Royal Society of Chemistry response

7 March 2024

Consultation on reforming the producer responsibility system for waste electrical and electronic equipment 2023

Increasing collections of waste electrical and electronic equipment from households

24. Please provide any other comments and supporting evidence on the proposal for producers (and distributors that do not provide take-back services) to finance a system of kerbside collection of small WEEE and on-demand collections of large WEEE for households?

The Royal Society of Chemistry welcomes the proposal for additional collection infrastructure that may increase convenience for consumers.

In a nationally representative survey carried out by the Royal Society of Chemistry and IPSOS Mori (1), the majority of respondents (56.6%) said that manufacturers should be responsible for recycling/the sustainability of consumer tech. Retailers (27.0%), consumers (33.2%) and national government (26.7%) were also identified as having responsibility.

A barrier to the collection of WEEE for consumers is the convenience of recycling options.

- 6% of participants in the RSC and IPSOS Mori survey said that they had tried recycling in the past but it was too much of a hassle (1).
- In a follow-up survey by the RSC, just over half of respondents said they worry about the environmental effect of the unused devices they have at home, but either do not know what to do with them or are unconvinced the current processes available in their local area deal with e-waste effectively (2).
- In a survey of 321 respondents, 53% of participants said that recycling small WEEE (sWEEE) is inconvenient, while the inconvenience of taking sWEEE to HWRC or to retailers take back schemes were selected as reasons for not recycling more by 47% and 35% of respondents respectively (3).
- Other research identifies inconvenience as an important factor which leads to WEEE being stored(4).

Improvements to collection infrastructure, e.g. household collection of sWEEE or provision of other disposal points, should help to improve the convenience of recycling for consumers. It is likely also that there is no 'one size fits all' solution to collection infrastructure. Different items of sWEEE may be treated differently, e.g. USB cables vs mobile phones (3), and demographics or rural versus urban locations, may affect infrastructure requirements. When considering additional collection points, workplace collection points may be a useful option for people to dispose of domestic WEEE. However, consideration would need to be given about implementing this kind of provision in a way that aligns with business WEEE collection regulations.

(1) Royal Society of Chemistry and IPSOS Mori, 2019, please contact policy@rsc.org
(2) Royal Society of Chemistry and IPSOS Mori, 2020, please contact policy@rsc.org
(3) What are WE(EE) doing? Using a social practice theory approach to analyse the disposal of small electrical and electronic items in the UK. Monk, 2023, unpublished study.
(4) For example:
Ongondo, F. O. and Williams, I.D. (2011) 'Mobile phone collection, reuse and recycling in the UK', Waste Management, 31(6), pp. 1307–1315. Available at: https://doi.org/10.1016/j.wasman.2011.01.032

Martinho, G., Magalhães, D. and Pires, A. (2017) 'Consumer behavior with respect to the consumption and recycling of smartphones and tablets: An exploratory study in Portugal',

Journal of Cleaner Production, 156, pp. 147–158. Available at: https://doi.org/10.1016/j.jclepro.2017.04.039

Kurisu, K. *et al.* (2020) 'Hibernating behavior for household personal computers', *Resources, Conservation and Recycling*, 162, p. 105015. Available at: https://doi.org/10.1016/j.resconrec.2020.105015

27. Are there alternative, non-regulatory approaches that could be established to increase separate collection of WEEE from households for re-use and recycling? If so, please describe what this might look like.

While improving the convenience of collections is likely to be important in increasing recycling and re-use rates, addressing other barriers to re-use and recycling such as data security concerns and knowledge and awareness of recycling options as part of a suite of measures is likely to be important. In a nationally representative survey conducted by the Royal Society of Chemistry and IPSOS Mori (1), concerns about security and that data could be stolen were identified by respondents as reasons for not recycling old or unused devices by 28% and 24% of respondents respectively. In a survey of 321 participants, 45% of respondents said concerns about data or information stored on the device was a reason for not recycling more WEEE (2). In the same survey, 53.1% of respondents said they did not know about the options for recycling (2). Similarly, in the RSC survey, 21% of respondents said they did not know where they would take items for recycling, and 18% said they would not know how to arrange to have WEEE recycled (1).

(1) Royal Society of Chemistry and IPSOS Mori, 2019, please contact policy@rsc.org
(2) What are WE(EE) doing? Using a social practice theory approach to analyse the disposal of small electrical and electronic items in the UK. Monk, 2023, unpublished study.

Dealing with the environmental impacts of vaping products

63. Do you agree or disagree with the proposal to create a new category for vapes? Please select one of the following options:

a. Agree
b. Disagree
c. Unsure

65. Are there any other measures, beyond those for eco-modulation and littering set out in the call for evidence, you think government should take to curb the environmental impact of vapes? Please provide evidence to support your answer.

The Royal Society of Chemistry agrees that a new category should be added for vapes on environmental grounds. Vapes are composed of a mixture of materials, including plastics, critical minerals and the vape liquid; collection, depollution and proper recycling are therefore important. Although vapes are a growing category of WEEE, the economies of scale means that there are likely to be different technoeconomic considerations compared to, e.g., EV batteries. There is little assessment currently of their life cycle environmental footprint, and this may be an evidence gap that should be addressed to support decision making. As a relatively new product, with a growing market share understanding of consumer behaviour with respect to vapes specifically is likely to be limited and again should be addressed to ensure that decision making is based on evidence.

System governance, the creation of a WEEE Scheme Administrator and performance indicators

66. Do you agree or disagree with the principle of establishing Government approved, producer-led Scheme Administrator to carry out specified functions in the reformed WEEE system? Please select one of the following options:

a. Agree
b. Disagree
c. Unsure

71. Please provide any other comments on the role of a Scheme Administrator.
The Royal Society of Chemistry does not have a strong opinion on whether the proposed Scheme Administrator is the correct method of governance for the revised WEEE system. However, we welcome the proposal of a governance system that will lead to coherent oversight across all the nations. We also welcome the suggestion that the Scheme Administrator may have a number of functions to fulfil if this leads to evidence informed, coherent decision making.

73. Are there any other measures of success which government should consider to assess the performance of the system?
In principle, the Royal Society of Chemistry welcomes the introduction of other success measures in the revised WEEE system, particularly those that may lead to evidence on the circularity of the system, critical mineral flows, or that may measure and monitor a breadth of environmental impacts, including greenhouse gas emissions and water usage. Mass-based targets as in the current system do not give an indication of, e.g., critical mineral flows, or any kind of environmental weighting to the type and composition of WEEE. Even if no additional measures are put in place, several members of our community commented on the need for better data collection within the existing system of mass-based targets so as to gain an accurate understanding of WEEE flows which would better inform decision making. Therefore, not only is there a need for additional success measures which track progress against a broader range of metrics, the current data collection system needs to be improved. New performance measures will need to be carefully implemented to ensure they are collecting useful, measurable data; some proposed measures above, for example b and d, may be particularly difficult to measure.

Electrical waste: reforming the producer responsibility system – call for evidence

Allocation of costs for the collection and treatment of household WEEE

15. Do you agree or disagree that we should establish a rolling 3-year process for setting the financial obligations of producers to create more certainty in the system? Please select one of the following options:

a. Agree
b. Disagree
c. Unsure

16. Please provide evidence of whether or not setting a rolling three-year forecast would provide more certainty in the system and act to encourage increased investment by the treatment sector.
The Royal Society of Chemistry welcomes the intention to increase certainty in the waste system to encourage increased investment by, and in, the treatment sector. Investment in recycling infrastructure, alongside changes in product design, research and innovation in novel methods, will be important to enable the increased recovery of critical minerals from WEEE. In addition investment in repair and re-use infrastructure are important in a circular economy. At present, accurate assessments of WEEE flows are lacking, particularly around what happens to WEEE that is not recorded as being collected and recycled according to the mass-based targets. This means we neither agree nor disagree that a rolling three-year forecast will provide more certainty in the system. One of the challenges with the current method of producing targets based on EEE generation, is that product lifetimes may differ, and in addition storage and hoarding behaviour of sWEEE is also common. Although storage behaviour is probably quite widespread, it is not frequently studied (1).

In a nationally representative survey carried out in 2019 by the Royal Society of Chemistry and IPSOS Mori, 51% of UK households had at least one unused electronic device (2). In a survey of 321 respondents, just under two thirds (64.5%) reported they were storing at least one functional item (3). Other studies have reported higher figures. For example, Bovea et al., (2018) found that 73.91% of respondents reported storing small ICT devices (4), while Pekarkova et al., (2021) found that 72.8% of respondents were storing at least one item of functional EEE (5). Wilkinson and Williams (2020) estimate around 61 million home entertainment EEE devices are hoarded in UK households (6). Storage behaviour may also differ depending on the item of WEEE (3). Not only are many households storing items, these can also be stored for a number of years. For example, in the RSC survey the average age of the oldest unused laptop was 9 years, and that of a smartphone 7 years (2). This storage behaviour means there is potentially a long disconnect between EEE being placed on the market, and the disposal and collection of it, which may make accurate forecasting problematic. Collecting additional data and evidence, including around (i) actual product lifespans, (ii) storage behaviour by consumers (iii) amount of WEEE entering other waste streams and landfill and (iv) amount of WEEE sent for re-use, may help to improve overall understanding of WEEE flows in the UK and ultimately be important in improving certainty in the WEEE system.

(1) For example: Garcia, D.G. and Langen, S.K. van (2021) 'Urban Mining of e-Waste and the Role of Consumers', *Waste Material Recycling in the Circular Economy - Challenges and Developments* [Preprint]. Available at: https://doi.org/10.5772/INTECHOPEN.100363.
Islam, M.T. *et al.* (2021) 'A global review of consumer behavior towards e-waste and implications for the circular economy', *Journal of Cleaner Production*, 316, p. 128297. Available at: https://doi.org/10.1016/j.jclepro.2021.128297.
Newaz, M.S. and Appolloni, A. (2023) 'Evolution of behavioral research on E-waste management: Conceptual frameworks and future research directions', *Business Strategy and the Environment*, n/a(n/a). Available at: https://doi.org/10.1002/bse.3503.

(2) Royal Society of Chemistry and IPSOS Mori, 2019, please contact policy@rsc.org

(3) What are WE(EE) doing? Using a social practice theory approach to analyse the disposal of small electrical and electronic items in the UK. Monk, 2023, unpublished study.

(4) Bovea, M.D. et al. (2018) 'A survey on consumers' attitude towards storing and end of life strategies of small information and communication technology devices in Spain', Waste Management, 71, pp. 589–602. Available at: https://doi.org/10.1016/j.wasman.2017.10.040.

(5) Pekarkova, Z. et al. (2021) 'Economic and climate impacts from the incorrect disposal of WEEE', Resources, Conservation and Recycling, 168, p. 105470. Available at: https://doi.org/10.1016/j.resconrec.2021.105470.
(6) Wilkinson, A. and Williams, I.D. (2020) 'Why do (W)EEE hoard? The effect of consumer behaviour on the release of home entertainment products into the circular economy', *Detritus*, (12), p. 18. Available at: https://doi.org/10.31025/2611-4135/2020.14004.

23. Do you agree or disagree that we should introduce new targets for the re-use (or preparation for re-use) of WEEE that has been collected separately from other types of waste to incentivise more collections for re-use (or preparation for re-use)? Please select one of the following options:

a. Agree
b. Disagree
c. Unsure

24. Please provide any evidence you have to support your answer to question 23.
The Royal Society of Chemistry welcomes the intention to introduce measures that will increase re-use of EEE. In a circular economy, repair, re-use, and re-manufacturing are vital. By implementing waste hierarchy principles, material flows can be slowed, and consumption and waste minimised (1). In principle, we agree with introducing new targets to incentivise greater re-use; however, these are likely to need to be part of a package of interventions that may extend beyond the WEEE system. Products need to be designed in ways that meet eco-design principles – for example design for disassembly for both repair and end-of-life recovery is important. The UK Right to Repair Law signals a welcome intention to increase repair rates; however, it is limited in scope at present. EU legislation such as the Eco-design Directive and Right to Repair legislation may be useful for developing this kind of legislation further. In addition, some coherence with EU and other legislation is likely to be helpful for producers. One of the principles of a circular economy is to keep materials circulating at their 'highest value' for as long as possible, and within the tightest loops of the circular economy. Therefore, a balance may need to be struck between durability, repairability, re-manufacturability, and recyclability of products. Facilitating discussions of this nature may be valuable for the various actors in the EEE value chain. The definition of whether something is still re-usable depends on the proposed re-use purpose, e.g. electric car batteries could be directly re-used in domestic energy storage. In addition, whether something is re-usable may differ depending on country context, and items that are no longer classed as re-usable in the UK may potentially be appropriate for re-use elsewhere. However, precautions should be taken to ensure that items shipped abroad that are designated as 'usable EEE' (UEEE) are in fact usable and are not being shipped in this manner to avoid restrictions on the illegal shipping of WEEE. Some studies suggest that WEEE is shipped illegally between countries (2), with some authors suggesting that the ambiguity in the wording of the Basel Convention is one of the primary reasons for the illegality of exports (3). Reforms to the WEEE system may therefore be an opportune moment to tighten any ambiguity on what counts as UEEE vs WEEE from the UK perspective.

A circular economy needs to be enabled at material, component and product level as this will ensure as many loops are closed as possible. To support recovery and re-use of materials and components, understanding the scale of the 'urban mine' is important. For urban mining to be successful and economically viable, WEEE must enter the formal recycling system reliably, and at sufficient scale (4). Legislation may need to be changed to fully realise the potential of urban mining.

In the reformed WEEE system, data need to be collected at sufficient granularity not only to be able to map and track critical mineral and other material flows which will support recovery and re-use of specific materials, but also to have an accurate understanding of the scale of WEEE that is available for mining now, and in the future. The storage of many items of sEEE (see response to question 16) at the end of their use phase acts as a barrier to circularity on material, product and component level. If items are stored for many years, the likelihood that the product will have reached obsolescence, e.g. because of hardware or software incompatibility, will increase, therefore rendering the product useless. When it comes to re-use and recovery of materials and components, the items need to be entering in quantities that are economically viable to disassemble them, although if and when supply chains of critical minerals are disrupted the economics of this is likely to change over time. If items have been stored for long periods, it means that it is more likely that they will not be entering into the waste system in these kinds of quantities. In addition, future improvements, e.g. the increased use of robotic disassembly methods, may help to mitigate some of these economic viability considerations. While the materials that an obsolete piece of WEEE contains will likely still have the same value as those recovered from non-obsolete WEEE, there is a decreasing chance that components can be recovered and re-used in a new product. Ultimately, it seems likely that the

longer an item is stored for before entering the circular economy, the more likely it is that it will not be following as tight a loop and therefore its potential value will not have been optimised.

At present, there are some examples of materials recovered from WEEE being used as secondary raw material, e.g. by the Royal Mint. However, increasing the usage of secondary raw materials so this is done at scale will likely require incentivisation or regulation by Government. Alongside this, facilitating cross-sector collaboration to enable the circularity of materials, components and products at industry level will be important in helping to close loops and establishing the usage of secondary raw materials. This is likely to require additional data to be gathered to understand the industrial reliance on various materials, including critical minerals.

(1) *Charles, R.G. et al. (2023) 'Circular economy for perovskite solar cells – drivers, progress and challenges', Energy & Environmental Science, 16(9), pp. 3711–3733. Available at: https://doi.org/10.1039/D3EE00841J.*

(2) *For example:*
Li, J. *et al.* (2013) 'Regional or global WEEE recycling. Where to go?', *Waste Management*, 33(4), pp. 923–934. Available at: https://doi.org/10.1016/j.wasman.2012.11.011.

Sthiannopkao, S. and Wong, M.H. (2013) 'Handling e-waste in developed and developing countries: Initiatives, practices, and consequences', *Science of The Total Environment*, 463–464, pp. 1147–1153. Available at: https://doi.org/10.1016/j.scitotenv.2012.06.088.

Daum, K., Stoler, J. and Grant, R.J. (2017) 'Toward a More Sustainable Trajectory for E-Waste Policy: A Review of a Decade of E-Waste Research in Accra, Ghana', International Journal of Environmental Research and Public Health, 14(2), p. 135. Available at: https://doi.org/10.3390/ijerph14020135.

Odeyingbo, A.O., Nnorom, I.C. and Deubzer, O.K. (2019) 'Used and waste electronics flows into Nigeria: Assessment of the quantities, types, sources, and functionality status', *Science of The Total Environment*, 666, pp. 103–113. Available at: https://doi.org/10.1016/j.scitotenv.2019.02.102.

Puckett, J., Brandt, C. and Palmer, H. (2019) Holes in the Circular Economy: WEEE Leakage from Europe. Seattle: Basel Action Network.

(3) *Arabi et al., 2018 in Cheshmeh, Z.A. et al. (2023) 'A comprehensive review of used electrical and electronic equipment management with a focus on the circular economy-based policy-making', Journal of Cleaner Production, 389, p. 136132. Available at: https://doi.org/10.1016/j.jclepro.2023.136132.*

(4) *For example:*
Ongondo, F.O., Williams, I.D. and Whitlock, G. (2015) 'Distinct Urban Mines: Exploiting secondary resources in unique anthropogenic spaces', *Waste Management*, 45, pp. 4–9. Available at: https://doi.org/10.1016/j.wasman.2015.05.026.

Wang, M. et al. (2017) 'Recovery of rare and precious metals from urban mines—A review', Frontiers of Environmental Science & Engineering, 11(5), p. 1. Available at: https://doi.org/10.1007/s11783-017-0963-1.

Ghisellini, P. et al. (2022) 'Toward circular and socially just urban mining in global societies and cities: Present state and future perspectives', Frontiers in Sustainable Cities, 4. Available at: https://www.frontiersin.org/articles/10.3389/frsc.2022.930061 (Accessed: 1 May 2023).

29. Do you agree or disagree that access to data from retailers and Local Authorities on how much used equipment is received at these collection facilities for re-use (and consequentially diverted away from entering the WEEE producer responsibility system) would provide significant and useful new insight into volumes of equipment being re-used that is not classified as waste? Please select one of the following options:

a. Agree
b. Disagree
c. Unsure

30. Please provide any evidence you may have to support your answer to question 29.

Items of EEE are re-used via both 'informal' (e.g. among family members) and 'formal' (e.g. donated to charity) channels. The proposed changes to the WEEE system outlined above are unlikely to capture the flow of EEE being re-used in more informal ways, but collection data from retailers and local authorities would provide valuable additional information about the more formal re-use flows. Understanding the scale of re-use that is happening via informal methods, and the length of time this might be expanding some product lifespans is likely to be valuable as well. For example, in a nationally representative survey conducted by the Royal Society of Chemistry and IPSOS Mori, intention to re-use a device as a spare was selected by the majority of respondents in a question probing why items were being stored (1).

(1) Royal Society of Chemistry and IPSOS Mori, 2019, please contact policy@rsc.org

31. Please provide evidence (including from international sources) of other potential mechanisms to increase levels of re-use and preparation for reuse activities across a broad range of products.

Better repair infrastructure will be vital in a circular economy and supports the re-use of EEE. However, the challenges of getting items repaired is potentially acting as a significant barrier to re-use at present. In a survey of 321 participants, the majority of respondents considered repairing small items of sEEE to be time consuming, inconvenient and expensive (1) Similar findings were made in a national representative survey carried out by the Royal Society of Chemistry and IPSOS Mori (2). As highlighted in our response to question 24, eco-design principles are important in facilitating repair of EEE, and may need to be incentivised or regulated by Government to drive this change. At present, the growing network of repair cafes helps to support and facilitate repair of EEE, but these rely on volunteers, are infrequent and not widespread across the UK. Repairing items is often expensive and may cost more than buying a new product. The UK's right to repair law introduced in 2021 is welcomed by the Royal Society of Chemistry as an important indication of the intention to improve repair rates in the UK. Given the recent roll out of this law, it is yet unclear what effect it is having. However, expanding the legislation to cover a broader range of products such as laptops and smartphones, alongside other measures to both improve the accessibility of repair infrastructure and also lower the cost of repair, will likely be important in truly supporting repair within a circular economy.

(1) What are WE(EE) doing? Using a social practice theory approach to analyse the disposal of small electrical and electronic items in the UK. Monk, 2023, unpublished study.
(2) Royal Society of Chemistry and IPSOS Mori, 2019, please contact policy@rsc.org

Moving to a circular economy through the design of better products and business models

32. Do you agree or disagree that implementing a system of eco-modulation into the UK's WEEE system could incentivise more sustainable product design? Please select one of the following options:

a. Agree
b. Disagree
c. Unsure

33. Please provide any evidence you have to support your answer to question 32.
The Royal Society of Chemistry is supportive of implementing a system of eco-modulation into the WEEE system with the intention of incentivising more sustainable product design but does not have a position on which of the approaches outlined in Q34 would be most appropriate. Alignment with other jurisdictions beyond the UK is likely to be helpful for producers.

36. Which of the following criteria should be used as an effective basis for eco-modulation:

a. Recycled content
b. Recyclability
c. Reparability
d. Durability
e. Energy efficiency
f. Hazardous substances

37. Are there any other criteria, other than those set out in question 36, which you feel would be relevant? Please specify what these could be.
Expanding on our response to Question 36: When deciding which products to prioritise for eco-modulation, a combination of metrics may be required. A mass-based metric does not take into account the complexity of recycling an item. For example, washing machines have a high mass while tablets are much lower mass but due to their construction are more challenging to recycle. Consideration of the environmental impact of a product across its life cycle as a metric for prioritisation would take into account the differing environmental footprints (e.g. greenhouse house gases, water usage) that products have and, in conjunction with other metrics listed above, may allow for a more nuanced approach to prioritisation. Similarly, taking into account social impacts (e.g. use of conflict minerals) may be an additional metric to consider. Given supply chain risks and the growing demand for many of the critical minerals contained within EEE, prioritisation according to the materials that a product contains may also be useful as part of the efforts to diversify supply chains through greater circularity.
The criteria listed above, used in combination, would be an effective basis for eco-modulation. However, there are potentially some tensions between criteria (e.g. durability vs recyclability or repairability), so finding the correct balance between these criteria will be important and may differ for different types of WEEE. As mentioned in the response to Question 16, facilitating discussions between different actors in a product's value chain will be important when setting these criteria.

39. Do you agree or disagree that eco-modulation should be supported by mandatory labelling to give consumers visibility of the extent to which the product has met certain eco-design criteria? Please select one of the following options:

d) Agree
e) Disagree
f) Unsure

40. Please provide any evidence you have to support your answer to question 39.
In a survey carried out by the Royal Society of Chemistry, the majority of respondents said they would be more likely to buy a piece of technology from a rival to their preferred brand if they knew it was sustainably produced (1). The majority also agreed that it is currently difficult to find out if a device has been produced sustainably before purchasing. Therefore, product labelling that gives consumers better visibility of the sustainability of a product (including eco-design criteria) is likely to be a helpful part of the proposed eco-modulation criteria, and in principle is something the Royal Society of Chemistry is supportive of, depending on the quality, reliability, and implementation of this labelling.

(1) Royal Society of Chemistry and IPSOS Mori, 2019, please contact policy@rsc.org

Improving treatment standards

59. Do you agree or disagree that the recovery and recycling rates for WEEE should be reviewed to ensure that those targets remain sufficiently challenging whilst achievable? Please select one of the following options:

a. Agree
b. Disagree
c. Unsure

60. Please provide details of evidence sources used to support your answer and evidence on the extent current targets are being met and exceeded.
The extent to which WEEE collection targets are met in the UK is unclear (1) although it is likely they have been missed for several years. This is not a problem unique to the UK - tracking what happens to WEEE is complicated (2). Estimates suggest that only 17.4% of global WEEE is collected and recycled properly (3), with rates differing considerably between, and even within, the same geographic region (3; 4). However, as has been outlined in previous responses to questions, being able to map and track WEEE streams, including at the material level, is essential for a number of reasons and will be pivotal for many of the proposals set out in this call for evidence. Therefore, while setting targets that are challenging but achievable is important, ensuring that the data exist to accurately assess whether these targets are being met will be crucial.

(1) Environmental Audit Committee (2020) *Electronic Waste and the Circular Economy - Environmental Audit Committee - House of Commons*. Available at: https://publications.parliament.uk/pa/cm5801/cmselect/cmenvaud/220/22006.htm#_idTextAnchor011

(2) Cheshmeh, Z.A. et al. (2023) 'A comprehensive review of used electrical and electronic equipment management with a focus on the circular economy-based policy-making', Journal of Cleaner Production, 389, p. 136132. Available at: https://doi.org/10.1016/j.jclepro.2023.136132.

(3) *Forti, V. et al. (2020) The Global E-waste Monitor 2020. Bonn, Geneva, Rotterdam: United Nations University (UNU)/United Nations Institute for Training and Research (UNITAR) – co-hosted SCYCLE Programme, International Telecommunication Union (ITU) & International Solid Waste Association (ISWA), p. 120. Available at: http://ewastemonitor.info/wp-content/uploads/2020/12/GEM_2020_def_dec_2020-1.pdf*

(4) *United Nations Environment Programme and United Nations Institute for Training and Research (2023) 2050 Electrical and Electronic Waste Outlook in West Asia. Nairobi and Bonn. Available at: ewastemonitor.info/wp-content/uploads/2023/03/UNEP-UNITAR-2050-Electronic-and-Electrical-Waste-Outlook-in-West-Asia.pdf*

64. Do you agree or disagree that the introduction of individual recovery targets for specific materials, including critical minerals would drive recovery of and demand for those materials thereby contributing to Net Zero and Circular Economy ambitions whilst supporting security of supply of certain materials? Please select one of the following options:

a. Agree
b. Disagree
c. Unsure

65. Please provide any evidence you have to support your answer to question 64.

The Royal Society of Chemistry would welcome the introduction of individual recovery targets for specific materials, including critical minerals. However, it is unlikely that, unless these targets are part of a package of measures, they would be sufficient to drive recovery of and demand for these materials. As was outlined in our response to Question 24, growing the usage of secondary raw materials recovered from WEEE in new products will probably require incentivisation and/or legislation. Understanding the industrial need domestically for critical minerals and other materials recovered from WEEE and how this may change over time (e.g. due to growth in renewables) will be important when considering the domestic versus export market. Investment will be needed in recycling infrastructure if a growing range of materials are to be recovered. The use of different technologies that are better able to separate out individual materials will be needed, e.g. hydrometallurgical rather than pyrometallurgical methods. The current widespread shredding of WEEE as the processing method means that potentially large quantities of important materials are currently either being lost from the system completely, or their potential value decreased. This may need to be specifically addressed either in the targets or via other measures by mandating recovery at a specific value level. Data will need be collected at a sufficiently granular level to be able to ascertain whether these targets are being met.

Expanding on our responses to Questions 66 and 67: Reporting on specified materials ahead of setting targets will likely provide a valuable evidence base that is currently lacking, so we are supportive of this. At the moment, the scale of the 'urban mine' in the UK is not well understood. Some estimates have been made about the potential scale and economic value of WEEE in the urban mine, although several of these studies by necessity are based on old data or have to make several assumptions because the data currently are not available at national level. Different types of WEEE contain different quantities of critical minerals and there may be variation in quantity even within the same product type, even if the same set of materials is broadly being used. Therefore, collecting additional data (and synthesising existing data) before setting targets will help evidence informed decision making.

Once set, in principle we are supportive of the targets being mandatory as this may be a helpful mechanism for improving circularity of materials and eco-design of products.

66. If you agree with question 64: would you support the introduction of reporting on specified materials to form a useful evidence base ahead of setting targets in the future? Please select one of the following options:

a. Agree
b. Disagree
c. Unsure

67. If you answered agree to question 66, should these targets be mandatory or nonbinding?

a. Mandatory
b. Non-binding

68. We require treatment facilities to demonstrate sound management of WEEE, including removal of specified hazardous material and POPs. Are there any other substances and components which should be added to the restricted list? Please provide evidence to support your answer.

The depollution of WEEE is important because of the potential negative impacts on the environment and human health from improperly processed WEEE (1). While treatment facilities in the UK have to demonstrate sound management of WEEE, WEEE that ends up abroad may not be subjected to the same treatment standards. As has been outlined in our response to Question 24, the UK should ensure that the shipping of UEEE which is actually WEEE, or illegally shipping WEEE, is not something that we are contributing to as is currently likely to be the case (2). Within the UK, items that do not get collected in the WEEE stream will be contaminating other waste streams or entering landfill. Both are potentially challenging for the safe management of the hazardous materials that it contains. For example, municipal waste incineration is often not hot enough to fully combust PFAS. If WEEE contaminates normal municipal waste streams, it is likely that PFAS will not be fully mineralised.

Incentivising the move away from hazardous chemicals towards greener alternatives, e.g. via the proposed eco-modulation criteria, could be useful if done in an appropriate way. Banning chemicals on a named basis may not be the most effective way of doing this as it may encourage the use of chemicals with similar compositions and similar impacts being used as replacements. In addition, this does not address existing legacy contamination. Reviewing product standards may also be important as some chemicals or materials may be being used by default (e.g. flame retardants) when they are not strictly necessary for the product in question.

Better product labelling of what is contained within an item, including where the hazardous materials are located, would probably be beneficial to treatment facilities.

While incineration is important to treating hazardous substances, it means that important materials are lost. In addition, incineration has a high energy demand and significant greenhouse gas emissions. Therefore, the treatment of hazardous chemicals needs to be balanced with material recovery and other environmental impacts. This may require additional processing steps so that materials can be recovered, and hazardous chemicals treated appropriately.

PFAS are prolific chemicals in WEEE and should be managed appropriately if they are not already. To support this, ensuring the many hundreds of sources of PFAS are reported and captured in a national inventory is vital. Companies need to know what PFAS they are using, even if the chemical comes from further up in their supply chain, e.g. in equipment or ingredients that are used in their process. Our work on PFAS (3) highlights some of the issues that can occur if they end up in the water supply.

Finally, clarity and transparency about the work of the hazardous chemicals advisory committee would be helpful for the chemical sciences sector.

(1) *For example:*

Charles, R.G. et al. (2019) 'Sustainable Energy Storage for solar home systems in rural Sub-Saharan africa – a comparative examination of lifecycle aspects of battery technologies for circular economy, with emphasis on the South African context', Energy, 166, pp. 1207–1215. doi:10.1016/j.energy.2018.10.053.

Bruce-Vanderpuije, P. et al. (2019) 'Background levels of dioxin-like polychlorinated biphenyls (dlpcbs), polychlorinated, polybrominated and mixed halogenated dibenzo-p-dioxins and dibenzofurans (PCDD/Fs, PBDD/FS & PXDD/FS) in Sera of pregnant women in Accra, Ghana', Science of The Total Environment, 673, pp. 631–642. doi:10.1016/j.scitotenv.2019.04.060.

Bruce-Vanderpuije, P. et al. (2021) 'Infant dietary exposure to dioxin-like polychlorinated biphenyls (dlpcbs), polybrominated and mixed halogenated dibenzo-p-dioxins and Furans (PBDD/Fs and PXDD/FS) in milk samples of lactating mothers in Accra, Ghana', Chemosphere, 263, p. 128156. doi:10.1016/j.chemosphere.2020.128156.

(2) *Environmental Audit Committee (2020) Electronic Waste and the Circular Economy - Environmental Audit Committee - House of Commons. Available at: https://publications.parliament.uk/pa/cm5801/cmselect/cmenvaud/220/22006.htm#_idTextAnchor011*

(3) *Our engagement on chemicals, waste and pollution, Royal Society of Chemistry. Accessible at:* A chemicals strategy for a sustainable chemicals revolution (rsc.org)

69. What do you think are the key barriers to improving material recovery when treating WEEE? Please select one of the following options:

a. Information barrier
b. Technological barrier
c. Other

70. If you answered 'other' to question 69, please specify what this would be.

There are a number of barriers to improving material recovery when treating WEEE. The widespread shredding and incineration of WEEE means that large quantities of critical minerals and other materials are currently being lost from the system. Pyrometallurgical processes also have a high energy demand and high greenhouse gas emissions. Alternative processes such as hydrometallurgy or bio-based recovery may be better at separating and recovering materials; however, these need to be scaled up and the uptake of new technologies by the sector can be slow. Some of this may be down to the regulatory and economic environment within the waste sector, and therefore would need to be addressed to support implementation of new technologies. In addition, better product design can help address the complexity of materials which are being used in a product as this can pose a problem for recycling.

Assessment of the relative environmental impacts of recycling technologies is important to ensure assumptions are not made about which processes are 'greenest'. There will always be trade-offs between the different processes, but a better understanding of these would help support decision making. Assessments should be done at both research and industrial scale. One of the challenges at the research phase of doing lifecycle analysis is access to data that are needed to perform analysis. These data are often classed as commercially sensitive or may be expensive to access. Mechanisms to facilitate access to sensitive data for life cycle analysis, or for reasons that have been outlined previously in this response, would help to support necessary research in these areas. Full lifecycle assessment from 'cradle to cradle' is also important. Any recycling process will have an energy expenditure whether it is in the solvents used in hydrometallurgy or a smelter in pyrometallurgy. However, this should be weighed against the energy and environmental impacts of primary production and processing to avoid 'burden shifting' around the system. These kinds of assessments are lacking at present. For example, Pekarkova et al., (2021) calculate potential emissions reductions of between 312 and 344 Mt CO_2e by 2030 if the quantity of WEEE entering landfill is reduced according to different scenarios (1). Further work should be done to assess and quantify the environmental impacts (positive and/or negative) of a move to a circular economy.

There is likely a skills need or gap. The chemical sciences are integral across the WEEE value chain. Recent analysis carried out by the Royal Society of Chemistry suggests that chemistry jobs are projected to grow in the waste collection, treatment and supply/disposal sector (2). Many of the challenges and barriers that need to be overcome in enabling a circular economy are trans-discipline and trans-sector. Facilitating relationships and synergies between different sectors and parts of the value chain will be essential.

Some types of WEEE are projected to grow substantially, e.g. consumer electronics and solar PV (3). This means that the UK needs to have built the capacity and infrastructure to cope with increased amount of WEEE or will risk the continued loss of critical and valuable materials if these are exported for processing.

Finally, consumers will be pivotal in enabling a circular economy (4) because they dictate what happens to EEE at the end of its life and the path (repair, reuse, recycling, storage, landfill) that an item takes. However, there is a significant gap in understanding how consumer WEEE behaviour can be integrated into a circular economy (5). This needs to be addressed at UK level because it is likely that consumer behaviour is very country context-specific (5).

(1) *Pekarkova, Z. et al. (2021) 'Economic and climate impacts from the incorrect disposal of WEEE', Resources, Conservation and Recycling, 168, p. 105470. Available at: https://doi.org/10.1016/j.resconrec.2021.105470Lightcast*

(2) The Future Chemistry Workforce and Educational Pathways, Royal Society of Chemistry and Lightcast, 2024. Available at: Chemistry future workforce and education pathways data report (rsc.org)

(3) S.Weckend, A.Wade and G.Heath, End-of-life management - Solar Photovoltaic Panels, 2016.

(4) *For example:*
Iacovidou, E., Hahladakis, J.N. and Purnell, P. (2021) 'A systems thinking approach to understanding the challenges of achieving the circular economy', Environmental Science and Pollution Research, 28(19), pp. 24785–24806. Available at: https://doi.org/10.1007/s11356-020-11725-9

Sutcliffe, T.E. (2022) 'Consumption work in household circular economy activities: findings from a cultural probe experiment', Journal of Cultural Economy, 15(5), pp. 568–583. Available at: https://doi.org/10.1080/17530350.2022.2066150

Cheshmeh, Z.A. *et al.* (2023) 'A comprehensive review of used electrical and electronic equipment management with a focus on the circular economy-based policy-making', *Journal of Cleaner Production*, 389, p. 136132. Available at: https://doi.org/10.1016/j.jclepro.2023.136132

(5) *Islam, M.T. et al. (2021) 'A global review of consumer behavior towards e-waste and implications for the circular economy', Journal of Cleaner Production, 316, p. 128297. Available at: https://doi.org/10.1016/j.jclepro.2021.128297.*

71. What information do you think suppliers of products should be required to provide to assist waste treatment operators to increase the recovery of specific materials or components commonly found in WEEE?

Additional information such as (i) what materials are in a product, (ii) where these materials are, (iii) what hazardous materials are used and where they are, and (iv) disassembly instructions, would all help to support material recovery. To support the move up the waste hierarchy, additional information would help to support repair and re-use, including (i) how to repair an item, (ii) how to diagnose faults, and (iii) how to source spares. As has been outlined in a previous answer, labelling for consumers may help support decisions who want to make more sustainable choices with their purchase. In addition, more prominent labelling of the need to recycle or re-use products may act as a useful reminder for consumers.