www.scopus.com/inward/record.uri?eid=2-s2.0-85105424966&doi=10.1088%2f1742-6596%2f1849%2f1%2f012003&partnerID=40&md5=ab3dc2cbb5de262cb45e3c82b75130c7	Bhartiya Skill Development University, Jaipur, India; Manipal University, Jaipur, India; National Institute of Technology, Uttarakhand, India	17426588			Conference Paper	Final	All Open Access, Gold	Scopus	2-s2.0-85105424966
Mahmoudi S., Huda N., Behnia M.	Multi-levels of photovoltaic waste management: A holistic framework	2021	Journal of Cleaner Production	294		126252			10.1016/j.jclepro.2021.126252	https://www.scopus.com/inward/record.uri?eid=2-s2.0-85101054552&doi=10.1016%2fj.jclepro.2021.126252&partnerID=40&md5=be2ac8718d6ec284cf6642fc713cc567	School of Engineering, Macquarie University, 44 Waterloo Road (44 WR)NSW 2109, Australia; Macquarie Graduate School of Management, Macquarie University, North Ryde, NSW 2109, Australia	09596526		JCROE	Article	Final		Scopus	2-s2.0-85101054552
Wickerts S., Arvidsson R., Sandan B.A., Peters G., Hou L., Albinsson B.	Prospective Life-Cycle Modeling of Quantum Dot Nanoparticles for Use in Photon Upconversion Devices	2021	ACS Sustainable Chemistry and Engineering	9	14		5187	5195	10.1021/acssuschemeng.1c00376	https://www.scopus.com/inward/record.uri?eid=2-s2.0-85104907139&doi=10.1021%2facssuschemeng.1c00376&partnerID=40&md5=e0f5af7d09ed24329e780172469a2a08	Environmental Systems Analysis, Chalmers University of Technology, Vera Sandbergs Allé 8, Gothenburg, 412 96, Sweden; Chemistry and Chemical Engineering, Chalmers University of Technology, Kemigården 4, Gothenburg, 412 96, Sweden	21680485			Article	Final	All Open Access, Hybrid Gold, Green	Scopus	2-s2.0-85104907139
Chen W.-S., Chen Y.-J., Lee C.-H., Cheng Y.-J., Chen Y.-A., Liu F.-W., Wang Y.-C., Chueh Y.-L.	Recovery of valuable materials from the waste crystalline-silicon photovoltaic cell and ribbon	2021	Processes	9	4	712			10.3390/pr9040712	https://www.scopus.com/inward/record.uri?eid=2-s2.0-85104969983&doi=10.3390%2fpr9040712&partnerID=40&md5=80f8c64aec0d8f79b9da257815ac7306	Department of Resources Engineering, National Cheng Kung University, No. 1, Daxue Rd., East Dist., Tainan City, 701401, Taiwan; Department of Materials Science and Engineering, National Tsing Hua University, No. 101, Section 2, Kuang-Fu Road, Hsinchu, 30013, Taiwan	22279717			Article	Final	All Open Access, Gold	Scopus	2-s2.0-85104969983

Table A-3: PV Recycling Literature Review

Authors	Title	Year	Source Title	Volume	Issue	Art. No.	Page Start	Page End	DOI	Link	Affiliations	ISSN	ISBN	CODEN	Document Type	Publication Stage	Open Access	Source	EID
Lovato É.S., Donato L.M., Lopes P.P., Tanabe E.H., Bertuol D.A.	Application of supercritical CO2 for delaminating photovoltaic panels to recover valuable materials	2021	Journal of CO2 Utilization	46		101477			10.1016/j.jcou.2021.101477	https://www.scopus.com/inward/record.uri?eid=2-s2.0-85101105955&doi=10.1016%2fj.jcou.2021.101477&partnerID=40&md5=d684dd22e9aedc738bc51c9be1fc43f5	Environmental Processes Laboratory (LAPAM), Chemical Engineering Department, Federal University of Santa Maria, Santa Maria, RS, 97105-900, Brazil	22129820			Article	Final		Scopus	2-s2.0-85101105955
Gautam A., Shankar R., Vrat P.	End-of-life solar photovoltaic e-waste assessment in India: a step towards a circular economy	2021	Sustainable Production and Consumption	26			65	77	10.1016/j.spc.2020.09.011	https://www.scopus.com/inward/record.uri?eid=2-s2.0-85091761849&doi=10.1016%2fj.spc.2020.09.011&partnerID=40&md5=305e58cc576ef113c9620b262ca0729d	Department of Management Studies, Indian Institute of Technology, Delhi, India; The NorthCap University, Gurgaon, India	23525509			Article	Final		Scopus	2-s2.0-85091761849
Gallucci T., Lagioia G., Piccinno P., Lacalamita A., Pontrandolfo A., Paiano A.	Environmental performance scenarios in the production of hollow glass containers for food packaging: an LCA approach	2021	International Journal of Life Cycle Assessment	26	4		785	798	10.1007/s11367-020-01797-7	https://www.scopus.com/inward/record.uri?eid=2-s2.0-85088981988&doi=10.1007%2fs11367-020-01797-7&partnerID=40&md5=76cc7d206a76b9938d61955ebab68027	Department of Economics, Management and Business Law, University of Bari Aldo Moro, Largo Abbazia Santa Scolastica, Bari, 53-70124, Italy; P&R Project, via Martinelli Diego 24, Rutigliano, BA 70018, Italy	09483349		IJLCF	Article	Final	All Open Access, Hybrid Gold	Scopus	2-s2.0-85088981988
Barker B.	Solar after Sunset	2021	EPRI Journal	2021	1		13	16		https://www.scopus.com/inward/record.uri?eid=2-s2.0-85133354339&partnerID=40&md5=5db9cfb9aa3f8be9447dc621080c7951		03623416		EPRJD	Article	Final		Scopus	2-s2.0-85133354339
Kung C.-C., Lee T.-J., Chen L.-J.	Economic growth and environmental sustainability from renewable energy applications	2021	Energy Exploration and Exploitation	39	2		531	535	10.1177/0144598720964207	https://www.scopus.com/inward/record.uri?eid=2-s2.0-85102076309&doi=10.1177%2f0144598720964207&partnerID=40&md5=ba28ed9709e4764c4cc239cf850ffcb9	School of Economics at Jiangxi, University of Finance and Economics, Nanchang, China; Department of Finance, Feng, Chia University, Taichung, Taiwan	01445987		EEEXD	Editorial	Final	All Open Access, Gold	Scopus	2-s2.0-85102076309
Tokoro C., Nishi M., Tsunazawa Y.	Selective grinding of glass to remove resin for silicon-based photovoltaic panel recycling	2021	Advanced Powder Technology	32	3		841	849	10.1016/j.apt.2021.01.030	https://www.scopus.com/inward/record.uri?eid=2-s2.0-85101327018&doi=10.1016%2fj.apt.2021.01.030&partnerID=40&md5=d696fd8ddf8fa1537ea7846587b1050f	Department of Resources and Environmental Engineering, Faculty of Science and Engineering, Waseda University, Tokyo, 169–8555, Japan; Mineral Resources Research Group, Institute for Geo-Resources and Environment, Geological Survey of Japan, National Institute of Advanced Industrial Science and Technology, Tsukuba, 305–8567, Japan	09218831		APTEE	Article	Final	All Open Access, Hybrid Gold	Scopus	2-s2.0-85101327018
Mahdi J.M., Pal Singh R., Taqi Al-Najjar H.M., Singh S., Nsofor E.C.	Efficient thermal management of the photovoltaic/phase change material system with innovative exterior metal-foam layer	2021	Solar Energy	216			411	427	10.1016/j.solener.2021.01.008	https://www.scopus.com/inward/record.uri?eid=2-s2.0-85100400487&doi=10.1016%2fj.solener.2021.01.008&partnerID=40&md5=7d88b3a3b93a3d522aac022cbfabc02d	Department of Energy Engineering, University of Baghdad, Baghdad, 10071, Iraq; Department of Mechanical Engineering, Punjab Agricultural University, Ludhiana, 141004, India; Department of Renewable Energy Engineering, Punjab Agricultural University, Ludhiana, 141004, India; Department of Mechanical Engineering and Energy Processes, Southern Illinois University, Carbondale, IL, United States	0038092X		SRENA	Article	Final		Scopus	2-s2.0-85100400487
Rubino A., Schiavi P.G., Altimari P., Pagnanelli F.	Valorization of polymeric fractions and metals from end of life photovoltaic panels	2021	Waste Management	122			89	99	10.1016/j.wasman.2020.12.037	https://www.scopus.com/inward/record.uri?eid=2-s2.0-85099706747&doi=10.1016%2fj.wasman.2020.12.037&partnerID=40&md5=97048774b4fbab8edd1923f86da0b8d1	Department of Chemistry, Sapienza University of Rome, P.le Aldo Moro 5, Rome, 00185, Italy	0956053X		WAMAE	Article	Final		Scopus	2-s2.0-85099706747
Kristiansen A.B., Zhao B.Y., Ma T., Wang R.Z.	The viability of solar photovoltaic powered off-grid Zero Energy Buildings based on a container home	2021	Journal of Cleaner Production	286		125312			10.1016/j.jclepro.2020.125312	https://www.scopus.com/inward/record.uri?eid=2-s2.0-85097716251&doi=10.1016%2fj.jclepro.2020.125312&partnerID=40&md5=fc95a940943029fcc2306f868dd847e4	Institute of Refrigeration and Cryogenics, MOE Engineering Research Center of Solar Energy, Shanghai Jiao Tong University, Shanghai, 200240, China	09596526		JCROE	Article	Final		Scopus	2-s2.0-85097716251
Chung J., Seo B., Lee J., Kim J.Y.	Comparative analysis of I2-KI and HNO3 leaching in a life cycle perspective: Towards sustainable recycling of end-of-life c-Si PV panel	2021	Journal of Hazardous Materials	404		123989			10.1016/j.jhazmat.2020.123989	https://www.scopus.com/inward/record.uri?eid=2-s2.0-85092293781&doi=10.1016%2fj.jhazmat.2020.123989&partnerID=40&md5=35be3de05e16fef4d517e41853ee13b9	Water Cycle Research Center, Korea Institute of Science and Technology, Seoul, 136-791, South Korea; Department of Civil and Environmental Engineering, Seoul National University, Seoul, 151-744, South Korea	03043894		JHMAD	Article	Final		Scopus	2-s2.0-85092293781
Tembo P.M., Heninger M., Subramanian V.	An Investigation of the Recovery of Silicon Photovoltaic Cells by Application of an Organic Solvent Method	2021	ECS Journal of Solid State Science and Technology	10	2	025001			10.1149/2162-8777/abe093	https://www.scopus.com/inward/record.uri?eid=2-s2.0-85101617770&doi=10.1149%2f2162-8777%2fabe093&partnerID=40&md5=47fdd9dec11f989e18ee3827d61c7ac1	Department of Chemical and Materials Engineering, University of Nevada-Reno, Reno, NV 89557, United States; Enel Green Power North America, Inc., Reno, NV 89502, United States	21628769			Article	Final	All Open Access, Green	Scopus	2-s2.0-85101617770
Majewski P., Al-shammari W., Dudley M., Jit J., Lee S.-H., Myoung-Kug K., Sung-Jim K.	Recycling of solar PV panels- product stewardship and regulatory approaches	2021	Energy Policy	149		112062			10.1016/j.enpol.2020.112062	https://www.scopus.com/inward/record.uri?eid=2-s2.0-85097458099&doi=10.1016%2fj.enpol.2020.112062&partnerID=40&md5=506fc0c9ead1a300b9ebf5cc896e7ec3	Future Industries Institute, University of South Australia, Australia; School of Engineering, University of South Australia, Australia; SustainabilityVictoria, Australia; Tindo Solar, Mawson Lakes, Australia	03014215		ENPYA	Article	Final		Scopus	2-s2.0-85097458099
Dias P., Schmidt L., Monteiro Lunardi M., Chang N.L., Spier G., Corkish R., Veit H.	Comprehensive recycling of silicon photovoltaic modules incorporating organic solvent delamination – technical, environmental and economic analyses	2021	Resources, Conservation and Recycling	165		105241			10.1016/j.resconrec.2020.105241	https://www.scopus.com/inward/record.uri?eid=2-s2.0-85095709398&doi=10.1016%2fj.resconrec.2020.105241&partnerID=40&md5=b8e8da5419df49265b6a4682c3342d60	School of Photovoltaic and Renewable Energy Engineering, University of New South Wales, Sydney, NSW 2052, Australia; Universidade Federal do Rio Grande do Sul (UFRGS), Programa de Pós-Graduação em Engenharia de Minas, Metalúrgica e de Materiais (PPGE3M), Av. Bento Gonçalves 9500, Porto Alegre, RS, Brazil	09213449		RCREE	Article	Final		Scopus	2-s2.0-85095709398
Islam M.T., Nizami M.S.H., Mahmoudi S., Huda N.	Reverse logistics network design for waste solar photovoltaic panels: A case study of New South Wales councils in Australia	2021	Waste Management and Research	39	2		386	395	10.1177/0734242X20962837	https://www.scopus.com/inward/record.uri?eid=2-s2.0-85092152713&doi=10.1177%2f0734242X20962837&partnerID=40&md5=3593c552c278b9c794c9fdc18b2c3cf2	School of Engineering, Macquarie University, Sydney, NSW, Australia	0734242X		WMARD	Article	Final		Scopus	2-s2.0-85092152713

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Krebs-Moberg M., Pitz M., Dorsette T.L., Gheewala S.H.	Third generation of photovoltaic panels: A life cycle assessment	2021	Renewable Energy	164			556	565	10.1016/j.renene.2020.09.054	https://www.scopus.com/inward/record.uri?eid=2-s2.0-85091764367&doi=10.1016%2fj.renene.2020.09.054&partnerID=40&md5=505677de6c15827a7084b84ad3ff50e2	Institute for the Environment, University of North Carolina at Chapel Hill, Chapel Hill, NC 27599, United States; The Joint Graduate School of Energy and Environment, King Mongkut's University of Technology Thonburi, Bangkok, Thailand; Center of Excellence on Energy Technology and Environment, PERDO, Ministry of Higher Education, Science, Research and Innovation, Bangkok, Thailand; Department of Environmental Sciences and Engineering, Gillings School of Global Public Health, University of North Carolina, Chapel Hill, NC 27514, United States	09601481			Article	Final		Scopus	2-s2.0-85091764367
Mosai A.K., Tutu H.	Simultaneous sorption of rare earth elements (including scandium and yttrium) from aqueous solutions using zeolite clinoptilolite: A column and speciation study	2021	Minerals Engineering	161		106740			10.1016/j.mineng.2020.106740	https://www.scopus.com/inward/record.uri?eid=2-s2.0-85098054504&doi=10.1016%2fj.mineng.2020.106740&partnerID=40&md5=cae0ff09c30c33c75453e7c508a7d260	Molecular Sciences Institute, School of Chemistry, University of the Witwatersrand, Private Bag X3, WITS2050, South Africa	08926875		MENGE	Article	Final		Scopus	2-s2.0-85098054504
Iyer R.K., Pilla S.	Environmental profile of thermoelectrics for applications with continuous waste heat generation via life cycle assessment	2021	Science of the Total Environment	752		141674			10.1016/j.scitotenv.2020.141674	https://www.scopus.com/inward/record.uri?eid=2-s2.0-85090158186&doi=10.1016%2fj.scitotenv.2020.141674&partnerID=40&md5=1963cbeb2713e4f9aab264da689ac3f1	Department of Automotive Engineering, Clemson University, Greenville, SC, United States; Clemson Composites Center, Clemson University, Greenville, SC, United States; Department of Materials Science and Engineering, Clemson University, Clemson, SC, United States; Department of Mechanical Engineering, Clemson University, Clemson, SC, United States	00489697		STEVA	Article	Final		Scopus	2-s2.0-85090158186
Schileo G., Grancini G.	Lead or no lead? Availability, toxicity, sustainability and environmental impact of lead-free perovskite solar cells	2021	Journal of Materials Chemistry C	9	1		67	76	10.1039/d0tc04552g	https://www.scopus.com/inward/record.uri?eid=2-s2.0-85099132661&doi=10.1039%2fd0tc04552g&partnerID=40&md5=869f6d18b4177bf1e1993e0cecc0e03d	Department of Chemistry, University of Pavia and Instm, via Taramelli 16, Pavia, 27100, Italy	20507534		JMCCC	Review	Final		Scopus	2-s2.0-85099132661
Stromberg R.	Reuse of Solar Photovoltaic Systems for Social and Economic Benefit	2021	American Solar Energy Society National Solar Conference 2021 Proceedings, SOLAR 2021				81	92		https://www.scopus.com/inward/record.uri?eid=2-s2.0-85127448711&partnerID=40&md5=599a74ae7cfd4d042df7326439761ebb	University of Alaska, Fairbanks, United States; Alaska Center for Energy and Power, Fairbanks, United States; Western Colorado University, Gunnison, United States; Coldharbour Institute, Gunnison, United States; Community Appropriate Sustainable Energy Security (CASES) Partnership, Saskatoon, Canada		9.78398E+12		Conference Paper	Final		Scopus	2-s2.0-85127448711
Tao M.	Technologies to Improve the Profitability of Silicon PV Module Recycling	2021	Proceedings of AM-FPD 2021 - 28th International Workshop on Active-Matrix Flatpanel Displays and Devices: TFT Technologies and FPD Materials				55	58		https://www.scopus.com/inward/record.uri?eid=2-s2.0-85125806009&partnerID=40&md5=aa618b1ec64736cc2b566620e334af22	School of Electrical, Computer, and Energy Engineering, Arizona State University, Tempe, AZ 85287-5706, United States		9784991216909		Conference Paper	Final		Scopus	2-s2.0-85125806009
Mulazzani A., Eleftheriadis P., Leva S.	Recycling of c-Si PV Modules: An Energy Analysis and Further Improvements	2021	21st IEEE International Conference on Environment and Electrical Engineering and 2021 5th IEEE Industrial and Commercial Power System Europe, EEEIC / I and CPS Europe 2021 - Proceedings						10.1109/EEEIC/ICPSEurope51590.2021.9584572	https://www.scopus.com/inward/record.uri?eid=2-s2.0-85124231543&doi=10.1109%2fEEEIC%2fICPSEurope51590.2021.9584572&partnerID=40&md5=1d5d73998abd561a3bf22236af3006d6	Department of Energy, Politecnico di Milano, Milano, Italy		9781665436120		Conference Paper	Final		Scopus	2-s2.0-85124231543
Vanek J., Maule P., Jandová K., Langer F.	Determination of the Best Working Conditions for the Recycling of Solar Modules	2021	ECS Transactions	105	1		281	289	10.1149/10501.0281ecst	https://www.scopus.com/inward/record.uri?eid=2-s2.0-85122462914&doi=10.1149%2f10501.0281ecst&partnerID=40&md5=0cba62e51cdcf88511935af35dea2d73	Fakulta Elektrotechniky A Komunikacnich Technologii, Vysoke Uceni Technicke v Brn, Technicka 10, Brno, 612 00, Czech Republic	19386737	9781607685395		Conference Paper	Final		Scopus	2-s2.0-85122462914
Aravelli S.L.K.G., Ramavathu S.N.	Smart and sustainable technologies for recycling photovoltaic panels	2021	Environmental Challenges	2		100020			10.1016/j.envc.2020.100020	https://www.scopus.com/inward/record.uri?eid=2-s2.0-85112584199&doi=10.1016%2fj.envc.2020.100020&partnerID=40&md5=301d018e1fd2e486329d07f3f24a1ee4	Department of EE, Andhra University College of Engineering (A), Visakhapatnam, India	26670100			Article	Final	All Open Access, Gold	Scopus	2-s2.0-85112584199

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Punathil L., Mohanasundaram K., Tamilselavan K.S., Sathyamurthy R., Chamkha A.J.	Recovery of Pure Silicon and Other Materials from Disposed Solar Cells	2021	International Journal of Photoenergy	2021		5530213			10.1155/2021/5530213	https://www.scopus.com/inward/record.uri?eid=2-s2.0-85105898956&doi=10.1155%2f2021%2f5530213&partnerID=40&md5=bc4ede0197447b2007c2d735fb791367	Department of Chemical Engineering, KPR Institute of Engineering and Technology, Coimbatore, 641407, India; Department of Electrical and Electronics Engineering, KPR Institute of Engineering and Technology, Coimbatore, 641407, India; Department of Electronics and Communication Engineering, KPR Institute of Engineering and Technology, Coimbatore, 641407, India; Department of Mechanical Engineering, KPR Institute of Engineering and Technology, Coimbatore, 641407, India; Faculty of Engineering, Kuwait College of Science and Technology, Doha, Kuwait; Institute of Research and Development, Duy Tan University, Da Nang, 550000, Viet Nam	1110662X			Article	Final	All Open Access, Gold	Scopus	2-s2.0-85105898956
Li Y., Wang G., Shen B., Zhang Q., Liu B., Xu R.	Conception and policy implications of photovoltaic modules end-of-life management in China	2021	Wiley Interdisciplinary Reviews: Energy and Environment	10	1	e387			10.1002/wene.387	https://www.scopus.com/inward/record.uri?eid=2-s2.0-85088008346&doi=10.1002%2fwene.387&partnerID=40&md5=179d4f1afe9181f220e5dc39710beca1	School of Economics and Management, China University of Petroleum-Beijing, Changping, Beijing, China; School of Economics and Management, North China Electric Power University, Beijing, China; Energy Analysis and Environmental Impact Assessment Division, Lawrence Berkeley National Laboratory, Berkeley, CA, United States	20418396			Article	Final		Scopus	2-s2.0-85088008346
Nguyen T.H., Lee M.S.	A Review on Germanium Resources and its Extraction by Hydrometallurgical Method	2021	Mineral Processing and Extractive Metallurgy Review	42	6		406	426	10.1080/08827508.2020.1756795	https://www.scopus.com/inward/record.uri?eid=2-s2.0-85084367848&doi=10.1080%2f08827508.2020.1756795&partnerID=40&md5=3c3b65c2f6361306da2c1409f159c413	College of Natural Sciences, Can Tho University, Can Tho City, Viet Nam; Department of Advanced Materials Science Engineering, Institute of Rare Metal, Mokpo National University, Jeollanamdo, South Korea	08827508		MPERE	Review	Final		Scopus	2-s2.0-85084367848
Vargas C., Chesney M.	End of life decommissioning and recycling of solar panels in the United States. A real options analysis	2021	Journal of Sustainable Finance and Investment	11	1		82	102	10.1080/20430795.2019.1700723	https://www.scopus.com/inward/record.uri?eid=2-s2.0-85078036986&doi=10.1080%2f20430795.2019.1700723&partnerID=40&md5=1f327025bd645a0a1fa495dfbe27e715	EGADE Business School, Tecnológico de Monterrey, Monterrey, Mexico; Banking and Finance Institute, University of Zurich, Zürich, Switzerland	20430795			Article	Final	All Open Access, Green	Scopus	2-s2.0-85078036986
Zhou Z., Sun K., Jiang L., Jia M., Liu F.	Research progress on recycling technology of end-of-life silicon photovoltaic modules [废旧光伏组件回收技术研究进展]	2020	Zhongnan Daxue Xuebao (Ziran Kexue Ban)/Journal of Central South University (Science and Technology)	51	12		3279	3288	10.11817/j.issn.1672-7207.2020.12.002	https://www.scopus.com/inward/record.uri?eid=2-s2.0-85099446340&doi=10.11817%2fj.issn.1672-7207.2020.12.002&partnerID=40&md5=80572dfdaaa44372b330fd459a45b0c0	School of Metallurgy and Environment, Central South University, Changsha, 410083, China	16727207		ZDXZA	Review	Final		Scopus	2-s2.0-85099446340
Rubino A., Granata G., Moscardini E., Baldassari L., Altimari P., Toro L., Pagnanelli F.	Development and techno-economic analysis of an advanced recycling process for photovoltaic panels enabling polymer separation and recovery of Ag and Si	2020	Energies	13	24	6690			10.3390/en13246690	https://www.scopus.com/inward/record.uri?eid=2-s2.0-85106585361&doi=10.3390%2fen13246690&partnerID=40&md5=c84cf6c51e79bbb9f7e8e48ab12815c1	Department of Chemistry, Sapienza University of Rome, P.le Aldo Moro 5, Rome, 00185, Italy; Intelligen, Inc, 2326 Morse Avenue, Scotch Plains, NJ 07076, United States; Eco Recycling Srl, Via di Vannina 88/94, Roma, 00156, Italy	19961073			Article	Final	All Open Access, Gold, Green	Scopus	2-s2.0-85106585361
Bogacka M., Potempa M., Milewicz B., Lewandowski D., Pikoń K., Klejnowska K., Sobik P., Misztal E.	Pv waste thermal treatment according to the circular economy concept	2020	Sustainability (Switzerland)	12	24	10562	1	13	10.3390/su122410562	https://www.scopus.com/inward/record.uri?eid=2-s2.0-85098226005&doi=10.3390%2fsu122410562&partnerID=40&md5=975ccd65d35191265fd5c7df33be26cf	Department of Technologies and Installations for Waste Management, Silesian University of Technology, Konarskiego 18, Gliwice, 44-100, Poland; Department of Metallurgy, Łukasiewicz Research Network, Institute of Non-Ferrous Metals, Sowińskiego 5, Gliwice, 44-100, Poland; Helioenergia Sp. z o.o, Rybnicka 68, Czerwionka-Leszczyny, 44-230, Poland; Institute for Chemical Processing of Coal, Zamkowa 1, Zabrze, 41-803, Poland	20711050			Article	Final	All Open Access, Gold, Green	Scopus	2-s2.0-85098226005
Tao M., Hamada H., Druffel T., Lee J.-J., Rajeshwar K.	Review-research needs for photovoltaics in the 21st century	2020	ECS Journal of Solid State Science and Technology	9	12	125010			10.1149/2162-8777/abd377	https://www.scopus.com/inward/record.uri?eid=2-s2.0-85100123189&doi=10.1149%2f2162-8777%2fabd377&partnerID=40&md5=7a7b483f7245c2e35288f53ef35d8686	School of Electrical Computer and Energy Engineering, Arizona State University, Tempe, AZ 85287-5706, United States; Department of Electric and Electronic Engineering, Faculty of Science and Engineering, Kindai University, Higahiosaka, 577-8502, Japan; Conn Center for Renewable Energy Research, University of Louisville, Louisville, KY 40292, United States; Department of Energy and Materials Engineering, Dongguk University, Junggu, Seoul, 04620, South Korea; Department of Chemistry and Biochemistry, University of Texas at Arlington, Arlington, TX 76019, United States	21628769			Review	Final	All Open Access, Hybrid Gold	Scopus	2-s2.0-85100123189
Norgren A., Carpenter A., Heath G.	Design for Recycling Principles Applicable to Selected Clean Energy Technologies: Crystalline-Silicon Photovoltaic Modules, Electric Vehicle Batteries, and Wind Turbine Blades	2020	Journal of Sustainable Metallurgy	6	4		761	774	10.1007/s40831-020-00313-3	https://www.scopus.com/inward/record.uri?eid=2-s2.0-85097290474&doi=10.1007%2fs40831-020-00313-3&partnerID=40&md5=9d7e25792c963b6ec2fc922d80348706	Strategic Energy Analysis Center, National Renewable Energy Laboratory, Golden, CO, United States; Joint Institute for Strategic Energy Analysis, Golden, CO, United States	21993823			Article	Final	All Open Access, Hybrid Gold	Scopus	2-s2.0-85097290474
Liu C., Zhang Q., Wang H.	Cost-benefit analysis of waste photovoltaic module recycling in China	2020	Waste Management	118			491	500	10.1016/j.wasman.2020.08.052	https://www.scopus.com/inward/record.uri?eid=2-s2.0-85091328816&doi=10.1016%2fj.wasman.2020.08.052&partnerID=40&md5=ca17512451a32bee3bc7e4c553ea3f32	College of Economics and Management, Nanjing University of Aeronautics and Astronautics, Nanjing, 210016, China; Research Centre for Soft Energy Science, Nanjing University of Aeronautics and Astronautics, Nanjing, 210016, China	0956053X		WAMAE	Article	Final		Scopus	2-s2.0-85091328816

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Salim H.K., Stewart R.A., Sahin O., Dudley M.	Systems approach to end-of-life management of residential photovoltaic panels and battery energy storage system in Australia	2020	Renewable and Sustainable Energy Reviews	134		110176			10.1016/j.rser.2020.110176	https://www.scopus.com/inward/record.uri?eid=2-s2.0-85088989342&doi=10.1016%2fj.rser.2020.110176&partnerID=40&md5=680457b355b77b743e03a5c151c1ae15	School of Engineering and Built Environment, Griffith University, Southport, QLD 4222, Australia; Cities Research Institute, Griffith University, Southport, QLD 4222, Australia; Griffith Climate Change Response Program, Griffith University, Southport, QLD 4222, Australia; Australia New Zealand Recycling Platform Limited, Melbourne, VIC, 3000, Australia	13640321		RSERF	Article	Final		Scopus	2-s2.0-85088989342
Yıldız G., Çalış B., Gürel A.E., Ceylan İ.	Investigation of life cycle CO2 emissions of the polycrystalline and cadmium telluride PV panels	2020	Environmental Nanotechnology, Monitoring and Management	14		100343			10.1016/j.enmm.2020.100343	https://www.scopus.com/inward/record.uri?eid=2-s2.0-85087972314&doi=10.1016%2fj.enmm.2020.100343&partnerID=40&md5=79000f70b3570bb4f95e1cf50b38a1e2	Düzce University, Graduate School of Natural and Applied Sciences, Department of Mechanical Engineering, Konuralp, Düzce, 81620, Turkey; Karabük University, Technology Faculty, Department of Energy Systems Engineering, 100.Yıl, Karabük, 78050, Turkey; Düzce University, Technology Faculty, Department of Mechanical Engineering, Konuralp, Düzce, 81620, Turkey; Düzce University, Vocational School, Department of Electricity and Energy, Düzce, 81010, Turkey	22151532			Article	Final		Scopus	2-s2.0-85087972314
Chitra, Sah D., Lodhi K., Kant C., Saini P., Kumar S.	Structural composition and thermal stability of extracted EVA from silicon solar modules waste	2020	Solar Energy	211			74	81	10.1016/j.solener.2020.09.039	https://www.scopus.com/inward/record.uri?eid=2-s2.0-85091658487&doi=10.1016%2fj.solener.2020.09.039&partnerID=40&md5=bc5c80f8c04f63912e4b09b1b9aa1107	Photovoltaic Metrology Section, Advanced Materials & Device Metrology Division, CSIR – National Physical Laboratory, Dr. K.S. Krishnan Road, New Delhi, 110012, India; Academy of Scientific and Innovative Research (AcSIR), Ghaziabad, 201002, India	0038092X		SRENA	Article	Final		Scopus	2-s2.0-85091658487
Jin H., Yoon Y., Liles M.R., Chua B., Son A.	A simple reagent-less approach using electrical discharge as a substitution for chelating agent in addressing genomic assay inhibition by divalent cations	2020	Analyst	145	21		6846	6858	10.1039/d0an01666g	https://www.scopus.com/inward/record.uri?eid=2-s2.0-85094684826&doi=10.1039%2fd0an01666g&partnerID=40&md5=829292a8f083186747e3de4ebf28bbd0	Department of Environmental Science and Engineering, Ewha Womans University, Seoul, 03760, South Korea; Department of Civil and Environmental Engineering, University of South Carolina, Columbia, SC 29208, United States; Department of Biological Sciences, Auburn University, Auburn, AL 36849, United States; School of Electrical Engineering, Korea University, Seoul, 02841, South Korea	00032654		ANALA	Article	Final		Scopus	2-s2.0-85094684826
Okoroigwe F.C., Okoroigwe E.C., Ajayi O.O., Agbo S.N., Chukwuma J.N.	Photovoltaic Modules Waste Management: Ethical Issues for Developing Nations	2020	Energy Technology	8	11	2000543			10.1002/ente.202000543	https://www.scopus.com/inward/record.uri?eid=2-s2.0-85091732300&doi=10.1002%2fente.202000543&partnerID=40&md5=c6c6e77267c5c046972921513c40ba86	Natural Science Unit, School of General Studies, University of Nigeria, Nsukka, Nsukka, Enugu State, Nigeria; Department of Nutrition and Dietetics, University of Nigeria, Nsukka, Nsukka, Enugu State, Nigeria; Department of Mechanical Engineering, University of Nigeria, Nsukka, Nsukka, Enugu State, Nigeria; Faculty of Law, Obafemi Awolowo University, Ile Ife, Oyo State, Nigeria; Forschungszentrum Julich GmbH, Wilhelm-Johnen-Straße, Julich, 52428, Germany; Department of Philosophy, University of Nigeria, Nsukka, Nsukka, Enugu State, Nigeria	21944288			Review	Final		Scopus	2-s2.0-85091732300
Venkatachary S.K., Samikannu R., Murugesan S., Dasari N.R., Subramaniyam R.U.	Economics and impact of recycling solar waste materials on the environment and health care	2020	Environmental Technology and Innovation	20		101130			10.1016/j.eti.2020.101130	https://www.scopus.com/inward/record.uri?eid=2-s2.0-85090349966&doi=10.1016%2fj.eti.2020.101130&partnerID=40&md5=145dc634d15ff4d6f3a8de36443ab49d	Grant Thornton, Acumen Park, Fairgrounds, Gaborone, Botswana; Department of Electrical Computer and Telecommunications Engineering, Botswana International University of Science and Technology, Botswana; Department of Electrical and Electronics Engineering, Kongu Engineering College, Erode, Tamilnadu, India; Department of Electrical Power Engineering, College of Engineering, Defence University, Bishoftu, Ethiopia; Department of Electronics and Instrumentation Engineering, Kongu Engineering College, Erode, Tamilnadu, India	23521864			Article	Final		Scopus	2-s2.0-85090349966
Nain P., Kumar A.	Understanding the possibility of material release from end-of-life solar modules: A study based on literature review and survey analysis	2020	Renewable Energy	160			903	918	10.1016/j.renene.2020.07.034	https://www.scopus.com/inward/record.uri?eid=2-s2.0-85088009300&doi=10.1016%2fj.renene.2020.07.034&partnerID=40&md5=035269967ae18464820fcec1537c8b19	Department of Civil Engineering, Indian Institute of Technology, New Delhi, India	09601481			Article	Final		Scopus	2-s2.0-85088009300
Khouri S., Behun M., Knapcikova L., Behunova A., Sofranko M., Rosova A.	Characterization of customized encapsulant polyvinyl butyral used in the solar industry and its impact on the environment	2020	Energies	13	20	5391			10.3390/en13205391	https://www.scopus.com/inward/record.uri?eid=2-s2.0-85093359522&doi=10.3390%2fen13205391&partnerID=40&md5=68f3cfdd14065ddadd9f843742c44f31	Institute of Earth Resources, Faculty of Mining, Ecology, Process Control and Geotechnologies, Technical University of Kosice, Kosice, 04200, Slovakia; Department of Industrial Engineering and Informatics, Faculty of Manufacturing Technologies with the seat in Presov, Technical University of Kosice, Presov, 08001, Slovakia	19961073			Article	Final	All Open Access, Gold, Green	Scopus	2-s2.0-85093359522
MacAlova K., Vaclavik V., Dvorsky T., Svoboda J., Charvat J., Gola L.	Recycling of photovoltaic panels - A review of the current trends	2020	IOP Conference Series: Materials Science and Engineering	867	1	012029			10.1088/1757-899X/867/1/012029	https://www.scopus.com/inward/record.uri?eid=2-s2.0-85093971478&doi=10.1088%2f1757-899X%2f867%2f1%2f012029&partnerID=40&md5=770aa1d7397e0e3efa383fe3a8bce07f	Vsb - Technical University of Ostrava, Faculty of Mining and Geology, Department of Environmental Engineering, Czech Republic	17578981			Conference Paper	Final	All Open Access, Gold	Scopus	2-s2.0-85093971478

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Tao M., Fthenakis V., Ebin B., Steenari B.-M., Butler E., Sinha P., Corkish R., Wambach K., Simon E.S.	Major challenges and opportunities in silicon solar module recycling	2020	Progress in Photovoltaics: Research and Applications	28	10		1077	1088	10.1002/pip.3316	https://www.scopus.com/inward/record.uri?eid=2-s2.0-85088299314&doi=10.1002%2fpip.3316&partnerID=40&md5=a49409f6fb46d7739668b6f586baddfe	School of Electrical, Computer and Energy Engineering, Arizona State University, Tempe, AZ 85287, United States; Center for Life Cycle Analysis, Columbia University, New York, NY 10027, United States; Department of Chemistry and Chemical Engineering, Chalmers University of Technology, Gothenburg, SE-412 96, Sweden; Solar Energy Industries Association, Washington, DC 20005, United States; First Solar, Inc., Tempe, AZ 85281, United States; Australian Centre for Advanced Photovoltaics, University of New South Wales, Sydney, NSW 2052, Australia; bifa Umweltinstitut GmbH, Augsburg, 86167, Germany; DuPont Photovoltaic and Advanced Materials, Wilmington, DE 19803, United States	10627995		PPHOE	Article	Final		Scopus	2-s2.0-85088299314
Maani T., Celik I., Heben M.J., Ellingson R.J., Apul D.	Environmental impacts of recycling crystalline silicon (c-SI) and cadmium telluride (CDTE) solar panels	2020	Science of the Total Environment	735		138827			10.1016/j.scitotenv.2020.138827	https://www.scopus.com/inward/record.uri?eid=2-s2.0-85085245646&doi=10.1016%2fj.scitotenv.2020.138827&partnerID=40&md5=30640325b34002ba56dd4e353cb13802	Wright Center for Photovoltaics Innovation and Commercialization, Department of Civil and Environmental Engineering, The University of Toledo, 2801 W. Bancroft St., Toledo, United States; Sustainability and Renewable Energy Systems Program, Department of Electrical and Computer Engineering, University of Wisconsin-Platteville, 1 University Plz, Platteville, WI, United States; Wright Center for Photovoltaics Innovation and Commercialization, Department of Physics and Astronomy, The University of Toledo, 2801 W. Bancroft St., Toledo, United States	00489697		STEVA	Article	Final		Scopus	2-s2.0-85085245646
Kosovich J.	Questioning the future of solar energy	2020	The Future of Energy: Challenges, Perspectives, and Solutions				179	200		https://www.scopus.com/inward/record.uri?eid=2-s2.0-85125337588&partnerID=40&md5=9bccc979d1fe6e7337749aeddfb35fba			9781536183481		Book Chapter	Final		Scopus	2-s2.0-85125337588
Ravikumar D., Seager T., Sinha P., Fraser M.P., Reed S., Harmon E., Power A.	Environmentally improved CdTe photovoltaic recycling through novel technologies and facility location strategies	2020	Progress in Photovoltaics: Research and Applications	28	9		887	898	10.1002/pip.3279	https://www.scopus.com/inward/record.uri?eid=2-s2.0-85086114962&doi=10.1002%2fpip.3279&partnerID=40&md5=8226ecca502825ad2ce035014cfb31eb	School of Sustainable Engineering and the Built Environment, Arizona State University, Tempe, AZ, United States; School for the Future of Innovation in Society, Arizona State University, Tempe, AZ, United States; Global Sustainability, First Solar, Tempe, AZ, United States; Yale University, New Haven, CT, United States; Chandler-Gilbert Community College, Chandler, AZ, United States	10627995		PPHOE	Article	Final	All Open Access, Bronze	Scopus	2-s2.0-85086114962
Franz M., Piringer G.	Market development and consequences on end-of-life management of photovoltaic implementation in Europe	2020	Energy, Sustainability and Society	10	1	31			10.1186/s13705-020-00263-4	https://www.scopus.com/inward/record.uri?eid=2-s2.0-85090849950&doi=10.1186%2fs13705-020-00263-4&partnerID=40&md5=0faf85ca5a91e0658967c8ae79e9d11b	TU-Wien, Gußhausstraße 27-29/E366, Wien, 1040, Austria; University of Applied Sciences Burgenland, Steinamangerstrasse 21, Pinkafeld, 7423, Austria	21920567			Article	Final	All Open Access, Gold, Green	Scopus	2-s2.0-85090849950
Celik I., Lunardi M., Frederickson A., Corkish R.	Sustainable end of life management of crystalline silicon and thin film solar photovoltaic waste: The impact of transportation	2020	Applied Sciences (Switzerland)	10	16	5465			10.3390/APP10165465	https://www.scopus.com/inward/record.uri?eid=2-s2.0-85089908650&doi=10.3390%2fAPP10165465&partnerID=40&md5=a024efa686814cea3db13a7f1ca510c6	Sustainability and Renewable Energy Systems, Department of Electrical Engineering, University of Wisconsin-Platteville, 1 University Plaza, Platteville, WI 53818, United States; Australian Centre for Advanced Photovoltaics, School of Photovoltaic and Renewable Energy Engineering, UNSW Sydney, Sydney, 2052, Australia; Department of Civil and Environmental Engineering, University of Wisconsin-Platteville, 1 University Plaza, Platteville, WI 53818, United States	20763417			Article	Final	All Open Access, Gold, Green	Scopus	2-s2.0-85089908650
Nain P., Kumar A.	Metal dissolution from end-of-life solar photovoltaics in real landfill leachate versus synthetic solutions: One-year study	2020	Waste Management	114			351	361	10.1016/j.wasman.2020.07.004	https://www.scopus.com/inward/record.uri?eid=2-s2.0-85088043193&doi=10.1016%2fj.wasman.2020.07.004&partnerID=40&md5=9758292d2e63871d3b7c2b4790044766	Department of Civil Engineering, Indian Institute of Technology, New Delhi, India	0956053X		WAMAE	Article	Final		Scopus	2-s2.0-85088043193
Farrell C.C., Osman A.I., Doherty R., Saad M., Zhang X., Murphy A., Harrison J., Vennard A.S.M., Kumaravel V., Al-Muhtaseb A.H., Rooney D.W.	Technical challenges and opportunities in realising a circular economy for waste photovoltaic modules	2020	Renewable and Sustainable Energy Reviews	128		109911			10.1016/j.rser.2020.109911	https://www.scopus.com/inward/record.uri?eid=2-s2.0-85085300529&doi=10.1016%2fj.rser.2020.109911&partnerID=40&md5=60fe8a8b9b38d72a85909dd8a9c26a96	Innotech Centre, South West College, Cookstown, Co. Tyrone, Northern IrelandBT80 8DN, United Kingdom; School of Mechanical and Aerospace Engineering, Queen's University Belfast, Northern Ireland, Belfast, BT9 5AH, United Kingdom; School of Chemistry and Chemical Engineering, Queen's University Belfast, Northern Ireland, Belfast, BT9 5AG, United Kingdom; School of Natural and Built Environment, Queen's University Belfast, Northern Ireland, Belfast, BT9 5AG, United Kingdom; Department of Environmental Science, School of Science, Institute of Technology Sligo, Ash Lane, Sligo, F91 YW50, Ireland; School of Science & Technology, Nottingham Trent University, Clifton, Nottingham, England NG11 8NF, United Kingdom; Department of Chemical and Process Engineering, James Weir Building, University of Strathclyde, Glasgow, G1 1XJ, United Kingdom; Department of Petroleum and Chemical Engineering, College of Engineering, Sultan Qaboos University, Muscat, Oman	13640321		RSERF	Review	Final	All Open Access, Hybrid Gold, Green	Scopus	2-s2.0-85085300529

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Xi Z.-Z., Song Z.-C., Guo Y.-G., Wu X.	Progress and prospects of recovery of spent photovoltaic module [光伏组件资源回收进展与前景展望]	2020	Xiandai Huagong/Modern Chemical Industry	40	7		65	68	10.16606/j.cnki.issn0253-4320.2020.07.014	https://www.scopus.com/inward/record.uri?eid=2-s2.0-85088092172&doi=10.16606%2fj.cnki.issn0253-4320.2020.07.014&partnerID=40&md5=c283ce5c0d9c515bc2f7bb4d5789ff25	SPIC Xi'an Solar Power Co., Ltd., Xi'an, 710010, China	02534320		HTKUD	Article	Final		Scopus	2-s2.0-85088092172
Markert E., Celik I., Apul D.	Private and externality costs and benefits of recycling crystalline silicon (c-Si) photovoltaic panels	2020	Energies	13	14	3650			10.3390/en13143650	https://www.scopus.com/inward/record.uri?eid=2-s2.0-85089800502&doi=10.3390%2fen13143650&partnerID=40&md5=99046143c1c23ff9c7ac139b49492c74	Department of Civil and Environmental Engineering, University of Toledo, Toledo Lucas County, OH 43606, United States; Department of Electrical and Computer Engineering, University of Wisconsin–Platteville, Platteville Grant County, WI 53818, United States	19961073			Article	Final	All Open Access, Gold, Green	Scopus	2-s2.0-85089800502
Heath G.A., Silverman T.J., Kempe M., Deceglie M., Ravikumar D., Remo T., Cui H., Sinha P., Libby C., Shaw S., Komoto K., Wambach K., Butler E., Barnes T., Wade A.	Research and development priorities for silicon photovoltaic module recycling to support a circular economy	2020	Nature Energy	5	7		502	510	10.1038/s41560-020-0645-2	https://www.scopus.com/inward/record.uri?eid=2-s2.0-85087802621&doi=10.1038%2fs41560-020-0645-2&partnerID=40&md5=2665f6c6f6136eb14d450e41bd13ef0b	National Renewable Energy Laboratory, Golden, CO, United States; International Energy Agency, Photovoltaics Power Systems Technology Collaboration Programme, Task 12 Sustainability, St. Ursen, Switzerland; School for Environment and Sustainability, University of Michigan, Ann Arbor, MI, United States; Metallurgical and Materials Engineering Department, Colorado School of MinesCO, United States; First Solar Inc., Tempe, AZ, United States; Electric Power Research Institute, Palo Alto, CA, United States; Mizuho Information & Research Institute, Inc., Tokyo, Japan; Wambach-Consulting, Aindling, Germany; Solar Energy Industries Association, Washington, DC, United States; Orlando Utilities Commission, Orlando, FL, United States; Nevada Gold Mines LLC, Elko, NV, United States	20587546			Article	Final		Scopus	2-s2.0-85087802621
Contreras Lisperguer R., Muñoz Cerón E., de la Casa Higueras J., Martin R.D.	Environmental Impact Assessment of crystalline solar photovoltaic panels' End-of-Life phase: Open and Closed-Loop Material Flow scenarios	2020	Sustainable Production and Consumption	23			157	173	10.1016/j.spc.2020.05.008	https://www.scopus.com/inward/record.uri?eid=2-s2.0-85086439622&doi=10.1016%2fj.spc.2020.05.008&partnerID=40&md5=44b4fe80269251754723f613771175f1	Natural Resources Division, Energy and Water Unit, United Nations Economic Commission for Latin America and the Caribbean; Department of Graphic Engineering, Design and Project, University of Jaén, IDEA Research Group (Research and Development in Solar Energy); Electronics and Automation Engineering Department, University of Jaén, IDEA Research Group (Research and Development in Solar Energy); Department of Industrial Engineering, School of Technical Science and Engineering, Madrid Open University	23525509			Article	Final		Scopus	2-s2.0-85086439622
Yan Y., Wang Z., Wang D., Cao J., Ma W., Wei K., Yun L.	Recovery of Silicon via Using KOH-Ethanol Solution by Separating Different Layers of End-of-Life PV Modules	2020	JOM	72	7		2624	2632	10.1007/s11837-020-04193-6	https://www.scopus.com/inward/record.uri?eid=2-s2.0-85084498446&doi=10.1007%2fs11837-020-04193-6&partnerID=40&md5=097bb6675d31cd8bd08ed54e8f7a1985	Key Laboratory of Green Process and Engineering, National Engineering Laboratory for Hydrometallurgical Cleaner Production Technology, Institute of Process Engineering, Chinese Academy of Sciences, Beijing, 100190, China; Innovation Academy for Green Manufacture, Chinese Academy of Sciences, Beijing, 100190, China; National Engineering Laboratory for Vacuum Metallurgy, Faculty of Metallurgical and Energy Engineering, Kunming University of Science and Technology, Kunming, 650093, China	10474838		JOMME	Article	Final		Scopus	2-s2.0-85084498446
Bogust P., Smith Y.R.	Physical Separation and Beneficiation of End-of-Life Photovoltaic Panel Materials: Utilizing Temperature Swings and Particle Shape	2020	JOM	72	7		2615	2623	10.1007/s11837-020-04197-2	https://www.scopus.com/inward/record.uri?eid=2-s2.0-85084449786&doi=10.1007%2fs11837-020-04197-2&partnerID=40&md5=50bdbc8abe74cee05a52e32d40e37692	Materials Science & Engineering Department, University of Utah, Salt Lake City, UT, United States	10474838		JOMME	Article	Final		Scopus	2-s2.0-85084449786
Zhao R.-N., Dong L., Bai L., Zhang Y., Li X.-Y., Qiao Q., Xie M.-H., Wang W.	Inventoryanalysis on carbon emissions of photovoltaicindustry [光伏行业生命周期碳排放清单分析]	2020	Zhongguo Huanjing Kexue/China Environmental Science	40	6		2751	2757		https://www.scopus.com/inward/record.uri?eid=2-s2.0-85087827605&partnerID=40&md5=58f8af5a28fce7cdcb1b87d3ddd58857	Chinese Research Academy of Environmental Sciences, Beijing, 100012, China; Renmin University of China, Beijing, 100872, China; China Association of Environmental Protection Industry, Beijing, 100037, China	10006923		ZHKEE	Article	Final		Scopus	2-s2.0-85087827605
Tao M., Fthenakis V., Ebin B., Butler E., Sinha P., Corkish R., Wambach K., Simon E.	Major Challenges and Opportunities in Silicon Solar Panel Recycling	2020	Conference Record of the IEEE Photovoltaic Specialists Conference	2020-June		9300650	292	294	10.1109/PVSC45281.2020.9300650	https://www.scopus.com/inward/record.uri?eid=2-s2.0-85099551866&doi=10.1109%2fPVSC45281.2020.9300650&partnerID=40&md5=79f59b87b234f8b6e1d46a89cb1b2aff	School of Electrical, Computer Energy Engineering, Arizona State University, Tempe, United States; Columbia University, Department of Earth and Environmental Engineering, New York, United States; Solar Energy Industries Association, Washington, DC, United States; First Solar Inc., Tempe, United States; Australian Centre for Advanced Photovoltaics, University of New South Wales, Sydney, Australia; Bifa Umweltinstitut, Augsburg, Germany; DuPont Photovoltaic Solutions, Wilmington, United States	01608371	9781728161150	CRCND	Conference Paper	Final		Scopus	2-s2.0-85099551866
Fan Y., Jiang L., Kang J., Wang S., Zhang C., Zhang M., Song B., Zhang G.	Study on Characteristics of Discharge Channels Induced by Pulsed Discharge in Water and Its Application in Solar Panel Recycling	2020	2020 IEEE Electrical Insulation Conference, EIC 2020			9158703	430	433	10.1109/EIC47619.2020.9158703	https://www.scopus.com/inward/record.uri?eid=2-s2.0-85092143050&doi=10.1109%2fEIC47619.2020.9158703&partnerID=40&md5=72efc8fb05c6e4f2fdf92e19eb7cacb0	State Grid Qinghai Electric, Power Company, Xining, Qinghai, China; Electric Power Research Institude, State Grid Qinghai Electric Power Company, Xining, Qinghai, China; State Key Laboratory of Electrical Insulation and Power Equipment, Xi'An Jiaotong University, Xi'an, Shaanxi, China		9781728154855		Conference Paper	Final		Scopus	2-s2.0-85092143050

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Dobra T., Wellacher M., Pomberger R.	End-of-life management of photovoltaic panels in Austria: Current situation and outlook	2020	Detritus	10	June		75	81	10.31025/2611-4135/2020.13915	https://www.scopus.com/inward/record.uri?eid=2-s2.0-85087845207&doi=10.31025%2f2611-4135%2f2020.13915&partnerID=40&md5=bcac8afc34b05a99fe96cc4dd67cc00e	Montanuniversitaet Leoben, Department of Environmental and Energy Process Engineering, Chair of Waste Processing Technology and Waste Management, Franz-Josef-Straße 18, Leoben, A-8700, Austria	26114127			Article	Final	All Open Access, Gold	Scopus	2-s2.0-85087845207
de Oliveira L.S.S., Lima M.T.W.D.C., Yamane L.H., Siman R.R.	Silver recovery from end-of-life photovoltaic panels	2020	Detritus	10	June		62	74	10.31025/2611-4135/2020.13939	https://www.scopus.com/inward/record.uri?eid=2-s2.0-85087844506&doi=10.31025%2f2611-4135%2f2020.13939&partnerID=40&md5=955e7177d4b053f1bb9da233c97c4018	Department of Environmental Engineering, Federal University of Espírito Santo, Fernando Ferrari Avenue 514, Goiabeiras, Vitória, 29075-910, Brazil; Department of Chemistry, Federal University of Espírito Santo, Fernando Ferrari Avenue 514, Goiabeiras, Vitória, 29075-910, Brazil	26114127			Article	Final	All Open Access, Gold	Scopus	2-s2.0-85087844506
Ratner S., Gomonov K., Revinova S., Lazanyuk I.	Eco-design of energy production systems: The problem of renewable energy capacity recycling	2020	Applied Sciences (Switzerland)	10	12	4339			10.3390/app10124339	https://www.scopus.com/inward/record.uri?eid=2-s2.0-85087296312&doi=10.3390%2fapp10124339&partnerID=40&md5=4e8e3ed65bb901e864f2260682149bca	Department of Economic and Mathematical Modelling, Peoples' Friendship University of Russia (RUDN University), 6 Miklukho-Maklaya Street, Moscow, 117198, Russian Federation; Economic Dynamics and Innovation Management Laboratory, V.A. Trapeznikov Institute of Control Sciences, Russian Academy of Sciences, 65 Profsoyuznaya Street, Moscow, 117997, Russian Federation	20763417			Article	Final	All Open Access, Gold, Green	Scopus	2-s2.0-85087296312
Zhao P., Guo J., Yan G., Zhu G., Zhu X., Zhang Z., Zhang B.	A novel and efficient method for resources recycling in waste photovoltaic panels: High voltage pulse crushing	2020	Journal of Cleaner Production	257		120442			10.1016/j.jclepro.2020.120442	https://www.scopus.com/inward/record.uri?eid=2-s2.0-85079345939&doi=10.1016%2fj.jclepro.2020.120442&partnerID=40&md5=e3f86a5691f8f670b69ef3f30aeb8390	Key Laboratory of Coal Processing and Efficient Utilization of Ministry of Education, China University of Mining & Technology, Xuzhou, Jiangsu 221116, China; College of Chemical and Environmental Engineering, Shandong University of Science and Technology, Qingdao, Shandong 266590, China; Research Center of Coal Resources Safe Mining and Clean Utilization, Liaoning Technical University, Fuxin, Liaoning 123000, China	09596526		JCROE	Article	Final		Scopus	2-s2.0-85079345939
Tsanakas J.A., van der Heide A., Radavičius T., Denafas J., Lemaire E., Wang K., Poortmans J., Voroshazi E.	Towards a circular supply chain for PV modules: Review of today's challenges in PV recycling, refurbishment and re-certification	2020	Progress in Photovoltaics: Research and Applications	28	6		454	464	10.1002/pip.3193	https://www.scopus.com/inward/record.uri?eid=2-s2.0-85073993126&doi=10.1002%2fpip.3193&partnerID=40&md5=833d329aefb0dc2e08c61fb121b869a2	PV Department, IMEC, EnergyVille II Campus, Thor Park 8320, Genk, 3600, Belgium; Soli Tek R&D JSC, Mokslininkų str. 6A, Vilnius, 08412, Lithuania; Department of Solar Technologies, CEA-INES, 50 avenue du Lac Léman, Le Bourget-du-Lac, F-73375, France; Unit Sustainable Materials Management, VITO NV, Boeretang 200, Mol, 2400, Belgium; Kaunas University of Technology, K. Donelaičio g. 73, Kaunas, 44249, Lithuania; Katholieke Universiteit Leuven, Oude Markt 13, Leuven, 3000, Belgium; Universiteit Hasselt, Martelarenlaan 42, Hasselt, 3500, Belgium	10627995		PPHOE	Review	Final	All Open Access, Green	Scopus	2-s2.0-85073993126
Sheoran M., Sharma S., Kumar P.	A compatible standard policy measure to tackle solar photovoltaic waste in Indian scenario	2020	Journal of Physics: Conference Series	1504	1	012012			10.1088/1742-6596/1504/1/012012	https://www.scopus.com/inward/record.uri?eid=2-s2.0-85086505380&doi=10.1088%2f1742-6596%2f1504%2f1%2f012012&partnerID=40&md5=fa87e072b2b3dd4ab03c41f65f11c5e1	Bhartiya Skill Development University, Rajasthan, Jaipur, India	17426588			Conference Paper	Final	All Open Access, Bronze	Scopus	2-s2.0-85086505380
Fthenakis V., Athias C., Blumenthal A., Kulur A., Magliozzo J., Ng D.	Sustainability evaluation of CdTe PV: An update	2020	Renewable and Sustainable Energy Reviews	123		109776			10.1016/j.rser.2020.109776	https://www.scopus.com/inward/record.uri?eid=2-s2.0-85080052255&doi=10.1016%2fj.rser.2020.109776&partnerID=40&md5=f19cec3f51f98122830a072fcc661d12	Center for Life Cycle Analysis, Earth and Environmental Engineering, Columbia University, New York, NY, United States	13640321		RSERF	Review	Final		Scopus	2-s2.0-85080052255
Eshraghi N., Berardo L., Schrijnemakers A., Delaval V., Shaibani M., Majumder M., Cloots R., Vertruyen B., Boschini F., Mahmoud A.	Recovery of Nano-Structured Silicon from End-of-Life Photovoltaic Wafers with Value-Added Applications in Lithium-Ion Battery	2020	ACS Sustainable Chemistry and Engineering	8	15		5868	5879	10.1021/acssuschemeng.9b07434	https://www.scopus.com/inward/record.uri?eid=2-s2.0-85084532789&doi=10.1021%2facssuschemeng.9b07434&partnerID=40&md5=2d295e1369d1766c83dadd3753911195	GREENMAT, CESAM Research Unit, Department of Chemistry, University of Liege, Liege, 4000, Belgium; Nanoscale Science and Engineering Laboratory (NSEL), Department of Mechanical and Aerospace Engineering, Monash University, Clayton, Victoria 3168, Australia	21680485			Article	Final		Scopus	2-s2.0-85084532789
Wang H., Kong H., Pu Z., Li Y., Hu X.	Feasibility of high efficient solar hydrogen generation system integrating photovoltaic cell/photon-enhanced thermionic emission and high-temperature electrolysis cell	2020	Energy Conversion and Management	210		112699			10.1016/j.enconman.2020.112699	https://www.scopus.com/inward/record.uri?eid=2-s2.0-85082116713&doi=10.1016%2fj.enconman.2020.112699&partnerID=40&md5=143dfac383ad80bb74c3a28a8cb5b1db	MOE Key Laboratory of Hydrodynamic Machinery Transients (Wuhan University), Ministry of Education, School of Power and Mechanical Engineering, Wuhan University, Wuhan, Hubei 430072, China; Department of Chemical System Engineering, School of Engineering, The University of Tokyo, 7-3-1 Hongo, Bunkyo-kuTokyo 113-8656, Japan; State Key Laboratory of Power System, Department of Thermal Engineering, Tsinghua-BP Clean Energy Center, Tsinghua University, Beijing, 100084, China; China Energy Technology & Economics Research Institute, Research Building 1, Research Garden of Shenhua Innovation Base, Future Science Park, Changping District, Beijing, 102211, China; Hubei International Scientific and Technological Cooperation Base of Sustainable Resource and Energy, Wuhan University, Wuhan, Hubei 430079, China	01968904		ECMAD	Article	Final		Scopus	2-s2.0-85082116713

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Zhang X., Xu W., Wang S., Liu D., Deng P., Deng J., Jiang W.	Research Status of Recovery of Tellurium from Cadmium Telluride Photovoltaic Modules	2020	IOP Conference Series: Materials Science and Engineering	782	2	022024			10.1088/1757-899X/782/2/022024	https://www.scopus.com/inward/record.uri?eid=2-s2.0-85083720851&doi=10.1088%2f1757-899X%2f782%2f2%2f022024&partnerID=40&md5=e03fb7c4c41e40e6903a1e483d5cc901	National Engineering Laboratory for Vacuum Metallurgy, Kunming University of Science and Technology, Kunming, 650093, China; State Key Laboratory of Complex Nonferrous Metal Resources Clear Utilization, Kunming University of Science and Technology, Kunming, 650093, China; Yunnan Provincial Key Laboratory for Nonferrous Vacuum Metallurgy, Kunming University of Science and Technology, Kunming, 650093, China	17578981			Conference Paper	Final	All Open Access, Bronze	Scopus	2-s2.0-85083720851
Staub C.	One state moves toward mandating solar panel recycling	2020	Resource Recycling	39	4		17			https://www.scopus.com/inward/record.uri?eid=2-s2.0-85095783534&partnerID=40&md5=8ce08c316d22996346af8096e938c44d		07444710			Note	Final		Scopus	2-s2.0-85095783534
Sokolov A., Ostromukhov R., Vezhenkova I., Kovalevskaya A., Kustov T., Jimenez-Castaneda R., Rodriguez-Barroso M.R., Castro M., Al-Zoubi A.	Virtual ecological laboratory to develop a PV module recycling workshop	2020	IEEE Global Engineering Education Conference, EDUCON	2020-April		9125260	434	441	10.1109/EDUCON45650.2020.9125260	https://www.scopus.com/inward/record.uri?eid=2-s2.0-85087910012&doi=10.1109%2fEDUCON45650.2020.9125260&partnerID=40&md5=53aac8012208d67821528699f7c4e29c	Saint-Petersburg State Electrotechnical University, Department of Environmental Engineering, Saint-Petersburg, Russian Federation; University of Cadiz, Department of Electrical Engineering, Cadiz, Spain; University of Cadiz, Department of Environmental Technologies, Cadiz, Spain; Uned, Electrical and Computer Engineering Department, Madrid, Spain; Princess Sumaya University for Technology, Department of Electrical Engineering, Amman, Jordan	21659559	9781728109305		Conference Paper	Final		Scopus	2-s2.0-85087910012
Bosio A., Pasini S., Romeo N.	The history of photovoltaics with emphasis on CdTe solar cells and modules	2020	Coatings	10	4	344			10.3390/coatings10040344	https://www.scopus.com/inward/record.uri?eid=2-s2.0-85083846530&doi=10.3390%2fcoatings10040344&partnerID=40&md5=516e88e92b841a80f2036f60dfa6930e	Department of Mathematical, Physical and Computer Science, University of Parma, Parma, 43124, Italy	20796412			Review	Final	All Open Access, Gold, Green	Scopus	2-s2.0-85083846530
Dassisti M., Florio G., Maddalena F.	Cryogenic delamination: mathematical modeling and analysis of an innovative recycling process for photovoltaic crystalline modules	2020	Journal of Remanufacturing	10	1		43	56	10.1007/s13243-019-00073-8	https://www.scopus.com/inward/record.uri?eid=2-s2.0-85073988446&doi=10.1007%2fs13243-019-00073-8&partnerID=40&md5=58814f5e3b18e7b924c3be0dcc0bcc61	Dipartimento di Meccanica, Matematica and Management, Politecnico di Bari, Via E. Orabona 4, Bari, I–70125, Italy; INFN, Sezione di Bari, Bari, I–70126, Italy	2210464X			Article	Final		Scopus	2-s2.0-85073988446
Hidaka S., Ito T., Kanemaru S., Baba Y.	Synthesis of citric acid-immobilized chitosan derivative and its selective separation and recovery of in(III) and ga(III) from model waste of solar panels	2020	Kagaku Kogaku Ronbunshu	46	2		13	17	10.1252/kakoronbunshu.46.13	https://www.scopus.com/inward/record.uri?eid=2-s2.0-85083813454&doi=10.1252%2fkakoronbunshu.46.13&partnerID=40&md5=f2cf30bc3e132d2014e1b5b0ca480509	Department of Applied Chemistry, Faculty of Engineering, Miyazaki University, 1–1 Gakuenkibanadai Nishi, Miyazaki, Miyazaki-shi, 889–2192, Japan	0386216X			Article	Final		Scopus	2-s2.0-85083813454
Savvilotidou V., Gidarakos E.	Pre-concentration and recovery of silver and indium from crystalline silicon and copper indium selenide photovoltaic panels	2020	Journal of Cleaner Production	250		119440			10.1016/j.jclepro.2019.119440	https://www.scopus.com/inward/record.uri?eid=2-s2.0-85075812104&doi=10.1016%2fj.jclepro.2019.119440&partnerID=40&md5=8702b704b8033c9bf883a1f5b9b4d283	School of Environmental Engineering, Technical University of Crete, Politechnioupolis, Chania, 73100, Greece	09596526		JCROE	Article	Final		Scopus	2-s2.0-85075812104
Ogbonnaya C., Turan A., Abeykoon C.	Novel thermodynamic efficiency indices for choosing an optimal location for large-scale photovoltaic power generation	2020	Journal of Cleaner Production	249		119405			10.1016/j.jclepro.2019.119405	https://www.scopus.com/inward/record.uri?eid=2-s2.0-85075854073&doi=10.1016%2fj.jclepro.2019.119405&partnerID=40&md5=77b013ba9df5eb48759e054e0d6ee14c	Department of Mechanical, Aerospace and Civil Engineering, The University of ManchesterM60 1QD, United Kingdom; Aerospace Research Institute, Department of Materials, The University of Manchester, Oxford RoadM13 9PL, United Kingdom; Faculty of Engineering and Technology, Alex Ekwueme Federal University Ndufu-Alike Ikwo, Nigeria	09596526		JCROE	Article	Final	All Open Access, Green	Scopus	2-s2.0-85075854073
Hałacz J., Skotnicka-Siepsiak A., Neugebauer M., Nalepa K., Sołowiej P.	Assessment of options to reduce pollutant emissions in single-family houses in north-eastern Poland	2020	E3S Web of Conferences	154		07005			10.1051/e3sconf/202015407005	https://www.scopus.com/inward/record.uri?eid=2-s2.0-85082669663&doi=10.1051%2fe3sconf%2f202015407005&partnerID=40&md5=c2199677fc8c28379586c2f53bf781f1	University of Warmia and Mazury in Olsztyn, Faculty of Technical Sciences, M. Oczapowskiego str. 2, Olsztyn, 10-719, Poland; University of Warmia and Mazury in Olsztyn, Faculty of Geodesy, Geospatial and Civil Engineering, M. Oczapowskiego str. 2, Olsztyn, 10-719, Poland	25550403			Conference Paper	Final	All Open Access, Gold, Green	Scopus	2-s2.0-85082669663
Piasecka I., Bałdowska-Witos P., Piotrowska K., Tomporowski A.	Eco-energetical life cycle assessment of materials and components of photovoltaic power plant	2020	Energies	16	3	1385			10.3390/en13061385	https://www.scopus.com/inward/record.uri?eid=2-s2.0-85081959000&doi=10.3390%2fen13061385&partnerID=40&md5=481631a0f6155b85a219a3615f776f71	Faculty of Mechanical Engineering, University of Science and Technology in Bydgoszcz, Bydgoszcz, 85-796, Poland; Faculty of Mechanical Engineering, Lublin University of Technology, Lublin, 20-618, Poland	19961073			Article	Final	All Open Access, Gold, Green	Scopus	2-s2.0-85081959000
Sagariga M.R., Balaram S., Menon P., Aiswarya B., Pramod D., Bharath K.R.	Plastic to Fuel Conversion System Using Renewable Energy Assisted Pyrolysis	2020	2020 6th International Conference on Advanced Computing and Communication Systems, ICACCS 2020			9074266	523	527	10.1109/ICACCS48705.2020.9074266	https://www.scopus.com/inward/record.uri?eid=2-s2.0-85084661926&doi=10.1109%2fICACCS48705.2020.9074266&partnerID=40&md5=baf048d4ede30683c45e94dc42d7600b	Amrita Vishwa Vidyapeetham, Department of Electrical and Electronics Engineering, India		9781728151977		Conference Paper	Final		Scopus	2-s2.0-85084661926
Abadías Llamas A., Bartie N.J., Heibeck M., Stelter M., Reuter M.A.	Simulation-Based Exergy Analysis of Large Circular Economy Systems: Zinc Production Coupled to CdTe Photovoltaic Module Life Cycle	2020	Journal of Sustainable Metallurgy	6	1		34	67	10.1007/s40831-019-00255-5	https://www.scopus.com/inward/record.uri?eid=2-s2.0-85076909050&doi=10.1007%2fs40831-019-00255-5&partnerID=40&md5=6659cbbaf33e1b59b31c9c90fd9d8387	Technische Universität Bergakademie Freiberg, Institute for Nonferrous Metallurgy and Purest Materials, Leipziger Str. 34, Freiberg, 09599, Germany; Helmholtz-Zentrum Dresden-Rossendorf, Helmholtz Institute Freiberg for Resource Technology, Chemnitzer Str. 40, Freiberg, 09599, Germany	21993823			Article	Final		Scopus	2-s2.0-85076909050

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Klugmann-Radziemska E., Kuczyńska-Łażewska A.	The use of recycled semiconductor material in crystalline silicon photovoltaic modules production - A life cycle assessment of environmental impacts	2020	Solar Energy Materials and Solar Cells	205		110259			10.1016/j.solmat.2019.110259	https://www.scopus.com/inward/record.uri?eid=2-s2.0-85074208391&doi=10.1016%2fj.solmat.2019.110259&partnerID=40&md5=5d8cd0463300e8ff6e1bd8b5b828549b	Gdansk University of Technology, Faculty of Chemistry, ul. Narutowicza 11/12, Gdansk, PL-80-233, Poland	09270248		SEMCE	Article	Final		Scopus	2-s2.0-85074208391
Chen W.-S., Chen Y.-J., Yueh K.-C., Cheng C.-P., Chang T.-C.	Recovery of valuable metal from Photovoltaic solar cells through extraction	2020	IOP Conference Series: Materials Science and Engineering	720	1	012007			10.1088/1757-899X/720/1/012007	https://www.scopus.com/inward/record.uri?eid=2-s2.0-85078335345&doi=10.1088%2f1757-899X%2f720%2f1%2f012007&partnerID=40&md5=e4aee2e4142d735864ad076c6467f25a	Department of Resource Engineering, National Cheng-Kung University, Tainan, Taiwan; Institute of Environmental Engineering and Management, National Taipei University of Technology, Taipei, Taiwan	17578981			Conference Paper	Final	All Open Access, Bronze	Scopus	2-s2.0-85078335345
Zhang X., Huang D., Jiang W., Zha G., Deng J., Deng P., Kong X., Liu D.	Selective separation and recovery of rare metals by vulcanization-vacuum distillation of cadmium telluride waste	2020	Separation and Purification Technology	230		115864			10.1016/j.seppur.2019.115864	https://www.scopus.com/inward/record.uri?eid=2-s2.0-85069924079&doi=10.1016%2fj.seppur.2019.115864&partnerID=40&md5=6ce1551d67c1113883a852f1e2303000	State Key Laboratory of Complex Nonferrous Metal Resources Clear Utilization, Kunming University of Science and TechnologyKunming 650093, China; National Engineering Laboratory for Vacuum Metallurgy, Kunming University of Science and TechnologyKunming 650093, China; Yunnan Provincial Key Laboratory for Nonferrous Vacuum Metallurgy, Kunming University of Science and TechnologyKunming 650093, China	13835866		SPUTF	Article	Final		Scopus	2-s2.0-85069924079
Vanek J., Maule P., Jandova K.	Development of recycling of photovoltaic systems from the point of view of prolonging the total service life of photovoltaic modules and circular energetic	2020	ECS Transactions	99	1		211	219	10.1149/09901.0211ecst	https://www.scopus.com/inward/record.uri?eid=2-s2.0-85099249408&doi=10.1149%2f09901.0211ecst&partnerID=40&md5=35031f6b183d42981c3a3a983dda6f22	Department of Electrical and Electronic Technology, Brno University of Technology, Brno, 616 00, Czech Republic; Czech Photovoltaic Association, Plzeň, Czech Republic	19386737	9781607685395		Conference Paper	Final		Scopus	2-s2.0-85099249408
Tokoro C., Lim S., Sawamura Y., Kondo M., Mochidzuki K., Koita T., Namihira T., Kikuchi Y.	Copper/silver recovery from photovoltaic panel sheet by electrical dismantling method	2020	International Journal of Automation Technology	14	6		966	974	10.20965/ijat.2020.p0966	https://www.scopus.com/inward/record.uri?eid=2-s2.0-85095435171&doi=10.20965%2fijat.2020.p0966&partnerID=40&md5=4ed03ca2d6b2ac7ebd42a64fede9f59f	Faculty of Science and Engineering, Waseda University, 3-4-1 Okubo, Shinjuku-ku, Tokyo, 169-8555, Japan; Waseda Research Institute for Science and Engineering, Waseda University, 3-4-1 Okubo, Shinjuku-ku, Tokyo, 169-8555, Japan; Graduate School of Creative Science and Engineering, Waseda University, 3-4-1 Okubo, Shinjuku-ku, Tokyo, 169-8555, Japan; Retoca Laboratory LLC, 3-9-1 Marbarahigashi, Chiba, Funabashi, 274-0824, Japan; Institute of Industrial Nanomaterials, Kumamoto University, 2-39-1 Kurokami, Chuo-ku, Kumamoto, 860-8555, Japan; Institute for Future Initiatives, The University of Tokyo, 7-3-1 Hongo, Bunkyo-ku, Tokyo, 113-8654, Japan	18817629			Article	Final	All Open Access, Gold	Scopus	2-s2.0-85095435171
Wongnaree N., Kritsarikun W., Ma-Ud N., Kansomket C., Patcharawit T., Khumkoa S.	Recovery of silver from solar panel waste: An experimental study	2020	Materials Science Forum	1009 MSF			137	142	10.4028/www.scientific.net/MSF.1009.137	https://www.scopus.com/inward/record.uri?eid=2-s2.0-85091150722&doi=10.4028%2fwww.scientific.net%2fMSF.1009.137&partnerID=40&md5=01e3b5ad30988dc0254b0692fade1af8	School of Metallurgical Engineering, Institute of Engineering, Suranaree University of Technology, Nakhon Ratchasima, Thailand	02555476	9783035716887	MSFOE	Conference Paper	Final		Scopus	2-s2.0-85091150722
Oh A.H., Lee H.S., Kim B.-G., Choi S.-C., Jung Y.-G., An G.S.	Fabrication of silicon carbide particles from recycled polysilicon photovoltaic cells	2020	Journal of Ceramic Processing Research	21	4		400	406	10.36410/jcpr.2020.21.4.400	https://www.scopus.com/inward/record.uri?eid=2-s2.0-85090530974&doi=10.36410%2fjcpr.2020.21.4.400&partnerID=40&md5=e028ea8959d2b74cfc1822596546367d	Division of Materials Science and Engineering, Hanyang University, 222 Wangsimni-ro, Seongdong-gu, Seoul, 04763, South Korea; School of Materials Science and Engineering, Changwon National University, 20 Changwondaehak-ro,, Changwon, Gyeongnam 51140, South Korea	12299162			Article	Final		Scopus	2-s2.0-85090530974
Lunardi M.M., Zhang X., Schmidt L., Dias P.R., Veit H.M., Bilbao J., Corkish R.	Life cycle assessment of two experimental recycling processes for c-si solar modules	2020	Proceedings of the ISES Solar World Congress 2019 and IEA SHC International Conference on Solar Heating and Cooling for Buildings and Industry 2019				1981	1990	10.18086/swc.2019.42.05	https://www.scopus.com/inward/record.uri?eid=2-s2.0-85086825432&doi=10.18086%2fswc.2019.42.05&partnerID=40&md5=21426b92c9bbd0e5f5a8a3d1c932c660	Australian Centre for Advanced Photovoltaics (ACAP), School of Photovoltaic and Renewable Energy Engineering, University of New South Wales, Sydney, 2052, Australia; Universidade Federal do Rio Grande do Sul (UFRGS), Porto Alegre, Rio Grande do Sul, 91509-900, Brazil		9783982040813		Conference Paper	Final		Scopus	2-s2.0-85086825432
Matsumoto Y., Omi S., Owada S., Harita M., Terasaki H., Kato S.	Production of high purity glass from wasted photovoltaic panels by electrical disintegration	2020	15th International Symposium on East Asian Resources Recycling Technology, EARTH 2019							https://www.scopus.com/inward/record.uri?eid=2-s2.0-85086811886&partnerID=40&md5=774d48960dace60baa05b4a8efa973b3	Waseda University, Okubo 3-4-1, Shinjuku-ku Tokyo, 169-8555, Japan; Harita Metals Co.,Ltd., 1053-1 Honryo Fukuoka-machi, Takaoka-shi Toyama, 939-0135, Japan; Glass Recycling Committee, 3-4-23-203 Roppongi Minato-ku, Tokyo, 106-0032, Japan				Conference Paper	Final		Scopus	2-s2.0-85086811886
Saisinchai S., Wiwattanadate D.	Silicon recovery from end-of-life solar PV cell	2020	15th International Symposium on East Asian Resources Recycling Technology, EARTH 2019							https://www.scopus.com/inward/record.uri?eid=2-s2.0-85086811610&partnerID=40&md5=60b4631b2034313dd794226dbf2b6032	Department of Mining and Petroleum Engineering, Faculty of Engineering, Chulalongkorn University, Bangkok, Thailand				Conference Paper	Final		Scopus	2-s2.0-85086811610

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Chen W.-S., Chen Y.-J., Yueh K.-C.	Separation of valuable metal from waste Photovoltaic ribbon through extraction and precipitation	2020	15th International Symposium on East Asian Resources Recycling Technology, EARTH 2019							https://www.scopus.com/inward/record.uri?eid=2-s2.0-85086811273&partnerID=40&md5=5c1b4fa61913fe1ae2cd6b1f00476694	Department of Resource engineering, National Cheng-Kung University, Tainan, 70101, Taiwan				Conference Paper	Final		Scopus	2-s2.0-85086811273
Hsu E., Kuo C.-M.	A Recycling System for Sustainable Management of Waste Solar Photovoltaic Panels in Taiwan	2020	Minerals, Metals and Materials Series				241	248	10.1007/978-3-030-36830-2_23	https://www.scopus.com/inward/record.uri?eid=2-s2.0-85079092995&doi=10.1007%2f978-3-030-36830-2_23&partnerID=40&md5=c38a4abee4fd02caf635e4178ac322c8	Department of Statistics, National Taipei University, 67 Section 3, Min-Sheng East Rd., Taipei, 104, Taiwan; Department of Mechanical and Automation Engineering, I-Shou University, 1 Section 1, Syuecheng Rd., Dashu, Kaohsiung, 84001, Taiwan	23671181	9783030368296		Conference Paper	Final		Scopus	2-s2.0-85079092995
Cosnita M., Manciulea I., Cazan C.	All-waste hybrid composites withwaste silicon photovoltaic module	2020	Polymers	12	1	53			10.3390/polym12010053	https://www.scopus.com/inward/record.uri?eid=2-s2.0-85078424824&doi=10.3390%2fpolym12010053&partnerID=40&md5=39ae702ccac50c63ab882bd7d81e64ef	Centre Product Design for Sustainable Development, Transilvania University of Brasov, Eroilor 29, Brasov, 500036, Romania	20734360			Article	Final	All Open Access, Gold, Green	Scopus	2-s2.0-85078424824
Chowdhury M.S., Rahman K.S., Chowdhury T., Nuthammachot N., Techato K., Akhtaruzzaman M., Tiong S.K., Sopian K., Amin N.	An overview of solar photovoltaic panels' end-of-life material recycling	2020	Energy Strategy Reviews	27		100431			10.1016/j.esr.2019.100431	https://www.scopus.com/inward/record.uri?eid=2-s2.0-85077070623&doi=10.1016%2fj.esr.2019.100431&partnerID=40&md5=0c7342a88d46ac4455bc0d96b91e5978	Department of Sustainable Energy, Faculty of Environmental Management, Prince of Songkla University, Songkhla, 90110, Thailand; Solar Energy Research Institute, The National University of Malaysia, Bangi, Selangor 43600, Malaysia; Institute of Sustainable Energy, Universiti Tenaga Nasional (@The National Energy University), Jalan IKRAM-UNITEN, Kajang, Selangor 43000, Malaysia; Environmental Assessment and Technology for Hazardous Waste Management Research Center, Faculty of Environmental Management, Prince of Songkla University, Songkhla, 90110, Thailand; Center of Excellence on Hazardous Substance Management (HSM), Bangkok, 10330, Thailand; Department of Computer Science and Information Technology, Southern University Bangladesh, Chittagong, Bangladesh	2211467X			Review	Final	All Open Access, Gold	Scopus	2-s2.0-85077070623
Sovacool B.K., Hook A., Martiskainen M., Brock A., Turnheim B.	The decarbonisation divide: Contextualizing landscapes of low-carbon exploitation and toxicity in Africa	2020	Global Environmental Change	60		102028			10.1016/j.gloenvcha.2019.102028	https://www.scopus.com/inward/record.uri?eid=2-s2.0-85076982208&doi=10.1016%2fj.gloenvcha.2019.102028&partnerID=40&md5=c4e66bfd6e1ada6c973c3f94a8c03edf	Science Policy Research Unit (SPRU), University of Sussex, Jubilee Building, Room 367, Falmer, East Sussex, BN1 9SL, United Kingdom; Center for Energy Technologies, Department of Business Development and Technology, Aarhus University, Denmark; International Relations, School of Global Studies, University of Sussex, United Kingdom; University of Manchester, United Kingdom; Laboratoire Interdisciplinaire Sciences Innovations Sociétés (LISIS) - CNRS, ESIEE, INRAE, UPEM - Université Paris-Est Marne-la-Vallée, France	09593780		GECHE	Article	Final	All Open Access, Hybrid Gold, Green	Scopus	2-s2.0-85076982208
Bagarić M., Banjad Pečur I., Milovanović B.	Hygrothermal performance of ventilated prefabricated sandwich wall panel from recycled construction and demolition waste – A case study	2020	Energy and Buildings	206		109573			10.1016/j.enbuild.2019.109573	https://www.scopus.com/inward/record.uri?eid=2-s2.0-85074944330&doi=10.1016%2fj.enbuild.2019.109573&partnerID=40&md5=b4bd4fbc66b86b6261e33c43de19b342	Faculty of Civil Engineering, University of Zagreb, Croatia	03787788		ENEBD	Article	Final		Scopus	2-s2.0-85074944330
Song B.-P., Zhang M.-Y., Fan Y., Jiang L., Kang J., Gou T.-T., Zhang C.-L., Yang N., Zhang G.-J., Zhou X.	Recycling experimental investigation on end of life photovoltaic panels by application of high voltage fragmentation	2020	Waste Management	101			180	187	10.1016/j.wasman.2019.10.015	https://www.scopus.com/inward/record.uri?eid=2-s2.0-85073151944&doi=10.1016%2fj.wasman.2019.10.015&partnerID=40&md5=615b559452ebfbe390cd45612548cf2c	School of Electrical Engineering, State Key Laboratory of Electrical Insulation and Power Equipment, Xi'an Jiaotong University, Xi'an, 710049, China; State Grid Qinghai Electric Power Company, Xining, 810008, China; Qinghai Key Laboratory of High Altitude Electric Power Research, Qinghai Engineering Research Center of High Altitude Electric Power, Electric Power Research Institude of State Grid Qinghai Electric Power Company, Xining, 810008, China; School of Earth Sciences, State Key Laboratory of Geological Processes and Mineral Resources, China University of Geosciences, Wuhan, 430074, China	0956053X		WAMAE	Article	Final		Scopus	2-s2.0-85073151944
Lu X., Miki T., Takeda O., Zhu H., Nagasaka T.	Thermodynamic criteria of the end-of-life silicon wafers refining for closing the recycling loop of photovoltaic panels	2019	Science and Technology of Advanced Materials	20	1		813	825	10.1080/14686996.2019.1641429	https://www.scopus.com/inward/record.uri?eid=2-s2.0-85069966853&doi=10.1080%2f14686996.2019.1641429&partnerID=40&md5=c25ebc94def4c78c9b7b0edf14f7f75f	Graduate School of Engineering, Tohoku University, Miyagi, Japan	14686996			Article	Final	All Open Access, Gold, Green	Scopus	2-s2.0-85069966853
Mishra S., Rout P.K., Das A.P.	Solar photovoltaic panels as next generation waste: A review	2019	Biointerface Research in Applied Chemistry	9	6		4539	4546	10.33263/BRIAC96.539546	https://www.scopus.com/inward/record.uri?eid=2-s2.0-85075934689&doi=10.33263%2fBRIAC96.539546&partnerID=40&md5=dda19cc172ae02310425b1c47b74ed68	Department of Life Science, Rama Devi Women's University, Bhubaneswar, Odisha, India; Department of Material science and Engineering, Tripura University (A Central University), Agartala, Tripura, India	20695837			Review	Final	All Open Access, Bronze	Scopus	2-s2.0-85075934689
Rhodes C.J.	Endangered elements, critical raw materials and conflict minerals	2019	Science Progress	102	4		304	350	10.1177/0036850419884873	https://www.scopus.com/inward/record.uri?eid=2-s2.0-85074849853&doi=10.1177%2f0036850419884873&partnerID=40&md5=f670f8fa83258031d595fb85f2467d17	Fresh-Lands Environmental Actions, Berkshire, United Kingdom	00368504			Review	Final	All Open Access, Hybrid Gold	Scopus	2-s2.0-85074849853

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Farrell C., Osman A.I., Zhang X., Murphy A., Doherty R., Morgan K., Rooney D.W., Harrison J., Coulter R., Shen D.	Assessment of the energy recovery potential of waste Photovoltaic (PV) modules	2019	Scientific Reports	9	1	5267			10.1038/s41598-019-41762-5	https://www.scopus.com/inward/record.uri?eid=2-s2.0-85063623604&doi=10.1038%2fs41598-019-41762-5&partnerID=40&md5=fe8b7b5916dadf22f1bfcce1395e0fc8	South West College, Cookstown, Co., Tyrone, BT80 8DN, United Kingdom; School of Mechanical and Aerospace Engineering, Queen's University Belfast, Belfast, BT9 5AH, United Kingdom; School of Chemistry and Chemical Engineering, Queen's University Belfast, Belfast, BT9 5AG, United Kingdom; Chemistry Department, Faculty of Science - Qena, South Valley University, Qena, 83523, Egypt; School of Natural and Built Environment, Civil Engineering, Queen's University Belfast, Belfast, BT9 5AG, United Kingdom; Department of Thermal Power Engineering, Southeast University, 2 Sipailou, Xuanwu Qu, Nanjing Shi, Jiangsu Sheng 210018, China	20452322			Article	Final	All Open Access, Gold, Green	Scopus	2-s2.0-85063623604
Wu J., Zhang Q., Xu Z.	Research on China's photovoltaic modules recycling models under extended producer responsibility	2019	International Journal of Sustainable Engineering	12	6		423	432	10.1080/19397038.2019.1674940	https://www.scopus.com/inward/record.uri?eid=2-s2.0-85074597810&doi=10.1080%2f19397038.2019.1674940&partnerID=40&md5=c74049336d4656f29144dc70786b3b8f	College of Economics and Management, Nanjing University of Aeronautics and Astronautics, Nanjing, China	19397038			Article	Final		Scopus	2-s2.0-85074597810
Maraveas C.	Environmental sustainability of greenhouse covering materials	2019	Sustainability (Switzerland)	11	21	6129			10.3390/su11216129	https://www.scopus.com/inward/record.uri?eid=2-s2.0-85074833673&doi=10.3390%2fsu11216129&partnerID=40&md5=d19b78c877059e2d64c1c26435f3fa40	Department of Civil Engineering, University of Patras, Patra, 26500, Greece	20711050			Review	Final	All Open Access, Gold, Green	Scopus	2-s2.0-85074833673
Salim H.K., Stewart R.A., Sahin O., Dudley M.	End-of-life management of solar photovoltaic and battery energy storage systems: A stakeholder survey in Australia	2019	Resources, Conservation and Recycling	150		104444			10.1016/j.resconrec.2019.104444	https://www.scopus.com/inward/record.uri?eid=2-s2.0-85070627120&doi=10.1016%2fj.resconrec.2019.104444&partnerID=40&md5=260d644344c76e18708236f77c388ecf	School of Engineering and Built Environment, Griffith University, Southport, QLD 4222, Australia; Cities Research Institute, Griffith University, Southport, QLD 4222, Australia; Griffith Climate Change Response Program, Griffith University, Southport, QLD 4222, Australia; Sustainability Victoria, Melbourne, VIC 3000, Australia	09213449		RCREE	Article	Final		Scopus	2-s2.0-85070627120
Pagnanelli F., Moscardini E., Altimari P., Padoan F.C.S.M., Abo Atia T., Beolchini F., Amato A., Toro L.	Solvent versus thermal treatment for glass recovery from end of life photovoltaic panels: Environmental and economic assessment	2019	Journal of Environmental Management	248		109313			10.1016/j.jenvman.2019.109313	https://www.scopus.com/inward/record.uri?eid=2-s2.0-85069846615&doi=10.1016%2fj.jenvman.2019.109313&partnerID=40&md5=975a7271eae3188a9fe4ed28b9e5857e	Department of Chemistry, Sapienza University of Rome, P.le a. Moro 5, Rome, 00185, Italy; Eco Recycling Srl, Via di Vannina 88/94, Roma, 00156, Italy; Department of Life and Environmental Sciences, Università Politecnica Delle Marche, Via Brecce Bianche, Ancona, Italy	03014797		JEVMA	Article	Final	All Open Access, Green	Scopus	2-s2.0-85069846615
Santhoshkumar A., Ramanathan A.	Energy and Life Cycle Assessment of Solar Assisted Microwave Pyrolysis of Waste Biomass	2019	IOP Conference Series: Earth and Environmental Science	312	1	012017			10.1088/1755-1315/312/1/012017	https://www.scopus.com/inward/record.uri?eid=2-s2.0-85074688492&doi=10.1088%2f1755-1315%2f312%2f1%2f012017&partnerID=40&md5=6bede15d47d5213c8f5490343a0fdc44	Department of Mechanical Engineering, National Institute of Technology, Tiruchirappalli, TamilNadu, 620 015, India	17551307			Conference Paper	Final	All Open Access, Gold	Scopus	2-s2.0-85074688492
Carolus J., Merckx T., Purohit Z., Tripathi B., Boyen H.-G., Aernouts T., De Ceuninck W., Conings B., Daenen M.	Potential-Induced Degradation and Recovery of Perovskite Solar Cells	2019	Solar RRL	3	10	1900226			10.1002/solr.201900226	https://www.scopus.com/inward/record.uri?eid=2-s2.0-85078072281&doi=10.1002%2fsolr.201900226&partnerID=40&md5=ddecec3b594c793bf481c070466c8300	Institute for Materials Research (IMO) and IMOMEC, Hasselt University and imec vzw, Diepenbeek, 3590, Belgium; imec, Leuven, 753000, Belgium; Pandit Deendayal Petroleum University, Gujarat, 382421, India	2367198X			Article	Final		Scopus	2-s2.0-85078072281
Hocine L., Mounia Samira K.	Optimal PV panel's end-life assessment based on the supervision of their own aging evolution and waste management forecasting	2019	Solar Energy	191			227	234	10.1016/j.solener.2019.08.058	https://www.scopus.com/inward/record.uri?eid=2-s2.0-85071722507&doi=10.1016%2fj.solener.2019.08.058&partnerID=40&md5=bc61e78d17e702f72a18e2a8890420a3	Department of Electrical Engineering, Laboratory d'Electrotechnique d'Annaba, Badji Mokthar University, BP 12 Sidi Amar, Annaba, 23000, Algeria	0038092X		SRENA	Article	Final		Scopus	2-s2.0-85071722507
Liu B., Li J., Ding Y., Zheng H., Zhang S.	Recycling Status of Scrap Photovoltaic Panels [报废光伏板回收利用的研究现状]	2019	Xiyou Jinshu/Chinese Journal of Rare Metals	43	9		987	996	10.13373/j.cnki.cjrm.XY19010021	https://www.scopus.com/inward/record.uri?eid=2-s2.0-85076524325&doi=10.13373%2fj.cnki.cjrm.XY19010021&partnerID=40&md5=22beef385c20bb054146973de211cfdd	Institute for Advanced Materials and Technology, University of Science and Technology Beijing, Beijing, 100083, China	02587076		XIJID	Article	Final		Scopus	2-s2.0-85076524325
Kuczyńska-Łazewska A., Klugmann-Radziemska E.	Influence of fragment size on the time and temperature of ethylene vinyl acetate lamination decomposition in the photovoltaic module recycling process	2019	Materials	12	18	2857			10.3390/ma12182857	https://www.scopus.com/inward/record.uri?eid=2-s2.0-85072538430&doi=10.3390%2fma12182857&partnerID=40&md5=a84820b5c640ccf1b44842378e91f039	Faculty of Chemistry, Gdansk University of Technology, ul. Narutowicza 11/12, Gdansk, PL-80-233, Poland	19961944			Article	Final	All Open Access, Gold, Green	Scopus	2-s2.0-85072538430
Sharma A., Pandey S., Kolhe M.	Global review of policies & guidelines for recycling of solar pv modules	2019	International Journal of Smart Grid and Clean Energy	8	5		597	610	10.12720/sgce.8.5.597-610	https://www.scopus.com/inward/record.uri?eid=2-s2.0-85071440658&doi=10.12720%2fsgce.8.5.597-610&partnerID=40&md5=5716c0f75c864563234d96b0f0c2f19c	University of Agder, P.O.Box 422, Kristiansand, 4604, Norway; The Energy and Resources Institute (TERI), New Delhi, 110 003, India	23154462			Review	Final	All Open Access, Bronze	Scopus	2-s2.0-85071440658
Gangwar P., Kumar N.M., Singh A.K., Jayakumar A., Mathew M.	Solar photovoltaic tree and its end-of-life management using thermal and chemical treatments for material recovery	2019	Case Studies in Thermal Engineering	14		100474			10.1016/j.csite.2019.100474	https://www.scopus.com/inward/record.uri?eid=2-s2.0-85067203178&doi=10.1016%2fj.csite.2019.100474&partnerID=40&md5=6ab8c6dcbeaa2ff0d0d172d13b59cee0	Department of Electronics and Communication Engineering, Indian Institute of Information Technology, Allahabad, Uttar Pradesh 211015, India; School of Energy and Environment, City University of Hong Kong, Kowloon, Hong Kong; Department of Mechatronics Engineering, Chennai Institute of Technology, Kundrathur, Chennai, Tamil Nadu 600069, India; School of Engineering, Deakin University, Waurnponds, Geelong, VIC 3216, Australia	2214157X			Article	Final	All Open Access, Gold	Scopus	2-s2.0-85067203178

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Del Pero F., Delogu M., Berzi L., Escamilla M.	Innovative device for mechanical treatment of End of Life photovoltaic panels: Technical and environmental analysis	2019	Waste Management	95			535	548	10.1016/j.wasman.2019.06.037	https://www.scopus.com/inward/record.uri?eid=2-s2.0-85068182054&doi=10.1016%2fj.wasman.2019.06.037&partnerID=40&md5=449e5547ea7975156ad96da16a574efa	Department of Industrial Engineering, University of Florence, Via di Santa Marta 3, Florence, 50139, Italy; Leitat Technological Centre, C/ de la Innovació, 2, Terrassa, Barcelona 08225, Spain	0956053X		WAMAE	Article	Final	All Open Access, Green	Scopus	2-s2.0-85068182054
Mahar A.M., Shaikh P.H., Mahar A.R., Memon Z.A., Khatri S.A., Shah S.F.	Simulation of efficient non-isolated DC-DC boost converter topology for photovoltaic application	2019	AIP Conference Proceedings	2119		020019			10.1063/1.5115378	https://www.scopus.com/inward/record.uri?eid=2-s2.0-85069717221&doi=10.1063%2f1.5115378&partnerID=40&md5=78199e7b341591964c7827d6cf591b3a	Energy Systems Engineering, Mehran University of Engineering and Technology, Jamshoro, 76062, Pakistan; Mehran University Center for Energy and Development (MUCED), Mehran University of Engineering and Technology, Jamshoro, 76062, Pakistan; Office of Research, Innovation and Commercialization (ORIC), Mehran University of Engineering and Technology, Jamshoro, 76062, Pakistan; Department of Electrical Engineering, Mehran University of Engineering and Technology, Jamshoro, 76062, Pakistan; Department of Basic Sciences and Related Studies, Mehran University of Engineering and Technology, Jamshoro, 76062, Pakistan	0094243X	9780735418592		Conference Paper	Final		Scopus	2-s2.0-85069717221
Li Q., Liu K., Zhang Z.-H.	Robust design of a strategic network planning for photovoltaic module recycling considering reclaimed resource price uncertainty	2019	IISE Transactions	51	7		691	708	10.1080/24725854.2018.1501169	https://www.scopus.com/inward/record.uri?eid=2-s2.0-85061067463&doi=10.1080%2f24725854.2018.1501169&partnerID=40&md5=4689598db6b00f28f2145c88405a8fe3	Department of Industrial Engineering, Tsinghua University, Beijing, China	24725854			Article	Final	All Open Access, Green	Scopus	2-s2.0-85061067463
Deng R., Chang N.L., Ouyang Z., Chong C.M.	A techno-economic review of silicon photovoltaic module recycling	2019	Renewable and Sustainable Energy Reviews	109			532	550	10.1016/j.rser.2019.04.020	https://www.scopus.com/inward/record.uri?eid=2-s2.0-85064680484&doi=10.1016%2fj.rser.2019.04.020&partnerID=40&md5=cf8b58cf244721502d5471e0e447f961	School of Photovoltaic and Renewable Energy Engineering, University of New South Wales, Sydney, NSW 2052, Australia	13640321		RSERF	Review	Final	All Open Access, Hybrid Gold	Scopus	2-s2.0-85064680484
Mahmoudi S., Huda N., Behnia M.	Photovoltaic waste assessment: Forecasting and screening of emerging waste in Australia	2019	Resources, Conservation and Recycling	146			192	205	10.1016/j.resconrec.2019.03.039	https://www.scopus.com/inward/record.uri?eid=2-s2.0-85064315779&doi=10.1016%2fj.resconrec.2019.03.039&partnerID=40&md5=48ad4276cc24dda27ce79fc566cddb45	School of Engineering, Macquarie UniversityNSW 2109, Australia; Macquarie Graduate School of Management, Macquarie University, North Ryde, NSW 2109, Australia	09213449		RCREE	Article	Final		Scopus	2-s2.0-85064315779
Mahmoudi S., Huda N., Alavi Z., Islam M.T., Behnia M.	End-of-life photovoltaic modules: A systematic quantitative literature review	2019	Resources, Conservation and Recycling	146			1	16	10.1016/j.resconrec.2019.03.018	https://www.scopus.com/inward/record.uri?eid=2-s2.0-85063198039&doi=10.1016%2fj.resconrec.2019.03.018&partnerID=40&md5=b336de66b875bb60e3cd558662707105	School of Engineering, Macquarie University, North Ryde, NSW 2109, Australia; Macquarie Graduate School of Management, Macquarie University, North Ryde, NSW 2109, Australia	09213449		RCREE	Review	Final		Scopus	2-s2.0-85063198039
Xu C., Li B., Yuan X., Liu C., Shen C.	Recycling of waste crystalline silicon photovoltaic modules [废旧晶体硅光伏组件的回收利用]	2019	Chinese Journal of Environmental Engineering	13	6		1417	1424	10.12030/j.cjee.201901113	https://www.scopus.com/inward/record.uri?eid=2-s2.0-85070299671&doi=10.12030%2fj.cjee.201901113&partnerID=40&md5=3d8a9b84452a1c8547e5805e9b8f482f	School of Materials Science and Engineering, East China University of Science and Technology, Shanghai, 200237, China; School of Mechanical and Power Engineering, East China University of Science and Technology, Shanghai, 200237, China; State Key Laboratory of Chemical Engineering, School of Chemical Engineering, East China University of Science and Technology, Shanghai, 200237, China	16739108			Article	Final		Scopus	2-s2.0-85070299671
Fletcher R.W., Shandi N.R.	Using recycled photovoltic modules and batteries for engineering education, student projects, and as viable portable, backup storage power sources	2019	ASEE Annual Conference and Exposition, Conference Proceedings							https://www.scopus.com/inward/record.uri?eid=2-s2.0-85078724274&partnerID=40&md5=f00b51a63216682bd92811c44793492a	Lawrence Technological University, United States	21535965			Conference Paper	Final		Scopus	2-s2.0-85078724274
Libby C., Shaw S.	Environmental and Economic Considerations for PV Module End-of-Life Management	2019	Conference Record of the IEEE Photovoltaic Specialists Conference			8981209	2458	2463	10.1109/PVSC40753.2019.8981209	https://www.scopus.com/inward/record.uri?eid=2-s2.0-85081573374&doi=10.1109%2fPVSC40753.2019.8981209&partnerID=40&md5=a60c35f5921bb225d688c5e18d6d8890	Electric Power Research Institute, Palo Alto, CA 94304, United States	01608371	9781728104942	CRCND	Conference Paper	Final		Scopus	2-s2.0-85081573374
Tamizhmani G., Shaw S., Libby C., Patankar A., Bicer B.	Assessing Variability in Toxicity Testing of PV Modules	2019	Conference Record of the IEEE Photovoltaic Specialists Conference			8980781	2475	2481	10.1109/PVSC40753.2019.8980781	https://www.scopus.com/inward/record.uri?eid=2-s2.0-85081564512&doi=10.1109%2fPVSC40753.2019.8980781&partnerID=40&md5=a1bec207586d0a81d690cde6d4c9f3fe	Arizona State University, Photovoltaic Reliability Laboratory (ASU-PRL), Mesa, AZ, United States; Electric Power Research Institute (EPRI), Palo Alto, CA, United States	01608371	9781728104942	CRCND	Conference Paper	Final		Scopus	2-s2.0-85081564512
Kuczyńska-łażewska A., Klugmann-Radziemska E.	Recycling of metals from used photovoltaic modules [Recykling metali z zużytych modułów fotowoltaicznych]	2019	Przemysl Chemiczny	98	6		931	935		https://www.scopus.com/inward/record.uri?eid=2-s2.0-85077691033&partnerID=40&md5=53581e8a005847f67bb9f0e966cb7ddf	Politechnika Gdańska, Poland	00332496			Article	Final		Scopus	2-s2.0-85077691033
Huang X., Atasu A., Beril Toktay L.	Design implications of extended producer responsibility for durable products	2019	Management Science	65	6		2573	2590	10.1287/mnsc.2018.3072	https://www.scopus.com/inward/record.uri?eid=2-s2.0-85066957244&doi=10.1287%2fmnsc.2018.3072&partnerID=40&md5=a97d5523044357c2d4d5810623664507	Carlson School of Management, University of Minnesota, Minneapolis, MN 55455, United States; Scheller College of Business, Georgia Institute of Technology, Atlanta, GA 30308, United States	00251909		MSCIA	Article	Final		Scopus	2-s2.0-85066957244
Ardente F., Latunussa C.E.L., Blengini G.A.	Resource efficient recovery of critical and precious metals from waste silicon PV panel recycling	2019	Waste Management	91			156	167	10.1016/j.wasman.2019.04.059	https://www.scopus.com/inward/record.uri?eid=2-s2.0-85065119634&doi=10.1016%2fj.wasman.2019.04.059&partnerID=40&md5=df77c46e1e219bf142bb4ec246003a92	European Commission, Joint Research Centre (JRC), Ispra, Italy; Politecnico di Torino, Corso Duca degli Abruzzi 24, Torino, TO 10129, Italy	0956053X		WAMAE	Article	Final	All Open Access, Hybrid Gold, Green	Scopus	2-s2.0-85065119634

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Authors	Title	Year	Source Title	Volume	Issue	Art. No.	Page Start	Page End	DOI	Link	Affiliations	ISSN	ISBN	CODEN	Document Type	Publication Stage	Open Access	Source	EID
Azeumo M.F., Conte G., Ippolito N.M., Medici F., Piga L., Santilli S.	Photovoltaic module recycling, a physical and a chemical recovery process	2019	Solar Energy Materials and Solar Cells	193			314	319	10.1016/j.solmat.2019.01.035	https://www.scopus.com/inward/record.uri?eid=2-s2.0-85060692170&doi=10.1016%2fj.solmat.2019.01.035&partnerID=40&md5=bd285c3e0d1996de9d5ced8494033bda	Department of Chemical Engineering, Materials and Environment, Sapienza University of Rome, via Eudossiana 84, Rome, 00184, Italy; Enel Green Power, viale Regina Margherita, 137, Rome, 00198, Italy; Municipality of Celano, L'Aquila, Italy	09270248		SEMCE	Article	Final		Scopus	2-s2.0-85060692170
Salman R.K.	Research note: Light emitting diodes as solar power resources	2019	Lighting Research and Technology	51	3		476	483	10.1177/1477153518764211	https://www.scopus.com/inward/record.uri?eid=2-s2.0-85044283397&doi=10.1177%2f1477153518764211&partnerID=40&md5=9c4de7f83ad18d29f33e9a17a090115a	Department of Physics, College of Education for Pure Science, University of Anbar, Anbar, Iraq	14771535		LRTEA	Article	Final		Scopus	2-s2.0-85044283397
Lamnatou C., Smyth M., Chemisana D.	Building-Integrated Photovoltaic/Thermal (BIPVT): LCA of a façade-integrated prototype and issues about human health, ecosystems, resources	2019	Science of the Total Environment	660			1576	1592	10.1016/j.scitotenv.2018.12.461	https://www.scopus.com/inward/record.uri?eid=2-s2.0-85060125020&doi=10.1016%2fj.scitotenv.2018.12.461&partnerID=40&md5=c22bc8cd540b74aa150e4304d7770da9	Applied Physics Section of the Environmental Science Department, University of Lleida, Jaume II 69, Lleida, 25001, Spain; Centre for Sustainable Technologies, Belfast School of Architecture and the Built Environment, Ulster University, Newtownabbey, Northern Ireland BT370QB, United Kingdom	00489697		STEVA	Article	Final	All Open Access, Green	Scopus	2-s2.0-85060125020
Xu C., Li B., Yuan X., Liu C., Shen C.-Y., Dai G.-C.	Separation of backsheets from waste photovoltaic(PV) modules by ultrasonic irradiation	2019	IOP Conference Series: Earth and Environmental Science	242	3	032046			10.1088/1755-1315/242/3/032046	https://www.scopus.com/inward/record.uri?eid=2-s2.0-85064415797&doi=10.1088%2f1755-1315%2f242%2f3%2f032046&partnerID=40&md5=5d4abac5f0bf319cb8d845fdeeee8e39	School of Materials Science and Engineering, East China University of Science and Technology, Shanghai, Shanghai, 200237, China; School of Mechanical and Power Engineering, East China University of Science and Technology, Shanghai, Shanghai, 200237, China; State Key Laboratory of Chemical Engineering, School of Chemical Engineering, East China University of Science and Technology, Shanghai, 200237, China	17551307			Conference Paper	Final	All Open Access, Bronze	Scopus	2-s2.0-85064415797
Macias-Macias K.Y., Ceniceros-Gómez A.E., Gutiérrez-Ruiz M.E., González-Chávez J.L., Martínez-Jardines L.G.	Extraction and recovery of the strategic element gallium from an iron mine tailing	2019	Journal of Environmental Chemical Engineering	7	2	102964			10.1016/j.jece.2019.102964	https://www.scopus.com/inward/record.uri?eid=2-s2.0-85062177427&doi=10.1016%2fj.jece.2019.102964&partnerID=40&md5=c47e04b304dd06b8e1970c1494f6eafb	Laboratorio de Biogeoquímica Ambiental, Facultad de Química, Universidad Nacional Autónoma de México, Ciudad Universitaria, Av. Universidad No. 3000, Coyoacán, Cd. De México, C.P. 04510, Mexico; Departamento de Química Analítica, Facultad de Química, Universidad Nacional Autónoma de México, Ciudad Universitaria, Av. Universidad No. 3000, Coyoacán, Cd. De México, C.P. 04510, Mexico; Instituto de Geología, Universidad Nacional Autónoma de México, Ciudad Universitaria, Av. Universidad No. 3000, Coyoacán, Cd. De México, C.P. 04510, Mexico	22133437			Article	Final		Scopus	2-s2.0-85062177427
Gönen Ç., Kaplanoğlu E.	Environmental and economic evaluation of solar panel wastes recycling	2019	Waste Management and Research	37	4		412	418	10.1177/0734242X19826331	https://www.scopus.com/inward/record.uri?eid=2-s2.0-85061983693&doi=10.1177%2f0734242X19826331&partnerID=40&md5=4d83ffbbee8a93d90ac48accceed8c81	Engineering Faculty, Niğde Ömer Halisdemir University, Niğde, Turkey; School of Economics, Management and Statistics, Alma Mater Studiorum, Universita di Bologna, Bologna, Italy	0734242X		WMARD	Article	Final		Scopus	2-s2.0-85061983693
Faircloth C.C., Wagner K.H., Woodward K.E., Rakkwamsuk P., Gheewala S.H.	The environmental and economic impacts of photovoltaic waste management in Thailand	2019	Resources, Conservation and Recycling	143			260	272	10.1016/j.resconrec.2019.01.008	https://www.scopus.com/inward/record.uri?eid=2-s2.0-85059858526&doi=10.1016%2fj.resconrec.2019.01.008&partnerID=40&md5=0abfa723e829a976fcd3c4c5a4e62940	Institute for the Environment, University of North Carolina at Chapel Hill, Chapel Hill, NC 27599, United States; The Joint Graduate School of Energy and Environment, King Mongkut's University of Technology Thonburi, Bangkok, Thailand; The School of Energy, Environment and Materials, King Mongkut's University of Technology Thonburi, Bangkok, Thailand; Center of Excellence on Energy Technology and Environment, PERDO, Bangkok, Thailand; Department of Environmental Sciences and Engineering, Gillings School of Global Public Health, University of North Carolina, Chapel Hill, NC 27514, United States	09213449		RCREE	Article	Final		Scopus	2-s2.0-85059858526
Domínguez A., Geyer R.	Photovoltaic waste assessment of major photovoltaic installations in the United States of America	2019	Renewable Energy				1188	1200	10.1016/j.renene.2018.08.063	https://www.scopus.com/inward/record.uri?eid=2-s2.0-85052976201&doi=10.1016%2fj.renene.2018.08.063&partnerID=40&md5=1eba34aec0b3b77445283ffdfe889317	Bren School of Environmental Science and Management, University of California at Santa Barbara, Santa Barbara, CA 93106, United States	09601481			Article	Final		Scopus	2-s2.0-85052976201
Fiandra V., Sannino L., Andreozzi C., Corcelli F., Graditi G.	Silicon photovoltaic modules at end-of-life: Removal of polymeric layers and separation of materials	2019	Waste Management	87			97	107	10.1016/j.wasman.2019.02.004	https://www.scopus.com/inward/record.uri?eid=2-s2.0-85061032947&doi=10.1016%2fj.wasman.2019.02.004&partnerID=40&md5=3545ed6d9d9d5cea0b405d6758024536	ENEA, Italian National Agency for New Technologies, Energy and Sustainable Economic Development – Research Centre ENEA, P.le E. Fermi 1, 80055 Portici, Naples, Italy; Department of Science and Technology, Parthenope University of Naples, Centro Direzionale – Isola C4, Naples, 80143, Italy	0956053X		WAMAE	Article	Final		Scopus	2-s2.0-85061032947
Nevala S.-M., Hamuyuni J., Junnila T., Sirviö T., Eisert S., Wilson B.P., Serna-Guerrero R., Lundström M.	Electro-hydraulic fragmentation vs conventional crushing of photovoltaic panels – Impact on recycling	2019	Waste Management	87			43	50	10.1016/j.wasman.2019.01.039	https://www.scopus.com/inward/record.uri?eid=2-s2.0-85060933862&doi=10.1016%2fj.wasman.2019.01.039&partnerID=40&md5=9df11e9a778b7e3766de4781cdf268f4	Hydrometallurgy and Corrosion, Department of Chemical and Metallurgical Engineering (CMET), Aalto University, PO Box 16200, Aalto, 00076, Finland; ImpulsTec GmbH, Industriestraße 65, Dresden, 01129, Germany; Mechanical Processing and Recycling, Department of Chemical and Metallurgical Engineering (CMET), Aalto University, PO Box 16200, Aalto, 00076, Finland; Outotec Research Center, Kuparitie 10, PO Box 69, Pori, 28101, Finland	0956053X		WAMAE	Article	Final	All Open Access, Green	Scopus	2-s2.0-85060933862
Amato A., Beolchini F.	End-of-life CIGS photovoltaic panel: A source of secondary indium and gallium	2019	Progress in Photovoltaics: Research and Applications	27	3		229	236	10.1002/pip.3082	https://www.scopus.com/inward/record.uri?eid=2-s2.0-85055201668&doi=10.1002%2fpip.3082&partnerID=40&md5=70ed12eaac7cb756f805e8b361fa51c9	Department of Life and Environmental Sciences, Università Politecnica delle Marche, Via Brecce Bianche, Ancona, 60131, Italy	10627995		PPHOE	Article	Final		Scopus	2-s2.0-85055201668

Table A-3: PV Recycling Literature Review

Authors	Title	Year	Source Title	Volume	Issue	Art. No.	Page Start	Page End	DOI	Link	Affiliations	ISSN	ISBN	CODEN	Document Type	Publication Stage	Open Access	Source	EID
Howard J.M., Tennyson E.M., Neves B.R.A., Leite M.S.	Machine Learning for Perovskites' Reap-Rest-Recovery Cycle	2019	Joule	3	2		325	337	10.1016/j.joule.2018.11.010	https://www.scopus.com/inward/record.uri?eid=2-s2.0-85060314630&doi=10.1016%2fj.joule.2018.11.010&partnerID=40&md5=8e455edefa9df5f596ba0b53690e89a1	Department of Materials Science and Engineering, University of Maryland, College Park, MD 20740, United States; Institute for Research in Electronics and Applied Physics, University of Maryland, College Park, MD 20740, United States; Department of Physics, Federal University of Minas Gerais, Belo Horizonte, MG 31270-901, Brazil	25424351			Review	Final	All Open Access, Hybrid Gold	Scopus	2-s2.0-85060314630
Salim H.K., Stewart R.A., Sahin O., Dudley M.	Drivers, barriers and enablers to end-of-life management of solar photovoltaic and battery energy storage systems: A systematic literature review	2019	Journal of Cleaner Production	211			537	554	10.1016/j.jclepro.2018.11.229	https://www.scopus.com/inward/record.uri?eid=2-s2.0-85057296698&doi=10.1016%2fj.jclepro.2018.11.229&partnerID=40&md5=3399a0f0ee03eb0bbc40e23f34257b98	School of Engineering and Built Environment, Griffith University, Southport, QLD 4222, Australia; Cities Research Institute, Griffith University, Southport, QLD 4222, Australia; Griffith Climate Change Response Program, Griffith University, Southport, QLD 4222, Australia; Sustainability Victoria, Melbourne, VIC 3000, Australia	09596526		JCROE	Review	Final		Scopus	2-s2.0-85057296698
Tasnia K., Begum S., Tasnim Z., Khan M.Z.R.	End-of-life management of photovoltaic modules in Bangladesh	2019	ICECE 2018 - 10th International Conference on Electrical and Computer Engineering			8636782	445	448	10.1109/ICECE.2018.8636782	https://www.scopus.com/inward/record.uri?eid=2-s2.0-85062892259&doi=10.1109%2fICECE.2018.8636782&partnerID=40&md5=e40a78148cbe183492e0d424efd572c9	Department of Electrical and Electronic Engineering, Bangladesh University of Engineering and Technology, Dhaka, 1205, Bangladesh		9781538674826		Conference Paper	Final		Scopus	2-s2.0-85062892259
Fiandra V., Sannino L., Andreozzi C., Graditi G.	End-of-life of silicon PV panels: A sustainable materials recovery process	2019	Waste Management	84			91	101	10.1016/j.wasman.2018.11.035	https://www.scopus.com/inward/record.uri?eid=2-s2.0-85057113365&doi=10.1016%2fj.wasman.2018.11.035&partnerID=40&md5=78334c05b88cf5d371f408644451d849	ENEA, Italian National Agency for New Technologies, Energy and Sustainable Economic Development – Research Centre ENEA Portici, Naples, Italy	0956053X		WAMAE	Article	Final		Scopus	2-s2.0-85057113365
Lapko Y., Trianni A., Nuur C., Masi D.	In Pursuit of Closed-Loop Supply Chains for Critical Materials: An Exploratory Study in the Green Energy Sector	2019	Journal of Industrial Ecology	23	1		182	196	10.1111/jiec.12741	https://www.scopus.com/inward/record.uri?eid=2-s2.0-85042433536&doi=10.1111%2fjiec.12741&partnerID=40&md5=2975ed62b3396ba0599034319abdde2f	Department of Management, Economics and Industrial Engineering, Politecnico di Milano, Milan, Italy; Department of Industrial Economics and Management, KTH Royal Institute of TechnologyStockholm, Sweden; School of Systems, Management and Leadership, Faculty of Engineering and Information Technology, University of Technology Sydney, Sydney, NSW, Australia; Warwick Manufacturing Group, University of WarwickCoventry, United Kingdom	10881980		JINEF	Article	Final	All Open Access, Green	Scopus	2-s2.0-85042433536
Nair S., Rao R.R., Kumar T., Guru Prasad G., Kumar M., Khadeeia Henna P., Saifudeen A., Mani M.	'Roshini'-Developing a DIY Rural Solar Light: Utilizing Products at End-of-Life (EoL) Stage	2019	GHTC 2018 - IEEE Global Humanitarian Technology Conference, Proceedings			8601891			10.1109/GHTC.2018.8601891	https://www.scopus.com/inward/record.uri?eid=2-s2.0-85061792648&doi=10.1109%2fGHTC.2018.8601891&partnerID=40&md5=f0800b55d90c2639fc3abc793b81ee7c	Indian Institute of Science, Centre for Product Design and Manufacturing, Bengaluru, India; Indian Institute of Science, Centre for Sustainable Technologies, Bengaluru, India		9781538655665		Conference Paper	Final		Scopus	2-s2.0-85061792648
Möller H.J.	Wafer processing	2019	Handbook of Photovoltaic Silicon				269	309	10.1007/978-3-662-56472-1_16	https://www.scopus.com/inward/record.uri?eid=2-s2.0-85082736690&doi=10.1007%2f978-3-662-56472-1_16&partnerID=40&md5=3af438e4fe5ab5c9e8cecc22c2ceab9a	Fraunhofer Technology Center for Semiconductor Materials, Freiberg, Germany				Book Chapter	Final		Scopus	2-s2.0-85082736690
Kim J.-H., Lee J.-K., Ahn Y.-S., Yeo J.-G., Lee J.-S., Kang G.-H., Cho C.-H.	Peeling behavior of backsheet according to surface temperature of photovoltaic module	2019	Korean Journal of Materials Research	29	11		703	708	10.3740/MRSK.2019.29.11.703	https://www.scopus.com/inward/record.uri?eid=2-s2.0-85079075356&doi=10.3740%2fMRSK.2019.29.11.703&partnerID=40&md5=d77ffbe9a34d8a3c12a1ac26c8befd51	Separation and Conversion Materials Laboratory, Korea Institute of Energy Research, Daejeon, 34129, South Korea; Photovoltaic Laboratory, Korea Institute of Energy Research, Dajeon, 34129, South Korea; Graduate School of Energy Science and Technology, Chungnam National University, Dajeon, 34134, South Korea	12250562			Article	Final	All Open Access, Hybrid Gold	Scopus	2-s2.0-85079075356
De Luca D., D'Alessandro C., De Maio D., Di Gennaro E., Musto M., Rotondo G., Russo R.	Infrared mirror coating to improve efficiency in solar thermal energy applications	2019	Optics InfoBase Conference Papers	Part F131-IPRSN 2019						https://www.scopus.com/inward/record.uri?eid=2-s2.0-85077184737&partnerID=40&md5=779dc990cfad616bd849f57d8d63cbc8	Physics Department, Università degli studi di Napoli "Federico II", Napoli, 80125, Italy; Dipartimento di Ingegneria Industriale, Università degli studi di Napoli "Federico II", Napoli, 80125, Italy; CNR-Istituto per la Microelettronica ed i Microsistemi, Via Pietro Castellino 111, Napoli, 80131, Italy		9781557528209		Conference Paper	Final		Scopus	2-s2.0-85077184737
Kaya M.	Hydrometallurgical Recovery of Critical REEs and Special Metals from WEEE	2019	Minerals, Metals and Materials Series				277	288	10.1007/978-3-030-26593-9_11	https://www.scopus.com/inward/record.uri?eid=2-s2.0-85074581655&doi=10.1007%2f978-3-030-26593-9_11&partnerID=40&md5=c1f8125f3096c6aac4ba7a9e13d6768e	Mining Engineering Department, Eskisehir Osmangazi University, Eskisehir, Turkey	23671181			Book Chapter	Final		Scopus	2-s2.0-85074581655
Stehlík M., Knapová J., Kostka V.	Possibilities of use of glass recyclate from photovoltaic panels for concrete masonry units	2019	IOP Conference Series: Materials Science and Engineering	549	1	012006			10.1088/1757-899X/549/1/012006	https://www.scopus.com/inward/record.uri?eid=2-s2.0-85068996488&doi=10.1088%2f1757-899X%2f549%2f1%2f012006&partnerID=40&md5=5a17aa349d8acdfa24362fc0ca353acb	Brno University of Technology, Faculty of Civil Engineering, Veveří 331/95, Brno, 602 00, Czech Republic	17578981			Conference Paper	Final	All Open Access, Bronze	Scopus	2-s2.0-85068996488
Chen W.S., Chen Y.J., Chen Y.A.	The application of organic solvents and thermal process for eliminating EVA resin layer from waste photovoltaic modules	2019	IOP Conference Series: Earth and Environmental Science	291	1	012012			10.1088/1755-1315/291/1/012012	https://www.scopus.com/inward/record.uri?eid=2-s2.0-85068917904&doi=10.1088%2f1755-1315%2f291%2f1%2f012012&partnerID=40&md5=26a44688a615ad3385be0c1ee4b21e94	National Cheng-Kung University, Resource Engineering, Taiwan	17551307			Conference Paper	Final	All Open Access, Bronze	Scopus	2-s2.0-85068917904

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Authors	Title	Year	Source Title	Volume	Issue	Art. No.	Page Start	Page End	DOI	Link	Affiliations	ISSN	ISBN	CODEN	Document Type	Publication Stage	Open Access	Source	EID
Wang R., Song E., Zhang C., Zhuang X., Ma E., Bai J., Yuan W., Wang J.	Pyrolysis-based separation mechanism for waste crystalline silicon photovoltaic modules by a two-stage heating treatment	2019	RSC Advances	9	32		18115	18123	10.1039/c9ra03582f	https://www.scopus.com/inward/record.uri?eid=2-s2.0-85068061571&doi=10.1039%2fc9ra03582f&partnerID=40&md5=012922740ad1d563de32e7a4f3dd0d2c	Research Center of Resource Recycling Science and Engineering, Shanghai Polytechnic University, No. 2360 Jinhai Road, Shanghai, 201209, China; Shanghai Collaborative Innovation Centre for Waste Electrical and Electronic Equipment Recycling, Shanghai Polytechnic University, No. 2360 Jinhai Road, Shanghai, 201209, China	20462069		RSCAC	Article	Final	All Open Access, Gold, Green	Scopus	2-s2.0-85068061571
Li Y., Li H., Wang G., Liu X., Zhang Q.	Study on the optimal deployment for Photovoltaic components recycle in China	2019	Energy Procedia	158			4298	4303	10.1016/j.egypro.2019.01.794	https://www.scopus.com/inward/record.uri?eid=2-s2.0-85063911737&doi=10.1016%2fj.egypro.2019.01.794&partnerID=40&md5=8de42cad5c728258036b829554c6e09c	Academy of Chinese Energy Strategy, China University of Petroleum-Beijing, Changping, Beijing, 102249, China; Mälardalen University, School of Sustainable Development of Society and Technology, Västerås, SE-721 23, Sweden	18766102			Conference Paper	Final	All Open Access, Gold	Scopus	2-s2.0-85063911737
Fouad M.M., ElSayed A.G., Shihata L.A., Kandil H.A., Morgan E.I.	Life cycle assessment for photovoltaic integrated shading system with different end of life phases	2019	International Journal of Sustainable Energy	38	9		821	830	10.1080/14786451.2019.1588272	https://www.scopus.com/inward/record.uri?eid=2-s2.0-85063084648&doi=10.1080%2f14786451.2019.1588272&partnerID=40&md5=4479a5999a49d7f74d3129f9ef43a654	Mechatronics Engineering Department, German University in Cairo, Cairo, Egypt; Design and Production Engineering Department, Ain Shams University, Cairo, Egypt; Design and Production Engineering Department, German University in Cairo, Cairo, Egypt	14786451			Article	Final		Scopus	2-s2.0-85063084648
Padoan F.C.S.M., Altimari P., Pagnanelli F.	Recycling of end of life photovoltaic panels: A chemical prospective on process development	2019	Solar Energy	177			746	761	10.1016/j.solener.2018.12.003	https://www.scopus.com/inward/record.uri?eid=2-s2.0-85057599290&doi=10.1016%2fj.solener.2018.12.003&partnerID=40&md5=89b1558a552a53c5282fcdf6900c782d	Department of Chemistry, Sapienza University of Rome, Piazzale Aldo Moro 5, Rome, 00185, Italy	0038092X		SRENA	Review	Final		Scopus	2-s2.0-85057599290
Yamagiwa M., Uehara M.	Development of eco volunteer computing system	2018	Proceedings - 2018 6th International Symposium on Computing and Networking Workshops, CANDARW 2018			8590932	387	390	10.1109/CANDARW.2018.00078	https://www.scopus.com/inward/record.uri?eid=2-s2.0-85061435648&doi=10.1109%2fCANDARW.2018.00078&partnerID=40&md5=1ca52ace46ad7b7a39c85faee4f0368e	Faculty of Education, Graduate Faculty of Interdisciplinary Research, Graduate School, University of Yamanashi, 4-4-37 Takeda, Kofu, Yamanashi, 400-8510, Japan; Department of Information Sciences and Arts, Toyo University, 2100 Kujirai, Kawagoe, Saitama, 350-8585, Japan		9781538691847		Conference Paper	Final		Scopus	2-s2.0-85061435648
Libby C., Shaw S., Heath G., Wambach K.	Photovoltaic Recycling Processes	2018	2018 IEEE 7th World Conference on Photovoltaic Energy Conversion, WCPEC 2018 - A Joint Conference of 45th IEEE PVSC, 28th PVSEC and 34th EU PVSEC			8547376	2594	2599	10.1109/PVSC.2018.8547376	https://www.scopus.com/inward/record.uri?eid=2-s2.0-85059917954&doi=10.1109%2fPVSC.2018.8547376&partnerID=40&md5=2eedabf9b5ded6d69a3200be72437f5c	Electric Power Research Institute, Palo Alto, CA 94304, United States; National Renewable Energy Laboratory, Golden, CO 80401, United States; Wambach Consulting, Aindling OT Hausen, D 86447, Germany		9781538685297		Conference Paper	Final		Scopus	2-s2.0-85059917954
Komoto K., Oyama S., Sato T., Uchida H.	Recycling of PV Modules and its Environmental Impacts	2018	2018 IEEE 7th World Conference on Photovoltaic Energy Conversion, WCPEC 2018 - A Joint Conference of 45th IEEE PVSC, 28th PVSEC and 34th EU PVSEC			8547691	2590	2593	10.1109/PVSC.2018.8547691	https://www.scopus.com/inward/record.uri?eid=2-s2.0-85059913565&doi=10.1109%2fPVSC.2018.8547691&partnerID=40&md5=0254226cd2db4331411fe3ac5509b9ec	Mizuho Information and Research Institute, Inc., Tokyo, 101-8443, Japan		9781538685297		Conference Paper	Final		Scopus	2-s2.0-85059913565
Palitzsch W., Killenberg A., Schonherr P., Loser U.	Photovoltaic Recycling with the help of Water and Light - It does not get greener	2018	2018 IEEE 7th World Conference on Photovoltaic Energy Conversion, WCPEC 2018 - A Joint Conference of 45th IEEE PVSC, 28th PVSEC and 34th EU PVSEC			8548095	2465	2466	10.1109/PVSC.2018.8548095	https://www.scopus.com/inward/record.uri?eid=2-s2.0-85059911587&doi=10.1109%2fPVSC.2018.8548095&partnerID=40&md5=637826159be4583cfc594341aa74d37b	Loser Chemie GmbH, Kopernikusstrae 38-42, Zwickau, 08056, Germany		9781538685297		Conference Paper	Final		Scopus	2-s2.0-85059911587
Gabor A.M., Lincoln J., Schneller E.J., Seigneur H., Janoch R., Anselmo A., Harwood D.W.J., Rowell M.W.	Compressive Stress Strategies for Reduction of Cracked Cell Related Degradation Rates in New Solar Panels and Power Recovery in Damaged Solar Panels	2018	2018 IEEE 7th World Conference on Photovoltaic Energy Conversion, WCPEC 2018 - A Joint Conference of 45th IEEE PVSC, 28th PVSEC and 34th EU PVSEC			8547207	2820	2825	10.1109/PVSC.2018.8547207	https://www.scopus.com/inward/record.uri?eid=2-s2.0-85059889912&doi=10.1109%2fPVSC.2018.8547207&partnerID=40&md5=5a06d876107d4520a8bdfff522e3bcf0	BrightSpot Automation LLC, Westford, MA, United States; Florida Solar Energy Center, University of Central Florida, Cocoa, FL, United States; D2Solar, San Jose, CA, United States		9781538685297		Conference Paper	Final		Scopus	2-s2.0-85059889912

Table A-3: PV Recycling Literature Review

Authors	Title	Year	Source Title	Volume	Issue	Art. No.	Page Start	Page End	DOI	Link	Affiliations	ISSN	ISBN	CODEN	Document Type	Publication Stage	Open Access	Source	EID
Einhaus R., Madon F., Degoulange J., Wambach K., Denafas J., Lorenzo F.R., Abalde S.C., Garcia T.D., Bollar A.	Recycling and Reuse potential of NICE PV-Modules	2018	2018 IEEE 7th World Conference on Photovoltaic Energy Conversion, WCPEC 2018 - A Joint Conference of 45th IEEE PVSC, 28th PVSEC and 34th EU PVSEC			8548307	561	564	10.1109/PVSC.2018.8548307	https://www.scopus.com/inward/record.uri?eid=2-s2.0-85059882889&doi=10.1109%2fPVSC.2018.8548307&partnerID=40&md5=04fbff720fcfd6fa8af25bcd68ffc4c9	Apollon Solar, Lyon, 69002, France; Bifa Umweltinstitut GmbH, Bamberg, 86167, Germany; UAB Soli Tek RD Porrino-Pontevedra, Vilnius, Lithuania, 36418, Spain; AIMEN, Laser Applications Centre, Porriño-Pontevedra, 36418, Spain; INGESEA Automation SL, Elgoibar, Spain		9781538685297		Conference Paper	Final		Scopus	2-s2.0-85059882889
Ito M., Doi T.	PV Module Recycling Solution and Module Defects in the Field	2018	2018 IEEE 7th World Conference on Photovoltaic Energy Conversion, WCPEC 2018 - A Joint Conference of 45th IEEE PVSC, 28th PVSEC and 34th EU PVSEC			8547313	709	711	10.1109/PVSC.2018.8547313	https://www.scopus.com/inward/record.uri?eid=2-s2.0-85059879505&doi=10.1109%2fPVSC.2018.8547313&partnerID=40&md5=e31b3e8262a8e58d145d9c716fd438ae	NPC Incorporated, Taito-ku, Tokyo, 1100015, Japan		9781538685297		Conference Paper	Final		Scopus	2-s2.0-85059879505
Corcelli F., Ripa M., Leccisi E., Cigolotti V., Fiandra V., Graditi G., Sannino L., Tammaro M., Ulgiati S.	Sustainable urban electricity supply chain – Indicators of material recovery and energy savings from crystalline silicon photovoltaic panels end-of-life	2018	Ecological Indicators	94			37	51	10.1016/j.ecolind.2016.03.028	https://www.scopus.com/inward/record.uri?eid=2-s2.0-84962137656&doi=10.1016%2fj.ecolind.2016.03.028&partnerID=40&md5=3d0df643d878b1003d45ff19c0d4b8ea	Department of Science and Technology, Parthenope University of Naples, Centro Direzionale – Isola C4, Naples, 80143, Italy; ENEA, Italian National Agency for New Technologies, Energy and the Environment, Portici Research Centre, P. le E. Fermi, 1, Portici, Naples, 80055, Italy; School of Environment, Beijing Normal University, 19 Xinjiekouwai St., Haidian District, Beijing, 100875, China	1470160X			Article	Final	All Open Access, Green	Scopus	2-s2.0-84962137656
Kim H., Park H.	PV waste management at the crossroads of circular economy and energy transition: The case of South Korea	2018	Sustainability (Switzerland)	10	10	3565			10.3390/su10103565	https://www.scopus.com/inward/record.uri?eid=2-s2.0-85054519504&doi=10.3390%2fsu10103565&partnerID=40&md5=a0ee6e55d4b145de7502c1b0f6177e6c	Corporate Course for Climate Change, Sejong University, Seoul, 05006, South Korea; Asian Institute for Energy, Environment and Sustainability, Seoul National University, Seoul, 08826, South Korea	20711050			Article	Final	All Open Access, Gold, Green	Scopus	2-s2.0-85054519504
Santos J.D., Alonso-García M.C.	Projection of the photovoltaic waste in Spain until 2050	2018	Journal of Cleaner Production	196			1613	1628	10.1016/j.jclepro.2018.05.252	https://www.scopus.com/inward/record.uri?eid=2-s2.0-85049345853&doi=10.1016%2fj.jclepro.2018.05.252&partnerID=40&md5=0ee10cbdd85ef64c0b5afc8183444e60	Centro de Investigaciones Energéticas Medioambientales y Tecnológicas (CIEMAT), Renewable-Energy Department, Av. Complutense 40, Madrid, 28040, Spain	09596526		JCROE	Article	Final		Scopus	2-s2.0-85049345853
Orkisz M.	Estimating Effects of Individual PV Panel Failures on PV Array Output	2018	IEEE Transactions on Industry Applications	54	5	8368292	4825	4832	10.1109/TIA.2018.2841818	https://www.scopus.com/inward/record.uri?eid=2-s2.0-85047810486&doi=10.1109%2fTIA.2018.2841818&partnerID=40&md5=90888f2565da80531430cdc27fb9e2b9	ABB Corporate Research Center, Kraków, 31-038, Poland	00939994		ITIAC	Article	Final		Scopus	2-s2.0-85047810486
Brenner W., Bednar N., Biermayr P., Adamovic N.	Standardization and Life Cycle Cost Assessment Approach in Circular Economy for Photovoltaic Waste	2018	2018 3rd International Conference on Smart and Sustainable Technologies, SpliTech 2018			8448370				https://www.scopus.com/inward/record.uri?eid=2-s2.0-85053468706&partnerID=40&md5=f3661e7f0e23130bf5a8eecc0b1231de	Technische Universität Wien, Vienna, Austria; Institute of Sensor and Actuator Systems, Austria; Institute of Energy Systems and Electrical Drives, Austria		9789532900835		Conference Paper	Final		Scopus	2-s2.0-85053468706
Lunardi M.M., Alvarez-Gaitan J.P., Bilbao J.I., Corkish R.	Comparative life cycle assessment of end-of-life silicon solar photovoltaic modules	2018	Applied Sciences (Switzerland)	8	8	1396			10.3390/app8081396	https://www.scopus.com/inward/record.uri?eid=2-s2.0-85051731524&doi=10.3390%2fapp8081396&partnerID=40&md5=c8cc5f1ada6bac1c37c34e34f14e4744	The Australian Centre for Advanced Photovoltaics (ACAP), School of Photovoltaic and Renewable Energy Engineering, University of New South Wales, Sydney, 2052, Australia; School of Civil and Environmental Engineering, University of New South Wales, Sydney, 2052, Australia	20763417			Article	Final	All Open Access, Gold, Green	Scopus	2-s2.0-85051731524
Akimoto Y., Iizuka A., Shibata E.	High-voltage pulse crushing and physical separation of polycrystalline silicon photovoltaic panels	2018	Minerals Engineering	125			1	9	10.1016/j.mineng.2018.05.015	https://www.scopus.com/inward/record.uri?eid=2-s2.0-85047440322&doi=10.1016%2fj.mineng.2018.05.015&partnerID=40&md5=207cbbd79bedd049b6e8c412241fdded	Graduate School of Environmental Studies, Tohoku University, 468-1, Aoba, Aramaki, Aoba-ku, Sendai, Miyagi 980-0845, Japan; Research Center for Sustainable Science and Engineering, Institute of Multidisciplinary Research for Advanced Materials, Tohoku University, 2-1-1, Katahira, Aoba-ku, Sendai, Miyagi 980-8577, Japan	08926875		MENGE	Article	Final		Scopus	2-s2.0-85047440322
Townsend J.H., Coroama V.C.	Digital acceleration of sustainability transition: The paradox of push impacts	2018	Sustainability (Switzerland)	10	8	2816			10.3390/su10082816	https://www.scopus.com/inward/record.uri?eid=2-s2.0-85054931760&doi=10.3390%2fsu10082816&partnerID=40&md5=bbf9930f855de94bd6d0aa30467a159c	Electronics and Computer Science (ECS), University of Southampton, Southampton, SO17 1BJ, United Kingdom; Institute for Pervasive Computing, ETH Zurich, Zurich, 8092, Switzerland	20711050			Article	Final	All Open Access, Gold, Green	Scopus	2-s2.0-85054931760
Kawashima R., Sakai T., Ota Y., Nishioka K.	Weed control and albedo improvement effects in photovoltaic installation sites using recycled white foam glass	2018	Japanese Journal of Applied Physics	57	8	08RH04			10.7567/JJAP.57.08RH04	https://www.scopus.com/inward/record.uri?eid=2-s2.0-85050966149&doi=10.7567%2fJJAP.57.08RH04&partnerID=40&md5=9ce6f07217a8630ca1108a2a3bf11cf7	Faculty of Engineering, University of Miyazaki, Miyazaki, 889-2192, Japan; Organization for Promotion of Tenure Track, University of Miyazaki, Miyazaki, 889-2192, Japan	00214922			Article	Final		Scopus	2-s2.0-85050966149

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Eskew J., Ratledge M., Wallace M., Gheewala S.H., Rakkwamsuk P.	An environmental Life Cycle Assessment of rooftop solar in Bangkok, Thailand	2018	Renewable Energy	123			781	792	10.1016/j.renene.2018.02.045	https://www.scopus.com/inward/record.uri?eid=2-s2.0-85042863277&doi=10.1016%2fj.renene.2018.02.045&partnerID=40&md5=9f6c1d19655ac30307bfa9fac0feafd7	Institute for the Environment, University of North Carolina, Chapel Hill, NC 27599, United States; The Joint Graduate School for Energy and the Environment, King Mongkut's University of Technology Thonburi, Thailand; The School of Energy, Environment and Materials, King Mongkut's University of Technology Thonburi, Thailand; Center of Excellence on Energy Technology and Environment, PERDO, Bangkok, Thailand; Department of Environmental Sciences and Engineering, Gillings School of Global Public Health, University of North Carolina, Chapel Hill, NC 27514, United States	09601481			Article	Final		Scopus	2-s2.0-85042863277
Hachichi K., Lami A., Zemmouri H., Cuellar P., Soni R., Ait-Amar H., Drouiche N.	Silicon Recovery from Kerf Slurry Waste: a Review of Current Status and Perspective	2018	Silicon	10	4		1579	1589	10.1007/s12633-017-9642-x	https://www.scopus.com/inward/record.uri?eid=2-s2.0-85038104290&doi=10.1007%2fs12633-017-9642-x&partnerID=40&md5=befc3d781ccf4c2d4464edafaa52bdc4	Laboratoire des Sciences du Génie des Procédés Industriels, USTHB, BP 32 El Alia, Bab Ezzouar, Algiers, 16111, Algeria; Centre de Recherche en Technologie des Semi-conducteurs pour l'Energétique (CRTSE), 2, Bd Dr. Frantz Fanon P.O. Box 140, Algiers-7 merveilles, Algiers, 16038, Algeria; ManEngenius, Hoofddorp, Netherlands; School of Engineering, Indian Institute of Technology-Mandi, Mandi, India	1876990X			Article	Final		Scopus	2-s2.0-85038104290
Dias P., Schmidt L., Gomes L.B., Bettanin A., Veit H., Bernardes A.M.	Recycling Waste Crystalline Silicon Photovoltaic Modules by Electrostatic Separation	2018	Journal of Sustainable Metallurgy	4	2		176	186	10.1007/s40831-018-0173-5	https://www.scopus.com/inward/record.uri?eid=2-s2.0-85064151940&doi=10.1007%2fs40831-018-0173-5&partnerID=40&md5=86dac08462e51a3e953f4b7e69252dd4	Programa de Pós-Graduação em Engenharia de Minas, Metalúrgica e de Materiais (PPGE3M), Universidade Federal do Rio Grande do Sul (UFRGS), Av. Bento Gonçalves, 9500, Porto Alegre, RS 91509-900, Brazil; Faculty of Science and Engineering, Macquarie University, Sydney, NSW 2109, Australia; X-Ray Diffraction Laboratory, Geosciences Institute, Federal University of Rio Grande do Sul (UFRGS), Av. Bento Gonçalves, 9500 - Prédio 43126 - Sala 211, Caixa Postal 15001, Porto Alegre, RS 91501-970, Brazil	21993823			Article	Final		Scopus	2-s2.0-85064151940
Perez-Gallardo J.R., Azzaro-Pantel C., Astier S.	Combining Multi-Objective Optimization, Principal Component Analysis and Multiple Criteria Decision Making for ecodesign of photovoltaic grid-connected systems	2018	Sustainable Energy Technologies and Assessments	27			94	101	10.1016/j.seta.2018.03.008	https://www.scopus.com/inward/record.uri?eid=2-s2.0-85044753456&doi=10.1016%2fj.seta.2018.03.008&partnerID=40&md5=1b9ea7278d8fd52b24857c3ba2f2adc3	Laboratoire de Génie Chimique, Université de Toulouse, CNRS, Toulouse, France; LAPLACE, Université de Toulouse, CNRS, Toulouse, France; CONACYT-Centro de Investigación en Matemáticas, A.C., Unidad Aguascalientes, Fray Bartolomé de las Casas 314, Col. La Estación, Aguascalientes, 20259, Mexico	22131388			Article	Final	All Open Access, Green	Scopus	2-s2.0-85044753456
Marchetti B., Corvaro F., Giacchetta G., Polonara F., Cocci Grifoni R., Leporini M.	Double Green Process: a low environmental impact method for recycling of CdTe, a-Si and CIS/CIGS thin-film photovoltaic modules	2018	International Journal of Sustainable Engineering	11	3		173	185	10.1080/19397038.2018.1424963	https://www.scopus.com/inward/record.uri?eid=2-s2.0-85041909108&doi=10.1080%2f19397038.2018.1424963&partnerID=40&md5=9fc311c79a25c8f7234fcca0f02b59a7	Facoltà di Ingegneria, Università degli Studi eCampus, Novedrate, Italy; Dipartimento di Ingegneria Industriale e Scienze Matematiche, Universita' Politecnica delle Marche, Ancona, Italy; Dipartimento di Ingegneria Industriale, Università Politecnica delle Marche, Ancona, Italy; Scuola di Architettura e Design, UNICAM Università degli Studi di Camerino, Camerino, Italy	19397038			Article	Final		Scopus	2-s2.0-85041909108
Ilias A.V., Meletios R.G., Yiannis K.A., Nikolaos B.	Integration & assessment of recycling into c-Si photovoltaic module's life cycle	2018	International Journal of Sustainable Engineering	11	3		186	195	10.1080/19397038.2018.1428833	https://www.scopus.com/inward/record.uri?eid=2-s2.0-85041365670&doi=10.1080%2f19397038.2018.1428833&partnerID=40&md5=30d13b4e566f9bc5e1d38c5c18e7bb04	School of Production Engineering and Management, Technical University of Crete, University Campus, Chania, Greece	19397038			Article	Final		Scopus	2-s2.0-85041365670
Jimenez-Millan J., Abad I., Jimenez-Espinosa R., Yebra-Rodriguez A.	Assessment of solar panel waste glass in the manufacture of sepiolite based clay bricks	2018	Materials Letters	218			346	348	10.1016/j.matlet.2018.02.049	https://www.scopus.com/inward/record.uri?eid=2-s2.0-85042233628&doi=10.1016%2fj.matlet.2018.02.049&partnerID=40&md5=907af742021daeef37ff3353d52136c2	Department of Geology and CEACTierraUniversity of Jaen, Campus Las Lagunillas s/n, Jaen, 23071, Spain	0167577X		MLETD	Article	Final		Scopus	2-s2.0-85042233628
Xu Y., Li J., Tan Q., Peters A.L., Yang C.	Global status of recycling waste solar panels: A review	2018	Waste Management	75			450	458	10.1016/j.wasman.2018.01.036	https://www.scopus.com/inward/record.uri?eid=2-s2.0-85042150920&doi=10.1016%2fj.wasman.2018.01.036&partnerID=40&md5=f96f0961b4ef8d16c00a805a588c64dd	State Key Joint Laboratory of Environment Simulation and Pollution Control, School of Environment, Tsinghua University, Beijing, 100084, China; Room 825, Sino-Italian Environmental and Energy-efficient Building, School of Environment, Tsinghua University, Haidian District, Beijing, 100084, China	0956053X		WAMAE	Review	Final		Scopus	2-s2.0-85042150920
Lee J.-K., Lee J.-S., Ahn Y.-S., Kang G.-H., Song H.-E., Kang M.-G., Kim Y.-H., Cho C.-H.	Simple pretreatment processes for successful reclamation and remanufacturing of crystalline silicon solar cells	2018	Progress in Photovoltaics: Research and Applications	26	3		179	187	10.1002/pip.2963	https://www.scopus.com/inward/record.uri?eid=2-s2.0-85041582961&doi=10.1002%2fpip.2963&partnerID=40&md5=1b87da1e47c99babfe92c37c936daee3	Separation and Conversion Materials Laboratory, Korea Institute of Energy Research, Daejeon, 305-343, South Korea; Photovoltaic Laboratory, Korea Institute of Energy Research, Daejeon, 305-343, South Korea; DRAM Process Architecture Team, Samsung Electronics, Hwaseong, 18448, South Korea; Graduate School of Energy Science and Technology, Chungnam National University, Daejeon, 305-764, South Korea	10627995		PPHOE	Article	Final		Scopus	2-s2.0-85041582961
Kuczyńska-Łażewska A., Klugmann-Radziemska E., Sobczak Z., Klimczuk T.	Recovery of silver metallization from damaged silicon cells	2018	Solar Energy Materials and Solar Cells	176			190	195	10.1016/j.solmat.2017.12.004	https://www.scopus.com/inward/record.uri?eid=2-s2.0-85037537702&doi=10.1016%2fj.solmat.2017.12.004&partnerID=40&md5=1e6bd63b3961a586b18c61b13464f949	Gdansk University of Technology, Faculty of Chemistry, Poland; Gdansk University of Technology, Faculty of Applied Physics and Mathematics, ul. Narutowicza 11/12, Gdansk, PL-80-233, Poland	09270248		SEMCE	Article	Final		Scopus	2-s2.0-85037537702

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Sica D., Malandrino O., Supino S., Testa M., Lucchetti M.C.	Management of end-of-life photovoltaic panels as a step towards a circular economy	2018	Renewable and Sustainable Energy Reviews	82			2934	2945	10.1016/j.rser.2017.10.039	https://www.scopus.com/inward/record.uri?eid=2-s2.0-85033230568&doi=10.1016%2fj.rser.2017.10.039&partnerID=40&md5=9c68c75ae433c85d01ba56634b83f991	Department of Business Sciences–Management & Innovation Systems (DISA-MIS), University of Salerno, Italy; Department of Human Science and Promotion of the Quality of Life, San Raffaele University, Rome, Italy; Department of Business Studies, University of Roma Tre, Italy	13640321		RSERF	Review	Final		Scopus	2-s2.0-85033230568
Townsend J.H.	Ict for sustainability beyond efficiency: Pushing cleantech and the circular economy	2018	EPiC Series in Computing	52			332	349	10.29007/s8s3	https://www.scopus.com/inward/record.uri?eid=2-s2.0-85120172325&doi=10.29007%2fs8s3&partnerID=40&md5=30bffb1a69f86f713623d7f749a341b9	ECS, University of Southampton, United Kingdom	23987340			Conference Paper	Final	All Open Access, Bronze, Green	Scopus	2-s2.0-85120172325
Stephen O., Okonkwo E., Ogbonna J.	Completing the value chain for plastic recyclers in Nigeria: An integration of renewable solar and conventional gas energy sources for fuel production	2018	Society of Petroleum Engineers - SPE Nigeria Annual International Conference and Exhibition 2018, NAIC 2018						10.2118/193436-ms	https://www.scopus.com/inward/record.uri?eid=2-s2.0-85086687331&doi=10.2118%2f193436-ms&partnerID=40&md5=14789288d1388ebd2ce239a2696b0cd7	World Bank African Center for Excellence, University of Port Harcourt, Nigeria		9781613996140		Conference Paper	Final		Scopus	2-s2.0-85086687331
Fu Sze Wai R., Chi-Wing T., Chu Kar-Kit G., Tin-Chi P., Wai-Fong W., Wai-Choi W.	Prediction of future materials, maintenance and waste recovery costs on photovoltaics solar panels	2018	IET Conference Publications	2018	CP757				10.1049/cp.2018.1826	https://www.scopus.com/inward/record.uri?eid=2-s2.0-85081655319&doi=10.1049%2fcp.2018.1826&partnerID=40&md5=2607ebc83855873cab2631823f07b7c6	Faculty of Science and Technology, Technological and Higher Education Institute of Hong Kong, Hong Kong, Hong Kong; Faculty of Science and Technology, University of Macau, Macau				Conference Paper	Final		Scopus	2-s2.0-85081655319
Pestalozzi F., Eisert S., Woidasky J.	Benchmark comparison of high voltage discharge separation of photovoltaic modules by electrohydraulic and electrodynamic fragmentation	2018	Recycling	3	2	13			10.3390/recycling3020013	https://www.scopus.com/inward/record.uri?eid=2-s2.0-85074240228&doi=10.3390%2frecycling3020013&partnerID=40&md5=d92924490c40d616061f0d05a5752120	Pforzheim University of Applied Sciences, School of Engineering, Pforzheim, Baden-Württemberg 75175, Germany; ImpulsTec GmbH, Dresden, Sachsen 01129, Germany	23134321			Article	Final	All Open Access, Gold, Green	Scopus	2-s2.0-85074240228
Grassi A., Delogu M., Baldanzini N., Berzi L., Pierini M.	Structural analysis of a mobile device for the End-of-Life treatment of photovoltaic panels	2018	Procedia Structural Integrity	8			594	603	10.1016/j.prostr.2017.12.058	https://www.scopus.com/inward/record.uri?eid=2-s2.0-85064657622&doi=10.1016%2fj.prostr.2017.12.058&partnerID=40&md5=46f09246165378f051ab44019f8e81e8	Department of Industrial Engineering, University of Florence, Via di S.Marta 3, Firenze, 50139, Italy	24523216			Conference Paper	Final	All Open Access, Gold, Green	Scopus	2-s2.0-85064657622
Briones R., Aguilar F., Rodríguez Á., Calderón V., Montero E.	Study of the impact on energy demand due to the use of new opaque panels with recycled additives on curtain walls on an office building	2018	ECOS 2018 - Proceedings of the 31st International Conference on Efficiency, Cost, Optimization, Simulation and Environmental Impact of Energy Systems							https://www.scopus.com/inward/record.uri?eid=2-s2.0-85064147826&partnerID=40&md5=58a670ad64a1b89e42572a3cbf08e7f8	University of Burgos, Burgos, Spain; University of Burgos, Burgos, Spain; University of Burgos, Burgos, Spain; University of Burgos, Burgos, Spain; University of Burgos, Burgos, Spain		9789729959646		Conference Paper	Final		Scopus	2-s2.0-85064147826
Pecorino F., Rametta S., Sapiente D., Squillaci C., Matarazzo A., Donato A.	Ecodesign applied to real estate market: Cost benefits analisys	2018	Procedia Environmental Science, Engineering and Management	5	4		167	174		https://www.scopus.com/inward/record.uri?eid=2-s2.0-85063035811&partnerID=40&md5=8a2c5be67f7d84fa259c2b70c41f76e7	Università di Catania, Dipartimento di Economia e Impresa, Corso Italia 55, Catania, 95129, Italy; EcoHouse Immobiliare, Via Garibaldi 88, Adrano (CT), 95031, Italy	23929537			Article	Final		Scopus	2-s2.0-85063035811
Lee J.-S., Ahn Y.-S., Kang G.-H., Ahn S.-H., Wang J.-P.	Development of new device and process to recover valuable materials from spent solar module	2018	Key Engineering Materials	780 KEM			48	56	10.4028/www.scientific.net/KEM.780.48	https://www.scopus.com/inward/record.uri?eid=2-s2.0-85054816861&doi=10.4028%2fwww.scientific.net%2fKEM.780.48&partnerID=40&md5=8997ba5803bab0417069282130ddee1b	Advanced Materials and Devices Laboratory, Korea Institute of Energy Research, Daejeon, 34129, South Korea; Photovoltaic Laboratory, Korea Institute of Energy Research, Daejeon, 34129, South Korea; Department of Metallurgical Engineering, Pukyong National University, Busan, 48547, South Korea	10139826	9783035713558	KEMAE	Conference Paper	Final		Scopus	2-s2.0-85054816861
Bracquene E., Peeters J.R., Dewulf W., Duflou J.R.	Taking Evolution into Account in a Parametric LCA Model for PV Panels	2018	Procedia CIRP	69			389	394	10.1016/j.procir.2017.11.103	https://www.scopus.com/inward/record.uri?eid=2-s2.0-85047096739&doi=10.1016%2fj.procir.2017.11.103&partnerID=40&md5=5017cafcf3118d2278a5181a671c4025	KU Leuven, Mechanical Engineering Department, Celestijnenlaan 300, Heverlee, 3001, Belgium	22128271			Conference Paper	Final	All Open Access, Gold, Green	Scopus	2-s2.0-85047096739
Duflou J.R., Peeters J.R., Altamirano D., Bracquene E., Dewulf W.	Demanufacturing photovoltaic panels: Comparison of end-of-life treatment strategies for improved resource recovery	2018	CIRP Annals	67	1		29	32	10.1016/j.cirp.2018.04.053	https://www.scopus.com/inward/record.uri?eid=2-s2.0-85046371088&doi=10.1016%2fj.cirp.2018.04.053&partnerID=40&md5=30171d5f472a5e562aa63005847a1a9d	KU Leuven, Department of Mechanical Engineering, Celestijnenlaan 300A, Heverlee, B-3001, Belgium	00078506		CIRAA	Article	Final		Scopus	2-s2.0-85046371088
Prado P.F.A., Tenório J.A.S., Espinosa D.C.R.	Leaching of indium from ITO present in amorphous silicon photovoltaic modules	2018	Minerals, Metals and Materials Series	Part F6			495	500	10.1007/978-3-319-72362-4_46	https://www.scopus.com/inward/record.uri?eid=2-s2.0-85042311816&doi=10.1007%2f978-3-319-72362-4_46&partnerID=40&md5=d0e3d073e8ca070ad1659626e89c68a5	LAREX—Department of Chemical Engineering, University of Sao Paulo, Rua do Lago, 250, 2nd Floor, Sao Paulo, 05508-080, Brazil	23671181	9783319723617		Conference Paper	Final		Scopus	2-s2.0-85042311816
Smith Y.R., Bogust P.	Review of solar silicon recycling	2018	Minerals, Metals and Materials Series	Part F6			463	470	10.1007/978-3-319-72362-4_42	https://www.scopus.com/inward/record.uri?eid=2-s2.0-85042270717&doi=10.1007%2f978-3-319-72362-4_42&partnerID=40&md5=7afa604e594e6adea70b455b144b8474	Metallurgical Engineering Department, University of Utah, Salt Lake City, UT, United States	23671181	9783319723617		Conference Paper	Final		Scopus	2-s2.0-85042270717

Table A-3: PV Recycling Literature Review

Authors	Title	Year	Source Title	Volume	Issue	Art. No.	Page Start	Page End	DOI	Link	Affiliations	ISSN	ISBN	CODEN	Document Type	Publication Stage	Open Access	Source	EID
Skripkiūnas G., Vasarevičius S., Danila V.	Immobilization of copper indium selenide solar module waste in concrete constructions	2018	Cement and Concrete Composites	85			174	182	10.1016/j.cemconcomp.2017.10.009	https://www.scopus.com/inward/record.uri?eid=2-s2.0-85032961269&doi=10.1016%2fj.cemconcomp.2017.10.009&partnerID=40&md5=fd17a0263a3bbe7bd25c8ce21f3cf4ba	Department of Building Materials, Vilnius Gediminas Technical University, Sauletekis avenue 11, Vilnius, LT-10223, Lithuania; Department of Environmental Protection, Vilnius Gediminas Technical University, Sauletekis avenue 11, Vilnius, LT-10223, Lithuania	09589465		CCOCE	Article	Final		Scopus	2-s2.0-85032961269
Perez-Gallardo J.R., Azzaro-Pantel C., Astier S.	A Multi-objective Framework for Assessment of Recycling Strategies for Photovoltaic Modules based on Life Cycle Assessment	2018	Waste and Biomass Valorization	9	1		147	159	10.1007/s12649-017-9878-0	https://www.scopus.com/inward/record.uri?eid=2-s2.0-85017169081&doi=10.1007%2fs12649-017-9878-0&partnerID=40&md5=37537b921b52c9df8aae81cbbb6c2edf	Laboratoire de Génie Chimique, Université de Toulouse, CNRS, INPT, UPS, 4 Allée Emile Monso, Toulouse, 31432, France; Université de Toulouse, INP, ENSEEIHT, LAPLACE (Laboratoire PLAsma et Conversion d'Energie), UMR CNRS 5213, 2 Rue Charles Camichel, BP 7122, Toulouse Cedex 7, 31071, France	18772641			Article	Final	All Open Access, Green	Scopus	2-s2.0-85017169081
Domínguez A., Geyer R.	Photovoltaic waste assessment in Mexico	2017	Resources, Conservation and Recycling	127			29	41	10.1016/j.resconrec.2017.08.013	https://www.scopus.com/inward/record.uri?eid=2-s2.0-85028420985&doi=10.1016%2fj.resconrec.2017.08.013&partnerID=40&md5=e8371080a684ec0471c17609e78ca600	Bren School of Environmental Science and Management, University of California at Santa Barbara, Santa Barbara, CA 93106, United States	09213449		RCREE	Article	Final		Scopus	2-s2.0-85028420985
Uppal B., Tamboli A., Wubhayavedantapuram N.	Sustainable recycling technologies for Solar PV off-grid system	2017	E3S Web of Conferences	23		01003			10.1051/e3sconf/20172301003	https://www.scopus.com/inward/record.uri?eid=2-s2.0-85036613558&doi=10.1051%2fe3sconf%2f20172301003&partnerID=40&md5=155edca8ab1976d59463f8fd5951b126	Global Production Engineering, Technical University Berlin, Department Assembly Technology and Factory Management, Pascalstr. 8-9, Berlin, D-10587, Germany	22671242			Conference Paper	Final	All Open Access, Gold, Green	Scopus	2-s2.0-85036613558
Yuasa K., Tsurusaki T., Yamasaki S.	Environmental load reduction effect by recycling used photovoltaic generation panel glass	2017	Journal of Environmental Engineering (Japan)	82	741		949	955	10.3130/aije.82.949	https://www.scopus.com/inward/record.uri?eid=2-s2.0-85037171987&doi=10.3130%2faije.82.949&partnerID=40&md5=2a225abf806b5650b393bd7ae58b1a58	School of Environment and Society, Tokyo Institute of Technology, Japan; Graduate School of Science and Engineering, Tokyo Institute of Technology, Jyukankyo Research Institute Inc., Japan; Graduate School of Science and Engineering, Tokyo Institute of Technology, Takenaka Corporation, Japan	13480685			Article	Final	All Open Access, Bronze	Scopus	2-s2.0-85037171987
Corcelli F., Ripa M., Ulgiati S.	End-of-life treatment of crystalline silicon photovoltaic panels. An emergy-based case study	2017	Journal of Cleaner Production	161			1129	1142	10.1016/j.jclepro.2017.05.031	https://www.scopus.com/inward/record.uri?eid=2-s2.0-85019920391&doi=10.1016%2fj.jclepro.2017.05.031&partnerID=40&md5=ab9e272d643ca2c5b6faf3e5e578955d	Department of Science and Technology, Parthenope University of Naples, Centro Direzionale - Isola C4, Naples, 80143, Italy; Institute of Environmental Science and Technology (ICTA), Autonomous University of Barcelona, Bellaterra, 08193, Spain; School of Environment, Beijing Normal University, 19 Xinjiekouwai St., Haidian District, Beijing, 100875, China	09596526		JCROE	Article	Final		Scopus	2-s2.0-85019920391
Kadro J.M., Hagfeldt A.	The End-of-Life of Perovskite PV	2017	Joule	1	1		29	46	10.1016/j.joule.2017.07.013	https://www.scopus.com/inward/record.uri?eid=2-s2.0-85032970831&doi=10.1016%2fj.joule.2017.07.013&partnerID=40&md5=3bdf433cacea79914f5b72f6404e0a19	Laboratoire des sciences photomoléculaires, Institut des sciences et ingénierie chimiques-Ecole Polytechnique Fédérale de Lausanne, LSPM-SB-ISIC-EPFL, Station 6, Lausanne, 1015, Switzerland	25424351			Review	Final	All Open Access, Bronze	Scopus	2-s2.0-85032970831
Lee J.-S., Ahn Y.-S., Kang G.-H., Wang J.-P.	Recovery of Pb-Sn Alloy and Copper from Photovoltaic Ribbon in Spent Solar Module	2017	Applied Surface Science	415			137	142	10.1016/j.apsusc.2017.02.072	https://www.scopus.com/inward/record.uri?eid=2-s2.0-85013074496&doi=10.1016%2fj.apsusc.2017.02.072&partnerID=40&md5=857e38acdf15d4990807d028f2c7dbe7	Advanced Materials and Devices Laboratory, Korea Institute of Energy Research, Daejeon, 305-343, South Korea; Photovoltaic Laboratory, Korea Institute of Energy Research, Daejeon, 305-343, South Korea; Department of Metallurgical Engineering, Pukyong National University, Busan, 608-739, South Korea	01694332		ASUSE	Article	Final		Scopus	2-s2.0-85013074496
Zhang Z.-S., Cui Z., Yang J., Yue Z.-W., Wei Y.-S.	Optimization of electrostatic separation of Si and PET in waste solar panels	2017	Zhongguo Huanjing Kexue/China Environmental Science	37	8		3048	3055		https://www.scopus.com/inward/record.uri?eid=2-s2.0-85034742432&partnerID=40&md5=602dd73cc2fd7be523b870dd5fe7faef	Institute of Static Electricity, School of Physical Science and Technology, Hebei University, Baoding, 071002, China	10006923		ZHKEE	Article	Final		Scopus	2-s2.0-85034742432
A. dos Reis Benatto G., Espinosa N., Krebs F.C.	Life-Cycle Assessment of Solar Charger with Integrated Organic Photovoltaics	2017	Advanced Engineering Materials	19	8	1700124			10.1002/adem.201700124	https://www.scopus.com/inward/record.uri?eid=2-s2.0-85020878062&doi=10.1002%2fadem.201700124&partnerID=40&md5=79837914f3eaf065fd6c2d38b770d4b6	Department of Energy Conversion and Storage, Technical University of Denmark, Frederiksborgvej 399, Roskilde, DK-4000, Denmark	14381656			Article	Final		Scopus	2-s2.0-85020878062
Brenner W., Adamovic N.	A circular economy for Photovoltaic waste - The vision of the European project CABRISS	2017	2017 40th International Convention on Information and Communication Technology, Electronics and Microelectronics, MIPRO 2017 - Proceedings			7973407	146	151	10.23919/MIPRO.2017.7973407	https://www.scopus.com/inward/record.uri?eid=2-s2.0-85027710747&doi=10.23919%2fMIPRO.2017.7973407&partnerID=40&md5=db24e9d34a060006b68fa3d016c6e756	TU Wien, Institute of Sensor and Actuator Systems, Vienna, Austria		9789532330922		Conference Paper	Final		Scopus	2-s2.0-85027710747
Nanno I., Ahmed T., Takamori M.	Advanced photovoltaic MPPT control method using an electromagnetic relay for solving the partial shade problem	2017	Proceedings of the International Conference on Power Electronics and Drive Systems	2017-December			136	141	10.1109/PEDS.2017.8289217	https://www.scopus.com/inward/record.uri?eid=2-s2.0-85045261467&doi=10.1109%2fPEDS.2017.8289217&partnerID=40&md5=fac9b39ad9366f0fd5a47dab09212605	National Institute of Technology, Ube College, Japan; Electrical Engineering Department, Assiut University, Egypt	21645256	9781509023646	85RTA	Conference Paper	Final		Scopus	2-s2.0-85045261467
Kopacek P., Kopacek B.	Economy of Disassembly	2017	IFAC-PapersOnLine	50	1		5161	5165	10.1016/j.ifacol.2017.08.787	https://www.scopus.com/inward/record.uri?eid=2-s2.0-85031786769&doi=10.1016%2fj.ifacol.2017.08.787&partnerID=40&md5=993a3d2ab2b23713c73eda80f76d42c5	Institute for Handling Devices and Robotics, TU Wien, Favoritenstrasse 9, Vienna, A - 1040, Austria; Austrian Society for Systems Engineering and Automation (SAT), Beckmanngasse 51/28, Vienna, A-1140, Austria	24058963			Conference Paper	Final	All Open Access, Bronze	Scopus	2-s2.0-85031786769

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Yamagiwa M., Uehara M.	Energy-aware volunteer computing using solar photovoltaics and older models of single board computers	2017	Proceedings - 31st IEEE International Conference on Advanced Information Networking and Applications Workshops, WAINA 2017			7929716	427	432	10.1109/WAINA.2017.25	https://www.scopus.com/inward/record.uri?eid=2-s2.0-85021406850&doi=10.1109%2fWAINA.2017.25&partnerID=40&md5=658d394857e3266bbea1de6f672f4768	Faculty of Education, Graduate Faculty of Interdisciplinary Research, Graduate School, University of Yamanashi, 4-4-37 Takeda, Kofu, Yamanashi, 400-8510, Japan; Department of Information Sciences and Arts, Toyo University, 2100 Kujirai, Kawagoe, Saitama, 350-8585, Japan		9781509062300		Conference Paper	Final		Scopus	2-s2.0-85021406850
Zhang Z., Sun B., Yang J., Wei Y., He S.	Electrostatic separation for recycling silver, silicon and polyethylene terephthalate from waste photovoltaic cells	2017	Modern Physics Letters B	31	11	1750087			10.1142/S0217984917500877	https://www.scopus.com/inward/record.uri?eid=2-s2.0-85017479976&doi=10.1142%2fS0217984917500877&partnerID=40&md5=8b8f9b22666b3d75aef8e52135c4d3f7	College of Physics Science and Technology, HeBei University, Baoding, 071002, China	02179849		MPLBE	Article	Final		Scopus	2-s2.0-85017479976
[No author name available]	Erratum to: Targeting fluorescent lamp waste for the recovery of cerium, lanthanum, europium, gadolinium, terbium and yttrium (Mineral Processing and Extractive Metallurgy, (2016), 125, 4, (199-203), 10.1080/03719553.2016.1181398)	2017	Transactions of the Institutions of Mining and Metallurgy, Section C: Mineral Processing and Extractive Metallurgy	126	1-2		124		10.1080/03719553.2017.1280962	https://www.scopus.com/inward/record.uri?eid=2-s2.0-85013705818&doi=10.1080%2f03719553.2017.1280962&partnerID=40&md5=264ba08b13a91da3057e5d457378bca5		03719553		TMEMA	Erratum	Final	All Open Access, Bronze	Scopus	2-s2.0-85013705818
Shin J., Park J., Park N.	A method to recycle silicon wafer from end-of-life photovoltaic module and solar panels by using recycled silicon wafers	2017	Solar Energy Materials and Solar Cells	162			1	6	10.1016/j.solmat.2016.12.038	https://www.scopus.com/inward/record.uri?eid=2-s2.0-85007508311&doi=10.1016%2fj.solmat.2016.12.038&partnerID=40&md5=608a7c39611cb2bec58ba78693239f5f	Electronic Convergence Material & Device Research Center, Korea Electronic Technology Institute, #68 Yaptap-dong, Bundang-gu, Seongnam-si, Gyeonggi-do, 463-816, South Korea; School of Photovoltaic and Renewable Energy Engineering, University of New South Wales (UNSW), Sydney, NSW 2052, Australia	09270248		SEMCE	Article	Final		Scopus	2-s2.0-85007508311
Malandrino O., Sica D., Testa M., Supino S.	Policies and measures for sustainable management of solar panel end-of-life in Italy	2017	Sustainability (Switzerland)	9	4	481			10.3390/su9040481	https://www.scopus.com/inward/record.uri?eid=2-s2.0-85017338066&doi=10.3390%2fsu9040481&partnerID=40&md5=1791e461d001825f0001caaa27ec221b	Department of Business Sciences-Management and Innovation Systems (DISA-MIS), University of Salerno, Salerno, 84084, Italy; Department of Human Science and Promotion of the Quality of Life, San Raffaele University, Rome, 00166, Italy	20711050			Review	Final	All Open Access, Gold, Green	Scopus	2-s2.0-85017338066
Pa P.-S.	Environmentally friendly electrochemical recycling of indium from scrap ITO glass and PET	2017	International Journal of Advanced Manufacturing Technology	89	5-8		1295	1306	10.1007/s00170-016-9174-3	https://www.scopus.com/inward/record.uri?eid=2-s2.0-84979582222&doi=10.1007%2fs00170-016-9174-3&partnerID=40&md5=4d4c1deac7fff6251374492130c71df8	Department of Digital Content Design, Graduate School of Toy and Game Design, National Taipei University of Education, No. 134, Sec. 2, Heping E. Rd, Taipei City, 106, Taiwan	02683768		IJATE	Article	Final		Scopus	2-s2.0-84979582222
Sinha P.	Potential environmental hazards of photovoltaic panel disposal: Discussion of Tammaro et al. (2015)	2017	Journal of Hazardous Materials	323			733	734	10.1016/j.jhazmat.2016.04.021	https://www.scopus.com/inward/record.uri?eid=2-s2.0-85028255886&doi=10.1016%2fj.jhazmat.2016.04.021&partnerID=40&md5=573df6ad36baaf2d661aa1f517178b8d	First Solar, 350 W. Washington St., Suite 600, Tempe, AZ 85281, United States	03043894		JHMAD	Note	Final		Scopus	2-s2.0-85028255886
Lee J.-K., Lee J.-S., Ahn Y.-S., Kang G.-H., Song H.-E., Lee J.-I., Kang M.-G., Cho C.-H.	Photovoltaic performance of c-Si wafer reclaimed from end-of-life solar cell using various mixing ratios of HF and HNO3	2017	Solar Energy Materials and Solar Cells	160			301	306	10.1016/j.solmat.2016.10.034	https://www.scopus.com/inward/record.uri?eid=2-s2.0-84994560594&doi=10.1016%2fj.solmat.2016.10.034&partnerID=40&md5=3edf0c52ffc86e709e2bf6dc4627b58e	Advanced Materials and Devices Laboratory, Korea Institute of Energy Research, Daejeon, 305-343, South Korea; Photovoltaic Laboratory, Korea Institute of Energy Research, Daejeon, 305-343, South Korea; Graduate School of Energy Science and Technology, Chungnam National University, Daejeon, 305-764, South Korea	09270248		SEMCE	Article	Final		Scopus	2-s2.0-84994560594
Dias P., Javimczik S., Benevit M., Veit H.	Recycling WEEE: Polymer characterization and pyrolysis study for waste of crystalline silicon photovoltaic modules	2017	Waste Management	60			716	722	10.1016/j.wasman.2016.08.036	https://www.scopus.com/inward/record.uri?eid=2-s2.0-84994507699&doi=10.1016%2fj.wasman.2016.08.036&partnerID=40&md5=21ab9f6c4664c85fee2f9844a170da3e	Programa de Pós-Graduação em Engenharia de Minas, Metalúrgica e de Materiais (PPGE3M), Universidade Federal do Rio Grande do Sul (UFRGS), Av. Bento Gonçalves, 9500, Porto Alegre, RS 91509-900, Brazil	0956053X		WAMAE	Article	Final		Scopus	2-s2.0-84994507699
Johnston A., Riessner M., Luo C.	Some recent environmental pavement technologies – Fact or fiction	2017	2017 Transportation Association of Canada Conference and Exhibition, TAC 2017							https://www.scopus.com/inward/record.uri?eid=2-s2.0-85078514352&partnerID=40&md5=38e5664fbadc3a7cf280f8054aae907e	Transportation, Tetra Tech Canada				Conference Paper	Final		Scopus	2-s2.0-85078514352
Boonpramote T.	Review on polysilicon value chain for end-of-life silicon-based solar PV recycling	2017	14th International Symposium on East Asian Resources Recycling Technology, EARTH 2017							https://www.scopus.com/inward/record.uri?eid=2-s2.0-85065961257&partnerID=40&md5=1dc60c8389cbeaadc49cfcff013d6e69	Chulalongkorn University, Thailand				Conference Paper	Final		Scopus	2-s2.0-85065961257
Huang W.-H., Shin W.J., Wang L., Tao M.	Recovery of valuable and toxic metals from crystalline-Si modules	2017	2017 IEEE 44th Photovoltaic Specialist Conference, PVSC 2017				1	4	10.1109/PVSC.2017.8366856	https://www.scopus.com/inward/record.uri?eid=2-s2.0-85048507686&doi=10.1109%2fPVSC.2017.8366856&partnerID=40&md5=f25ed85be80e8afc668cb73b16e8f906	School for Engineering of Matter, Transport and Energy, Arizona State University, Tempe, AZ 85287, United States; School of Electrical, Computer and Energy Engineering, Arizona State University, Tempe, AZ 85287, United States		9781509056057		Conference Paper	Final		Scopus	2-s2.0-85048507686

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Strachala D., Hylský J., Jandová K., Vaněk J., Cingel Š.	Mechanical recycling of photovoltaic modules	2017	ECS Transactions	81	1		199	208	10.1149/08101.0199ecst	https://www.scopus.com/inward/record.uri?eid=2-s2.0-85046013577&doi=10.1149%2f08101.0199ecst&partnerID=40&md5=85ba9f77612242bc3a265a5c9076d67e	Department of Electrical and Electronic Technology, Brno University of Technology, Brno, 616 00, Czech Republic	19386737			Conference Paper	Final		Scopus	2-s2.0-85046013577
Lima F.M., Alves J.F.A., Júnior P.H.F.M., Martins F., Teixeira E.S., Do Nascimento Silva A.P., Moreira R.L., De Vasconcelos I.F., Almeida A.F.L., Freire F.N.A.	Use of SnOx:F in the recycling of silicon solar cells	2017	Materials Research	20			826	829	10.1590/1980-5373-MR-2016-0930	https://www.scopus.com/inward/record.uri?eid=2-s2.0-85046009480&doi=10.1590%2f1980-5373-MR-2016-0930&partnerID=40&md5=663ede86e8fc17717ed239697d2e7bc3	Universidade Federal do Ceará, Av. Humberto Monte s/n, Fortaleza, CE, CEP 60440-593, Brazil	15161439			Conference Paper	Final	All Open Access, Gold, Green	Scopus	2-s2.0-85046009480
Kratochvíl M., Jezerská L., Drozdová J., Zegzulka J., Landecká A., Brožová S., Drápala J.	Use of centrifugal gravity concentration for separation of cadmium telluride from photovoltaic cells	2017	METAL 2017 - 26th International Conference on Metallurgy and Materials, Conference Proceedings	2017-January			1827	1833		https://www.scopus.com/inward/record.uri?eid=2-s2.0-85043395359&partnerID=40&md5=edeed139368609f26119e061ec6dcac7	VSB - Technical University of Ostrava, Faculty of Mining and Geology, Institute of Mining Engineering and Safety, Ostrava, EU, Czech Republic; VSB - Technical University of Ostrava, ENET Centre, Bulk Solids Center, Ostrava, EU, Czech Republic; VSB - Technical University of Ostrava, Faculty of Metallurgy and Materials Engineering, Department of Nonferrous Metals, Ostrava, EU, Czech Republic		9788087294796		Conference Paper	Final		Scopus	2-s2.0-85043395359
Prado P.F.A., Tenório J.A.S., Espinosa D.C.R.	Alternative method for materials separation from crystalline silicon photovoltaic modules	2017	Minerals, Metals and Materials Series				277	282	10.1007/978-3-319-52192-3_27	https://www.scopus.com/inward/record.uri?eid=2-s2.0-85042407291&doi=10.1007%2f978-3-319-52192-3_27&partnerID=40&md5=5218185662575b9d6506b1d2c60e7491	LAREX—Department of Chemical Engineering, University of Sao Paulo, Rua Do Lago 250, 2nd Floor, Sao Paulo, 05508-080, Brazil	23671181			Book Chapter	Final		Scopus	2-s2.0-85042407291
Smith Y.R., Nagel J.R., Rajamani R.K.	Electrodynamic eddy current separation of end-of-life PV materials	2017	Minerals, Metals and Materials Series				379	386	10.1007/978-3-319-52192-3_37	https://www.scopus.com/inward/record.uri?eid=2-s2.0-85040762219&doi=10.1007%2f978-3-319-52192-3_37&partnerID=40&md5=2c512955d76d03d68e752ed6f4bb2dca	Metallurgical Engineering Department, University of Utah, Salt Lake City, UT, United States	23671181			Book Chapter	Final		Scopus	2-s2.0-85040762219
Strachala D., Hylský J., Vaněk J., Fafilek G., Jandová K.	Methods for recycling photovoltaic modules and their impact on environment and raw material extraction	2017	Acta Montanistica Slovaca	22	3		257	269		https://www.scopus.com/inward/record.uri?eid=2-s2.0-85037744159&partnerID=40&md5=299b57a0ee0f5b941bca6e34d6d0a5c9	Department of Electrotechnology, Faculty of Electrical Engineering and Communication, Brno University of Technology, Technická 10, Brno, 602 00, Czech Republic; Institute of Chemical Technologies and Analytics, University of Technology Vienna, Getreidemarkt, Wien, 91060, Austria	13351788			Article	Final		Scopus	2-s2.0-85037744159
Grabowski J., Cempa M., Całus Moszko J.	Analysis of the potential of rare earth elements in electronic waste in Poland	2017	International Multidisciplinary Scientific GeoConference Surveying Geology and Mining Ecology Management, SGEM	17	11		751	758	10.5593/sgem2017/11/S04.095	https://www.scopus.com/inward/record.uri?eid=2-s2.0-85032468871&doi=10.5593%2fsgem2017%2f11%2fS04.095&partnerID=40&md5=2247ceb923a755fb7c1bb198c5f1a041	Central Mining Institute, Poland	13142704	9786197408263		Conference Paper	Final		Scopus	2-s2.0-85032468871
Kusch S., Alsheyab M.A.T.	Waste electrical and electronic equipment (WEEE): A closer look at photovoltaic panels	2017	International Multidisciplinary Scientific GeoConference Surveying Geology and Mining Ecology Management, SGEM	17	41		317	324	10.5593/sgem2017/41/S18.041	https://www.scopus.com/inward/record.uri?eid=2-s2.0-85032449540&doi=10.5593%2fsgem2017%2f41%2fS18.041&partnerID=40&md5=11b1d70d59b85c27e2840a5b03e2a1b5	University of Padua, Italy; University of Southampton, United Kingdom; Qatar Foundation R&D - QNRF, Qatar	13142704	9786197408263		Conference Paper	Final		Scopus	2-s2.0-85032449540
Vellini M., Gambini M., Prattella V.	Environmental impacts of PV technology throughout the life cycle: Importance of the end-of-life management for Si-panels and CdTe-panels	2017	Energy	138			1099	1111	10.1016/j.energy.2017.07.031	https://www.scopus.com/inward/record.uri?eid=2-s2.0-85026761800&doi=10.1016%2fj.energy.2017.07.031&partnerID=40&md5=250c732ae3addf75e6691266266a4875	University of Rome "Tor Vergata", Via del Politecnico, 1, Rome, 00133, Italy	03605442		ENEYD	Article	Final		Scopus	2-s2.0-85026761800
McCarthy C.L., Brutchey R.L.	Solution processing of chalcogenide materials using thiol-amine "alkahest" solvent systems	2017	Chemical Communications	53	36		4888	4902	10.1039/c7cc02226c	https://www.scopus.com/inward/record.uri?eid=2-s2.0-85021637633&doi=10.1039%2fc7cc02226c&partnerID=40&md5=f90b1384052de102d4e35084424babbc	Department of Chemistry, University of Southern California, Los Angeles, CA 90089, United States	13597345		CHCOF	Article	Final		Scopus	2-s2.0-85021637633
Khaenson W., Maneewan S., Punlek C.	A comparison of the environmental impact of solar power generation using multicrystalline silicon and thin film of amorphous silicon solar cells: Case study in Thailand	2017	Journal of Ecological Engineering	18	4		1	14	10.12911/22998993/74386	https://www.scopus.com/inward/record.uri?eid=2-s2.0-85021356301&doi=10.12911%2f22998993%2f74386&partnerID=40&md5=b241215ba9d5d07f03fd500243fffedf	Department of Physics, Faculty of Science, Naresuan University, Phitsanulok, 65000, Thailand	2081139X			Article	Final	All Open Access, Gold, Green	Scopus	2-s2.0-85021356301
Ashfaq H., Hussain I., Giri A.	Comparative analysis of old, recycled and new PV modules	2017	Journal of King Saud University - Engineering Sciences	29	1		22	28	10.1016/j.jksues.2014.08.004	https://www.scopus.com/inward/record.uri?eid=2-s2.0-85021242061&doi=10.1016%2fj.jksues.2014.08.004&partnerID=40&md5=d237616e326439fb486305f42298dbe3	Department of Electrical Engineering, Jamia Millia Islamia (A Central University), New Delhi, India; Department of Electrical Engineering, Indian Institute of Technology Delhi, New Delhi, India	10183639			Article	Final	All Open Access, Gold	Scopus	2-s2.0-85021242061

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Dassisti M., Florio G., Maddalena F.	Cryogenic delamination and sustainability: Analysis of an innovative recycling process for photovoltaic crystalline modules	2017	Smart Innovation, Systems and Technologies	68			637	646	10.1007/978-3-319-57078-5_60	https://www.scopus.com/inward/record.uri?eid=2-s2.0-85018418011&doi=10.1007%2f978-3-319-57078-5_60&partnerID=40&md5=ddc3445c7e293067466bca7c624f2c9b	Dipartimento di Meccanica, Matematica e Management, Politecnico di Bari, Via E. Orabona 4, Bari, 70125, Italy; INFN, Sezione di Bari, Bari, 70126, Italy	21903018	9783319570778		Conference Paper	Final		Scopus	2-s2.0-85018418011
Choi J.-K.	A case study of sustainable manufacturing practice: End-of-life photovoltaic recycling	2017	Smart Innovation, Systems and Technologies	68			277	279	10.1007/978-3-319-57078-5_27	https://www.scopus.com/inward/record.uri?eid=2-s2.0-85018389685&doi=10.1007%2f978-3-319-57078-5_27&partnerID=40&md5=df9f5244ae62a4347c1ab5825d2a9b36	Department of Mechanical Engineering, University of Dayton, 300 College Park, Dayton, OH 45469-0238, United States	21903018	9783319570778		Conference Paper	Final		Scopus	2-s2.0-85018389685
Peeters J.R., Altamirano D., Dewulf W., Duflou J.R.	Forecasting the composition of emerging waste streams with sensitivity analysis: A case study for photovoltaic (PV) panels in Flanders	2017	Resources, Conservation and Recycling	120			14	26	10.1016/j.resconrec.2017.01.001	https://www.scopus.com/inward/record.uri?eid=2-s2.0-85009999869&doi=10.1016%2fj.resconrec.2017.01.001&partnerID=40&md5=e600f3131842de3506f73cafa73cb358	KU Leuven, Departement of Mechanical Engineering, Celestijnenlaan 300A Box 2422, Leuven, 3001, Belgium	09213449		RCREE	Article	Final		Scopus	2-s2.0-85009999869
Huang W.-H., Shin W.J., Wang L., Sun W.-C., Tao M.	Strategy and technology to recycle wafer-silicon solar modules	2017	Solar Energy	144			22	31	10.1016/j.solener.2017.01.001	https://www.scopus.com/inward/record.uri?eid=2-s2.0-85008895512&doi=10.1016%2fj.solener.2017.01.001&partnerID=40&md5=cff6feac15e28796568a6a55762078bc	School for Engineering of Matter, Transport and Energy, Arizona State University, Tempe, AZ 85287, United States; School of Electrical, Computer and Energy Engineering, Arizona State University, Tempe, AZ 85287, United States	0038092X		SRENA	Article	Final	All Open Access, Bronze	Scopus	2-s2.0-85008895512
Huang B., Zhao J., Chai J., Xue B., Zhao F., Wang X.	Environmental influence assessment of China's multi-crystalline silicon (multi-Si) photovoltaic modules considering recycling process	2017	Solar Energy	143			132	141	10.1016/j.solener.2016.12.038	https://www.scopus.com/inward/record.uri?eid=2-s2.0-85008502160&doi=10.1016%2fj.solener.2016.12.038&partnerID=40&md5=d739b219bb9d090c9b00f440d8b50e40	College of Environment and Architecture, University of Shanghai for Science and Technology, Shanghai, 200093, China; Department of Environment and Low Carbon Science, University of Shanghai for Science and Technology, Shanghai, 200093, China; Institute for Advanced Sustainability Studies (IASS), Potsdam, 14467, Germany; Key Lab of Pollution Ecology and Environmental Engineering, Institute of Applied Ecology, Chinese Academy of Science, Shenyang, 110016, China	0038092X		SRENA	Article	Final		Scopus	2-s2.0-85008502160
Pagnanelli F., Moscardini E., Granata G., Abo Atia T., Altimari P., Havlik T., Toro L.	Physical and chemical treatment of end of life panels: An integrated automatic approach viable for different photovoltaic technologies	2017	Waste Management	59			422	431	10.1016/j.wasman.2016.11.011	https://www.scopus.com/inward/record.uri?eid=2-s2.0-85006314523&doi=10.1016%2fj.wasman.2016.11.011&partnerID=40&md5=212ddc5f03ed122383de6ebc61293ed6	Department of Chemistry, Sapienza University, P.le Aldo Moro 5, Rome, 00185, Italy; Research Institute for Science and Engineering, Waseda University, Tokyo, Japan; Technical University of Kosice, Faculty of Metallurgy, Institute of Recycling Technologies, Letna 9, Kosice, 042 00, Slovakia	0956053X		WAMAE	Article	Final		Scopus	2-s2.0-85006314523
Savvilotidou V., Antoniou A., Gidarakos E.	Toxicity assessment and feasible recycling process for amorphous silicon and CIS waste photovoltaic panels	2017	Waste Management	59			394	402	10.1016/j.wasman.2016.10.003	https://www.scopus.com/inward/record.uri?eid=2-s2.0-85002062887&doi=10.1016%2fj.wasman.2016.10.003&partnerID=40&md5=eb576e5a9255ab20d3548f72e19ecf93	School of Environmental Engineering, Technical University of Crete, Politechnioupolis, Chania, 73100, Greece	0956053X		WAMAE	Article	Final		Scopus	2-s2.0-85002062887
Yang E.-H., Lee J.-K., Lee J.-S., Ahn Y.-S., Kang G.-H., Cho C.-H.	Environmentally friendly recovery of Ag from end-of-life c-Si solar cell using organic acid and its electrochemical purification	2017	Hydrometallurgy	167			129	133	10.1016/j.hydromet.2016.11.005	https://www.scopus.com/inward/record.uri?eid=2-s2.0-84997079135&doi=10.1016%2fj.hydromet.2016.11.005&partnerID=40&md5=143b25b0d1ffa0ea17a4b5fbcd3067e7	Advanced Materials and Devices Laboratory, Korea Institute of Energy Research, Daejeon, 305-343, South Korea; Photovoltaic Laboratory, Korea Institute of Energy Research, Daejeon, 305-343, South Korea; Graduate School of Energy Science and Technology, Chungnam National University, Daejeon, 305-764, South Korea	0304386X		HYDRD	Article	Final		Scopus	2-s2.0-84997079135
Nassar N.T., Wilburn D.R., Goonan T.G.	Byproduct metal requirements for U.S. wind and solar photovoltaic electricity generation up to the year 2040 under various Clean Power Plan scenarios	2016	Applied Energy	183			1209	1226	10.1016/j.apenergy.2016.08.062	https://www.scopus.com/inward/record.uri?eid=2-s2.0-84989157873&doi=10.1016%2fj.apenergy.2016.08.062&partnerID=40&md5=24607a7c041cd4d315524740a39c4e02	National Minerals Information Center, U.S. Geological Survey, United States	03062619		APEND	Article	Final		Scopus	2-s2.0-84989157873
Huang W.-H., Shin W.J., Wang L., Tao M.	Recovery of valuable and toxic metals from crystalline-Si modules	2016	Conference Record of the IEEE Photovoltaic Specialists Conference	2016-November		7750344	3602	3605	10.1109/PVSC.2016.7750344	https://www.scopus.com/inward/record.uri?eid=2-s2.0-85003485973&doi=10.1109%2fPVSC.2016.7750344&partnerID=40&md5=dbe879002bcad0ea326b6e40e7edada5	School for Engineering of Matter, Transport and Energy, United States; School of Electrical, Computer and Energy Engineering, Arizona State University, Tempe, AZ 85287, United States	01608371	9781509027248	CRCND	Conference Paper	Final		Scopus	2-s2.0-85003485973
Latunussa C.E.L., Ardente F., Blengini G.A., Mancini L.	Life Cycle Assessment of an innovative recycling process for crystalline silicon photovoltaic panels	2016	Solar Energy Materials and Solar Cells	156			101	111	10.1016/j.solmat.2016.03.020	https://www.scopus.com/inward/record.uri?eid=2-s2.0-84962656888&doi=10.1016%2fj.solmat.2016.03.020&partnerID=40&md5=754633fff5d0bf33d4ed2e12f9c24258	European Commission, Joint Research Centre (JRC), Institute for Environment and Sustainability (IES), via Enrico Fermi 2749, Ispra, VA 21027, Italy; Politecnico di Torino, Corso Duca degli Abruzzi 24, Torino, TO 10129, Italy	09270248		SEMCE	Article	Final	All Open Access, Hybrid Gold, Green	Scopus	2-s2.0-84962656888
Dias P., Javimczik S., Benevit M., Veit H., Bernardes A.M.	Recycling WEEE: Extraction and concentration of silver from waste crystalline silicon photovoltaic modules	2016	Waste Management	57			220	225	10.1016/j.wasman.2016.03.016	https://www.scopus.com/inward/record.uri?eid=2-s2.0-84960155225&doi=10.1016%2fj.wasman.2016.03.016&partnerID=40&md5=1cb8c914c8f2f92327004f6904d2579c	Programa de Pós-Graduação em Engenharia de Minas, Metalúrgica e de Materiais (PPGE3M), Universidade Federal do Rio Grande do Sul (UFRGS), Av. Bento Gonçalves, 9500, Porto Alegre, RS 91509-900, Brazil	0956053X		WAMAE	Article	Final		Scopus	2-s2.0-84960155225
Vasarevičius S., Skripkiūnas G., Danila V.	Experimental research into leaching of metals from immobilized CIS solar module waste	2016	Journal of Environmental Engineering and Landscape Management	24	4		269	277	10.3846/16486897.2016.1198262	https://www.scopus.com/inward/record.uri?eid=2-s2.0-84982273315&doi=10.3846%2f16486897.2016.1198262&partnerID=40&md5=883c8ac1db9c7e7a51010883788a3371	Department of Environmental Protection, Faculty of Environmental Engineering, Vilnius Gediminas Technical University, Saulėtekio al. 11, Vilnius, LT-10223, Lithuania; Department of Building Materials, Faculty of Civil Engineering, Vilnius Gediminas Technical University, Saulėtekio al. 11, Vilnius, LT-10223, Lithuania	16486897			Article	Final	All Open Access, Gold	Scopus	2-s2.0-84982273315

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Pagnanelli F., Moscardini E., Abo Atia T., Toro L.	Photovoltaic panel recycling: from type-selective processes to flexible apparatus for simultaneous treatment of different types	2016	Transactions of the Institutions of Mining and Metallurgy, Section C: Mineral Processing and Extractive Metallurgy	125	4		221	227	10.1080/03719553.2016.1200764	https://www.scopus.com/inward/record.uri?eid=2-s2.0-84979690528&doi=10.1080%2f03719553.2016.1200764&partnerID=40&md5=86fe190d5b33849583bcb6888da8208f	Department of Chemistry, Sapienza University of Rome, P.le Aldo Moro 5, Rome, 00185, Italy	03719553		TMEMA	Article	Final		Scopus	2-s2.0-84979690528
Zhang L., Xu Z.	Separating and recycling plastic, glass, and gallium from waste solar cell modules by nitrogen pyrolysis and vacuum decomposition	2016	Environmental Science and Technology	50	17		9242	9250	10.1021/acs.est.6b01253	https://www.scopus.com/inward/record.uri?eid=2-s2.0-84985946779&doi=10.1021%2facs.est.6b01253&partnerID=40&md5=bf192ef3ecf1e2b1b27b11c34e2fac31	School of Environmental Science and Engineering, Shanghai Jiao Tong University, 800 Dongchuan Road, Shanghai, 200240, China	0013936X		ESTHA	Article	Final		Scopus	2-s2.0-84985946779
Lee J.-S., Ahn Y.-S., Kang G.-H., Wang J.-P.	Recovery of 4N-grade copper from photovoltaic ribbon in spent solar module	2016	Materials Technology	31	10		574	579	10.1080/10667857.2016.1147139	https://www.scopus.com/inward/record.uri?eid=2-s2.0-84978476677&doi=10.1080%2f10667857.2016.1147139&partnerID=40&md5=7c0014288247b7bd5161c64755ddc818	Advanced Materials and Devices Laboratory, Korea Institute of Energy Research (KIER), Daejeon, 305-343, South Korea; Photovoltaic Laboratory, Korea Institute of Energy Research (KIER), Daejeon, 305-343, South Korea; Department of Metallurgical Engineering, Pukyong National University (PKNU), Busan, 608-739, South Korea	10667857		MATTE	Article	Final		Scopus	2-s2.0-84978476677
Jung B., Park J., Seo D., Park N.	Sustainable System for Raw-Metal Recovery from Crystalline Silicon Solar Panels: From Noble-Metal Extraction to Lead Removal	2016	ACS Sustainable Chemistry and Engineering	4	8		4079	4083	10.1021/acssuschemeng.6b00894	https://www.scopus.com/inward/record.uri?eid=2-s2.0-84979966789&doi=10.1021%2facssuschemeng.6b00894&partnerID=40&md5=05074bdc8371ab5a56da643fca824c2b	DSM CO. LTD, 251, Jimun-ro, Wongok-Myeon, Anseong-city, Gyeonggi-do, 17553, South Korea; School of Photovoltaic and Renewable Energy Engineering, University of New South Wales (UNSW), Sydney, NSW 2052, Australia; Electronic Convergence Material and Device Research Centre, Korea Electronics Technology Institute, Seong-Nam, 463-816, South Korea	21680485			Article	Final		Scopus	2-s2.0-84979966789
Besiou M., Van Wassenhove L.N.	Closed-Loop Supply Chains for Photovoltaic Panels: A Case-Based Approach	2016	Journal of Industrial Ecology	20	4		929	937	10.1111/jiec.12297	https://www.scopus.com/inward/record.uri?eid=2-s2.0-84934783605&doi=10.1111%2fjiec.12297&partnerID=40&md5=336631759404a995f1681f2f04844457	Kuehne Logistics University in Hamburg, Germany; INSEAD in Fontainebleau, France	10881980		JINEF	Article	Final		Scopus	2-s2.0-84934783605
Kim S., Jeong B.	Closed-loop supply chain planning model for a photovoltaic system manufacturer with internal and external recycling	2016	Sustainability (Switzerland)	8	7		1	17	10.3390/su8070596	https://www.scopus.com/inward/record.uri?eid=2-s2.0-84980473282&doi=10.3390%2fsu8070596&partnerID=40&md5=399f390940cb12aa79a0c0f9acb76a75	Department of Information and Industrial Engineering, Yonsei University, 50 Yonsei-ro Seodaemun-gu, Seoul, 03722, South Korea	20711050			Article	Final	All Open Access, Gold, Green	Scopus	2-s2.0-84980473282
Kim B.J., Kim D.H., Kwon S.L., Park S.Y., Li Z., Zhu K., Jung H.S.	Selective dissolution of halide perovskites as a step towards recycling solar cells	2016	Nature Communications	7		11735			10.1038/ncomms11735	https://www.scopus.com/inward/record.uri?eid=2-s2.0-84971280362&doi=10.1038%2fncomms11735&partnerID=40&md5=5789ef1fd064f0105f6d39091177f2aa	School of Advanced Materials Science and Engineering, Sungkyunkwan University, Suwon, 16419, South Korea; Chemistry and Nanoscience Center, National Renewable Energy Laboratory, Golden, CO 80401, United States	20411723			Article	Final	All Open Access, Gold, Green	Scopus	2-s2.0-84971280362
Wong J.H., Royapoor M., Chan C.W.	Review of life cycle analyses and embodied energy requirements of single-crystalline and multi-crystalline silicon photovoltaic systems	2016	Renewable and Sustainable Energy Reviews	58			608	618	10.1016/j.rser.2015.12.241	https://www.scopus.com/inward/record.uri?eid=2-s2.0-84954287116&doi=10.1016%2fj.rser.2015.12.241&partnerID=40&md5=2df1ebe14fcbaaa23b81c26e349329fa	Sir Joseph Swan Centre for Energy Research, Newcastle University, Newcastle upon Tyne, NE1 7RU, United Kingdom; Energy Institute, 61 New Cavendish Street, London, W1G 7AR, United Kingdom	13640321		RSERF	Review	Final		Scopus	2-s2.0-84954287116
Ravikumar D., Sinha P., Seager T.P., Fraser M.P.	An anticipatory approach to quantify energetics of recycling CdTe photovoltaic systems	2016	Progress in Photovoltaics: Research and Applications	24	5		735	746	10.1002/pip.2711	https://www.scopus.com/inward/record.uri?eid=2-s2.0-84946811674&doi=10.1002%2fpip.2711&partnerID=40&md5=5da29f4fdb40d21289e104d194b0b23a	School of Sustainable Engineering and the Built Environment, Arizona State University, 1151 S Forest Ave., Tempe, AZ 85287, United States; First Solar, 350 W Washington St., Suite 600, Tempe, AZ 85281, United States	10627995		PPHOE	Article	Final		Scopus	2-s2.0-84946811674
Park J., Kim W., Cho N., Lee H., Park N.	An eco-friendly method for reclaimed silicon wafers from a photovoltaic module: From separation to cell fabrication	2016	Green Chemistry	18	6		1706	1714	10.1039/c5gc01819f	https://www.scopus.com/inward/record.uri?eid=2-s2.0-84961832182&doi=10.1039%2fc5gc01819f&partnerID=40&md5=191fd818c8db08cf1ea9d29a07de3016	School of Photovoltaic and Renewable Energy Engineering, University of New South Wales(UNSW), Sydney, NSW 2052, Australia; Korea Interfacial Science and Engineering Institute, Cheonan, South Korea; School of Energy Materials and Chemical Engineering, Korea University of Technology and Education, Cheonan, South Korea; Robust Components and System Research Centre, Korea Electronics Technology Institute, Seong-Nam, South Korea	14639262		GRCHF	Article	Final		Scopus	2-s2.0-84961832182
Li M., Tong X.	Economic feasibility of recycling thin-film photovoltaic modules in Shandong Province	2016	Beijing Daxue Xuebao (Ziran Kexue Ban)/Acta Scientiarum Naturalium Universitatis Pekinensis	52	2		313	319	10.13209/j.0479-8023.2015.153	https://www.scopus.com/inward/record.uri?eid=2-s2.0-84966501442&doi=10.13209%2fj.0479-8023.2015.153&partnerID=40&md5=d0b0ffb1b48f1997f30b5a208097e7f1	College of Urban and Environmental Sciences, Peking University, Beijing, 100871, China	04798023		PCTHA	Article	Final		Scopus	2-s2.0-84966501442
Dias P.R., Benevit M.G., Veit H.M.	Photovoltaic solar panels of crystalline silicon: Characterization and separation	2016	Waste Management and Research	34	3		235	245	10.1177/0734242X15622812	https://www.scopus.com/inward/record.uri?eid=2-s2.0-84957571995&doi=10.1177%2f0734242X15622812&partnerID=40&md5=2386eafe954b6ad1bda92f7c72c12929	Programa de Pós-Graduação em Engenharia de Minas, Metalúrgica e de Materiais, Universidade Federal Do Rio Grande Do sul, Av. Bento Gonçalves, 9500, Porto Alegre, RS, 91509-900, Brazil	0734242X		WMARD	Article	Final		Scopus	2-s2.0-84957571995

Table A-3: PV Recycling Literature Review

Authors	Title	Year	Source Title	Volume	Issue	Art. No.	Page Start	Page End	DOI	Link	Affiliations	ISSN	ISBN	CODEN	Document Type	Publication Stage	Open Access	Source	EID
Bokányi L., Szabó S., Paulovics J.	Investigation of surface properties and floatability of cdte semiconductor for the sake of recycling of obsolete solar elements	2016	IMPC 2016 - 28th International Mineral Processing Congress	2016-September						https://www.scopus.com/inward/record.uri?eid=2-s2.0-85048346973&partnerID=40&md5=fe9f8302dc7041869162cc4ec660c894	Department Institute of Raw Materials Preparation and Environmental Processing, University of Miskolc, Hungary Miskolc-Egyetemváros3515, Hungary; Kiss Analitika LTD, Gyártelep Pf. 4. 3792, Sajóbábony, Hungary; ÉMK LTD, Sajóbábony, Gyártelep, 3792, Hungary		9781926872292		Conference Paper	Final		Scopus	2-s2.0-85048346973
Lister T.E., Diaz L.A., Clark G.G., Keller P.	Process development for the recovery of critical materials from electronic waste	2016	IMPC 2016 - 28th International Mineral Processing Congress	2016-September						https://www.scopus.com/inward/record.uri?eid=2-s2.0-85048335740&partnerID=40&md5=56f57e4fbba7e44457214042c610df96	Idaho National Laboratory, P.O. Box 1625, Idaho Falls, ID 83415, United States		9781926872292		Conference Paper	Final		Scopus	2-s2.0-85048335740
Klugmann-Radziemska E., Kuczyńska A.	Recovery of materials in chemical recycling of photovoltaic modules of 1st and 2nd generation [Odzysk materiałów w procesach chemicznych recyklingu modułów fotowoltaicznych I i II generacji]	2016	Przemysl Chemiczny	95	2		306	309	10.15199/62.2016.2.24	https://www.scopus.com/inward/record.uri?eid=2-s2.0-85048140963&doi=10.15199%2f62.2016.2.24&partnerID=40&md5=6d01a22b3d7f31fe6af9c80c479fe752	Katedra Aparatury i Maszynoznawstwa Chemicznego, Wydział Chemiczny, Politechnika Gdańska, ul. Gabriela Narutowicza 11/12, Gdańsk, 80-233, Poland	00332496			Review	Final		Scopus	2-s2.0-85048140963
Dassisti M., Intini F., Rospi G.	Sustainable demanufacturing technologies for photovoltaic panels	2016	Procedia Environmental Science, Engineering and Management	3	2		105	111		https://www.scopus.com/inward/record.uri?eid=2-s2.0-85028726264&partnerID=40&md5=b79b739efd5b60ff0e7cbb90d3e4b953	DMMM, Politecnico di Bari, Italy; University of Basilicata, Department of European, Mediterranean Cultures: Architecture, Environment, Cultural Heritages, DICEM, Matera, Italy	23929537			Article	Final		Scopus	2-s2.0-85028726264
Medojevic M., Cosic I., Sremcev N., Lazarevic M.	Conceptual theoretical model for life cycle energy analysis of photovoltaic modules	2016	Annals of DAAAM and Proceedings of the International DAAAM Symposium	27	1		534	543	10.2507/27th.daaam.proceedings.079	https://www.scopus.com/inward/record.uri?eid=2-s2.0-85010780483&doi=10.2507%2f27th.daaam.proceedings.079&partnerID=40&md5=546afb41f297905139ce8465c934516b		17269679			Conference Paper	Final	All Open Access, Bronze	Scopus	2-s2.0-85010780483
Buerhop C., Pickel T., Scheuerpflug H., Camus C., Hauch J., Brabec C.J.	Statistical overview of findings by IR-inspections of PV-plants	2016	Proceedings of SPIE - The International Society for Optical Engineering	9938		99380L			10.1117/12.2237821	https://www.scopus.com/inward/record.uri?eid=2-s2.0-85006277012&doi=10.1117%2f12.2237821&partnerID=40&md5=193bfa6a58cc4d0b7a0a40f870530fb5	Bavarian Center for Applied Energy Research (ZAE Bayern), Haberstrabe 2a, Erlangen, 91058, Germany; I-MEET, FAU Erlangen-Nörnberg, Martensstrabe 7, Erlangen, 91058, Germany	0277786X	9781510602670	PSISD	Conference Paper	Final		Scopus	2-s2.0-85006277012
Oishi T., Koyama K., Tanaka M.	Electrorefining of silicon using molten salt and liquid alloy electrodes	2016	Journal of the Electrochemical Society	163	14				10.1149/2.0391614jes	https://www.scopus.com/inward/record.uri?eid=2-s2.0-85001018577&doi=10.1149%2f2.0391614jes&partnerID=40&md5=268dcbe6375f9a23fb909f5cd4408950	Environmental Management Research Institute, National Institute of Advanced Industrial Science and Technology (AIST), Tsukuba, Ibaraki 305-8569, Japan; Advanced Materials Science and Engineering, Faculty of Engineering, Chiba Institute of Technology, Narashino, Chiba 275-0016, Japan	00134651		JESOA	Article	Final		Scopus	2-s2.0-85001018577
Issa Y.M., Abdel-Fattah H.M., Shehab O.R., Abdel-Moniem N.B.	Determination and speciation of tellurium hazardous species in real and environmental samples	2016	International Journal of Electrochemical Science	11	9		7475	7498	10.20964/2016.09.02	https://www.scopus.com/inward/record.uri?eid=2-s2.0-84987879315&doi=10.20964%2f2016.09.02&partnerID=40&md5=5f87dfe4f93f04c45c9ca6e9cf4777c1	Chemistry Department, Faculty of Science, Cairo University, Giza, 12613, Egypt	14523981			Article	Final	All Open Access, Bronze	Scopus	2-s2.0-84987879315
Shen Y.-L.	Numerical Study of Solder Bond Failure in Photovoltaic Modules	2016	Procedia Engineering	139			93	100	10.1016/j.proeng.2015.08.1113	https://www.scopus.com/inward/record.uri?eid=2-s2.0-84976339055&doi=10.1016%2fj.proeng.2015.08.1113&partnerID=40&md5=d380c95288da76db43c3a5ddb6e84c67	Department of Mechanical Engineering, University of New Mexico, Albuquerque, NM 87131, United States	18777058			Conference Paper	Final	All Open Access, Bronze	Scopus	2-s2.0-84976339055
Duan H., Wang J., Liu L., Huang Q., Li J.	Rethinking China's strategic mineral policy on indium: Implication for the flat screens and photovoltaic industries	2016	Progress in Photovoltaics: Research and Applications	24	1		83	93	10.1002/pip.2654	https://www.scopus.com/inward/record.uri?eid=2-s2.0-84955058374&doi=10.1002%2fpip.2654&partnerID=40&md5=b5d198b9fb74697c26527db385cf8355	College of Civil Engineering, Shenzhen University, Shenzhen, 518060, China; State Key Joint Laboratory of Environment Simulation and Pollution Control, School of Environment, Tsinghua University, Beijing, 100084, China; State Key Laboratory of Environmental Criteria and Risk Assessment, Chinese Research Academy of Environmental Sciences, Beijing, 100012, China	10627995		PPHOE	Article	Final		Scopus	2-s2.0-84955058374
Palitzsch W., Loser U.	Inexpensive and environmentally friendly recycling of photovoltaic scrap	2015	2015 IEEE 42nd Photovoltaic Specialist Conference, PVSC 2015			7356389			10.1109/PVSC.2015.7356389	https://www.scopus.com/inward/record.uri?eid=2-s2.0-84961654785&doi=10.1109%2fPVSC.2015.7356389&partnerID=40&md5=fede72358014ed589666c5ce7070b033	Loser Chemie GmbH, Bahnhofstraβe 10, Langenweiβbach, 08134, Germany		9781479979448		Conference Paper	Final		Scopus	2-s2.0-84961654785
Kurogi S., Hirohata T., Ahmad N., Ota Y., Nishioka K.	Repair of damaged lens surface of CPV using silica based coating	2015	2015 IEEE 42nd Photovoltaic Specialist Conference, PVSC 2015			7355762			10.1109/PVSC.2015.7355762	https://www.scopus.com/inward/record.uri?eid=2-s2.0-84961575655&doi=10.1109%2fPVSC.2015.7355762&partnerID=40&md5=01dc2ac4b69cc2df709b5311d927fcf7	Faculty of Engineering, University of Miyazaki, 1-1 Gakuen Kibanadai-nishi, Miyazaki, 889-2192, Japan		9781479979448		Conference Paper	Final		Scopus	2-s2.0-84961575655
Chen C.-C., Chang F.-C., Peng C.Y., Wang H.P.	Conducting glasses recovered from thin film transistor liquid crystal display wastes for dye-sensitized solar cell cathodes	2015	Environmental Technology (United Kingdom)	36	23		3008	3012	10.1080/09593330.2014.982206	https://www.scopus.com/inward/record.uri?eid=2-s2.0-84946476015&doi=10.1080%2f09593330.2014.982206&partnerID=40&md5=f43adb1d2707b21387900a57d7c414e7	Department of Environmental Engineering, National Cheng Kung University, Tainan, 70101, Taiwan; Experimental Forest, National Taiwan University, Nan-Tou, 55750, Taiwan	09593330		ENVTE	Article	Final		Scopus	2-s2.0-84946476015
Sinha P.	Cadmium telluride leaching behavior: Discussion of Zeng et al. (2015)	2015	Journal of Environmental Management	163			184	185	10.1016/j.jenvman.2015.08.015	https://www.scopus.com/inward/record.uri?eid=2-s2.0-84940031871&doi=10.1016%2fj.jenvman.2015.08.015&partnerID=40&md5=d94d57b3fa19381cef86ea69e8c01ba6	First Solar, 350 W. Washington St., Suite 600, Tempe, AZ 85281, United States	03014797		JEVMA	Note	Final		Scopus	2-s2.0-84940031871

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Lamnatou C., Chemisana D.	Evaluation of photovoltaic-green and other roofing systems by means of ReCiPe and multiple life cycle-based environmental indicators	2015	Building and Environment	93	P2		376	384	10.1016/j.buildenv.2015.06.031	https://www.scopus.com/inward/record.uri?eid=2-s2.0-84938083152&doi=10.1016%2fj.buildenv.2015.06.031&partnerID=40&md5=897ec13e2974ca6cc784941156350829	Applied Physics Section, Environmental Science Department, University of Lleida, C/Pere Cabrera s/n, Lleida, 25001, Spain	03601323		BUEND	Article	Final		Scopus	2-s2.0-84938083152
Espinosa N., Laurent A., Krebs F.C.	Ecodesign of organic photovoltaic modules from Danish and Chinese perspectives	2015	Energy and Environmental Science	8	9		2537	2550	10.1039/c5ee01763g	https://www.scopus.com/inward/record.uri?eid=2-s2.0-84940476305&doi=10.1039%2fc5ee01763g&partnerID=40&md5=7145dbec3b3d445c5ef68244a6a77f3a	Department of Energy Conversion and Storage, Technical University of Denmark, Frederiksborgvej 399, Roskilde, DK-4000, Denmark; Division for Quantitative Sustainability Assessment, Department of Management Engineering, Technical University of Denmark (DTU), Produktionstorvet 424, Kgs. Lyngby, DK-2800, Denmark	17545692			Review	Final	All Open Access, Green	Scopus	2-s2.0-84940476305
Goe M., Gaustad G., Tomaszewski B.	System tradeoffs in siting a solar photovoltaic material recovery infrastructure	2015	Journal of Environmental Management	160			154	166	10.1016/j.jenvman.2015.05.038	https://www.scopus.com/inward/record.uri?eid=2-s2.0-84937974552&doi=10.1016%2fj.jenvman.2015.05.038&partnerID=40&md5=033ea7fa9bac635dfe4c80fb1828e5ce	Golisano Institute for Sustainability, Rochester Institute of Technology, 111 Lomb Memorial Drive, Rochester, NY 14623, United States; Department of Information Sciences and Technologies, Rochester Institute of Technology, 31 Lomb Memorial Drive, Rochester, NY 14623, United States	03014797		JEVMA	Article	Final	All Open Access, Bronze	Scopus	2-s2.0-84937974552
Tammaro M., Rimauro J., Fiandra V., Salluzzo A.	Thermal treatment of waste photovoltaic module for recovery and recycling: Experimental assessment of the presence of metals in the gas emissions and in the ashes	2015	Renewable Energy	81			103	112	10.1016/j.renene.2015.03.014	https://www.scopus.com/inward/record.uri?eid=2-s2.0-84925633556&doi=10.1016%2fj.renene.2015.03.014&partnerID=40&md5=5476b06c6aa7a28ca2f8b41e2ae2b744	ENEA, Italian National Agency for New Technologies, Energy and the Environment, Centre of Research of Portici, Naples, Italy	09601481			Article	Final		Scopus	2-s2.0-84925633556
Hu Y., Yan H., Liu K., Cao H., Li W.	Hydrogen production using solar grade wasted silicon	2015	International Journal of Hydrogen Energy	40	28		8633	8641	10.1016/j.ijhydene.2015.05.025	https://www.scopus.com/inward/record.uri?eid=2-s2.0-84930931174&doi=10.1016%2fj.ijhydene.2015.05.025&partnerID=40&md5=6cba8cf8638875116410a6813c2ec4cf	College of Materials Science and Engineering, Sichuan University610064, China; College of Chemistry, Sichuan University, Chengdu, 610064, China	03603199		IJHED	Article	Final		Scopus	2-s2.0-84930931174
Corinaldesi V., Donnini J., Nardinocchi A.	Lightweight plasters containing plastic waste for sustainable and energy-efficient building	2015	Construction and Building Materials	94		6884	337	345	10.1016/j.conbuildmat.2015.07.069	https://www.scopus.com/inward/record.uri?eid=2-s2.0-84937147662&doi=10.1016%2fj.conbuildmat.2015.07.069&partnerID=40&md5=a59a13e3a2f092bd61543eb1746ced75	Engineering Faculty, Università Politecnica delle MarcheAncona, Italy	09500618		CBUME	Article	Final	All Open Access, Green	Scopus	2-s2.0-84937147662
Tao J., Yu S.	Review on feasible recycling pathways and technologies of solar photovoltaic modules	2015	Solar Energy Materials and Solar Cells	141		7717	108	124	10.1016/j.solmat.2015.05.005	https://www.scopus.com/inward/record.uri?eid=2-s2.0-84936749288&doi=10.1016%2fj.solmat.2015.05.005&partnerID=40&md5=ada66b57601c4f0ff07ddde31fa248d5	School of Mechanical and Power Engineering, Shanghai Jiao Tong University, 800 Dongchuan Road, Shanghai, 200240, China	09270248		SEMCE	Review	Final		Scopus	2-s2.0-84936749288
Tong X., Wang W., Li M.	Recycling modes of photovoltaic modules	2015	Yingyong Jichu yu Gongcheng Kexue Xuebao/Journal of Basic Science and Engineering	23			59	67	10.16058/j.issn.1005-0930.2015.s1.007	https://www.scopus.com/inward/record.uri?eid=2-s2.0-84940870348&doi=10.16058%2fj.issn.1005-0930.2015.s1.007&partnerID=40&md5=81c6b41b252d4348c511995e6451f8e2	College of Urban and Environmental Science, Peking University, Beijing, 100871, China	10050930			Article	Final		Scopus	2-s2.0-84940870348
Cucchiella F., D'Adamo I., Lenny Koh S.C., Rosa P.	Recycling of WEEEs: An economic assessment of present and future e-waste streams	2015	Renewable and Sustainable Energy Reviews	51		4546	263	272	10.1016/j.rser.2015.06.010	https://www.scopus.com/inward/record.uri?eid=2-s2.0-84936928656&doi=10.1016%2fj.rser.2015.06.010&partnerID=40&md5=ea3b6275793e9f9b68368cff8b3d6d15	Department of Industrial and Information Engineering and Economics, University of L'Aquila, Via G. Gronchi, 18, Zona Industriale Pile, L'Aquila, 67100, Italy; Logistics and Supply Chain Management (LSCM) Research Centre, Centre for Energy, Environment and Sustainability (CEES), University of Sheffield, Conduit Road, Sheffield, S10 1FL, United Kingdom; Department of Management, Economics and Industrial Engineering, Politecnico di Milano, Piazza Leonardo da Vinci, 32, Milano, 20133, Italy	13640321		RSERF	Review	Final	All Open Access, Green	Scopus	2-s2.0-84936928656
Rocchetti L., Beolchini F.	Recovery of valuable materials from end-of-life thin-film photovoltaic panels: Environmental impact assessment of different management options	2015	Journal of Cleaner Production	89			59	64	10.1016/j.jclepro.2014.11.009	https://www.scopus.com/inward/record.uri?eid=2-s2.0-84919336558&doi=10.1016%2fj.jclepro.2014.11.009&partnerID=40&md5=93ec4c6363e203a08d264f0b7730e2f1	Department of Life and Environmental Sciences, Università Politecnica Delle Marche, Via Brecce Bianche, Ancona, 60131, Italy	09596526		JCROE	Article	Final		Scopus	2-s2.0-84919336558
Bartosinski M., Michaelis D., Friedrich B.	Separation of semiconductor layers from thin film solar panels using microwave radiation	2015	Proceedings - European Metallurgical Conference, EMC 2015	2			715	724		https://www.scopus.com/inward/record.uri?eid=2-s2.0-85081122695&partnerID=40&md5=5ebdbe3067bf1af6a8ac460069b5f98d	RWTH Aachen, IME Process Metallurgy and Metal Recycling, Intzestrae 3, Aachen, 52072, Germany		9783940276629		Conference Paper	Final		Scopus	2-s2.0-85081122695
Dias P.R., Benevit M.G., Veit H.M.	Characterization and recycling of silicon PV modules	2015	Proceedings - European Metallurgical Conference, EMC 2015	2			911	924		https://www.scopus.com/inward/record.uri?eid=2-s2.0-85081115685&partnerID=40&md5=1bc3995492d280e4d1687f2fe1d5da89	Universidade Federal do Rio Grande do Sul, PPGE3M - UFRGS, Av. Bento Goncalves, 9500, Setor IV, Predio 43426, Porto Alegre, Rio Grande do Sul, CEP: 91501-970, Brazil		9783940276629		Conference Paper	Final		Scopus	2-s2.0-85081115685

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Lee J.-S., Jang B.-Y., Kim J.-S., Ahn Y.-S., Kang G.-H., Wang J.-P.	Development of recycling process of photovoltaic ribbon in spent solar module using water vapor generated by waste heat	2015	ISES Solar World Congress 2015, Conference Proceedings				336	341	10.18086/swc.2015.05.05	https://www.scopus.com/inward/record.uri?eid=2-s2.0-85016999327&doi=10.18086%2fswc.2015.05.05&partnerID=40&md5=0ae754e1ab2b85a4c1587a900e42410d	Advanced Materials and Devices Laboratory, Korea Institute of Energy Research, Daejeon, 305-343, South Korea; Photovoltaic Laboratory, Korea Institute of Energy Research, Daejeon, 305-343, South Korea; Department of Metallurgical Engineering, Pukyong National University, Busan, 608-739, South Korea		9783981465952		Conference Paper	Final		Scopus	2-s2.0-85016999327
Huang J., Wang X., Mao X., Li L.	A comparison research on pollution index between thermal power generation and solar power generation	2015	Energy Science and Applied Technology - Proceedings of the 2nd International Conference on Energy Science and Applied Technology, ESAT 2015				99	104	10.1201/b19779-25	https://www.scopus.com/inward/record.uri?eid=2-s2.0-84960371528&doi=10.1201%2fb19779-25&partnerID=40&md5=e6e76ea25c1c3919ef431bb82f06b063	North China Electric Power University, Boading, China		9781138028333		Conference Paper	Final		Scopus	2-s2.0-84960371528
Chenvidhya D., Seapan M., Sangpongsanont Y., Chenvidhya T., Limsakul C., Songprakorp R.	PV industry growth and module reliability in Thailand	2015	Proceedings of SPIE - The International Society for Optical Engineering	9563		95630G			10.1117/12.2188494	https://www.scopus.com/inward/record.uri?eid=2-s2.0-84951188892&doi=10.1117%2f12.2188494&partnerID=40&md5=273d782dac947458df09e068346011b4	CES Solar Cells Testing Center, Pilot Plant Development and Training Institute, King Mongkut's University of Technology Thonburi-Bang Khun Thian, 49 Bang Khun Thian Chai Thale Rd, Tha Kham, Bang Khun Thian, Bangkok, 10150, Thailand; Energy Technology Div, School of Energy, Environment and Materials, King Mongkut's University of Technology Thonburi, 126 Pracha-uthit, Bang Mod, Thungkru, Bangkok, 10140, Thailand	0277786X	9781628417296	PSISD	Conference Paper	Final		Scopus	2-s2.0-84951188892
Hacke P., Terwilliger K., Glick S.H., Perrin G., Kurtz S.R.	Survey of potential-induced degradation in thin-film modules	2015	Proceedings of SPIE - The International Society for Optical Engineering	9563		95630B			10.1117/12.2188958	https://www.scopus.com/inward/record.uri?eid=2-s2.0-84951163400&doi=10.1117%2f12.2188958&partnerID=40&md5=6369bf76a0a78b779d3b73499ddbb3f9	National Renewable Energy Laboratory, 15013 Denver West Parkway, Golden, CO 80401, United States	0277786X	9781628417296	PSISD	Conference Paper	Final		Scopus	2-s2.0-84951163400
Lim J., Lee S.	Dynamic properties of non-cement matrix based on blast furnace slag and polysilicon sludge ratio and addition rate of alkali activator	2015	Asian Journal of Chemistry	27	11		4204	4206	10.14233/ajchem.2015.19489	https://www.scopus.com/inward/record.uri?eid=2-s2.0-84949977027&doi=10.14233%2fajchem.2015.19489&partnerID=40&md5=46691353e89f0c44358f4fb506a7ea54	Department of Architectural Engineering, Hanbat National University, Daejeon, 305-719, South Korea	09707077		AJCHE	Article	Final	All Open Access, Hybrid Gold	Scopus	2-s2.0-84949977027
Giacchetta G., Leporini M., Marchetti B.	Evaluation of the economic impact of a new high value process for the management of the end of life of thin film photovoltaic modules	2015	International Journal of Productivity and Quality Management	15	4		528	541	10.1504/IJPQM.2015.069712	https://www.scopus.com/inward/record.uri?eid=2-s2.0-84930445556&doi=10.1504%2fIJPQM.2015.069712&partnerID=40&md5=2baa8e3cd67b5adf2d6c3f10715ed603	Dipartimento di Ingegneria Industriale, Università Politecnica Delle Marche, Italy; Facoltà di Ingegneria, Università Degli Studi ECampus, Italy	17466474			Article	Final		Scopus	2-s2.0-84930445556
Cucchiella F., D'Adamo I., Rosa P.	End-of-Life of used photovoltaic modules: A financial analysis	2015	Renewable and Sustainable Energy Reviews	47		4231	552	561	10.1016/j.rser.2015.03.076	https://www.scopus.com/inward/record.uri?eid=2-s2.0-84925610470&doi=10.1016%2fj.rser.2015.03.076&partnerID=40&md5=b79f91e50f989f13a0c2bf3f3ae01599	Department of Electric and Information Engineering, Faculty of Engineering, University of L'Aquila, Via G. Gronchi, 18, L'Aquila, 67100, Italy; Department of Economics, Management and Industrial Engineering, Politecnico di Milano, Piazza Leonardo da Vinci, 32, Milano, 20133, Italy	13640321		RSERF	Review	Final	All Open Access, Green	Scopus	2-s2.0-84925610470
Redlinger M., Eggert R., Woodhouse M.	Evaluating the availability of gallium, indium, and tellurium from recycled photovoltaic modules	2015	Solar Energy Materials and Solar Cells	138		7629	58	71	10.1016/j.solmat.2015.02.027	https://www.scopus.com/inward/record.uri?eid=2-s2.0-84925015995&doi=10.1016%2fj.solmat.2015.02.027&partnerID=40&md5=cdc9bd133594188859eeee40a6263aa3	Division of Economics and Business, Colorado School of Mines, 816 15th Street, Golden, CO 80401, United States; Strategic Energy Analysis Center, National Renewable Energy Laboratory, 15013 Denver West Parkway, Golden, CO 80401, United States	09270248		SEMCE	Article	Final	All Open Access, Green	Scopus	2-s2.0-84925015995
Paiano A.	Photovoltaic waste assessment in Italy	2015	Renewable and Sustainable Energy Reviews	41			99	112	10.1016/j.rser.2014.07.208	https://www.scopus.com/inward/record.uri?eid=2-s2.0-84907485594&doi=10.1016%2fj.rser.2014.07.208&partnerID=40&md5=b48b69b9eb2080d74844013e8f578573	Department of Business and Law Studies, University of Bari Aldo Moro, Largo Abbazia Santa Scolastica, Bari, 53-70124, Italy	13640321		RSERF	Review	Final		Scopus	2-s2.0-84907485594
Carnevale E., Lombardi L., Zanchi L.	Life cycle assessment of solar energy systems: Comparison of photovoltaic and water thermal heater at domestic scale	2014	Energy	77			434	446	10.1016/j.energy.2014.09.028	https://www.scopus.com/inward/record.uri?eid=2-s2.0-84909647195&doi=10.1016%2fj.energy.2014.09.028&partnerID=40&md5=26b7e2ac6ec278af3824f957163c79dc	Industrial Engineering Department, University of Florence, Via Santa Marta 3, Florence, 50139, Italy; Niccolò Cusano University, Via Don Carlo Gnocchi 3, Rome, 00166, Italy	03605442		ENEYD	Article	Final		Scopus	2-s2.0-84909647195
Bonificio W.D., Clarke D.R.	Bacterial recovery and recycling of tellurium from tellurium-containing compounds by Pseudoalteromonas sp. EPR3	2014	Journal of Applied Microbiology	117	5		1293	1304	10.1111/jam.12629	https://www.scopus.com/inward/record.uri?eid=2-s2.0-84907976985&doi=10.1111%2fjam.12629&partnerID=40&md5=131c4704f2e071f1f09911d23cacd278	School of Engineering and Applied Sciences, Harvard University, Cambridge, MA, United States	13645072		JAMIF	Article	Final	All Open Access, Bronze, Green	Scopus	2-s2.0-84907976985
Jaeckel B., Cosic M., Arp J.	Investigation of c-Si modules degradation and recovery effect under high potentials: CV-PID	2014	2014 IEEE 40th Photovoltaic Specialist Conference, PVSC 2014			6925067	937	942	10.1109/PVSC.2014.6925067	https://www.scopus.com/inward/record.uri?eid=2-s2.0-84912144859&doi=10.1109%2fPVSC.2014.6925067&partnerID=40&md5=4b7d5ca92edd920bf07484a86319ef96	UL International GmbH, Admiral-Rosendahl-Strasse 9, Neu-Isenburg (Zeppelinheim), 63263, Germany; PV LAB Germany GmbH, Gartenstrasse 36, Potsdam, 14482, Germany		9781479943982		Conference Paper	Final		Scopus	2-s2.0-84912144859

Table A-3: PV Recycling Literature Review

Authors	Title	Year	Source Title	Volume	Issue	Art. No.	Page Start	Page End	DOI	Link	Affiliations	ISSN	ISBN	CODEN	Document Type	Publication Stage	Open Access	Source	EID
Collins K., Anctil A.	Photovoltaic waste characterization with environmental considerations	2014	2014 IEEE 40th Photovoltaic Specialist Conference, PVSC 2014			6925183	1419	1423	10.1109/PVSC.2014.6925183	https://www.scopus.com/inward/record.uri?eid=2-s2.0-84912143758&doi=10.1109%2fPVSC.2014.6925183&partnerID=40&md5=a66d1f01c248d0b0dad413d323200550	Clemson University, Anderson, SC 29625, United States		9781479943982		Conference Paper	Final		Scopus	2-s2.0-84912143758
Dos Reis Benatto G.A., Roth B., Madsen M.V., Hösel M., Søndergaard R.R., Jørgensen M., Krebs F.C.	Carbon: The Ultimate Electrode Choice for Widely Distributed Polymer Solar Cells	2014	Advanced Energy Materials	4	15	1400732			10.1002/aenm.201400732	https://www.scopus.com/inward/record.uri?eid=2-s2.0-84924021403&doi=10.1002%2faenm.201400732&partnerID=40&md5=84026fbe79cd973762a10398bd158569	Department of Energy Conversion and Storage, Technical University of Denmark, Frederiksborgvej 399, Roskilde, DK-4000, Denmark	16146832			Article	Final		Scopus	2-s2.0-84924021403
Bergesen J.D., Heath G.A., Gibon T., Suh S.	Thin-film photovoltaic power generation offers decreasing greenhouse gas emissions and increasing environmental co-benefits in the long term	2014	Environmental Science and Technology	48	16		9834	9843	10.1021/es405539z	https://www.scopus.com/inward/record.uri?eid=2-s2.0-84906264621&doi=10.1021%2fes405539z&partnerID=40&md5=633f47b85b2a0eb897af8e49a3e8839b	Bren School of Environmental Science and Management, University of California, 2400 Bren Hall, Santa Barbara, CA 93106-5131, United States; National Renewable Energy Laboratory, Golden, CO 80401, United States; Industrial Ecology Programme, Department of Energy Process and Engineering, Norwegian University of Science and Technology (NTNU), Høgskoleringen 5, NO-7491 Trondheim, Norway	0013936X		ESTHA	Article	Final		Scopus	2-s2.0-84906264621
Haglid K.C.	Achieving net zero with a 649,848-square-foot industrial complex	2014	Energy Engineering: Journal of the Association of Energy Engineering	111	5		51	79	10.1080/01998595.2014.10877001	https://www.scopus.com/inward/record.uri?eid=2-s2.0-84906267392&doi=10.1080%2f01998595.2014.10877001&partnerID=40&md5=a317c0718cc72171f56ade4a09356103	Haglid Engineering and, Inc., Building Performance Equipment, Inc., United States	01998595		EENGD	Article	Final		Scopus	2-s2.0-84906267392
Goe M., Gaustad G.	Strengthening the case for recycling photovoltaics: An energy payback analysis	2014	Applied Energy	120			41	48	10.1016/j.apenergy.2014.01.036	https://www.scopus.com/inward/record.uri?eid=2-s2.0-84893671627&doi=10.1016%2fj.apenergy.2014.01.036&partnerID=40&md5=dab3f3e51e10211abe7462a245033d78	Golisano Institute for Sustainability, Rochester Institute of Technology, Bldg. 81-2175, 111 Lomb Memorial Drive, Rochester, NY 14623, United States	03062619		APEND	Article	Final		Scopus	2-s2.0-84893671627
Sinha P., Lyle Trumbull V., Kaczmar S.W., Johnson K.A.	Evaluation of potential health and environmental impacts from end-of-life disposal of photovoltaics	2014	Photovoltaics: Synthesis, Applications and Emerging Technologies				37	51		https://www.scopus.com/inward/record.uri?eid=2-s2.0-84940081943&partnerID=40&md5=43432304e38663c1b72a427c270b9558	First Solar, Tempe, AZ, United States; O'Brien and Gere, E. Norriton, PA, United States; SUNY Upstate Medical University, Syracuse, NY, United States; Tetra Tech BAS, Phoenix, AZ, United States				Book Chapter	Final		Scopus	2-s2.0-84940081943
Granata G., Pagnanelli F., Moscardini E., Havlik T., Toro L.	Recycling of photovoltaic panels by physical operations	2014	Solar Energy Materials and Solar Cells	123			239	248	10.1016/j.solmat.2014.01.012	https://www.scopus.com/inward/record.uri?eid=2-s2.0-84893721362&doi=10.1016%2fj.solmat.2014.01.012&partnerID=40&md5=da91bd7e38aa9a499b8c6c626f8fcfde	Sapienza University of Rome, Department of Chemistry, P.le A. Moro 5, 00185 Rome, Italy; Technical University O Kosice, Department of Metallurgy, Department of Non-Ferrous Metals and Waste Treatment, Letna 9, 04200 Kosice, Slovakia	09270248		SEMCE	Article	Final		Scopus	2-s2.0-84893721362
Choi J.-K., Fthenakis V.	Crystalline silicon photovoltaic recycling planning: Macro and micro perspectives	2014	Journal of Cleaner Production	66			443	449	10.1016/j.jclepro.2013.11.022	https://www.scopus.com/inward/record.uri?eid=2-s2.0-84893772463&doi=10.1016%2fj.jclepro.2013.11.022&partnerID=40&md5=39d6a0a1fc8fee16624efcdb2b08a42e	University of Dayton, 300 College Park, Kettering Laboratories, Dayton, OH 45469, United States; Photovoltaic Environmental Research Center, Brookhaven National Laboratory Upton, NY 11973, United States	09596526		JCROE	Article	Final		Scopus	2-s2.0-84893772463
Krebs F.C., Espinosa N., Hösel M., Søndergaard R.R., Jørgensen M.	25th anniversary article: Rise to power - OPV-based solar parks	2014	Advanced Materials	26	1		29	39	10.1002/adma.201302031	https://www.scopus.com/inward/record.uri?eid=2-s2.0-84891829969&doi=10.1002%2fadma.201302031&partnerID=40&md5=6ed05e156d2ad0cbe0008d90e2803dab	Department of Energy Conversion and Storage, Technical University of Denmark, Frederiksborgvej 399, DK-4000 Roskilde, Denmark	09359648		ADVME	Review	Final		Scopus	2-s2.0-84891829969
Giacchetta G., Leporini M., Marchetti B.	Economic and environmental optimization of a new high value process for the management of the end of life of thin film photovoltaic modules	2014	Proceedings of the Summer School Francesco Turco	09-12-September-2014			100	107		https://www.scopus.com/inward/record.uri?eid=2-s2.0-84982860566&partnerID=40&md5=e8dbb53adb32acad024d1e1565b227d3	Department of Industrial Engineering and Mathematical Sciences, Polytechnic University of Marche, via Brecce Bianche, Ancona, 60100, Italy; E-Campus Telematic University, via Isimbardi 10, Novedrate (CO), 22060, Italy	22838996			Conference Paper	Final		Scopus	2-s2.0-84982860566
Eksteen J., Mwase J., Petersen J., Bradshaw S., Akdogan G., Mpinga N., Snyders C.	A novel, energy efficient, two stage heap leach process for the extraction and recovery of PGMs	2014	IMPC 2014 - 27th International Mineral Processing Congress	2014-January			1	9		https://www.scopus.com/inward/record.uri?eid=2-s2.0-84975065695&partnerID=40&md5=f0f39bbc649cd84457d6d8caaab89af8	Western Australia School of Mines, Australia; University of Cape Town, South Africa; University of Stellenbosch, South Africa				Conference Paper	Final		Scopus	2-s2.0-84975065695
Yi Y.K., Kim H.S., Tran T., Hong S.K., Kim M.J.	Recovering valuable metals from recycled photovoltaic modules	2014	Journal of the Air and Waste Management Association	64	7		797	807	10.1080/10962247.2014.891540	https://www.scopus.com/inward/record.uri?eid=2-s2.0-84906994894&doi=10.1080%2f10962247.2014.891540&partnerID=40&md5=0927eb58e433cb17bebd3e84738176e8	Department of Energy & Resources Engineering, Chonnam National University, Gwangju, South Korea; School of Materials Science and Engineering, Chonnam National University, Gwangju, South Korea	10962247		JIJME	Article	Final		Scopus	2-s2.0-84906994894
Hoang P., Goffe B., Jacquemin L., Billaudot H.A., Archambault V.	What metrics to evaluate sustainability of photovoltaic systems?	2014	Metallurgical Research and Technology	111	3		201	210	10.1051/metal/2014007	https://www.scopus.com/inward/record.uri?eid=2-s2.0-84906850108&doi=10.1051%2fmetal%2f2014007&partnerID=40&md5=d476e2fb960c04aa396e3ef593f613ff	Altran Research, 2 rue Paul Dautier, CS 90599, 78457 Vélizy-Villacoublay, France; Aix-Marseille Université, CNRS, CEREGE UM34, 13545 Aix en Provence, France	22713646			Article	Final		Scopus	2-s2.0-84906850108
Šimonová L., Vaněk J., Demchikhin S.	Reuse of recycled solar cells	2014	ECS Transactions	48	1		23	30	10.1149/04801.0023ecst	https://www.scopus.com/inward/record.uri?eid=2-s2.0-84906658031&doi=10.1149%2f04801.0023ecst&partnerID=40&md5=3f7cf9899d712a39c7313a6c2931c92d	Department of Electrical and Electronic Technology, Faculty of Electrical Engineering and Communication, Brno University of Technology, Technická 10, 616 00 Brno, Czech Republic	19385862	9781607683834		Conference Paper	Final		Scopus	2-s2.0-84906658031
Park J., Park N.	Wet etching processes for recycling crystalline silicon solar cells from end-of-life photovoltaic modules	2014	RSC Advances	4	66		34823	34829	10.1039/c4ra03895a	https://www.scopus.com/inward/record.uri?eid=2-s2.0-84906544596&doi=10.1039%2fc4ra03895a&partnerID=40&md5=88d6a5d6da0ecb7e5f3a686e78031e4f	Components and Materials Research Center, Korea Electronics Technology Institute (KETI), Kyeonggi-do, South Korea	20462069		RSCAC	Article	Final		Scopus	2-s2.0-84906544596

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Šimčák M., Majerová E.	Liquidation of fires of photovoltaic panels	2014	Advanced Materials Research	1001			342	349	10.4028/www.scientific.net/AMR.1001.342	https://www.scopus.com/inward/record.uri?eid=2-s2.0-84906261924&doi=10.4028%2fwww.scientific.net%2fAMR.1001.342&partnerID=40&md5=4b8583e3771836d22979a423083f33b5	Technical university of Košice, Institute of Geodesy, Cartography and Geographical Information Systems, Park Komenského 19, 043 84 Košice, Slovakia; Technical university of Košice, Institute of Montaneous Sciences and Environmental Protection, Park Komenského 19, 043 84 Košice, Slovakia	10226680			Article	Final		Scopus	2-s2.0-84906261924
Moravec M., Badida M., Liptai P.	Material potential of end-of-life photovoltaic panels in Slovak republic	2014	Advanced Materials Research	1001			90	93	10.4028/www.scientific.net/AMR.1001.90	https://www.scopus.com/inward/record.uri?eid=2-s2.0-84906231661&doi=10.4028%2fwww.scientific.net%2fAMR.1001.90&partnerID=40&md5=da24810662215c71527dca5c202be58f	Technical university of Kosice, Letna 9, Kosice, Slovakia	10226680			Article	Final		Scopus	2-s2.0-84906231661
Marwede M., Reller A.	Estimation of life cycle material costs of cadmium telluride- and copper indium gallium diselenide-photovoltaic absorber materials based on life cycle material flows	2014	Journal of Industrial Ecology	18	2		254	267	10.1111/jiec.12108	https://www.scopus.com/inward/record.uri?eid=2-s2.0-84898775836&doi=10.1111%2fjiec.12108&partnerID=40&md5=1328e8d75ff8144c14ea957a3c2d7691	Technical University of Berlin, Berlin, Germany; Institute of Physics, University of Augsburg, Augsburg, Germany	10881980		JINEF	Article	Final		Scopus	2-s2.0-84898775836
Cyrs W.D., Avens H.J., Capshaw Z.A., Kingsbury R.A., Sahmel J., Tvermoes B.E.	Landfill waste and recycling: Use of a screening-level risk assessment tool for end-of-life cadmium telluride (CdTe) thin-film photovoltaic (PV) panels	2014	Energy Policy	68			524	533	10.1016/j.enpol.2014.01.025	https://www.scopus.com/inward/record.uri?eid=2-s2.0-84895520246&doi=10.1016%2fj.enpol.2014.01.025&partnerID=40&md5=4f336e52f2610f62cffcffb55902cfdf	Cardno ChemRisk, 101 2nd St. Suite 700, San Francisco, CA 94105, United States; Cardno ChemRisk, 4840 Pearl East Circle Suite 300 West, Boulder, CO 80301, United States	03014215		ENPYA	Article	Final		Scopus	2-s2.0-84895520246
Houari Y., Speirs J., Candelise C., Gross R.	A system dynamics model of tellurium availability for CdTe PV	2014	Progress in Photovoltaics: Research and Applications	22	1		129	146	10.1002/pip.2359	https://www.scopus.com/inward/record.uri?eid=2-s2.0-84890551873&doi=10.1002%2fpip.2359&partnerID=40&md5=b899a24e09602de229e775384fbf4b9a	Imperial College Centre for Energy Policy and Technology, Imperial College London, London SW7 2AZ, United Kingdom; Institute for Energy Systems, University of Edinburgh, Edinburgh, United Kingdom	10627995		PPHOE	Article	Final		Scopus	2-s2.0-84890551873
Kuroiwa K., Ohura S.-I., Morisada S., Ohto K., Kawakita H., Matsuo Y., Fukuda D.	Recovery of germanium from waste solar panels using ion-exchange membrane and solvent extraction	2014	Minerals Engineering	55			181	185	10.1016/j.mineng.2013.10.002	https://www.scopus.com/inward/record.uri?eid=2-s2.0-84887496781&doi=10.1016%2fj.mineng.2013.10.002&partnerID=40&md5=7b910a0767645023a97eb9a964e679e6	Department of Applied Chemistry, Saga University, Saga 840-8502, Japan; NT Corporation, 1542-2 Tachibana, Imari 848-0027, Japan	08926875		MENGE	Article	Final		Scopus	2-s2.0-84887496781
Pa P.S.	A reuse evaluation for solar-cell silicon wafers via shift revolution and tool rotation using magnetic assistance in ultrasonic electrochemical micromachining	2013	International Journal of Photoenergy	2013		293859			10.1155/2013/293859	https://www.scopus.com/inward/record.uri?eid=2-s2.0-84893742939&doi=10.1155%2f2013%2f293859&partnerID=40&md5=4ccc4668ec1d437f16f83f35921248b4	Department of Digital Content Design, Graduate School of Toy and Game Design, National Taipei University of Education, No. 134, Heping E. Road, Taipei City 106, Taiwan	1110662X			Article	Final	All Open Access, Gold	Scopus	2-s2.0-84893742939
Bartosinski M., Friedrich B., Weyhe R.	PHOTOREC - Recycling of EOL thin film solar panels by microwave heating	2013	European Metallurgical Conference, EMC 2013				1280	1281		https://www.scopus.com/inward/record.uri?eid=2-s2.0-84884944070&partnerID=40&md5=c1f4d177e4e430e376148b4c7a5b2fc3	RWTH Aachen University, IME Process Metallurgy and Metal Recycling, Intzestraße 3, 52062 Aachen, Germany; Accurec Recycling GmbH, Wiehagen 12-14, 45472 Mülheim, Germany				Conference Paper	Final		Scopus	2-s2.0-84884944070
Zhang J., Lv F., Ma L.Y., Yang L.J.	The status and trends of crystalline silicon PV module recycling treatment methods in Europe and China	2013	Advanced Materials Research	724-725			200	204	10.4028/www.scientific.net/AMR.724-725.200	https://www.scopus.com/inward/record.uri?eid=2-s2.0-84884809783&doi=10.4028%2fwww.scientific.net%2fAMR.724-725.200&partnerID=40&md5=a1eca5b6fe4887a4cdb1521d72346d34	Institute of Electrical Engineering, Chinese Academy of Sciences, Zhongguancun Bei'ertiao No.6, HaiDian District, Beijing, China; Beijing Jikedian Renewable Energy Development Center, Zhongguancun Bei'ertiao No.6, HaiDian District, Beijing, China	10226680	9783037857410		Conference Paper	Final		Scopus	2-s2.0-84884809783
Sinha P.	Life cycle materials and water management for CdTe photovoltaics	2013	Solar Energy Materials and Solar Cells	119			271	275	10.1016/j.solmat.2013.08.022	https://www.scopus.com/inward/record.uri?eid=2-s2.0-84884907147&doi=10.1016%2fj.solmat.2013.08.022&partnerID=40&md5=8a380b5dda49fbda67b11cb0782a6dc1	First Solar, 350 West Washington Street, Tempe, AZ, United States	09270248		SEMCE	Article	Final		Scopus	2-s2.0-84884907147
Dervišević I., Minic D., Kolarevic M., Kamberovic Z., Ristic M.	Study on properties of alloys with gallium, antimony and zinc from recycling	2013	Ecological Chemistry and Engineering S	20	3		579	599	10.2478/eces-2013-0042	https://www.scopus.com/inward/record.uri?eid=2-s2.0-84892150051&doi=10.2478%2feces-2013-0042&partnerID=40&md5=caddb7e84719f0b7591e66fe5dab8950	Faculty of Technical Science, University of Priština, Kos-Mitrovica, Serbia; Faculty of Mechanical Engineering, University of Kragujevac, Kraljevo, Serbia; Faculty of Technology and Metallurgy, University of Belgrade, Serbia	18986196			Article	Final	All Open Access, Bronze, Green	Scopus	2-s2.0-84892150051
Anctil A., Fthenakis V.	Critical metals in strategic photovoltaic technologies: Abundance versus recyclability	2013	Progress in Photovoltaics: Research and Applications	21	6		1253	1259	10.1002/pip.2308	https://www.scopus.com/inward/record.uri?eid=2-s2.0-84883053696&doi=10.1002%2fpip.2308&partnerID=40&md5=ee49221af8a25337a8b305cd632f7f1a	PV Environmental Research Center, Brookhaven National Laboratory, Upton, NY, United States; Center for Life Cycle Analysis, Columbia University, New York, NY, United States	10627995		PPHOE	Conference Paper	Final		Scopus	2-s2.0-84883053696
Bonoli A., Pompei A.	State of the art of recycling of photovoltaic panels using separation technology	2013	Separating Pro-Environment Technologies for Waste Treatment, Soil and Sediments Remediation				90	108	10.2174/97816080547251120101	https://www.scopus.com/inward/record.uri?eid=2-s2.0-84884448369&doi=10.2174%2f97816080547251120101&partnerID=40&md5=23aeba28f2ac8cf17cb00d467a96c6a8	Department of Civil Environment Materials Engineering, University of Bologna, Via Terracini, 28, Bologna, Italy		9781608055982		Book Chapter	Final	All Open Access, Bronze	Scopus	2-s2.0-84884448369

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Takemura H., Morisada S., Ohto K., Kawakita H., Matsuo Y., Fukuda D.	Germanium recovery by catechol complexation and subsequent flow through membrane and bead-packed bed column	2013	Journal of Chemical Technology and Biotechnology	88	8		1468	1472	10.1002/jctb.3985	https://www.scopus.com/inward/record.uri?eid=2-s2.0-84879886386&doi=10.1002%2fjctb.3985&partnerID=40&md5=5db51f9777adc5a2163e33a71bbbb8a1	Department of Applied Chemistry, Saga University, Saga, 840-8502, Japan; NT Corporation, 1542-2 Tachibana, Imari, 848-0027, Japan	02682575		JCTBD	Article	Final		Scopus	2-s2.0-84879886386
Woodhouse M., Goodrich A., Margolis R., James T., Dhere R., Gessert T., Barnes T., Eggert R., Albin D.	Perspectives on the pathways for cadmium telluride photovoltaic module manufacturers to address expected increases in the price for tellurium	2013	Solar Energy Materials and Solar Cells	115			199	212	10.1016/j.solmat.2012.03.023	https://www.scopus.com/inward/record.uri?eid=2-s2.0-84859929942&doi=10.1016%2fj.solmat.2012.03.023&partnerID=40&md5=002816b75eb6871a9d587dba4a8a9416	The National Renewable Energy Lab, Strategic Energy Analysis Center, 1617 Cole Blvd, Golden, CO 80401, United States; Colorado School of Mines United States, United States; The National Renewable Energy Laboratory, National Center for Photovoltaics, 1617 Cole Blvd, Golden, CO 80401, United States	09270248		SEMCE	Article	Final		Scopus	2-s2.0-84859929942
[No author name available]	2013 3rd International Conference on Mechatronics and Intelligent Materials, MIM 2013	2013	Advanced Materials Research	706-708						https://www.scopus.com/inward/record.uri?eid=2-s2.0-84879980333&partnerID=40&md5=0b908503edeea2a1a58b1d1679094908		10226680	9783037857106		Conference Review	Final		Scopus	2-s2.0-84879980333
Giacchetta G., Leporini M., Marchetti B.	Evaluation of the environmental benefits of new high value process for the management of the end of life of thin film photovoltaic modules	2013	Journal of Cleaner Production	51			214	224	10.1016/j.jclepro.2013.01.022	https://www.scopus.com/inward/record.uri?eid=2-s2.0-84879972185&doi=10.1016%2fj.jclepro.2013.01.022&partnerID=40&md5=8a9c6f358dca02a0d39063b259ae1738	Dipartimento di Ingegneria Industriale, Università Politecnica Delle Marche, Italy; Facoltà di Ingegneria, Università Degli Studi ECampus, Novedrate, Italy	09596526		JCROE	Article	Final		Scopus	2-s2.0-84879972185
Marwede M., Berger W., Schlummer M., Mäurer A., Reller A.	Recycling paths for thin-film chalcogenide photovoltaic waste - Current feasible processes	2013	Renewable Energy	55			220	229	10.1016/j.renene.2012.12.038	https://www.scopus.com/inward/record.uri?eid=2-s2.0-84872855615&doi=10.1016%2fj.renene.2012.12.038&partnerID=40&md5=e956689783beebf0625fa61f66085412	Technische Universität Berlin, Forschungsschwerpunkt Technologien der Mikroperipherik, Gustay-Meyer-Allee 25, 13355 Berlin, Germany; Bundesanstalt für Materialforschung und -prüfung, Unter den Eichen 87, 12205 Berlin, Germany; Fraunhofer-Institut für Verfahrenstechnik und Verpackung, Giggenhauser Straße 35, 85354 Freising, Germany; Lehrstuhl für Ressourcenstrategie, Wissenschaftszentrum Umwelt, Institut für Physik, Universitätsstr. 1a, 86159 Augsburg, Germany	09601481			Review	Final		Scopus	2-s2.0-84872855615
Goodrich A., Hacke P., Wang Q., Sopori B., Margolis R., James T.L., Woodhouse M.	A wafer-based monocrystalline silicon photovoltaics road map: Utilizing known technology improvement opportunities for further reductions in manufacturing costs	2013	Solar Energy Materials and Solar Cells	114			110	135	10.1016/j.solmat.2013.01.030	https://www.scopus.com/inward/record.uri?eid=2-s2.0-84876163809&doi=10.1016%2fj.solmat.2013.01.030&partnerID=40&md5=ecab1fc35f4017fa8a7169aa5aaa070c	National Renewable Energy Laboratory, Golden, CO, United States	09270248		SEMCE	Article	Final		Scopus	2-s2.0-84876163809
Simon F.-G., Holm O., Berger W.	Resource recovery from urban stock, the example of cadmium and tellurium from thin film module recycling	2013	Waste Management	33	4		942	947	10.1016/j.wasman.2012.12.025	https://www.scopus.com/inward/record.uri?eid=2-s2.0-84875812874&doi=10.1016%2fj.wasman.2012.12.025&partnerID=40&md5=1e1a97dc3dec2f7b9470cf3cecae29a0	BAM Federal Institute for Materials Research and Testing, Division 4.3 Contaminant Transfer and Environmental Technologies, Unter den Eichen 87, 12205 Berlin, Germany	0956053X		WAMAE	Article	Final		Scopus	2-s2.0-84875812874
Coffey V.C.	Photonics companies go green, naturally	2013	Photonics Spectra	47	3		40	42		https://www.scopus.com/inward/record.uri?eid=2-s2.0-84875358548&partnerID=40&md5=dd3cfa41d8d62269d69b97babe2cba54		07311230		PHSAD	Article	Final		Scopus	2-s2.0-84875358548
Chiang Y.-F., Chen R.-T., Shen P.-S., Chen P., Guo T.-F.	Extension lifetime for dye-sensitized solar cells through multiple dye adsorption/desorption process	2013	Journal of Power Sources	225			257	262	10.1016/j.jpowsour.2012.10.052	https://www.scopus.com/inward/record.uri?eid=2-s2.0-84868558164&doi=10.1016%2fj.jpowsour.2012.10.052&partnerID=40&md5=0cf984db42d5c2e307f79993a8689cc5	Department of Photonics, National Cheng Kung University, Tainan, 701, Taiwan; Department of Electro-Optical Engineering, Southern Taiwan University of Science and Technology, Tainan, Taiwan 701, Taiwan; Advanced Optoelectronic Technology Center, National Cheng Kung University, Tainan, 701, Taiwan	03787753		JPSOD	Article	Final		Scopus	2-s2.0-84868558164
Wybo J.-L.	Large-scale photovoltaic systems in airports areas: Safety concerns	2013	Renewable and Sustainable Energy Reviews	21			402	410	10.1016/j.rser.2013.01.009	https://www.scopus.com/inward/record.uri?eid=2-s2.0-84873371635&doi=10.1016%2fj.rser.2013.01.009&partnerID=40&md5=c75b183e1e41227dace56cc440f94434	MINES PARISTECH, Research Centre Risk and Crisis, CS 10207, 06904 Sophia Antipolis Cedex, France	13640321		RSERF	Review	Final		Scopus	2-s2.0-84873371635
Beliën J., De Boeck L., Colpaert J., Cooman G.	The best time to invest in photovoltaic panels in Flanders	2013	Renewable Energy	50			348	358	10.1016/j.renene.2012.06.047	https://www.scopus.com/inward/record.uri?eid=2-s2.0-84864238288&doi=10.1016%2fj.renene.2012.06.047&partnerID=40&md5=501459b762f45c4d540ea0a082f41506	HUBrussel, Center for Informatics, Modeling and Simulation, Warmoesberg 26, 1000 Brussels, Belgium; KU Leuven, Research Center for Operations Management, Naamsestraat 69, 3000 Leuven, Belgium	09601481			Article	Final	All Open Access, Green	Scopus	2-s2.0-84864238288
Cheng-Yu W., Fei S., Shi-Hong P., Chun-Sheng R., Ying T., Wang P.W.	Glass coating removal by atmospheric oxygen plasma	2013	Advanced Materials Research	629			19	24	10.4028/www.scientific.net/AMR.629.19	https://www.scopus.com/inward/record.uri?eid=2-s2.0-84872901682&doi=10.4028%2fwww.scientific.net%2fAMR.629.19&partnerID=40&md5=7dc770d50c4e203efcba5aa81bbc83de	Institute of Glass and New Inorganic Materials, Dalian Polytechnic University, Dalian, 116034, China; School of Chemical Engineering and Materials, Dalian Polytechnic University, Dalian, 116034, China; China Building Materials Academy, Beijing 100024, China; School of Physics and Optoelectronic Technology, Dalian University of Technology, Dalian, 116023, China; Bradley University, Peoria, IL 61625, United States	10226680	9783037855768		Conference Paper	Final		Scopus	2-s2.0-84872901682
Molina M.G., Juanicó L.E.	Recent advances in thermoelectric power generation: Stand-alone and grid-connected applications	2013	Advances in Energy Research. Volume 8				1	57		https://www.scopus.com/inward/record.uri?eid=2-s2.0-85108922871&partnerID=40&md5=65d662b3ab7a8811ff0f623ffe874288	CONICET, Instituto de Energía Eléctrica, Universidad Nacional de San Juan, San Juan, Argentina; CONICET, Centro Atómico Bariloche, Comisión Nacional de Energía Atómica, Río Negro, Argentina		9781620814864		Book Chapter	Final		Scopus	2-s2.0-85108922871

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Kim Y.-D., Thu K., Ghaffour N., Choon Ng K.	Performance investigation of a solar-assisted direct contact membrane distillation system	2013	Journal of Membrane Science	427			345	364	10.1016/j.memsci.2012.10.008	https://www.scopus.com/inward/record.uri?eid=2-s2.0-84871807392&doi=10.1016%2fj.memsci.2012.10.008&partnerID=40&md5=b205adbfbfb66c3636574dc95a01ad21	Water Desalination and Reuse Center, 4700 King Abdullah University of Science and Technology, Thuwal 23955-6900, Saudi Arabia; Department of Mechanical Engineering, National University of Singapore, 10 Kent Ridge Crescent, Singapore 117576, Singapore	03767388		JMESD	Article	Final	All Open Access, Green	Scopus	2-s2.0-84871807392
Chatterjee S., Dutta S., Basu S.	Removal and recovery of cadmium (II) using immobilized papain	2013	Recycling and Reuse of Materials and Their Products				125	142		https://www.scopus.com/inward/record.uri?eid=2-s2.0-85054691577&partnerID=40&md5=537453aef8c5a334e2c5922adbcec131	Research Fellow Department of Chemical Engineering, National Institute of Technology, Durgapur, West Bengal 713209, India; Department of Chemical Engineering, National Institute of Technology, Durgapur, Durgapur, 713209, India; Department of Biotechnology, Heritage Institute of Technology, Kolkata, 700107, India				Book Chapter	Final		Scopus	2-s2.0-85054691577
Heyer S., Steingrimsson J.G., Seliger G.	Identification and promotion of effective and efficient product and material cycles via crowdsourcing	2013	Re-Engineering Manufacturing for Sustainability - Proceedings of the 20th CIRP International Conference on Life Cycle Engineering				329	333	10.1007/978-981-4451-48-2_54	https://www.scopus.com/inward/record.uri?eid=2-s2.0-84926143661&doi=10.1007%2f978-981-4451-48-2_54&partnerID=40&md5=5968a855ae269067867a921ff42c4961	Institute of Machine Tools and Factory Management, Technische Universität Berlin, Berlin, Germany		9789814451475		Conference Paper	Final		Scopus	2-s2.0-84926143661
Palitzsch W., Loser U.	Systematic photovoltaic waste recycling	2013	Green	3	1		79	82	10.1515/green-2013-0008	https://www.scopus.com/inward/record.uri?eid=2-s2.0-84902181221&doi=10.1515%2fgreen-2013-0008&partnerID=40&md5=91e368a51bac392c4b8bd419b74a46c5	Loser Chemie GmbH, 08134 Langenweißbach, Germany	1869876X			Article	Final		Scopus	2-s2.0-84902181221
Di Francia G.	The impact of recycling policies on the photovoltaic Levelized Cost of the Electricity	2013	Proceedings of 2013 International Conference on Renewable Energy Research and Applications, ICRERA 2013			6749894	979	983	10.1109/ICRERA.2013.6749894	https://www.scopus.com/inward/record.uri?eid=2-s2.0-84899106963&doi=10.1109%2fICRERA.2013.6749894&partnerID=40&md5=7f9032cf1157ab5e234ebc4d96d19d0b	ENEA, P.le E. Fermi, 1, 80055 Portici (Napoli), Italy				Conference Paper	Final		Scopus	2-s2.0-84899106963
Dubey S., Jadhav N.Y., Zakirova B.	Socio-economic and environmental impacts of silicon based photovoltaic (PV) technologies	2013	Energy Procedia	33			322	334	10.1016/j.egypro.2013.05.073	https://www.scopus.com/inward/record.uri?eid=2-s2.0-84897541458&doi=10.1016%2fj.egypro.2013.05.073&partnerID=40&md5=ee5e3979f7a6db6a1e6a4692a51a9029	Energy Research Institute, Nanyang Technological University (ERI N), 06-04 CleanTech One, 1 CleanTech Loop, Singapore 637141, Singapore	18766102			Conference Paper	Final	All Open Access, Gold	Scopus	2-s2.0-84897541458
Abdul Hadi S., Al Kaabi M.R., Al Ali M.O., Arafat H.A.	Comparative Life Cycle Assessment (LCA) of streetlight technologies for minor roads in united arab emirates	2013	Energy for Sustainable Development	17	5		438	450	10.1016/j.esd.2013.05.001	https://www.scopus.com/inward/record.uri?eid=2-s2.0-84884816248&doi=10.1016%2fj.esd.2013.05.001&partnerID=40&md5=41df093093ca67a2610690e578cb4298	Water and Environmental Engineering Program, Masdar Institute of Science and Technology, P.O. Box 54224, Abu Dhabi, United Arab Emirates	09730826			Article	Final		Scopus	2-s2.0-84884816248
Simões C.L., Simoes R., Carvalho J., Pontes A.J., Bernardo C.A.	The quest for a sustainable product: An environmental study of tyre recyclates	2013	Materials and Design	52			196	206	10.1016/j.matdes.2013.05.051	https://www.scopus.com/inward/record.uri?eid=2-s2.0-84879354873&doi=10.1016%2fj.matdes.2013.05.051&partnerID=40&md5=40ef043c32025055ceaa08cb3d080f9c	Institute for Polymers and Composites - IPC/I3N, University of Minho, Campus de Azurém, 4800-058 Guimarães, Portugal; School of Technology, Polytechnic Institute of Cavado and Ave, Campus do IPCA, 4750-810 Barcelos, Portugal; Biosafe, S.A., EN 109, km 31, Lugar da Pardala, 3881-902 Ovar, Portugal; Innovation in Polymer Engineering - PIEP, University of Minho, Campus de Azurém, 4800-058 Guimarães, Portugal	02613069			Article	Final		Scopus	2-s2.0-84879354873
Sinha P., Meader A., De Wild-Scholten M.	Life cycle water usage in CdTe photovoltaics	2013	IEEE Journal of Photovoltaics	3	1	6313879	429	432	10.1109/JPHOTOV.2012.2214375	https://www.scopus.com/inward/record.uri?eid=2-s2.0-84871794856&doi=10.1109%2fJPHOTOV.2012.2214375&partnerID=40&md5=cb20d8bb42dbaa9c0f3a2f2a7c867396	First Solar, Tempe, AZ 85281, United States; First Solar, Perrysburg, OH 43551, United States; Smart Green Scans, Groet 1873GH, Netherlands	21563381			Article	Final		Scopus	2-s2.0-84871794856
Caron J.R., Littmann B.	Direct monitoring of energy lost due to soiling on first solar modules in California	2013	IEEE Journal of Photovoltaics	3	1	6338994	336	340	10.1109/JPHOTOV.2012.2216859	https://www.scopus.com/inward/record.uri?eid=2-s2.0-84871781166&doi=10.1109%2fJPHOTOV.2012.2216859&partnerID=40&md5=4d073b25c85c442c10fe9280266b3650	First Solar, San Francisco, CA 94105, United States	21563381			Article	Final		Scopus	2-s2.0-84871781166
Drouiche N., Naceur M.W., Ouslimane T.	Preliminary study of the regeneration of photovoltaic cells cutting oil by ultrafiltration reinforced by a chemical pretreatment	2012	CHISA 2012 - 20th International Congress of Chemical and Process Engineering and PRES 2012 - 15th Conference PRES							https://www.scopus.com/inward/record.uri?eid=2-s2.0-84874826996&partnerID=40&md5=cab51e3c4076c52cc3e3be1a6047ac2b	Silicon Technology Development Unit, Department of Environmental Engineering, 2, Bd Frantz Fanon BP140 Alger-7-mervielles, 16000, Algiers, Algeria; Department of Chemical Engineering, Saad Dahlab University of Blida, Blida, Algeria				Conference Paper	Final		Scopus	2-s2.0-84874826996

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Nieland S., Neuhaus U., Pfaff T., Radlein E.	New approaches for component recycling of crystalline solar modules	2012	Electronics Goes Green 2012+, ECG 2012 - Joint International Conference and Exhibition, Proceedings			6360552				https://www.scopus.com/inward/record.uri?eid=2-s2.0-84871832219&partnerID=40&md5=9e261998944e61517c000367f4b9374b	CiS Forschungsinstitut für Mikrosensorik und Photovoltaik GmbH, Konrad-Zuse-Straße 14, 99099 Erfurt, Germany; Technische Universität Ilmenau, Institut für Werkstofftechnik, Postfach 100565, 98684, Germany		9783839604397		Conference Paper	Final		Scopus	2-s2.0-84871832219
Gómez V., Lange A., Clyncke J.	Collective implementation of the take-back and recycling obligation for end-of-life PV panels: Experience of the European system	2012	Electronics Goes Green 2012+, ECG 2012 - Joint International Conference and Exhibition, Proceedings			6360553				https://www.scopus.com/inward/record.uri?eid=2-s2.0-84871830120&partnerID=40&md5=0d753389abebff84fd907e973e169987	PV CYCLE Aisbl, rue d Arlon 63-67, 1000, Brussels, Belgium		9783839604397		Conference Paper	Final		Scopus	2-s2.0-84871830120
Marwede M., Reller A.	Future recycling flows of tellurium from cadmium telluride photovoltaic waste	2012	Resources, Conservation and Recycling	69			35	49	10.1016/j.resconrec.2012.09.003	https://www.scopus.com/inward/record.uri?eid=2-s2.0-84867137101&doi=10.1016%2fj.resconrec.2012.09.003&partnerID=40&md5=300d94f38489a597a0932ef665a1686c	Technische Universität Berlin, Forschungsschwerpunkt Technologien der Mikroperipherik, Gustav-Meyer-Allee 25, 13355 Berlin, Germany; Lehrstuhl für Ressourcenstrategie, Wissenschaftszentrum Umwelt, Institut für Physik, Universitätsstr. 1a, 86159 Augsburg, Germany	09213449		RCREE	Article	Final	All Open Access, Green	Scopus	2-s2.0-84867137101
Wang T.-Y., Hsiao J.-C., Du C.-H.	Recycling of materials from silicon base solar cell module	2012	Conference Record of the IEEE Photovoltaic Specialists Conference			6318071	2355	2358	10.1109/PVSC.2012.6318071	https://www.scopus.com/inward/record.uri?eid=2-s2.0-84869421495&doi=10.1109%2fPVSC.2012.6318071&partnerID=40&md5=48fa7352d0f3211c05dcbb3c0bac4c93	Green Energy and Environment Research Labs, Industrial Technology Research Institute, Hsinchu, 31040, Taiwan; Department of Photonic, Institute of Electro-Optical Engineering, National Chiao Tung University, Hsinchu, 30010, Taiwan; Institute of NanoEngineering and MicroSystems, National Tsing Hua University, Hsinchu, 30013, Taiwan	01608371	9781467300643	CRCND	Conference Paper	Final		Scopus	2-s2.0-84869421495
Palitzsch W., Loser U.	Economic PV waste recycling solutions -Results from R&D and practice	2012	Conference Record of the IEEE Photovoltaic Specialists Conference			6317689	628	631	10.1109/PVSC.2012.6317689	https://www.scopus.com/inward/record.uri?eid=2-s2.0-84869414677&doi=10.1109%2fPVSC.2012.6317689&partnerID=40&md5=c0f7e7d2f7efb793676ba0346c2edee1	Loser Chemie GmbH, Bahnhofstraße 10, 08134 Langenweißbach, Germany	01608371	9781467300643	CRCND	Conference Paper	Final		Scopus	2-s2.0-84869414677
Doni A., Dughiero F.	Electrothermal heating process applied to c-Si PV recycling	2012	Conference Record of the IEEE Photovoltaic Specialists Conference			6317715	757	762	10.1109/PVSC.2012.6317715	https://www.scopus.com/inward/record.uri?eid=2-s2.0-84869392553&doi=10.1109%2fPVSC.2012.6317715&partnerID=40&md5=6266938e8a57247ab61491a875c89613	Department of Industrial Engineering, University of Padova, Padova, 35131, Italy	01608371	9781467300643	CRCND	Conference Paper	Final		Scopus	2-s2.0-84869392553
Kang S., Yoo S., Lee J., Boo B., Ryu H.	Experimental investigations for recycling of silicon and glass from waste photovoltaic modules	2012	Renewable Energy	47			152	159	10.1016/j.renene.2012.04.030	https://www.scopus.com/inward/record.uri?eid=2-s2.0-84860999810&doi=10.1016%2fj.renene.2012.04.030&partnerID=40&md5=1dc027544634623f751f78d9d08b4a7c	Energy Materials Research Center, Korea Research Institute of Chemical Technology, Yuseong, Daejeon 305-600, South Korea; Department of Chemistry, Chungnam National University, Yuseong, Daejeon 305-764, South Korea	09601481			Article	Final		Scopus	2-s2.0-84860999810
Fu Y., Lv Z., Wu H., Hou S., Cai X., Wang D., Zou D.	Dye-sensitized solar cell tube	2012	Solar Energy Materials and Solar Cells	102			212	219	10.1016/j.solmat.2012.03.029	https://www.scopus.com/inward/record.uri?eid=2-s2.0-84861097348&doi=10.1016%2fj.solmat.2012.03.029&partnerID=40&md5=a72a8f96abac144556e1db9a53e71814	Beijing National Laboratory for Molecular Sciences, College of Chemistry and Molecular Engineering, Peking University, Beijing 100871, China	09270248		SEMCE	Article	Final		Scopus	2-s2.0-84861097348
Fthenakis V.	Sustainability metrics for extending thin-film photovoltaics to terawatt levels	2012	MRS Bulletin	37	4		425	430	10.1557/mrs.2012.50	https://www.scopus.com/inward/record.uri?eid=2-s2.0-84860541427&doi=10.1557%2fmrs.2012.50&partnerID=40&md5=d6d88fd2a1f6c4ada6a545dee2f96582	Brookhaven National Laboratory, Columbia University, United States	08837694		MRSBE	Article	Final	All Open Access, Bronze	Scopus	2-s2.0-84860541427
Raugei M., Isasa M., Palmer P.F.	Potential Cd emissions from end-of-life CdTe PV	2012	International Journal of Life Cycle Assessment	17	2		192	198	10.1007/s11367-011-0348-9	https://www.scopus.com/inward/record.uri?eid=2-s2.0-84863085142&doi=10.1007%2fs11367-011-0348-9&partnerID=40&md5=2967fd1285d86246fa9e16b558075cd2	UNESCO of Life Cycle and Climate Change, Escola Superior de Comerç Internacional (ESCI), Universitat Pompeu Fabra, Pg. Pujades 1, 08003 Barcelona, Spain	09483349		IJLCF	Article	Final		Scopus	2-s2.0-84863085142
Sinha P., Meader A., De Wild-Scholten M.	Life cycle water usage in CdTe photovoltaics	2012	Conference Record of the IEEE Photovoltaic Specialists Conference		PART 2	2214375			10.1109/pvsc-vol2.2012.6656781	https://www.scopus.com/inward/record.uri?eid=2-s2.0-84891279122&doi=10.1109%2fpvsc-vol2.2012.6656781&partnerID=40&md5=8ee8871dd25e83720b8a4ac02cb65d75	First Solar, Tempe, AZ 85281, United States; First Solar, Perrysburg, OH 43551, United States; SmartGreenScans, Groet 1873GH, Netherlands	01608371	9781467328883	CRCND	Conference Paper	Final		Scopus	2-s2.0-84891279122
Lin K.-L., Chu T.-C., Cheng C.-J., Lee C.-H., Chang T.-C., Wang K.-S.	Recycling solar panel waste glass sintered as glass-ceramics	2012	Environmental Progress and Sustainable Energy	31	4		612	618	10.1002/ep.10587	https://www.scopus.com/inward/record.uri?eid=2-s2.0-84867746575&doi=10.1002%2fep.10587&partnerID=40&md5=fbaa48e6096dc2cd2cb48b0cfb4e406c	Department of Environmental Engineering, Center of Green Technology, National Ilan University, Yi-Lan City, 26047, Taiwan; Graduate Institute of Environmental Engineering, National Central University, Chung-Li 320, Taiwan; Department of Environmental Engineering, Da-Yeh University, Chang-Hua 515, Taiwan; Institute of Environmental Engineering and Management, National Taipei University of Technology, Taipei, Taiwan	19447442		ENVPD	Article	Final		Scopus	2-s2.0-84867746575
Klugmann-Radziemska E.	Recycling and reuse treatment technologies for photovoltaic cells and modules-A review	2011	Recycling: Processes, Costs and Benefits				205	221		https://www.scopus.com/inward/record.uri?eid=2-s2.0-84895226194&partnerID=40&md5=cc4ca2fc7edcc2b281886e95bbb6f0a1	Gdansk University of Technology, Chemical Faculty, Narutowicza 11/12, PL80-233 Gdansk, Poland		9781612095073		Book Chapter	Final		Scopus	2-s2.0-84895226194

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Authors	Title	Year	Source Title	Volume	Issue	Art. No.	Page Start	Page End	DOI	Link	Affiliations	ISSN	ISBN	CODEN	Document Type	Publication Stage	Open Access	Source	EID
Kuzevic S., Kuzevicova Z., Hojdova M., Pusztai A., Sikorska Z.	Environmental aspects of photovoltaic systems utilization	2011	11th International Multidisciplinary Scientific Geoconference and EXPO - Modern Management of Mine Producing, Geology and Environmental Protection, SGEM 2011	3			47	52		https://www.scopus.com/inward/record.uri?eid=2-s2.0-84890711291&partnerID=40&md5=67bc0b504f25c55b4a8de372401942ac	Centre of Renewable Energy, Institute of Business and Management, Ecology, Process Control and Geotechnologies, Technical University of Kosice, Slovakia; Institute of Geodesy, Cartography and GIS, Ecology, Process Control and Geotechnologies, Technical University of Kosice, Slovakia				Conference Paper	Final		Scopus	2-s2.0-84890711291
Palitzsch W., Loser U.	A new and intelligent de-metalization step of broken silicon cells and silicon cell production waste in the recycling procedure of crystalline Si modules	2011	Conference Record of the IEEE Photovoltaic Specialists Conference			6186635	3269	3270	10.1109/PVSC.2011.6186635	https://www.scopus.com/inward/record.uri?eid=2-s2.0-84861014875&doi=10.1109%2fPVSC.2011.6186635&partnerID=40&md5=badb5a216e91dec77dd69d4ededc1e11	Loser Chemie GmbH, Bahnhofstraße 10, 08134 Langenweißbach, Germany	01608371	9781424499656	CRCND	Conference Paper	Final		Scopus	2-s2.0-84861014875
Shiu S.-C., Lin T.-C., Pun K.-L., Syu H.-J., Hung S.-C., Lin C.-F.	Fabrication of multiple Si nanohole thin films from bulk wafer by controlling metal-assisted etching direction	2011	Proceedings of SPIE - The International Society for Optical Engineering	8102		810217			10.1117/12.893275	https://www.scopus.com/inward/record.uri?eid=2-s2.0-80054072118&doi=10.1117%2f12.893275&partnerID=40&md5=e8ff0aa7e22a3ab4d09412ca4406d592	Graduate Institute of Photonics and Optoelectronics, National Taiwan University, Taipei, 10617, Taiwan; Department of Electrical Engineering, National Taiwan University, Taipei, 10617, Taiwan	0277786X	9780819487124	PSISD	Conference Paper	Final		Scopus	2-s2.0-80054072118
Wang S.	Tellurium, its resourcefulness and recovery	2011	JOM	63	8		90	93	10.1007/s11837-011-0146-7	https://www.scopus.com/inward/record.uri?eid=2-s2.0-80052984613&doi=10.1007%2fs11837-011-0146-7&partnerID=40&md5=c06f2bbd846b79ccf8e042e07b71d899	Rio Tinto Kennecott Utah Copper, Magna, UT, United States	10474838		JOMME	Review	Final		Scopus	2-s2.0-80052984613
Zhong Z.W., Song B., Loh P.E.	LCAs of a polycrystalline photovoltaic module and a wind turbine	2011	Renewable Energy	36	8		2227	2237	10.1016/j.renene.2011.01.021	https://www.scopus.com/inward/record.uri?eid=2-s2.0-79952450794&doi=10.1016%2fj.renene.2011.01.021&partnerID=40&md5=4881baf306c4fc9b0a02d18b9e76f0ce	School of Mechanical and Aerospace Engineering, Nanyang Technological University, 50 Nanyang Avenue, Singapore 639798, Singapore; Singapore Institute of Manufacturing Technology, 71 Nanyang Drive, Singapore 638075, Singapore	09601481			Article	Final		Scopus	2-s2.0-79952450794
Martinson M., Van Den Brand M.	Remediation: An evolution to sustainable environmental practices	2011	International Conference on Health, Safety and Environment in Oil and Gas Exploration and Production				375	381		https://www.scopus.com/inward/record.uri?eid=2-s2.0-79960083753&partnerID=40&md5=fb79c04ddd3c8f50de03b125a275ef3d	Antea Group, Belgium		9781617823879		Conference Paper	Final		Scopus	2-s2.0-79960083753
Žák P., Tučan M., Kudláček I.	Recyklace funkčních prvků solární elektrárny	2011	Proceedings of the 12th International Scientific Conference Electric Power Engineering 2011, EPE 2011				339	342		https://www.scopus.com/inward/record.uri?eid=2-s2.0-84904740049&partnerID=40&md5=c22837cb7c3c6ea3f504631452be33d0	FEL ČVUT v Praze, Katedra Elektrotechnologie, Technická 2, 166 27 Praha 6-Dejvice, Taiwan		9788024823935		Conference Paper	Final		Scopus	2-s2.0-84904740049
Radziemska E., Ostrowski P., Cenian A., Sawczak M.	Chemical, thermal and laser processes in recycling of photovoltaic silicon solar cells and modules	2010	Ecological Chemistry and Engineering S	17	3		385	391		https://www.scopus.com/inward/record.uri?eid=2-s2.0-84860654923&partnerID=40&md5=7f25b62e11b9c89de36bdc0c027a0274	Chemical Faculty, Gdansk University of Technology, ul. G. Narutowicza 11/12, 80-233 Gdańsk, Poland; Institute of Fluid-Flow Machinery, Polish Academy of Science, ul. J. Fiszera 14, 80-233 Gdańsk, Poland	18986196			Article	Final		Scopus	2-s2.0-84860654923
Choi J.-K., Fthenakis V.	Economic Feasibility of Recycling Photovoltaic Modules: Survey and Model	2010	Journal of Industrial Ecology	14	6		947	964	10.1111/j.1530-9290.2010.00289.x	https://www.scopus.com/inward/record.uri?eid=2-s2.0-78449244416&doi=10.1111%2fj.1530-9290.2010.00289.x&partnerID=40&md5=34265d703e23d7d6a97e1db96b3cb02e	Brookhaven National Laboratory, Upton, NY, United States; University in New York City, New York, United States	10881980		JINEF	Article	Final		Scopus	2-s2.0-78449244416
Rockett A.A.	The future of energy - Photovoltaics	2010	Current Opinion in Solid State and Materials Science	14	6		117	122	10.1016/j.cossms.2010.09.003	https://www.scopus.com/inward/record.uri?eid=2-s2.0-78049278830&doi=10.1016%2fj.cossms.2010.09.003&partnerID=40&md5=8ac62751c6baaccbba019d297353ef6e	Department of Materials Science and Engineering, University of Illinois, 1304 W. Green St., Urbana, IL 61801, United States	13590286			Article	Final		Scopus	2-s2.0-78049278830
Klugmann-Radziemska E., Ostrowski P., Drabczyk K., Panek P., Szkodo M.	Experimental validation of crystalline silicon solar cells recycling by thermal and chemical methods	2010	Solar Energy Materials and Solar Cells	94	12		2275	2282	10.1016/j.solmat.2010.07.025	https://www.scopus.com/inward/record.uri?eid=2-s2.0-77957661298&doi=10.1016%2fj.solmat.2010.07.025&partnerID=40&md5=80ca3a015f301c7505c8555f35d140f9	Gdansk University of Technology, Chemical Faculty, Narutowicza 11/12, PL 80-233 Gdansk, Poland; Polish Academy of Sciences, Institute of Metallurgy and Materials Science, Poland; Gdansk University of Technology, Faculty of Mechanical Engineering, Poland	09270248		SEMCE	Article	Final		Scopus	2-s2.0-77957661298
McDonald N.C., Pearce J.M.	Producer responsibility and recycling solar photovoltaic modules	2010	Energy Policy	38	11		7041	7047	10.1016/j.enpol.2010.07.023	https://www.scopus.com/inward/record.uri?eid=2-s2.0-77957313779&doi=10.1016%2fj.enpol.2010.07.023&partnerID=40&md5=e0bcc2d61227af87c2e9b3326c6cb954	School of Environmental Studies, Queen's University, Canada; Department of Mechanical and Materials Engineering, Queen's University, 60 Union Street, Kingston, ON, K7L 3N6, Canada	03014215		ENPYA	Article	Final	All Open Access, Green	Scopus	2-s2.0-77957313779
Laronde R., Charki A., Bigaud D., Excoffier P.	Photovoltaic system lifetime prediction using Petri networks method	2010	Proceedings of SPIE - The International Society for Optical Engineering	7773		777306			10.1117/12.856110	https://www.scopus.com/inward/record.uri?eid=2-s2.0-77957834510&doi=10.1117%2f12.856110&partnerID=40&md5=d0bba9fdc6531092082436dedd3e65c3	LASQUO Laboratory, ISTIA, 62 Avenue Notre Dame du Lac, 49000 Angers, France; GINGER CEBTP, ZAC la Clé de Saint Pierre, 12 Avenue Gay Lussac, 78990 Elancourt, France	0277786X	9780819482693	PSISD	Conference Paper	Final		Scopus	2-s2.0-77957834510

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Berger W., Simon F.-G., Weimann K., Alsema E.A.	A novel approach for the recycling of thin film photovoltaic modules	2010	Resources, Conservation and Recycling	54	10		711	718	10.1016/j.resconrec.2009.12.001	https://www.scopus.com/inward/record.uri?eid=2-s2.0-77953347297&doi=10.1016%2fj.resconrec.2009.12.001&partnerID=40&md5=23c514ddf1d4f928df3814ff46d2ad57	BAM Federal Institute for Materials Research and Testing, Unter den Eichen 87, 12205 Berlin, Germany; Copernicus Institute of Sustainable Development and Innovation, Utrecht University, 3584 CS Utrecht, Netherlands	09213449		RCREE	Article	Final		Scopus	2-s2.0-77953347297
Klugmann-Radziemska E., Ostrowski P.	Chemical treatment of crystalline silicon solar cells as a method of recovering pure silicon from photovoltaic modules	2010	Renewable Energy	35	8		1751	1759	10.1016/j.renene.2009.11.031	https://www.scopus.com/inward/record.uri?eid=2-s2.0-77949566712&doi=10.1016%2fj.renene.2009.11.031&partnerID=40&md5=bdc4c80514b679aeb34a5779cb937261	Gdansk University of Technology, Chemical Faculty, PL80-233 Gdansk, Narutowicza 11/12, Poland	09601481			Article	Final		Scopus	2-s2.0-77949566712
Yoon J., Jo S., Chun I.S., Jung I., Kim H.-S., Meitl M., Menard E., Li X., Coleman J.J., Paik U., Rogers J.A.	GaAs photovoltaics and optoelectronics using releasable multilayer epitaxial assemblies	2010	Nature	465	7296		329	333	10.1038/nature09054	https://www.scopus.com/inward/record.uri?eid=2-s2.0-77952692175&doi=10.1038%2fnature09054&partnerID=40&md5=3fc47c8c4cb208bae601b0b9497dbf34	Department of Materials Science and Engineering, Beckman Institute for Advanced Science and Technology, University of Illinois at Urbana-Champaign, Urbana, IL 61801, United States; Department of Electrical and Computer Engineering, University of Illinois at Urbana-Champaign, Urbana, IL 61801, United States; Semprius, Inc., Durham, NC 27713, United States; Division of Materials Science Engineering, WCU Department of Energy Engineering, Hanyang University, Seoul 133-791, South Korea	00280836		NATUA	Article	Final		Scopus	2-s2.0-77952692175
Pa P.S.	Yield enhancement for the surface of solar-cell silicon wafers with electromechanical micromachining	2010	Electrochimica Acta	55	10		3504	3510	10.1016/j.electacta.2010.01.083	https://www.scopus.com/inward/record.uri?eid=2-s2.0-77749273442&doi=10.1016%2fj.electacta.2010.01.083&partnerID=40&md5=5bd4219800bf2566b2f19ae7aaf205d4	Department of Digital Content Design, Graduate School of Toy and Game Design, National Taipei University of Education, No. 134, Sec. 2, Heping E. Rd, Taipei City 106, Taiwan	00134686		ELCAA	Article	Final		Scopus	2-s2.0-77749273442
Thiaux Y., Seigneurbieux J., Multon B., Ben Ahmed H.	Load profile impact on the gross energy requirement of stand-alone photovoltaic systems	2010	Renewable Energy	35	3		602	613	10.1016/j.renene.2009.08.005	https://www.scopus.com/inward/record.uri?eid=2-s2.0-71549138711&doi=10.1016%2fj.renene.2009.08.005&partnerID=40&md5=87bcbfe708afa2750b3cae7ce280909f	SATIE, ENS CACHAN Bretagne, CNRS, Avenue Robert Schuman, F-35170 Bruz, France	09601481			Article	Final		Scopus	2-s2.0-71549138711
Mikolajczak C.	Availability of indium and gallium [Verfügbarkeit von Indium und Gallium]	2010	Galvanotechnik	101	2		390	392		https://www.scopus.com/inward/record.uri?eid=2-s2.0-77949287872&partnerID=40&md5=83e251bcf5ba2176341dedc9d07c03a0	Metalle und Chemikalien Indium Corporation, Germany	00164232		GVTKA	Article	Final		Scopus	2-s2.0-77949287872
Bravi M., Parisi M.L., Tiezzi E., Basosi R.	International journal of heat & technology: Life cycle assessment of advanced technologies for photovoltaic panels production	2010	International Journal of Heat and Technology	28	2		133	139		https://www.scopus.com/inward/record.uri?eid=2-s2.0-79954541706&partnerID=40&md5=ec6369946c79baa2024577294225e8ec	Polo Universitario Colle di Val d'Elsa, Via Matteotti 15, 53100 Siena, Italy; Department OfChemistry, University of Siena, Via A. Moro 2, 53100 Siena, Italy; Center for the Study of Complex Systems, Via Roma 56, 53100 Siena, Italy	03928764		HETEE	Article	Final		Scopus	2-s2.0-79954541706
Fischer A.L.	Flipping the switch: Trends in green applications	2010	Photonics Spectra	44	1					https://www.scopus.com/inward/record.uri?eid=2-s2.0-77955828709&partnerID=40&md5=b6cae38df283c3357757d6d21541be61		07311230		PHSAD	Article	Final		Scopus	2-s2.0-77955828709
Wohlmuth W.A.	Thin film CdTe module manufacturing	2009	2009 International Conference on Compound Semiconductor Manufacturing Technology, CS MANTECH 2009							https://www.scopus.com/inward/record.uri?eid=2-s2.0-84887469375&partnerID=40&md5=8bc54da524c904171f736a266cb2bddc	First Solar, Inc., 28101 Cedar Park Blvd., Perrysburg, OH 43551, United States				Conference Paper	Final		Scopus	2-s2.0-84887469375
Radziemska E., Ostrowski P., Seramak T.	Chemical treatment of crystalline silicon solar cells as a main stage of PV modules recycling	2009	Ecological Chemistry and Engineering S	16	3		379	387		https://www.scopus.com/inward/record.uri?eid=2-s2.0-84860679423&partnerID=40&md5=8c6a1f3bf62814e405cc13b0d88d8915	Gdansk University of Technology, Chemical Faculty, ul. Narutowicza 11/12, PL-80-233 Gdańsk, Poland; Gdansk University of Technology, Mechanical Faculty, ul. Narutowicza 11/12, PL-80-233 Gdańsk, Poland	18986196			Article	Final		Scopus	2-s2.0-84860679423
Zmeškal O., Štefková P., Hřebenová L., Bařinka R.	Pulse transient method as a tool for the study of thermal properties of solar cell laminating films	2009	International Journal of Thermophysics	30	6		1891	1901	10.1007/s10765-009-0687-y	https://www.scopus.com/inward/record.uri?eid=2-s2.0-74249098020&doi=10.1007%2fs10765-009-0687-y&partnerID=40&md5=7908de768978daa0f4bbdd67ad413622	Faculty of Chemistry, Institute of Physical and Applied Chemistry, Brno University of Technology, Purkyňova 118, Brno 61200, Czech Republic; Solartec S.r.o., Televizní 2618, Rožnov pod Radhoštěm 756 61, Czech Republic	0195928X		IJTHD	Article	Final		Scopus	2-s2.0-74249098020
Fthenakis V.	Sustainability of photovoltaics: The case for thin-film solar cells	2009	Renewable and Sustainable Energy Reviews	13	9		2746	2750	10.1016/j.rser.2009.05.001	https://www.scopus.com/inward/record.uri?eid=2-s2.0-68849086662&doi=10.1016%2fj.rser.2009.05.001&partnerID=40&md5=5e262802a2217068055b95aede715382	Photovoltaic Environmental Research Center, Brookhaven National Laboratory, Center for Life Cycle Analysis, Bldg. 130, Upton, NY 11973, United States	13640321		RSERF	Review	Final	All Open Access, Green	Scopus	2-s2.0-68849086662
Kushiya K.	Key near-term R&D issues for continuous improvement in CIS-based thin-film PV modules	2009	Solar Energy Materials and Solar Cells	93	6-7		1037	1041	10.1016/j.solmat.2008.11.063	https://www.scopus.com/inward/record.uri?eid=2-s2.0-67349200974&doi=10.1016%2fj.solmat.2008.11.063&partnerID=40&md5=22bb7a1a023c4e5ee876ee40d0f15195	Showa Shell Sekiyu K.K. and Showa Shell Solar K.K., 123-1 Shimo-Kawairi, Atsugi, Kanagawa, 243-0206, Japan	09270248		SEMCE	Article	Final		Scopus	2-s2.0-67349200974
Mezei A., Ashbury M., Canizares M., Molnar R., Given H., Meader A., Squires K., Ojebuoboh F., Jones T., Wang W.	Hydrometallurgical recycling of the semiconductor material from photovoltaic materials-part two; metal recovery	2008	Hydrometallurgy 2008: Proceedings of the 6th International Symposium				224	237		https://www.scopus.com/inward/record.uri?eid=2-s2.0-56449126424&partnerID=40&md5=f73d1a9e5134645b136de778f701de1b	SGS Minerals Services; First Solar, Inc.		9780873352666		Conference Paper	Final		Scopus	2-s2.0-56449126424

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Mezei A., Ashbury M., Canizares M., Molnar R., Given H., Meader A., Squires K., Ojebuoboh F., Jones T., Wang W.	Hydrometallurgical recycling of the semiconductor material from photovoltaic materials - Part one: Leaching	2008	Hydrometallurgy 2008: Proceedings of the 6th International Symposium				209	220		https://www.scopus.com/inward/record.uri?eid=2-s2.0-56449100175&partnerID=40&md5=29de0c335f2260885edec2ab7e151e0a	SGS Minerals Services; First Solar, Inc.		9780873352666		Conference Paper	Final		Scopus	2-s2.0-56449100175
Segebade C., Hedrich M., Haase O., Baede B.	Large sample activation analysis: Monitoring of photovoltaic module recycling using radioanalytical methods	2008	Journal of Radioanalytical and Nuclear Chemistry	276	1		29	33	10.1007/s10967-007-0405-9	https://www.scopus.com/inward/record.uri?eid=2-s2.0-42449123197&doi=10.1007%2fs10967-007-0405-9&partnerID=40&md5=38a6956c8ac8c05c0bc77f5c55e8690c	Federal Institute for Materials' Research and Testing (BAM), Berlin D-12205, Germany	02365731		JRNCD	Conference Paper	Final		Scopus	2-s2.0-42449123197
Kushiya K.	Future prospects of CIS-based thin-film PV modules	2008	Nihon Enerugi Gakkaishi/Journal of the Japan Institute of Energy	87	3		169	174		https://www.scopus.com/inward/record.uri?eid=2-s2.0-44349099820&partnerID=40&md5=b9ae634db0769c336884c16e0c5258f0	Showa Shell Sekiyu K.K, 123-1, Shimokawairi, Atsugi-shi, Kanagawa 243-0206, Japan	09168753		NENGE	Review	Final		Scopus	2-s2.0-44349099820
Timizar N.	Recycling. Used processors recycled into solar collectors [Recyclage. D'anciens processeurs recyclés en capteurs solaires]	2007	Info Chimie Magazine	44	483		29			https://www.scopus.com/inward/record.uri?eid=2-s2.0-43149124019&partnerID=40&md5=2ef04fac297fd029b5e4474cba1f9166		12860921			Article	Final		Scopus	2-s2.0-43149124019
Fthenakis V.M., Kim H.C.	CdTe photovoltaics: Life cycle environmental profile and comparisons	2007	Thin Solid Films	515	15 SPEC. ISS.		5961	5963	10.1016/j.tsf.2006.12.138	https://www.scopus.com/inward/record.uri?eid=2-s2.0-34247340875&doi=10.1016%2fj.tsf.2006.12.138&partnerID=40&md5=0d64664256101f350fc38818ea733e89	National PV EH and S Research Center, Brookhaven National Laboratory, Upton, NY, United States; Center of Life Cycle Analysis, Columbia University, New York, NY, United States	00406090		THSFA	Article	Final	All Open Access, Green	Scopus	2-s2.0-34247340875
Wang W., Fthenakis V.M.	Recovery of tellurium from cadmium telluride photovoltaic module manufacturing scrap and other sources	2006	TMS Annual Meeting	2006			935	942		https://www.scopus.com/inward/record.uri?eid=2-s2.0-33749247572&partnerID=40&md5=d3a4fd9072a387ba5ad76dbedf3309be	National Photovoltaic Environmental, Health and Safety Research Center, Environmental Sciences Department Brookhaven, National Laboratory, Upton, NY 11973, United States; Brookhaven National Laboratory, Building 830, Upton, NY 11973, United States			85MVA	Conference Paper	Final		Scopus	2-s2.0-33749247572
Weinreich W., Acker J., Gräber I.	The effect of H_2SiF_6 on the surface morphology of textured multi-crystalline silicon	2006	Semiconductor Science and Technology	21	9	012	1278	1286	10.1088/0268-1242/21/9/012	https://www.scopus.com/inward/record.uri?eid=2-s2.0-33747222406&doi=10.1088%2f0268-1242%2f21%2f9%2f012&partnerID=40&md5=c48b353a8f59bf36462dba6cb0c40b21	IFW Dresden, Institute for Solid State Analysis and Structural Research, PO Box 270116, D-01171 Dresden, Germany	02681242		SSTEE	Article	Final		Scopus	2-s2.0-33747222406
Fthenakis V.M., Wang W.	Extraction and separation of Cd and Te from cadmium telluride photovoltaic manufacturing scrap	2006	Progress in Photovoltaics: Research and Applications	14	4		363	371	10.1002/pip.676	https://www.scopus.com/inward/record.uri?eid=2-s2.0-33745395974&doi=10.1002%2fpip.676&partnerID=40&md5=efc6ec6f1373e6b3fc6e3120273e03ab	Brookhaven National Laboratory, Department of Environmental Sciences, Photovoltaic Environmental Health and Safety Research Center, Upton, NY 11973, United States	10627995		PPHOE	Article	Final	All Open Access, Bronze	Scopus	2-s2.0-33745395974
Müller A., Wambach K., Alsema E.	Life cycle analysis of solar module recycling process	2006	Materials Research Society Symposium Proceedings	895			89	94		https://www.scopus.com/inward/record.uri?eid=2-s2.0-33646423024&partnerID=40&md5=639913ae1cf7fdabef3c1a170dacd491	Deutsche Solar AG, Solar Material, Alfred Lange Straße 18, 09599 Freiberg, Germany; Science, Technology and Society, Copernicus Institute, Utrecht University, Utrecht, Netherlands	02729172		MRSPD	Conference Paper	Final		Scopus	2-s2.0-33646423024
[No author name available]	Life-Cycle Analysis Tools for "Green" Materials and Processes Selection	2006	Materials Research Society Symposium Proceedings	895						https://www.scopus.com/inward/record.uri?eid=2-s2.0-33646400564&partnerID=40&md5=bba2e9a4686db8c6cca52c0c5f17bccf		02729172		MRSPD	Conference Review	Final		Scopus	2-s2.0-33646400564
Yamashita K., Miyazawa A., Sannomiya H.	Reserch and development on recycling and reuse treatment technologies for crystalline silicon photovoltaic modules	2006	Conference Record of the 2006 IEEE 4th World Conference on Photovoltaic Energy Conversion, WCPEC-4	2		4060125	2254	2257	10.1109/WCPEC.2006.279621	https://www.scopus.com/inward/record.uri?eid=2-s2.0-41749117238&doi=10.1109%2fWCPEC.2006.279621&partnerID=40&md5=8b89a23a6ba178edfd9e1beb246867b6	SHARP Corporation Solar Systems Division, 282-1 Hajikami, Katsuragi-Shi, Nara 639-2198, Japan				Conference Paper	Final		Scopus	2-s2.0-41749117238
Hedrich M., Giese L., Adam C., Haase O., Segebade C.	Recycling of photovoltaic CdTe-modules - Analytical process monitoring	2005	Proceedings - European Metallurgical Conference, EMC 2005	4			1687	1696		https://www.scopus.com/inward/record.uri?eid=2-s2.0-84871295682&partnerID=40&md5=fce1d668fc54c632ea341ac8fb38b0c3	Federal Institute for Materials' Research and Testing (BAM), Unter den Eichen 87, D-12205 Berlin, Germany				Conference Paper	Final		Scopus	2-s2.0-84871295682
Shibasaki M., Warburg N., Eyerer P.	Recycling of thin film solar cell modules - LCA and ECO2 case study	2005	Proceedings - Fourth International Symposium on Environmentally Conscious Design and Inverse Manufacturing, Eco Design 2005	2005		1619234	310	311	10.1109/ECODIM.2005.1619234	https://www.scopus.com/inward/record.uri?eid=2-s2.0-33947166765&doi=10.1109%2fECODIM.2005.1619234&partnerID=40&md5=efe5b0653bdccfebab3d235c88b1402e	Department Life Cycle Engineering, IKP, University of Stuttgart, Germany				Conference Paper	Final		Scopus	2-s2.0-33947166765
Doi T., Igari S., Tsuda I.	Development of a recyclable PV-module - Expansion to multi-cells modules	2005	Conference Record of the IEEE Photovoltaic Specialists Conference				1773	1776	10.1109/PVSC.2005.1488494	https://www.scopus.com/inward/record.uri?eid=2-s2.0-27944493645&doi=10.1109%2fPVSC.2005.1488494&partnerID=40&md5=11c8a76bea44d7fe2ad5c2277abed09f	AIST RCPV, AIST Central 2, Tsukuba, Ibaraki, 305-8568, Japan	01608371	780387074	CRCND	Conference Paper	Final		Scopus	2-s2.0-27944493645

Table A-3: PV Recycling Literature Review

Authors	Title	Year	Source Title	Volume	Issue	Art. No.	Page Start	Page End	DOI	Link	Affiliations	ISSN	ISBN	CODEN	Document Type	Publication Stage	Open Access	Source	EID
[No author name available]	EPD Congress 2005 - Proceedings of Sessions and Symposia Sponsored by the Extraction and Processing Division of the Minerals, Metals and Materials Society, Held During the TMS 2005 Annual Meeting	2005	TMS Annual Meeting							https://www.scopus.com/inward/record.uri?eid=2-s2.0-23244468522&partnerID=40&md5=cd2034f4ddf1ac61a666de8cda94abeb				85MVA	Conference Review	Final		Scopus	2-s2.0-23244468522
Wang W., Fthenakis V.M.	Feasibility study on the recycling of cadmium-telluride photovoltaic modules	2005	TMS Annual Meeting				1053	1063		https://www.scopus.com/inward/record.uri?eid=2-s2.0-23244467147&partnerID=40&md5=3c9ba0060884c4720ee7c70897e8d9b4	National Photovoltaic EHS Assistance Center, Environmental Sciences Department, Brookhaven National Laboratory, Upton, NY 11973, United States; Brookhaven National Laboratory, Building 830, Upton, NY 11973, United States			85MVA	Conference Paper	Final		Scopus	2-s2.0-23244467147
Pearce F.	Tear off a sheet of solar cells	2004	New Scientist	184	2478		23			https://www.scopus.com/inward/record.uri?eid=2-s2.0-10844255031&partnerID=40&md5=9d4caf75939a5bc6b4532af0f4102077		02624079		NWSCA	Short Survey	Final		Scopus	2-s2.0-10844255031
Zeng D.-W., Born M., Wambach K.	Pyrolysis of EVA and its application in recycling of photovoltaic modules	2004	Journal of Environmental Sciences	16	6		889	893		https://www.scopus.com/inward/record.uri?eid=2-s2.0-21844458204&partnerID=40&md5=32550af6b87d19264109251e5298fa1c	Institut für Energieverfahrungstechnik und Chemieingenieurwesen, TU Bergakademie Freiberg, 09599 Freiberg, Germany; Deutsche Solar AG, Alfred-Lange-Str. 18, 09599 Freiberg, Germany; School of Chemistry and Chemical Engineering, Hunan University, Changsha 410082, China	10010742			Article	Final		Scopus	2-s2.0-21844458204
Oi K.	Examples of product development/Dai Nippon Insatsu: Sheet of reusable material using environment-friendly solar battery modules	2004	Kami,Parupu Gijutsu Taimusu/Japanese Journal of Paper Technology	47	8		58	59		https://www.scopus.com/inward/record.uri?eid=2-s2.0-17044420914&partnerID=40&md5=a2dd2c9820a4f1913c559935d7a005a3	Dai Nippon Insatsu Co. Ltd.	04531507		KPGTA	Review	Final		Scopus	2-s2.0-17044420914
Fthenakis V.M.	Life cycle impact analysis of cadmium in CdTe PV production	2004	Renewable and Sustainable Energy Reviews	8	4		303	334	10.1016/j.rser.2003.12.001	https://www.scopus.com/inward/record.uri?eid=2-s2.0-1542274593&doi=10.1016%2fj.rser.2003.12.001&partnerID=40&md5=021c1ba906f9c99bd8bcf499baacf1b3	Natl. Photovoltaic Environ. H.S.A.C., Environmental Sciences Department, Brookhaven National Laboratory, Upton, NY 11973, United States	13640321		RSERF	Review	Final	All Open Access, Green	Scopus	2-s2.0-1542274593
Xu C., Pan X., Xu X., Xu J., Yang X., Huang W., Liu H.	Economic evaluation on fuzzy analytic hierarchy process model for recycling Cu(In,Ga)Se2 PV modules	2003	Proceedings of the 3rd World Conference on Photovoltaic Energy Conversion	B			1992	1995		https://www.scopus.com/inward/record.uri?eid=2-s2.0-6344287749&partnerID=40&md5=ba777c985f3b7c687ce2501ed09d8cb4	Department of Precision Machinery, Univ. of Sci. and Technol. of China, Hefei 230027, China; School of Mechanical Engineering, Hefei University of Technology, Hefei 230009, China; Structure Research Laboratory, Univ. of Sci. and Technol. of China, Academia Sinica, Hefei 230026, China; Department of Physics, Univ. of Sci. and Technol. of China, Hefei 230026, China				Conference Paper	Final		Scopus	2-s2.0-6344287749
Doi T., Tsuda I., Sakuta K., Matsui G.	Development of a recyclable PV-module: Trial manufacturing and evaluation	2003	Proceedings of the 3rd World Conference on Photovoltaic Energy Conversion	B			1952	1955		https://www.scopus.com/inward/record.uri?eid=2-s2.0-6344277213&partnerID=40&md5=a4940f0c23bbea4ac17efbc5c991f36a	Energy Electronics Institute, Natl. Inst. Adv. Indust. Sci./T., AIST Central 2, Tsukuba, Ibaraki, 305-8568, Japan; Inst. of Eng. Mechanics and Systems, University of Tsukuba, Tsukuba, Ibaraki, 305-8573, Japan				Conference Paper	Final		Scopus	2-s2.0-6344277213
Yamashita K., Umemoto A., Okamoto K.	Research and development on recycling and reuse treatment technologies for crystalline silicon photovoltaic modules	2003	Proceedings of the 3rd World Conference on Photovoltaic Energy Conversion	B			1996	1999		https://www.scopus.com/inward/record.uri?eid=2-s2.0-6344237413&partnerID=40&md5=138dbbafbf46fd74e182e9177b3c691c	SHARP Corp. Solar Systems Division, 282-1 Hajikami, Shinjo-Cho, Kitakatsuragi-Gun, Nara 639-2198, Japan				Conference Paper	Final		Scopus	2-s2.0-6344237413
Xu C., Xu J., Xu X., Pan X., Xu H., Huang W., Liu H.	Green 3R-concept design for Cd-based PV modules	2003	Proceedings of the 3rd World Conference on Photovoltaic Energy Conversion	B			1942	1945		https://www.scopus.com/inward/record.uri?eid=2-s2.0-6344220004&partnerID=40&md5=27d37635431685b4b674be693584a714	Department of Precision Machinery, Univ. of Sci. and Technol. of China, Hefei 23.0027, China; Structure Research Laboratory, Univ. of Sci. and Technol. of China, Academia Sinica, Hefei 230026, China; Department of Physics, Univ. of Sci. and Technol. of China, Hefei 230026, China; School of Mechanical Engineering, Hefei University of Technology, Hefei 230009, China; Hefei Rongshida R.Co., Ltd., Hefei 230088, China				Conference Paper	Final		Scopus	2-s2.0-6344220004
Doi T., Tsuda I., Sakuta K., Matsui G.	Fabrication and characteristics of recyclable PV modules	2003	International Solar Energy Conference				453	458	10.1115/ISEC2003-44223	https://www.scopus.com/inward/record.uri?eid=2-s2.0-0346962564&doi=10.1115%2fISEC2003-44223&partnerID=40&md5=92c44af358c2535aeb2784da6f1513a2	Energy Electronics Institute, Natl. Inst. Adv. Indust. Sci./T., AIST Central 2, Tsukuba, Ibaraki 305-8568, Japan; Inst. of Eng. Mechanics and Systems, University of Tsukuba, Tsukuba, Ibaraki 305-8573, Japan			85MEA	Conference Paper	Final		Scopus	2-s2.0-0346962564
Sarti D., Einhaus R.	Silicon feedstock for the multi-crystalline photovoltaic industry	2002	Solar Energy Materials and Solar Cells	72	1-4		27	40	10.1016/S0927-0248(01)00147-7	https://www.scopus.com/inward/record.uri?eid=2-s2.0-0036533230&doi=10.1016%2fS0927-0248%2801%2900147-7&partnerID=40&md5=575c93768bf5dee5f17ba7c30fb628a4	Photowatt International S.A., 33 Rue Saint Honoré, F-38300 Bourgoin-Jallieu, France	09270248			Article	Final		Scopus	2-s2.0-0036533230
Menezes S.	Electrochemical approach for removal, separation and retrieval of CdTe and CdS films from PV module waste	2001	Thin Solid Films	387	1-2		175	178	10.1016/S0040-6090(00)01704-1	https://www.scopus.com/inward/record.uri?eid=2-s2.0-0035967558&doi=10.1016%2fS0040-6090%2800%2901704-1&partnerID=40&md5=f8285b06c1fe812cefc018e7e328e2af	InterPhases Research, P.O Box 1532, Thousand Oaks CA 91358, United States	00406090		THSFA	Article	Final		Scopus	2-s2.0-0035967558

Table A-3: PV Recycling Literature Review

Authors	Title	Year	Source Title	Volume	Issue	Art. No.	Page Start	Page End	DOI	Link	Affiliations	ISSN	ISBN	CODEN	Document Type	Publication Stage	Open Access	Source	EID
Greijer H., Karlson L., Lindquist S.-E., Hagfeldt A.	Environmental aspects of electricity generation from a nanocrystalline dye sensitized solar cell system	2001	Renewable energy	23	1		27	39	10.1016/S0960-1481(00)00111-7	https://www.scopus.com/inward/record.uri?eid=2-s2.0-0035342854&doi=10.1016%2fS0960-1481%2800%2900111-7&partnerID=40&md5=6e377e732904cbd56669513d070aaabf	Department of Physical Chemistry, University of Uppsala, P.O. Box 532, 751 21 Uppsala, Sweden; ABB Corporate Research, 721 78 Västerås, Sweden	09601481		RNENE	Article	Final		Scopus	2-s2.0-0035342854
Doi T., Tsuda I., Unagida H., Murata A., Sakuta K., Kurokawa K.	Experimental study on PV module recycling with organic solvent method	2001	Solar Energy Materials and Solar Cells	67	1-4		397	403	10.1016/S0927-0248(00)00308-1	https://www.scopus.com/inward/record.uri?eid=2-s2.0-0035283793&doi=10.1016%2fS0927-0248%2800%2900308-1&partnerID=40&md5=b7a25fe42dd52c64842e5f56c4d48250	Electrotechnical Laboratory, 1-1-4 Umezono, Tsukuba, 305-8568, Ibaraki, Japan; Tokyo Univ. of Agric. and Technology, 2-24-16 Nakamachi, Koganei, 184-8588, Tokyo, Japan	09270248		SEMCE	Article	Final		Scopus	2-s2.0-0035283793
Fthenakis V.M.	End-of-life management and recycling of PV modules	2000	Energy Policy	28	14		1051	1058	10.1016/S0301-4215(00)00091-4	https://www.scopus.com/inward/record.uri?eid=2-s2.0-0034332938&doi=10.1016%2fS0301-4215%2800%2900091-4&partnerID=40&md5=70b9bba2c4ded8395052815f8607cbb7	Environmental and Waste Technology Group, Department of Advanced Technology, Brookhaven National Laboratory, P.O. Box 5000, Upton, NY 11973-5000, United States	03014215		ENPYA	Article	Final	All Open Access, Green	Scopus	2-s2.0-0034332938
Hynes K.M., Newham J.	A comparison of window/buffer layer materials for CdTe thin film modules using environmental risk assessment	2000	Conference Record of the IEEE Photovoltaic Specialists Conference	2000-January		916182	1513	1516	10.1109/PVSC.2000.916182	https://www.scopus.com/inward/record.uri?eid=2-s2.0-84949557606&doi=10.1109%2fPVSC.2000.916182&partnerID=40&md5=2ea36e4e61c7c33c056cdbd0fb80c0f7	Northumbria Photovoltaics Applications Centre, University of Northumbria, Newcastle-upon-Tyne, NE1 8ST, United Kingdom	01608371	780357728	CRCND	Conference Paper	Final		Scopus	2-s2.0-84949557606
Bohland J.R., Smigielski K.	First solar's CdTe module manufacturing experience; environmental, health and safety results	2000	Conference Record of the IEEE Photovoltaic Specialists Conference			915904	575	578	10.1109/PVSC.2000.915904	https://www.scopus.com/inward/record.uri?eid=2-s2.0-84949555041&doi=10.1109%2fPVSC.2000.915904&partnerID=40&md5=2bc9b98d00a51a78a0bf0c343ae8bd5c	First Solar, 28101 Cedar Park Boulevard, Perrysburg, OH, 43551, United States	01608371	780357728		Article	Final		Scopus	2-s2.0-84949555041
Fthenakis V.M., Moskowitz P.D.	Photovoltaics: Environmental, health and safety issues and perspectives	2000	Progress in Photovoltaics: Research and Applications	8	1		27	38	10.1002/(SICI)1099-159X(200001/02)8:1<27::AID-PIP296>3.0.CO;2-8	https://www.scopus.com/inward/record.uri?eid=2-s2.0-0033903848&doi=10.1002%2f%28SICI%291099-159X%28200001%2f02%298%3a1%3c27%3a%3aAID-PIP296%3e3.0.CO%3b2-8&partnerID=40&md5=29ffe3fa618bafe717f15df5f15bff2e	Environ. and Waste Technology Group, Department of Advanced Technology, Brookhaven National Laboratory, Upton, NY 11973, United States	10627995		PPHOE	Article	Final		Scopus	2-s2.0-0033903848
Clock J., Beasley S., Cook B.	Development and implementation of tpo cover stock for instrument panels	1998	SAE Technical Papers						10.4271/980064	https://www.scopus.com/inward/record.uri?eid=2-s2.0-85072465567&doi=10.4271%2f980064&partnerID=40&md5=8760831b72801514dd7833c53f880824	Delphi Interiors and Lighting, United States	01487191			Conference Paper	Final		Scopus	2-s2.0-85072465567
Eberspacher Chris, Fthenakis Vasilis M.	Disposal and recycling of end-of-life PV modules	1997	Conference Record of the IEEE Photovoltaic Specialists Conference				1067	1072		https://www.scopus.com/inward/record.uri?eid=2-s2.0-0031389140&partnerID=40&md5=2ba3a9aa12fcdfddfc899310ee27d062	UNISUN	01608371		CRCND	Conference Paper	Final		Scopus	2-s2.0-0031389140
Bohland John, Anisimov Igor, Dapkus Todd	Economic recycling of CdTe photovoltaic modules	1997	Conference Record of the IEEE Photovoltaic Specialists Conference				355	358		https://www.scopus.com/inward/record.uri?eid=2-s2.0-0031377178&partnerID=40&md5=2d429f7189ecb0a6164bc641385d4b7f	Solar Cells, Inc, Toledo, United States	01608371		CRCND	Conference Paper	Final		Scopus	2-s2.0-0031377178
Becker F.E., Doyle E.F., Shukla K.C.	150 watt portable thermophotovoltaic power supply	1997	American Society of Mechanical Engineers, Advanced Energy Systems Division (Publication) AES	37			65	73		https://www.scopus.com/inward/record.uri?eid=2-s2.0-0031368559&partnerID=40&md5=9a1bc12633e4e77fc343e0eaf25a315d	Thermo Power Corporation, Tecogen Division, 45 First Avenue, Waltham, MA 02254-9046, United States			AMEAE	Article	Final		Scopus	2-s2.0-0031368559
Wilt D.M., Chubb D.L.	Thermophotovoltaic energy conversion technology development at NASA Lewis Research Center	1997	American Society of Mechanical Engineers, Advanced Energy Systems Division (Publication) AES	37			47	52		https://www.scopus.com/inward/record.uri?eid=2-s2.0-0031362519&partnerID=40&md5=fec0514b97068734cd87ab3e3123c216	Photovoltaic and Space Environ. Br., NASA Lewis Research Center, 21000 Brookpard Rd. M.S. 302-1, Cleveland, OH, United States			AMEAE	Article	Final		Scopus	2-s2.0-0031362519
Wilt David M., Fatemi Navid S., Jenkins Phillip P., Weizer Victor G., Hoffman Jr. Richard W., Murray Christopher S., Riley David R.	Electrical and optical performance characteristics of p/n InGaAs monolithic interconnected modules	1997	Proceedings of the Intersociety Energy Conversion Engineering Conference	2			1119	1124		https://www.scopus.com/inward/record.uri?eid=2-s2.0-0031357063&partnerID=40&md5=b031cde67476352f51f73fa04e55a3bb	NASA Lewis Research Cent, Cleveland, United States	0146955X		PIECD	Conference Paper	Final		Scopus	2-s2.0-0031357063
Goozner Robert E., Drinkard William F., Long Mark O., Byrd Christi M.	Process to recycle thin film PV materials	1997	Conference Record of the IEEE Photovoltaic Specialists Conference				1161	1163		https://www.scopus.com/inward/record.uri?eid=2-s2.0-0031348553&partnerID=40&md5=bdc637cf77216cd7e5e9c602fbf26806	Drinkard Metalox, Inc, Charlotte, United States	01608371		CRCND	Conference Paper	Final		Scopus	2-s2.0-0031348553

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Bohland John R., Anisimov Igor I.	Possibility of recycling silicon PV modules	1997	Conference Record of the IEEE Photovoltaic Specialists Conference				1173	1175		https://www.scopus.com/inward/record.uri?eid=2-s2.0-0031345194&partnerID=40&md5=add7a20ef4e6ab896a524dc8584d95be	Solar Cells, Inc, Toledo, United States	01608371		CRCND	Conference Paper	Final		Scopus	2-s2.0-0031345194
Endelman L.L.	The Hubble space telescope now and then	1997	Proceedings of SPIE - The International Society for Optical Engineering	2869			44	57	10.1117/12.273447	https://www.scopus.com/inward/record.uri?eid=2-s2.0-0037760064&doi=10.1117%2f12.273447&partnerID=40&md5=91d439cb4bb9220edc6c7cd6f422d331	1484 Pine Grove Way, San Jose, CA 95129-4732, United States	0277786X		PSISD	Conference Paper	Final		Scopus	2-s2.0-0037760064
Wilt D.M., Chubb D.L.	THERMOPHOTOVOLTAIC ENERGY CONVERSION TECHNOLOGY DEVELOPMENT AT NASA LEWIS RESEARCH CENTER	1997	ASME International Mechanical Engineering Congress and Exposition, Proceedings (IMECE)	1997-G			47	52	10.1115/IMECE1997-0972	https://www.scopus.com/inward/record.uri?eid=2-s2.0-85126905024&doi=10.1115%2fIMECE1997-0972&partnerID=40&md5=c45f03e7befa38128804066fa86fcc8f	Photovoltaic and Space Environment Branch NASA Lewis Research Center, 21000 Brookpard Rd. M.S. 302-1, Cleveland, OH, United States		9780791818459		Conference Paper	Final		Scopus	2-s2.0-85126905024
Becker F.E., Doyle E.F., Shukla K.C.	150 WATT PORTABLE THERMOPHOTOVOLTAIC POWER SUPPLY	1997	ASME International Mechanical Engineering Congress and Exposition, Proceedings (IMECE)	1997-G			65	73	10.1115/IMECE1997-0975	https://www.scopus.com/inward/record.uri?eid=2-s2.0-85126882817&doi=10.1115%2fIMECE1997-0975&partnerID=40&md5=c57b07f2e03ecef564df01a40c2a8c54	Thermo Power Corporation Tecogen Division, 45 First Avenue P.O. Box 9046, Waltham, MA 02254-9046, United States		9780791818459		Conference Paper	Final		Scopus	2-s2.0-85126882817
Yamawaki T., Mizukami S., Yamazaki A., Takahashi H.	Thermal recovery effect on light-induced degradation of amorphous silicon solar module under the sunlight	1997	Solar Energy Materials and Solar Cells	47	1-4		125	134	10.1016/S0927-0248(97)00033-0	https://www.scopus.com/inward/record.uri?eid=2-s2.0-0031251084&doi=10.1016%2fS0927-0248%2897%2900033-0&partnerID=40&md5=f4ab7a0637824a089717610f58a2569e	Electron. Mat. Researching Labs., Kaneka Corporation, 2-1-1 Hieitsuji, Otsu, Shiga, Japan; Department of Electrical Engineering, Nara National College of Technology, Yamatokoriyama, Nara, Japan	09270248		SEMCE	Article	Final		Scopus	2-s2.0-0031251084
Akhmad K., Okamoto H., Yamamoto F., Kitamura A.	Long-term performance modelling of amorphous silicon photovoltaic module	1997	Japanese Journal of Applied Physics, Part 1: Regular Papers and Short Notes and Review Papers	36	2		629	632	10.1143/jjap.36.629	https://www.scopus.com/inward/record.uri?eid=2-s2.0-0031073516&doi=10.1143%2fjjap.36.629&partnerID=40&md5=d13603b4dd2127b63ff6c49a163fc9c0	Department of Electrical Engineering, Faculty of Engineering Science, Osaka University, Toyonaka, Osaka 560, Japan; Technical Research Center, Kansai Electric Power Inc., Hyogo 661, Japan	00214922		JAPND	Article	Final		Scopus	2-s2.0-0031073516
Paknikar K.M., Rajwade J.M., Pethkar A.V., Goyal D.J., Bilurkar P.G., Mate N.V.	Integrated chemical-microbiological approach for the disposal of waste thin film cadmium telluride photovoltaic modules	1997	Materials Research Society Symposium - Proceedings	447			133	138		https://www.scopus.com/inward/record.uri?eid=2-s2.0-0030691587&partnerID=40&md5=098f44f7428ae27cbca088a72f39e573	MACS Agharkar Research Inst, Pune, India	02729172		MRSPD	Conference Paper	Final		Scopus	2-s2.0-0030691587
Eberspacher C., Gay C.F., Moskowitz P.D.	Strategies for enhancing the commercial viability of CdTe-based photovoltaics	1996	Solar Energy Materials and Solar Cells	41-42			637	653	10.1016/0927-0248(95)00120-4	https://www.scopus.com/inward/record.uri?eid=2-s2.0-18344413865&doi=10.1016%2f0927-0248%2895%2900120-4&partnerID=40&md5=34dbab87d376daaed38027f0f7fd6f85	UNISUN, Newbury Park, CA 9132, United States; Biomed. and Environ. Assess. Group, Department of Applied Science, Brookhaven National Laboratory, Upton, NY 1197, United States; National Renewable Energy Laboratory, Golden, CO 80401, United States	09270248		SEMCE	Article	Final		Scopus	2-s2.0-18344413865
Sasala Richard A., Bohland John, Smigielski Ken	Physical and chemical pathways for economic recycling of cadmium telluride thin-film photovoltaic modules	1996	Conference Record of the IEEE Photovoltaic Specialists Conference				865	868	10.1109/pvsc.1996.564265	https://www.scopus.com/inward/record.uri?eid=2-s2.0-0030388845&doi=10.1109%2fpvsc.1996.564265&partnerID=40&md5=264658462c9581fffc1c9c564dea8961	Solar Cells Inc, Toledo, OH, United States	01608371		CRCND	Conference Paper	Final		Scopus	2-s2.0-0030388845
Fthenakis V.M., Eberspacher C., Moskowitz P.D.	Recycling strategies to enhance the commercial viability of CIS photovoltaics	1996	Progress in Photovoltaics: Research and Applications	4	6		447	456	10.1002/(SICI)1099-159X(199611/12)4:6<447::AID-PIP147>3.0.CO;2-F	https://www.scopus.com/inward/record.uri?eid=2-s2.0-0030288295&doi=10.1002%2f%28SICI%291099-159X%28199611%2f12%294%3a6%3c447%3a%3aAID-PIP147%3e3.0.CO%3b2-F&partnerID=40&md5=f70131c4f2934eb67e793d40a2571396	Biomed. and Environ. Assess. Group., Dept. of Applied Science, Brookhaven National Laboratory, Upton, NY 11973, United States; UNISUN, Newbury Park, CA 91320, United States	10627995		PPHOE	Review	Final		Scopus	2-s2.0-0030288295
Fthenakis V.M., Moskowitz P.D.	Thin-film Photovoltaic Cells: Health and Environmental Issues in their Manufacture Use and Disposal	1995	Progress in Photovoltaics: Research and Applications	3	5		295	306	10.1002/pip.4670030504	https://www.scopus.com/inward/record.uri?eid=2-s2.0-0029373252&doi=10.1002%2fpip.4670030504&partnerID=40&md5=9e8685e89632eef6378a1a198d6abec3	Biomedical and Environmental Assessment Group, Brookhaven National Laboratory, Upton, New York, 11973, United States	10627995			Article	Final		Scopus	2-s2.0-0029373252
Sasala Richard A., Zhou Theodore, Kocher Walter M.	Environmentally responsible production, use and disposition of Cd-bearing PV modules	1994	Conference Record of the IEEE Photovoltaic Specialists Conference	1			311	314		https://www.scopus.com/inward/record.uri?eid=2-s2.0-0028710152&partnerID=40&md5=81eac09ee1b403df88edd8c2b7e1b4ea	Solar Cells, Inc, Toledo, United States	01608371		CRCND	Conference Paper	Final		Scopus	2-s2.0-0028710152
Eberspacher Chris, Gay Charles F., Moskowitz Paul D.	Strategies for recycling CdTe photovoltaic modules	1994	Conference Record of the IEEE Photovoltaic Specialists Conference	1			962	965		https://www.scopus.com/inward/record.uri?eid=2-s2.0-0028694572&partnerID=40&md5=08d49ae1a131aeb41b705e1a76c7f7e7	UNISUN, Newbury Park, United States	01608371		CRCND	Conference Paper	Final		Scopus	2-s2.0-0028694572

Table A-3: PV Recycling Literature Review

Authors	Title	Year	Source Title	Volume	Issue	Art. No.	Page Start	Page End	DOI	Link	Affiliations	ISSN	ISBN	CODEN	Document Type	Publication Stage	Open Access	Source	EID
Moskowitz P.D.	Environmental, Health and Safety Issues Related to the Production and USE of Cdte Photovoltaic Modules	1992	International Journal of Solar Energy	12	1-4		259	281	10.1080/01425919208909767	https://www.scopus.com/inward/record.uri?eid=2-s2.0-0343054601&doi=10.1080%2f01425919208909767&partnerID=40&md5=ae1924f6276bc5559263d5219545a615	Biomedical and Environmental Assessment Group, Brookhaven National Laboratory, United States	01425919			Article	Final		Scopus	2-s2.0-0343054601

APPENDIX B: INTERVIEW GUIDE FOR EPRI LCI STUDY ON PV RECYCLING

PV Recycling Expert Interviews

Karsten Wambach
wambach@wambach-consulting.com

Respondent Name(s):	
Respondent Title(s):	
Company Name:	
Contact Information (phone/email):	
Date/Time of Interview:	
Interviewer:	
Can name be used in report?	

Project goals: Wambach-Consulting carries out a PV recycling study for EPRI, USA, to identify best available technologies for EOL PV waste treatment and to assess upcoming technologies in laboratory and pilot stages by an international literature and patent survey. The interview results shall provide process understanding and fill data gaps in the collection of life cycle inventory data on the processes, and best practices for treatment and downstream utilization of the outputs, including associated costs.

He is surveying a number of PV waste treatment companies to examine their practices and costs surrounding disposal of solar PV modules. The investigation will encompass both the technical and economic aspects of PV waste treatment from the waste management company point of view.

Survey findings are intended to provide a benchmark against which recycling costs can be compared. Findings will be incorporated into an EPRI document. This effort also is intended to offer stakeholders a means for assessing module waste disposal options and inform their strategic thinking around PV project end-of-life planning.

Confidentiality: EPRI intends to include aggregate survey responses in a public white paper. Shared cost and pricing information will be anonymized such that responses from individual waste management companies cannot be identified. If subjects require additional confidentiality protection, this can potentially be arranged. If companies are willing to be identified sources, pending their review of statements they have made, we may include company-specific examples or data in the report.

Interview Intro

I'll be recording this interview, is that alright?

I'll plan to circulate any summary document text that we'd like to attribute to you or your company for fact-checking purposes.

Once completed, I'll plan to share the summary document with you for your review and use.

I. Context

Name, organization, and role of expert

- Company – Where is your company headquartered?
- How many locations do you have for processing PV modules?
- What is your annual throughput and capacity?

1.1 PV Background

- How long have you been accepting PV modules? Approximately how many modules have been recycled to date?
- What type(s) of solar modules are you able to recycle?
- Does the company offer refurbishing/reselling services for solar modules in addition to recycling services?
- Do you recycle solar racking structures, wiring, inverters, batteries, or any other materials from solar plants, or only modules? Does the company offer any other services? Do you remove the modules from the racking and handle packaging and transportation too?
- What are typical (or max/min) annual volumes for recycling, and resale if applicable (# modules/yr or ton/yr)?
- What fraction of modules received are sold for reuse versus recycled?
- Who do you typically receive modules from? Who are your target customers (e.g., % residential, commercial, utility-scale plants, manufacturers)?

II. Processes

2.1 Please describe the processes you follow from module collection to final disposal.

2.2 What do you do to ensure compliance with regulatory requirements for packing and shipping?

2.3 Please describe the recycling process and end use of each solar module component. Is any material sent to a landfill during the recycling process or is everything recycled/reused?

2.4 How is the output processed? Please specify by output type.

- Can you separate out trace amounts of metals?
- Is your recycling process primarily focused on glass, metal, e-waste, or other? Is there any customization for solar modules?
- What process steps does the recycling include (e.g., mechanical, thermal, chemical, optical, etc.)?

- What recovery fraction are you able to achieve? Do you recover silicon, silver, and copper at sufficient purity for reuse? Alternative: Do you recover Cd, Te, Mo, Sn, In, Ga, Se, etc.?
- Is there any special handling or treatment for modules with high lead/toxic material content (fail eluate testing)? Will you be able to process perovskite on silicon modules? Do you have concerns about toxic elements other than lead?
- Are any materials sent elsewhere for further processing (e.g., smelter, recovery of metal, or other product streams)?

2.5 For companies that offer resale, how do you assess the condition of the PV modules you receive to determine if they can be repurposed/reused or if they should be recycled?

If modules are still functional, is there a process to certify them for reuse?

What types of repairs or other refurbishment do you perform prior to reselling modules?

Is there a strong market for second-life modules? Where do you resell them?

2.6 Does the company perform any sampling and analysis to properly characterize the waste (non-hazardous or hazardous) prior to recycling?

- If so, what is your approach for sampling modules (cutting method, areas of module, including frame and/or jbox)?
    - Have you confirmed that the method is precise and repeatable?
    - Have you checked for variation between labs that receive identical samples?
    - Do you keep a database of eluate test results?
    - Have you done any work to characterize how lead content is changing over time, or how it varies between different module constructions?
- If not, do you require customers to characterize the modules prior to acceptance? If so, do you provide guidance to customers in how to sample and analyze modules?
- Do you use supplier BOM data, including information about toxic materials? Do you use SCIP data?

III. Regulations/Requirements

3.1 Which accreditations/certifications, e.g., Sustainability Electronics Recycling International (SERI) Responsible Recycling (R2) or e-Stewards, do you hold? Do you provide a Certificate of Destruction/Recycling (COD/COR)?

3.2 Does the company hold any special permits or variances for storage, treatment or disposal of hazardous waste?

3.3 Please describe any local, state, federal environmental reporting/handling/documentation requirements regarding solar panels received by your company.

3.4 Are there any special shipping requirements required to transport PV safely (e.g., packing of PV panels, shipping container type, removal of junction box or frame prior to shipping, etc.)?

IV. Economics of PV Waste Disposal

4.1 What information do you require from plant owners to determine pricing (e.g., MSDS or module spec sheet, eluate test results, module condition, etc.)?

4.2 Do prices include shipping and handling?

4.3 Does volume, condition, composition, or other factors affect pricing?

4.4 To what extent does recovery of valuable material (silicon, silver, copper) offset the cost of recycling?

4.5 What are obstacles for better PV collection and recycling?

4.6 What is your experience with international shipments of PV modules for reuse or PV waste and recycling outputs?

How can this be optimized?

IV. Conclusion

5.1 Have you identified any R&D needs? Would new high-value recycling processes be beneficial?

5.2 Is there anything I haven't asked you about on which you'd like to comment?

How were modules transported from the usage site to your facility?

Was any preprocessing conducted prior to transport (e.g., remove frames, junction boxes, etc.)?

Please describe on-site processing/disposal upon arrival at your facility.

Are you willing to share the price to the customer or your costs (can be kept anonymous) for this example?

5.3 If we have further questions, may we contact you again?

That's all, we're through! Thanks for your participation; we really appreciate it.

APPENDIX C: EXAMPLE PV RECYCLING VIDEOS

PV CYCLE: https://www.youtube.com/watch?v=81-MEpcA-Rc

Reiling: https://www.reiling.de/recycling-produkte#progress--anchor--157, or https://www.youtube.com/watch?v=ylE3h9gX2U0

ROSI: https://www.youtube.com/watch?v=_TaH0tabYRQ

LuxChemtech, Loser: https://www.youtube.com/watch?v=392uBSgPoNo

La Mia Energia s.c.ar.l.: https://www.youtube.com/watch?v=L7UDkRX-6Qw

Eggersmann: https://www.youtube.com/watch?v=filrKYLQeU0

NPC: https://www.youtube.com/watch?v=uR9ASY9afkY

Flaxres: https://www.youtube.com/watch?v=L5iMLBMkXUE

Buhck Group on reuse: https://www.youtube.com/watch?v=iqMqOGRJTm0

Henan Renewable Energy Technology Co. Ltd.: https://www.youtube.com/watch?v=wpkk6ihlB6s

Henan Honest Heavy Machinery Co., Ltd: https://www.youtube.com/watch?v=Z1t2ylEpPwA

Review movies:

https://www.youtube.com/watch?v=Sm0MlNsQKio, https://www.youtube.com/watch?v=fU8C5t2Jl48

https://www.youtube.com/watch?v=SsZCjy84o1g

Santa Monica, CA, partnered with the California Product Stewardship Council, CalRecycle, the California Conservation Corps, and Cal Micro to pilot the first-in-state solar panel recycling program: https://www.youtube.com/watch?v=uodHTg_vi1s

Technology Collaboration Programme

by iea

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