# Department of Energy
# Critical Materials Assessment

DATE: June 20, 2023
SUBJECT: Proposed Determination and Request for Information (RFI)

## Description

This is a Proposed Determination and Request for Information (RFI) issued by the U.S. Department of Energy (DOE). This Proposed Determination recommends a draft critical materials list pursuant to section 7002(a)(2) of the Energy Act of 2020 along with the methodology and analysis used by DOE. The RFI seeks public input to improve upon DOE's Critical Materials Assessment for energy. Specifically, this RFI seeks input on:

- Data and Information to Support Revision of Analysis
- Improvements to the Methodology

## Background

In 2010, DOE established a methodology to assess material criticality based on the potential for supply risk for a range of energy technologies, resulting in DOE's initial Critical Materials Strategy.[1] Section 7002(a)(2) of the Energy Act of 2020 (codified at 30 U.S.C. § 1606(a)(2)) authorizes the Secretary of Energy to determine critical materials according to the following statutory definition[2] of a "critical material":

- Any non-fuel mineral, element, substance, or material that the Secretary of Energy determines:
  - (i) has a high risk of a supply chain disruption; and
  - (ii) serves an essential function in one or more energy technologies, including technologies that produce, transmit, store, and conserve energy; or
- A critical mineral [as designated by the Secretary of the Interior[3]].

Historically, DOE has leveraged the assessment of critical materials to inform priorities for research activities. Since 2010, DOE's research portfolio has expanded into a Critical Materials Research, Development, Demonstration, and Commercialization Application (RDD&CA) Program.[4] Inclusion on DOE's critical material list will inform crosscutting priorities including, but not limited to:

[1] https://www.energy.gov/sites/prod/files/2019/06/f63/DOE_CMS2011_FINAL_Full_1.pdf
[2] Consolidated Appropriations Act, 2021, Public Law 116-260 (Dec. 27, 2020), Div. Z, Title VII, section 7002(a)(2) [hereinafter Energy Act of 2020].
[3] https://www.federalregister.gov/documents/2022/02/24/2022-04027/2022-final-list-of-critical-minerals
[4] https://www.energy.gov/critical-minerals-materials

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- Critical Materials RDD&CA Program priorities
- Eligibility for the Inflation Reduction Act 48C tax credit

The dynamic nature of criticality necessitates ongoing updates to the assessment. For example, in 2011 rare earth elements (terbium, europium, and yttrium) were assessed to be critical for fluorescent lighting, but the rapid market growth of light emitting diode (LED) lighting mitigated the supply risk. LED lighting requires roughly an order of magnitude less rare earth phosphor and has surpassed fluorescent lighting market share. DOE anticipates updating the assessment every three years to reflect the most current data underlying the methodology described below.

## I. Proposed Determination

*Draft Critical Materials List*

Using the methodology described below, DOE is tentatively proposing the following draft list of critical materials be:

- **Critical materials for energy:** aluminum, cobalt, copper, dysprosium, electrical steel, fluorine, gallium, iridium, lithium, magnesium, natural graphite, neodymium, nickel, platinum, praseodymium, silicon, and silicon carbide.
- **Critical minerals:** The Secretary of the Interior, acting through the Director of the U.S. Geological Survey (USGS), published a 2022 final list of critical minerals that includes the following 50 minerals: "Aluminum, antimony, arsenic, barite, beryllium, bismuth, cerium, cesium, chromium, cobalt, dysprosium, erbium, europium, fluorspar, gadolinium, gallium, germanium, graphite, hafnium, holmium, indium, iridium, lanthanum, lithium, lutetium, magnesium, manganese, neodymium, nickel, niobium, palladium, platinum, praseodymium, rhodium, rubidium, ruthenium, samarium, scandium, tantalum, tellurium, terbium, thulium, tin, titanium, tungsten, vanadium, ytterbium, yttrium, zinc, and zirconium."[5]

Uranium was evaluated under this methodology and, as noted below, meets the threshold to be included on the draft list of critical materials for energy. However, section 7002(a) of the Energy Act of 2020 restricts the listing of critical materials to "any non-fuel mineral, element, substance, or material." The assessment below included uranium's use as fuel for commercial power reactors in its analysis, as opposed to strictly focusing on its non-fuel energy uses. For that reason, DOE is not proposing to designate uranium as a critical material at this time.

The draft list of **critical materials for energy** is based on the criticality assessed in the short- and medium-term, as described in the matrices in Figures 1 and 2 below:

[5] https://www.federalregister.gov/documents/2022/02/24/2022-04027/2022-final-list-of-critical-minerals

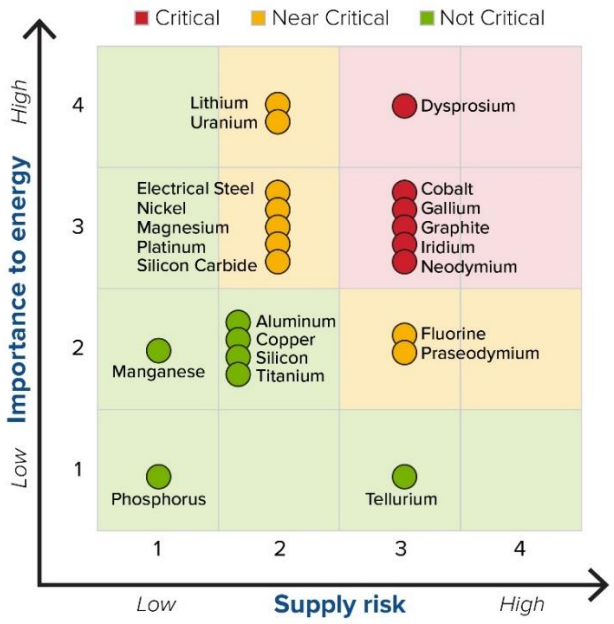


*Figure 1: Short-term (2020 – 2025) criticality matrix*


*Figure 2: Medium term (2025 – 2035) criticality matrix*

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DOE has applied a policy factor to include 4 tiers of materials on the draft critical materials list based on their criticality in the short and medium term as shown in Figure 3. These tiers are defined as follows:

- **Tier 1:** Materials that are critical in both the short and medium term;
- **Tier 2:** Materials that are critical in the medium term only;
- **Tier 3:** Materials that are near critical in both the short and medium term; and
- **Tier 4:** Materials that are near critical in the medium term, but not critical in the short term.

Materials that are not critical in either the short or medium term are not included on the draft critical material list.

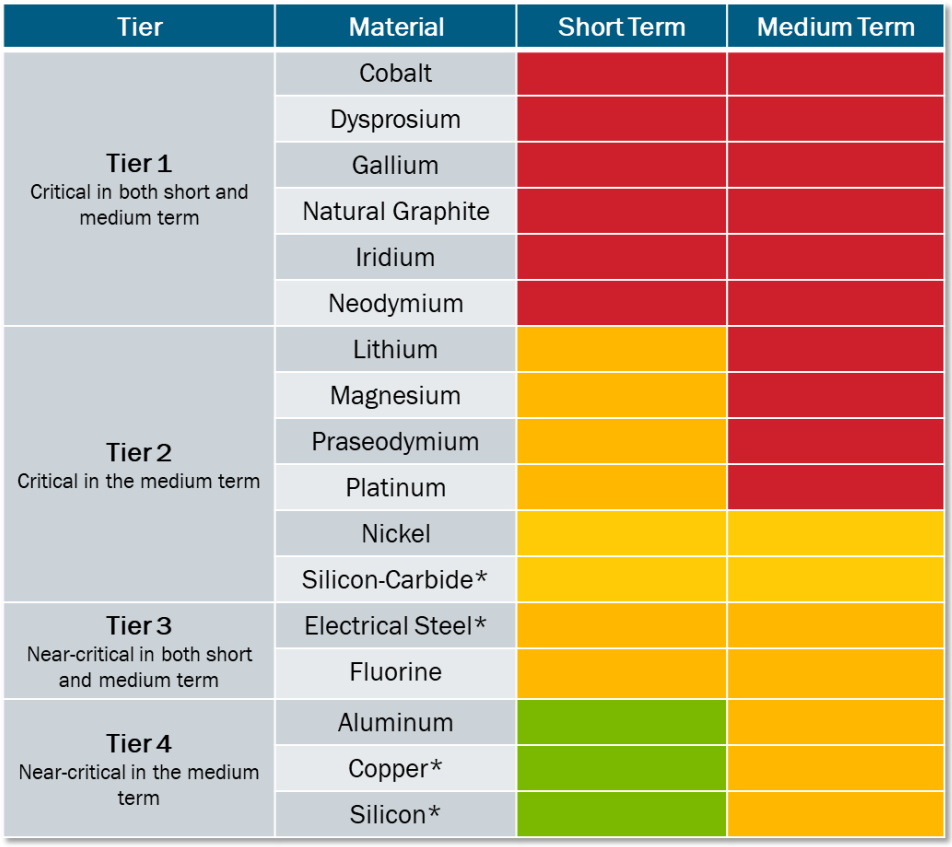


*Figure 3: Tiers indicating each materials criticality in the short and medium terms. *Indicates materials not designated as critical minerals by the Secretary of Interior.*

*Methodology*

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DOE determined that the existing methodology was consistent with the statutory definition and has applied this methodology to determine a draft list of critical materials. For the purposes of this assessment, **energy technologies** that support *both* the DOE mission and DOE critical minerals and materials (CMM) vision were considered.

- DOE Mission: to ensure America's security and prosperity by addressing its energy, environmental and nuclear challenges through transformative science and technology solutions.[6]
- DOE CMM Vision: to build reliable, resilient, affordable, diverse, sustainable, and secure **domestic CMM supply chains that support the clean energy transition and decarbonization** of the energy, manufacturing, and transportation economies while promoting safe, sustainable, economic, and environmentally just solutions to meet current and future needs.

The following energy technologies and materials were assessed:

| Energy application categories | Technology | Components/sub-technology | Materials |
|---|---|---|---|
| Transmission | HVDC | Converters, transformers, breakers & switches | Copper, electrical steel |
| | HVAC | Transformers | |
| Generation | Nuclear | Fuels, moderators | Uranium[7] |
| | Solar | PVs | Silicon, Tellurium |
| | Wind | Off-shore: Magnets | Neodymium, Praseodymium, Dysprosium, Gallium |
| | | Offshore: Wiring | Copper |
| | | Land-based: Wiring | Copper |
| Energy Storage | Batteries | Lithium-ion batteries, zinc air, iron air, sodium air, flow batteries | Lithium, graphite |
| End-use | Hydrogen | Electrolyzers | Platinum, Iridium, Titanium |

[6] https://www.energy.gov/mission

[7] Uranium was evaluated under this methodology and, as noted below, meets the threshold to be included on the list of critical materials. However, section 7002(a) of the Energy Act of 2020 restricts the listing of critical materials to "any non-fuel mineral, element, substance, or material." The assessment below included uranium's use as fuel for commercial power reactors in its analysis, as opposed to strictly focusing on its non-fuel energy uses. For that reason, the Secretary is not designating uranium as a critical material at this time.

| Energy application categories | Technology | Components/sub-technology | Materials |
|---|---|---|---|
| End-use | Lighting | LED | Gallium |
| | Consumer electronics | Power electronics | Silicon-Carbide |
| | Electric vehicles | Power electronics | Silicon-Carbide |
| | | Lightweighting | Magnesium, Silicon |
| | | Magnets in motors | Neodymium, Praseodymium, Dysprosium, Gallium |
| | | Batteries | Lithium, Nickel, Manganese, Cobalt, Graphite, Aluminum, Phosphorous, Fluorine |
| | | Motors | Electrical steel, Copper |
| | | Wiring | Copper |
| | Vehicles | Lightweighting | Magnesium |
| | | Wiring | Copper |

The following weighted metrics were assessed for each material over the short and medium terms:

- ***Importance to Energy***
  - **Energy Demand (70%):** Captures the importance of the material used in energy technologies in two aspects. The first aspect evaluates the importance of a specific material to energy applications, typically quantified by end-use application market share. The higher the market share of energy applications for a given material, the higher the score. The market share was calculated for 2025 and 2035 to account for the short and medium terms, respectively, based on demand projections for energy technologies and non-energy technologies. The second aspect evaluates the importance of a material sub-technology to the overall energy technology, typically reflected by the adoption or penetration rate of the sub-technology. Because multiple energy applications were evaluated for one material, the sub-technology adoption was assessed for the most dominant

energy technology that makes up the largest use of the material as identified by energy application share.

- **Substitutability Limitations (30%):** Addresses constraints on practically substituting for the material within energy technologies. Substitution could occur at any level of the supply chain. This may include using different raw materials, components, or even end-use technologies. This includes substitution by material, such as praseodymium for neodymium in magnets, as well as component-based substitutions, such as induction motors for permanent magnet motors. Because a material can be used in multiple energy applications, substitution limitations are evaluated across their energy applications.

- ***Supply Risk***
  - **Basic Availability (40%):** The extent to which global supply will be able to meet demand. Short-term and medium-term basic availability examines the gap between current production capacity and projected demands in 2025 and 2035, respectively. The qualitative score is informed by the projections in Appendix D of the draft report, but it may also take into account other factors, such as sufficiency of projects or capacity additions within the considered timeframe, or environmental or capacity constraints such as declining ore grade or access to water.
  - **Competing Technology Demand (10%):** Whether non-energy-sector demand is expected to grow rapidly, thus constraining the supply of the material available to the energy sector. The scoring of this metric relies on growth rates of non-energy applications.
  - **Political, Regulatory, and Social Factors (20%):** Risk associated with political, social, and regulatory factors within major producer countries. This includes the risk that political instability in a country will threaten mining and processing projects; that countries will impose export quotas or other restrictions; or that social pressures or permitting or regulatory processes will threaten sources of new or existing production. In addition, other factors can also affect supply risks such as the use of child labor or forced labor, improper occupational health and safety, and environmental concerns caused by a country's regulations. World Bank's World Governance Indicators (WGIs) including political stability, regulatory quality and rule of law were utilized along with Yale University's Environmental Performance Index. A weighted score of producing countries was calculated based on their market/production share.
  - **Codependence on Other Markets (10%):** Instances when a material is a coproduct or by-product of producing or refining other materials. Codependence

can be an advantage or a disadvantage, depending on which material is driving production levels. In general, coproducts with lower revenue streams (i.e., production rate multiplied by price) will have higher scores because they are less likely to drive production than coproducts with higher revenue.

- **Producer Diversity (20%):** Market risks due to the lack of diversity in producing countries or companies (e.g., monopoly or oligopoly).

A detailed description of the methodology can be found in Chapter 3 of the draft report: https://www.energy.gov/sites/default/files/2023-05/2023-critical-materials-assessment.pdf

## II. REQUEST FOR INFORMATION

### Purpose

The purpose of this RFI is to solicit feedback from industry, academia, research laboratories, government agencies, and other stakeholders on issues related to critical materials assessment. DOE is specifically interested in information and/or data that support revision of the draft results and improvements to the methodology for future updates. This is solely a request for information and not a Funding Opportunity Announcement (FOA). DOE is not accepting applications.

### Disclaimer and Important Notes

This RFI is not a Funding Opportunity Announcement (FOA); therefore, DOE is not accepting applications at this time. DOE may issue a FOA in the future based on or related to the content and responses to this RFI; however, DOE 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 DOE chooses to issue a FOA regarding the subject matter. Final details, including the anticipated award size, quantity, and timing of DOE 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. DOE 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. DIE will not provide reimbursement for costs incurred in responding to this RFI. Respondents are advised that DOE 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 DOE to any further actions related to this topic.

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## 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 DOE 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

### Category 1: Data and Information to Support Revision of Analysis

The Critical Materials Assessment is a structured hybrid of quantitative and qualitative analysis.

- Chapter 1 of the report gives the background information and scope of the analysis.
- Chapter 2 of the report describes the screening process to down select materials for inclusion in the overall Critical Materials Assessment.
- Chapter 3 describes the Critical Materials Assessment methodology and results.
- Appendix A details the findings from the Critical Materials Assessment for each material that was screened for inclusion in the analysis.
- Appendix B details the material intensity used in demand projections.
- Appendix C details the results for all materials in the screening process described in Chapter 2.
- Appendix D gives a summary of the assumptions and charts for the demand projections.

To support revision of the draft DOE Critical Materials List, please provide data and/or information that supports updating assumptions and/or data applied in the assessment. Data and/or information should inform the following factors taken into consideration in the methodology described below:

1.1 Importance to Energy

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1.1.1.1 Energy Demand
1.1.1.2 Substitutability Limitations

1.2 Supply Risk
1.2.1 Basic Availability
1.2.2 Competing Technology Demand
1.2.3 Political, Regulatory, and Social Factors
1.2.4 Codependence on Other Markets
1.2.5 Producer Diversity

**Category 2**: **Improvements to the Methodology**
DOE is interested in potential improvements to the methodology described above and in the accompanying report. Please submit recommendations for such improvements, such as:

2.1 Factors and/or subfactors that would change the scope of considered technologies

2.2 Weighting of factors and/or subfactors

2.3 Other improvements

## Request for Information Response Guidelines

Responses to this RFI must be submitted electronically to CriticalMaterialsRFI@ee.doe.gov no later than 5:00pm (ET) on June 20, 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.

DOE 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.

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