[6450-01-P]

DEPARTMENT OF ENERGY

Notice of Final Determination on 2023 DOE Critical Materials List

AGENCY: Department of Energy.

ACTION: Notice

SUMMARY: By this notice, the U.S. Department of Energy (DOE) presents 2023 DOE Critical Materials List. This list includes critical materials for energy, as determined by the Secretary of Energy, acting through the Under Secretary for Science and Innovation, pursuant to authority under the Energy Act of 2020, as well as those critical minerals on the 2022 final list published by the Secretary of Interior, acting through the Director of the U.S. Geological Survey (USGS). This notice also presents the assessment that forms the basis for the designation of critical materials for energy. The final 2023 DOE Critical Materials List includes certain critical materials for energy and critical minerals as listed below.

FOR FURTHER INFORMATION CONTACT: Questions may be addressed to Helena Khazdozian, 202-586-9236, helena.khazdozian@ee.doe.gov.

DATES: Effective: July 28, 2023

SUPPLEMENTARY INFORMATION: Section 7002(a)(2) of the Energy Act of 2020 defines "critical materials" to be: (A) Any non-fuel mineral, element, substance, or material that the Secretary of Energy determines (i) has high risk for supply chain disruption; and (ii) serves an

essential function in one or more energy technologies, including technologies that produce, transmit, store, and conserve energy [referred to here as a critical material for energy]; or (B) a critical mineral [as designated by the Secretary of the Interior].[1] The Final 2023 DOE Critical Materials List includes the following:

- Critical materials for energy: aluminum, cobalt, copper*, dysprosium, electrical steel* (grain-oriented electrical steel, non-grain-oriented electrical steel, and amorphous steel), fluorine, gallium, iridium, lithium, magnesium, natural graphite, neodymium, nickel, platinum, praseodymium, terbium, 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."

*Indicates materials not designated as critical minerals by the Secretary of Interior.

[1] 30 U.S.C. § 1606(a)(2)

The critical materials for energy included on the Final 2023 DOE Critical Material List[2] are based on the criticality assessed in the short- and medium-term.[3] A detailed description of DOE's methodology can be found in the assessment.[4] The materials on the Final 2023 DOE Critical Materials List will inform crosscutting priorities including, but not limited to:

- Critical Materials Research, Development, Demonstration, and Commercial Application (RDD&CA) Program priorities
- Eligibility for the Inflation Reduction Act (IRA) 48C tax credit

Public Comment on the Draft Critical Materials List

Pursuant to authority in section 7002(a)(2) of the Energy Act of 2020, on May 3, 2023, DOE published via the EERE Exchange website a Notice of Intent[5] to issue a Request for Information (RFI)[6] on the Proposed Determination of the Draft Critical Materials List and Draft Critical Materials Assessment. The RFI was published via the EERE Exchange on May 31, 2023. The RFI provided for a 20-day public comment period, and closed on June 20, 2023.

DOE received 79 comments during the comment period. Three comments were from individuals and 76 were submitted on behalf of organizations. Due to time constraints, comments received after the deadline were not taken into consideration for this assessment. DOE may take these comments into consideration for future assessments and determinations. Additionally, DOE

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[2] https://www.energy.gov/cmm/what-are-critical-materials-and-critical-minerals
[3] Several substances listed as critical materials for energy were also included on the U.S. Geological Survey's 2022 Final List of Critical Minerals. DOE's inclusion of these substances on its list is intended to signal the results of its criticality assessment. Under Section 7002(a), however, designation as a critical mineral is sufficient to make the substance a critical material.
[4] [INSERT LINK]
[5] https://eere-exchange.energy.gov/Default.aspx#FoaId6322a11b-4cb4-4ac7-96a2-a6814bc5fbf9
[6] https://eere-exchange.energy.gov/Default.aspx#FoaId82fa533b-3d3e-4b49-839d-9ddf13d56f40

received some comments that were out of scope or otherwise not responsive to the requests included in the RFI. DOE considered all of the responsive comments received before the submission deadline and below is a summary of DOE's responses.

The following revisions to the Draft DOE Critical Materials List were made based on the comments received:

- Terbium was added to the Final 2023 DOE Critical Materials List as a critical material for energy. Terbium was screened and then fully assessed for criticality based on information provided through the comments received. Based on that analysis, DOE has determined that terbium meets the definition of critical materials as defined in the Energy Act of 2020. More detail is provided in the Critical Material Assessment.

The following actions were taken based on the comments received, but did not change the results of the Critical Materials Assessment:

- Boron was revisited based on the comments that in addition to neodymium iron boron magnets, boron is important for additional clean energy end-uses including wind turbine blades, boron-doped photovoltaics, and battery coatings. DOE's conclusion is that there is a lack of substantiated data that quantifies the use of boron in these applications, including electric glass for wind turbine blades, and thus these applications would not drive a significant increase in demand for boron.
- Phosphorous was revisited based on the comments that phosphorous demand is expected to experience a shortfall for use in lithium iron phosphate (LFP) batteries, geoconcentration of production outside the U.S., and that agriculture is a competing use.

DOE provides further clarification that the Critical Materials Assessment considered high LFP adoption scenarios, geoconcentration of production outside the U.S., and agriculture as a competing use in the assessment of phosphorous. More details can be found in the Critical Materials Assessment report in section 4.3.15. Ultimately, phosphorous was not assessed to be critical under the DOE methodology.

DOE received a comment advocating the exclusion of copper from the Final 2023 DOE Critical Materials List based on (1) the results of the USGS methodology[7] to determine the 2022 Final List of Critical Minerals and (2) the potential to accelerate mining of copper under the IRA 48C tax credit.

- Regarding point (1), it should be noted that the methodologies employed by the USGS and DOE have several distinctions. While the USGS methodology is a supply-side approach that uses historical data to determine criticality within the context of the U.S. economy and national security, the DOE methodology is forward looking—incorporating global demand trajectories based on growth scenarios for various energy technologies, coupled with assumptions about the material intensity of those technologies, to determine criticality within the context of clean energy.
- Regarding point (2), critical materials eligibility for the IRA 48C tax credit is specifically for processing, refining, or recycling of critical materials.

DOE received a comment stating that uranium should not be excluded from the Final 2023 DOE Critical Materials List based on its categorization as a fuel-mineral because uranium does not

[7] https://pubs.er.usgs.gov/publication/ofr20211045

meet the U.S. Environmental Protection Agency (EPA) definition of a fuel, "material used to produce heat or power by burning." As noted in the RFI and accompanying proposed assessment, uranium was assessed for criticality under this methodology and met the threshold to be included on the 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" and therefore DOE is not designating uranium as a critical material at this time. DOE further responds noting the following:

- What EPA "considers a fuel to be"[8] for the purpose of its risk management programs for chemical accident prevention is not determinative of what is a fuel mineral, element, substance, or material element that DOE is required to exclude from the Critical Materials List by section 7002(a) of the Energy Act of 2020. The Merriam-Webster Dictionary defines fuel to include, not only a material used to produce heat or power by burning, but also "a material from which atomic energy can be liberated especially in a reactor."[9] Uranium used in commercial nuclear plants clearly meets this definition of a fuel material. Therefore, based on the plain meaning of fuel, DOE concludes that uranium used in commercial nuclear reactors is a fuel material. Based on the Critical Materials Assessment, which includes only use of uranium as a fuel, DOE is not designating uranium as a critical material at this time.

[8] U.S. Environmental Protection Agency, *Definition of Fuel*, https://www.epa.gov/rmp/definition-fuel#:~:text=There%20is%20no%20regulatory%20definition,heat%20or%20power%20by%20burning (“There is no regulatory definition of fuel; however, EPA considers a fuel to be a material used to produce heat or power by burning.”).

[9] https://www.merriam-webster.com/dictionary/fuel

DOE received several comments that provided information that may have the potential to adjust the criticality analyses of materials already included on the USGS Critical Minerals List. These comments were considered but ultimately not included in this determination, as such minerals are by definition already deemed to be critical materials. However, DOE may use the information to inform future assessments and activities related to critical materials for energy.

DOE received several comments advocating for increasing the scores of importance to energy or potential for supply risk within the Critical Materials Assessment for several materials on the Draft Critical Materials List, including copper and silicon. These comments were not taken into account for this assessment but may be considered to inform future assessments and activities at DOE.

DOE received many comments about the scope of the assessment. The following explanation and clarification are provided:

- Section 7002(a)(2) of the Energy Act of 2020 authorized the Secretary of Energy to determine critical materials according to the statutory definition:
    - Any non-fuel mineral, element, substance, or material that the Secretary of Energy determines:
        - Has high risk for supply chain disruption; and
        - 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].[10]

[10] 30 U.S.C. § 1606(a)(2)

- DOE has interpreted energy technologies to be "clean energy" technologies in alignment with the DOE Critical Minerals and Materials Vision and Strategy.[11] The anticipated unprecedented increase in demand for critical minerals and materials is driven by the global deployment of clean energy technologies to achieve net-zero goals by 2050. The International Energy Agency has estimated the demand for critical minerals and materials will increase by 400% to 600% by 2040 to achieve these goals.[12] The specific energy technologies[13] considered in this assessment are described in Chapter 2 of the Critical Materials Assessment and are aligned with the technologies DOE assessed as part of "America's Strategy to Secure the Supply Chain for a Robust Clean Energy Transition."
- DOE conducted the Critical Materials Assessment to inform the determination under section 7002(a)(2). The methodology applied in the DOE Critical Materials Assessment has several unique features:
    - It is forward looking, incorporating global demand trajectories based on growth scenarios for various energy technologies, coupled with assumptions about the material intensity of those technologies.
    - A limited set of engineered materials was assessed.
- The scope of materials assessed included a limited set of engineered materials: electrical steel and silicon carbide. This set of engineered materials was selected based on two factors: (1) the materials were found to have high potential for supply risk in the "supply chain deep dive" reports as part of "America's Strategy to Secure the Supply Chain for a Robust Clean Energy Transition"; and (2) the elements comprising the engineered

[11] https://www.energy.gov/cmm/critical-minerals-materials-program
[12] https://www.iea.org/reports/the-role-of-critical-minerals-in-clean-energy-transitions
[13] Vehicles, stationary storage, hydrogen electrolyzers, solar energy, wind energy, nuclear energy, electric grid, solid state lighting, and microchips.

materials (such as iron for electrical steel) were unlikely to be found critical and thus not indicate the risk posed to deploying energy technologies. Prior to the passage of the Energy Act of 2020, materials assessed for criticality were generally limited to an element. In practice, the designation of a critical material as an element does not restrict the mitigation strategies prioritized by DOE to be limited to the elemental form. For example, neodymium has been found to be critical in the past and mitigation strategies pursued by DOE include unlocking new sources, developing alternative magnets that reduce or eliminate the use of neodymium, improving efficiency of separation and metallization of neodymium as well as neodymium-based alloys and magnets, and recycling neodymium from end-of-life magnets.

    - Further clarification is provided on the definition of electrical steel. For the purposes of this assessment, electrical steel includes grain-oriented electrical steel, non-grain-oriented electrical steel, and amorphous steel.

- The scope of materials analyzed does not include materials that are used indirectly in the manufacturing process but do not contribute to the composition of the components or final products. For example, helium is used in cooling, cleaning, and creating an inert environment for semiconductors but it is not a constituent material of the semiconductor. While a disruption in helium supply chain can impact semiconductor production, the scope of this assessment has not been extended to indirect material use. DOE may consider the examination of materials used indirectly in manufacturing processes in future assessments.

DOE received many comments with recommendations to improve the methodology applied in the Critical Materials Assessment. DOE anticipates updating the assessment every three years

and may evaluate these recommendations for future assessments. Such future assessments will inform additional critical materials determinations, as appropriate.

The following table summarizes a subset of the relevant comments received, categorized by material, and describes DOE's response. This does not include comments on the improvements for the methodology, or the scope of the assessment which are discussed previously.

Material	On the USGS List?	On the Draft DOE List?	On the Final DOE List?	Number of Comments Received	Summary of Comment(s)	DOE Action
Aluminum	Yes	Yes	Yes	5	Aluminum score should increase in short-term and medium-term due to supply risk (low producer diversity – China) and importance to energy (more end-uses than considered in assessment).	No action: Aluminum is already on the USGS and DOE lists. DOE may consider this input for future assessments and activities.
Antimony	Yes	No	No	2	Antimony should be on the list. Antimony compounds used in electronics and for fire-retardance.	No action: Antimony is already on the USGS list and no substantial data or information were provided.
Beryllium	Yes	No	No	1	Beryllium should be on the list—important for solar photovoltaics (PV), nuclear, electric vehicle (EV) batteries. Data NOT provided. Most beryllium is imported from Kazakhstan.	No action: Beryllium is already on the USGS list and no data were provided.
Boron	No	No	No	8	Boron should be on the list and is used in more end-uses than Neodymium	DOE revisited the assessment of boron. DOE is not aware of any substantiated

Material	On the USGS List?	On the Draft DOE List?	On the Final DOE List?	Number of Comments Received	Summary of Comment(s)	DOE Action
					Iron Boron magnets (wind turbine blades, boron-doped photovoltaics, battery coatings). There is increased international demand for boron.	data that quantifies the use of boron in electric glass for wind turbine blades or that the use of boron in these end-use applications is driving significant increase in demand for boron.
Bromine	No	No	No	1	Bromine should be considered for the list—important to zinc bromide batteries.	No action: Zinc bromide batteries are currently an emerging battery technology with uncertainty in future deployment.
Butyllithium	No	No	No	1	Butyllithium should be on the list—important for manufacturing of "green" tires and lightweight automotive interior.	No action: The scope of materials for this assessment does not include materials that are used indirectly in the manufacturing process but do not contribute to the composition of the components or final products. DOE may consider this input for future assessments and activities.
Carbon Fiber	No	No	No	1	Should be assessed for wind turbine blades.	No Action. The scope of materials assessed included a limited set of engineered materials: electrical steel and silicon carbide. This set of engineered materials were selected based on two factors: (1) they were found to have high potential

Material	On the USGS List?	On the Draft DOE List?	On the Final DOE List?	Number of Comments Received	Summary of Comment(s)	DOE Action
						for supply risk in the "supply chain deep dive" reports as part of "America's Strategy to Secure the Supply Chain for a Robust Clean Energy Transition," and (2) the elements comprising the engineered materials (such as iron for electrical steel) were unlikely to be found critical and thus would not indicate the risk posed to deploying energy technologies.
Cerium	Yes	No	No	1	The risks associated with the overproduction of elements like cerium are overstated in the assessment.	No action: Cerium was not assessed for material criticality. Cerium is on the USGS list.
Cobalt	Yes	Yes	Yes	6	Information on dependency on Democratic Republic of Congo and China. LFP/LFMP (lithium iron phosphate/lithium iron-manganese-phosphate) technology will reduce cobalt dependency for batteries. Most mining and processing of cobalt occurs outside the US.	No action: Cobalt is already on the USGS list. DOE may consider this input for future assessments and activities.

Material	On the USGS List?	On the Draft DOE List?	On the Final DOE List?	Number of Comments Received	Summary of Comment(s)	DOE Action
Copper	No	Yes	Yes	9	Copper score should increase based on importance to energy (more end-uses than considered in assessment) and supply risk. Copper should not be on the list because: (1) it is not on the USGS list and (2) will incentivize mining through the IRA 48C tax credit and most copper deposits are within 35 miles of Native American Reservations.	No Action. Copper is already on DOE draft list. DOE may consider this input for future assessment and activities. (1) The methodologies employed by the USGS and DOE have several distinctions. While the USGS methodology is a supply-side approach that uses historical data to determine criticality within the context of the economy and national security, the DOE methodology is forward looking—incorporating demand trajectories based on growth scenarios for various energy technologies, coupled with assumptions about the material intensity of those technologies, to determine criticality within the context of clean energy. (2) Critical materials eligibility for the IRA 48C tax credit is specifically for processing, refining, or recycling of critical materials.

Material	On the USGS List?	On the Draft DOE List?	On the Final DOE List?	Number of Comments Received	Summary of Comment(s)	DOE Action
Dysprosium	Yes	Yes	Yes	1	Add dysprosium to critical materials list because of its use in magnets	No action: Dysprosium is already on the USGS list and DOE draft list.
Electrical Steel	No	Yes	Yes	1	Limitations on substitutability between non-grain oriented steels, grain oriented steels, and amorphous steel.	No action: Electrical steel is already on the DOE draft list. DOE will consider this input for future assessments and activities.
Fluorine	No	Yes	Yes	2	Fluorine-based compounds are used in lithium-ion batteries.	No action: Fluorine is already on the DOE draft list.
Polyviny-lidene fluoride (PVDF)	No	No	No	1	Extend analysis of fluorine to include suspension grade PVDF due to complexity of high-grade production and limited production capability and anticipated increase in demand.	No action: A limited set of engineered materials was assessed: electrical steel and silicon carbide. In practice, designation as a critical material is generally limited to an element, but does not restrict the mitigation strategies prioritized by DOE to be limited to the elemental form.
Gallium	Yes	Yes	Yes	1	Gallium's role in off-shore magnets was not well defined. Should be listed as critical to solar cells and power electronics.	No action: Gallium is already on the USGS list and DOE draft list.
Gallium Nitride	No	No	No	2	Gallium nitride should be on list for its use.	No action: Gallium nitride was considered, but it did not meet the threshold of the screening step of DOE methodology.

Material	On the USGS List?	On the Draft DOE List?	On the Final DOE List?	Number of Comments Received	Summary of Comment(s)	DOE Action
Gold	No	No	No	2	Gold should be on list due to competing uses and potential source of critical materials as byproducts.	Gold is outside the scope based on the definitions of energy technologies.
Graphite – natural	Yes	Yes	Yes	2	US has no domestic natural graphite mines.	No action: Graphite is already on the USGS list and DOE draft list.
Graphite – synthetic	Yes	No	No	6	Capacitors and supercapacitors are also end-uses. No data provided. Synthetic graphite has superior performance in EV batteries. Has multiple applications in nuclear, molten salt reactors. Most synthetic graphite is produced outside the US.	No action: Graphite (natural graphite and synthetic graphite) is already on the USGS list and no data were provided.
Helium	No	No	No	1	Helium, antimony, tungsten, and tin should be on the list. Helium is important for advanced technology and energy technology.	No action: The scope of materials for this assessment does not include materials that are indirectly used in the manufacturing process but not contributing to the composition of the components or final products. DOE may consider this input for future assessments and activities.
Iridium	Yes	Yes	Yes	2	U.S. needs to be strategic in importing iridium.	No action: Iridium is already on the USGS list and DOE draft list.

Material	On the USGS List?	On the Draft DOE List?	On the Final DOE List?	Number of Comments Received	Summary of Comment(s)	DOE Action
Iron ore	No	No	No	1	Iron ore fits the description of a critical material due to its widespread applications.	Iron ore is outside the scope based on the definitions of energy technologies.
Lanthanum	Yes	No	No	1	It is recommended that the DOE investigates the components needed for rare earth elements (REE) containing steels for carbon dioxide and hydrogen pipelines.	No action: Lanthanum was considered, but it did not meet the threshold of the screening step of DOE methodology. Lanthanum is on the USGS list.
Lead	No	No	No	1	Lead batteries provide most back up battery power for telecommunications industry. International demand for lead will begin to outpace US demand in the near term. There is no domestic primary lead production.	No action: Lead is outside the scope based on the definitions of energy technologies.
Lithium	Yes	Yes	Yes	5	Need more domestic lithium production facilities. Consider upgrading lithium as critical in short-term in Section 3.1.2.	No action: Lithium is already on the USGS list and DOE draft list. DOE will consider this input for future assessments and activities.
Manganese	Yes	No	No	2	Manganese should be on list due to lack of domestic capabilities, particularly for battery-grade	No action: Manganese is already on the USGS list and no data were provided.

Material	On the USGS List?	On the Draft DOE List?	On the Final DOE List?	Number of Comments Received	Summary of Comment(s)	DOE Action
					manganese. Data not provided. DOE should recognize the difference between bulk mined manganese used in steel-making and high purity manganese for batteries. China controls 95% of global battery grade manganese processing.	
Molyb-denum	No	No	No	1	Molybdenum should be the list due to its use in high strength steels used in vehicle lightening and energy infrastructure (wind turbine supports).	No action: Molybdenum was not found to be material of concern in the DOE Wind Energy Supply Chain Deep Dive. Assessment.[14] DOE may consider this input for future assessments and activities.
Neodymium	Yes	Yes	Yes	2	Recommends DOE to investigate the components needed for REE-bearing steels needed for carbon dioxide and hydrogen pipelines. In the assessment, neodymium should be considered critical for applications in motors.	No action: Neodymium is already on the USGS list and DOE draft list. DOE may consider this input for future assessments and activities.
Nickel	Yes	Yes	Yes	2	Nickel as a copper byproduct should be seen as a factor	No action: Nickel is already on the DOE draft list. DOE may consider this input

[14] https://www.energy.gov/sites/default/files/2022-02/Wind%20Supply%20Chain%20Report%20-%20Final%202.25.22.pdf

Material	On the USGS List?	On the Draft DOE List?	On the Final DOE List?	Number of Comments Received	Summary of Comment(s)	DOE Action
					that reduces supply risk.	for future assessments and activities.
Palladium	Yes	No	No	3	Palladium and rhodium should be on the list. Potential substitute for platinum and iridium in fuel cells and electrolyzers.	No action: Palladium is already on the USGS list. DOE may consider this input for future assessments and activities.
Phosphates	No	No	No	3	Phosphates should be on the list. Phosphates are a potential precursor material for LFP batteries, and the usage competes with agricultural and food industry uses.	No action: A limited set of engineered materials was assessed: electrical steel and silicon carbide. In practice, designation as a critical material is generally limited to an element, but does not restrict the mitigation strategies prioritized by DOE to be limited to the elemental form.
Phosphorus	No	No	No	1	Phosphorus is important for agriculture and production is geoconcentrated outside US. Phosphorus demand for lithium iron phosphate (LFP) batteries is expected to experience shortfall in supply. Most battery grade phosphorus has to be imported.	DOE revisited the assessment of phosphorous. DOE provides further clarification that Critical Materials Assessment considered high LFP adoption scenarios, geoconcentration of production outside the U.S., and agriculture as a competing use in the assessment of phosphorous. More details can be found in the Critical Materials Assessment report in Section 4.3.15.

Material	On the USGS List?	On the Draft DOE List?	On the Final DOE List?	Number of Comments Received	Summary of Comment(s)	DOE Action
						While phosphorous passed the initial screen, ultimately, it was not assessed as critical under the DOE methodology.
Platinum	Yes	Yes	Yes	3	Platinum supply not a risk in short-term. Propose addition of fuel cell applications to end-use and align platinum as Tier 1. Remove electrolyzers as an end-use application and replace with "energy conservation" category.	No action: Platinum is already on the USGS list and DOE draft list. DOE may consider this input for future assessments and activities.
Rhodium	Yes	No	No	2	Palladium and rhodium should be on the list. Potential substitute for platinum and iridium in fuel cells and electrolyzers.	No action: Rhodium is already on the USGS list. DOE may consider this input for future assessments and activities.
Silicon	No	Yes	Yes	6	Silicon should be on the list. There are multiple uses for silicon: photovoltaic solar cells, semiconductors, silicones, metallurgical processing. China produces over 70% of silicon.	No action: Silicon is already on the DOE draft list. DOE may consider this input for future assessments and activities.
Silicon carbide	No	Yes	Yes	1	Needed for wide band-gap semiconductors. Demand is likely to exceed supply.	No action: Silicon carbide is already on the DOE draft list. DOE may consider this input for future

Material	On the USGS List?	On the Draft DOE List?	On the Final DOE List?	Number of Comments Received	Summary of Comment(s)	DOE Action
						assessments and activities.
Silicon metal	No	No	No	2	China dominates silicon metal production. Silicon metal should be analyzed as a separate material for short- and long-term scarcity.	No Action. A limited set of engineered materials was assessed: electrical steel and silicon carbide. In practice, designation as a critical material is generally limited to an element, but does not restrict the mitigation strategies prioritized by DOE to be limited to the elemental form.
Silver	No	No	No	2	Silver should be on list due to competing uses and potential source of critical materials as byproducts.	Sliver was not found to be material of concern in the DOE Solar Photovoltaics Supply Chain Deep Dive Assessment.[15] DOE may consider this input for future assessments and activities.
Terbium	Yes	No	Yes	2	Terbium should be on the list—important for neodymium-iron-boron (NdFeB) magnets (equally so as dysprosium).	Terbium was screened and assessed for NdFeB magnets. Based on the assessment, DOE has determined that terbium is on the Final DOE Critical Materials List as a critical material for energy.
Tin	Yes	No	No	1	Tin should be on the list.	No action: Tin is already on the USGS list and no substantial data or

[15] https://www.energy.gov/sites/default/files/2022-02/Solar%20Energy%20Supply%20Chain%20Report%20-%20Final.pdf

Material	On the USGS List?	On the Draft DOE List?	On the Final DOE List?	Number of Comments Received	Summary of Comment(s)	DOE Action
						information were provided.
Titanium	Yes	No	No	1	Titanium should be on the list—important for fuel cells and lightweighting.	No action: Titanium is already on the USGS list. Titanium is unlikely to pass screening due to importance for lightweighting being primarily outside of energy end-use applications. DOE may consider this input for future assessments and activities.
Tungsten	Yes	No	No	1	Helium, antimony, tungsten, and tin should be on list.	No action: Tungsten is already on the USGS list and no substantial data or information were provided.
Uranium	No	No	No	3	Uranium should be on list due to foreign reliance. Uranium is not a fuel and doesn't meet the EPA definition for fuel.	No action: As described above, for the purposes of the assessment, DOE has determined that uranium used in commercial nuclear power reactors is a fuel based on the plain meaning of fuel.
Vanadium	Yes	No	No	1	Vanadium is needed for the emerging battery technology of "flow batteries".	No action: Vanadium is already on the USGS list. DOE will consider this input for future assessments and activities.
Xenon	No	No	No	1	Xenon should be considered—important for manufacturing of energy tech.	No action: The scope of materials for this assessment does not include materials that are used indirectly in the

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						manufacturing process but not contributing to the composition of the components or final products. DOE may consider this input for future assessments and activities.

SIGNING AUTHORITY: This document of the Department of Energy was signed on July 28, 2023, by Dr. Geraldine Richmond, Under Secretary for Science and Innovation pursuant to delegated authority from the Secretary of Energy. That document with the original signature and date is maintained by DOE. For administrative purposes only, and in compliance with requirements of the Office of the Federal Register, the undersigned DOE Federal Register Liaison Officer has been authorized to sign and submit the document in electronic format for publication, as an official document of the Department of Energy. This administrative process in no way alters the legal effect of this document upon publication in the Federal Register.

Signed in Washington, DC, on July 28, 2023.

Dr. Geraldine Richmond
Under Secretary for Science and Innovation