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Issues associated to photovoltaic panels and compliance with EPR legislation



Photovoltaic (PV) panels have been in the scope of Directive 2012/19/EU on waste electrical and electronic equipment (WEEE) since August 2012 and are classified as category 4: “large equipment”. Member States are supposed to ensure that collection targets for this category¹ are achieved on a yearly basis. From 2019, the collection targets to be achieved is 65% of the average weight of EEE placed on the market (POM) in the three preceding years in the Member State concerned, or 85% of WEEE generated on the territory of that Member State.

The 2019 Commission Implementing Decision 2019/2193 lays down rules for establishing data formats for the purposes of Directive 2012/19/EU: for category 4, data shall be reported under two sub-categories, namely ‘4a: Large equipment excluding photovoltaic panels’ and ‘4b: Photovoltaic panels’.

This paper analyses the PV market situation and the difficulties in achieving the EPR obligations laid down in WEEE legislation and offers policy recommendations.

Main message

Significant amounts of PV panels are placed on the market in Europe every year, and there has been a significant increase of these quantities in the past three years. However, due to the long lifespans of PV panels and recent market penetration, PV panels are not yet arising as waste in significant quantities². The WEEE Directive does not set a specific category for PV panels, nor a specific collection target. PROs in some Member States are still required to report PV panels mixed with other category 4 waste types, making it impossible to trace and monitor the actual behaviour of PV panel flows.

Most Member States apply the collection target based on the POM methodology, which means that collection targets for PV panels are not achievable. Sadly, to be able to reach those collection targets, PROs are required to compensate the low return of PV panels by collecting higher amounts of other category 4 waste appliances, which distorts the basic principles of the Directive, especially the extended producer responsibility principle.

- *The WEEE Forum calls on legislators and policymakers to stop applying collection targets based on the put on the market (POM) methodology to PV panels.*
- *Authorities should support research aimed at understanding the flow of PV panels at EU level to lay down realistic separate collection targets.*
- *In the meantime, alternatives such as service upon demand schemes should be considered a valid solution during and after this transition process. Alternatively, a derogation of the POM collection target should be considered until the volumes of waste PV panels start to arise in sufficient volumes to warrant a meaningful target.*
- *To avoid a distortion of the EPR principle, a separate category for PV panels in the legislation should be considered. The European Commission should enforce the requirement that Member States report PV panels placed on the market and collected in a separate category (4b) as per Implementing Decision (EU) 2019/2193.*
- *Member States are called on to raise this issue at EU level and **urgently** request harmonized specific legislative measures for ensuring a fair and realistic compliance of the extended producer responsibility principle for PV panels.*

¹ Category 4 comprises other equipment such as washing machines, luminaries, coin-slot machines etc. It should be noted that category 5 “ Small equipment” comprises also small equipment with integrated photovoltaic panels.

² C.P. Baldé, M. Wagner, G. Iattoni, R. Kuehr, In-depth Review of the WEEE Collection Rates and Targets in the EU-28, Norway, Switzerland, and Iceland, 2020, United Nations University (UNU) / United Nations Institute for Training and Research (UNITAR) – co-hosting the SCYCLE Programme, Bonn, Germany.

Current situation in numbers

On the basis of the Commission Implementing Regulation 2017/699, the European Commission makes the WEEE calculation tools customised for each one of the Member States³ publicly available. The tool provides a common methodology for the calculation of the quantity of WEEE generated in each Member State. **The WEEE tool estimates an average lifetime of PV panels of 22½ years** (reference year 2019, example for Sweden). It should be noted that PV panel technologies currently placed on the market may guarantee up to 25 years of performance and product and this value is very likely to go up in the near future.

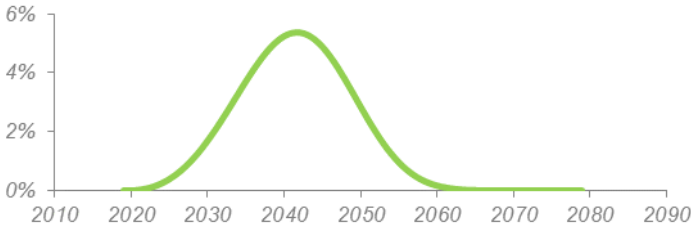


Figure 1. WEEE generated per year in percentage of POM (reference year and country for the calculation: 2019, Sweden). Source: WEEE Tool

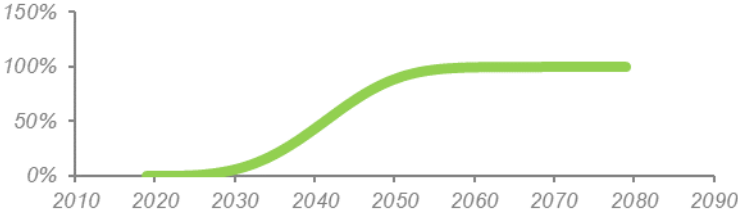


Figure 2. WEEE generated per year in percentage of POM (cumulative) (reference year and country for the calculation: 2019, Sweden). Source: WEEE Tool.

The lifespan of a PV panel is very much based on whether it is used in a utility power plant or within the context of a residential PV installation. Households tend to keep their modules for longer because they are less interested in optimizing the financial return. On the other hand, utility scaled PV power plants owners try to optimize their returns because for them this is an investment, and it may be financially more interesting to replace functional PV panels or a complete, large PV installation by a new installation or new PV Panels when the installation has reached its return on investment (repowering) (source: PV CYCLE France).

The European Union's ambition to become the first climate-neutral bloc in the world by 2050 is aligned to the European Green Deal presented in December 2019 and it is expected to boost the solar photovoltaic market.

Recent figures on solar capacity installed show a significant increase of PV panels placed on the market in most EU Member States. According to the EU Market Outlook for Solar Power 2020-2024 (SolarPower Europe, 2020), in 2019, the global solar power sector returned to a two-digit growth path, increasing by 13% to 116.9 GW, marking a new annual installation record. The newly installed solar power in the European Union increased by 11% to 18.2 GW in 2020, an 11% improvement over the 16.2 GW deployed in 2019. 2020 was the second-best year ever for solar in the EU, only topped by 2011, when 21.4 GW were installed.

³ https://ec.europa.eu/environment/waste/weee/data_en.htm

The broadening acknowledgment of solar PV’s benefits can also be observed in another trend: in 2020, 22 of the 27 EU member states installed more solar than the year before, compared to 21 out of 28 in 2019. All this has resulted in the European Union increasing the cumulative installed solar power capacity by 15% to 137.2 GW by end of 2020.

It should be noted that the installed capacity provides an indication of the number of panels installed, but the correlation between power and number of panels may be 1:2 or even higher. It is observed in France for example, that the declared POM is almost double of the reported new connections to the grid (source PV CYCLE France) and this factor may be 1:4 in the future; in order to maximize the electrical output, utility scaled installations are oversized compared to their ability to supply electricity to the grid, therefore analysis based on the energy market tend to underestimate the amount of PV panels installed.

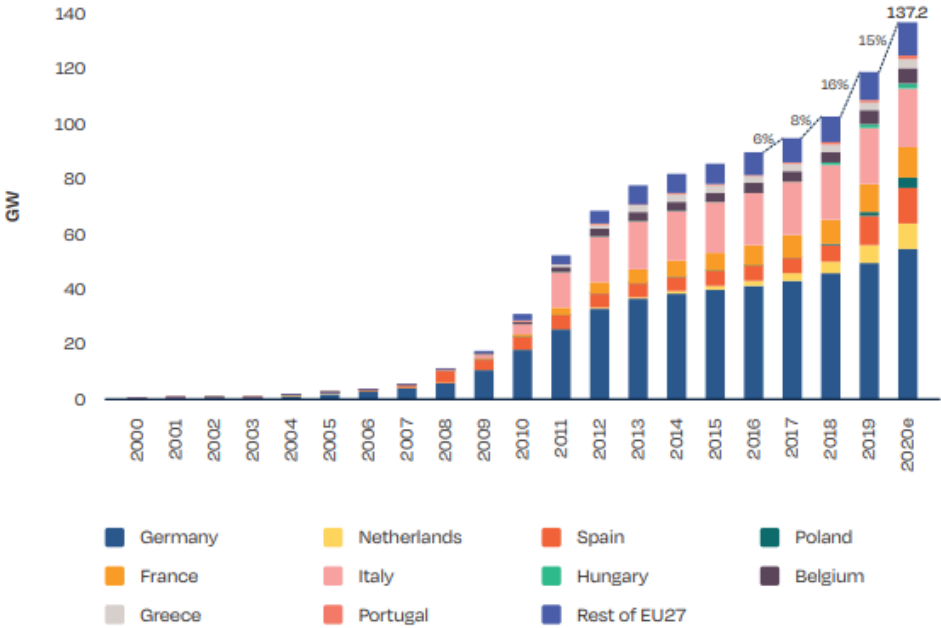


Figure 3. EU 27 Cumulative Solar PV installed capacity 2000-2020 (source: SolarPower Europe (2020): EU Market Outlook for Solar Power 2020-2024)

Freeriding, however, causes an opposite effect, and in some countries, POM officially reported is estimated to be lower than the installed amounts of PV panels.

All PV panels put on the market contribute to the EEE POM target; UNITAR, a UN body, estimates that the impact of PV panels on the target based on EEE POM is, on average, 0.6 kg/inh in 2018, or 4% of the total target. However, the amount can be higher for individual countries as differences exist between countries. The two countries with the highest impact are the Netherlands and Malta, with 11% and 10% of the total, respectively.

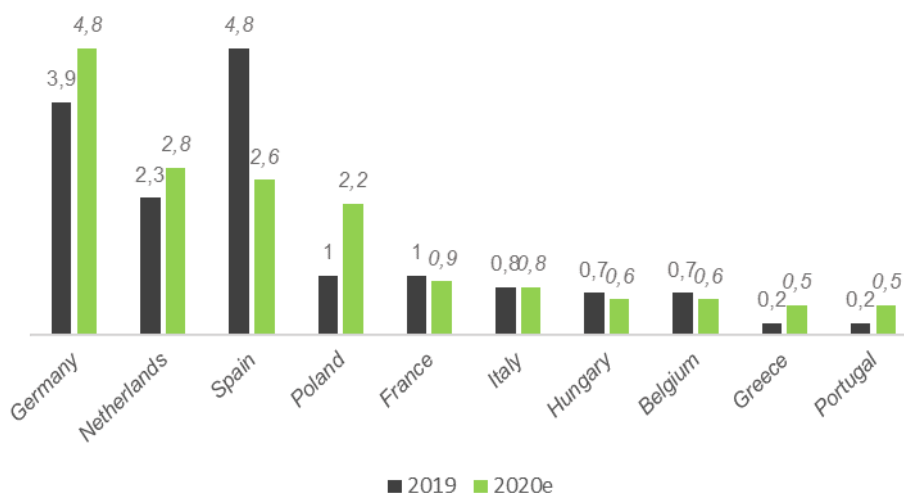


Figure 4. EU 27 Top 10 Solar PV markets (installed GW), 2019-2020 (source: SolarPower Europe (2020): EU Market Outlook for Solar Power 2020-2024⁴)

The UNITAR report concludes that EEE POM for PV panels was considerably higher in the early years after 2010. It peaked at 4.0 kg/inh in 2012 for the entire region, even being as high as 6.9 kg/inh in Eastern Europe (for 2011). Furthermore, the future renewable energy policies might cause another increase of the POM of PV panels, which will affect the EEE POM collection target. Consequently, the PV panel POM are very volatile and lead to very volatile collection targets, based on EEE POM; **the 65% EEE POM collection target for PV panels is unreachable.**

A clear illustration of the issue is represented by Malta, where the amount of PV panels that were marketed from 2016 to 2018 was 2.66 kg/inh. The share of PV panels in 2016 resulted in 10% of the total EEE sales, which is considerably above the European average (5%). As such, PV panels can be evaluated as a key factor in achieving the 65% POM collection target for Malta. Indeed, the influence of PV panels on the overall potential collection for 2018 was equivalent to 10%, or 2.64 kg/inh, of EEE put on the market.

Figures on PV panel collection and sales available in Eurostat are compiled in Table 1.

Another example comes from Spain, where official collection targets set for 2021 show that PV panels represent 50% of the non-household (B2B) WEEE collection target and 13% of the total national target comprising both, household and non-household WEEE.

Table 1 and the chart associated to it clearly illustrate data scarcity on PV panels; the most basic figures on PV panels do not appear in Eurostat files for 2019 and 2020, which is somehow in contradiction with the data dependent collection targets set by the WEEE Directive.

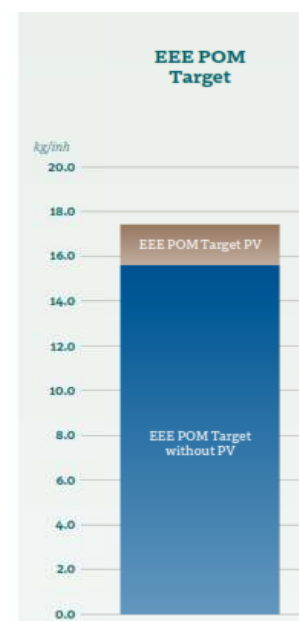


Figure 5. Estimated collection target for Malta based on the POM methodology (UNITAR).

⁴ Most updated data received from Poland shows almost 2,5 GW were installed in 2020, reaching 4,0 GW at the end of the year (source APPLiA Polska).

Tons	POM				Target		Collection			
	2015	2016	2017	2018	Average 3 years	65% Target	2015	2016	2017	2018
BE		8,681.00	11,823.00	24,258.00	14,920.67	9,698.43		242.00	117.00	168.00
CH*	14,643.00	11,546.00	11,166.00	12,209.00	11,640.33	7,566.22	71.00	126.00	337.00	277.00
CZ	365.00	543.00	753.00	1,203.00	833.00	541.45	39.00	129.00	8.00	16.00
DK	438.00	288.00	4,721.00	2,698.00	2,569.00	1,669.85	2.00	3.00	5.00	6.00
DE		106,895.00	155,539.00	211,142.00	157,858.67	102,608.13		2,032.00	3,595.00	7,865.00
GR		383.00	908.00	2,782.00	1,357.67	882.48				
ES		1,099.00	1,532.00	21,855.00	8,162.00	5,305.30		27.00	155.00	462.00
FR	58,078.00	50,802.00	83,621.00	72,151.00	68,858.00	44,757.70	366.00	223.00	1,885.00	1,555.00
IT			30,053.00							1,350.00
LX				69.00						
HU				7,898.00						2,289.00
NL	27,496.00	33,672.00	64,383.00	96,285.00	64,780.00	42,107.00		100.00	90.00	131.00
AT		7,317.00	7,084.00	7,750.00	7,383.67	4,799.38		12.00	22.00	8.00
RO		305.00								
SK		30.00	92.00	244.00	122.00	79.30				14.00
UK	62,791.00	49,235.00	33,813.00	19,217.00	34,088.33	22,157.42	147.00	104.00	106.00	87.00

Table 1. Figures on PV panels put on the market and collected (Source: Eurostat, *WEEE Forum Key Figures).

Figure 6 shows the percentage of the collection target achieved by Member States for PV panels, targets were calculated with 2016-18 data and compared to 2018 collection. Percentages calculated run from 0.17% to 17.65%. Data available on Eurostat is scarce but clearly shows that Member States are not even remotely close to meeting the targets set for PV panels.

Data on the types of PV panels collected and the waste channels that are most used for collecting PV panels is hard to find.

The evolution of the sales market within solar power is fast and highly influenced by energy policies, which are in constant change and will affect market dynamics.

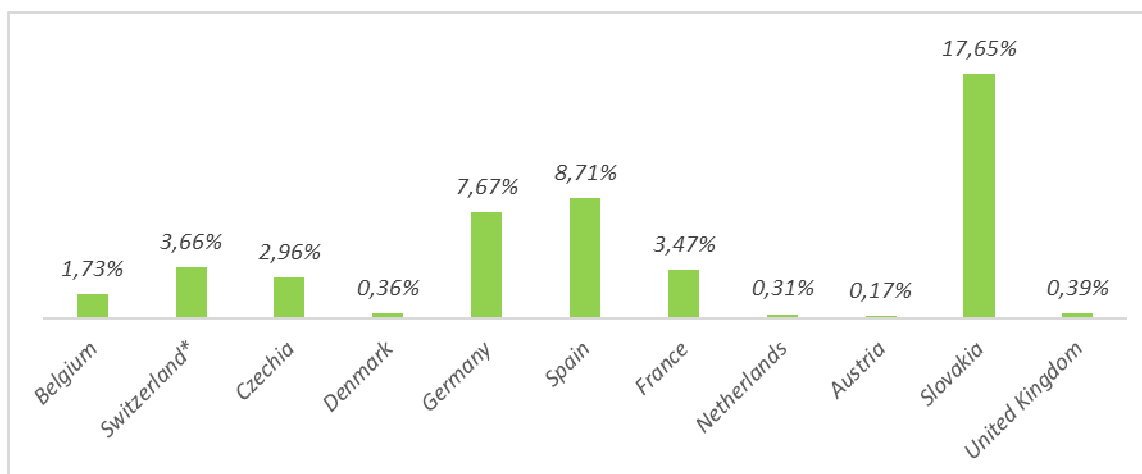


Figure 6. Percentage of the collection target achieved by MS for PV panels, target calculated with 2016-18 data, and compared to 2018 collection (source: Eurostat. *WEEE Forum Key Figures)

Available data on PV panels placed on the market and collected are scarce. Statistics show that Member States do not even remotely meet the collection targets, which are mostly calculated using the POM methodology. The lifespan of a PV panel is estimated to exceed 20 years and hence it is impossible to meet the 65% target. More and more PV panels have been placed on the market recently, which is directly affecting the collection target and increasing the difficulty to reach it.

Issues that have an impact on PV panel management

Waste classification and reporting

In practice, currently, there is no harmonized classification of PV panels at EU level:

- PV panels may be considered hazardous, non-hazardous waste or both, depending on the Member State, and studies about this topic are not available,
- PV panels may be considered household, non-household waste or both,
- PV panels may be reported separately in a dedicated category, or in category 4 or as part of the latter in category 4b, depending on the Member State.

Given that there are not many treatment facilities in Europe, mostly due to the lack of significant volumes arising, a harmonized classification of the waste would facilitate intra EU shipments of PV panels for appropriate treatment in PV panel dedicated facilities. EU and national policies should ensure that sufficient treatment capacity is available when significant volumes of PV panels arise. Appropriate measures and planning allowing the development and piloting of efficient treatment technologies are relevant. Additionally, a specific waste code for PV panels could help monitor traceability and improve the transparency of shipments of PV panels to recycling facilities within EU countries.

We should make the most of the available technologies for improving the monitoring and reporting of PV panels, especially those installed in large PV power plants. National databases collecting information on the location and volumes installed have been set in some EU regions. Without considering the financial aspects of it, a technical example is shown in Italy, where this system is already implemented and offers the possibility to monitor the status of PV panels, from the installation phase to end of life management (source: Cobat). Another example is the e-inventory of PV panels installed that was proposed in the Catalan region in Spain after a project funded by the regional waste agency⁵. The use of these technologies should be cost efficient and reduce administrative burden.

The lack of full harmonisation of the classification of PV panels complicates the process of shipping this waste to the few specialist treatment facilities available in Europe. Harmonised criteria for classification and a possible specific waste code would therefore be welcome. Available technologies for locating and tracing PV panels installed in utilities can improve considerably the management and reporting of PV panels and provide useful statistics. The use and development of such technologies should be cost efficient and aimed at reducing the burden of reporting, otherwise they may become a deterrent for compliance.

Calculation of appropriate collection targets and harmonized calculation of recovery rates

The UNITAR report concludes that the main methodological constraint of the EEE POM target calculation is the volatility due to the PV panels and changes in the economy.

⁵ <https://www.solartys.org/es/plataforma-para-la-gestion-de-residuos-de-placas-solares/>

Therefore, the amount of WEEE that can be collected does not keep pace with the growth of the EEE POM. Additionally, in case of decreasing sales or more efficient power output (e.g., lighter) products put on the market in 15-20 years from now, the target may not be aligned (too low) with the volumes arising.

The WEEE generated methodology considers the long lifespan of PV panels, however it is a data demanding and complex methodology.

Currently, and to be able to attain collection responsibility, PROs are forced to compensate the lack of PV panels arising in the waste stream by collecting additional category 4 appliances. This distorts the producer responsibility principle and creates an unfair treatment to category 4 producers. The quest for additional category 4 WEEE is at the same time affecting waste market behaviors and putting even more pressure to PROs struggling to reach collection targets. **Moreover, some Member States exact a penalty from PROs for not reaching their collection responsibility. This brings a sense of urgency to the matter and requires a fast-track solution from competent authorities starting in 2021.**

It is important to understand the current dynamics of PV panels and for this a robust set of statistics and further study of return mechanisms are required. In article 2.2, implementing Decision (EU) 2019/2193 requires Member States (“*Member States shall report*”) separate reporting of category 4 W/EEE into:

- 4a) Large equipment excluding photovoltaic panels and
- 4b) Photovoltaic panels.

Annex II sets out the format for reporting and clearly distinguishes both data sets (4a and 4b), however it is also expressed in note 1 of the annex that “(…) *if a Member State is not able to distinguish data under sub-categories 4a and 4b, it shall complete the cells in the different columns in aggregate line for category 4 only*”. Currently, not all Member States require separate reporting of PV panels placed on the market and collected as per Implementing Decision (EU) 2019/2193. This hinders the availability of separate PV panel statistics and impedes the option of considering alternatives for the current situation. A clear enforcement of separate reporting rules by the European Commission would be welcome.

An ideal situation allowing for separate reporting would be to simply create an additional category for PV panels, hence the reporting of PV panels with other category 4 items will not be possible. This solution will in turn solve the distortion of the EPR principle where large household appliances are being collected to cover for the lack of PV panels reaching their end of life. The Spanish transposition of the Directive into Royal Decree 110/2015 provides an example of this solution (a seventh category for PV panels is presented in this legal text).

Where a Member State calculates the collection rate based on the average weight of EEE placed on the market in the three preceding years, Implementing Decision (EU) 2019/2193 allows Member States to report, on a voluntary basis, data on the weight of WEEE generated and data on the WEEE collection rate based on WEEE generated for PV panels (art. 2.6). **Relevant differences in both data sets (POM and WEEE Generated sets) are unmistakable evidence for policymakers that the collection targets used are inadequate and not fit for purpose and serve as a justification for not meeting the collection targets.** Member States are encouraged to report such figures on a voluntary basis, as an immediate solution, and to consider bringing the issue to EU level.

UNITAR singles out France as a country that does not make photovoltaic panels subject to the collection target. PV CYCLE France, the only accredited PV panel PRO in the country, is required to respond to all pick-up requests, which has been the case since the sector’s launch. Photovoltaic panels have started to be installed in significant quantities since 2010 in France. Considering that they have a lifespan of 20-25 years, PV CYCLE France estimates

that the cruising speed volume will be reached around 2030, with 50,000 tons collected per year. In France, this young sector is already working well since most producers are in compliance and the recycling rate is the highest among all categories of equipment (a visible fee is applied in France). This approach is aligned with the extended responsibility principle and adapts to the special market behavior of PV panels. Subject to appropriate monitoring and enforcement, it is a perfectly valid solution to the issue presented in this document and allows MS to prepare the fundamentals of a proper collection target methodology.

When a cancellation of a quantitative target for PV panels is not an acceptable solution for whatever reason, it is strongly suggested to implement an exemption of the POM collection target. An exemption should be temporary and remain in force until the volume of PV panels reaching end of life would be coherent with the collection targets calculated. This exemption would be particularly relevant and helpful for MS that report sales much higher than the EU average. A derogation or exemption of the target for PV panels should reflect in the calculation of the national collection targets. In the meantime, a scheme that will respond to the needs of PV panel waste arising (service upon demand) can cover the needs of the market. This solution will ensure the extended responsibility principle is applied at all times and allows the sector to adapt to the increasing volumes of waste PV panels and volatility of the PV market.

Challenges in managing extended producer responsibility for PV panels.

It should be noted that PROs are facing unreachable collection targets because there are currently no relevant amounts (compared to the POM) of solar modules arising as waste. Depending on the specific country, these amounts may only appear after 15-20 years.

The characteristics and behavior of PV panels are quite different from other types of (W)EEE⁶. In 2014, when PV Panels entered the scope of the EU national WEEE laws, in the European Union around 90 GW or around 7 million tons were installed /already put on the market. At the end of 2020, the cumulative installed power was 137 GW.

PROs must design tailor-made financing models for meeting producers' and legislative expectations. Most PROs are using a "pay as you go" financing model, which allows for a sharp calculation of necessary costs on an annual basis. The long life of PV panels may induce financing models based on reserves for future treatment, however it is very complex to estimate the necessary costs for treating PV panels arising in 15-20 years, because as indicated earlier, the market is unpredictable, and the PV treatment sector is not fully developed yet. Some producers may be reluctant to pay upfront PV management costs for that reason. On the other hand, the downside of fees based on PV panels collected, is that producers that may go out of business in the next 15-20 years (which is a possible scenario) may not finance the responsibility arising from the PV panels they placed on the market.

Currently financing models based on upfront payment (calculated upon volumes put on the market), payment upon collection and non-household options (as per article 13 of the WEEE Directive) are being used by PROs for financing the EPR of PV panels in Europe. A derogation of the POM targets and a service upon demand scheme will simplify financing models and make them more suitable to the situation. A service upon demand scheme entails the collection of all PV panels arising and it is not driven by an (unrealistic) collection target. The scheme can co-exist and be complemented with other instruments that will prepare the market financially for waste streams arising in the near future. Shared responsibility based on market share is still valid in this scenario and ensures a fair distribution of the extended producer responsibility between producers.

⁶ However, we can still identify EEE that show long life cycles and may deserve a special consideration in the WEEE legislation and in particular when setting collection targets, such as LEDs, Air conditioning equipment and some non-household equipment.

It should be noted however, that the viability and effects of a service upon demand scheme must be carefully assessed for every situation. Implementing such a scheme for example, may result in relevant changes on the financing system of PROs that manage category 4 as a whole and build their business plans on a yearly basis.

Many PROs have identified financial risks related to the uncertainties in both, the anticipated POM as well as the anticipated collected volumes. These uncertainties and the corresponding possible risk mitigations may be affected and enhanced by the level of free riding in the country. In most EU countries, the grid connecting companies do not verify if the PV panel producer supplying the panels is compliant with the WEEE legislation and it is not a requirement for grid connection to prove the producer of PV panels is participating in a take back system (either collective or individual) and reporting POM amounts, whilst this could be a perfect instrument for ensuring compliance.

It is unclear, and rather unlikely, whether article 12 of the WEEE Directive referring to “historical waste”, or a revision of it within the forthcoming recast of the Directive, may provide a solution for “orphan” PV panels arising in the future. An adequate financial preparation for future waste streams should ensure that PV panels arising in 15 to 20 years will be financially covered even if the producers that placed them on the market have ceased their activities by then. To the extent that PV recycling is paid upfront, there should be a mechanism ensuring that in case of failure or liquidation of the PRO, the funds accumulated are used for its original purpose. National transpositions of the WEEE Directive should be flexible and allow for different solutions ensuring the treatment of PV panels arising in the future.

Finally, a harmonized calculation of recycling and recovery rates at EU level should be promoted, and for this, we believe that implementing CENELEC EN 50625 series of standards on a mandatory basis in Europe would solve the issue.

EU research aimed at understanding the flow of PV panels should be conducted for defining well founded separate collection targets. In the meantime, other alternatives such as service upon demand schemes should be considered a valid solution during and after this transition process. Alternatively, a derogation of the target until end-of-life volumes are consistent with the targets calculated is recommended. Member States are called on to raise this issue at EU level and prevent the attainment of collection targets at any cost (e.g., by putting more pressure on other types of WEEE to compensate the lack of PV panels arising). Calculation of recycling and recovery rates should be harmonized at EU level through the implementation of mandatory CENELEC EN 50625 standards.

About the WEEE Forum a.i.s.b.l.

The WEEE Forum, set up in 2002, is a Brussels-based international for-impact not-for-profit association speaking for forty-three not-for-profit electrical and electronic equipment waste (WEEE) producer compliance schemes – alternatively referred to as ‘producer responsibility organisations’ (PRO). The PROs are based in Australia, Austria, Belgium, Bosnia, Canada, Czechia, Cyprus, Colombia, Denmark, Estonia, France, Greece, Iceland, India, Ireland, Italy, Lithuania, Luxembourg, Malta, Moldova, the Netherlands, New Zealand, Nigeria, Norway, Poland, Portugal, Romania, Slovenia, South Africa, Spain, Sweden, Switzerland and the United Kingdom. It is the biggest organisation of its kind in the world. In 2019, its member organisations reported collection and proper de-pollution and recycling of 2,780,000 tons of WEEE. Members in 2021: Appliances Recycling, Australia New Zealand Recycling Platform, Cobat RAEE, EcoCómputo, Ecolec, Ecologic, ecosystem, Ecotic, ECOTIC, Ecotrel, EES-Ringlus, EGIO, El-Kretsen, Electrao, EPA, Electronic Products Recycling Association, ElektroEko, Elektrowin, elretur, Environ, Epron, ERA, Erion WEEE, Fotokiklosi, Karo Sambhav, Lightcycle, MoldControl, Norsirk, Recipo, Recupel, Recyclia, Red Verde, RENAS, Repic, RoRec, SENS e-Recycling, SWICO, UFH, Úrvinnslusjóður, Wecycle, WEEE Cyprus, WEEE Ireland, WEEE Malta, WEEE Recycle and Zeos. Contact: info@weee-forum.org. Website: www.weee-forum.org. See also [15 Years On](#).

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