Uppdatering om PV-system

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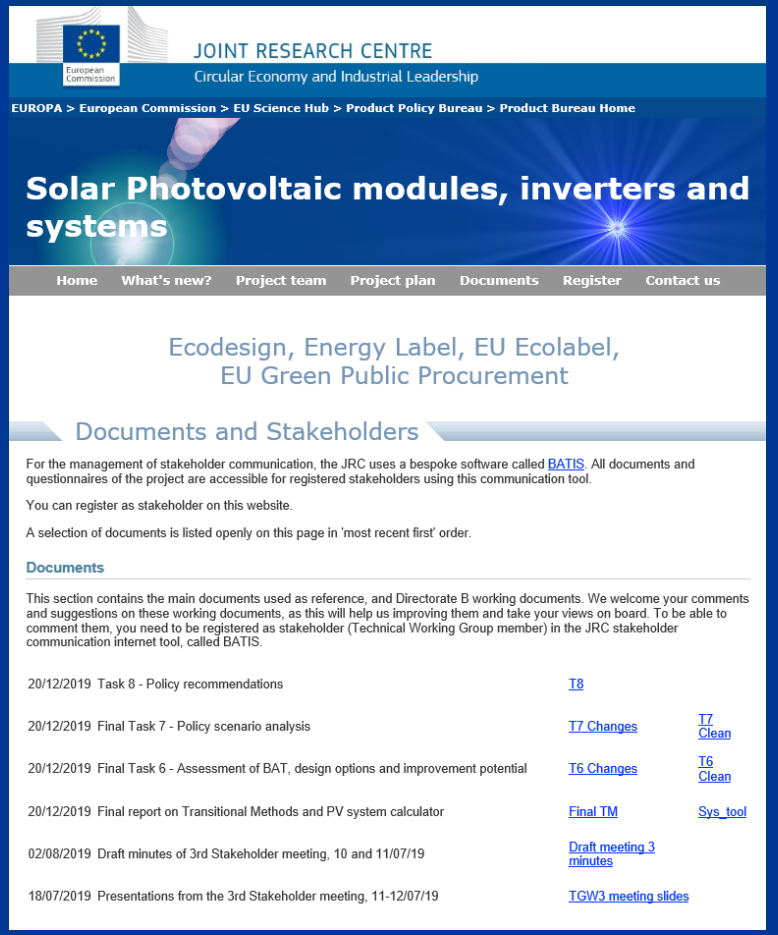
PV and batteries on the ecodesign list

- Treated separately but with connections – e.g. solar systems with batteries
- Not typical ecodesign products:
  - Introduces a ”Functional unit” as the base for the LCA/LCOE and policy options
  - Production phase:
    - Material use, in particular Critical Raw Material (such as rare earth metals)
    - Carbon footprint: local or EU electricity mix? Very important difference!
  - User phase:
    - Carbon footprint: EU electricity mix?
  - Resource efficiency requirements – in line with a Circular economy
    - Quality, Lifetime, Repairability, Recycleability, …
- Lot to learn from off-grid experiences in regions outside EU

PV-panels and inverters

- Link to EU prep study: http://susproc.jrc.ec.europa.eu/solar_photovoltaics/documents.html

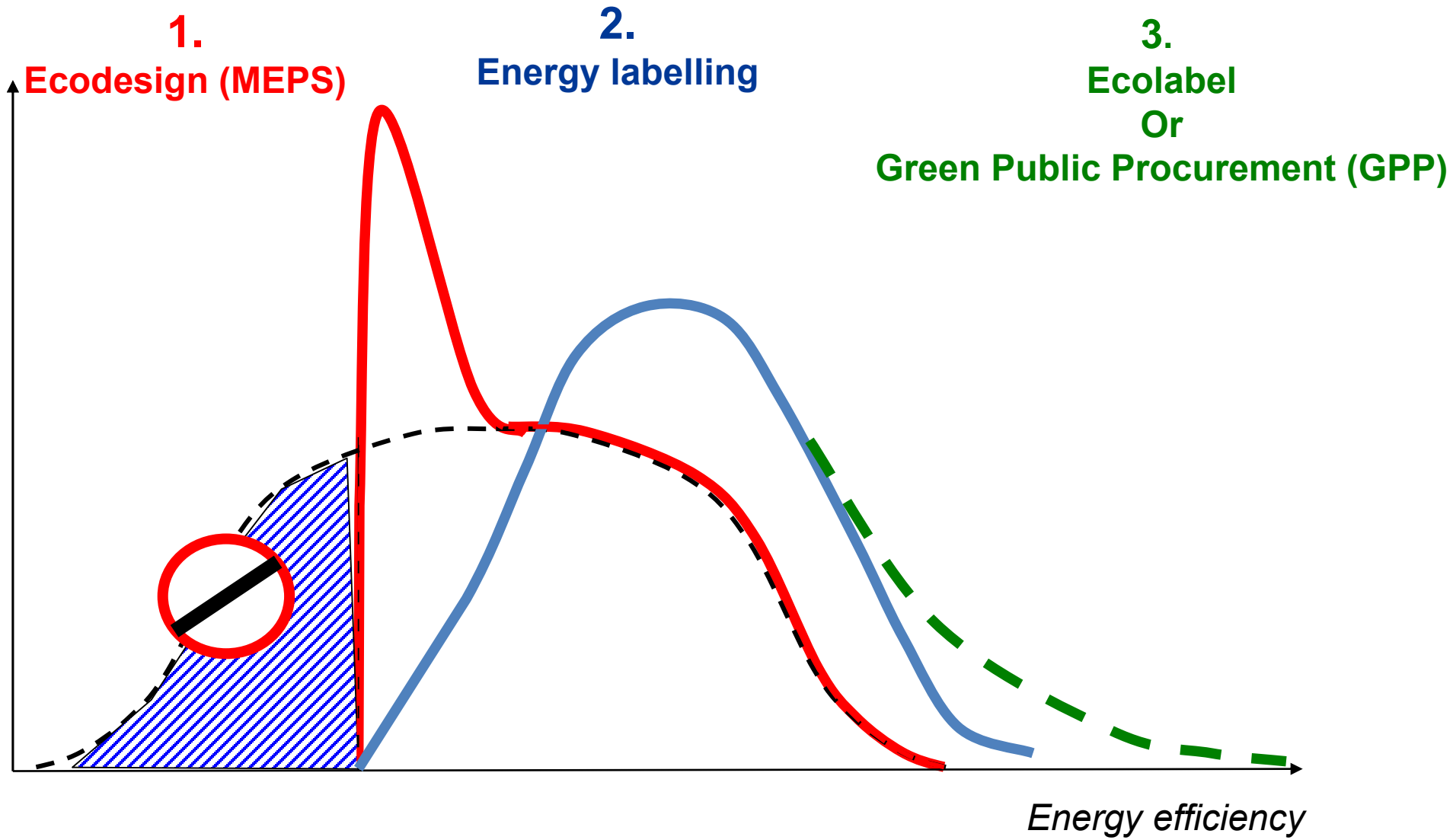
- Timetable:
  - Prep studies ready 2019
    - *See in particular slides from TWG3 in July 2019 and reports T7 and T8 from December 2019*
  - Decision during 2020? Not clear



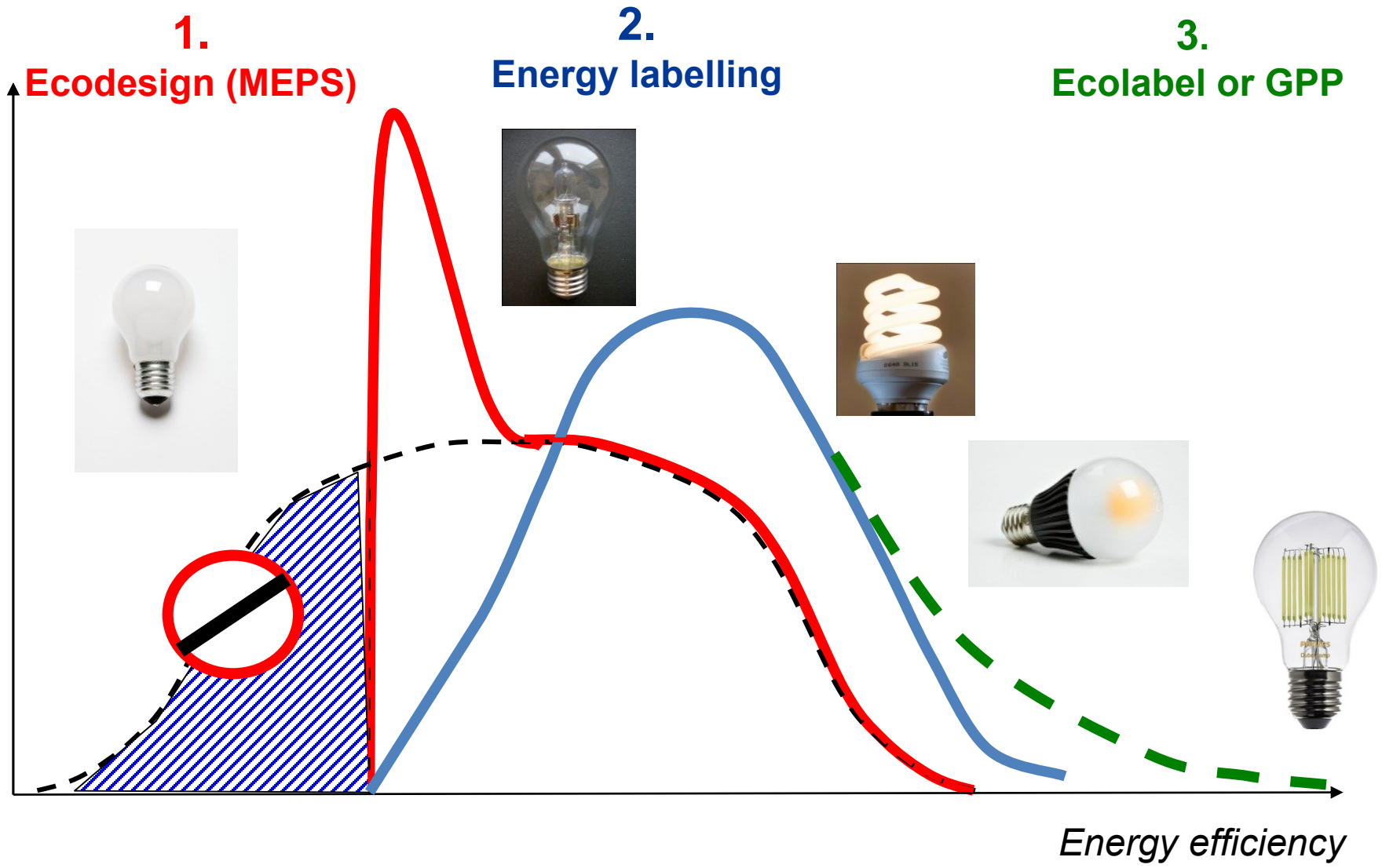
Features of ecodesign and energy labeling

- Base: performance per power or energy unit, such as:
  - Light sources: maximum light output per W, or lumen per W, or lm/W
  - Dish washer: minimum kWh per dish
- Other aspects:
  - Quality parameters such as colour rendering, dish cleaning performance etc
  - Minimum noise, water use etc
- Ecodesign: *minimum* performance
- Energy labeling: *grading* of performance (higher than the minimum performance
- Resource efficiency:
  - Minimum impact during production
  - Repairability, upgradability, recyclability
  - Long lifetime

Accelerating the transformation of the product *market*



Ca 50 products on the list – eg *lighting*



Huge impact of ecodesign and energy labelling

- Delivers *half* of the EU 20 % goal to 2020 for Energy efficiency
- Delivers a *quarter* of the EU 20 % goal of reduced GHG reductions
- Reduces *other* environmental impacts such as emissions of Nox, Hg, particles etc
- Increases the *resource* efficiency – material use, water use (indirectly)
- Increases the *security of supply* – less import of energy in EU
- *Saves money* for companies and households – e.g. ca 500 Euro/hh, yr
- *Defends the market* from poor products
- Stimulates *product innovation*

Important concepts

Policy Instrument	Stringency	Scope	Life cycle stage	Verification
Ecodesign	Mandatory	Products, packages of products	Requirements can be set on tested use stage product performance, Information on material efficiency aspects can be requested	Market surveillance is carried out at member state level.
Energy label	Mandatory	Products, packages of products	Energy Efficiency Index (EEI) shall address performance in the use stage.	Market surveillance is carried out at member state level.
EU Ecolabel	Voluntary	Can be products or services	Criteria can be set on any life cycle stage and can include manufacturing sites as well as tested product performance.	Member State Competent Bodies verify compliance evidence and award the label.
GPP	Voluntary	Can be products or services	Criteria can be set on any life cycle stage and can include manufacturing sites as well as tested product performance. The criteria must always link to the subject matter.	Verification is through evidence from tenderers provided during the procurement process.

MEErP

LCA

Reporting against functional unit

Environment

The environmental impacts are expressed per kWh of electricity generated and reflecting 30 years lifespan. E.g. primary energy (MJ/kWh)

Cost

LCOE is the levelised cost over 30 years of generating the FU. It includes: initial investment (incl. module and inverter costs), operations and maintenance, cost of fuel and cost of capital

Product specific inputs

Functional unit

Modules: 1 kWh DC under predefined climatic and installation conditions for a typical year. Service life: 30 years

Inverters: 1 kWh AC from a reference photovoltaic system (excl. the inverter efficiency) under predefined climatic and installation conditions for a typical year. Service life: 30 years

Systems: 1 kWh AC supplied under fixed climatic conditions for a typical year (with reference to IEC 61853 part 4). Service life: 30 years

	BC1	BC2	BC3	unit
System	3	24.4	1875	kWp
Inverter	2.5	20	1500	kW
Inverter:module DC capacity	1:1.20	1:1.20	1:1.25	
Life span system	30	30	30	years
Life span inverter	10	10	30	years
Inverter units in the LC	3	3	1 (replacement of parts)	unit
Electricity output system	81	662	50862	MWh
Inverter units per kWh	3.69E-05	4.53E-06	1.97E-08	inverters per kWh

	Module parameters
Module Size (m^2/module)	1.6
Module conversion efficiency (%)	14.7
Wafer thickness (micrometer)	200
Cell size (mm^2)	156*156
Technology	Average technology mix of front/back cell connection, diffusion and front collection grid
Main data source	De Wild-Scholten (2014)
Rated power (Wp/m^2)	147
Cells area per module (%)	95.39%
System yield - Yf (in year 1) (kWh_{DC}/kWp)	997
Expected life time (years)	30
Module area per kWh energy produced (m^2)	**2.45E-04**

European Commission

Product specific inputs

Life cycle cost and Levelised cost of electricity

- The MEErP methodology is usually based on an analysis of life cycle cost (LCC). Why LCOE instead of LCC
- Levelised Cost of Electricity (LCOE) is widely used in the electricity sector to express the total life cycle cost of delivering electricity to the grid.
- The difference of LCOE with respect of LCC is that it is normalized to the unit of power generated.

$$LCOE = \frac{CAPEX + \sum_{t=1}^{n}[OPEX(t)/(1+WACC_{Nom})^t]}{\sum_{t=1}^{n}[Utilisation_0 \cdot (1-Degradation)^t/(1+WACC_{Real})^t]}$$

Products and segments

PV products

- Modules
- Inverters
- Systems

Market segments

- Residential
- Commercial
- Utility

Module design options

Design options	Description
Option 1: Optimised multi Si	Optimized BSF modules as of today (2019): - white EVA - more busbars (6) - better glass (AR properties) - factory quality control measures
Option 2: PERC	PERC cells
Option 3: Bifacial + PERC	Bifacial PERC cells and a glass backsheet
Option 4: CdTe	Thin film CdTe
Option 5: CIGS	Thin film CIGS
Option 6: Kerfless old	Epitaxial Si/Ribbon Si
Option 7: SHJ	Silicon heterojunction
Option 8: MSi cleaner cell production	MSi base case module

Module BNAT design options

Option 9: BNAT kerfless new	Kerfless wafer production
Option 10: Back-contact *	Compared to two-sides contacted solar cells, back-contact solar cells have both contact polarities on the rear side which significantly reduces optical losses at the illuminated front side both from cell metallization and cell-to-cell interconnection (task 4 report)
Option 11: Perovskite	Perovskite based thin film PV is not yet in production, but this technology has made remarkable progress in the past few years. Because of its potential of very low-cost production, and its suitable bandgap for tandem formation with crystalline silicon, it could be (or pave the way for) a significant and disruptive technology PV energy generation (task 4 report)
Option 12: Perovskite/Si-tandem	The start-up Oxford PV showed that the tandem configuration has the potential to outperform single junction Si PV with efficiencies over 22%. They have acquired a production facility in Germany targeting tandem pilot production by 2019-2020 (task 4 report)

* Pending manufacturer LCI

Inverter design options

Design options	Description
Residential	
Option 1: more efficient	This design option represents the potential for improvement on the Euro efficiency of the base case
Option 2: longer life time	This design option represents the potential for extension of the design lifetime of the base case
Option 3: repair (repaired)	This design option represents the extent to which a product is designed for repair along its lifetime
Option 4: monitor/smart	This design option represents the potential for monitoring to diagnose and react to faults related to firmware or hardware. It can help additionally the consumer to adjust their demand to increase self-consumption
Option 5: Module Level Converter (MLI)	This design option represents the installation of module level inverters that may increase yield in mismatch conditions
Option 6: Hybrid storage worst performer	These design options represent the installation of inverter with integrated storage to either: - provide peak shaving in feed in (German EEG case). - increase hourly and quarterly self-consumption
Option 7: Hybrid storage best performer	

System design options

Design options	Description
Residential	
System Options	
System Option 1: Multi Si optimised + best inverter (SO 1)	This option combines the best module with the best inverter
System Option 2: Multi Si optimised + best inverter + better design (SO 2)	This system combines the best module with the best inverter and includes a better design by installer
System Option 3: Multi Si optimised + best inverter + optimised O&M (SO 3)	This system combines the best module with the best inverter and includes optimized operation and maintenance routine.
Package option 1 (PO 1)	Multi Si module and reference inverter
Package option 2 (PO 2)	Multi Si optimised module and reference inverter
Package option 3 (PO 3)	PERC module and reference inverter
Package option 4 (PO 4)	CIGS module and reference inverter

T8: Policy recommendations

2.1 Modules: Requirements on life time electricity yield: Information, not actual yield requirement

Given that this is a relatively new performance measurement, having been first introduced as a standard in 2018, it is not yet considered possible to establish thresholds that could form the basis for mandatory minimum requirements. Instead as the initial proposal is for an information requirement in order to stimulate its adoption as a standard metric to be reported on module product datasheets.

If a yield threshold were to be pursued as the basis for a minimum requirement, further data gathering would be required in order to determine the market spread of yield, as this information is not yet readily available. Consideration would also need to be given as to how new technologies that initially enter the market with lower yields should be treated. This would be with the aim of not dissuading innovation.

Table 8-1. Preferred module policy option 2.1: Yield information requirement

Performance aspect	**Detailed proposed requirements**
Preferred option: Module energy yield	The module energy output (yield) expressed in kWh/kWp and calculated according to IEC 61853-3 for each of the three reference EU climate zones shall be declared by the manufacturer.

2.2 Modules: Performance requirements on quality, durability and circularity

Table 8-2. Preferred module policy option 2.2: Quality, durability and circularity requirements

Performance aspect	**Detailed proposed requirements**
Performance requirements	
2.2.1 Durability product test sequency	Each model shall be certified to have passed the product test sequence required for qualification under IEC 61215. *This requirement could be further extended to require factory quality controls and auditing according to IEC TS 62941 and IECRE OD 405.*
Information requirements	
2.2.2 Lifetime performance degradation	The manufacturer shall declare the average linear degradation rate expected over a notional service lifetime of 30 years. This shall be the same rate that is used as the basis for the power warranty (if offered). The declaration shall be clearly identified as being either: – *Validated:* The manufacturer's claim shall be an average derived from a series of field observations made according to the Transitional Method, in regard to the number, geographical coverage and the time series. – *Unvalidated:* on the manufacturer shall report on the basis for their

2.2 Modules: Performance requirements on quality, durability and circularity (cont)

	claimed rate with reference to accelerate life testing methods and modelling..
2.2.3 Repairability	The manufacturer shall report on: – the possibility to access and replace the bypass diodes in the junction box [1], – the possibility to replace the whole junction box of the module *Note: the possibility exists to include semi-quantitative criterion if a product specific standard is developed in accordance with the forthcoming horizontal standard for repairability prEN 45554.*
2.2.4 Dismantleability	The manufacturers shall report on the potential to separate and recover the semi-conductor from the frame, glass, encapsulants and backsheet. Design measures to prevent breakage and enable a clean separation of the glass, contacts and internal layers during the operations shall be detailed. *Note: the possibility exists to include semi-quantitative criterion if a product specific standard is developed in accordance with the forthcoming horizontal standard for recyclability prEN 45555.*
2.2.5 Material disclosure	The manufacturer shall declare the content in grams of the following materials in the product: – Antimony – Cadmium – Gallium – Indium – Lead – Silicon metal – Silver – Tellurium For the encapsulant and backsheet the manufacturer shall also declare the type of polymers used (including if it is fluorinated or contains fluorinated additives) and the content in grams.

2.3 Inverters: Efficiency requirements

Table 8-3. Preferred inverter policy option 2.3: Efficiency requirements

Performance aspect	**Detailed proposed requirements**
2.3.1 Euro Efficiency minimum requirement for PV inverters without storage	Require a minimum Euro efficiency at Tier 1 of 94% and Tier 2 at 96% measured according to EN 50530. *Allowances shall be provided for micro-inverters and hybrid inverters to offset for their other benefits.*
2.3.2 Euro Efficiency supporting information requirement	In addition the following supporting information shall be provided: - The efficiency values shall be presented in a tabulated form. - An annual temperature derating factor for the climate zones defined in IEC 61853-4 and calculated relative to 25°C
2.3.2 Efficiency requirements for PV inverters with possibility to connect storage or with integrated storage	Require a minimum system efficiency of 90% at 25% of nominal power, at minimum MPP voltage with the battery at around 50% state of charge. Measurement to be made according 'Effizienzleitfaden 2.0'.
2.3.3 Smart readiness	Manufacturers shall ensure that the inverter supports class C data monitoring according to IEC 61724-1. The inverter shall have physical and/or wireless connectivity and be capable of communicating with other devices using the Modbus data transfer protocol in accordance with IEC 61158..

2.4 Inverters: Performance requirements on quality, durability and circularity

Table 8-4. Preferred inverter policy option 2.4: Quality, durability and circularity requirements

Performance aspect	**Detailed proposed requirements**
2.4.1 Durability product test sequence	Each model shall be certified to have passed the product test sequence required for qualification under IEC 62093.clearly stating whether the product is for indoor or outdoor applications. *This requirement could be further extended to require factory quality controls and auditing according to IEC TS 63157 and the associated IECRE OD [pending a code].*
Additional information requirements	
2.4.2 Repairability requirements for inverters <30 kW	The manufacturer shall identify which of the circuit boards can be replaced on site.
2.4.3 Repairability requirements for inverters >30 kW	Manufacturers shall provide a preventative maintenance and replacement cycle. This shall include a list of parts that may be replaced and the timing of preventative measures to achieve a declared intended design technical lifetime (as required in IEC TS 63157). *Note: the possibility exists to include semi-quantitative criterion if a product specific standard is developed in accordance with the forthcoming horizontal standard for repairability prEN 45554.*
2.4.4 Material disclosure	The manufacturer shall declare the content in grams of the following materials in the product as a whole and in the replaceable circuit boards: - Lead - Cadmium - Silicon carbide - Silver - Indium - Gallium - Tantalum

2.5 Inverters: Life cycle Gross Energy Requirement (GER) and Global Warming Potential (GWP) information requirement

Table 8-5. Preferred Ecodesign policy option 2.5: Life cycle data information requirement

Performance aspect	**Detailed proposed requirements**
2.5.1 Life cycle GER and GWP product declaration	At the latest by [*delayed year of introduction*] and for a representative product from each module series placed on the market, an Environmental Product Declaration for, as a minimum, life cycle primary energy (GER) and Global Warming Potential (GWP) shall be developed and provided. *For further discussion: options are for the EPD to be in conformity with EN 15804 or the PEFCR and to have been registered with a Type III Product Category Rule operator.*

And so on… check T8

- T8 is the final report from JRC
- Up to the Commission to make a proposal
- New Swedish meeting whenever this happens
- Our measurements will contribute to the Swedish proposal
- Comments before are welcome!