Challenges and Opportunities of Increasing Material Circularity

DATE: March 24, 2023
SUBJECT: Request for Information (RFI)

Description

This is a Request for Information (RFI) issued by the U.S. Department of Energy (DOE) on behalf of the Advanced Materials and Manufacturing Office (AMMTO). The intent of this RFI is to better understand the key opportunities and challenges associated with increased material circularity to inform future funding in this area.

Background

The mission of DOE is to ensure U.S. security and prosperity by addressing its energy, environmental, and nuclear challenges through transformative science and technology solutions.[1] To advance its mission, the priorities of the DOE are to combat the climate crisis, create clean energy union jobs, and promote energy justice. Over the last decade, national investments in advanced manufacturing and decarbonization have grown significantly. DOE is investing more than ever in a decarbonized and competitive industrial sector and a domestic clean energy manufacturing base.

In recognition of the national urgency to address and focus on the missions of DOE, the AMMTO office was established to focus on accelerating innovation in the manufacturing sector and supporting a domestic clean energy technology manufacturing economy.[2] The mission of AMMTO is to advance energy-related materials and manufacturing technologies to increase domestic competitiveness and build a clean, decarbonized economy. AMMTO programs support research, development, and demonstration of next-generation materials and innovative manufacturing technologies that enable more efficient use and domestic production of clean energy technologies.

The Secure and Sustainable Materials Program within AMMTO is intended to ensure secure and sustainable supply chains for the clean economy. The program funds research, development, and demonstration to advance the circular economy for a broad range of materials through material and product design, recycling technology development, and reverse supply chain logistics.[3] The program also includes a critical minerals and materials portfolio that addresses high-impact opportunities and challenges across the entire life cycle of high priority critical

[1] U.S. Department of Energy, Mission, 2022. https://www.energy.gov/mission
[2] U.S. Department of Energy, About the AMO Restructure, 2022. https://www.energy.gov/eere/amo/about-amo-restructure
[3] U.S. Department of Energy, Secure and Sustainable Materials, 2022. https://www.energy.gov/eere/amo/secure-and-sustainable-materials

minerals and materials for energy technologies.[4] Material circularity aims to minimize waste and maximize the re-use of materials to maximize the amount of material re-entering the economy at the end of life for a product. For example, re-using or recycling extends the lifetime of materials in the economy.

Energy Equity: On January 20, 2021, President Biden signed Executive Order 13985 - Advancing Racial Equity and Support for Underserved Communities Through the Federal Government. The E.O. defines "equity" to mean the consistent and systematic fair, just, and impartial treatment of all individuals, including individuals who belong to underserved communities that have been denied such treatment. Discussion of energy equity should focus on how AMMTO funding could drive equitable access to, participation in, and distribution of the benefits produced from successful technology innovations to disadvantaged communities and groups.

Prize Competitions: Prize competitions are an approach the Federal government can use to engage a broad range of stakeholders to develop solutions to difficult problems. The prize sponsor defines a problem and offers a reward for a solution.[5] Rewards can be monetary as well as non-monetary, such as national recognition, testing and validation of technologies, access to experts and specialists, and other organizational support. A key characteristic of challenges and prize competitions is they clearly define a problem without prescribing a particular solution path and rewards provided at the end of the competition. This contrasts with traditional grant or cooperative R&D funding in which participants are selected up front with funding provided at the beginning to pursue a target or goal. Examples of DOE prize competitions include the U.S. Lithium-Ion Battery Recycling Prize[6] and the Community Clean Energy Coalition Prize.[7] Examples of other Federal prizes can be viewed at American Made Challenges and Challenge.gov. Prizes are issued under 15 USC 3719 and which is a separate and distinct authority from grants, cooperative agreements under 2 CFR 200 or procurement contracts under the Federal Acquisition Regulation.

Purpose

The purpose of this RFI is to solicit feedback from industry, academia, research laboratories, government agencies, and other stakeholders on issues related to the key opportunities and challenges associated with increased material circularity.

[4] U.S. Department of Energy, Critical Minerals and Materials, 2022. https://www.energy.gov/eere/amo/critical-minerals-and-materials

[5] For an overview of challenges and prize competitions, see Hendrix, M. 2014. *The Power of Prizes: Incentivizing Radical Innovation*. Washington, DC: U.S. Chamber of Commerce Foundation.

[6] U.S. Department of Energy, Lithium-Ion Battery Recycling Prize, 2021. https://americanmadechallenges.org/challenges/batteryrecycling/

[7] U.S. Department of Energy, Community Clean Energy Coalition Prize, 2022. https://americanmadechallenges.org/challenges/cleanenergycoalition/

EERE is specifically interested in information on:

- Challenges and opportunities in transitioning from a linear to a circular economy
- Life Cycle Databases and tools used in generating Environmental Product Declarations
- Prizes to incentivize innovation and reduce demand for virgin materials
- Potential for electronic waste (e-waste) to be a viable source of critical materials and associated barriers.

This is solely a request for information and not a Funding Opportunity Announcement (FOA). EERE is not accepting applications. DOE will not publish the information collected through this RFI. DOE may use the information provided through this RFI to develop funding opportunities, challenges, and prize competitions.

Disclaimer and Important Notes

This RFI is not a Funding Opportunity Announcement (FOA); therefore, EERE is not accepting applications at this time. EERE may issue a FOA in the future based on or related to the content and responses to this RFI; however, EERE may also elect not to issue a FOA. There is no guarantee that a FOA will be issued as a result of this RFI. Responding to this RFI does not provide any advantage or disadvantage to potential applicants if EERE chooses to issue a FOA regarding the subject matter. Final details, including the anticipated award size, quantity, and timing of EERE funded awards, will be subject to Congressional appropriations and direction.

Any information obtained as a result of this RFI is intended to be used by the Government on a non-attribution basis for planning and strategy development; this RFI does not constitute a formal solicitation for proposals or abstracts. Your response to this notice will be treated as information only. EERE will review and consider all responses in its formulation of program strategies for the identified materials of interest that are the subject of this request. EERE will not provide reimbursement for costs incurred in responding to this RFI. Respondents are advised that EERE is under no obligation to acknowledge receipt of the information received or provide feedback to respondents with respect to any information submitted under this RFI. Responses to this RFI do not bind EERE to any further actions related to this topic.

Confidential Business Information

Pursuant to 10 CFR 1004.11, any person submitting information that he or she believes to be confidential and exempt by law from public disclosure should submit via email, postal mail, or hand delivery two well-marked copies: one copy of the document marked “confidential” including all the information believed to be confidential, and one copy of the document marked “non-confidential” with the information believed to be confidential deleted. Submit these documents via email or on a CD, if feasible. DOE will make its own determination about the confidential status of the information and treat it according to its determination.

Evaluation and Administration by Federal and Non-Federal Personnel

Federal employees are subject to the non-disclosure requirements of a criminal statute, the Trade Secrets Act, 18 USC 1905. The Government may seek the advice of qualified non-Federal personnel. The Government may also use non-Federal personnel to conduct routine, nondiscretionary administrative activities. The respondents, by submitting their response, consent to EERE providing their response to non-Federal parties. Non-Federal parties given access to responses must be subject to an appropriate obligation of confidentiality prior to being given the access. Submissions may be reviewed by support contractors and private consultants.

Request for Information Categories and Questions

You may answer as few or as many of the questions below as you would like, but please focus on the aspects that are most pertinent to you or your field.

Category A: Challenges and Opportunities of Transitioning from a Linear to Circular Economy

Manufacturing systems have traditionally been based on a linear model. Raw materials are extracted from nature, manufactured into intermediate and then end-products, and finally disposed of in a landfill at the end of the product's useful life. Decreasing demand for virgin materials by utilizing materials recovered from waste streams is critical to decarbonizing the U.S. economy. Circular economy approaches[8], described in Figure 1, below, can decrease the lifetime energy cost of materials[9] and could have a significant impact on global emissions.[10]

The transition to a circular economy represents a strategic opportunity for the United States to pioneer new technologies with international demand and to strengthen domestic supply chains ranging from critical materials to commodities. However, recovery supply chains are complex with diverse value propositions and waste stream compositions that vary by region and over time.

[8] Potting, J., Hekkert, M., Worrell, E., and A. Hanemaaijer, Circular Economy: Measuring Innovation in the Product Chains. Policy Report, The Hague: PBL Netherlands Environmental Assessment Agency, 2017. https://www.pbl.nl/sites/default/files/downloads/pbl-2016-circular-economy-measuring-innovation-in-product-chains-2544.pdf.

[9] U.S. Department of Energy, Circular Economy Technologies and Systems, 2022. https://www.energy.gov/eere/amo/circular-economy-technologies-and-systems

[10] Ellen MacArthur Foundation, Completing the Picture: How the Circular Economy Tackles Climate Change, 2021. https://ellenmacarthurfoundation.org/completing-the-picture

	Strategy		Description
Smarter product use and manufacture	R0	Refuse	Making products redundant by abandoning their function or by offering the same function with a radically different product
	R1	Rethink	Make product use more intensive (e.g. through product-as-aservice, reuse and sharing models or by putting multi-functional products on the market)
	R2	Reduce	Increase efficiency in product manufacture or use by consuming fewer natural resources and materials
Extend lifespan of product and its parts	**R3**	**Re-use**	**Re-use by another consumer of discarded product which is still in good condition and fulfills its original function**
	R4	**Repair**	**Repair and maintenance of defective product so it can be used for its original function**
	R5	**Refurbish**	**Restore an old product and bring it up to date**
	R6	**Remanufacture**	**Use parts of discarded products in a new product with the same function**
	R7	**Repurpose**	**Use discarded products or their parts in a new product with a different function**
Useful application of materials	**R8**	**Recycle**	**Process materials to a commodity level with same or lower quality**
	R9	Recovery	Incineration of materials with energy recovery

In Scope

Increasing Circularity

Figure 1. Circular Strategies within the production chain (Potting et al., 2017).[11]

For the purposes of this RFI, we are interested in strategies that re-introduce a broad range of materials from end-of-life products back into the economy. Materials of interest include: plastics, paper, wood, metals, textiles, glass, concrete, construction materials, semi-conductors, critical minerals, and other manufacturing materials. Food and biomass other than paper and wood are not of interest. Strategies of interest include: re-use (R3), repair (R4), refurbish (R5), remanufacture (R6), repurpose (R7) and recycle (R8) as illustrated in Figure 1. We are not interested in refuse (R0), rethink (R1), reduce (R2) or recovery (R9). End uses where waste is converted to fuel or incinerated for energy are not of interest nor are uses that do not reduce the demand for virgin materials in manufacturing. Except for hazardous waste, we are interested in all waste streams such as municipal solid waste, industrial waste, non-biomass agricultural waste, and construction and demolition debris.

We are not soliciting policy recommendations or proposals; however, we are interested in understanding how current, new, or proposed policies impact the transition from a linear economy. We are particularly interested in learning about technical solutions to reduce

[11] Potting, J., Hekkert, M., Worrell, E., and A. Hanemaaijer, Circular Economy: Measuring Innovation in the Product Chains. Policy Report, The Hague: PBL Netherlands Environmental Assessment Agency, 2017. https://www.pbl.nl/sites/default/files/downloads/pbl-2016-circular-economy-measuring-innovation-in-product-chains-2544.pdf.

development time and accelerate adoption of emerging circular economy technologies as well as technical solutions for manufacturing challenges related to circular economy approaches to improve energy efficiency, reduce carbon intensity, and ensure economic competitiveness.

Responses to Category A may address one or more of the following questions. Please be as specific as possible, indicating materials, technologies, industry sector or waste stream being considered when answering.

Challenges, opportunities, and impacts of increased materials recovery

A1. What are the key technical and non-technical challenges that, if overcome, would allow significant increase in materials recovered from waste streams re-entering the U.S. economy?

A2. To overcome these challenges, what tools, data, standards, technology development, or supply chain innovation would be most impactful if developed or expanded?

A3. Which materials or waste streams have the largest potential for decarbonizing the U.S. economy via an increase in re-use, repair, refurbish, remanufacture, repurpose or recycling?

   a. Which opportunities are addressable with commercial technologies? Which require further technology development?

A4. What metrics should be used to evaluate the impact of increased circularity of different materials or waste streams?

A5. How can the impact of different approaches such as re-use, repair, refurbish, remanufacture, repurpose and recycle be best compared? Do new tools or analysis approaches need to be developed?

Market development and supply chains for recovered materials

A6. What are the challenges to finding markets and developing end-uses for end-of-life materials?

A7. What are the main barriers to scaling up the use of materials diverted from waste streams?

A8. How are changes in policy at the international, federal, state, or local level impacting market development for materials diverted from waste streams?

A9. Who are the main players in the value chain[12] and are there gaps?

A10. Are there barriers to replicating approaches across regions/localities? If so, what are they, and how may they be best addressed?

[12] For this RFI, we use the term value chain to represent the processes that a material or component goes through between end of life and reintroduction into a manufacturing supply chain.

Energy Justice and Equity implications of increased material recovery

A11. What steps can be taken to ensure that the needs and perspectives of underserved communities are considered and incorporated when expanding the use of end-of-life materials in U.S. manufacturing?

A12. Which communities will be most affected by a transition to a circular economy?

A13. Which human health, environmental or ecological factors do you consider when assessing technologies for a circular economy?

Other Considerations

A14. How can AMMTO support companies or industries in working together to increase adoption of circular economy practices or technology? What stakeholder engagement mechanisms could be used to inform, engage, and incentivize companies and industries to collaborate?

A15. What recent advances in manufacturing technologies, material science, or supply chains are poised to have the greatest impact on the circular economy?

A16. Please comment on any other challenges or opportunities related to the circular economy that AMMTO should be aware of?

Category B: Life cycle databases and tools used in generating Environmental Product Declarations

Quantification of the impacts of various circular economy approaches is complex and the lack of data and test cases can make it challenging for companies and consumers to weigh the benefits with the costs. Environmental Product Declarations (EPD) and Life Cycle Assessments (LCA) are tools that are used to compare the environmental impacts of different products. An EPD is defined as a declaration that "quantifies environmental information on the life cycle of a product to enable comparisons between products fulfilling the same function."[13] LCA is a tool that quantifies the environmental impacts of the life cycle of a product or process or service from raw material acquisition through production, use, end-of-life treatment, recycling, and final disposal.

Data quality and interoperability is a challenge. However, there are publicly-available resources such as the U.S. Life Cycle Inventory (USLCI) database[14] and the Federal LCA Commons (FLCAC)[15] that provide lifecycle data and methodologies on a variety of products.

[13] ISO 14025:2006 Environmental labels and declarations Type III environmental declarations Principles and procedures

[14] NREL, U.S. Life Cycle Inventory Database, 2012. https://www.nrel.gov/lci/

[15] NREL, Federal Life Cycle Assessment Commons, 2022. https://www.lcacommons.gov/

AMMTO is interested in understanding how EPD and LCA methodologies as well as the USLCI and FLCAC are currently being used, how they could be used to accelerate the transition to a more circular economy, what the barriers to wider adoption are, and what tools or data development is needed.

Responses to Category B may address one or more of the following questions:

B1. How are LCAs or EPDs used to make decisions in your organization?

B2. If you or your organization perform LCAs or generate EPDs:

   a. Who generates them and what is the motivation?
   b. What is the benefit for you or your organization?
   c. What are the challenges?

B3. What tools do you use to perform LCAs or to generate EPDs? Are there barriers to access for LCA/EPD tools (i.e., costs of software/hiring a consulting company, data availability or other factors)?

B4. What are the challenges with regards to LCA methodology? Are ISO standards sufficient to establish LCA methodologies for your specific products/services? If not, why?

B5. What are barriers for small, medium, or large businesses when generating EPDs? What would be most helpful in reducing these barriers?

B6. If you use the U.S. Life Cycle Inventory Database or Federal Life Cycle Assessment Commons:

   a. Why and how do you use them?
   b. What are the challenges to using them and how could they be improved?

B7. What would increase manufacturer participation in databases used in generating EPDs such as the U.S. Life Cycle Inventory Database or the Federal Life Cycle Assessment Commons datasets?

   a. What additional tools are needed?
   b. What support could be offered to facilitate use?

B8. What improvements to data are needed for such LCI/LCA databases?

B9. Please comment on any other challenges or opportunities related to LCI/LCA databases or EPDs that AMMTO should be aware of.

Category C: Prize to incentivize innovation and reduce demand for virgin materials

DOE is considering a potential prize competition that is intended to encourage U.S. researchers, entrepreneurs, and innovators across the value chain to collaborate to find and deploy novel solutions that have the potential to substantially reduce the amount of virgin materials used in

U.S. manufacturing. Prize participants are expected to develop and demonstrate a new supply chain or an improvement in an existing supply chain that diverts material that is currently landfilled or incinerated back into the economy through circular economy approaches of re-use, repair, refurbish, remanufacture, repurpose or recycling. Teams are likely to be comprised of innovators from academia, for-profit entities, non-profit entities, and municipalities. The envisioned outcome of this prize is to pioneer new technologies with international demand, provide a forum to spur new connections along the recovery value chain, and socialize innovations across regions. An additional objective is to generate LCA data for real-world circular economy test cases that can be used broadly.

As currently envisioned, the prize would consist of three phases:

- Phase 1 Incubation: teams form and conceptualize their innovation.
- Phase 2 Prototyping: teams refine their innovation and ensure it can be integrated into a supply chain.
- Phase 3 Demonstration: teams demonstrate their innovation is fully integrated into a supply chain and providing substantial impact.

Winners would demonstrate potential for substantial benefit over the existing state and have the potential to be deployed broadly. AMMTO anticipates awarding $7 million over the course of the prize.

Quantitative metrics would play a critical role in the judging process of all phases of the competition. DOE envisions applicants will need to demonstrate their concepts' potential to reduce embodied emissions of products manufactured from diverted materials, as well as the amount and value of diverted material re-entering the economy. Additional metrics or guidance would be developed to assess submissions on other criteria, including ability to scale / replicate, innovate, additional environmental justice benefits, and robustness.

Input from this RFI may be used to further develop the prize objectives, structure, rules, metrics, and incentives.

Responses to Category C may address one or more of the following questions:

C1. Can such a prize have impact on reducing the amount of virgin materials used in U.S. manufacturing? Are there other complementary activities that can be pursued to increase the impact of the prize?

C2. Is the proposed three-phase prize the most effective prize design to achieve the goal? If not, please suggest and justify an alternative structure.

C3. What would be a suitable length for each phase?
C4. What monetary award values would be sufficient to incentivize participation at each stage?
C5. How could the proposed prize encourage a diverse range of competitors from a broad range of stakeholder sectors, including participants across the value chain, to participate?
C6. What metrics should be used to evaluate impact of the innovations? These could include economic viability, decarbonization potential, justice and equity implications, scalability, or other metrics.
   a. If suggesting a quantitative metric, please comment on an appropriate tool or methodology to perform the quantification.
   b. If suggesting a qualitative metric, please comment on an appropriate approach for incorporation into the judging.
C7. Would a voucher for national lab assistance to do an LCA incentivize participation?
   a. What is the right timing for this support?
   b. What confidentiality concerns might the competitors have about generating and publishing LCA data related to their innovations? If so, please explain.
   c. Are there alternative ways to support the goal of publishing LCA data other than providing national lab support? If so, please describe.
C8. In order to maximize impact, who are the primary partners or competitors needed?
C9. Please share any other perspectives on details of prize design and any other considerations AMMTO should keep in mind.

Category D: Critical material recovery from electronic waste

- Critical materials[16] provide the building blocks for many modern technologies and are essential to our national security and economic prosperity. These materials can be found in electronic waste, which includes devices like mobile phones and household appliances. Clean energy technologies such as electric vehicles, wind turbines, and solar panels also rely heavily on critical materials, the demand for which is set to skyrocket by 400-600 percent over the next several decades.[17,18]

[16] Critical Materials are defined in the Energy Act of 2020 and outlined on the DOE Critical Minerals and Materials website: https://www.energy.gov/critical-minerals-materials.
[17] White House Fact Sheet: Securing a Made in America Supply Chain for Critical Minerals, 2022. https://www.whitehouse.gov/briefing-room/statements-releases/2022/02/22/fact-sheet-securing-a-made-in-america-supply-chain-for-critical-minerals/
[18] U.S. Department of Energy, Critical Minerals and Materials, 2022. https://www.energy.gov/eere/amo/critical-minerals-and-materials

The agency has a comprehensive strategy and vision[19] for building a secure and sustainable supply chain of critical materials, which depends on a robust, scalable, and economically viable circular economy that can extend the lifetime of critical materials and displace the reliance on virgin feedstocks.

E-waste is the world's fastest growing waste stream with the U.S. responsible for producing one sixth of all e-waste. Global e-waste production is projected to double 2014 levels by 2030. Nearly 83% of e-waste was landfilled in 2019, representing a $47 billion value.[20] The e-waste recycling value chain is fragmented with stakeholders developing extraction and separation technologies missing the vital information on collection, sorting, and concentration to optimize their processes. As the complexity of the e-waste feedstock grows with increased heterogeneity and new material structures each year, data sharing along the value chain is essential. As e-waste recycling technologies are developed and optimized, they must undergo life cycle and technoeconomic analysis (LCA/TEA) to validate e-waste streams as a secure and sustainable source of critical materials compared to virgin feedstocks.

AMMTO is interested in developing a prize to encourage connectivity across the e-waste recycling value chain, including collection, sorting and feedstock concentration, separation and extraction, qualification, and reintroduction. The prize would emphasize collaborations that inform and improve the efficiency and economic viability of critical materials recovery from e-waste. Successful teams would demonstrate recovered material as a viable replacement for virgin material, by spurring innovative approaches that can be deployed at scale to enhance the efficiency and cost of extracting critical materials from recycled electronic waste. This prize would also serve to build on existing DOE investments to develop extraction and separation technologies that recover critical materials from e-waste. Implementing these technologies through integration, scaling, streamlining, and optimization within the value chain will help to transition the technologies and realize the benefits that attracted DOE investment at early stages of development.

This RFI aims to solicit responses that describe the barriers to developing a secure and sustainable supply of critical materials from e-waste that can displace virgin feedstocks and recommend innovative solutions or opportunities to reduce or mitigate those barriers. To the extent possible, DOE is interested in learning where connections can be fortified across the value chain to build a more robust supply of critical materials from e-waste. For the purposes of this RFI, we are interested in strategies that address the recovery of critical materials from end-

19 U.S. Department of Energy, Critical Minerals and Materials: U. S. Department of Energy's Strategy to Support Domestic Critical Mineral and Material Supply Chains (FY 2021-FY2031), 2021.

20 Orti V., Baldé C.P., Kuehr R., Bel G. The Global E-waste Monitor 2020: Quantities, flows and the circular economy potential. 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), Bonn/Geneva/Rotterdam. [GEM_2020_def_july1_low.pdf (ewastemonitor.info)]

of-life (EOL) electronic devices, components, or materials that would otherwise be landfilled or incinerated. The scope of opportunity spans from end-of-life to reintroduction, therefore including, but not limited to, collection, sorting and feedstock concentration, separation and extraction, qualification, and reintroduction.

Approaches that address lithium-ion batteries are not of interest to this RFI.

Responses to this Category may address one or more of the following questions:

Market Development

- D1. Where are disconnects along the critical material recovery in the e-waste recycling value chain? For example, separation and extraction process developers lack the feedstock composition and economics data that is necessary to optimize the technologies.
    - a. What tools, data, or other government functions may address these disconnects?
    - b. Where would teaming or creating connection along the value chain have the biggest impact? How can this best be achieved or incentivized?
- D2. To what extent is material characterization or benchmarking a barrier to establishing a critical material supply from e-waste?
    - a. What are the challenges with specifying[21] or benchmarking e-waste entering a recycling process?
    - b. What are the challenges with specifying or benchmarking critical materials recovered from a recycling process?
    - c. What technological or non-technological developments would overcome these challenges?
- D3. Is there opportunity to improve economics of recovery of a primary critical material by recovering one or more additional materials?
    - a. What materials are commonly found together where co-recovery would be beneficial? If needed, please specify e-waste type, where they are found together, and at which step in the value chain co-recovery should occur.
    - b. What are the technical or non-technical challenges to co-recovery?
    - c. For recyclers currently processing e-waste, does CM recovery pose a disruption to business as usual, and if so, what considerations should be considered to mitigate the disruption?

[21] Specifying: the act of choosing the material best suited to achieve the requirements of a given application.

D4. What are the metrics (properties of materials, costs, availability) of Ga, In, Mg, Pt, or other critical materials from virgin feedstocks that recycled feedstocks would need to match to be competitive?

D5. What plans do manufactures have for utilizing recycled materials?
   a. Will they be used "as is" or will they be blended with virgin material and processed together?
   b. If they are to be blended, what percent of recycled/recovered content (in mass percent) is targeted?

D6. How do other EOL pathways (re-use, repair, refurbish, remanufacture, repurpose) for e-waste currently compete with critical material recovery via recycling? Will they compete in the future?
   a. Is there an opportunity or market for direct reuse of electronic components to displace the use of virgin materials to develop new components? If so, please explain.

Technological Challenges

D7. What are the current technological challenges facing the following recycling steps: collection, sorting, pre-treatment, processing, refining, validation, material qualification? What needs to be done to overcome those challenges?

D8. What are the technical and/or economic opportunities and challenges to concentrate critical material from electronic waste streams across the value chain?

Justice, Equity, and Health Considerations

D9. Describe possible human health, environmental, or ecological considerations, both positive and negative (e.g., air quality impacts, sensitive ecosystems, National Environmental Policy Act (NEPA) issues, environmental justice communities, etc.) related to critical material recovery from e-waste recycling.

D10. How are adverse impacts of waste and recycling facilities currently measured or monitored? Which materials, processes, and/or components result in the largest environmental impacts? What opportunities exist to minimize such impacts?

Other Considerations

D11. What are the trade-offs between regional vs. more centralized development of e-waste recycling and reintroduction?
   a. What role do state and local governments have in building a regional e-waste recycling network?

This is a Request for Information (RFI) only. EERE will not pay for information provided under this RFI and no project will be supported as a result of this RFI. This RFI is not accepting applications for financial assistance or financial incentives. EERE may or may not issue a Funding Opportunity Announcement (FOA) based on consideration of the input received from this RFI.

D12. Are there recent advances in technology, material science, or supply chains related recovery of critical materials from EOL e-waste that DOE should be aware of?
D13. What opportunities are there for education and workforce training to support the growth of critical material production from e-waste?
D14. Please comment on any other challenges or opportunities related to recovery of critical materials from EOL e-waste that DOE should be aware of.

Request for Information Response Guidelines

Responses to this RFI must be submitted electronically to CircularEconomyRFI@ee.doe.gov no later than 5:00pm (ET) on May 1, 2023. Responses must be provided as attachments to an email. It is recommended that attachments with file sizes exceeding 25MB be compressed (i.e., zipped) to ensure message delivery. Responses must be provided as a Microsoft Word (.docx) attachment to the email, and no more than 10 pages in length, 12 point font, 1 inch margins. Only electronic responses will be accepted.

Please identify your answers by responding to a specific question or topic if applicable. Respondents may answer as many or as few questions as they wish.

EERE will not respond to individual submissions or publish publicly a compendium of responses. A response to this RFI will not be viewed as a binding commitment to develop or pursue the project or ideas discussed.

Respondents are requested to provide the following information at the start of their response to this RFI:

- Company / institution name;
- Company / institution contact;
- Contact's address, phone number, and e-mail address.