TC82/Sec00192/INF

BUSINESS PLAN

CENELEC/TC or SC	Secretariat	Date
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TC or SC title: **Solar photovoltaic energy systems**

A Background

Technical Committee 82 (CLC/TC 82) initiated its activity in CENELEC in 2002 and has met regularly.

The standardization activities of CLC/TC 82 are currently made by two working groups:

WG1 - Wafers, cells and modules

WG2 - BOS components and systems

The scope of CLC/TC 82 is to prepare standards for systems of photovoltaic conversion of solar energy into electrical energy and for all elements in the entire photovoltaic energy system. In this context, the concept "photovoltaic energy system" includes the entire field from light input to a solar cell and including the interface with the electrical system(s) to which energy is supplied. The scope is, then, the same as IEC TC82 but it is related to European standards taking into account the European Directives.

The standardization activities of CLC/TC 82 foresee, amongst others, the endorsement of IEC TC82 standards, in the frame of the cooperation with IEC. Modifications of IEC standards are made, if necessary, to take into consideration special European needs or European Directives. Moreover, European standards are developed when there are urgent requirements from the European market and/or European Directives. After their publication, these European standards, in the frame of the cooperation with IEC, are submitted to the IEC/TC82 as committee draft for vote (CDV).

Furthermore, CLC/TC 82 activities are developed in order to achieve standards complying with national legislation but meeting European legislation and market needs, thus avoiding "barriers" within Europe in this time of expansion. The role of CLC/TC 82 is also aimed at the supervision of IEC standardization activities during the preparation phase, just to adopt timely the standards which are necessary but complying with EU Directives.

CLC/TC 82 is participated by **26** NC’s members (AT, BE, BG, CY, CZ, DK, FI, FR, DE, GR, HR, HU, IE, IT, MT, NL, NO, PL, PT, RS, SI, ES, SE, CH, TR, GB) and 9 Observers (EC, Georgia, Montenegro, EUROPACABLE, CLC/TC 8X, CLC/TC64, CEN/TC 127, CEN/TC 128, CEN TC 129).

NOTE: It is recognised that there will be common areas of interest between TC 82 and other technical committees in CENELEC and also in CEN. Therefore, all interested parties should be vigilant for such overlapping interests and be prepared to share expertise and to avoid conflicts and duplication of effort.

B Business Environment

B.1 General

Photovoltaic (PV) technology is still a relatively new technology that challenges the conventional approach to energy sources and power systems (e.g. fossil fuel powered generators, transmission lines and grid extensions). In the last decades this technology has begun to receive world-wide acceptance. PV has already proven to be cost effective in many off-grid applications and has become in several cases an important source of alternative energy generation for Utilities. Development of new technologies within the PV sector is continuing for further greater efficiencies and lower costs.

The large scale centralized PV power stations, typically owned or operated by Utilities or other power Providers, are continuously increasing their power capability and the supply of grid services, and thanks to that, certainly this sector will be one major driver of PV systems in the future. In addition, roof mounted PV plants continue increasing their capability to supply distributed energy to the electric distribution grid.

Moreover, stimulations of EU politics and, as consequence, of national decisions indicate in the use of RES and, above them mainly the photovoltaic plants, the measure to reduce CO_2 emissions and the use of fossil fuels.

In this perspective, a great increase of installed PV plants has been already registered in Europe, due to the national incentives but also for the economic convenience of this energetic resource.

The International Energy Agency's Photovoltaic Power System Programme's latest report found that 98 GW of PV solar were installed globally in 2017 -- bringing the installed global photovoltaic capacity to at least 402.5 GW (at least 70 times higher than in 2006). China, the USA, India and Japan represented the largest markets in 2017 accounting for more than 80% of the additional installed capacity in these four countries alone. That equates to producing 500 TWh of solar power each year which is roughly the 2 % of the world's electricity generation.

Finally, with declining prices in the last few years, PV has appeared on the radar of policymakers in charge of energy policies in numerous countries and plans for PV development have increased rapidly all over the world. With dozens of countries developing PV now, and much more to come, the globalisation of PV is now a reality.

Moreover, several Asian countries have announced their intention to continue developing PV, but the market size remains the question. In the USA, the policy choices of the new administration could have consequences on the PV market in the coming years, but the extent is unknown. In Europe, the picture is more contrasted with a complex process of transitioning from the current financially supported markets to a more competitive PV market. In emerging countries, the potential for solar PV deployment is gigantic, but so are the challenges. All these elements considered together could propel the future PV market to new heights, but under the condition of continuous support.

The significant increase of PV installations has led also to the growing need to adapt IEC standards and/or to develop European standards for their compliance with European Directives. This compliance is being careful managed by CCMC though a successful cooperation with the EU consultant.

Another important need for developing European standards is coming from the presence in Europe of the very vital sector of Small and Medium Enterprises (SMEs), that calls for a special approach in standardization (simpler, minimum effort, essential/easier application which requires more guides than huge standards).

B.2 Market demand

Basic standards written within the IEC TC82 and/or CLC/TC 82 are for design qualification and type approval of flat-plate modules and concentrator PV devices. These basic standards are used by qualification testing laboratories throughout the world in testing product submitted by manufacturers who wish to enter the PV market place. Included in the basic standard, realm are safety standards associated with flat-plate and CPV modules, while a relevant importance are reaching the standards related to the maintenance of PV plants . Obviously, manufacturers in the PV sector are customers who take advantage of these standards as well as the supporting standards that determine methods of testing, simulator spectrum requirements. Included in users are teaching and research universities and colleges, government laboratories, and others with an interest in the PV technologies.

There is also a need for standards to support opening the market to new actors, and new forms of business, offering new services and improved quality of the electricity supply. In general, there is a demand for standards that comes from:

- PV manufacturers,
- test laboratories,
- PV installers,
- electric utilities,
- energy planners,
- National authorities.

The customers of CLC/TC 82 standards need also guides in order to correctly utilize the European standards, but also to efficiently increase the knowledge in such new generation systems.

The CLC/TC 82 publications are often mentioned at regional/national/European level and are widely used in trade between European countries and as the basis for contracts. Often the CLC/TC 82 publications are in support of laws and regulations, particularly for the application of the essential requirements of EU Directives.

B.3 Trends in technology

Crystalline silicon photovoltaic modules are still the dominant commercial type, while thin-film photovoltaic modules maintain a substantial market, with CdTe being the main thin-film technology and CIGS appearing to increase its market share; other PV technologies (like as organic and dye sensitized PV cells) are still not such as to enter the market.

Applications for thin-film modules include building facades, which serve as architectural features as well as power producing elements, and other types of Building Integrated or Building Applied PV product.

The PV modules and the other components of PV systems (the so-called Balance of System or BOS) are increasing their reliability to convert the solar energy into useable power for the application and/or the electric grid integration. Trends of PV components' behaviours are perceptible in the following features:

- most crystalline modules have established a respectable track record, and many thin-film technologies are increasing quickly their reliability;
- the PV system design is becoming rather good, even if in some cases the inadequate design constitutes the source of many problems and, consequently, a reduction of energy production;
- the reliability of the balance of systems components is increasing, although several failures occur during component lifetime, especially in the power electronics;
- the increase of the technological capacity of power electronics, together with the accumulation of energy and the data communication with the network operator, are providing new opportunities for more efficient, diverse, cost-effective and "dispatchable" power from PV plants.

Major Energy Operators have recently recognised the industrial potentiality of PV plants and are significantly, integrating them into their product portfolio. This increase in the global PV demand and production capacity indicates an industry poised for a sustained and significant growth, contributing to the global economy. The trends in PV technology at European level reflect those at international level, with a particular focus on the interface to the electric grids, especially concerning devices, protection systems and services for the grid.

The substantial increase of the solar power in the European electric energy scenario requires special care. With the reached relevant PV share and the weather / time related availability, major attention has been paid for the PV source integration into the electric grid, through for instance Demand Side Management and Storage Solutions. In this context, the area of smart grids requires the development of suitable equipment and devices to connect properly PV systems to the grid, in particular as regards to the characteristics and related performance of the inverters.

In addition, the increased popularity of solar applications in buildings, with use of BIPV (Building Integrated PhotoVoltaics), photovoltaic modules used as construction products whose needs to comply with the essential building requirements as specified in the European Construction Product Regulation CPR 305/2011 (ref. EN 50583-1:2016, EN 50583-2:2016).

About the global energy data, at the end of 2017 the PV represents around 2,1% of the global electrical energy demand. In several countries, the PV contribution to the electricity demand has passed the 1% mark with Honduras in the first place with 13%, Germany in second place with close to 7,5%, Greece third with an estimated 7,3% and Italy fourth at a similar level. The overall European PV contribution amounts to close to 4% of the electricity demand. Japan reached the 5,9% mark in 2017 and China reached 3% (ref. "2018 Snapshot of global photovoltaic markets" Report IEA PVPS T1-33:2018).

B.4 Market trends

The global PV market grew significantly, to at least 98 GW in 2017, compared to 76 GW in 2016. This represents a 29% growth year-on-year. This year confirmed the strength of China's growth that now accounts for 32% of the global installed capacity and 54% of the PV market in 2017. China installed 53 GW in 2017 and is the leader in terms of total capacity with 131 GW. Asia ranks first for the fifth year in a row with around 75% of the global PV market; up from 67% last year. Outside of China, the global PV market grew from 41,5 GW to 45 GW.

Currently, crystalline silicon technologies account for more than 90% of the overall cell production and more than 94% in the IEA PVPS (PhotoVoltaic Power System program) countries. Thin-film modules used to have lower conversion efficiencies than basic crystalline silicon technologies but this has changed in recent years. Today they are potentially less expensive to manufacture than crystalline cells. Amorphous (a-Si) and micromorph silicon (µ-Si) used to have a significant market share but failed to follow both the price of crystalline silicon cells and the efficiency increase of other thin-film technologies.

Photovoltaic modules are typically rated between 40 W and 400 W with specialized products for building integrated PV systems (BIPV) at even larger sizes. wafer-based crystalline silicon modules have commercial efficiencies between 14 and 24,1%. Crystalline silicon modules consist of individual PV cells connected together and encapsulated between a transparent front, usually glass, and a backing material, usually polymer foils or glass. Thin-film modules encapsulate PV cells formed into a single substrate, in a flexible or rigid module, with transparent plastic or glass as the front material. Their efficiency ranges between 7% (a-Si) and 18,1% (CdTe). CPV modules offer now efficiencies above 38%.

Crystalline silicon will continue to be the dominating technology of annual sales. However Thin- Films is slowly enhancing their sales in those applications where their additional costs and space requirements can be accepted (and also CPV is a technology which is having interesting developments). Other PV technologies are not present in the market.

B.5 Ecological environment

As it is known, along the entire life cycle of photovoltaic systems, their impact on the environment is generally minimal, due to:

- the energy consumption for the module manufacturing processes is low, while the related production of waste and pollution in general are very reduced;
- during their daily operation, the PV systems have no moving parts that create objectionable noise nor create waste effluent or residue for disposal.

For these reasons, PV is one of the most attractive of the renewable energy sources from the environmental point of view.

Continuous improvement of the environmental performance of PV devices (i.e., use of new materials, phase-out of materials currently in use) needs to be considered and addressed through application of holistic life cycle assessment. This will allow evaluating and validating potential alternatives for material substitutions and further reduction of potential environmental hazards, which need to be evaluated and assessed through accepted risk assessment methodology for all existing technologies and future developments. For example, most module technologies are still containing heavy metals (i.e., Lead in solders and metallization pastes, Lead in batteries of BOS components, etc.).

The use of chemicals and potentially harmful substances in the production process and the recycling of production scrap as well as production chemicals will need to be addressed. In addition, the issues of environmentally acceptable packaging materials, visual pollution, and electromagnetic interference (EMI) are being examined. In particular, at European level, all the Directives (e.g. WEEE, EMC and LV) have to be followed; therefore, demanding standards that will take into account the regulatory requirements. These activities should be examined in cooperation with other TCs (i.e. WG 6 of TC111X, which is currently developing take back and recycling standards for PV Modules).

ISO and CEN standards on environmental management systems will be also examined in the future for applicability to PV modules, components and systems, requiring also complying with the requirements of "Performance evaluation" and/or “Life Cycle Assessment" sections.

B.6 Involvement of societal stakeholders

The Stakeholders in the PV sector are mainly Manufacturers of photovoltaic modules, Installers, Designers, various associations, Test laboratories, Certification bodies, Utilities, both Government organizations and authorities at national and European level, each of these actors to their expertise and interest.

The involvement of such entities is already on an ongoing basis by the standardization activity of the Technical Committees at National and European level, but also through the media. The involvement of the actors is of course pushed by European Directives, related national laws and legislative decrees.

B.7 Involvement of SMEs

Photovoltaic systems are often suited to be designed, installed and maintained by Small / Medium Enterprises (SMEs). For this reason it seems very appropriate the involvement of these entities in the work of standardization in the various European countries.

On the other hand, the development of technical guides for the standardization of design and installation of PV plants could be a driving factor in the PV business of SMEs.

In this context, it is important the role of National Technical Committees that should take steps to promote domestic conferences and relevant training courses to encourage a wide participation of SME specialists.

C System approach aspects

Photovoltaic system designs require extensive experience in many electrical and electronic aspects. Therefore, the system approach for CLC/TC 82 standard development should be the continuous connection with other Technical Committees at European and national level. This cooperation could be deployed even through joint working groups and should consider both the role of customer and of supplier.

The liaisons with IEC Technical Committees represent also an important means for the preparation of standards shared at European and international level.

Furthermore, the connections with additional standardization entities (e.g. IEEE, ASTM, UL) could supply a wider perspective to afford the increasingly large problems in PV systems.

Besides that, the involvement of national enterprises associations and national authorities are certainly critical success factors for the development of adequate standards.

Connections of CLC/TC 82 for coordination of standardization work are active with:

- CLC/TC 8X (System aspects of electrical energy supply)

- CEN TC 127 (Fire safety in buildings),

- CEN/TC 128 (Roof covering products for discontinuous laying and products for wall cladding)

- CEN/TC 129 (Glass in building)

- CLC/TC 64/JWG TC 82 (Installation of PV – Equipment)

D Objectives and strategies (3 to 5 years)

Continued maintenance on existing standards and development of new standards will be undertaken by the two working groups of the CLC/TC 82, in cooperation with the related WGs of IEC/TC 82.

It is expected that new standards will be developed in the following topics:

- CPV sun trackers and safety (WG1),
- PV module energy and power rating (WG1),
- Characterization of PV module materials (WG1),
- PV system energy and power rating (WG2),
- Embedded electronics within PV modules (WG1 and WG2),
- additional tests on new technology PV modules, related to new materials and manufacturing processes (WG1); the tests will be deployed once new PV modules have been proven to have met the user expectations of long outdoor deployment and safe operation,
- Maintenance & operation procedures for PV plants (WG2).

E Action plan

All CLC/TC 82 working groups plan the necessary meetings per year (usually once a year). Project teams within the two working groups have been created to facilitate timely completion of the documents. Due to the financial restraints and limitations on time for international meetings, it is expected that more homework will be required to the participating experts and that electronic mail communication will continue to play a much larger role in this work of standard preparation and opinion sharing.

WG1 will continue to develop international standards for wafers, cells and terrestrial photovoltaic modules and for related components. These standards will be in the general areas of electric performance, environmental testing, quality assurance and assessment criteria. WG1 will co-operate with IEC TC82, particularly with its WG2 (Modules, non-concentrating), and WG7 (Concentrator modules) in developing new PV standards and will promote specific European standards, when necessary.

WG2 will continue to develop international standards for BOS components, included the aspects related to the electric grid interfaces of PV systems. These standards will be in the general areas of electric performance, environmental testing, quality assurance and assessment criteria. Moreover, WG2 will cooperate with IEC/TC 82, particularly with its WG3 (Systems) and WG6 (BOS components), in developing new PV standards and will promote specific European standards, when necessary.

To respond to the increasing market and international exchange of PV products, the PV standards being prepared should have a certain flexibility to be able to follow the evolution of the technology. Consideration should also be given to the natural environmental impact issues of manufacturing and disposal of PV products.

F Useful links to CENELEC web site

CLC/TC 82 home page giving access to Membership, TC/SC Officers, Scope, Publications, Work programme [password-protected area]:

https://www.cenelec.eu/dyn/www/f?p=104:7:190962050148101::::FSP_ORG_ID:1258463

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