Development of a recyclability index for photovoltaic products

2nd stakeholder meeting

9 October 2024
10:30-12:30 & 14:00-16:00

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NATIONAL RENEWABLE ENERGY CENTRE

UNIVERSIDAD DE MURCIA

Agenda

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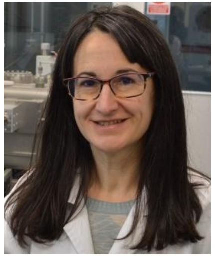
1	Welcome – 10:30
2	Policy Background – European Commission 10:40 – 11:00
3	Scientific Background of the study 11:00 – 11:30
4	Scoring System Method – Parameters 11:30 – 12:30
5	Scoring System Method – Priority Materials / Components 14:00 – 14:30
6	Scoring System Method – Scoring, Weight and Aggregation 14:30 – 15:00
7	Next steps of the study 15:00 – 15:30
8	General Questions and Answers 15:30 – 15:55
9	AOB, closure 16:00

The team

Viegand Maagøe



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Housekeeping rules & practical information for stakeholders

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More than 110 registered for the meeting

1. Remain muted, unless speaking when invited by the chair
2. Only audio connection, no video
3. At each Q&A session, use chat when asking for the floor, stating name and organisation
4. Else please do not use chat - difficult to monitor during the meeting
5. Concise question or intervention when given the floor
6. Written comments and inputs after the meeting are welcomed, deadline 1st Nov 2024
7. Slides and brief minutes will be published at the study web site after the meeting, at https://www.pv-recyclability-index.eu/
8. The meeting is being recorded for the purpose of the minutes. You gave consent when registering.

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Policy Background

Requirements/labelling under preparation

PV modules

- **Durability(quantitative)**
- **Carbon footprint**
- **Repairability (information)**
- **Recyclability (information)**
- **energy yield (information)**

PV inverters

- **Efficiency (quantitative)**
- **Durability (quantitative)**
- **Smart readiness (compulsory feature)**
- **Repairability(compulsory feature)**
- **Recyclability (information)**

Energy label

- **PV modules**

Initial product scope

- Modules
- Inverters
- ~~Systems~~

Market segments

- Residential
- Commercial
- Utility

Research / policy question: can more be made, to regulate the recyclability of PV modules?

A recyclability index for photovoltaic modules!

How to proceed for a recyclability index?

A 'CONCEPTUAL SWITCH'

FROM:

'Disassembly': means a process whereby a product is separated into its parts and/or components in such a way that it could subsequently be reassembled and made operational (→ REPARABILITY SCORE)

[Definition from EU Regulation 2023/1669]

TO

'Dismantling': means a process whereby a product is separated into its parts and/or components, in a way that could be irreversible, and with the aim to scavenge materials/components (→ RECYCLABILITY INDEX)

[Draft definition]

Potential policy implications for a recyclability index:

- displayed/made available by manufacturers for each PV module model placed on the EU market, as an effect of Ecodesign and/or energy labelling measures;
- public procurement: public procurers could use the index as awarding criteria;
- a recyclability index could also be used to modulate fees under collective collection schemes (waste legislation)

How to create synergy btw the PV Regulations with the study presented today?

Development of a recyclability index for photovoltaic products

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Depending on timing, incorporation of the index, and related method, in the Regulation(s) as information, or feeding standardization work

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Objectives

The purpose of this study is:

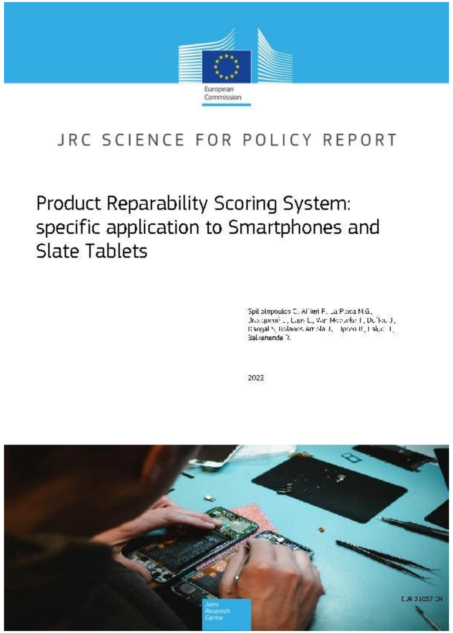
I. Analysis and **development of scoring systems** (indexes) for the recyclability of PV **modules** and **inverters** (the scoring system for each of the two products can differ).

II. **Calibration** and **validation** of the scoring systems on **products** available in the EU market.

Objectives

The purpose of this study is to provide the technical / scientific basis for a future policy implementation.

A similar study carried out by JRC to support Repair Scoring System in EU Energy Label for Smartphones and tablets


European Commission

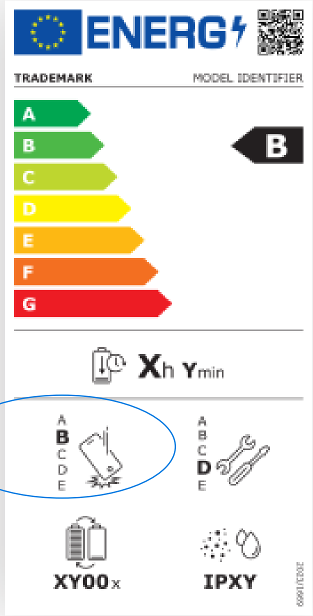
JRC SCIENCE FOR POLICY REPORT

Product Reparability Scoring System: specific application to Smartphones and Slate Tablets

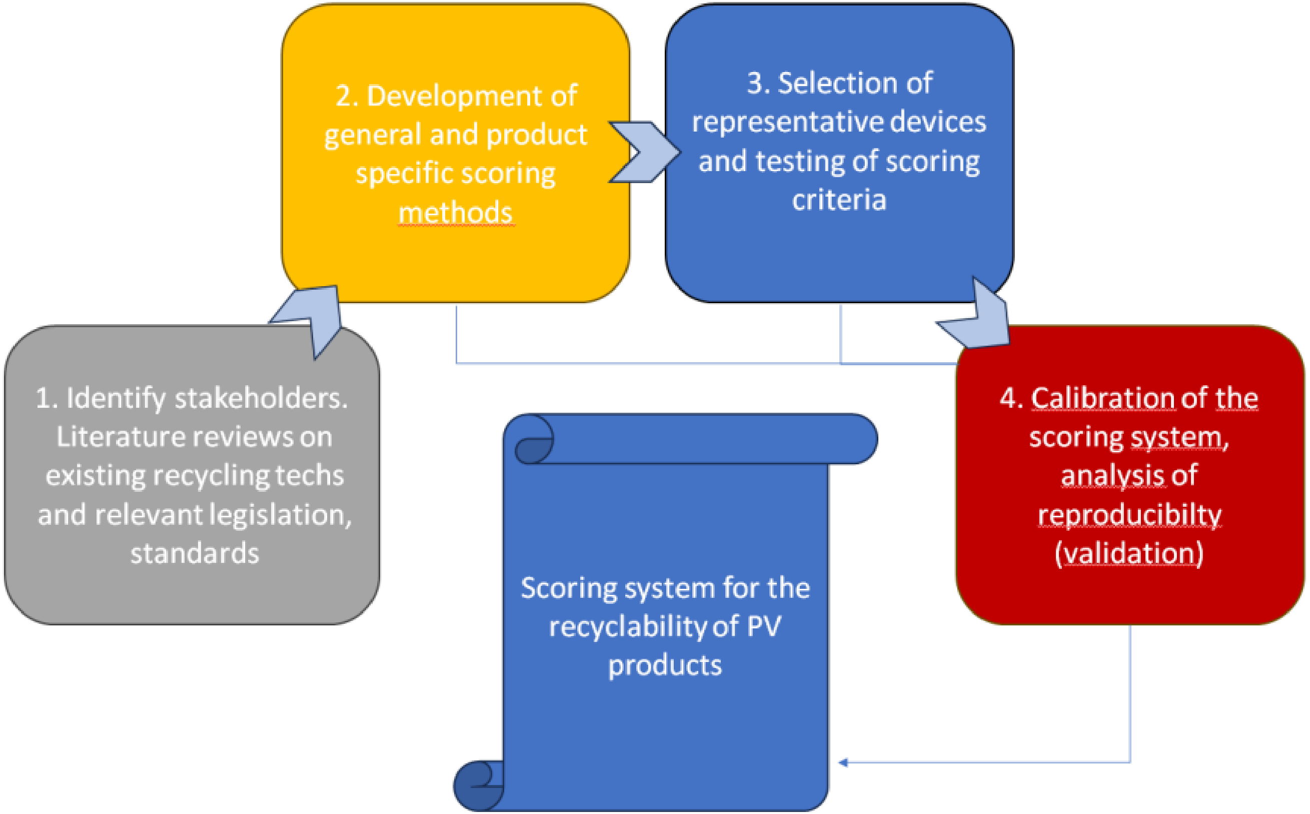
2022

EUR 31057 EN

Joint Research Centre



Phases and Deliverables



Objectives of this meeting

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1. Present you the draft scoring methodology

2. Collect your inputs on the proposed scoring methodology

3. Present next steps of the study and discuss them with you

Existing scoring systems: EPEAT

EPEAT is a voluntary label at global level:

- It assesses various lifecycle environmental aspects of a device (including recyclability aspects).
- Ranks products as Gold, Silver or Bronze based on a set of environmental performance criteria.
- EPEAT is based on a mix of mandatory and optional criteria. The optional criteria are used to rank products.
- Based on NSF/ANSI 457 – 2019.

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Existing scoring systems: EPEAT

Criteria related to recyclability
9.1.1. Required – Product take-back service and processing requirements (corporate)
9.2.1 Optional – Identification of materials for EoL management (only applicable to PV modules)
5.2.3 Optional – Bromine, chlorine, and fluorine content in electric cables
5.2.4 Optional – Bromine, chlorine, and fluorine content in plastic parts
10.2.1 Required – Enhancing recyclability of packaging materials

Existing scoring systems: RECYCLASS (packaging)

FULL COMPATIBILITY	LIMITED COMPATIBILITY	LOW COMPATIBILITY
Green column gathers the preferred design features, that guarantee the best recyclability and quality of the recyclate.	Yellow column lists the second choices for each packaging feature, that have been tested or are known to slightly impact the recycling process and/or the quality of the recyclate.	Red column classifies the detrimental and disqualifying features that should be avoided when designing packaging, as these strongly impact the recycling process and/or the quality of the recyclate.

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Existing scoring systems: RECYCLASS

RecyClass

HDPE Crates & Pallets

		YES - FULL COMPATIBILITY	CONDITIONAL - LIMITED COMPATIBILITY	NO - LOW COMPATIBILITY
	MATERIAL COMPOSITION (AMOUNT OF **PO** IN THE PACKAGING)	A >= 95%, B >= 90% and all packaging features are FULLY compatible with recycling	C >= 70% and all packaging features are FULLY compatible with recycling	D >= 50%, E >= 30% and all packaging features are FULLY compatible with recycling
	DESCRIPTION (TEST PROTOCOL)	Materials that passed the testing protocols with no negative impact OR materials that have not been tested (yet), but are known to be acceptable in PE-HD or PP recycling	Materials that passed the testing protocols if certain conditions are met OR materials that have not been tested (yet), but pose a low risk of interfering with PE-HD or PP recycling	Materials that failed the testing protocols OR materials that have not been tested (yet), but pose a high risk of interfering with PE-HD or PP recyclin
	DESCRIPTION (METHODOLOGY)	In case of at least one limited compatibility one penalty is applied, lowering the recyclability class from A to B or from B to C	In case of at least one limited compatibility one penalty is applied, lowering the recyclability class from C to D	In case of at least one limited compatibility one penalty is applied, lowering the recyclability class from D to E or from E to F
MAIN BODY	MATERIALS*	HDPE, Multilayer PE with HDPE prevalence (LLDPE, LDPE, MDPE)	PP <= 10 wt%	Multilayers HDPE with PLA, PVC, PS, PET, PETG; 10 wt% < PP <= 30 wt% (-2 classes); PP > 30 wt% (-3 classes)
MAIN BODY	COLOURS	Light colours	Dark colours	Non NIR-detectable colours
MAIN BODY	ADDITIVES	Additives that are unavoidable in processing (stabilizers, antioxidants, lubricants, nucleating agents, peroxides) and density remains < 0,97 g/cm³	Mineral fillers ($CaCO_3$, talc) not increasing density more than 0,97 g/cm³	Additives changing the material density > 1 g/cm³,Flame-retardant additives, plasticizers, Bio-/oxo-/photodegradable additives
ATTACHMENTS	COVERING SYSTEM	PE	PP	Any other
DECORATION	INKS	Non-bleeding inks compliant with EuPIA Exclusion Policy		Inks that bleed, Inks non-compliant with EuPIA Exclusion Policy, PVC binders
DECORATION	LABEL MATERIALS**	Low size labels in PE (all with density < 1 g/cm³); Avoid multilple labels	Low size labels in PP, PO (with density < 1 g/cm³); Low size labels in PET, PETG, PLA, PS (all with density > 1 g/cm³); Low size labels in Paper without fibreloss; Low size PO-foamed labels; Low size In-Mould-Labels in PE (except bleeding inks); Avoid multiple labels	Labels that hinder the recognition of the PE; Labels in non PO-materials with density < 1 g/cm³; Paper labels with fibreloss during recycling process; Cardboard or paper In-Mould-Labels; Aluminium; Metallised labels; PVC
DECORATION	ADHESIVES FOR LABELS	Water soluble adhesive (@ less than 40°C); Water releasable adhesive (@ less than 40°C)	Non-water soluble or non-releasable adhesive approved by RecyClass in combination with filmic PO labels	Non-water soluble adhesive (@ less than 40°C); Non-water releasable adhesive (@ less than 40°C)
DECORATION	DIRECT PRINTING	Laser marked	Direct printing (low extent of printing)	

RECYCLED CONTENT: No change in the recyclability assessment. A separate 'Recycled Plastics Traceability Certification' based on a Chain of Custody approach is available with RecyClass.

* Polymer resin can be either fossil-or bio-based, virgin or recycled . If different grades of the same polymer are present, weights should be cumulated.
** The surface coverage of a low size label is currently under definition.

Last update: July 2023

Existing Scoring Systems: FRENCH RECYCLABILITY SCORE

“Anti-waste for a circular economy law” (AGEC) (2020) requires to:

- display the sorting instructions;
- display the recyclability and other Environmental Qualities and Characteristics (EQC) →products under Extended Producer Responsibility (EPR) schemes.

The information to be, based on 5 criteria, displayed is as follows:

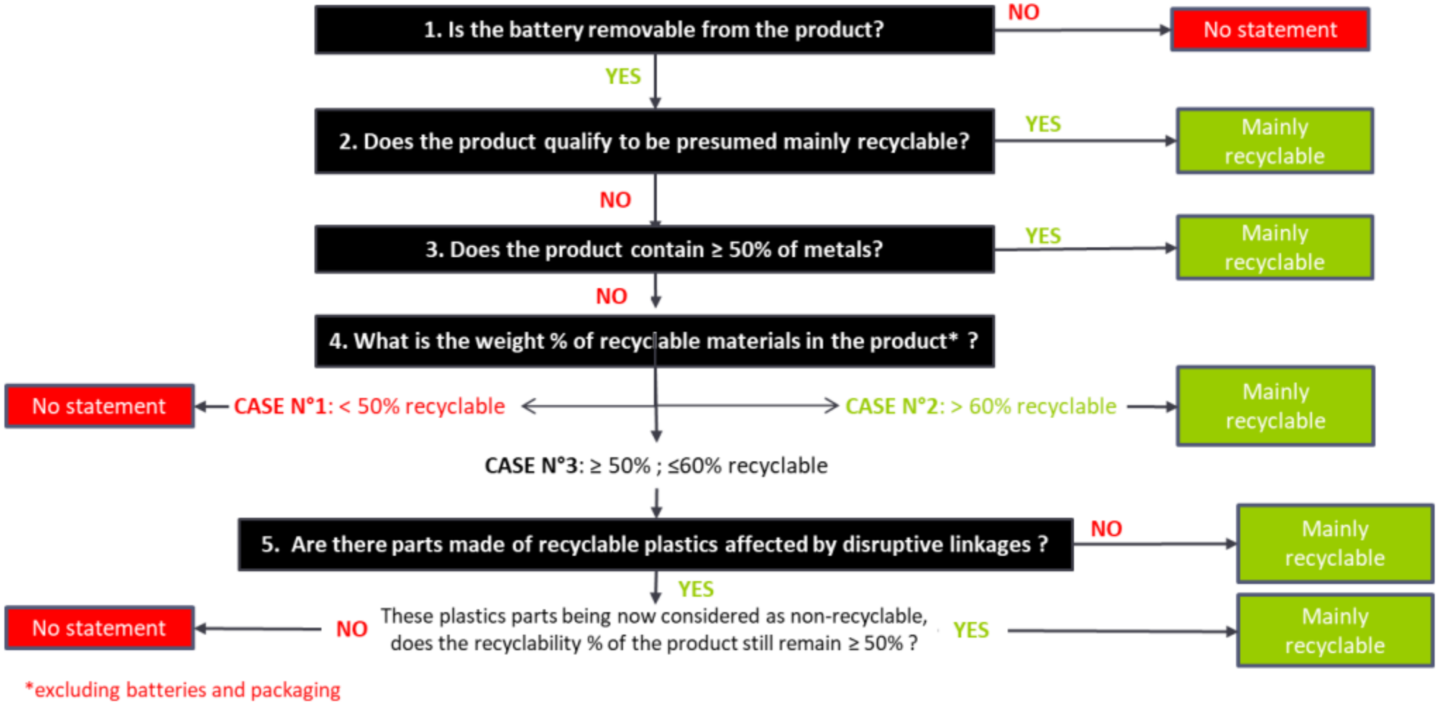
- **either no mention**, if the product does not meet at least one of the 5 recyclability criteria
- "**mainly recyclable**", if the product is **more than 50% recyclable**
- "**fully recyclable**", if the product is **more than 95% recyclable**.

Existing scoring systems: FRENCH RECYCLABILITY SCORE

1. Battery easy to be dismantled
2. Products presumed to be mainly recyclable
3. Does the product contain >50% metals?
4. The table here qualifies the recyclability of the main materials and components
5. Disruptive linkages: gluing, overmoulding, co-injection, crimping, heat or ultrasonically insertion

	Materials recyclability			
Green list				
All metals and metal alloys	YES			
ABS not filled with BFR and density < 1.1	YES			
PS not filled with BFR and density < 1.1	YES			
PE not filled with BFR and density < 1.1	YES			
PP not filled with BFR and density < 1.1	YES			
Orange list				
Products categories	cat. 1	cat. 4 & 8 (if > 50 cm)	cat. 5, 6 & 8 (if < 50 cm)	cat. 2
WEEE collection flow	LHA-cold	LHA-non-cold	SHA	Screens
ABS-PC not filled with BFR and density < 1.1	NO	NO	YES	YES
PMMA not filled with BFR	NO	NO	NO	YES
Concrete	NO	YES	NO	NO
Glass	YES	NO	NO	NO
Red list				
All plastics filled with BFR or with density > 1.1 (excepted PMMA)	NO			
All BFR-filled plastics	NO			
Expanded foams	NO			
Rubbers, silicones, elastomers	NO			
Ceramic	NO			
Glass ceramics	NO			
Wood	NO			
Textiles	NO			
Gas	NO			
All materials not listed elsewhere	NO			

Existing scoring systems: FRENCH RECYCLABILITY SCORE



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SCIENTIFIC LITERATURE ON SCORING RECYCLABILITY

1. Evaluation of Products at Design Phase for an Efficient Disassembly at End-of-Life
2. A Design for Disassembly Tool Oriented to Mechatronic Product Demanufacturing and Recycling
3. Manufacturing and Assembly for the Ease of Product Recycling: A Review
4. The Design Value for Recycling End-of-Life Photovoltaic Panels
5. The End of Life of PV Systems: Is Europe Ready for It?
6. A critical review of the circular economy for lithium-ion batteries and photovoltaic modules – status, challenges, and opportunities
7. Emerging waste streams – Challenges and opportunities
8. PV module eco-design: new encapsulant for high sustainability and recyclability of photovoltaic value chain
9. Solar Photovoltaic Module Recycling: A Survey of U.S. Policies and Initiatives
10. Analysis of material recovery from photovoltaic panels
11. Addressing uncertain antimony content in solar glass for recycling
12. Product design and recyclability: How statistical entropy can form a bridge between these concepts - Case study of a smartphone

SCIENTIFIC LITERATURE ON SCORING RECYCLABILITY

Key Comparison Criteria

- Scope and Focus
- Methodologies Used
- Challenges Identified
- Solutions Proposed
- Regional Focus
- Relevance to PV Circularity

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SCIENTIFIC LITERATURE ON SCORING RECYCLABILITY

Paper	Scope	Methodology	Challenges Identified	Proposed Solutions	Region	Relevance to PV Circularity
1 Sabaghi et al. (2016)	Design for Disassembly	Hybrid DOE-TOPSIS methodology	Significant parameters affecting disassembly (e.g., accessibility, connection types)	Systematic evaluation of disassemblability; categorized indices (easy, mild, difficult); Design for modulari**ty**	Cross-industry	High: Provides a structured framework for evaluating PV recyclability based on disassembly parameters and indices
2 Favi et al. (2019)	Design for Disassembly, sustainability in EoL management	LeanDfD Tool (CAD integration and Liaison Database)	Limitations in existing DfD tools; lack of accurate **disassembly time calculation**	LeanDfD: Quantitative assessment of disassembly time, criticality identification, integration with CAD systems	Cross-industry (mechatronics, adaptable to PV)	High: The quantitative assessment of disassemblability and recyclability can be adapted for PV systems, helping create a robust recyclability index for PV technologies
3 Shahhoseini et al. (2023)	Review 9 papers (DFMA, EoL)		Limited integration of design for recycling and EoL in practice; Waste disposal costs often overlooked	Ease of Disassembly Metric (eDiM); Integration of DFMA with sustainability (e.g., 3D scanning for recyclability)	Global	High: The review's insights on disassembly, recyclability indices, and circular economy support provide a comprehensive basis for developing a PV recyclability index. Highlights the need to link design and EoL processes, crucial for PV recycling

SCIENTIFIC LITERATURE ON SCORING RECYCLABILITY

Paper	Scope	Methodology	Challenges Identified	Proposed Solutions	Region	Relevance to PV Circularity
4 Calì et al. (2022)	Design strategies (DfR, DfD) optimizing recyclability and durability	Material analysis, thermo-mechanical failure simulations (TMF), and parametric failure models	• **Use of non-reversible adhesives and encapsulants;** • **Limited recyclability of some components, e.g. backsheet**	Use of recyclable polymers, minimal encapsulants, optimized geometric parameters, and silicone rubber layers to enhance recyclability and durability	Global	High: This paper directly addresses the optimization of DfR and Dfd, providing valuable design insights for developing a PV recyclability index, particularly in terms of material selection and structural improvements
5 Bošnjak ovíc et al. (2023)	Barriers to recycling PV modules and explores readiness for EoL manag.	Analysis of material and design complexities	Complexity and variety of materials and designs; multiple recycling techniques required to handle different materials	Design for Recycling (DfR) and Design for the Environment approaches to simplify recycling	Europe	High: Highlights critical design and recycling challenges relevant to the PV recyclability index, particularly the necessity for DfR and the awareness of recycling techniques among designers
6 Heath et al. (2022)	Explores circular economy pathways	Identification of key insights, gaps, and opportunities	-EVA requires high-temperature recycling; alternatives -Hazardous waste -Materials traceability to improve recyclability -High costs	**- Non-adhesive release layers.** **- Lead-free solder (e.g., tin-bismuth) but might lower durability.** **- Digital technologies (RFIDs, material passport).** **- Fluorine-free backsheets, but may reduce durability**	US	

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SCIENTIFIC LITERATURE ON SCORING RECYCLABILITY

Paper	Scope	Methodology	Challenges Identified	Proposed Solutions	Region	Relevance to PV Circularity
7 Oko Institute (2021)	Waste streams analysis	Analysis of valuable materials and recycling processes.	• Complex material separation (delamination, Si purification) • Economic inefficiencies. • Hazardous substances. • Logistic challenges in access.	- Advanced recycling technologies for better recovery. - Improved design to reduce hazardous materials. - Streamlined disassembly processes (considering logistics).	Global	- Emphasize technologies for recovering valuable materials. - Incorporate design strategies that minimize hazards. - Address logistics in disassembly for improved recyclability assessments.
8 Izzy, 2023	New encapsulant materials	Comparative analysis of encapsulation materials (EVA, TPO, POE)	- Current EVA encapsulation hinders high-value recycling. - Limited options for sustainable alternatives.	- Explore thermoplastics (TPO) and elastomers (POE) for encapsulation. - Enhance physical and optical properties of new materials.	EU	**- Advocate for encapsulant innovations that facilitate recycling.** **- Integrate material selection into the recyclability index to promote circularity.**
9 Curtis et al. (2021)	Policy barriers in PV module recycling	Survey and SHs interviews	- Lack of information exchange among solar value chain actors. - No mandates for manufacturers to disclose chemical composition. - Variable EoL management costs and documentation issues.	Enhance transparency by incentivizing labelling of PV module composition. - Improve information exchange to lower costs and enhance stakeholder relationships.	US	- Highlights the need for policies promoting information sharing to improve recyclability and reduce EoL costs.

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SCIENTIFIC LITERATURE ON SCORING RECYCLABILITY

Paper	Scope	Methodology	Challenges Identified	Proposed Solutions	Region	Relevance to PV Circularity
10 JRC (2016)	Material recovery from silicon PV panels	Analysis of recycling treatments and composition testing	• Uncertainty in panel composition reduces treatment efficiency. • Presence of hazardous substances complicates recycling methods. • Lack of detailed composition information from manufacturers	- Encourage manufacturers to disclose detailed panel compositions. - Prioritize recycling methods based on composition (e.g., avoiding halogenated plastics).	EU & Global	- Emphasizes the importance of material composition data for optimizing recycling processes, relevant for recyclability assessments.
11 ESIA (2023)	Antimony content in solar glass for recycling	Review of recycling processes for float glass and antimony impacts	- **Recycling antimony-containing glass is economically inefficient and complicates manufacturing processes.** - Lack of transparency in glass composition hinders recycling efforts.	- Mandate disclosure of solar glass composition and manufacturing processes in Ecodesign Regulation. - Implement measures to improve recyclability of glass.	EU & Global	- Stresses the need for transparency in material composition for effective recycling, informing recyclability indices for PV modules.
12 Roithner et al. (2022)	Statistical entropy as a measure of recyclability	Recyclability assessment method using entropy	- Existing product designs often fail to consider material distribution and recyclability potential.	- Use statistical entropy to evaluate recyclability during the design phase. - Identify design weaknesses to improve recyclability.	EU & Global	- Introduces a novel metric for evaluating product design in terms of recyclability, applicable to PV module design considerations.

DECALOGUE TO DEVELOP SCORING RECYCLABILITY METHOD

- **Integrate DfR Principles**: Emphasize design for recycling to enhance end-of-life recovery.
- **Optimize Material Selection**: Use recyclable materials and minimize hazardous substances.
- **Enhance Component Transparency**: Ensure manufacturers label materials and provide detailed product compositions.
- **Prioritize Recyclable Components**: Focus on key materials like aluminum, glass, and critical metals (e.g., silver, indium).
- **Facilitate Disassembly**: Design products for easy disassembly, reducing costs and damage during recycling.
- **Incorporate Digital Tools**: Utilize technologies (e.g., RFID, QR codes) for tracking materials and components.
- **Address Design Variability**: Standardize designs to simplify recycling processes and reduce economic inefficiencies.
- **Focus on Lifecycle Assessment**: Use LCA methodologies to evaluate and optimize the environmental impact of materials.
- **Engage Stakeholders**: Foster collaboration between manufacturers, recyclers, and policymakers for better recycling strategies.
- **Develop Scoring Metrics**: Create clear scoring criteria that reflect the recyclability potential based on the insights gathered.

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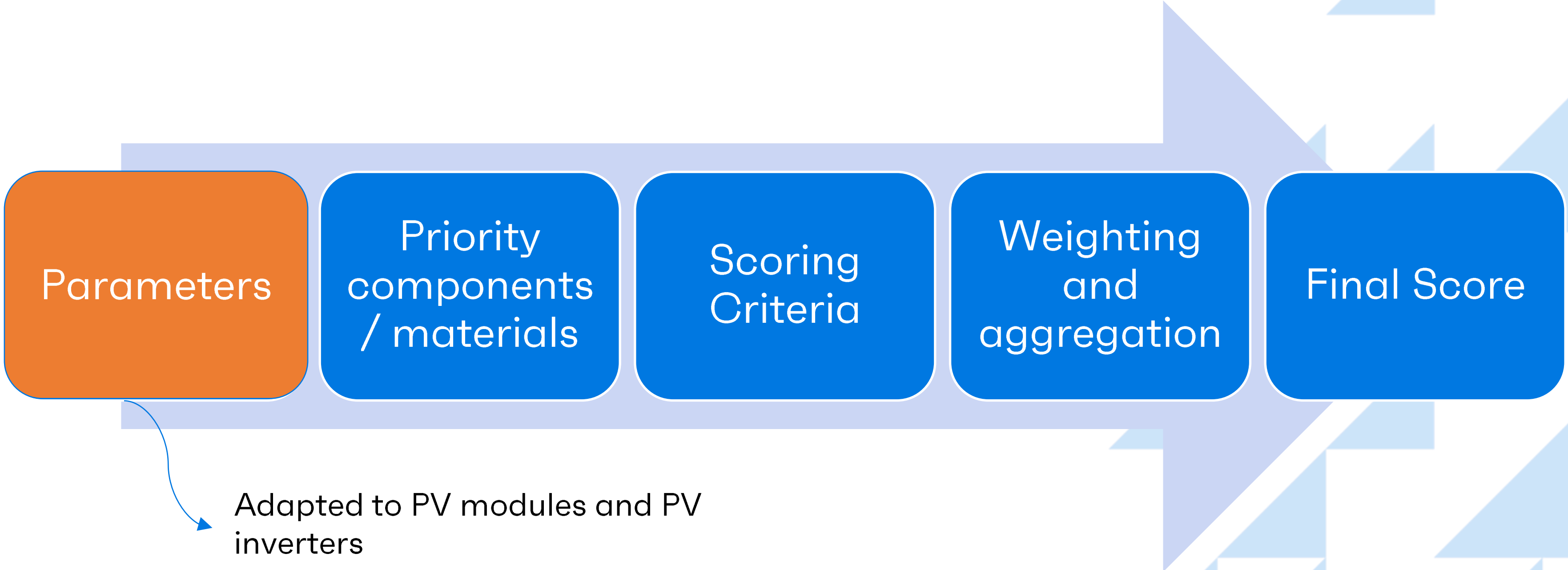
Development of the scoring method

Key steps for developing the recyclability scoring system:



Parameters: summary table

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Type of parameters	N	Parameter
Service-Related Parameters	1	Technology identification
	2	Information on the presence (or absence) of substances of concern
	3	Dismantling information and condition for access
	4	Information on composition (including critical and strategic raw materials): #4.1 Disclosure of material composition
		Information on composition (including critical and strategic raw materials): # 4.2 Disclosure of presence and location of Critical, Strategic and Environmental Relevant materials
Dismantling Related Parameters	5	Number of steps for the dismantling of priority parts (dismantling depth)
	6	Types of tools to dismantle priority parts
	7	Removability of fasteners to dismantle priority parts, reversibility of sealants and encapsulants
Material based parameters	8	Level of concentration of hazardous substances and other substances affecting the recycling process
	9	Selection of materials based on recyclability complexity
	10	Combination of materials used / homogeneity

1. Technology Identification

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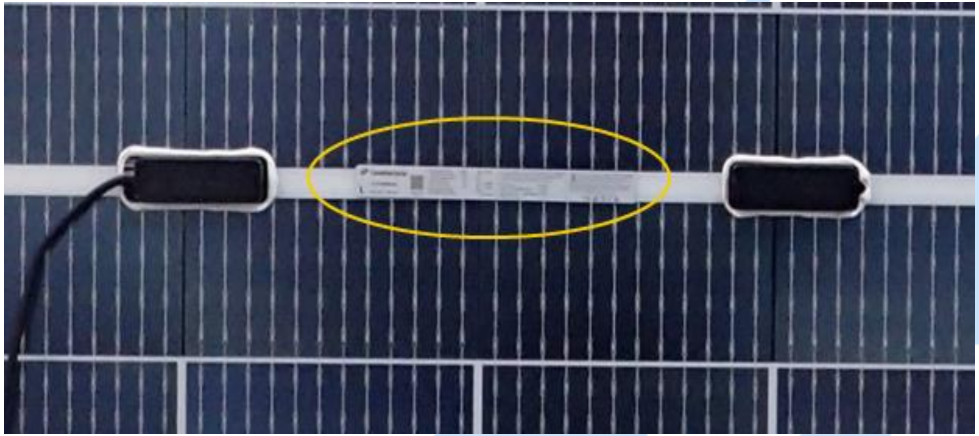
- Distinction of PV technologies is not always possible by optical inspection, especially in the case of thin film PV modules (as indicated in the EN 50625-2-4:2017 – Annex AA)

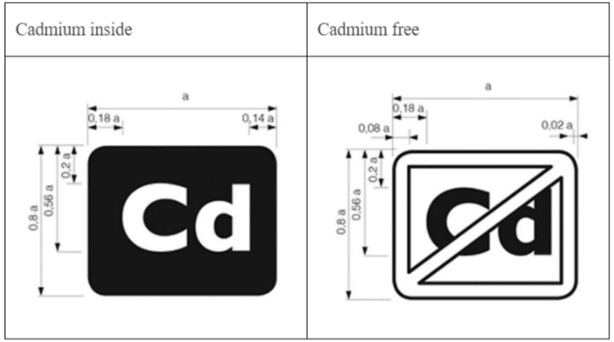
- Identifying composition and construction may permit sorting and higher tolerance at the recycling plants



2. Information on the presence of SoC

- Information can be added to the product data plate, embossed or engraved on the product itself or accessible from the product by electronic means in the form of bar codes, radio-frequency identification (RFID) or product passport based on blockchain technologies (in the future)

- Example in current Ecodesing on Electronic Displays (Regulation on ecodesign for electronic displays (EU) 2019/2021)



3. Dismantling information / access

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The dismantling instructions freely available on third party database / website. This would ensure that this information will be available for future use. The instruction should also include:

- the unequivocal **product identification;**
- the **dismantling map** or exploded view;
- the detailed **step-by-step instructions on the dismantling** of priority parts, including information on the unfastening operations, type of tools needed;
- diagnostic fault and error information (including manufacturer-specific codes, where applicable) component and diagnosis information (such as minimum and maximum theoretical values for measurements);
- **type of recycling technology needed** to carry our specific recycling steps.

4. Information on composition

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4.1 Disclosure of composition

- Different levels of ambitions could be awarded based on the percentage of product mass disclosed (e.g. 70% - 90% - 95% - 99%).
- A similar scoring criterion is provided by the NSF/ANSI 457 standard where the manufacturer shall demonstrate to have in place a system for recording information, calculating percentages of data acquired.

4.2 Disclosure of presence and location of Critical, Strategic and Environmental Relevant materials

PV Modules	PV Inverters
Cadmium, Silicon metal, Silver, Aluminium, Copper, Indium, Gallium, Germanium, Tellurium, Lead, Antimony Tin	Aluminium, Gold, Lead, Copper, Silicon carbide, Silver, Indium, Gallium, Tantalum, Nickel, Palladium Tin, Cobalt, Zinc

5. Dismantling Depth

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This scoring criterion award points based on the **number of dismantling steps (N)** to reach and remove specific priority parts. For the calculation of dismantling steps, the following rules are proposed:

- the dismantling depth count is completed when the **target part is separated** and individually accessible.
- where multiple tools need to be used simultaneously, **the use of each tool counts as a separate step**.
- operations like applying **thermal or chemical treatments to the product** in order to facilitate the dismantling **are also counted as steps**.
- The Dismantling Depth score (DDi) for each priority part shall be calculated based on the number of steps required to remove that part from the product. **The counting of the steps for each part starts from the fully assembled product.**

6. Types of tools to dismantle priority parts

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This scoring criterion award points based on the **complexity of tools needed** to reach and remove specific priority parts.

In this context

- **‘basic tools’** means list of tools specifically defined for the product groups under assessment, considering the preliminary list in Table A.3 of the standard EN45554:2020;

- **‘commercially available tool’** means a tool that is available for purchase by the general public and is neither a basic tool nor a proprietary tool;

- **‘proprietary tool’** means a tool that is not available for purchase by the general public or for which any applicable patents are not available to license under fair, reasonable and non-discriminatory terms.

7. Removability of fasteners, reversibility of sealants and encapsulants

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7.1 Type of fasteners to dismantle priority part (X) (inverters)

Taking apart components for recycling can have different levels of complexity and circularity based on the type of fastening (or joining) technique applied:

- **“reusable fasteners”** An original fastening system that can be completely re-used, or any elements of the fastening system that cannot be reused are supplied with the new part for a repair, re-use or upgrade process.

- **“removable fastener”** means a fastener that is not a reusable fastener, but whose removal does not damage the product, or leave residue, which precludes reassembly (e.g. a screw is typically designed in a way that allows fastening and unfastening);

- **“non-removable fasteners”** means a permanent fastening (joining) techniques that makes the separation of the target part from the rest of the product not feasible or only feasible by damaging the part itself or the entire product.

7. Removability of fasteners, reversibility of sealants and encapsulants

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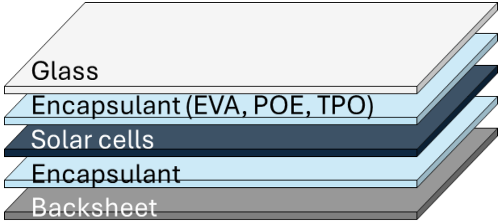
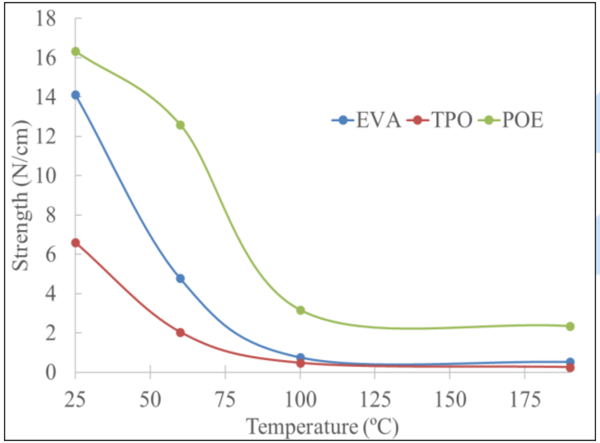
#7.2 Removability of the encapsulant after heating process (mono-facial PV modules)

Measure the reversibility of the encapsulant bond at conditions simulating a thermal-based recycling process (hot-knife) by a peel-off test applied to the interface encapsulant-glass.

Peel-off test at different temperatures (25ºC, 60ºC, 100ºC, 190ºC)





Preliminary test:
The **adhesion difference decreases as test T increases**, especially above 60°C.

Parameter: force decrease from T_{amb} to $T_{dissamble}$

7. Removability of fasteners, reversibility of sealants and encapsulants

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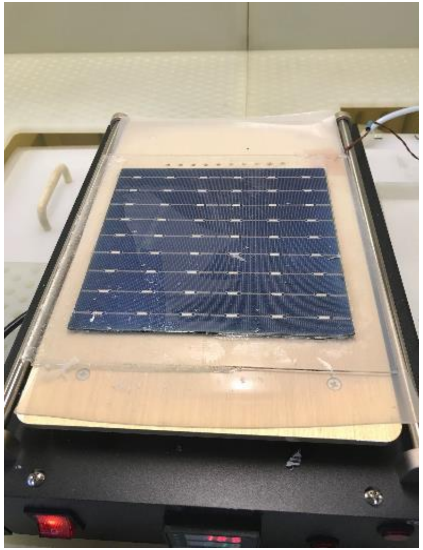
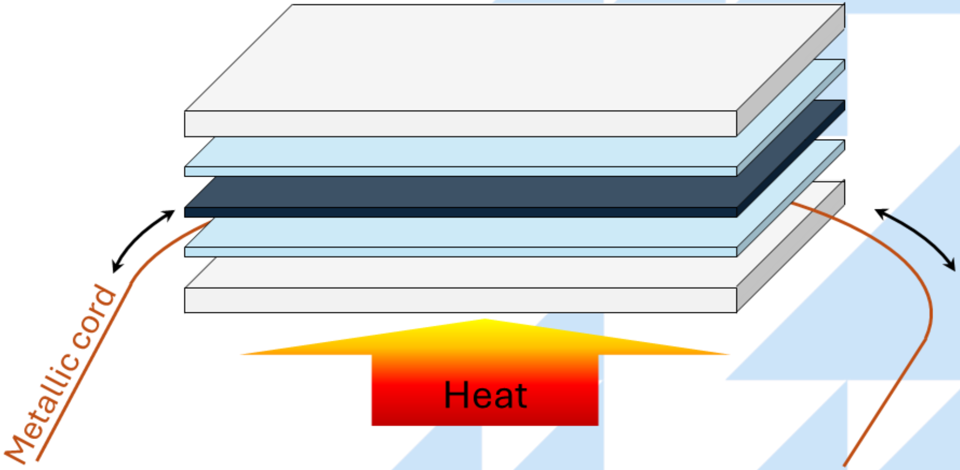
#7.3 Removability of the encapsulant after heating process (bi-facial PV modules)

We propose a hot-wire technique (Peel-off test cannot be applied in glass-glass modules)

Heat up the panel and measure at which temperature and force the module can be dismantled by means of a metallic cord in standardised conditions / force measured by a load cell

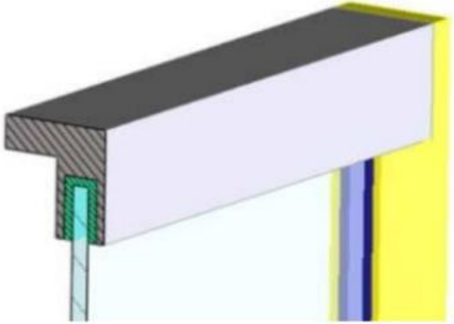




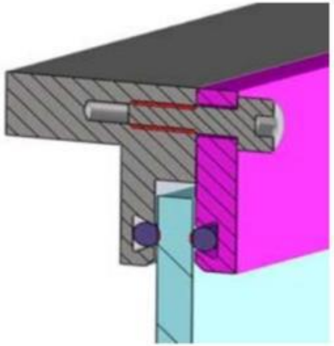
7. Removability of fasteners, reversibility of sealants and encapsulants

#7.4 Removability of the frame (only applicable to PV modules with frame)

According to Bilbao et a. (2021) O-ring and U-profile techniques are alternative, easy-to-remove edge-sealing solutions that are suitable for PV modules. This sub-criterion aims to **penalise the use of adhesives for fixing the frame on the surface of the module and award the presence of alternative edge sealing techniques, as the use of O-ring or U-profile**



U-profile rubber



O-ring

8. Concentration of hazardous substances and other substances affecting the recycling process

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This parameter aims to assess the concentration of **substances of concern, including specific substances affecting the recycling process**, in specific homogenous parts of the product.

Reducing the presence of these substances is likely to enhance the possibilities and economic profitability of recycling of PV products and decrease the negative impacts on the health of workers in recycling plants.

The identifed substances for this parameter include:

- **Fluorine in backsheets**
- **Antimony in glass**
- **Brominated flame retardants in plastic components**

9. Selection of materials based on recyclability complexity

- **green list:** substances that are the easiest to be recycled (metals and metal alloys such as copper, aluminium, steel, silver).
- **orange list:** substances that are easy to be recycled but for which the fulfilment of specific design conditions should be verified (e.g. plastics as ABS, PE and PP not filled with BFR; glass without intentionally added antimony).
- **red list:** substances that are more complex to recycle: thermoset and composites, rubbers, silicones, elastomers, foams, BFR-filled plastics, magnets).

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10. Combination of materials used

This scoring criterion award points based on the way different materials are combined in single parts and aims to award design based on homogeneous or separable materials versus the use of **"disruptive" linkages** (non-separable material combinations). The assessment has to be carried out at priority part level.

Identified disruptive linkages include:

- **Moulding different material types together by multiple-K processes** (different plastic materials injected into the same mould, over-moulding, or in-mould decoration).
- **Connections that enclose a material permanently.** Avoid methods such as moulding-in inserts into plastics, rivets, staples, press-fits, bolts, bolt and nuts, brazing, welding, and clinching.
- Use of **coatings on plastics.**
- **Plating, galvanizing, and vacuum-metallization** as a coating on plastics.
- **Fixing ferrous metals to non-ferrous metals** in either parts or fasteners.
- **Multi-material injection moulding** is the process of moulding two or more different materials into one plastic part, at the same time.

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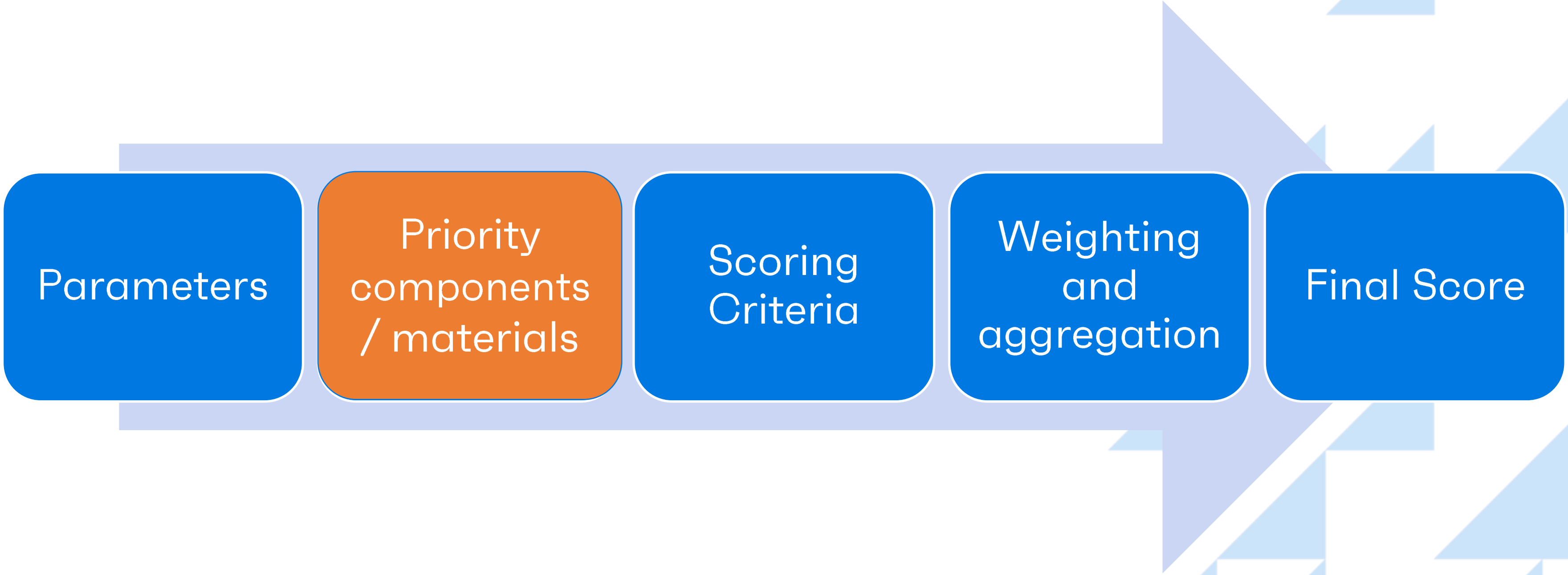
5. Scoring System Method – Priority Materials / Components 14:00 – 14:30
6. Scoring System Method – Scoring, Weight and Aggregation 14:30 – 15:00
7. Next steps of the study 15:00 – 15:30
8. General Questions and Answers 15:30 – 15:55
9. AOB, closure 16:00

Development of the scoring method

Key steps for developing the recyclability scoring system:



Key criteria for prioritization

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1. **Mass Content Relevance**
   - Higher relevance assigned to abundant materials in PV modules and PV inverters.
2. **Environmental Relevance**
   - Using Life Cycle Assessment (LCA) and the Environmental Footprint 3.0 method.
   - Ecoinvent database for background data.
   - Materials' impacts normalized with established factors.
3. **Criticality and Strategic Relevance**
   - Based on EU CRM list (2023).
   - Scale of 1 to 4 (1 = not critical, 4 = critical raw material).
4. **Economic / Demand Relevance**
   - Prioritizes high-value materials with strong market demand.
   - Data from Trading Economics and Price Metal websites.

Typical Si PV module Break-down

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Material/parts		Concentration (%)
Glass		73,19
		10,17
Polymers	EVA (ethylvinylacetate)	3,55
	Tedlar (polyvinylfluoride)	
Solar cell		3,43
Adhesive		1,14
Copper		0,56
Junction box		1,31

SOLAR CELL

Material	Concentration (%)
Silver	0,69
Aluminium	9,00
Lead	0,04
Tin	0,06
Silicon	90,00
Copper	0,01

Environmental Aspect & Material Prioritization in PV Modules

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MASS CONTENT

Glass is the most relevant material

ENVIRONMENTAL IMPACT CALCULATION

1. **Impact Calculation**:
   - Normalized impacts were calculated using Simapro and the Environmental Footprint method.
   - Ag shows the highest cumulative environmental impacts in PV modules.
2. **Impact Categories**:
   - **Resource Use (minerals and metals)** is the most significant category.
   - Followed by **Freshwater eutrophication** and **Ecotoxicity in freshwater**.

CRITICALITY INSIGHTS

- **Si**: Critical and strategic; EU only produces 0.6% of global crystalline silicon cells.
- **Al**: Critical, but not strategic.
- **Ag**: Not classified, but heavily used in PV module production.
- **Ge**: Marginal impact on energy markets.

ECONOMIC VALUE

- **Ag** is the most valuable material in solar cells, with a price over **€953/kg**, more than 1500 times higher than other materials.

Material	Mass-content	Env. impacts	Criticality / EU strategy	Economic / demand	Weighted Relevance score
Silver	3,28E-04	1,00	0,75	1,00	2,75
Glass (material)*	1,00	9,19E-06	0,50	6,50E-04	1,50
Silicon*	0,04	7,40E-05	1,00	0,02	1,06
Aluminium	0,14	8,55E-05	0,75	2,64E-03	0,90
Copper	0,01	9,19E-03	0,75	0,01	0,78
Tin	2,73E-05	3,41E-02	0,50	0,03	0,57
Lead	1,37E-05	1,67E-03	0,50	2,30E-03	0,50
Ethyl vinyl acetate (EVA)	0,09	3,28E-05	0,25	1,94E-03	0,34
Tedlar (PVF)/Polydivinyl fluoride (PVDF)	0,05	2,17E-04	0,25	0,01	0,31

Environmental Aspect & Material Prioritization in PV Modules

Priority parts for PV modules
Solar Cell (silver, silicon, tin, lead)
Glass
Frame (aluminium)
Cables (copper)
Junction box (copper)

Typical inverter Break-down

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Material	Concentration (%)
Aluminium (CRM)	19%
Copper (SRM)	28%
Nickel (SRM)	0,4%
Silicon	9%
Tin	0,4%
Gold	0,4%
Silver	1%
Lead	0,2%
Palladium	0,002%
Steel	21%
Cobalt	0,002%
Zinc	0,002%
Specific plastic polymers:	11%
FR-4, Glass-reinforced epoxy laminate material	1%
Ferrite	2%

Environmental Aspect & Material Prioritization in PV Inverters

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MASS CONTENT

Al, **Cu** and **steel** are the most relevant materials

ENVIRONMENTAL IMPACT CALCULATION

1. **Impact Calculation**:
   - Normalized impacts were calculated using Simapro and the Environmental Footprint method.
2. **Impact Categories**:
   - **Resource Use (minerals and metals)** is the most significant category.
   - Followed by **Climate change** and **Resource use (fossils)**.

CRITICALITY INSIGHTS

- **Si, Pd** Critical and strategic; EU only produces 0.6% of global crystalline silicon cells.
- **Al**: Critical, but not strategic.
- **Cu, Ni,** : Not classified, but heavily used in PV inverters.

ECONOMIC VALUE

- **Au** and **Pd** are the most valuable material in solar cells, with a price ca **€70k** and **€30k/kg** respectively; more than 70000 times higher than other materials.

Metal/Material	Mass-content	Env. impacts	Criticality / EU strategy	Economic / demand	Weighted score
Gold	2,82E-03	2,50E-01	0,13	2,50E-01	0,63
Copper (SRM)	0,25	2,77E-05	0,19	3,51E-05	0,44
Aluminium (CRM)	0,17	2,60E-07	0,25	9,05E-06	0,42
Palladium	0,00	3,22E-03	0,25	1,10E-01	0,36
Silicon	0,08	6,11E-07	0,19	6,04E-06	0,27
Steel	0,19	7,82E-09	0,06	1,22E-05	0,25
Silver	0,01	3,04E-03	0,19	3,43E-03	0,20
Nickel (SRM)	0,00	8,40E-06	0,19	6,21E-05	0,19
Tin	0,00	1,04E-04	0,13	1,17E-04	0,13
Ferrite	0,02	2,85E-08	0,06	8,61E-08	0,08
Glass-reinforced epoxy (FR4)	0,01	3,47E-03	0,06	1,1E-05	0,07
Lead	0,00	5,09E-06	0,06	7,88E-06	0,06
Cobalt	0,00	6,11E-05	0,06	9,76E-05	0,06
Zinc	0,00	5,84E-06	0,06	1,03E-05	0,06

Environmental Aspect & Material Prioritization in PV Inverters

Priority parts for PV inverters
Printed Circuit Board (PCB) (gold, silver, copper, tin, lead)
Heat sink (copper, aluminium)
Casing (aluminium)
Cables (copper)
DC link Capacitors (palladium, tantalum)

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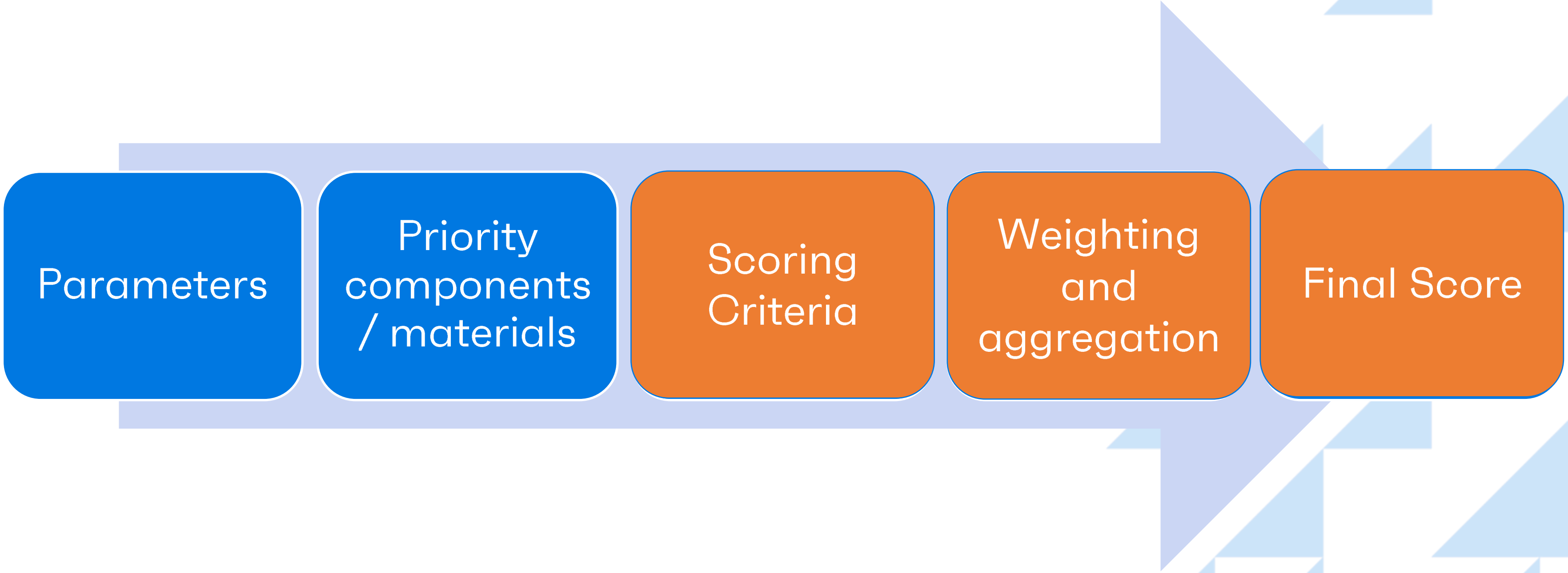

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Scoring Criteria

	Numerical score (1 to 5) Less recyclable ⟷ More recyclable				
5 scoring options	1	2	3	4	5
4 scoring options	1	2	--	4	5
3 scoring options	1	--	3	--	5
2 scoring options	1	--	--	--	5

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Scoring Criteria: service-related parameters

N°	Parameters	Product specific parameters	Applicability	Scoring Criteria	Points
1	Technology identification		PV modules	No technology identification available/accessible on the product itself.	1
				Technology identification available/accessible on the product itself.	5
2	Information on the presence (or absence) of substance of concern		PV modules and PV inverters	No information specifying the presence/absence of substances of concern on the product itself.	1
				Information specifying the presence/absence of substances of concern on the product itself.	5
3	Availability of dismantling instructions		PV modules and PV inverters	Dismantling instructions not freely available on a third-party database / website.	1
				Dismantling instructions freely available on a third-party database / website.	5

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Scoring Criteria: service-related parameters

N◦	Parameters	Product specific parameters	Applicability	Scoring Criteria	Points
4	Information on composition	4.1 Disclosure of material composition	PV modules and PV inverters	Disclosure of material composition (≤70% of product mass) freely available on a third-party database / website.	1
				Disclosure of material composition (> 70% of product mass) freely available on a third-party database freely available on a third-party database / website.	2
				Disclosure of material composition (> 90% of product mass) freely available on a third-party database / website.	3
				Disclosure of material composition (> 95% of product mass) freely available on a third-party database / website.	4
				Disclosure of material composition (> 99% of product mass) freely available on a third-party database / website.	5

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Scoring Criteria: service-related parameters

N◦	Parameters	Product specific parameters	Applicability	Scoring Criteria	Points
4	Information on composition	4.2 Disclosure of presence and location of Critical, Strategic and Environmental Relevant materials	PV modules and PV inverters	Presence and location of CRM, Strategic and Environmental Relevant materials not disclosed	1
				Presence and location of CRM, Strategic and Environmental Relevant materials only partially disclosed	3
				Presence and location of CRM, Strategic and Environmental Relevant materials fully disclosed and available on a third-party database / website.	5

Scoring Criteria: dismantling-related parameters

N◦	Parameters	Product specific parameters	Applicability	Scoring Criteria	Points
5	Number of steps for the dismantling of priority part (X)		PV modules and PV inverters	DDi > A steps	1
				A steps ≥ DDi > B steps	2
				B steps ≥ DDi > C steps	3
				C steps ≥ DDi > D steps	4
				DD ≤ D steps	5
6	Type of tools to dismantle priority part (X)		PV modules and PV PV inverters	Proprietary tools	1
				Commercially available tools	2
				Basic tools	4
				No tools	5

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Scoring Criteria: dismantling-related parameters

N◦	Parameters	Product specific parameters	Applicability	Scoring Criteria	Points
7	Removability of fasteners, reversible sealants and encapsulant layers	7.1 Type of fasteners to dismantle priority part (X)	PV Inverters	Not-removable fasteners	1
				Reusable or Removable fasteners	5
		7.2 Removability of the encapsulant after heating process: peel-off test	Mono-facial PV modules	"Non-reversible encapsulant": the product / components are damaged during the testing peel-off process (the peel-off test is not passed)	1
				Difficult to remove encapsulant: based on the measurement of the drop of the adhesion force between 100 at 140 °C	3
				Easy to remove encapsulant[22]: based on the measurement of the drop of the adhesion force between 100 at 140 °C	5
		7.3 Removability of the encapsulant from the glass after heating process: metal cord test	Bifacial PV modules	"Non-removable encapsulant": the product / components are damaged during the dismantling process	1
				Difficult to remove encapsulant: the dismantling with the cord is feasible but only at a temperature equal or higher than 140 °C	3
				Easy to remove encapsulant: the dismantling with the cord is feasible but only at a temperature higher than 150 °C	5
		7.4 Removability of the frame	PV modules with frame	Presence of adhesive on the glass / frame interface	1
				Use of edge sealing techniques (e.g. O-ring or U-profile design)	5

Scoring Criteria: material-based parameters

N∘	Parameters	Product specific parameters	Applicability	Scoring Criteria	Points
8	Concentration of substances of concern, including substances affecting the recycling process in Priority Part (X)	Applicable to the following parts / substances in PV panels 1) Antimony in Glass; 2) Fluorine in backsheet 3) Brominated flame retardants in plastic components	PV modules PV inverters	Substance concentration by weight (%) in homogeneous material > A%	1
				Substance concentration by weight (%) in homogeneous material ≤ A% and > B%	2
				Substance concentration by weight (%) in homogeneous material ≤ B% and > C%	3
				Substance concentration by weight (%) in homogeneous material ≤ C% and > D%	4
				Substance concentration by weight (%) in homogeneous material ≤ D%	5

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Scoring Criteria: material-based parameters

N◦	Parameters	Product specific parameters	Applicability	Scoring Criteria	Points
9	Selection of materials based on their recyclability complexity in Priority Part (X)		PV modules and PV inverters	Use of materials with low recyclability (red list)	1
				Use of materials with conditional recyclability (orange list)	3
				Use of materials with high recyclability (green list)	5
10	Combination of materials used / homogeneity in Priority Part (X)		PV modules and PV inverters	Use of combined materials that are not separable.	1
				Use of combined materials that are separable (allow easy liberation)	3
				Use of homogenous material in a specific part	5

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Scoring Aggregation: PV panels

Parameter	Score for priority part/material i [1-5]	Weight for priority part/material i [%]	Parameter Score [1-5]	Parameter Weight [%]	Final Score [1-5]
#1 Technology Identification			S_1	W_1	Recyclability Index $R = \sum_{j=1}^{10} S_j \cdot W_j$
#2 Information on the presence (or absence) of substance of concern			S_2	W_2	
#3 Availability of dismantling instructions			S_3	W_3	
#4.1 Disclosure of material composition			$S_{4.1}$	$W_{4.1}$	
#4.2 Disclosure of presence and location of Critical, Strategic and Environmental Relevant materials			$S_{4.2}$	$W_{4.2}$	
#5 Dismantling depth	$S_{5,i}$	$\omega_{5,i}$	$S_5 = \sum_{i=1}^{N} S_{5,i} \cdot \omega_i$	W_5	
#6 Tools (type)	$S_{6,i}$	$\omega_{6,i}$	$S_6 = \sum_{i=1}^{N} S_{6,i} \cdot \omega_i$	W_6	
Optional # 7.2 or #7.3 Removability of the encapsulant after heating process			$S_{7.2}$ or $S_{7.3}$	$W_{7.2}$ or $W_{7.3}$	
Optional #7.4 Removability of the frame (only applicable to PV modules with frame)			$S_{7.4}$	$W_{7.4}$	
#8 Substances of concern	$S_{8,i}$	$\omega_{8,i}$	$S_8 = \sum_{i=1}^{N} S_{,i} \cdot \omega_i$	W_8	
#9 Selection of materials based on their recyclability complexity	$S_{9,i}$	$\omega_{9,i}$	$S_9 = \sum_{i=1}^{N} S_{,i} \cdot \omega_i$	W_9	
#10 Combination of materials used / homogeneity	$S_{10,i}$	$\omega_{10,i}$	$S_{10} = \sum_{i=1}^{N} S_{,i} \cdot \omega_i$	W_{10}	

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Scoring Aggregation: PV inverters

Parameter	Score for priority part/material i [1-5]	Weight for priority part/material i [%]	Parameter Score [1-5]	Parameter Weight [%]	Final Score [1-5]
#2 Information on the presence (or absence) of substance of concern			S_2	W_2	$R = \sum_{j=1}^{10} S_j \cdot W_j$
#3 Availability of dismantling instructions			S_3	W_3	
#4.1 Disclosure of material composition			$S_{4.1}$	$W_{4.1}$	
#4.2 Disclosure of presence and location of Critical, Strategic and Environmental Relevant materials			$S_{4.2}$	$W_{4.2}$	
#5 Dismantling depth	$S_{5,i}$	$\omega_{5,i}$	$S_5 = \sum_{i=1}^{N} S_{5,i} \cdot \omega_i$	W_5	
#6 Tools (type)	$S_{6,i}$	$\omega_{6,i}$	$S_6 = \sum_{i=1}^{N} S_{6,i} \cdot \omega_i$	W_6	
#7.1 Fasteners (type)	$S_{7,i}$	$\omega_{7,i}$	$S_{7.1} = \sum_{i=1}^{N} S_{7,i} \cdot \omega_i$	$W_{7.1}$	
#8 Substances of concern	$S_{8,i}$	$\omega_{8,i}$	$S_8 = \sum_{i=1}^{N} S_{8,i} \cdot \omega_i$	W_8	
#9 Selection of materials based on their recyclability complexity	$S_{9,i}$	$\omega_{9,i}$	$S_9 = \sum_{i=1}^{N} S_{9,i} \cdot \omega_i$	W_9	
#10 Combination of materials used / homogeneity	$S_{10,i}$	$\omega_{10,i}$	$S_{10} = \sum_{i=1}^{N} S_{10,i} \cdot \omega_i$	W_{10}	

Scoring Aggregation: PV inverters

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Weighting of parameters for the recyclability index of PV modules and inverters

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Introduction

This questionnaire is part of the study commissioned by The European Climate, Infrastructure and Environment Executive Agency (CINEA), for the development of recyclability indexes for photovoltaic products (PV modules and inverters).

In particular, the aim is to assess the importance of the weighting that the parameters that compose the index can have.

For further details about recycling parameters and definitions please check the Interim Report for Consultation at the project website: https://www.pv-recyclability-index.eu/documents/

Note: please be aware that all responses will be treated confidentially, no answer will be linked to any respondent.

General information

Company name

Country of operation

Type of organisation
- Recycler
- Manufacturer
- Research institution
- Other (please specify)
- Answer 5

Please specify here (other type of organisation)

Service-related parameters

Please prioritise the following parameters of the recyclability index, indicating their level of importance to a successful recycling
Use drag&drop or the up/down buttons to change the order or accept the initial order.
- Technology Identification
- Information on the presence (or absence) of substances of concern
- Dismantling information and condition for access
- Information on composition (including critical and strategic raw materials)

Do they have the same level of importance? i.e. 25% each, or do you consider that there is one that has higher relevance?
- Same level, 25%
- Different level, see Table below
- Don't know

Provide here the level of importance in percentage, that the parameter should have (sum up to 100%)

	Weighting (%)
Technology identification	
Information on the presence/absence of substances of concern	
Dismantling information and condition for access	
Information on composition (including critical and strategic raw materials)	

If we look at "Information on composition (including critical and strategic raw materials)", which sub parameter out of the following has a higher level of importance to a successful recycling
Use drag&drop or the up/down buttons to change the order or accept the initial order.
- Disclosure of material composition
- Disclosure of presence and location of Critical, Strategic and Environmental Relevant materials

Dismantling-related parameters

Please prioritise the following parameters of the recyclability index, indicating their level of importance to a successful recycling
Use drag&drop or the up/down buttons to change the order or accept the initial order.
- Number of steps for the dismantling of priority parts (dismantling depth)
- Types of tools to dismantle priority parts
- Removability of fasteners to dismantle priority parts, reversibility of sealants and encapsulants

Material-based parameters

Please prioritise the following parameters of the recyclability index, indicating their level of importance to a successful recycling
Use drag&drop or the up/down buttons to change the order or accept the initial order.
- Level of concentration of hazardous substances and other substances affecting the recycling process
- Selection of materials based on recyclability complexity
- Combination of materials used / homogeneity

Section Title

Single Choice Question
- Answer 1
- Answer 2

Table

	A	B	C
1			
2			
3			

Closing remarks

Provide your comments

Submit

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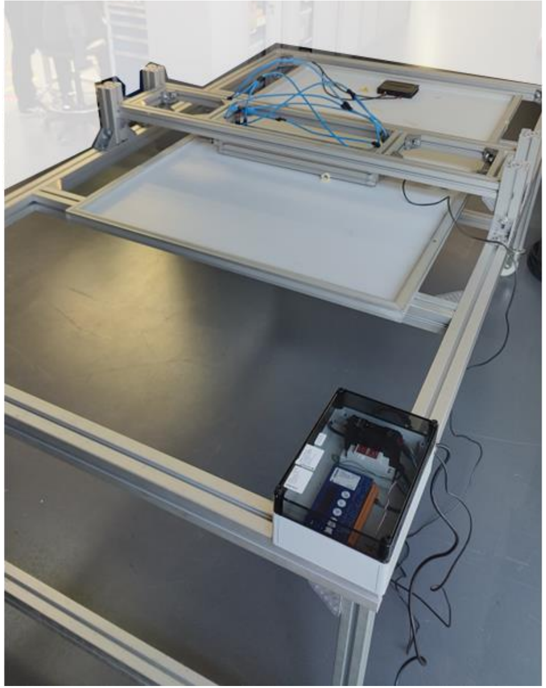
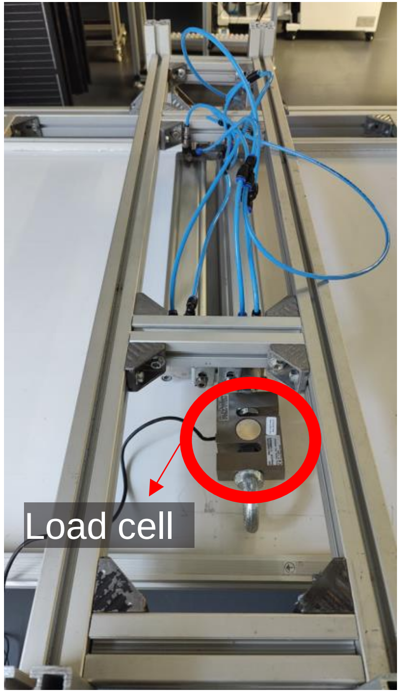
TESTING

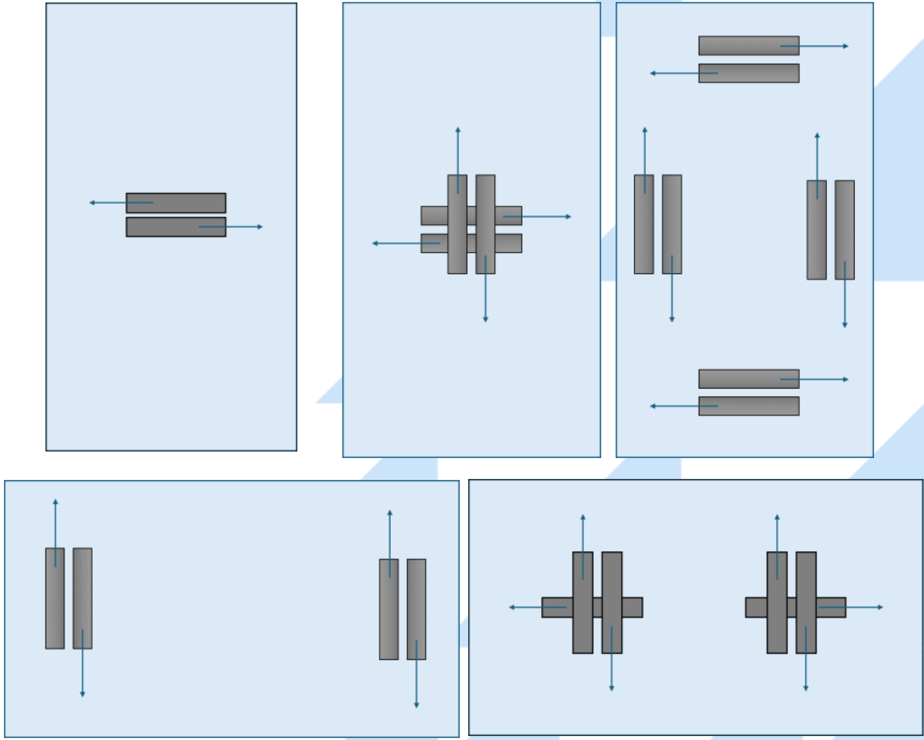
Aluminium frame removal



Preliminary setup



Other possible schemes

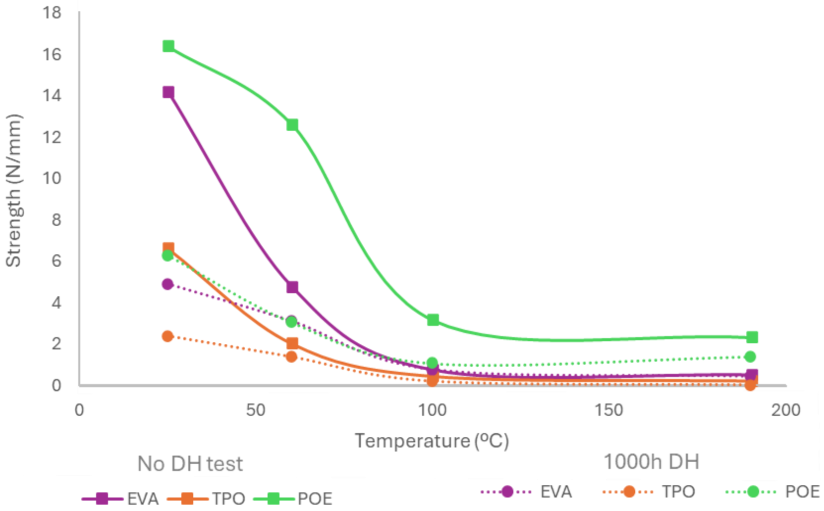


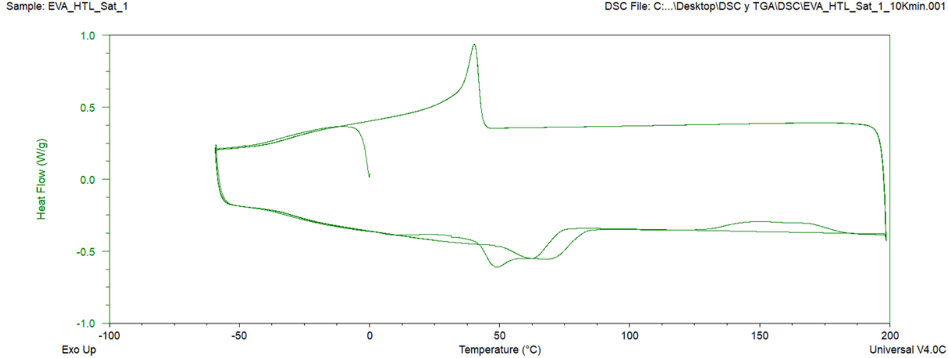
TESTING

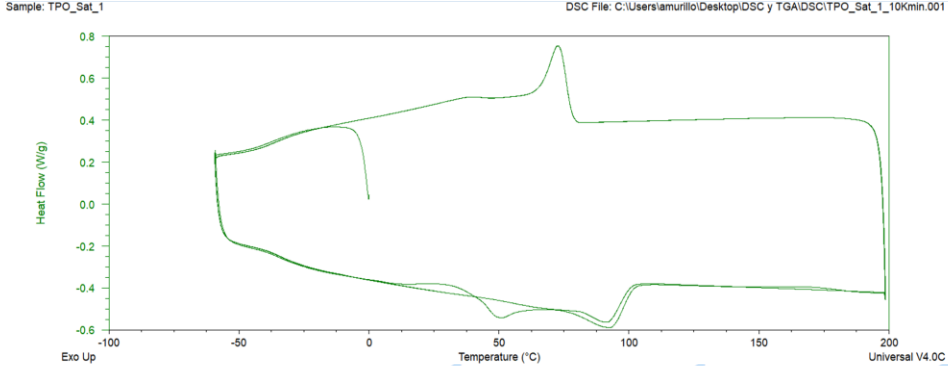
Peel-off test (@ different temperatures)

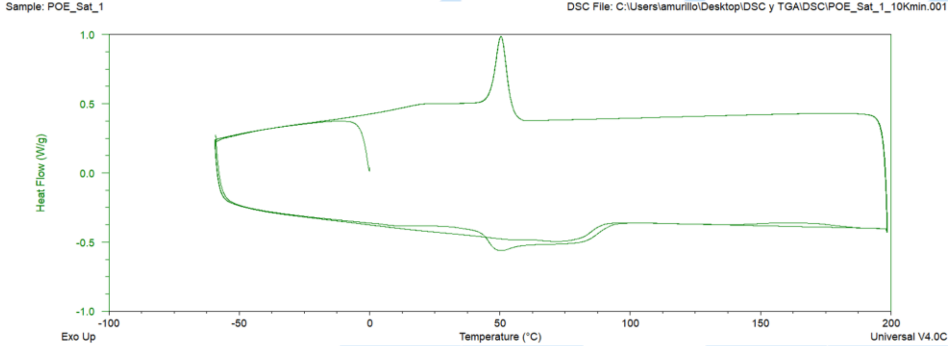
- Backsheet-encapsulant adhesion
- Encapsulant-glass adhesion

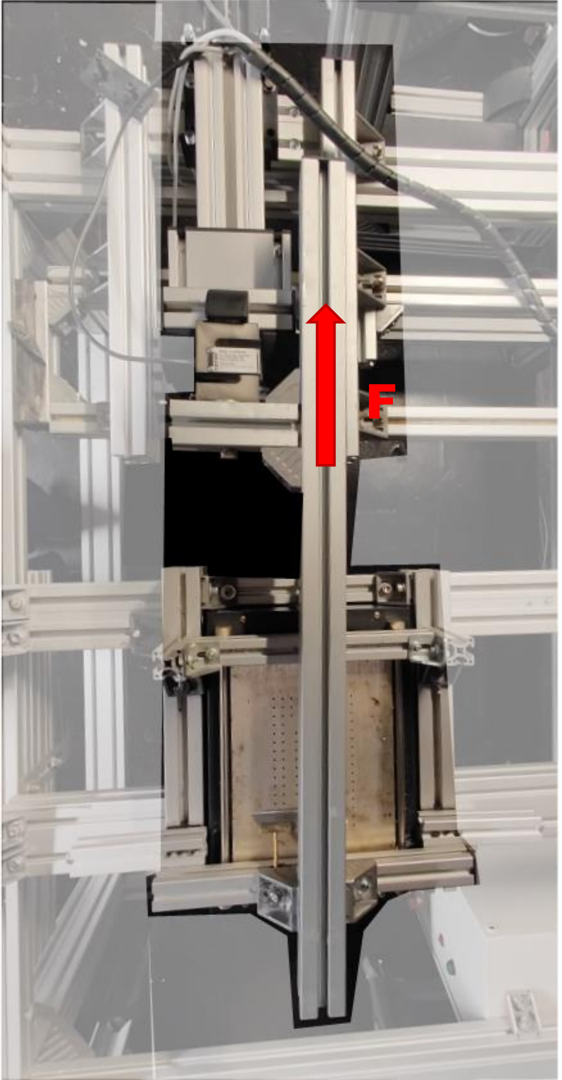
Relation with the TGA (thermogravimetric analysis) measurements of the different types of encapsulants







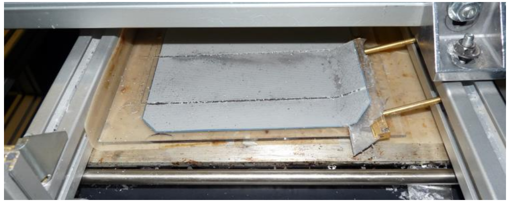




TESTING

Delamination process (monofacial PV modules)

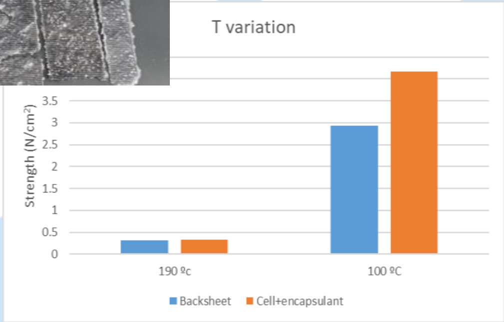
Viegand Maagøe



We'll take note of the steps and tools needed for dismantle the PV modules

1. Remove the backsheet (easy to streep, good for pyrolysis)
2. Remove encapsulant + cells + encapsulant

We obtain the separation of the main components



TESTING

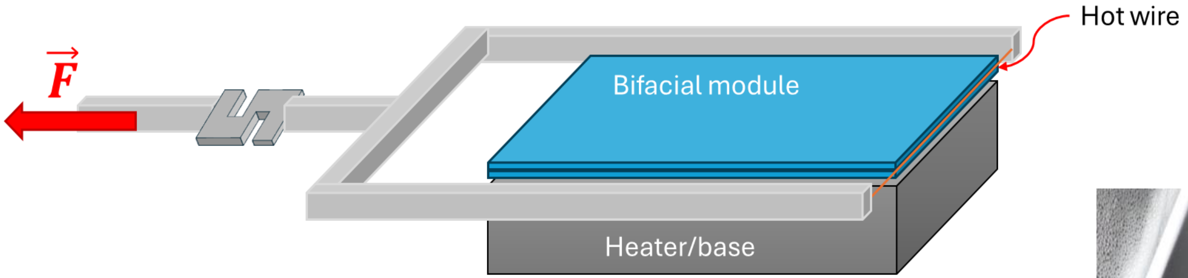
Delamination process (bifacial PV modules) @ 190 ºC

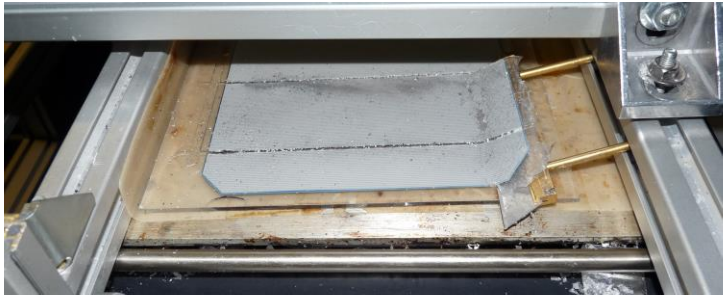
1. Hot-wire to separate both glasses
2. Remove encapsulant + cells + encapsulant (x2)

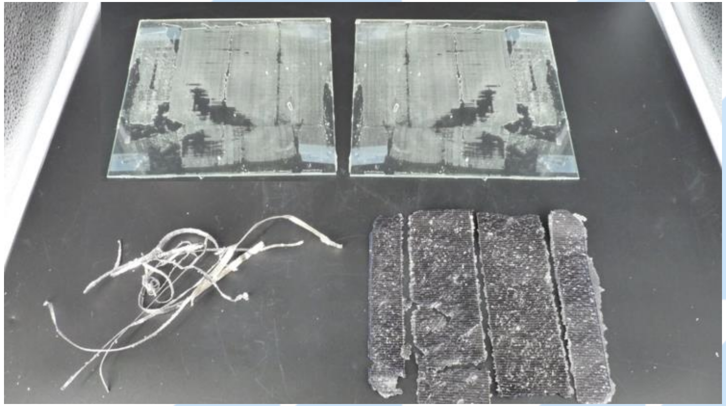
We obtain the separation of the main components

Measurable parameters:

- Force
- Temperature
- Time
- Wire has broken?







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TESTING

Inverters: (dismantling test)

We will separate the priority parts

- Printed Circuit Board (PCB)
- Heat sinks (copper, aluminium)
- Casing (aluminium)
- Cables (copper)
- DC link Capacitors (palladium, tantalum).

We will take note of the number of steps, tools needed and the fasterners removed

Viegand Maagøe

SELECTION OF THE SAMPLES

PV modules (8 different types)

PV technology	PERC	TopCon	HJT	IBC
Modules	2	3	1	2

PV configuration	Monofacial	Bifacial
Modules	4	4

PV recycling	Conventional	Easy-to-disassemble
Modules	8	2?

PV inverters (8 different types)

Inverter power	0-1 kW	1-10 kW	10-30 kW
Inverters	1	5	2

Inverter phase	Single-phase	Three-phase
Inverters	4	4

	Micro-inverter	With battery charger
Inverters	1	3

Excluded:

- Central PV packed with transformers
- DC-to- DC converters
- DC optimisers

Out of the scope of Ecodesign measures on PV products

Next steps

Viegand Maagøe

- Written comments and inputs after the meeting are welcomed, **deadline 1 November 2024**, send comments to **info@pv-recyclability-index.eu**

- Slides and minutes will be uploaded to: https://www.pv-recyclability-index.eu/documents/
- **November 2024:** Survey on weighting factors
- **Spring 2025:** Third stakeholder consultation meeting
  - Presentation of testing results (calibration and validation of the method)
  - Presentation and consultation on the revised methodology

- **June 2025:** Publication of final report of the study

Study web site

Viegand Maagøe

https://www.pv-recyclability-index.eu/

- Please register not only for the meeting but also for receiving news / updates
- You will find slides and brief notes of this meeting at the project website

European Commission

Development of a recyclability index for photovoltaic products

Home | The Study | Register | Meetings | Documents | Contact

The European Climate, Infrastructure and Environment Executive Agency (CINEA) has commissioned a study for the development of recyclability indexes for photovoltaic products (PV modules and inverters).

This comprehensive study is conducted by Viegand Maagøe, in collaboration with Universidad de Murcia and Centro Nacional de Energias Renovables (CENER). This website serves as the primary information exchange platform between the study team, CINEA and the stakeholders. All the consultation documents and deliverables prepared in the context of this study will be made available through this website. Please register here for receiving updates and invitations to stakeholder meetings.

Please note that the information and views expressed in this study are those of the consultants and do not necessarily represent the official opinion of CINEA, see further Disclaimer and Copyright information for this website.

What's new

26/1/2024: Invitation to first stakeholder meeting to be held on 12 February 2024. Register for the meeting here.

01/2024: Launch of the study.

Agenda

Viegand Maagøe

1	Welcome – 10:30
2	Policy Background – European Commission 10:40 – 11:00
3	Scientific Background of the study 11:00 – 11:30
4	Scoring System Method – Parameters 11:30 – 12:30
5	Scoring System Method – Priority Materials / Components 14:00 – 14:30
6	Scoring System Method – Scoring, Weight and Aggregation 14:30 – 15:00
7	Next steps of the study 15:00 – 15:30
8	General Questions and Answers 15:30 – 15:55
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Thank you for attending this meeting!

info@pv-recyclability-index.eu

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