DEVELOPMENT OF STANDARDISATION METHODS FOR ECO-DESIGN AND ENERGY LABELLING OF PHOTOVOLTAIC PRODUCTS

First Stakeholder Meeting

Online, April 9th 2024

Supported by CINEA

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01

WELCOME & PROJECT OVERVIEW

1.1 WELCOME

- Over 95 people registered to the project and meeting.
- The meeting will be recorded for the purpose of analysing in detail the outputs and discussions. Consent was given when registering.

1.2 GROUND RULES FOR THE MEETING

- Video is not allowed. Please, switch off your cameras.
- Use the chat to send your questions and comments.
- Remain muted until the chair gives you the floor.
- When participating, first indicate name and institution. Please, be concise.

1.3 PROJECT OVERVIEW

- **CINEA call for tenders** CINEA/OP/2023/0009 "*Development of standardisation methods for eco-design and energy labelling of photovoltaic products*".
- Development of **standardisation (pre-normative) methods** related to:
  - Calculation and testing of the **Energy Yield (EY) of bifacial PV devices**.
  - Measurement and testing of the **long-term degradation of the PV modules' performance.**
- Both methods shall be relevant for the **potential implementation** in the ecodesign and energy label measures on PV modules.

1.3 PROJECT OVERVIEW

- ❑ Duration **36 months**, from December 2023 to November 2026.
- ❑ **Consortium**:
  - TÜV Rheinland Italia
  - German National Metrology Institute - PTB
  - National Renewable Energy Centre (Spain) – Fundación CENER

Appointed Leader

1.3 PROJECT OVERVIEW

- **CINEA**'s project is supported also by the EC´s DG for
  - Research and Innovation (**DG RTD**)
  - Internal Market, Industry, Entrepreneurship and SMEs (**DG GROW**)
- The EC is in this project represented by:
  - Francesca Harris – CINEA
  - Maria Getsiou - DG RTD
  - Davide Polverini - DG GROW

1.3 PROJECT OVERVIEW – PROJECT CORE TEAM

PTB Physikalisch-Technische Bundesanstalt Braunschweig und Berlin Nationales Metrologieinstitut

Stefan Riechelmann

Stefan Winter

Bettina Friedel

Hendrik Sträter

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Giorgio Bardizza

Marco Piva

Mario Comboni

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Jaione Bengoechea **(Project Leader)**

Jaime Moracho

Ana Gracia

Ana Belén Cueli

Juan Manual Cuadra

Javier Díaz

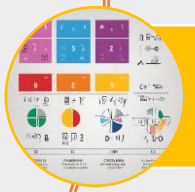
Mikel Ezquer

1.3 PROJECT OVERVIEW – WORK PACKAGES

- The project is divided in **four work packages**:

1. Work methodology and work plan development, and contract management.

2. Testing plan design and execution.



3. Preparation of standardised methods.

4. Stakeholder consultation.

1.3 PROJECT OVERVIEW – GANTT CHART

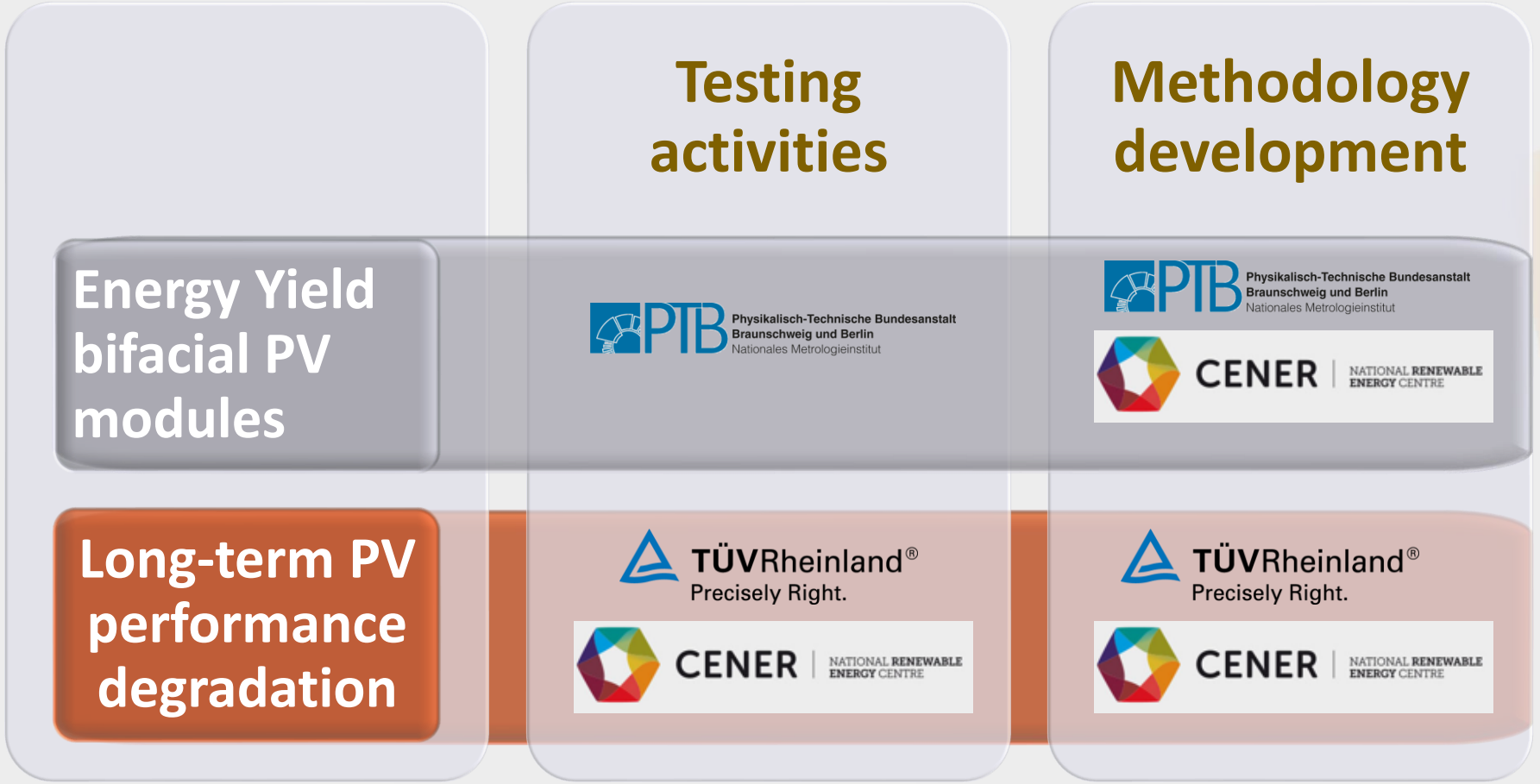
Workpackages and Tasks		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36
WP1. Work methodology, work plan and management																																					
T1.1	Set-up of the study																																				
T1.2	Management, quality, risk, handover																																				
T1.3	Coordination with CA and reporting																																				
WP2. Testing plan design and execution																																					
T2.1	Desk research and elaboration of a testing plan																																				
T2.2	Testing regarding bifacial EY estimation model																																				
T2.3	Testing regarding long-term degradation model																																				
WP3. Preparation of standardised methods																																					
T3.1	Standardised method for bifacial EY																																				
T3.2	Standardised method long-term degradation																																				
WP 4. Stakeholder consultation																																					
T4.1	Consultation Plan																																				
T4.2	Consultation Activities																																				
T4.3	Stakeholder meetings																																				
T4.4	Analysing and Reporting																																				

Deliverables	1	2	3	4	5	6	7	8	9	10	11	12	13	17	18	19	20	21	22	23	24	25	26	27	28	29	30	34	35	36
Inception Report																														
Final Testing Plan																														
Interim Report on WP2																														
Final Report on WP2																														
Interim Progress Report																														
Interim Report on WP3																														
Draft Final Report on all WPs																														
Final Publishable Report																														

March 2025

September 2026

1.3 PROJECT OVERVIEW - ROLES AND RESPONSIBILITIES



02

POLICY BACKGROUND

2.1 TIMELINE

In **2017** the EC launched a **feasibility study** for the application of those policy tools to PV products and a technical preparatory study.

At present, **final drafts** are being prepared on:

- Potential Commission Regulation (EU) laying down the **Ecodesign requirements for PV modules and PV inverters**.
- Potential Commission Delegated Regulation (EU) with regard to **Energy Labelling of PV modules.**

Commission **adoption planned** for end of **2024**

More info at:

https://ec.europa.eu/info/law/better-regulation/have-your-say/initiatives/12819-Ecodesign-European-Commission-to-examine-need-for-new-rules-on-environmental-impact-of-photovoltaics_en

https://ec.europa.eu/info/law/better-regulation/have-your-say/initiatives/12820-Energy-labelling-European-Commission-to-examine-need-for-new-rules-on-environmental-impact-of-photovoltaics_en

2.2 PROPOSED ECODESIGN FOR PV MODULES

- Durability
- Long-term PV performance degradation rate
- Repairability
- Recyclability
- Carbon footprint of the manufacturing phase
- …

Transitional method presented so far

- Default values:
  - Si-based modules: 0.7%/yr
  - Thin film modules: 1%/yr
- Alternative method:
  - 5 years
  - 2 locations / ref. climatic region
  - 2 configurations

2.3 PROPOSED ENERGY LABEL FOR PV MODULES

- Based on the estimated PV production over the first year of installation, normalized by module area (kWh/m^2).
- ***EN IEC 61853 Photovoltaic (PV) module performance testing and energy rating*** (only applicable to monofacial devices):
  - *Part 1: Irradiance and temperature performance measurements and power rating* (2011).
  - *Part 2: Spectral responsivity, incidence angle and module operating temperature measurements* (2016).
  - *Part 3: Energy rating of PV modules* (2018).
  - *Part 4: Standard reference climatic profiles* (2018).

CLIMATIC SPECIFIC ENERGY RATING

$$CSER = \frac{EY_{DC,Y1} \cdot G_{ref}}{P_{max,STC} \cdot H_p}$$

2.3 PROPOSED ENERGY LABEL FOR PV MODULES

Transitional method presented so far for bifacial modules

- Bifacial Nameplate Irradiance BNPI
- Fixed gain of 13.5% to monofacial

$$P_{BNPI} = P_{max,front} \cdot \left(1 + \left(0.135 \cdot \varphi_{Pmax}\right)\right)$$

$$EY_{MB\ DC,Y1} = \frac{CSER \cdot P_{BNPI} \cdot H_p}{G_{ref}}$$

2.4 SYNERGY BETWEEN THIS STUDY AND THE POLICY WORK

- ❑ Policy work will be completed presumably within this year ⟶ **not feasible to include the considerations/findings of this study**.
- ❑ This study will feed/be in **synergy with any (ongoing) standardization work**.
- ❑ The considerations/findings of the study could be reflected in the **future standardization request in support to the Ecodesign/Energy Labelling Regulation**.

03

QUESTIONS & ANSWERS – INTRODUCTION

04

ENERGY YIELD OF BIFACIAL PV MODULES

4.1 OBJECTIVE AND OVERVIEW

➢ Calculation and testing of the **Energy Yield (EY) of bifacial PV devices**.

WP2 Testing plan design and execution:

- T2.1 Desk research and elaboration of a testing plan
- T2.2 Testing activities to define a standardised method for calculating and testing the yield of bifacial modules

WP3 Preparation of standardized methods:

- T3.1 Preparation of a standardised method for calculating and testing the yield of bifacial modules

4.2 LITERATURE REVIEW – Relevant Standards and Transitional Methods

- **Energy Yield of monofacial devices** calculated by **EN IEC 61853 Standard series** "*Photovoltaic (PV) module performance testing and energy rating*" for the three most representative climate zones for Europe from those defined in Part 4 (subtropical arid, temperate continental and temperate coastal).
- **Energy Yield of bifacial devices** are not yet covered by standards.
- Therefore, a simple **transitional method** is used until a more sophisticated method has been developed in this project:

$$EY_{\text{bifi}} = EY_{\text{mono}} \cdot (1 + \varphi_{P\text{max}} \cdot 0.135)$$

- Energy Yield $\neq$ Energy Rating

4.2 LITERATURE REVIEW – Projects and Scientific publications

- **Amendments to EN IEC 61853** are under development by a group of experts of the **IEC TC 82 WG 2** to include bifacial devices in the standard series' scope.
- All four parts of the standard series are under revision.
- **If you are interested in contributing to one of the project teams, please contact: stefan.riechelmann@ptb.de.**
- Several EU-financed projects and publications contributed to the topic (e.g. PV-Enerate, MetroPV).
- Still a lot of testing and parameter studies need to be done. These aspects will be covered in this project.

4.3 PROPOSED TESTING PLAN – MODULE SELECTION

❑ **At least five different bifacial PV modules** from different manufacturers.

- Representative of products designs and technologies **available at present in the EU market** or expected to be **within the next five years**.
- **Specific devices to be defined**.

❑ Additionally, the module selection will look for:

- As much different market-relevant technologies as possible.
- Broad range of Bifaciality factor.
- No samples with NDA, preferably purchased at a distributor.
- Readily available in small batches in Germany.

4.3 PROPOSED TESTING PLAN – MODULE SELECTION

- Preselected modules

Module	Technology	φ_{Pmax}	Comment
M1	HJT, n-Type	90 %	
M2	TOPCon	85 %	
M3	PERC, frameless	85 %	TOPCon available?
M4	PERC, Ga-doped	70 %	
M5	PERC, Bo-doped	70 %	
(M6)	IBC	?	available soon

4.3 PROPOSED TESTING PLAN – MODULE MEASUREMENTS

- Measure Energy Rating (ER) input parameters of **at least five different bifacial devices**, according to the **modified procedures** of the EN IEC 61853 Standard series **Parts 1 and 2, at PTB**.

- **Higher-than-usual resolution and ranges** will be measured in order to have a dataset for parameter studies to check whether this resolution is really necessary. The final procedures will be less demanding.

4.3 PROPOSED TESTING PLAN – MODULE MEASUREMENTS

GT matrix measurements (EN IEC 61853-1)

- T=15-75°C and G=100-1300 W/m² (extended irradiance, more steps than in the standard).
- In addition, a front and back measurement at 1000 W/m² will be performed to determine φ_Pmax.

Spectral response measurements (EN IEC 61853-2)

- SR of all devices will be measured for both front and back using an LED-based solar simulator at PTB.

Angle of Incidence measurements (EN IEC 61853-2)

- The AOI of both the front and back sides of the bifacial modules will be measured at PTB.

Temperature coefficients (EN IEC 61853-2)

- The coefficients will be measured analogous to monofacial modules.

4.3 PROPOSED TESTING PLAN – PTB MEASUREMENTS SITES

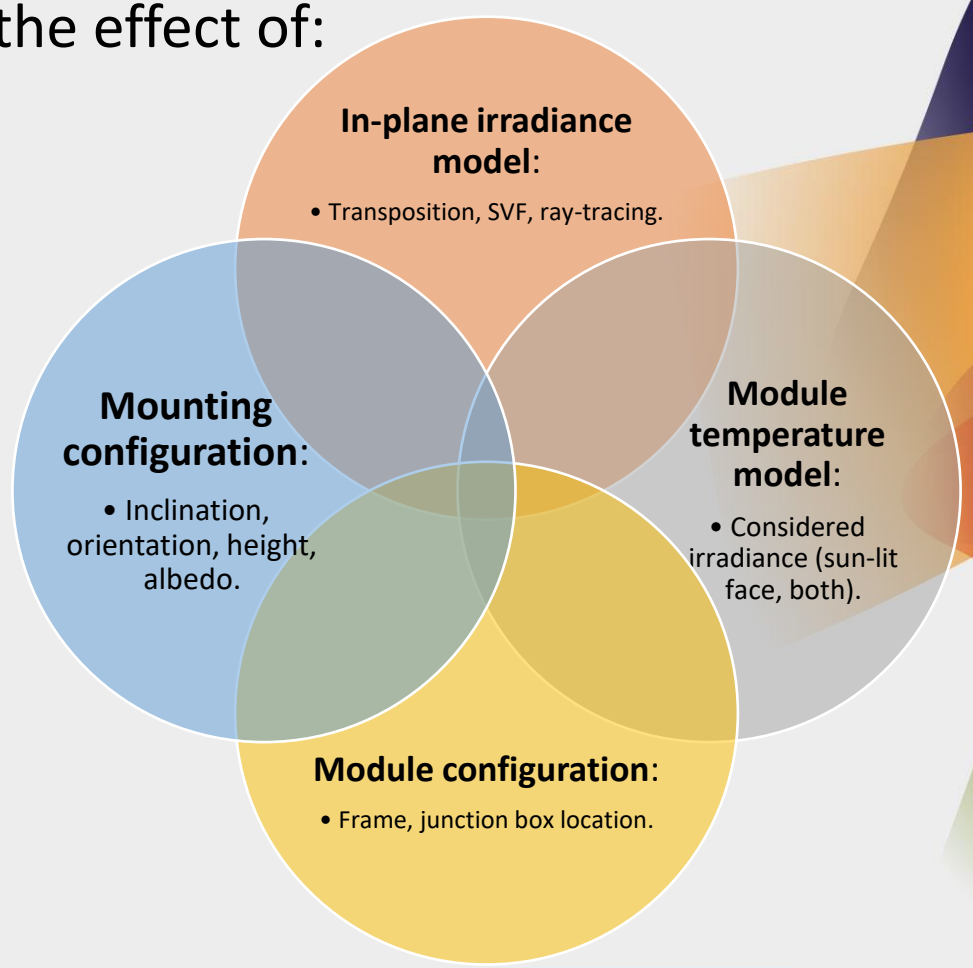
- LED-based solar simulator for < 1 % MU on STC measurements.
- Outdoor facility, including large solar tube for utilizing direct sunlight for AOI measurements.
- Test stand for wind coefficients with additional wind machines to speed up measurement time.
- Working group 4.53 solar modules with 12 people.

4.4 PROPOSED METHODOLOGY – ENERGY YIELD SIMULATION

❑ Compare the **Energy Yield methodologies** identified in the literature review.

- Simulate different **mounting conditions**.
- Compare simulations to **real performance measurements** (expected discrepancies due to rear irradiance non-uniformity, albedo, performance simulations).

❑ Analyse the effect of:



4.4 PROPOSED METHODOLOGY – ENERGY YIELD SIMULATION

❑ Extend Energy Yield calculation to support bifacial modules.

New mounting configurations
(as discussed in EN IEC 61853-3 PT)

Extended datasets (EN IEC 61853-4)
in-plane irradiance (G, Gλ).

Methodology as similar as possible to the monofacial one (EN IEC 61853-3)

Extended power matrix
(EN IEC 61853-1) if necessary.

Modified tests in Part 2 (a_r, SR, U_0 and U_1)
& **estimation steps** in Part 3 (T_{mod}, G_{eff}, P (inter/extrapolation and bifacial/2 monofacials)).

4.4 PROPOSED METHODOLOGY – ENERGY YIELD SIMULATION

- ❑ **Assess the ability** of the methodology to differentiate and classify bifacial devices.
- ❑ **Tolerances and uncertainties**.
- ❑ Easy to be **implemented by Market Surveillance Authorities.**

05

QUESTIONS & ANSWERS – ENERGY YIELD OF BIFACIAL PV MODULES

06

LONG-TERM PV PERFORMANCE DEGRADATION RATE

6.1 OBJECTIVE AND OVERVIEW

➢ Measurement and testing of the **long-term degradation of the PV modules' performance** (including monofacial and bifacial devices).

WP2 Testing plan design and execution:

- T2.1 Desk research and elaboration of a testing plan.
- T2.3 Testing activities to define a standardised method for the assessment of the long-term degradation of PV modules' performance.

WP3 Preparation of standardized methods:

- T3.2 Preparation of a standardised method for assessing the long-term degradation of PV modules' performance.

6.2 LITERATURE REVIEW – Relevant Standards and Transitional Methods

Relevant Standards

- Performance (**IEC 61215 series**) and safety (**IEC 61730**) qualification Standards with **increased severity**.
- **IEC TS 63209-1** to align test protocols from different laboratories.
- **IEC TR 63279** to define accelerated stress tests.

Transitional method in ecodesign measures to PV modules

- **Default values**: Si-based modules **0.7%/year,** thin-film modules **1%/year.**
- **Estimated values**: 5 years data, 2 mounting configurations and 2 locations per reference climate.

6.2 LITERATURE REVIEW – Projects and Scientific publications

- ❑ **IEC standardisation initiatives**.
- ❑ Several **EU projects**.
- ❑ **Scientific publications**: long-term measurement of different devices under different climatic conditions.
    - Analysed devices may be different from those in the scope of this service contract.

6.3 PROPOSED TESTING PLAN – MODULE SELECTION

- **At least seven different devices** from different manufacturers, with at least ten units per device model.
  - At least one **thin-film** and one **heterojunction** device.
  - Representative of products **available at present in the EU PV market** or expect to be **within the next five years**.
  - **Specific devices to be defined**.
- Tests to be performed by **TÜV Rheinland** (Italia&Cologne) and **CENER**.

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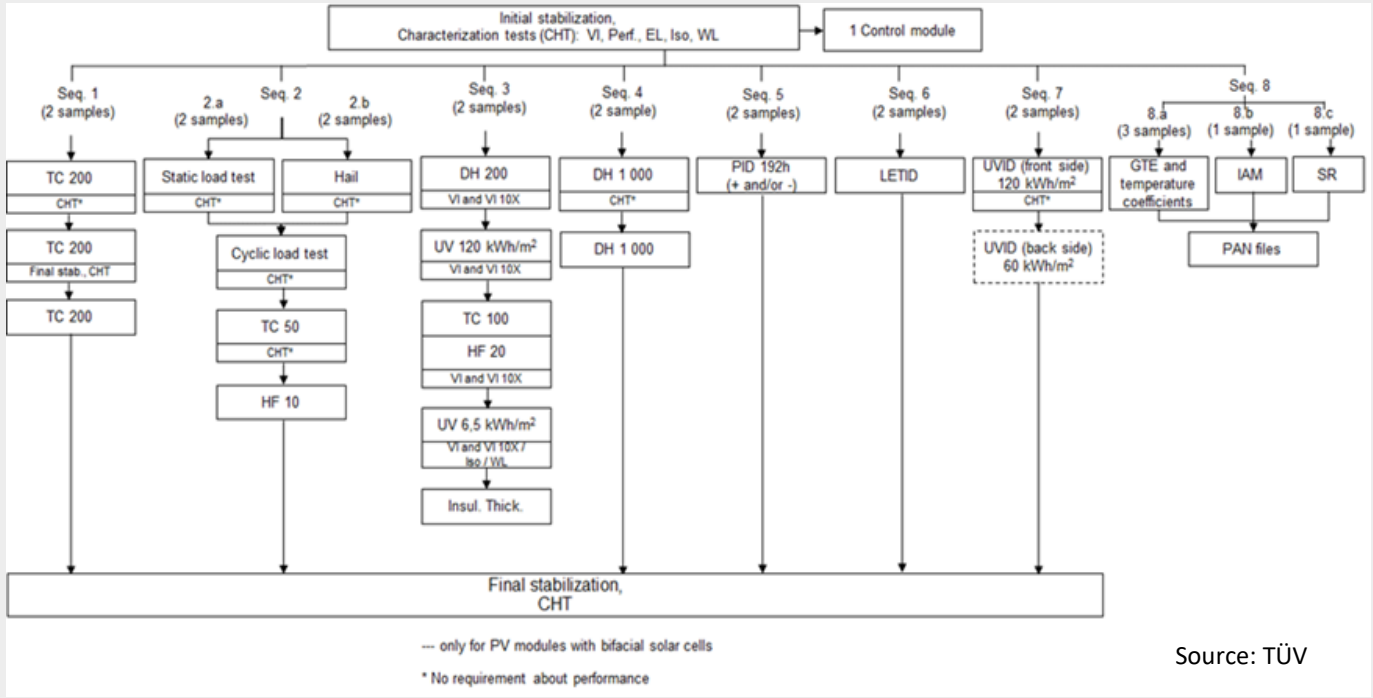
6.3 PROPOSED TESTING PLAN – MODULE SELECTION

Preselected modules

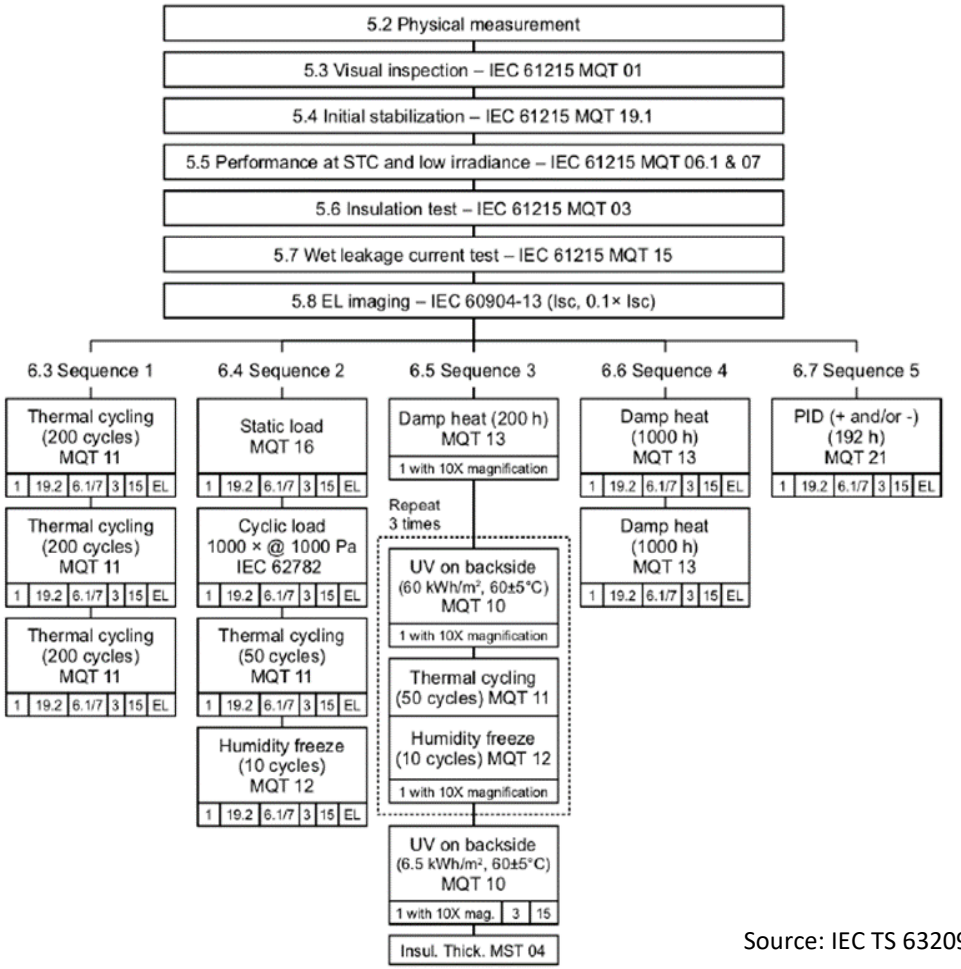
Module	Technology	Dimensions	Comment
M1	HJT, n-Type	< 2 m	
M2	C-Si TOPCon	< 2 m	
M3	Mono PERC Ga-doped	< 2 m	
M4	Mono PERC Bo-doped	< 2 m	
M5	Interdigitated back contact (IBC)	< 2 m	
M6	Thin film (CdTe)	< 2 m	
M7	Thin film (CIGS or amorphous silicon)	< 2 m	if available
(M8)	Tandem perovskite	< 2 m	if available

6.3 PROPOSED TESTING PLAN – MODULE MEASUREMENTS

- Testing sequences similar to:



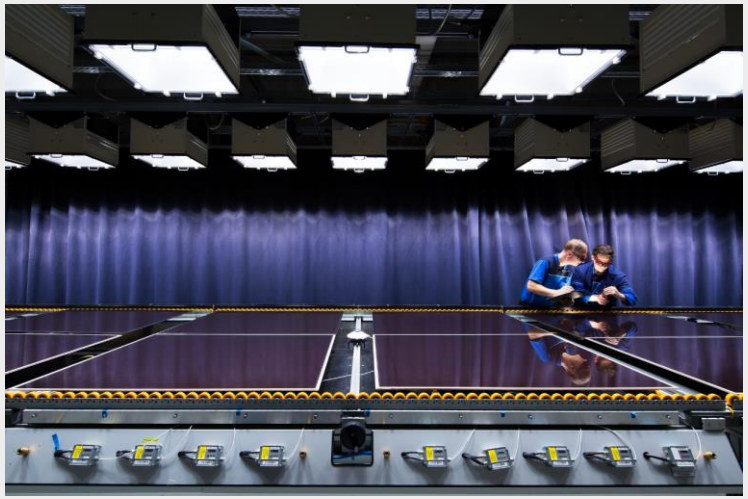
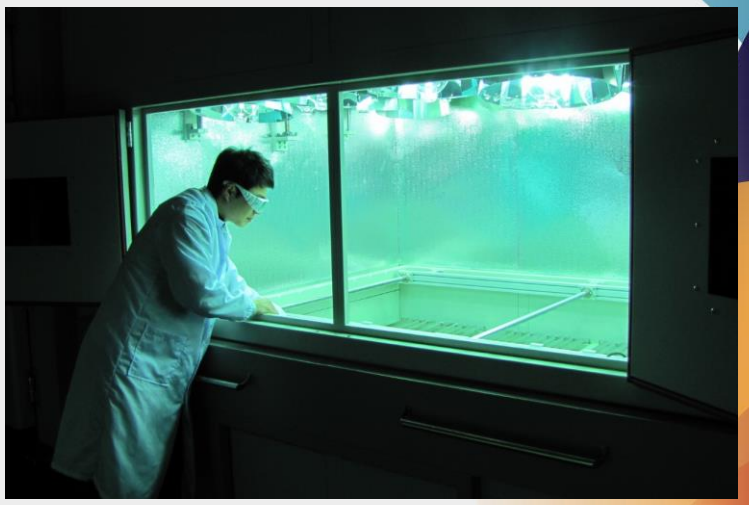
Source: TÜV



Source: IEC TS 63209-1

Ageing tests adjusted to climatological differences of the EU reference climates.

6.3 PROPOSED TESTING PLAN – TÜV TESTING FACILITIES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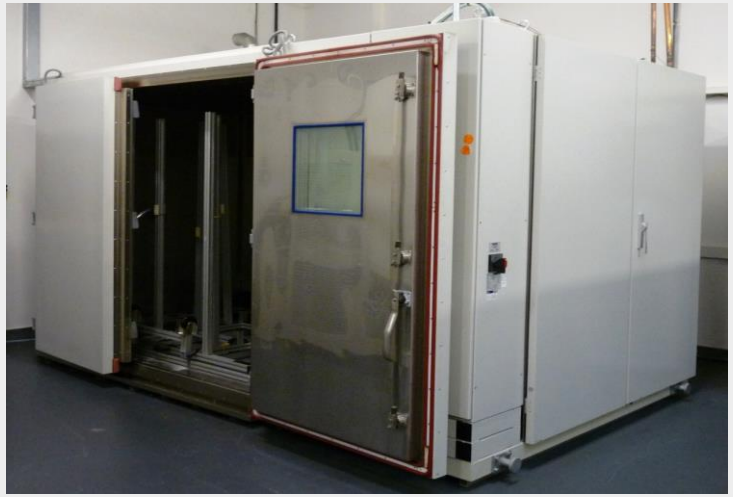
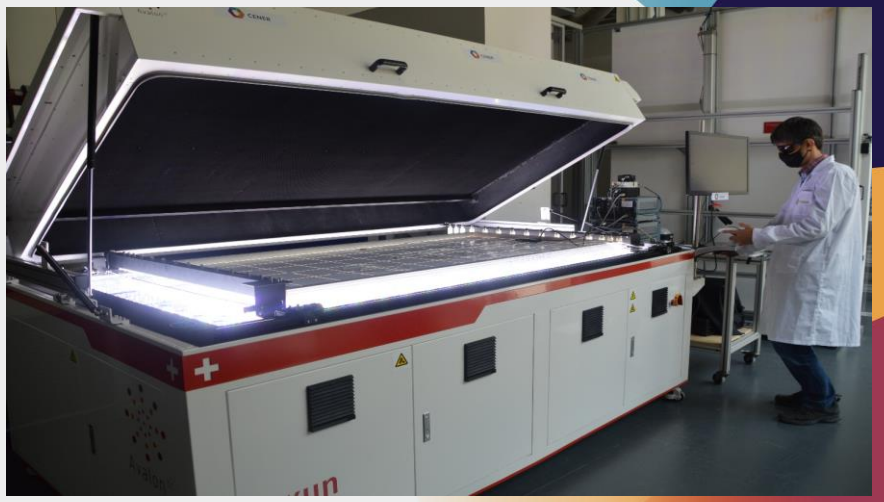
6.3 PROPOSED TESTING PLAN – CENER TESTING FACILITIES





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6.4 PROPOSED METHODOLOGY – LONG-TERM DEGRADATION RATE

Identification of specific **failure modes and degradation rates** at the EU reference climates from the literature review and Contractor's measurements/experience.

Identification of **sequences of tests** from literature review and manufacturers experience.

Adjustment of selected tests to the **EU reference climates**.

Consideration of the effect of **environmental and internal stress factors**.

6.4 PROPOSED METHODOLOGY – LONG-TERM DEGRADATION RATE

- ❑ Assess the **ability of the methodology** to deliver different degradation rates for the same PV module under different stress conditions.
- ❑ Need to define:
  - **Characterization and stabilization** requirements.
  - Procedure for selecting the **testing samples** (size, number).
  - Overall **duration** of the test sequence. Possible correlation factors.
  - **Model** to define the long-term PV module performance degradation.
- ❑ Easy to be **implemented by Market Surveillance Authorities**.

07

QUESTIONS & ANSWERS – LONG-TERM PV PERFORMANCE DEGRADATION RATE

08

NEXT STEPS

NEXT STEPS – STAKEHOLDERS' FEEDBACK

- **Written comments and feedback** are welcome. Please send them to info@ecodesign-pv-testing.eu. **Deadline May 9th 2024**.
- **Questionnaire** with specific questions to collect your views on the project will be available in **approximately 2 weeks** in https://ecodesign-pv-testing.eu/documents/. Questions related to:
  - Methodology
  - PV technologies
  - Testing plan
  - …

NEXT STEPS – STAKEHOLDER MEETINGS

❑ **Three stakeholder meetings:**

- **First** on M4 (Apr 2024): general approach, methodology, testing plan.
- **Second** on M15 (Mar 2025): results of WP2.
- **Third** on M33 (Sept 2026): final results and conclusions. Draft final report.

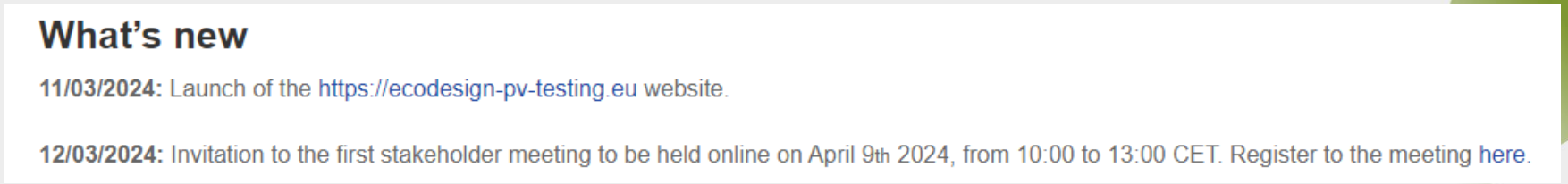
❑ Dates, invitation to meetings and further stakeholder consultation activities will be communicated to the **registered stakeholders** and published on the project's website https://ecodesign-pv-testing.eu/.

09

QUESTIONS & ANSWERS

10
CLOSURE

- **Minutes and slides** of this meeting will be available shortly in https://ecodesign-pv-testing.eu/documents/.
- **Project updates** will be published on the website and sent to the stakeholders registered to the project. To register, please visit https://ecodesign-pv-testing.eu/register/.



Thank you for your attention

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