

# Development of a recyclability index for photovoltaic products

## 1<sup>st</sup> online stakeholder meeting

12 February 2024  
10:00-12:00

[www.pv-recyclability-index.eu](http://www.pv-recyclability-index.eu)

[info@pv-recyclability-index.eu](mailto:info@pv-recyclability-index.eu)



**CENER**  
NATIONAL RENEWABLE  
ENERGY CENTRE



UNIVERSIDAD  
DE MURCIA

# Agenda

Viegand Maagøe

- 1 Welcome
- 2 Background – European Commission
- 3 Questions & answers
- 4 Study workplan
- 5 Methodology
- 6 Questions & answers
- 7 Next steps
- 8 AOB, closure

# Housekeeping rules & practical information

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 11 March 2024
7. Slides and brief minutes will be published at the study web site after the meeting, at <https://www.pv-recyclability-index/>
8. The meeting is being recorded for the purpose of the minutes. You gave consent when registering.

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# The team

Viegand Maagøe



**Project  
Manager**

Viegand Maagøe



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# Background and scope

- The Ecodesign Directive (2009/125/EC) (ED)
- The Energy Labelling Framework Regulation ((EU) 2017/1369)
- The WEEE Directive (2012/19/EU)
- Circular Economy Action Plans (December 2015 and March 2020) (CEAP)



The purpose of this study is:

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

II. **Calibration** and **validation** of the scoring systems on **real products**.



# 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

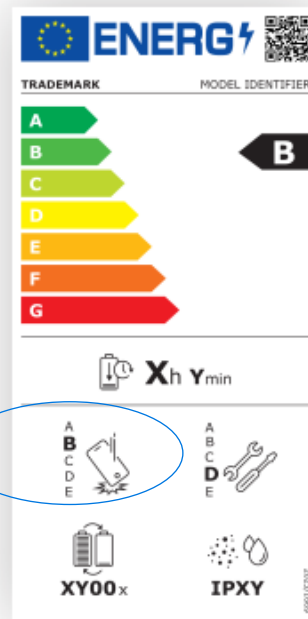


JRC SCIENCE FOR POLICY REPORT

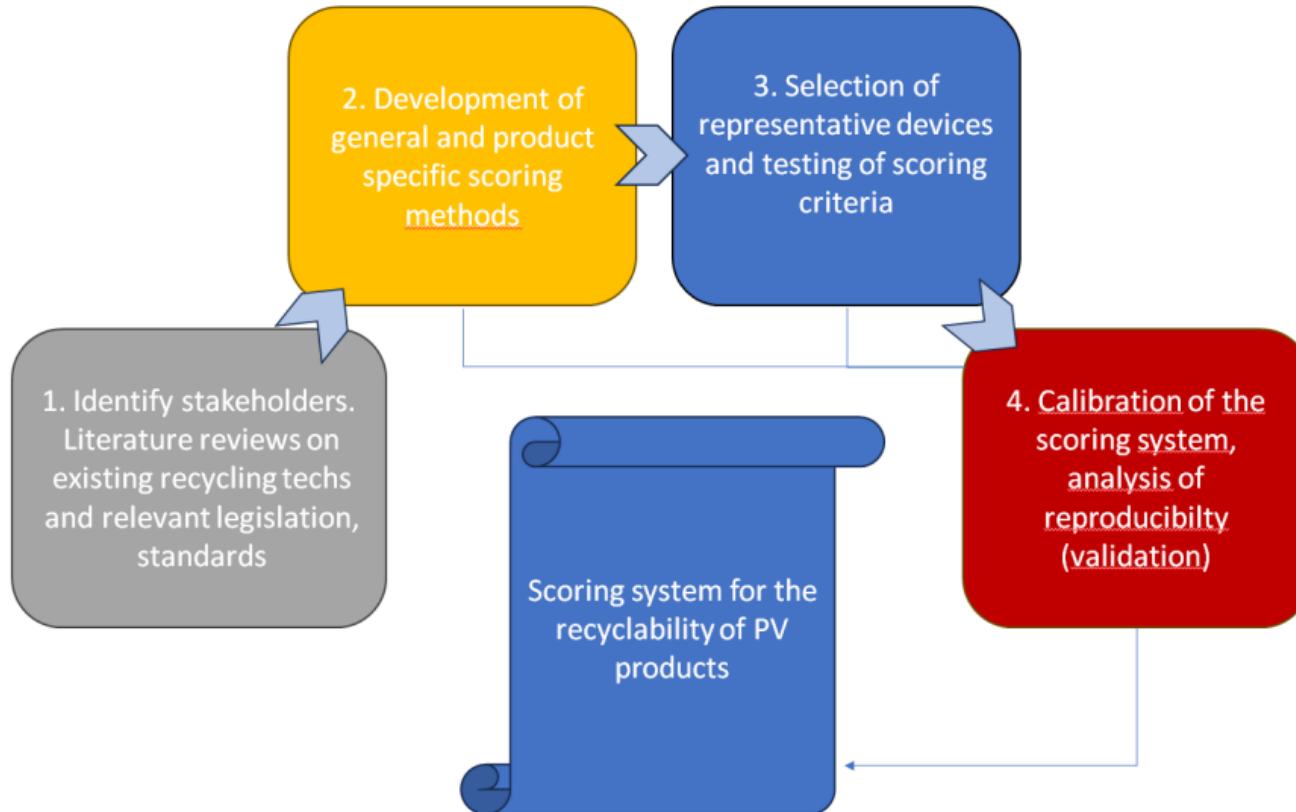
Product Reparability Scoring System:  
specific application to Smartphones and  
Slate Tablets

Titel: Strategie zur Erreichung der Ziele der Richtlinie über die Reparaturfähigkeit von Produkten  
Autoren: Laura von Mecklenburg, J. de Vos, J. Trapp, M. Tolboom, A. de Vries, J. de Vries, J. de Vries, J. de Vries

2022



# Phases and Deliverables



# Project Deliverables

- 1. Interim Report** presenting potential criteria for the scoring system of the products under scope ( Draft version in July 2024)
- 2. Final Report** presenting the revised methodology for scoring system and the results of the testing campaign and calibration / validation results
- 3. Stakeholder documents:** Slides of the meetings, minutes, questionnaires, summary of comments/inputs will be available on the project webpage: <https://www.pv-recyclability-index.eu/documents/>

# Overall timeline and stakeholder involvement

- **January 2024, start study**
- **12 Feb 2024 10:00-12:00: Online stakeholder meeting**
  - Presentation of aim and methodology of the study
  - Preliminary considerations on the methodology
  - Input from stakeholders
- **Autumn 2024: Second stakeholder consultation meeting**
  - Presentation and consultation on the draft recyclability scoring methodology
  - Input from stakeholders
- **Spring 2025: Third stakeholder consultation meeting**
  - Presentation and consultation of the results of validation and calibration stage
  - Input from stakeholders
- **June 2025: Publication of final report of the study**

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# Key Concepts

## Recycling vs Recyclability

**Recyclability** means “**the ability of a product to be recycled**”. Recyclability does not measure the actual recycled material at the end-of-life. On the contrary, the recyclability is an ex-ante estimated value, describing the potential/ability of a product to be recycled at its end-of-life.

A recyclability index aim to measure the **design-for-recycling** features of a product.



Scoring the **products in scope** and **not the recycling technologies**

# Phases 1: Literature Review and Stakeholders

## Literature review

The aim is to collect evidence:

- Existing technical barriers to recycling
- Current recycling practices and prioritised materials / components
- Existing design for recycling practices / best practices in the sector
- Relevant legislation, standards, voluntary labels including recyclability aspects

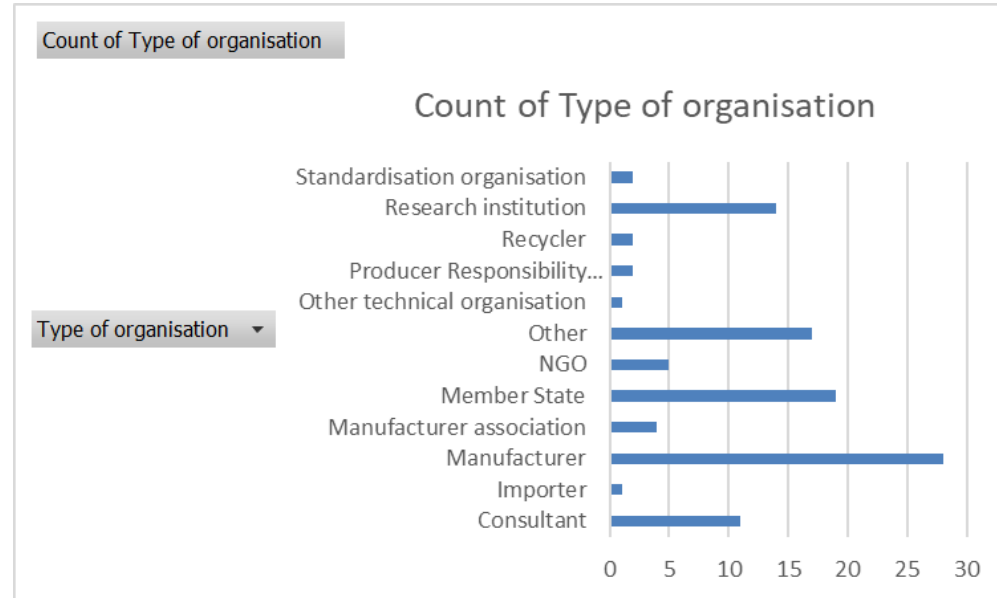
Inputs from  
stakeholders !!!



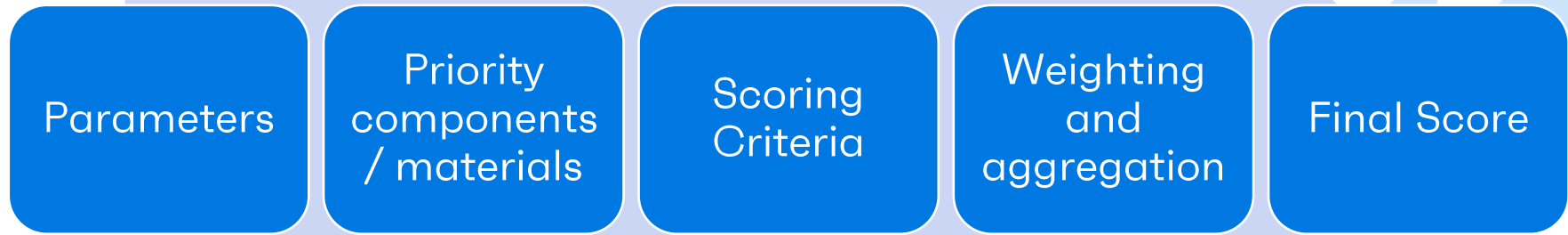
# Phases 1: Literature Review and Stakeholders

## Identification of stakeholders

- Manufacturers
- Importers
- Recyclers
- Producer Responsibility Organisations
- Manufacturers of recycling technologies
- European Commission and Member States
- Research Institutes
- Standardisation Organisations
- Testing Organisations
- Market Surveillance Authorities
- NGOs
- Other???



## Phase 2: Development of the scoring method



## Phase 2: Development of the scoring method

### Identification of relevant parameters affecting recyclability:

**(a) dismantling-related** referring to parameters which characterize the technical design of the product and affect its ability to be dismantled (e.g. easy of dismantling of Al frame, cables, junction box)

**(b) material-related** covering the assessment of the material composition of the PV products

**(c) service-related** which refer to provisions by the product manufacturer that deem the product recyclable (e.g. provision of information)

Inputs from  
stakeholders  
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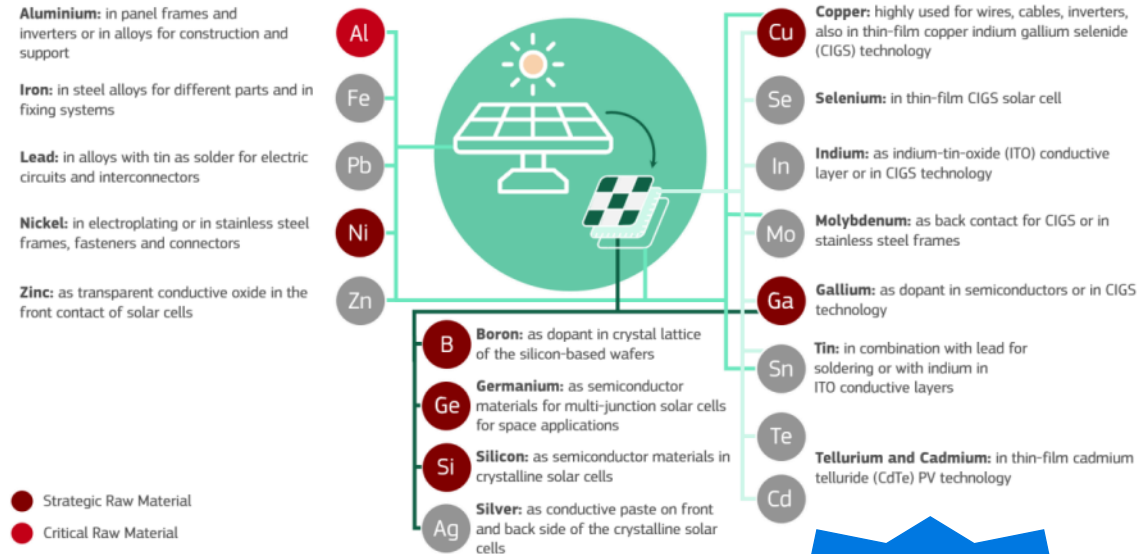
## Phase 2: Development of the scoring method

### Identification of priority materials:

Prioritisation could be based on a combination of aspects like:

- the abundance of different materials in the product and specific parts,
- the presence of materials relevant from the environmental and criticality perspective and
- the presence of not recyclable or hazardous materials to be object of selective treatment / depollution.

Figure 40. Selection of raw materials used in solar PV and their function



Source: JRC analysis.

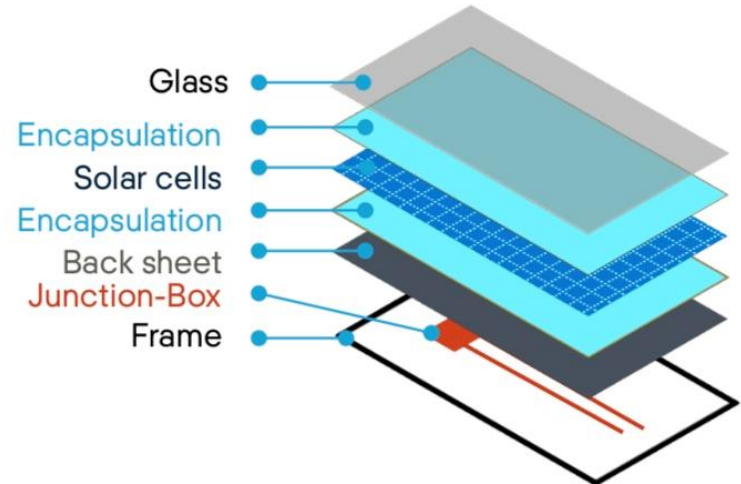
Inputs from  
stakeholders  
!!!

## Phase 2: Development of the scoring method

### Identification of priority components:

#### Prioritisation criteria

- the intrinsic value of the constituent materials (financial or otherwise, such as Critical Raw Material and Strategic Raw Material content);
- or the environmental advantages associated with recycling the embedded materials within the component;
- potential for reusing a component (provided it meets quality standards and outlives the product's lifespan).



<https://formesolar.com/solar-energy-system-parts/>

Inputs from  
stakeholders  
!!!

# Phase 2: Development of the scoring method

## Definition of scoring criteria

The aim is to define evaluation criteria for each parameters and for the priority part/material or for the entire product.

Here below an example from the Repair Scoring System on scoring the Disassembly Depth

A score is assigned for each priority part based on their disassembly depth (DDi). A discrete score is proposed. Points are assigned at priority part level:

Rating Class I)  $DDi \leq 2$  steps = 5 pt.

Rating Class II)  $5 \geq DDi > 2$  steps = 4 pt.

Rating Class III)  $10 \geq DDi > 5$  steps = 3 pt.

Rating Class IV)  $15 \geq DDi > 10$  steps = 2 pt.

Rating Class V)  $DDi > 15$  steps = 1 pt.

Example of scoring criteria the Repair Score

Inputs from  
stakeholders  
!!!

## Phase 2: Development of the scoring method

### Weighting and aggregation

- This is the final stage of a scoring system.
- The scoring results from different parameters and parts/materials need to be weighted according to their relevance
- The final result is a single aggregated score

Inputs from  
stakeholders  
!!!

Parameter	Score for priority part i [1-5]	Weight for priority part i [%]	Parameter Score [1-5]	Parameter Weight [%]	Final Score [1-5]
#1 Disassembly depth	$S_{1,i}$	$\omega_{1,i}$	$S_1 = \sum_{i=1}^N S_{1,i} \cdot \omega_{1,i}$	$W_1$	<b>Overall Repairability Index</b> $R = \sum_{j=1}^6 S_j \cdot W_j$
#2 Fasteners (type)	$S_{2,i}$	$\omega_{2,i}$	$S_2 = \sum_{i=1}^N S_{2,i} \cdot \omega_{2,i}$	$W_2$	
#3 Tools (type)	$S_{3,i}$	$\omega_{3,i}$	$S_3 = \sum_{i=1}^N S_{3,i} \cdot \omega_{3,i}$	$W_3$	
#4 Spare parts (target group)	...	...	$S_4$	$W_4$	
#5 Software updates (duration)	...	...	$S_5$	$W_5$	
#6 Repair Information	...	...	$S_6$	$W_6$	

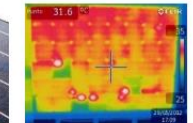
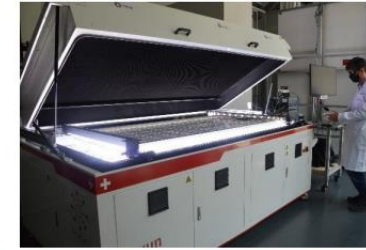
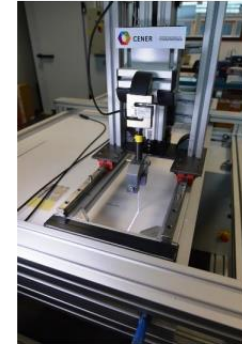
Example of weighting and aggregation from the Repair Score

# Phase 3: Testing

## Selection of representative devices

The proposed recyclability method will be complemented by a physical testing exercise, aiming at the calibration and validation of the scoring systems based on the assessment of the scoring for models recently placed on the market.

A number of eight (8) different PV module models and eight (8) inverter device models will be tested by CENER at their testing facilities in Sarriguren (Spain).



Some representative testing facilities at CENER and examples of PV modules being tested



## Phase 3: Testing

Testing needs are not defined yet, however it is foreseeable that they will **address the easiness of dismantling PV modules and inverters, regardless of any specific recycling method** (mechanical, thermal, chemical or combination of them), including:

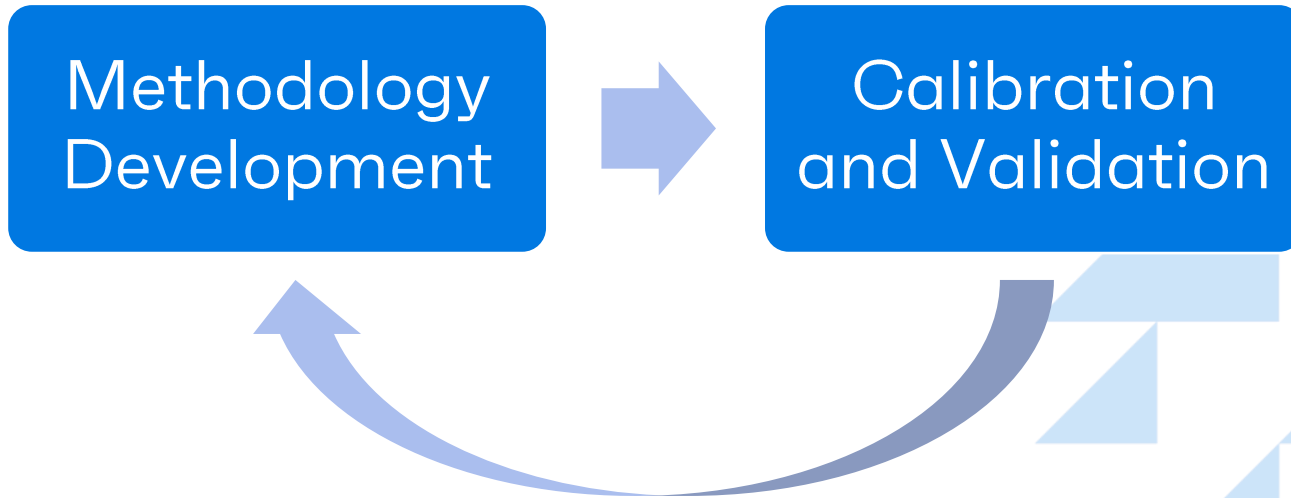
- **Quantitative tests** to identify, for example, the number of steps or disassembly time needed.

Test performed at CENER's facilities such as the encapsulant peel-off test, providing the encapsulant adhesion force, which is a relevant parameter assessing the easiness of dismantling the PV module, and/or mechanical load tests

- **Qualitative tests** to define the tools needed, type of fasteners used, etc.

Test performed by 2 CENER personnel supervised by senior researchers from Viegand Maagøe and University of Murcia

## Phase 4: Calibration and validation



# Phase 4: Calibration and validation

## Calibration

- The aim of the calibration exercise is to investigate how models already placed on the market are positioned in the proposed scoring range
- Scoring ranges can be expressed numerically (e.g. 1 to 10) or alphabetically (e.g. A to G)
- For an effective calibration it is important the selection of models to be tested

Inputs from  
stakeholders  
!!!



# Phase 4: Calibration and validation

## Validation

The aim of the validation is to verify whether the scoring system method is suitable for the intended use. The objectives are to verify:

1. The technical reproducibility of the scoring assessment
2. The methodological challenges encountered by the CENER experts in the application of the method
3. Feedback to the Viegand team on how to correct and improve the methodology (if necessary)
4. Assess and define robust tolerance to be applied in market surveillance



Inputs from  
stakeholders  
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# Questions & Answers

- Scope definition (aligned with Ecodesign)
- Existing technical barriers to recycling
- Current recycling practices and prioritised materials / components
- Existing design for recycling practices / best practices in the sector
- Relevant legislation, standards, voluntary labels including recyclability aspects
- Development of scoring methods
- Testing, calibration & validation

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# Next steps

- Written comments and inputs after the meeting are welcomed, **deadline 11 March 2024**, send comments to [info@pv-recyclability-index.eu](mailto:info@pv-recyclability-index.eu)
- Form for collecting your input on the project in general and on specific topics:
  - Data on end-of-life of PV and inverters
  - Technical barriers to recycling of PV and inverters
  - Existing design for recycling practices / best practices in the sector
  - Relevant legislation, standards, voluntary labels including recyclability aspects
  - Reflect on priority parts and materials
  - Reflect on scoring parameters
  - Reflect on scoring criteria
  - Testing and market surveillance
- Slides and minutes will be uploaded to: <https://www.pv-recyclability-index.eu/documents/>
- Autumn 2024: Second stakeholder consultation meeting
  - Presentation and consultation on draft Methodology
  - Input from stakeholders

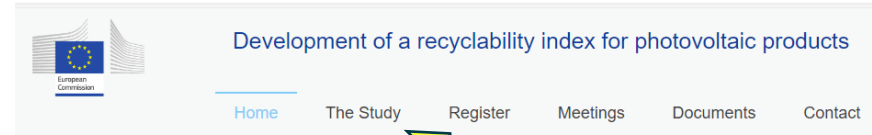


# Study web site

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



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 Energías 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.

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