Brussels, 30 January 2019

Solar photovoltaic modules, inverters and systems:
Comments on review preparatory study draft report Tasks 4 and 5

Comment #	Chapter No. / Section No.	Page #	Selected information subject to the comment	Major/Minor Comment	Comment description	Proposal for modification	Rationale / supporting data
		Specific page or a range of pages	Very brief reference to the title or the object of the comment	Major if it can block our support to the outcome Minor if it is a comment adding information, or will not block our support	What is the problem? What needs to be changed?	What is our proposal for change or further work	It is also possible to upload documents / graphs as supporting evidence for the rationale
1	4.1.1.1.2	pp.6-7	Silicon metal or ultrapure quartz mineral	Major	The report lacks information about silica sourcing. PV module performance grows every year, and so does the market share of monocrystalline technologies. One way to support this increase in performance is to produce silicon using ultra-pure silica. Neither the global resources nor the origin of ultra-pure silica are identified in the report. This is problematic as the end-user should be informed of the availability and conditions of sourcing of the raw materials (sand or quartz) used to produce PV panels.	The global resources of ultra-pure silica available for solar applications should be clearly estimated in the report. The source of ultra-pure quartz should be clearly identified, and the working conditions of workers in mines guaranteed through a label similar to FSC.	
2	4.1.1.2 and 4.3.1	p.7 and p.52	Module design options (BAT)	Minor	Half-cells modules are already available on the market and could be considered as BAT, which is not the case in the current report. These modules are interesting from an environmental point-of-view, as they enable to obtain a higher yield using the same amount of raw materials as regular modules.	Include half-cells in BAT as these should represent 10% of the market in 2020.	Source: ITRPV 2018 http://www.itrpv.net/.cm4all/uproc.php/0/ITRPV%20Ninth%20Edition%202018_1.pdf?cdp=a&_=16224ec6558 Fig.46 p.41: Half cells should represent 10% of the market in 2020

3	4.1.2.4	p.19	Recycling of PV modules - technologies	Minor	The WEEE Directive sets mass-based recycling targets. The aluminium frame and front- glass sheet are the heavy parts in a PV module, and the current target can be reached without recycling economically valuable metals such as silver.	The section could highlight the value of silver recycling and document available processes to perform it.	
4	4.1.2.5	p.21	Summary and reference data on the performance and cost of the products and technologies described.	Major	Some manufacturing processes present environmental benefits and should be promoted: -Fluidized Bed Reactor (FBR), is an alternative to Siemens Reactor for polysilicon production, which consumes less electricity. -Diamond Wafer Sawing (DWS) is an alternative to slurry-based wafering (which still represents 50% of the market for multi-Si). It reduces kerf loss by 30%, and so directly reduces material and energy consumption.	Include these processes in the report as promising alternatives from an environmental point of view.	Source: International Technology Roadmap for Photovoltaic, ITRPV, 2017 results. The document is available online: http://www.itrpv.net/.cm4all/uproc.php/0/ITRPV%20Ninth%20Edition%202018_1.pdf?cdp=a&_=16224ec6558 See in particular Figure 3 on page 7 for FBR: Siemens reactor is nearly 90% of the market share in 2018. And figure 21 p 21 for DWS: Kerf loss from slurry-based is about 125 µm and from diamond wire sawing about 85 µm, so there is a reduction of 40 µm between the two technologies (or 30% less).
5	4.1.2.5	p.22	Table 2 Power Temperature Coefficient (%/°C)	Minor	There is an error for the base case for Power Temperature Coefficient (%/°C): it should be -0.40 and not -40	Correct the typo.	
6	4.1.2.5	p.22	Table 2 Compatible with epitaxial wafer	Minor	Silicon epitaxy processes in industrial settings present serious fire hazard.	The report should consider the fire hazards linked to silicon epitaxy processes.	
7	4.1.2.5	p.22	Table 2 Compatible with Pb-free metallisation	Major	Photovoltaics are currently not covered by the RoHS Directive, and therefore there is an opportunity to	Lead-free soldering should be considered more in depth and	

					promote lead (Pb) - free modules through Ecodesign. The report does not currently emphasize this, and Table 2 does not show the advantages of lead-free modules.	promoted throughout the report.	
8	4.1.2.5	p.22	Table 2	Major	Table 2 is not clear enough: it is unclear which of the technologies presented are BATs, and which processes should be promoted.	Consider reworking the table.	
9	4.1.4.1	p.26	Inverter performance and energy efficiency	Minor	MPPT efficiency is not the right parameter to measure the performance of the inverter.	European efficiency (euro-efficiency) should be the criterion to measure the performance of the inverter.	EN 50530
10	4.1.4.1	p.27	Categories of inverters 2. Microinverters	Minor	Temperature resistance of MLPE is a critical parameter to consider. As the modules are installed on roofs, considering the temperature resistance helps preventing degradation, reduced lifetime or adjusting the conditions of the guarantee.	The operating temperature range of MLPE should be aligned with temperature observed on roofs (usually there is no guarantee that the system can work above 65°C).	The datasheet of IQ7+ from Enphase shows an operating temperature range up to 65°C: https://enphase.com/sites/default/files/downloads/support/IQ7-IQ7plus-DS-EN-US.pdfThe datasheet of optimizers OPJ 300- LV from Solaredge shows an operating temperature range up to 85°C: https://www.solaredge.com/sites/default/files/se-pb-csi-datasheet.pdf
11	4.1.4.3	p.34	‘Base Case’ 2 – BC2	Major	The proposed 20 kW for Base Case 2 is not representative of a median PV system installed in Europe, and 100 kW would be much more representative. The European market segmentation proposed by SolarPower Europe defines 4 categories, and the base case 2 corresponds to the commercial + industrial segments, in which PV power can be much more important than 20 kW.	Base Case 2 should be a 100 kWp transformer-less three-phase string inverter.	See SolarPower Europe / GLOBAL MARKET OUTLOOK FOR SOLAR POWER 2018-2022, available through this link: http://www.solarpowereurope.org/global-market-outlook-2018-2022/ *“In 2017, around 26% of solar systems were installed on residential rooftops, around **18% on commercial roofs, while the industrial segment accounted for 20%** and the utility market for 36%.”* Figure 27 p.72

12	4.1.4.3	p.34	'Base Case' 3 – BC3	Minor	Mention that power for BC-3 is 1500 kW AV (found in task 5).	Add power for BC 3 (1500 kW AV)	
13	4.1.4.3	p.35	Table 5 BC1-MLI (module level converter)	Minor	The wide supply of module level inverters for residential systems is very recent on the market (5 years of less) and their long-term performance has still to be proven, especially because these are electronic installed on roofs and there are concerns linked with the temperature as developed previously. This kind of technology cannot be considered as a base case because of insufficient feedback.	Remove BC1-MLI from the Base Cases.	
14	4.1.4.3	pp.35-36	Table 5 BC1-repair (repaired) Table 6 BC2-repair (repaired)	Major	When an inverter fails, the main consequences are production and revenue losses triggered by the standard exchange time. If some critical components (e.g. cards of condensers) were placed in racks, repair would be easier and faster. This should be reflected in Task 5, and the on-site repairability of PV systems should be promoted. In tables 5 and 6, we wonder if the failure rate for BC1- repair and BC2-repair is overestimated and should be lowered.	Consider lowering the failure rate of BC1 and BC2-repair in tables 5 and 6. The report should consider design options enabling repairability.	Report on technical risks in PV project development and PV plant operation Solarbankability 6.2.2 p.63
15	4.1.5.4	p.42	Solar Trackers	Major	Single-axis trackers are reported to increase the yield by up to 25%. This value is not representative of improvements achievable in France for example, which are closer to between 5 and 15%.	A 10% yield increase would be more appropriate, as it would take into account more frequent failures.	Energy production estimation realised by PVGIS interface, for a 100 kWp system located in Strasbourg, shows a yield increase of 13,5% for single-axis tracking compared to fixed-tilted system: 1110 kWh/kWp if 30° south 1260 kWh/kWp if single-axis tracking
16	4.1.5.6	p.43	Base Case BC 2	Major	Same comment as for 4.1.4.3: From a PV-system point of view, there is no significant difference between 3 and 20 kW. The "commercial" case (BC2) should at least be 100 kW to be more significant.	Base Case 2 should be a 100 kWp transformer-less three-phase string inverters.	

17	4.1.5.6	p.43	Base Case BC 3	Major	Task 1 excludes large transformers from PV system scope because they are subject to a specific Ecodesign regulation. Nevertheless, grid connection requires high voltage for high power, so transformers should be taken into account in some way to calculate the environmental impact of large PV systems (unless the energy produced cannot be used). Transformers are currently missing in the assessment of large PV systems and their environmental impact should be considered, in order to compare the environmental relevance of producing solar electricity from industrial-scale systems vs producing it from small roof systems.	Include transformer loss and report environmental impacts of transformer for high voltage PV systems.	Data can be extracted from the Ecodesign study on transformers.
18	4.1.5.6	p.44	Design improvement options identified as potential candidates for BAT : BC-des	Minor	A production simulation should be delivered to every customer before purchase, as well as a system documentation as mentioned in IEC 62446-1 standard.	Give a more precise definition of BC-des.	
19	4.1.5.6	p.44	Design improvement options identified as potential candidates for BAT: BC-mon	Minor	This BAT should be promoted as systematic monitoring improves PV production throughout the year. This option should be defined further, and it could become mandatory to include a communication card in the inverter.	Promote this BAT as it enhances production and reflect on the possible mandatory inclusion of a communication cards.	
20	4.1.5.6	pp.44-45	Table 10 Table 11 Maintenance	Minor	Performing regular maintenance of PV systems for commercial and industrial scale (once a year) improves their lifetime and performance	Promote the regular maintenance of PV systems as a best practice.	
21	4.1.5.6	p.45	Table 11 Performance Ratio (PR)	Minor	PR for large utility scale systems is above 0.8 because it is driven by financial performance	Include 0.8 instead of 0.75 in the table.	Task 3 3.1.6 Table 12 p.36
22	4.1.6.1	p.45	BIPV	Minor	In relation to the performance of BIPV the study should mention that lower performance can be tolerated because of their multi-functionality,	Add this nuance about the performance in the paragraph.	

					at least taking into account the performance of the building component they replace. These cannot be expected to perform as a standard PV module mounted in a ground system.		
23	4.2.1.2	p.49	Base case central inverter	Major	It is not realistic to extrapolate the BOM for 20 kW inverters to a 1500 kW inverter.	Reconsider this hypothesis.	
24	4.2.1.3	p.50	Table 12	Minor	As mentioned in 4.1.1.1.1, reference thickness of Si wafers is 180 µm, so the base case for multi-Si should be based on a 180 µm wafer.	Change the Wafer thickness (micrometer) for Multi Si from 200 to 180.	
25	5.1.1.1.	p.9	Selection of base cases	Major	It is commonly agreed that existing standards such as EN 61215 do not validate a 30-year lifetime for modules. If the environmental impact of PV panels is calculated based on the hypothesis that PV modules have a 30-years life span, it should be verified if this hypothetical lifespan is realistic in real-use conditions.	Modules manufacturers could be required to test the modules in line with real-life conditions. These tests should be performed by an authorised third party and a minimum import volume above which this extra testing would apply should be defined.	Example of extra-testing description: J.Wohlgemuth, S.Kurtz, Reliability Testing beyond Qualification as a Key Component in Photovoltaic's Progress Toward Grid Parity, NREL, 2011 Qualification Plus Performance and Durability Tests Beyond IEC 61215 – NREL https://www.nrel.gov/docs/fy14osti/61518.pdf Photovoltaic Module Qualification Plus Testing - NREL/TP-5200-60950 December 2013 https://www.nrel.gov/docs/fy14osti/60950.pdf PV Durability initiative from Fraunhofer https://www.ise.fraunhofer.de/en/press-media/press-releases/2013/first-pv-durability-initiative-report.html
26	5.1.1.1.	p.9	Table 1 Performance Ratio	Minor	Where do the performance ratio values come from?	Specify the source of the performance ratio values	

						presented in the table.	
27	5.1.1.1.	p.9	Table 1 Base-Case 2	Major	As stated in earlier comments related to Task 4, from a PV-system point-of-view, a 100 kWp power would be more representative of a "commercial" system.	Base Case 2 should be a 100 kWp transformer-less three-phase string inverters.	
28	5.1.1.1.	p.9	Table 1 Base-Case 3	Major	Task 1 excludes large transformers from PV system scope because they are subject to a specific Ecodesign regulation. Nevertheless, grid connection requires high voltage for high power, so transformers should be taken into account in some way to calculate the environmental impact of large PV systems (unless the energy produced cannot be used). Transformers are currently missing in the assessment of large PV systems and their environmental impact should be considered, in order to compare the environmental relevance of producing solar electricity from industrial-scale systems vs producing it from small roof systems.	Ensure to include transformer loss in the performance calculation of large PV systems and consider the environmental impacts of transformers for high voltage PV systems.	Data can be extracted from the Ecodesign study on transformers.
29	5.1.1.1.	p.10	Table 2 - System parameters for calculation of functional unit	Minor	Wafer thickness: 180 µm instead of 200 µm is more representative of the average module market (cf previous comment in Task 4).	Wafer thickness of 180 µm instead of 200 µm.	
30	5.1.1.1.	p.10	Table 2 System parameters for calculation of functional unit	Minor	Yield: Please specify if the electrical output is DC or AC.	Please specify if electrical output is DC or AC.	
31	5.1.1.1.	p.11	Table 3 Electricity output system	Minor	The calculation method used to derive the electricity output should be explained here.	Elaborate on the method used to derive the electricity output in this table.	

32	5.1.1.6	p.13	Table 4 CAPEX and OPEX for Base-case 2	Major	The total CAPEX for the 20 kW system is overestimated: it should be maximum 1,7 €/kWp for all expenses. Same goes for the total OPEX range: it should be limited to 10 €/kW per year.	Modify the table as follows: Total CAPEX for 20 kW systems should be 1,7 €/kWp max. Total OPEX for 20 kW systems should be 10€/kW max.	National Survey Report of PV Power Applications in France – 2017 http://www.iea-pvps.org/index.php?id=93 Table 8 P.14 – commercial
33	5.1.1.6	p.13	Table 4 CAPEX and OPEX for Base-case 3	Major	Module prices are overestimated for utility-scale systems: they should be below 0,35 €/Wp instead of the current 0,45 €/Wp. OPEX are overestimated for utility-scale systems: it should be below 5 €/kW/year	Modify the table as follows: Modules prices for utility-scale systems: below 0,35 €/Wp. OPEX for utility-scale systems: below 5 €/kW/year	National Survey Report of PV Power Applications in France – 2017 http://www.iea-pvps.org/index.php?id=93 Table 10 p.16 – utility scale
34	5.1.2.3	p.21		Minor	The study mentions that distribution takes place mostly via air freight. However, shipment of PV modules, inverters etc. is mostly done by sea freight.	Correct this section taking into account that distribution is mostly done via sea freight.	See PEFCR on PV modules p.79: *“Air cargo shipping semi-finished products such as wafers and cells is usually very rare.”* And table 6.3 p.81 for suppliers located outside Europe
35	5.1.2.4	p.21	Table 13	Major	This table should be properly filled in, not refer to Table 1	Please fill in the table in an acceptable way (see proposal in Annex I).	
36	5.1.2.5	p.22	Table 14 EoL mass fraction to (materials) recycling, in %	Major	Extra: The table mentions 60% for the “extra” column (referring to glass). Bulk recycling, implemented in Europe in line with the WEEE Directive, allows to achieve 89% recycling by weight for glass. The total mass fraction for recycling should be above the WEEE Directive requirements.	Recycling rate for glass is more than 85%. This is specified in Task 4	Cf Task 4 - Fig. 4.5 p.21

37	5.2	p.23	Impact Categories	Major	We would like nuclear wastes and materials depletion to also be listed as an impact category. These could be relevant for Ecolabel and GPP in particular.	Add materials depletion and nuclear wastes as impacts categories	Nuclear wastes are taken into account in PEFCR (Product Environmental Footprint Category Rules for Photovoltaics) as environmental additional information.
38	5.2.4	p.31	EcoReport results	Minor	Annex D is missing but there are references to it in the report.	Provide Annex D	
39	5.2.4	p.31	Results Base-Cases for systems	Major	Transformers for high-voltage systems are not taken into account within the scope of PV system for the EcoReport calculation, and this makes the assessment incomplete.	Include BOS within PV system scope for the MEErP EcoReport tool calculation. Transformers should be considered in a consistent way with the LCOE calculation (kWh fed to the grid) because 5% losses need to be taken into account.	
40	5.6.2.2	p.66	GWP gases emissions	Minor	Please find additional sources for information: Technical background information can be found in semiconductor industry : https://www.epa.gov/sites/production/files/2016-02/documents/final_tt_report.pdf Alsema, E.A. & de Wild-Scholten, Mariska & Fthenakis, V.M. & Agostinelli, G & Dekkers, Harold & Roth, K & Kinzig, Volker. (2007). Fluorinated Greenhouse Gases in Photovoltaic Module Manufacturing: Potential Emissions and Abatement Strategies.		Technical background information can be found in semiconductor industry : https://www.epa.gov/sites/production/files/2016-02/documents/final_tt_report.pdf Alsema, E.A. & de Wild-Scholten, Mariska & Fthenakis, V.M. & Agostinelli, G & Dekkers, Harold & Roth, K & Kinzig, Volker. (2007). Fluorinated Greenhouse Gases in Photovoltaic Module Manufacturing: Potential Emissions and Abatement Strategies.

Annex I – Proposal for Table 13 p.21 (Task 5)

	Base-Case 1	Base-Case 2	Base-Case 3
Scale	residential	commercial	utility
Reference yield (hours in year 1) before PR?	1331 kWh/kWp	1331 kWh/kWp	1331 kWh/kWp
Performance ratio (in year 1)	0,75	0,825 Proposal : 0,75 cf task 4 Table 4.10 p.46 but 0,8 in Task 3 3.1.6 Table 12 p.36	0,825 Proposal : 0,75 cf task 4 Table 4.10 p.46 but 0,8 in Task 3 3.1.6 Table 12 p.36)
Performance degradation rate (% per year)	0,7% (modules)	0,7% (modules)	0,7% (modules)
Number of maintenance operations during the lifetime	0 Proposal 3 (1 per 10 years when inverter replacement)	1 Proposal : 30 to 60 (1 per year for preventive maintenance, and additional operations for curative maintenance)	1 Proposal : 30 to 60 (1 per year for preventive maintenance, and additional operations for curative maintenance)

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