European Commission

JRC SCIENCE FOR POLICY REPORT

Photovoltaic energy systems

Summary of the Joint Research Centre's contribution to international and European standards in 2019

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2020

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EUR 30115 EN

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EU Science Hub
https://ec.europa.eu/jrc

JRC119538

EUR 30115 EN

PDF	ISBN 978-92-76-16863-8	ISSN 1831-9424	doi:10.2760/37907
Print	ISBN 978-92-76-16864-5	ISSN 1018-5593	doi:10.2760/494380

Luxembourg: Publications Office of the European Union, 2020

How to cite this report: Sample, T., Müllejans, H., Salis, E., Bardizza, G., Gracia Amillo, A., Kenny, R., Dunlop, E. and Taylor, N., *Photovoltaic Energy Systems: Summary of the Joint Research Centre's contribution to international and European standards in 2019*, EUR 30115 EN , Publications Office of the European Union, Luxembourg, 2020, ISBN 978-92-76-16863-8, doi:10.2760/37907, JRC119538.

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Abstract

This report outlines the European Commission's Joint Research Centre's contribution to standardisation activities within the field of Photovoltaic Energy Systems.

The Joint Research Centre (JRC) continues to play a significant role in European and international standardisation activities on Photovoltaic Energy Systems. In particular, JRC experts are the convenors of the International Electrotechnical Commission (IEC) and the European Committee for Electrotechnical Standardization (CENELEC) working groups; led the project which published an IEC standard in 2019; and are members of the project teams for 4 additional publications in 2019. JRC is also the project leader for two standards under development and regularly contributes too many other documents under development.

Executive summary

Photovoltaics (PV) are expected to make a major contribution to European and global climate change mitigation goals. It is the renewable energy technology with the largest scope for cost reduction and efficiency gains, as well as exploiting the largest resource. Rapid technical evolution needs to be matched by standards developed and accepted at international level to ensure product quality, reliability and sustainability, as well as transparent market conditions. The JRC plays a prominent role in both International and European standards committees for PV. This exploits expertise developed in the European Solar Test Installation (ESTI), a European reference laboratory to validate electrical performance and lifetime of PV devices based on established as well as emerging technologies.

Policy context

The European Union has set out plans for a new energy strategy based on a more secure, sustainable and low-carbon economy. It has committed itself to achieving a 32% share of renewables by 2030([1]) with the aim of encouraging private investment in infrastructure and low-carbon technologies. The work programmes for European standardisation support these Energy Union priorities, notably the decarbonisation of the economy and support for green public procurement.

Key conclusions

The continued development of the PV sector as one of the main enablers for decarbonisation and climate change mitigation presents new challenges for the associated standards systems. This relates to innovation in the technology itself, its application and integration, and to sustainability requirements. The JRC has specific expertise to allow it to effectively contribute to achieving these goals.

Main findings

The JRC continues to play a significant role in European and International standardisation activities within the field of Photovoltaic Energy Systems. In particular JRC staff have been appointed convenors of working groups within the International Electrotechnical Commission (IEC) and the European Committee for Electrotechnical Standardization (CENELEC) technical committees, and led the project which published the standard IEC 60904-4 in 2019. The JRC was also project team member of four additional publications during 2019 (see section 2.3). JRC is the project leader for another two standards (IEC 60904-1 and IEC 60904-10) which are progressing through the standardisation process and has made contributions to 24 others (as part of the various project teams).

Related and future JRC work

Photovoltaics are an area of strategic importance for EU policies and initiatives on renewable energy, energy performance of buildings and the circular economy. The JRC work programme for 2020 foresees continued efforts to support the standardisation process in the following specific areas: a) power calibration, b) energy rating, c) reliability and lifetime, d) module electrical safety, e) PV products for buildings and f) Ecodesign, Energy Labelling, Ecolabel and Green Public Procurement policy tools.

The level of commitment in 2020 is expected to be roughly equal to that of 2019, with the support for the International Electrotechnical Commission's Technical Committee 82 Working Group 2 and the European Committee for Electrotechnical Standardization's Technical Committee 82 Working Group 1 being the most significant.

([1]) Directive 2018/2001/EU of 11 December 2018 on the promotion of the use of energy from renewable sources

1 Introduction

1.1 Background

The EU's Energy Union policy aims to make energy more secure, affordable and sustainable. The policy framework for energy and climate for 2030 includes a commitment to achieve a 32% share of renewables by 2030([2]). Furthermore, the EU's commitment to achieving a competitive and climate neutral economy by 2050([3]) recognises the importance of renewable energy to achieving that goal.

Photovoltaics (PV) are expected to make a significant contribution to achieving these goals, being the renewable energy technology with the largest scope for cost reduction and efficiency gains. The sector is growing rapidly, with world-wide installed capacity increasing from around 40 GW in 2010 to over 600 GW at the end of 2019, with potential to reach up to 1.4 TW by 2024([4]). This growth is characterised by rapid technological development, not just scaling up existing systems. In this context, international standards are essential to ensuring market transparency, helping to cut costs and strengthening investor confidence. When correctly designed, they can also play a critical role in accelerating the uptake of innovative solutions ([5]).

The European Commission's work programme on standardisation ([6]) acknowledges the role of standardisation in the Energy Union strategy. It specifically notes that "to this end, standardisation has also been identified as an important enabler for market-adoption of low-carbon technologies in the Accelerating Clean Energy Innovation Communication. Specific action should target the interconnection of electricity networks, support diversified gas supply streams and integrate renewable energy into the consumption mix".

The JRC supports this by performing pre-normative R&D on technical areas within its competence and by taking a proactive role on International and European standardisation bodies. Its expertise in PV is based on 40 years of activity of the European Solar Test Installation (ESTI), which today provides a European reference laboratory for validating electrical performance and lifetime of PV devices based on traditional and emerging technologies. ESTI also performs pre-normative research to develop and improve traceable, accurate measurement techniques.

In particular, as part of the European Commission's liaison with the International Electrotechnical Commission (IEC), ESTI staff contribute to International Standards within Technical Committee 82 (TC 82) “Solar photovoltaic energy systems”. Many of the more than 129 publications issued by IEC TC 82 have been either based on original JRC Specifications (such as those on calibration and type approval) or to a larger extent developed or supported from JRC work results. They are in use world-wide and play an essential role for the high-quality level PV products maintain, no matter where they are produced or deployed. The International Standards in place allowed the PV industry a real global reach.

The JRC's contributions to the further development of IEC and CENELEC standards are summarized below in sections 2 and 3, respectively. Section 4 covers related initiatives likely to impact on future developments. Finally, section 5 summarises priorities for activities in 2020.

1.2 Relevance to EU Policies

EU policy on energy shall, under Lisbon Treaty Article 194/1c, "promote energy efficiency and energy saving and the development of new and renewable forms of energy". JRC’s activities provide scientific support to the EU policy introduced in 2015, in particular regarding the following aspects:

- Buildings resemble the complexity of energy systems. Historically an energy consumer only, they increasingly use renewable resources to provide their own energy (in particular PV and heat-pumps), and to deliver excess electricity to the electricity grid. With Europe's policy of making "Nearly Zero Energy

([2]) Directive 2018/2001/EU of 11 December 2018 on the promotion of the use of energy from renewable sources

([3]) A Clean Planet for all: a European strategic long-term vision for a prosperous, modern, competitive and climate neutral economy.

([4]) EUR 29938 EN “PV Status Report 2019” Arnulf Jäger-Waldau, ISBN 978-92-76-12607-2

([5]) COM(2016) 358, Standardisation package, European Standards for the 21st Century

([6]) COM(2017) 453 "The annual Union work programme for European standardisation for 2018"

Buildings" a requirement in 3.5 years from now under the Energy Performance of Buildings Directive, PV will have a strongly increasing market. The success of this market will depend also on the availability of building-specific PV modules, regarding their functionality as building product beyond their electricity production, like providing roof insulation and water protection, their cost-effective installation within current building technologies and the integration into the overall appearance and style of buildings.

- The 2015 SET-Plan ([7]) communication identifies the need to sustain technological leadership by developing highly performant renewable technologies, as well as recognising the role of standards as "additional enabling conditions".
- The revised Renewable Energy Directive (RED II) was formally adopted by the European Council in 2018 ([8]). It sets a new, binding, renewable energy target for the EU for 2030 of at least 32%, including a review clause by 2023 for an upward revision of the EU level target. It supersedes the 2009 RES Directive ([9]), which placed an obligation on the EU as a whole to reach specific targets by 2020, including 20% renewable energy.

The Ecodesign and Energy Labelling legislative framework has the dual purpose of ensuring that more energy-efficient products come to the market (through Ecodesign) while encouraging and empowering consumers to buy the most efficient products based on useful information (through energy labelling). The Ecodesign Working Plan 2016-2019([10]) foresees studies on energy-savings potentials of PV panels and inverters. In particular, a preparatory study on sustainable product policy instruments for the product group 'solar photovoltaic panels, inverters and systems' was launched in November 2017. The JRC.B5 unit led the study under an administrative arrangement (AA) from DG GROW, with a specific contribution regarding standards also from JRC.C2.

The European Green Deal, announced ([11]) in December 2019, aims to make Europe the world's first climate-neutral continent by 2050 with implications across the entire energy sector. The commitment to a power sector based largely on renewable sources implies substantial further growth of PV, with sustainable products fully embodying circular economy principles. This presents a new series of challenges for standardisation. As the communication notes, "Reliable, comparable and verifiable information also plays an important part in enabling buyers to make more sustainable decisions and reduces the risk of 'green washing'."

([7]) C(2015) 6317 final Towards an Integrated Strategic Energy Technology (SET) Plan: Accelerating the European Energy System Transformation

([8]) Directive 2018/2001/EU of 11 December 2018 on the promotion of the use of energy from renewable sources

([9]) Directive 2009/28/EC of 23 April 2009 on the promotion of the use of energy from renewable sources

([10]) COM(2016) 773 COMMUNICATION FROM THE COMMISSION Ecodesign Working Plan 2016-2019

([11]) COM(2019) 640 The European Green Deal

2 IEC TC 82

2.1 IEC Background

The IEC is the partner organisation of the International Organization for Standardization (ISO) and forms, together with the International Telecommunication Union (ITU), the United Nations related, worldwide standardisation process. IEC is entrusted with all standards aspects in the electrotechnical field, and was founded in 1904. Membership is required for all countries which are part of the World Trade Organisation (WTO) as commitment to remove international trade barriers, but it is open to all other United Nations members.

IEC TC 82 was established in 1981 to deal with Solar Photovoltaic Energy Systems. Since then it has published more than 129 documents (as of 2019-12-31), which have laid the foundation for the strong increase of world-wide trade for PV products.

2019 saw the addition of two new countries, Côte D'Ivoire and Qatar (participating country), to the list of TC 82 member states. IEC TC 82 currently has 54 member states (43 Participating countries and 11 Observer countries), see table 1.

Table 1 List of Countries

Africa:	Algeria, Côte D'Ivoire, Egypt, Kenya, Morocco, Nigeria, South Africa
Americas:	Brazil, Canada, Chile, Mexico, United States of America
Asia/Pacific:	Australia, P.R. China and independent Province of Taiwan, India, Indonesia, Japan, Republic of Korea, Malaysia, New Zealand, Singapore, Thailand
EU28:	Austria, Belgium, Bulgaria, Czech Republic, Denmark, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Netherlands, Poland, Portugal, Romania, Slovenia, Spain, Sweden, United Kingdom (20, all but CY, EE, HR, LV, LT, LU, MT, SK)
Europe:	Norway, Russian Federation, Serbia, Switzerland, Turkey, Ukraine
Middle East:	Bahrain, Iran, Israel, Oman, Qatar, Saudi Arabia

(Source: IEC 2019)

TC 82 maintains formally a Type A Liaison with the European Commission, DG GROW. This is the highest possible level of Liaison, and puts the European Commission (and the JRC) on the same level as National Committees, however without voting rights.

TC 82 also has Type A Liaison with the International Energy Agency (IEA) and the International PV Quality Assurance Task Force (PVQAT), which was established in 2017.

Other IEC technical committees under the Type A Liaison with DG GROW (and thus JRC) are:

- TC 23 Electrical accessories
- TC 45 Nuclear instrumentation
- SC 45B Radiation protection instrumentation
- TC 59 Performance of household and similar electrical appliances
- TC 100 Audio, video and multimedia systems and equipment
- TC 105 Fuel cell technologies
- ISO/IEC JTC 1 Information technology
- ISO/IEC JTC 1/SC 25 Interconnection of information technology equipment

Technical committees under the Type B Liaison with DG GROW (and thus JRC) are:

- ISO/IEC JTC 1/SC 2 Coded character sets

2.2 Technical Committee 82 Solar Photovoltaic Energy Systems

The TC 82 Secretariat is traditionally provided by the US National Committee, which makes a secretary and two assistant secretaries available to assist in all standards processes. A technical officer from the IEC Central Office in Geneva assists in all formal aspects (aided by an administrative assistant and editor), as well as serving as the IEC direct contact for the chairman and the secretariat.

The current list of TC 82 officers and IEC Central Office contacts are listed in table 2 and 3 respectively.

Table 2 TC 82 Officers

Chair	Mr Michio Kondo (JP) Term of office : 2022-08
Vice-Chair	Mr Zhengxin Liu (CN) Term of office : 2020-06
Secretary	Mr George Kelly (US)
Assistant Secretary	Mr Howard O Barikmo (US)
Assistant Secretary	Mr Liang Ji (US)

(Source: IEC 2019)

Table 3 IEC Central Office Contacts

Technical Officer	Mr Anson Chiah
Administrative Assistant	Ms Anouchka Blattler
Editor	Ms Claire Louca

(Source: IEC 2019)

The organisation of TC 82 is arranged into a number of Working Groups (WG), Project Teams (PT) and Joint Working Groups (JWG), as detailed in table 4 below

Table 4 TC 82 Subcommittee(s) and/or Working Group(s)

Label	**Convenor**	**Title**
Working Groups		
WG 1	Mr Hidenori Shimizu	Glossary
WG 2	Mr Tony Sample	Modules, non-concentrating
WG 3	Mr Martin Cotterell Mr Ted Spooner	Systems
WG 6	Mr Greg J. Ball	Balance-of-system components

WG 7	Mr Kenji Araki Mr Shitao Wang	Concentrator modules
WG 8	Mr Hao Jin	Photovoltaic (PV) cells
Project Teams		
PT 62994-1	Mr Changho Lim	Environmental Health and Safety (EH&S) Risk Assessment for the sustainability of PV module manufacturing - Part 1. General principles and definition of terms
PT 63092	Mr Thomas Moran	Building Integrated Photovoltaics (BIPV)
Joint Working Groups		
JWG 1	Mr Leon Andre Drotsché Mr Arne Jacobson	Photovoltaic off grid systems, including decentralized rural electrification and hybrid systems
JWG 10	Mr Giuseppe Dell'Olio Mr Liangzhong Yao	Distributed Energy Resources Interconnection with the Grid Managed by TC 8
JWG 4	Mr Qing LI	Grid code compliance assessment for grid connection of wind and PV power plants Managed by SC 8A
JWG 5	Mr Jiabing HU Mr Jason MacDowell	System issues regarding integration of wind and PV generation into bulk electrical grid Managed by SC 8A
JWG 82	Mr Herbert K. Giess	TC 21/ TC 82 - Secondary cells and batteries for Renewable Energy Storage Managed by TC 21
JWG 32	Mr Norman Graham Frederick Bird Mr Adrian Häring	Electrical safety of PV system installations Managed by TC 64

(Source: IEC 2019)

TC 82 continues to be the most active technical committee within the IEC, with the largest work-programme of any technical committee (currently 82 active documents), reflecting the nature of the rapidly growing and innovative PV industry.

In addition to the development of new standards, technical committees are also responsible for the maintenance of published standards. A simplified schematic of the standards process is show in Figure 1. Each published document has a stability date, which lists the time when the TC will verify the up-to-date applicability of the standard. Where appropriate, they will then make a revision of the document to adapt to progress in the field or, if no revision is necessary, confirm this fact and establish a new stability date. The development of new standards as well as the updating of existing standards through the maintenance cycle requires input from organisations familiar with the existing standards and the current state of the art in the particular field. The ESTI laboratory has a key role in delivering both of these aspects in the case of PV measurement and characterisation (which can be overall summarised as “PV metrology”). The history of the ESTI laboratory over the last 40 years and its long-term involvement with the development of standards has ensured that technological developments within the PV industry are reflected within the standards. This is a role also played by several national laboratories around the world, with which ESTI has developed a solid scientific and technical collaboration; such as

- the National Renewable Energy Laboratory (NREL) USA
- the National Institute of Advanced Industrial Science and Technology (AIST) Japan
- the Physikalisch-Technische Bundesanstalt (PTB) Germany

Table 5 summarises the projects being currently handled by TC 82 (extract of 2019-12-31).

Figure 1. Simplified standards development process

(Source: IEC 2019)

Table 5. IEC TC 82 Projects (shading in light blue denotes significant JRC contribution, also see section 2.3)

Project Reference	Title	WG	Forecast Publication Date	Maintenance Cycle
PNW TS 82-1549	Tracker structure design using local wind conditions	WG 7	2022-03	
PNW TS 82-1599	Extended-stress testing of photovoltaic modules for risk analysis – Part 2: Durability characterization of polymeric component materials and packaging sets.	WG 2	2021-11	
IEC 60891 ED3	Photovoltaic devices - Procedures for temperature and irradiance corrections to measured I-V characteristics	WG 2	2020-12	Yes
IEC 60904-1 ED3	Photovoltaic devices - Part 1: Measurement of photovoltaic current-voltage characteristics	WG 2	2020-09	Yes
IEC 60904-5/AMD1 ED2	Amendment 1 - Photovoltaic devices - Part 5: Determination of the equivalent cell temperature (ECT) of photovoltaic (PV) devices by the open-	WG2	2021-05	Yes

Project Reference	Title	WG	Forecast Publication Date	Maintenance Cycle
	circuit voltage method			
IEC 60904-8/AMD1 ED3	Amendment 1 - Photovoltaic devices - Part 8: Measurement of spectral responsivity of a photovoltaic (PV) device	WG 2	2021-03	Yes
IEC 60904-9 ED3	Photovoltaic devices - Part 9: Solar simulator performance requirements	WG 2	2020-07	Yes
IEC 60904-9-1 ED1	Photovoltaic devices - Part 9-1: Collimated beam solar simulator performance requirements	WG 7	2021-01	Yes
IEC 60904-10 ED3	Photovoltaic devices - Part 10: Methods of linearity measurement	WG 2	2020-12	Yes
IEC 61215-1 ED2	Terrestrial photovoltaic (PV) modules - Design qualification and type approval - Part 1: Test requirements	WG 2	2020-12	Yes
IEC 61215-1-1 ED2	Terrestrial photovoltaic (PV) modules - Design qualification and type approval - Part 1-1: Special requirements for testing of crystalline silicon photovoltaic (PV) modules	WG 2	2020-12	Yes
IEC 61215-1-2 ED2	Terrestrial photovoltaic (PV) modules - Design qualification and type approval - Part 1-2: Special requirements for testing of thin-film Cadmium Telluride (CdTe) based photovoltaic (PV) modules	WG 2	2020-12	Yes
IEC 61215-1-3 ED2	Terrestrial photovoltaic (PV) modules - Design qualification and type approval - Part 1-3: Special requirements for testing of thin-film amorphous silicon based photovoltaic (PV) modules	WG 2	2020-12	Yes
IEC 61215-1-4 ED2	Terrestrial photovoltaic (PV) modules - Design qualification and type approval - Part 1-4: Special requirements for testing of thin-film $Cu(In,GA)(S,Se)_2$ based photovoltaic (PV) modules	WG 2	2020-12	Yes
IEC 61215-2 ED2	Terrestrial photovoltaic (PV) modules - Design qualification and type approval - Part 2: Test procedures	WG 2	2020-12	Yes
IEC 61701 ED3	Salt mist corrosion testing of photovoltaic (PV) modules	WG 2	2020-07	Yes
IEC 61724-1 ED2	Photovoltaic system performance - Part 1: Monitoring	WG 3	2021-06	Yes

Project Reference	Title	WG	Forecast Publication Date	Maintenance Cycle
IEC 61730-1/AMD1 ED2	Amendment 1 - Photovoltaic (PV) module safety qualification - Part 1: Requirements for construction	WG 2	2021-01	Yes
IEC 61730-2/AMD1 ED2	Amendment 1 - Photovoltaic (PV) module safety qualification - Part 2: Requirements for testing	WG 2	2021-01	Yes
IEC 61853-2/AMD1 ED1	Amendment 1 - Photovoltaic (PV) module performance testing and energy rating - Part 2: Spectral responsivity, incidence angle and module operating temperature measurements	WG 2	2020-12	Yes
IEC 62093 ED2	Power conversion equipment for photovoltaic systems - Design qualification testing	WG 6	2021-01	Yes
IEC 62108 ED3	Concentrator photovoltaic (CPV) modules and assemblies - Design qualification and type approval	WG 7	2021-02	Yes
IEC 62109-1 ED2	Safety of power converters for use in photovoltaic power systems - Part 1: General requirements	WG 6	2020-12	Yes
IEC 62109-2 ED2	Safety of power converters for use in photovoltaic power systems - Part 2: Particular requirements for inverters	WG 6	2020-12	Yes
IEC 62109-3 ED1	Safety of power converters for use in photovoltaic power systems - Part 3: Particular requirements for electronic devices in combination with photovoltaic elements	WG 6	2020-07	
IEC TS 62257-1 ED4	Recommendations for renewable energy and hybrid systems for rural electrification - Part 1: General introduction to IEC 62257 series and rural electrification	JWG 1	2020-12	Yes
IEC TS 62257-2 ED3	Recommendations for renewable energy and hybrid systems for rural electrification - Part 2: From requirements to a range of electrification systems	JWG 1	2020-12	Yes
IEC TS 62257-3 ED3	Recommendations for renewable energy and hybrid systems for rural electrification - Part 3: Project development and management	JWG 1	2020-12	Yes
IEC TS 62257-4 ED3	Recommendations for renewable energy and hybrid systems for rural electrification - Part 4: System selection and design	JWG 1	2020-12	Yes
IEC TS 62257-5 ED3	Recommendations for renewable energy and hybrid systems for rural electrification - Part 5: Protection against electrical hazards	JWG 1	2020-12	Yes
IEC TS 62257-6 ED3	Recommendations for renewable energy and hybrid systems for rural electrification - Part 6:	JWG 1	2020-12	Yes

Project Reference	Title	WG	Forecast Publication Date	Maintenance Cycle
	Acceptance, operation, maintenance and replacement			
IEC TS 62257-7-2 ED1	Renewable energy and hybrid systems for rural electrification - Part 7-2: Generators – Wind Turbines	JWG 1	2020-12	
IEC TS 62257-9-1 ED3	Renewable energy and hybrid systems for rural electrification - Part 9-1: Integrated systems - Micropower systems	JWG 1	2021-07	Yes
IEC TS 62257-9-4 ED3	Renewable energy and hybrid systems for rural electrification - Part 9-4: Integrated systems - User installation	JWG 1	2010-12	Yes
IEC TS 62257-9-5 ED5	Renewable energy and hybrid systems for rural electrification - Part 9-5: Integrated systems - Laboratory evaluation of stand-alone renewable energy products for rural electrification	JWG 1	2020-12	Yes
IEC TS 62257-9-8 ED1	Renewable energy and hybrid systems for rural electrification – Part 9-8: Integrated systems – Quality standards for stand-alone renewable energy products with power ratings less than or equal to 350 W	JWG 1	2020-09	Yes
IEC TS 62257-12-1 ED3	Recommendations for renewable energy and hybrid systems for rural electrification - Part 12-1: Selection of lamps and lighting appliances for off-grid electricity systems	JWG 1	2020-04	Yes
IEC 62446-1 ED2	Photovoltaic (PV) systems - Requirements for testing, documentation and maintenance - Part 1: Grid connected systems - Documentation, commissioning tests and inspection	WG 3	2021-08	Yes
IEC 62446-2 ED1	Photovoltaic (PV) systems - Requirements for testing, documentation and maintenance - Part 2: Grid connected systems - Maintenance of PV systems	WG 3	2020-04	
IEC 62548 ED2	Photovoltaic (PV) arrays - Design requirements	WG 3	2021-04	Yes
IEC 62759-1 ED2	Photovoltaic (PV) modules - Transportation testing - Part 1: Transportation and shipping of module package units	WG 2	2020-12	Yes
IEC 62787 ED1	Concentrator photovoltaic (CPV) solar cells and cell-on-carrier (COC) assemblies - Reliability qualification	WG 7	2020-11	

Project Reference	Title	WG	Forecast Publication Date	Maintenance Cycle
IEC 62788-1-1 ED1	Measurement procedures for materials used in photovoltaic modules – Part 1-1: Encapsulants – Polymeric materials used for encapsulants	WG 2	2021-01	
IEC 62788-1-4 /AMD1 ED1	Amendment 1 - Measurement procedures for materials used in photovoltaic modules - Part 1-4: Encapsulants - Measurement of optical transmittance and calculation of the solar-weighted photon transmittance, yellowness index, and UV cut-off wavelength	WG 2	2020-10	Yes
IEC 62788-1-6 /AMD1 ED1	Amendment 1 - Measurement procedures for materials used in photovoltaic modules - Part 1-6: Encapsulants - Test methods for determining the degree of cure in Ethylene-Vinyl Acetate	WG 2	2020-07	Yes
IEC 62788-1-7 ED1	Measurement procedures for materials used in photovoltaic modules – Part 1-7: Test procedure for the optical durability of transparent polymeric PV packaging materials	WG 2	2020-04	
IEC TS 62788-2/AMD1 ED1	Amendment 1 - Measurement procedures for materials used in photovoltaic modules - Part 2: Polymeric materials - Frontsheets and backsheets	WG 2	2021-06	Yes
IEC 62788-2-1 ED1	Measurement procedures for materials used in photovoltaic modules - Part 2-1: Polymeric materials - Frontsheet and backsheet - Safety requirements	WG 2	2021-04	
IEC 62788-5-1 ED1	Measurement procedures for materials used in photovoltaic modules - Part 5-1: Edge seals - Suggested test methods for use with edge seal materials	WG 2	2020-04	
IEC 62788-5-2 ED1	Measurement procedures for materials used in photovoltaic modules - Part 5-2: Edge seals - Edge-seal durability evaluation guideline	WG 2	2020-11	
IEC 62788-6-2 ED1	Measurement procedures for materials used in photovoltaic modules - Part 6-2: General tests - Moisture permeation testing with polymeric materials	WG 2	2020-04	
IEC TS 62788-6-3 ED1	Measurement procedures for materials used in photovoltaic modules - Part 6-3: Adhesion testing of interfaces within PV modules	WG 2	2020-12	
IEC 62788-7-3 ED1	Measurement procedures for materials used in photovoltaic modules - Part 7-3: Environmental exposures - Accelerated abrasion tests of PV module external surfaces	WG 2	2020-12	

Project Reference	Title	WG	Forecast Publication Date	Maintenance Cycle
IEC 62790/AMD1 ED1	Amendment 1 - Junction boxes for photovoltaic modules - Safety requirements and tests	WG 2	2020-04	Yes
IEC TS 62804-1-1 ED1	Photovoltaic (PV) modules - Test methods for the detection of potential-induced degradation - Part 1-1: Crystalline silicon - Delamination	WG 2	2020-01	
IEC TS 62804-2 ED1	Photovoltaic (PV) modules - Test methods for the detection of potential-induced degradation - Part 2: Thin-film	WG 2	2020-12	
IEC 62852/AMD1 ED1	Amendment 1 - Connectors for DC-application in photovoltaic systems - Safety requirements and tests	WG 2	2020-02	Yes
IEC 62891 ED1	Overall efficiency of grid connected photovoltaic inverters	WG 6	2020-08	
IEC TS 62910 ED2	Utility-interconnected photovoltaic inverters - Test procedure for low voltage ride-through measurements	WG 6	2020-05	Yes
IEC TS 62915 ED2	Photovoltaic (PV) modules - Type approval, design and safety qualification - Retesting	WG 2	2021-05	Yes
IEC 62920/AMD1 ED1	Amendment 1 - Photovoltaic power generating systems - EMC requirements and test methods for power conversion equipment	WG 6	2021-06	Yes
IEC 62938 ED1	Non-uniform snow load testing for photovoltaic (PV) modules	WG 2	2020-06	
IEC 63027 ED1	DC arc detection and interruption in photovoltaic power systems	WG 6	2020-12	
IEC 63092-1 ED1	Photovoltaics in buildings – Part 1: Building integrated photovoltaic modules	PT 63092	2020-12	
IEC 63092-2 ED1	Photovoltaics in buildings – Part 2: Building integrated photovoltaic systems	PT 63092	2020-12	
IEC 63104 ED1	Solar trackers - Safety requirements	WG 7	2021-03	
IEC TS 63106-1 ED1	Basic requirements for simulator used for testing of photovoltaic power conversion equipment - Part 1: a.c. power simulator	WG 6	2020-12	
IEC TS 63106-2 ED1	Basic requirements for simulator used for testing of photovoltaic power conversion equipment - Part 2: d.c. power simulator	WG 6	2020-12	

Project Reference	Title	WG	Forecast Publication Date	Maintenance Cycle
IEC TS 63109 ED1	Measurement of diode ideality factor by quantitative analysis of electroluminescence images	WG 2	2021-09	
IEC 63112 ED1	Safety, functionality and classification of Photovoltaic Earth Fault Protection (PV EFP) equipment	WG 6	2021-02	
IEC TS 63126 ED1	Guidelines for qualifying PV modules, components and materials for operation at higher temperatures	WG 2	2020-11	
IEC TS 63140 ED1	Photovoltaic (PV) modules – Partial shade endurance testing for monolithically integrated products	WG 2	2020-12	
IEC TS 63156 ED1	Photovoltaic systems – Power conditioners - Energy evaluation method	WG 6	2020-12	
IEC 63163 ED1	Terrestrial photovoltaic (PV) modules for consumer products - Design qualification and type approval	WG 2	2021-02	
IEC TS 63202-2 ED1	Photovoltaic cells - Part 2: Electroluminescence image for crystalline silicon solar cells	WG 8	2020-12	
IEC TS 63209 ED1	Extended-stress testing of photovoltaic modules for risk analysis	WG 2	2020-12	
IEC TR 63217 ED1	Utility-interconnected photovoltaic (PV) inverters – Test procedure of high-voltage ride-through measurements		2020-10	
IEC TR 63226 ED1	Managing risk related to photovoltaic (PV) systems on buildings		2020-05	
IEC TR 63227 ED1	Lightning and surge voltage protection for photovoltaic (PV) power supply systems		2020-05	
IEC 63257 ED1	Power line communication for DC shutdown equipment	WG 6	2021-12	
IEC TS 63265 ED1	Reliability practices for the operation of photovoltaic power systems	WG 3	2021-03	
IEC TR 63279 ED1	Sequential and combined accelerated stress testing for de-risking photovoltaic modules		2020-10	

(Source: IEC 2019)

2.3 TC 82 Working Group 2 Modules, non-concentrating

WG 2 held two 4½ day meetings in 2019. The first, in April in Braunschweig, Germany was attended by 90 experts from industry, research and testing organisations. The second, in October held in Mississauga, Canada was attended by 88 experts.

JRC is convenor of WG 2 (T. Sample) and chaired both meetings of WG 2.

Asian countries provide the largest delegations, confirming their commitment to the international standardisation process which fosters innovation and facilitates global trade in this very dynamic industry. Continuing progress was made on the new set of materials standards that underpin the production supply chain.

TC 82 continues to be the most active technical committee within the IEC, with the largest work-programme of any technical committee (currently 82 active documents), with WG 2 having the largest share within TC 82 with 40 active documents.

One of the IEC TC 82's most widely used document series (IEC 61215 for photovoltaic (PV) module design qualification and type approval) is undergoing a series of revisions together with the module safety standard series (the IEC 61730 for photovoltaic (PV) module safety qualification).

The JRC acts as either a project leader for a particular standard or as a technical expert of the project team. The different roles are as follows.

The project leader shall act in a purely international capacity, divesting him- or her- self of a national point of view. The project leader should be prepared to act as consultant, when required, regarding technical matters arising at the proposal stage through to the publication stage.

Experts in relevant technical fields for each TC or Sub Committee are individuals appointed by their National Committees, via the Expert Management System, and designated to one or more working group, maintenance team or project team. They will have access (granted by their National Committees) to working documents located on the IEC website. In the case of the JRC, the experts are nominated under a type A liaison between the IEC and the European Commission.

The experts act in a personal capacity and not as the official representative of the organization by which they were appointed. However, it is recommended that they keep close contact with their organization (National Committee or other International Organization in liaison) in order to inform them about the progress of the work. Experts are capable of advising on technical issues in the field of the committee in which they have been appointed.

Those items to which the JRC has provided significant technical input in 2019 include:

- IEC 60904-4 ED2 Photovoltaic devices - Part 4: Reference solar devices - Procedures for establishing calibration traceability. **(Published November 2019)**. The JRC was the project leader.
- IEC TS 60904-1-2, Photovoltaic devices – Part 1-2: Measurement of current-voltage characteristics of bifacial photovoltaic devices. **(Published January 2019)**. The JRC contributed as experts within the project team.
- IEC 60904-3 ED4 Photovoltaic devices - Part 3: Measurement principles for terrestrial photovoltaic (PV) solar devices with reference spectral irradiance data. **(Published February 2019)**. The JRC contributed as experts within the project team.
- IEC 60904-7 Ed. 4.0, Photovoltaic devices - Part 7: Computation of the spectral mismatch correction for measurements of photovoltaic devices. **(Published August 2019)**. The JRC contributed as experts within the project team.
- IEC TR 63228, Measurement protocols for photovoltaic devices based on organic, dye-sensitized or perovskite material. **(Published July 2019)**. The JRC contributed as experts within the project team.
- IEC 60891 Ed. 3.0, Photovoltaic devices - Procedures for temperature and irradiance corrections to measured I-V characteristics. CDV in preparation. The JRC contributes as experts within the project team.
- IEC 60904-1 Ed. 3.0, Photovoltaic devices - Part 1: Measurement of photovoltaic current-voltage characteristics. FDIS in preparation. The JRC is the project leader.

- IEC 60904-5/AMD1 ED2, Amendment 1 - Photovoltaic devices - Part 5: Determination of the equivalent cell temperature (ECT) of photovoltaic (PV) devices by the open-circuit voltage method. CD in preparation. The JRC contributes as experts within the project team.
- IEC 60904-8/AMD1 ED3, Amendment 1 - Photovoltaic devices - Part 8: Measurement of spectral responsivity of a photovoltaic (PV) device. CD in preparation. The JRC contributes as experts within the project team.
- IEC 60904-9 Ed 3, Photovoltaic devices - Part 9: Solar simulator performance requirements. FDIS submitted. The JRC contributes as experts within the project team.
- IEC 60904-10 Ed 3, Photovoltaic devices - Part 10: Methods of linearity measurement. CDV submitted. The JRC is the project leader.
- IEC 61215-1 Ed2, Terrestrial Photovoltaic (PV) Modules – Design Qualification and Type Approval Part 1: Test requirements. CDV submitted. The JRC contributes as experts within the project team.
- IEC 61215-2 Ed2, Terrestrial Photovoltaic (PV) Modules – Design Qualification and Type Approval Part 2: Test procedures. CDV submitted. The JRC contributes as experts within the project team.
- IEC 61215-1-1 Ed2, Terrestrial Photovoltaic (PV) Modules – Design Qualification and Type Approval Part 1-1: Special requirements for testing of crystalline silicon terrestrial photovoltaic (PV) modules. CDV submitted. The JRC contributes as experts within the project team.
- IEC 61215-1-2 Ed2, Terrestrial Photovoltaic (PV) Modules – Design Qualification and Type Approval Part 1-2: Special requirements for testing of thin-film Cadmium Telluride (CdTe) based terrestrial photovoltaic (PV) modules. CDV submitted. The JRC contributes as experts within the project team.
- IEC 61215-1-3 Ed2, Terrestrial Photovoltaic (PV) Modules – Design Qualification and Type Approval Part 1-3: Special requirements for testing of thin-film amorphous silicon based terrestrial photovoltaic (PV) modules. CDV submitted. The JRC contributes as experts within the project team.
- IEC 61215-1-4 Ed2, Terrestrial Photovoltaic (PV) Modules – Design Qualification and Type Approval Part 1-4: Special requirements for testing of thin-film $Cu(In,Ga)(S,Se)_2$ based terrestrial photovoltaic (PV) modules. CDV submitted. The JRC contributes as experts within the project team.
- Amendment 1 to IEC 61730-1 Ed. 2: Photovoltaic (PV) module safety qualification - Part 1: Requirements for construction, CD2 submitted. The JRC contributes as experts within the project team.
- Amendment 1 to IEC 61730-2 Ed. 2: Photovoltaic (PV) module safety qualification - Part 1: Requirements for testing, CD submitted. The JRC contributes as experts within the project team.
- IEC 61853-2/AMD1 ED1, Amendment 1 - Photovoltaic (PV) module performance testing and energy rating - Part 2: Spectral responsivity, incidence angle and module operating temperature measurements. CD in preparation. The JRC contributes as experts within the project team.
- IEC TS 62788-2/AMD1 ED1, Amendment 1 - Measurement procedures for materials used in photovoltaic modules - Part 2: Polymeric materials - Frontsheets and backsheets. CD in preparation. The JRC contributes as experts within the project team.
- IEC TS 62788-2-1 ED1, Measurement procedures for materials used in photovoltaic modules - Part 2-1: Polymeric materials - Frontsheet and backsheet - Safety requirements. CD submitted. The JRC contributes as experts within the project team.
- IEC 62790 Ed2, Junction boxes for photovoltaic modules - Safety requirements and tests, FDIS submitted. The JRC contributes as experts within the project team.
- Amendment 1 to IEC 62852 Ed1, Connectors for DC-application in photovoltaic systems - Safety requirements and tests, FDIS submitted. The JRC contributes as experts within the project team.
- IEC 63092-1 ED1, Photovoltaics in buildings – Part 1: Building integrated photovoltaic modules, CDV submitted. The JRC contributes as experts within the project team.
- IEC 63092-2 ED1, Photovoltaics in buildings – Part 2: Building integrated photovoltaic systems, CDV submitted. The JRC contributes as experts within the project team.
- IEC TS 63126 Ed1, Guidelines for qualifying PV modules, components and materials for operation at higher temperatures, DTS submitted. The JRC contributes as experts within the project team.

- IEC TS 63140 Ed1, Photovoltaic (PV) modules – Partial shade endurance testing for monolithically integrated products, CD2 in preparation. The JRC contributes as experts within the project team.
- IEC TS 63209 Ed1, Extended-stress testing of photovoltaic modules for risk analysis, DTS in preparation. The JRC contributes as experts within the project team.

3 CENELEC TC 82

3.1 CENELEC Background

CENELEC is the European Standards Organisation in the electrotechnical field. CEN/CENELEC (+ ETSI) hold the European Union's mandate in relation to the "Completion of the Internal Market". The specific mandate for standardisation in the field of solar photovoltaic energy systems and components is M/089 EN.

This is implemented by TC 82: Solar Photovoltaic Systems. Under the terms of the Frankfurt Agreement between IEC and CENELEC, the latter transforms IEC standards into European standards, usually in a "fast track" procedure of 2 months, keeping the IEC document numbers. CENELEC together with the European National Committees (EU28+EEA) fosters also the translation of international standards into national languages. The Frankfurt Agreement requires mutual notification of standards work, and the commitment by either party not to engage in topics which the other party is already working on.

3.2 CENELEC TC 82

CENELEC TC 82 is organized in two working groups: WG 1 and WG 2. The scope of WG1 "WAFERS, CELLS AND MODULES" is to develop international standards for wafers, solar cells and terrestrial photovoltaic modules and related components. The scope of WG 2 "BOS COMPONENTS AND SYSTEMS" is to develop international standards for balance of systems (BOS) components, interfaces of PV systems and system integration.

The JRC is convenor of CENELEC WG 1 (T. Sample) and chaired the annual meeting of the group held in Brussels in March 2019.

During 2019 no specific CENELEC documents were prepared. IEC standards from TC 82 which are circulated for vote are also subjected to a parallel vote by the national committees of CENELEC, via the Frankfurt agreement, and if voted positively to be adopted as EN standards.

As the amendments of the IEC 61730-1 and IEC 61730-2 progress through the IEC stages, an assessment will have to be made on the impact the amendments have on the listing of the current EN IEC 61730-1 and EN IEC 61730-2, which were adopted as harmonised standards under the Low Voltage Directive (LVD) ([12]) through the publication in the Official Journal of the European Union.

([12]) Directive 2014/35/EU of the European Parliament and of the Council of 26 February 2014 on the harmonisation of the laws of the Member States relating to the making available on the market of electrical equipment designed for use within certain voltage limits

4 Related Initiatives

4.1 International PV Quality Assurance Task Force (PVQAT, "PV cat")

The first International PV Module Quality Assurance Forum was held in July 2011, in San Francisco, California. The event fostered international participation to develop a rating system that meets the needs of all countries and customers so that PV manufacturers need to complete only a single test. At the Forum, the community expressed strong support for development of international PV QA standards, leading to the formation of The International Photovoltaic Quality Assurance Task Force (PVQAT). PVQAT is a purely voluntary organisation in which each individual participates to further the goals of developing the whole of the PV industry.

The PVQAT leads global efforts to craft quality and reliability standards for solar energy technologies. These standards will allow stakeholders to quickly assess a solar PV module's performance and ability to withstand local weather stresses, thereby reducing risk and adding confidence for those developing products, designing incentive programs, and determining private investments. As a result:

- Investors can gain confidence in solar PV investments.
- PV customers can use standards to choose products that meet their needs.
- Incentive programs can define a minimum durability for module designs.
- Insurance companies can adjust rates according to demonstrated reliability.
- PV module suppliers can optimize module design to minimize cost while still maintaining confidence in reliability for a specific use or application of the modules.
- The entire PV community benefits by reducing installed PV cost when standards are created that establish durability without adding unnecessary cost.

PVQAT strives to provide these benefits by coordinating international development of comprehensive technical standards for verifying PV component and system quality and bankability. To that end, PVQAT has a three-pronged approach that seeks to establish:

- A rating system to ensure durable design of PV modules for the climate and application of interest.
- A guideline for factory inspections and QA during manufacturing.
- A comprehensive system for certification of PV systems, verifying appropriate design, installation, and operation.

PVQAT now has 13 individual task groups focused on accelerating progress toward implementing these three approaches. Several hundred volunteers from around the world contribute to the various task groups within PVQAT and they have already made significant contributions to the standardisation activities. The JRC contributes to PVQAT activities based on the expertise developed at ESTI during the last decades.

In 2017 PVQAT attained a type A liaison with IEC TC 82 to enable close coordination of its work programme in support to standardisation activities.

The various task groups are undertaking basic research activities, intercomparisons and round-robin tests in a number of areas to define appropriate characterisation and testing methods for many of the basic material and component standards progressing within IEC TC 82.

Additional information can be obtained via the PVQAT website www.pvqat.org

The JRC has supported the development of the PVQAT from its inception and is represented on the 5-person steering committee by Tony Sample, who also contributes to some of the task groups.

4.2 IECRE

The IEC System for certification to standards relating to equipment for use in renewable energy applications (IECRE System) aims to facilitate international trade in equipment and services for use in renewable energy (RE) sectors while maintaining the required level of safety (see the IECRE website, www.iecre.org).

To achieve this it:

- operates a single, global certification system
- aims for acceptance by local/national authorities or other bodies requiring and benefiting from certification
- will make use of high quality International Standards and allow for continuous improvement

To be effective and avoid double work of what information must be given when and to whom, the system will include a mechanism to solve disagreements between stakeholders both on the content and its correct application.

Its goal is to offer a harmonised application around the globe, which ensures a uniform implementation and:

- mutual recognition between certification bodies and test labs
- delivery of information by suppliers, sub-suppliers, end users and others providing documentation for certification
- clear understanding of all suppliers, sub-suppliers, end users and other applicants for the elements and modules as well as reports, statements and certificates of the certification processes

RE sectors are known by different names such as Marine Energy, Solar PV Energy and Wind Energy, and relate to areas characterised by systems which generate electricity from renewable natural sources. They consist of complex arrangements of sub-systems including structures, which are usually directly exposed to the natural environment and whose reliability and performance is affected by direct interaction with the natural environment.

These areas may include the equipment and processes to produce energy, as well as the equipment to manufacture, transport and service the energy-producing equipment. Relevant standards exist for specific industry sectors to which the conformity assessment and certification of the IECRE System is done.

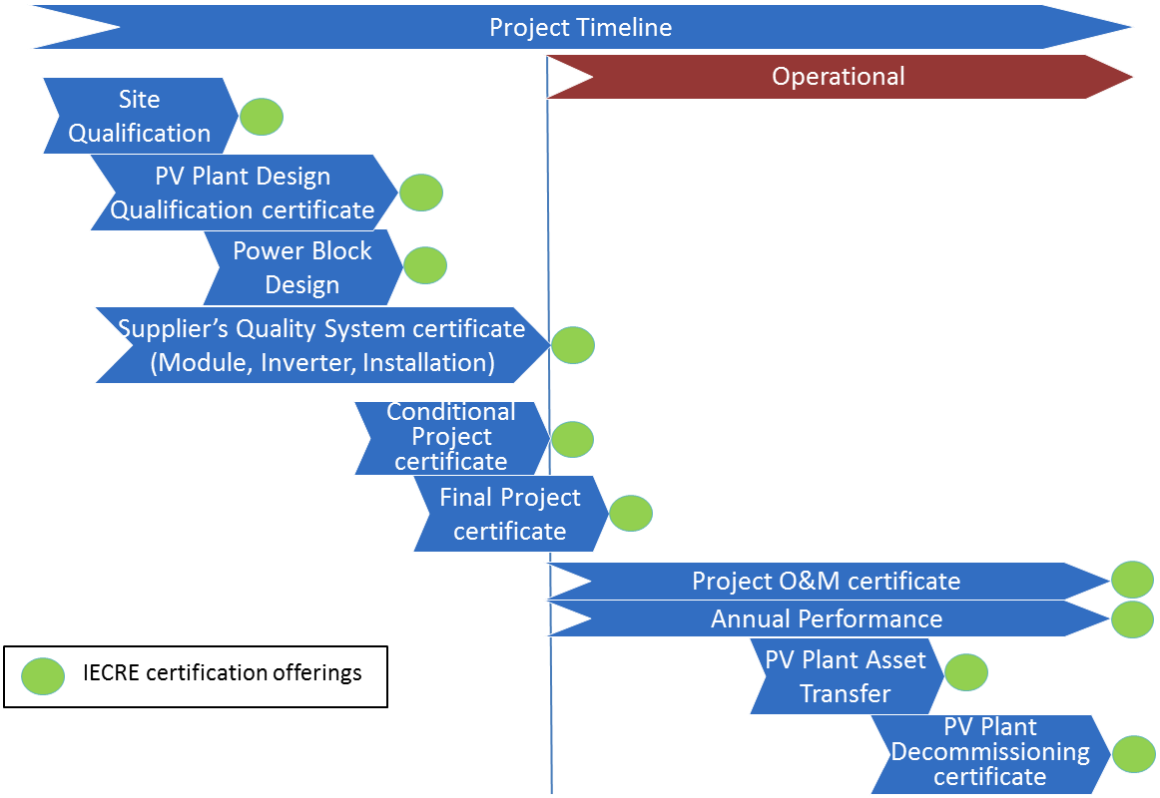
The IECRE was formed in 2014 and currently has 16 member bodies in total, of which 12 are part of the Solar PV sector. The JRC is not currently involved with the IECRE scheme, but we are watching the development of the certification scheme with interest.

Conformity assessment will be performed and certificate issued for an individual PV power plant on a specific site at various stages of its design and implementation (see figure 2).

The specific certificate categories could follow the following:

- PV site qualification certificate
- PV power block design qualification certificate
- PV plant design qualification certificate
- Conditional PV project certificate (construction complete / commissioning)
- Annual PV plant performance certificate
- PV asset transfer certificate
- PV decommissioning certificate

Figure 2. System timeline view



(Source: IECRE 2019)

4.3 TC 113 Nanotechnology standardisation for electrical and electronic products and systems

Nano-enabled PV are devices made from nanomaterial elements, involving a combination of organic and inorganic components and hard and soft matter, including liquid electrolytes, usually combined using low-cost preparation methods mainly by low temperature solution processing. In this class a variety of technical solutions and approaches are used to evaluate technologies.

The field has attracted the attention of the TC 113, which has published one technical specification IEC TS 62876-2-1 Nanotechnology - Reliability assessment - Part 2-1: Nano-enabled photovoltaic devices - Stability test (published 2018-08-29). It currently has two PV related items under consideration (extract of 2019-12-31) which are summarised below:

Table 6. IEC TC 113 Projects related to PV devices

Project Reference	Title	Forecast Publication
PWI 113-78 ED1	IEC 62607-7-1: Nanomanufacturing - Key control characteristics - Part 7-1: Nano-enabled photovoltaics measurement of the electrical performance and spectral response of tandem cells	
IEC TS 62607-7-2 ED1	IEC 62607-7-2: Nanomanufacturing - Key Control Characteristics - Part 7-2: Nano-enabled photovoltaics - Device evaluation method for indoor light	2021-02

(Source: IEC 2019)

The JRC does not take part in IEC TC 113 working groups, but is doing pre-normative research on performance testing of organic (OPV) and dye-sensitised (DSSC) devices, also in the framework of the International Summit on Organic Photovoltaic Stability (ISOS).

In this regard TC 82 has published (2019-07-08) an IEC technical report (TR) on the Measurement protocols for photovoltaic devices based on organic, dye-sensitized or perovskite material (IEC TR 63228). This TR may in part cover the area of characterisation under indoor lighting (i.e. much lower than natural daylight condition), which is the scope of the IEC TS 62607-7-2 (Nano-enabled photovoltaics - Device evaluation method for indoor light).

During 2019 the IEC 62607-7-1 did not progress through the TC 113; this may be due to the publication of the IEC 60904-1-1 and IEC 60904-8-1 (published 2017-05) from TC 82, which cover the same application area. It is possible that the proposed activity on IEC 62607-7-1 will be stopped.

During the October TC 82 WG 2 meeting a presentation/liaison report was given by Shinji Aramaki from TC 113. It was evident that although the title of the IEC TS 62607-7-2 includes "Nano-enabled photovoltaics" the scope of the document states that it would be applicable to other PV devices. This may cause problems in the future if the scope conflicts with any TC 82 documents. Shinji Aramaki stated that TC 113 is open to collaborate with members of TC 82 and equally encourages those members of TC 113 to participate to TC 82 WG 2.

4.4 Photovoltaics Products for Building Applications

Building integrated PV (BIPV) has long been recognised as an important area, but also one in which the lack of specific standards addressing both PV and building fields requirements is frequently cited as an issue. Given that in Europe the requirements of the Energy Performance in Buildings Directive is expected to push this market segment towards significant growth in the coming years, standards specific for BIPV products and systems are likely to be a priority area.

The publication, in January 2016, of the EN 50583-1 (Photovoltaics in buildings. BIPV modules) and EN 50583-2 (Photovoltaics in buildings. BIPV systems) standards was a major step forward in this complex area, which covers both building codes and standards as well as those standards aimed at PV devices.

The multifunctional role of PV products in such applications leads to different standards requirements:

- Electrical performance and safety, via CENELEC/IEC standards and the Low Voltage Directive.
- Building energy performance via CEN/ISO standards (as required under the Energy Performance of Buildings Directive)
- PV as building product, where PV is required to satisfy safety and performance specifications as any other product to be used in the building environment (related to the Construction Products Regulation).

EN 1999 provides a common approach for the design of buildings and other civil engineering works and construction products. They are the recommended means of giving a presumption of conformity with the basic requirements of the Construction Products Regulation (CPR) for construction works and products that bear the CE Marking, as well as the preferred reference for technical specifications in public contracts.

As part of the Frankfurt agreement both of the above-mentioned EN standards were sent to IEC TC 82 for their consideration for future work. A Project Team (PT 63092) was established to take these two standards forward.

- IEC 63092-1 ED1, Photovoltaics in buildings – Part 1: Building integrated photovoltaic modules, CDV submitted. The JRC contributes as experts within the project team.
- IEC 63092-2 ED1, Photovoltaics in buildings – Part 2: Building integrated photovoltaic systems, CDV submitted. The JRC contributes as experts within the project team.

Both documents are currently circulating to national committees as CDV and publication of the two documents is expected in December 2020.

4.5 Product Environmental Footprint Category Rules (PEFCR)

The EU initiative on the single market for green products includes two methods to measure environmental performance throughout the product lifecycle: the Product Environmental Footprint (PEF) and the Organisation Environmental Footprint (OEF). PV electricity generation was assessed as a pilot product, and the resulting Product Environmental Footprint Category Rules (PEFCR) provide a methodology for assessing the environmental impacts of PV technologies based on life cycle assessment. The document "Product Environmental Footprint Category Rules (PEFCR) Photovoltaic Modules Used In Photovoltaic Power Systems For Electricity Generation" was released in November 2018; for more information see the PEF site

https://webgate.ec.europa.eu/fpfis/wikis/display/EUENVFP/PEFCR+Pilot%3A+Photovoltaic+electricity+generation

4.6 Ecodesign preparatory study for solar photovoltaic modules, inverters and systems

As part of the European Commission's circular economy initiative, the Ecodesign Working Plan 2016-2019 includes studies on the energy-saving potentials of several energy-related products that have not been considered up to now, including solar PV panels and inverters. JRC has competence in several relevant aspects including energy-yield assessment, operational lifetime and life-cycle analysis and can directly support such studies.

With the inclusion of PV products within the scope of the Ecodesign Working Plan 2016-2019, the EC launched a preparatory study in 2017 to assess the feasibility of implementing sustainable policy instruments for PV modules, inverters and systems with the aim of creating a more sustainable European PV market.

The considered policy tools include the mandatory Ecodesign and Energy Labelling, and the voluntary Ecolabel and Green Public Procurement. In parallel, a dedicated study to model the performance of the said PV products was launched to support the implementation of the policy instruments. Based on existing standards, a methodology to estimate the lifetime AC energy yield of PV systems has been developed, modelling independently the performance of the various components. The method is a compromise between accuracy and available information, which in some cases limits the model to be implemented. The complete methodology takes into consideration the efficiency of the various components, and aspects like degradation, losses and lifetime, some of which are not covered by available standards. For these cases, transitional methods were proposed and, if the legislative process progresses, they will be implemented until international or European standards are developed.

The Ecodesign preparatory study was coordinated by the EC Directorate General Internal Market, Industry, Entrepreneurship and SMEs (DG GROW), with the active involvement of DG Energy (DG ENER) and DG Environment (DG ENV). The JRC provided technical and scientific support. In particular, unit B5 "Circular Economy and Industrial Leadership", which led the preparatory study, was also responsible for the analysis of the market and future prospects, modelling possible policy scenarios, as well as of the analysis of aspects such as life cycle assessment of different PV products, the methodology for the Ecodesign of Energy-related products (MERP) and techno-economical and environmental analyses. JRC unit C2 "Energy Efficiency and Renewables" provided technical and scientific support on aspects related to the considered PV products. It also provided a review of existing standards that could be relevant for the preparatory study and of the identification of those aspects not covered by any standard. For those aspects, the C2 unit was responsible for proposing transitional methods that could be adopted within the policy instruments until relevant European or international standards are developed.

The policy recommendations were published in December 2019 and are available on the website;

https://susproc.jrc.ec.europa.eu/solar_photovoltaics/documents.html

5 Planning

PV continues to be an area of strategic importance for EU policies and initiatives on renewable energy, energy performance of buildings and eco-industry. As such the JRC work programme for 2020 foresees continued efforts to a) support the standards process, b) perform relevant pre-normative research and c) promote harmonisation with international and European partners. This is consistent with the 2019 annual Commission work programme for European standardisation ([13]), in which energy is one of the main policy areas identified. The level of commitment in 2020 is expected to be roughly equal to that of 2019, with support for IEC TC82 WG2 and CENELEC TC82 WG1 being the most significant.

The JRC-ESTI staff will, via the PV-Energy institutional project, continue to support both IEC TC 82 and CENELEC TC 82. ESTI will prioritise technical input in the following areas:

a) Power calibration

The rated peak-power value remains the key parameter for commerce in PV products, as well as for regulatory purposes. Improving the standards used to define it brings benefits to producers and investors alike. JRC activities on this topic fall under two themes. Firstly, the improvement of existing procedures for PV products, specific items for 2020 include:

- revision of the standard IEC 60891 "Photovoltaic devices - Procedures for temperature and irradiance corrections to measured I-V characteristics" (IEC 60891 edition 3)
- revision of the standard IEC 60904-1 "Photovoltaic devices - Part 1: Measurement of photovoltaic current-voltage characteristics" (IEC 60904-1 edition 3)
- revision of the standard IEC 60904-9 "Photovoltaic devices - Part 9: Solar simulator performance requirements" (IEC 60904-9 edition 3)
- revision of the standard IEC 60904-10 "Photovoltaic devices - Part 10: Methods of linearity measurement" (IEC 60904-10 edition 3)

Secondly, the development of in-house methods to calibrate curved PV modules, which are increasingly being proposed for incorporation in electric vehicles.

b) Energy Rating

JRC has been active in promoting the development of an energy rating for PV modules, on the basis that this would provide investors with additional important information on actual electricity generation capability of a product in a representative range of climates. It would also open possibilities for product differentiation, which the peak-power value does not provide. The IEC 61853-1 was published in 2011 and the IEC 61853-2 in 2016, with the IEC 61853-3 and -4 published in 2018.

The ESTI laboratory was recently accredited to perform energy rating measurements and will promote its use in industry during 2020.

Although the standard series has just been completed, JRC is working towards the incorporation of bifacial module designs, and possibly also BIPV products, within the IEC 61853 standard series. This work will be supported by the results obtained within the PV Enerate project, which is a EURAMET project under the European Metrology Programme for Innovation and Research (EMPIR) programme, co-financed by the Participating States and by the European Union's Horizon 2020 research and innovation programme. The mission of EURAMET is to develop and disseminate an integrated, cost effective and internationally competitive measurement infrastructure for Europe. EMPIR coordinates research projects to address grand challenges, while supporting and developing the SI system of measurement units. There is an increased focus within EMPIR on innovation activities to target the needs of industry and accelerate the uptake of research outputs. The programmes capacity-building projects aim to bridge the gap between EU member states with emerging measurement systems and those with more developed capabilities. Intercomparisons of the calculation of climate specific energy ratings will also be performed as part of the PV Enerate project.

([13]) COM(2018) 686, The annual Union work programme for European standardisation for 2019

c) Reliability and Lifetime

This topic had been partly addressed in 2016 focussing mainly on the revision of the PV type approval standard series IEC 61215, which now combines more stringent requirements with a broader technology scope and technology specific parts for:

- IEC 61215 Part 1-1: Special requirements for testing of crystalline silicon photovoltaic (PV) modules
- IEC 61215 Part 1-2: Special requirements for testing of thin-film Cadmium Telluride (CdTe) based photovoltaic (PV) modules
- IEC 61215 Part 1-3: Special requirements for testing of thin-film amorphous silicon based photovoltaic (PV) modules
- IEC 61215 Part 1-4: Special requirements for testing of thin-film Cu (In,GA)$(S,Se)_2$ based photovoltaic (PV) modules

Although the 2016 editions were a major improvement in consolidating under the IEC 61215 series the type approval testing procedures previously dealt with by separate standards (IEC 61215 and IEC 61646), some issues were not covered at the time. The goals for 2020 are the continued preparation of new editions to the standards to incorporate specific issues of testing flexible PV modules and bifacial modules. Where appropriate, additional tests will be incorporated in the IEC 61215 standard series to cover specific failure modes (for example Potential Induced Degradation).

Compliance with the type approval is expected to ensure low failure rates in PV products entering service. Concerning degradation and useful lifetime, manufacturers are increasingly using long-term degradation rates as a marketing tool, but as yet there are no standard tests to substantiate these claims in reliable and transparent ways. This is an issue of key importance for investors, as it impacts directly the expected financial returns. JRC will continue to support international collaborative efforts to establish appropriate protocols in this area via the International PV Quality Assurance Forum.

In 2017 IEC TC 82 launched an activity (IEC TS 63126 Guidelines for qualifying PV modules, components and materials for operation at higher temperatures) aiming to determine how to modify existing standards to take into account operation at higher temperatures (e.g. desert applications or module integration in buildings), which would lead to module or component temperatures above 90 ˚C. The IEC TS 63126 is expected to be published before 2020-11.

In 2018 IEC TC 82 launched an activity (IEC TS 63209 Extended-stress testing of photovoltaic modules for risk analysis), intended to provide data for qualitative reliability risk analysis, highlighting potential failure modes, areas for improvement, and evaluating process changes. It utilises a series of documents describing various testing protocols. It is not intended to be used for service life prediction and, despite the use of quantitative data, is only useful for rank ordering modules and materials for special cases, for very large differences in performance, or with respect to specific understood failure modes and mechanisms. A robust module level rank ordering or service life prediction is beyond the scope of this document. The IEC TS 63209 is expected to be published before 2020-12. Additionally a project has been initiated (IEC TS 63209-2) to expand the extended testing to the component or mini-module level to adequately test for the UV doses expected from long-term field exposure.

d) Module Electrical Safety

A range of safety issues, including the use of voltage up to 1500 VDC, have been incorporated in the revision of the PV module safety standard series (IEC 61730 edition 2), which was published in 2016. Amendments to both IEC 61730-1 and -2 are ongoing to address specific weathering of components and to incorporate bifacial modules. This is currently being discussed by TC 82 WG2 and should progress through 2020. The two amendments are likely to be published toward the end of 2020 or early 2021.

e) PV Products for Buildings

The publication of the photovoltaics in buildings standards EN 50583-1 and EN 50583-2 at the beginning of 2016 was a major step forward. Further work on items specific to BIPV in CENELEC TC 82 depends on the feedback on these from users and other stakeholders. As part of the Frankfurt agreement both the EN 50583-1 and EN 50583-2 were transmitted to IEC TC 82 for their consideration for future work. This entailed forming project team PT 63092, which based much of its work on the existing EN 50583-1 and EN 50583-2 and consolidated the other BIPV activities within the PT 63092. Experts in the project team are

drawn from all of TC 82 with experts from ISO and the IEA. CDV's of the IEC 63092-1 and IEC 63092-1 are currently circulating to the NC's. The IEC TS 63092-1 and -2 are expected to be published before 2020-12.

It is noted that several general issues regarding use of PV in the built environment remain open. The Energy Performance of Buildings Directive (EPBD) 2010/31/EC includes standards for assessing the output of energy generating systems. Specifically, calculation of the PV energy contribution to building performance is covered by EN 15316-4-3. However, application of the method requires location-specific data, and Member States are responsible for reference climatic data, which may not always be available. Overall, while the EPBD requirements establish a framework, many details need to be clearly defined (e.g. system performance factors and degradation effects).

There are specific documents related to safety in building installations like the technical report CLC/TR 50670 "External fire exposure to roofs in combination with photovoltaic (PV) arrays - Test method(s)".

Development on such aspects will be monitored via JRC colleagues working on Eurocodes and other standards relevant to building energy efficiency and structural safety.

The JRC will hold a workshop entitled "Bringing the BIPV ecosystem together: building links between the BIPV sector, policymakers, municipalities and the construction sector" in spring 2020.

f) Ecodesign, Energy Labelling, Ecolabel and Green Public Procurement policy tools

Following the final publication of recommendations from the preparatory study, the EC will decide whether or not to continue and proceed in the consultation with Member States for the implementation of the policy tools to PV products.

Depending of the decision taken the JRC has competence in several relevant aspects including energy yield assessment, operational lifetime and life cycle analysis to support such a consultation phase.

List of abbreviations and definitions

AIST	National Institute of Advanced Industrial Science and Technology
BOS	Balance of Systems
CD	Committee Draft
CDV	Committee Draft for Vote
CEN	European Committee for Standardization
CENELEC	European Committee for Electrotechnical Standardization
CPR	Construction Product Regulation
CPV	Concentrator photovoltaic
DTS	Draft Technical Specification
EC	European Commission
EEA	European Economic Area
ESTI	European Solar Test Installation
ETSI	European Telecommunications Standards Institute
EU	European Union
EU28	European Union 28 member states
EURAMET	The European Association of National Metrology Institutes
FDIS	Final Draft International Standard
IEA	International Energy Agency
IEC	International Electrotechnical Commission
IEC/TS	International Electrotechnical Commission / Technical Specification
IECRE	IEC System for Certification to Standards Relating to Equipment for Use in Renewable Energy Applications
ISO	International Organization for Standardization
ISOS	International Summit on Organic Photovoltaic Stability
ITU	International Telecommunication Union
JRC	Joint Research Centre of the European Commission
JWG	Joint Working Group
PV	Photovoltaics
NREL	National Renewable Energy Laboratory
OPV	Organic Photovoltaics
PNW	Proposed New Work
PNW/TS	Proposed New Work/Technical Specification
prEN	project European standard
PTB	Physikalisch-Technische Bundesanstalt
PVQAT	International Photovoltaic Quality Assurance Task Force
QA	Quality Assurance
RES	Renewable Energy Sources
SET Plan	Strategic Energy Technology Plan
TC	Technical Committee
TS	Technical specification
TR	Technical report
WG	Working Group
WTO	World Trade Organisation

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KJ-NA-30115-EN-N

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doi:10.2760/37907

ISBN 978-92-76-16863-8