The Four Rs to Stabilize Critical Mineral Supplies for Renewable Energy

Christina Jovanovic

Christina Jovanovic is an in-house attorney with the Salt River Project located in Phoenix, Arizona. Her current practice focuses on natural resources and water law. The Salt River Project is part federal reclamation project and part electric utility. When she was in private practice, her work included supporting mining projects in Arizona.

Disclaimer

This presentation is provided for informational purposes only. It is not intended to constitute legal or other professional advice and should not be used as such or as a substitute for advice from your attorney(s) or other professional(s). The opinions expressed in this presentation are those of the presenter and not those of Salt River Project, its Board, employees, or customers.

Agenda

- Introduction to Critical Minerals and Their Supply Chains
- The Four Rs
  - Resupply
  - Recycle
  - Replace
  - Retreat (sort of)
- Questions

Introduction

- **Critical Mineral**
  - Any mineral, element, substance, or material designated as critical by the Secretary of the Interior, acting through the director of the U.S. Geological Survey.
  - 50 minerals
  - Includes lithium, nickel, cobalt, rare earth elements (REEs),and gallium.

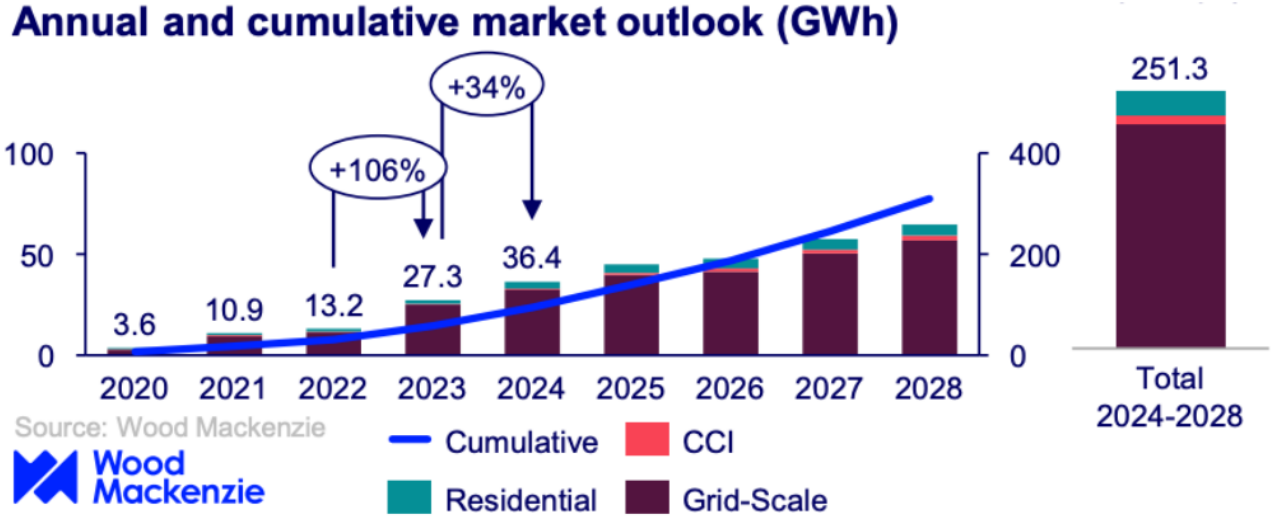
- **Critical Material**
  - Any non-fuel mineral, element, substance, or material that the Secretary of Energy determines: (i) has a high risk of supply chain disruption; and (ii) serves an essential function in one or more energy technologies, including technologies that produce, transmit, store, and conserve energy;
  - Or a critical mineral.
  - Includes copper, electrical steel, silicon and silicon carbide.

Critical Minerals Supply Chains

- Energy Storage
  - Lithium
    - >25% Import Reliance
      - Argentina, Chile, China, Russia
  - Cobalt
    - 67% Import Reliance
      - Norway, Canada, Finland, Japan
  - Nickel
    - 57% Import Reliance (increase)
      - Canada, Norway, Finland, Russia
- Wind Turbines
  - Rare Earth Elements
    - >95% Import Reliance
      - China, Malaysia, Japan, Estonia
      - China processes nearly 90% of worldwide REEs
- Solar Panels
  - Gallium
    - 100% Import Reliance
      - Japan, China, Germany, Canada

Why do we care?

- US energy transition-related demand for lithium, nickel and cobalt will be 23 times higher in 2035 than it was in 2021
- Fully electrifying the US car fleet requires 306,000 metric tons of lithium by 2050
- US grid battery storage capacity expected to increase
    - Lithium-ion batteries are the dominant form of grid storage
- Energy resource demands compete with other needs



Source: American Clean Power Association, US Grid-Scale Energy Storage Installations Surge, Setting New Q2 Record (Oct. 1, 2024)

Risks to Import Stability

- Export Restrictions
  - China restricted exports of REE to Japan for two months in 2010.
  - Indonesia banned exports of nickel in 2020.
  - Zimbabwe restricted exports of raw lithium in 2022.
  - China banned export of rare-earth extraction and separation technology to the US in 2023.
  - In December 2024, China banned export of gallium to the US.
- Frontier Mineral Markets
  - In November 2024, US finalized $150M loaned to Syrah Resources for Balama Mine (graphite) in Mozambique.
  - On December 12, 2024, civil unrest broke out causing Syrah Resources to close the mine and declare force majeure on the loan.
- World Trade Organization Appellate Body lacks two members

What do we do?

- Resupply
- Recycle
- Replace
- Retreat (sort of)

Photo Credit: Marli Miller/UCG/Universal Images Group via Getty Images

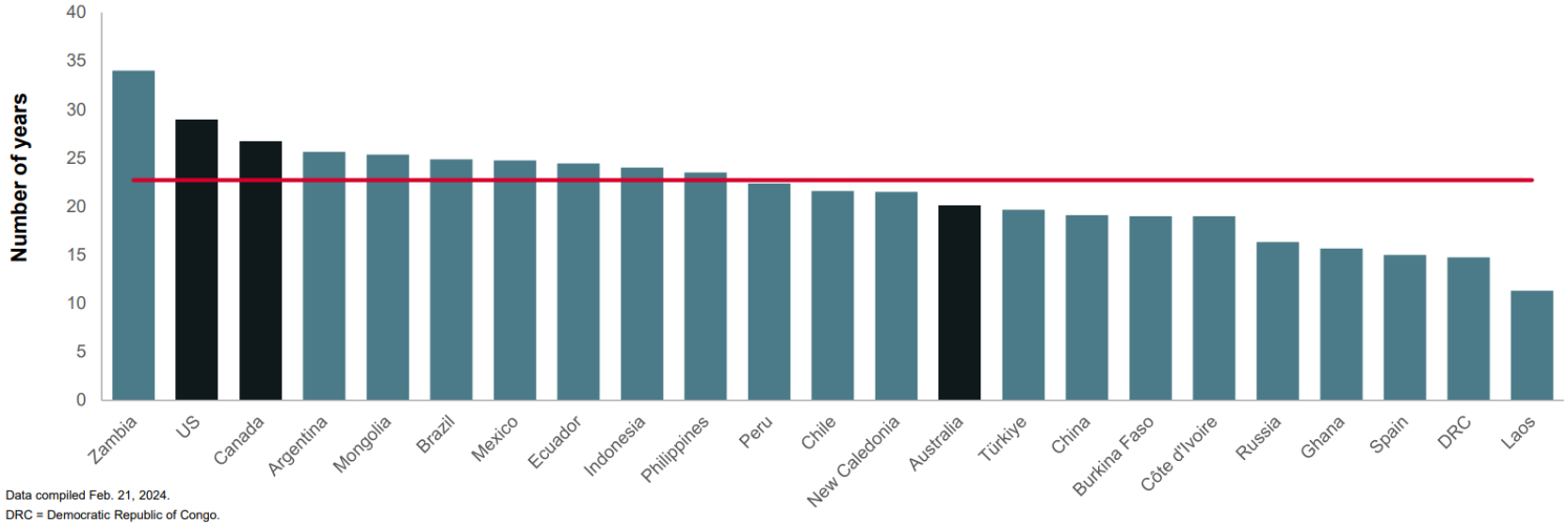
Resupply

Resupply - Why?

- Needs
- Risks
- Limited domestic supply (Mining and Refining)
  - Only 2 commercial scale lithium operations (Silver Peak, NV and IBAT, UT)
    - Other domestic operation stymied by litigation (Big Sandy, AZ)
  - Last primary nickel mine will be depleted in 2029 (Eagle Mine, MI)
  - One primary cobalt mine (ICO, ID)
  - One REE mine (Mountain Pass, CA)
  - No gallium mining operations
  - First, and only, US cobalt-nickel refinery opened in August 2024 (Westwind, OK)
  - Five lithium refineries
  - One REE refinery (Phoenix Tailings, MA)

Resupply – Current Issues

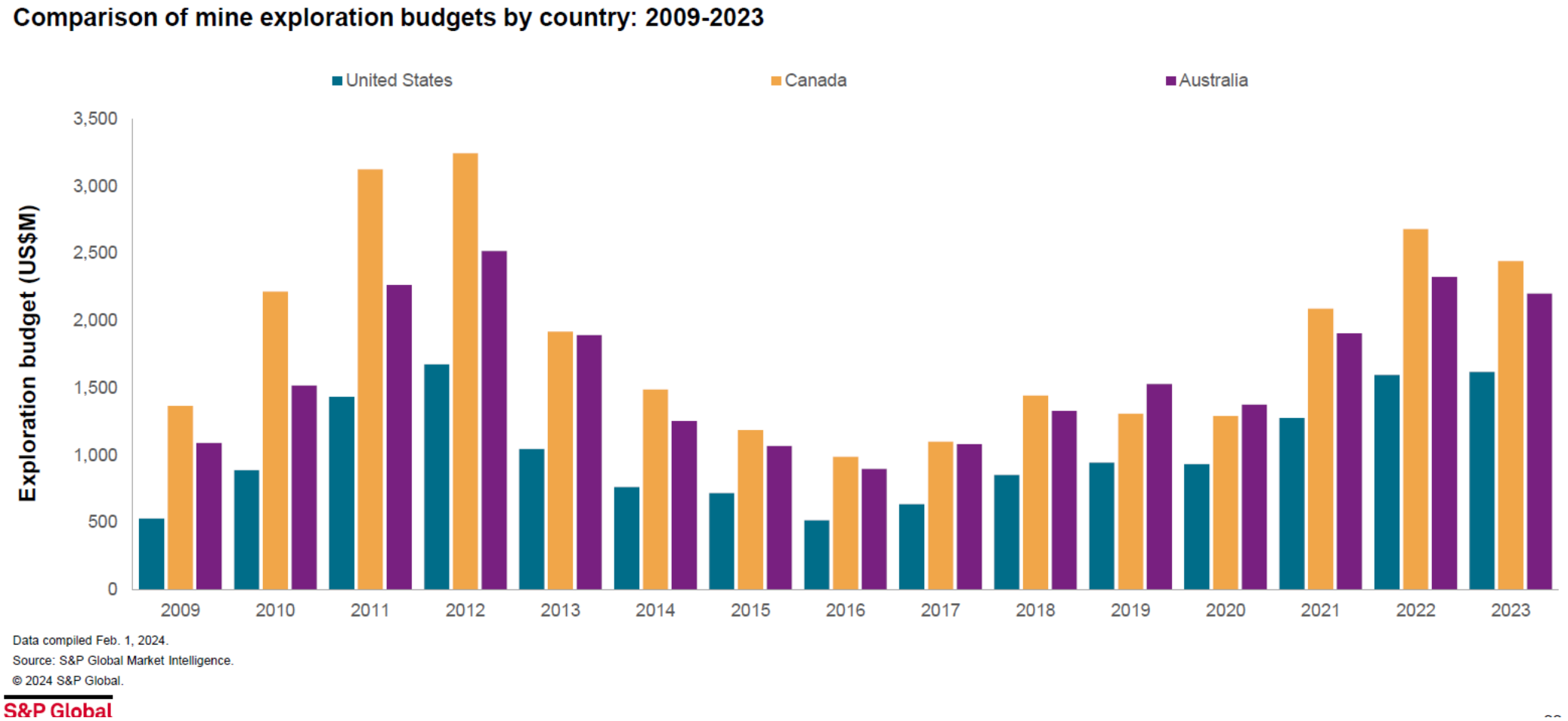
- S&P Global found it takes an average of 29 years for a U.S. mineral mine to be developed (from first discovery to first production).
  - Second longest lead time in the world, behind only Zambia.
- Since 2002, only three mines have come online in the US.
  - Eagle (2014), Ruby Hill (2007), and Pogo (2006) – none on federal land
- Resolution Copper Started its NEPA process in 2013



Data compiled Feb. 21, 2024.
DRC = Democratic Republic of Congo.
* Includes countries with at least two mines.
Source: S&P Global Market Intelligence.

S&P Global

Resupply – Current Issues



Resupply - Recent Incentives

- Bipartisan Infrastructure Law
  - **Battery Material Processing Grants** – $3 billion funding for the period of fiscal years 2022 through 2026
  - **Title XVII Loan Guarantee Program -** expanded the list of projects eligible to receive a DOE loan or loan guarantee to include projects that increase the domestically produced supply of critical minerals
- Inflation Reduction Act of 2022
  - **Section 48C Qualifying Advance Energy Project Tax Credit** - $10 billion; Up to 30% of qualified investment costs
    - Critical materials recycling, processing, and refining – $2.7 billion in tax credits
  - **Section 45X Advanced Manufacturing Production Tax Credit (PTC) -** Tax credit equal to 10% of production cost**.** PTC applies to equipment and minerals produced in the U.S.
    - No phase-out associated with the production of critical minerals meaning the credit maintains its value in perpetuity
      - ❑ Certain REEs (Lanthanum, Praseodymium, Samarium) and Gallium must have a minimum purity of 99% by mass to be eligible
    - Does not require purchaser to be an entity in the US
    - Per final rule, PTC can only be attained once an “eligible component” is produced, meaning only minerals that have been refined to their desired purity will qualify. This means that domestic mining projects will not receive the credit for extraction alone—they must have corresponding processing operations as well.

Resupply – Recent Incentives

- Inflation Reduction Act Continued
  - **Title XVII Loan Guarantee Program -** provides $40 billion in additional commitment authority for eligible projects under Title XVII through Sept. 30, 2026
- Executive Orders (EOs)
  - **Regulatory Freeze Pending Review** –
    - Sec. 2 Withdraw any rules that have been sent to the Office of the Federal Register but not published in the Federal Register, so that they can be reviewed and approved
    - Sec. 3 Postponing for 60 days from January 20, 2025, the effective date for any rules that have been published in the Federal Register, or any rules that have been issued in any manner but have not taken effect
    - Pauses the Permitting Council from issuing final rule redefining FAST41 covered mineral projects
  - **Unleashing American Energy –**
    - Sec. 2(b) establish the US as a leading producer and processor of non-fuel element
    - Sec. 3 Immediate Review of All Agency Actions that Potentially Burden the Development of Domestic Energy Resources. 30 days to submit plans

Resupply – Are the incentives working?

- Attracting Investment in Domestic Mineral Processing
  - A $300 million project in Yuma County, Arizona, that will be the first solar-powered cobalt processing facility in the country
    - ~$42.5 million in subsidies under the IRA
  - Lithium Americas received a $2.26 billion conditional DOE loan for the construction of a lithium carbonate processing plant at Thacker Pass in Humboldt County, Nevada
- Remaining Hurdles
  - Politics
    - Targeting Green New Deal incentives
  - Permitting timelines
  - Occupancy of federal land
  - Environmental effects

Resupply – Proposed Solutions

- Become a FAST41 covered project
- Enact legislation that authorizes occupation of federal land for tailings and waste rock storage
- Support research and remove impediments to commercialization

Resupply – Proposed Solutions

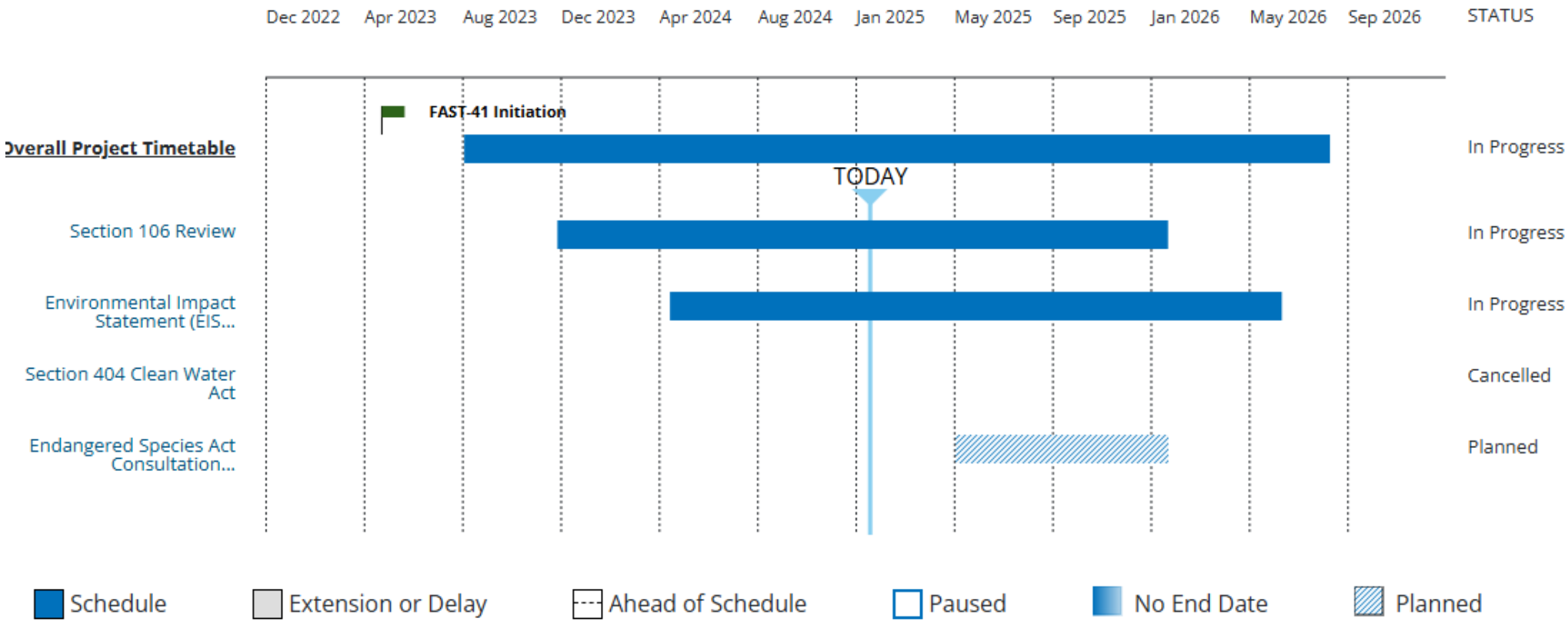
- Become a FAST41 covered project
  - FAST41 (42 USC 4370m et seq.) created a new governance structure, set of procedures, and funding authorities to improve the Federal environmental review and authorization process for covered infrastructure projects
    - High level oversight
    - Online Permitting Dashboard
    - Enhanced Coordination - Within 60 days of a project becoming covered under FAST41, the lead Federal agency must work with other cooperating agencies to develop project-specific plans for federal permitting compliance
  - All mining projects are eligible for FAST41

Resupply – Proposed Solutions

- **Benefits**
  - **Pushes the project to start**
  - Enhanced coordination
  - Increased accountability
  - **Enhanced legal protections (42 U.S.C. § 4370m-6)**
    - **2-year statute of limitations to challenge the covered project**
    - **Established guidance for judicial review of temporary restraining orders or preliminary injunctions**
  - Dispute resolution process
- **Risks**
  - Strong pressure to maintain deadlines

Resupply – Proposed Solutions

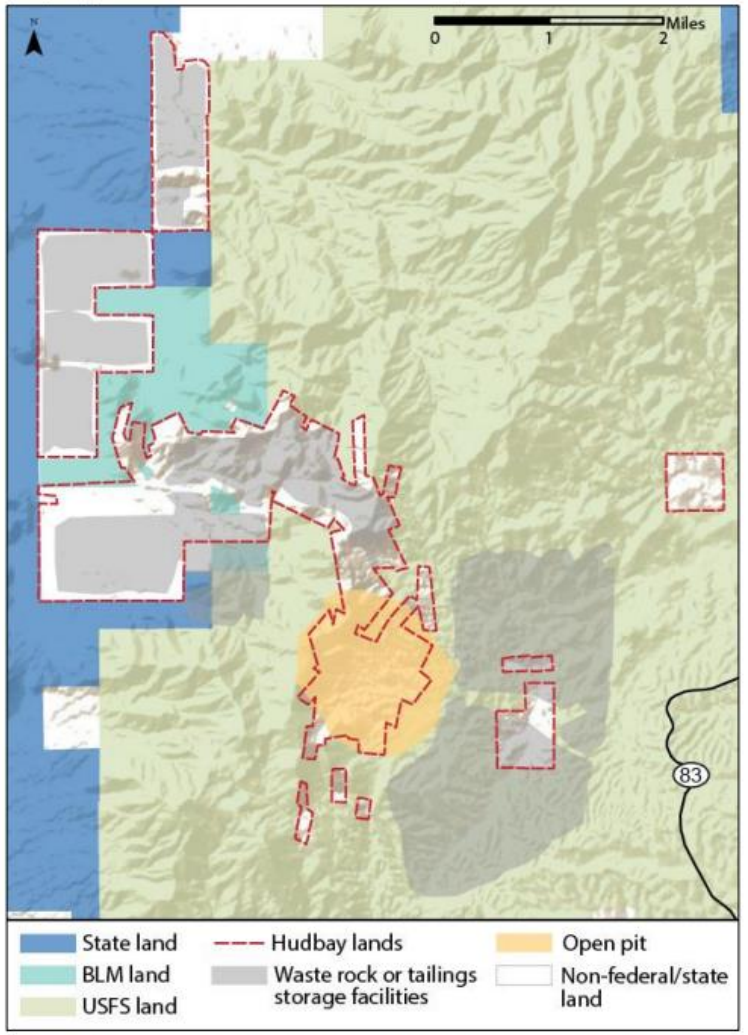
- South32 Hermosa Critical Minerals Project became the first mining sector project



Source: https://www.permits.performance.gov/permitting-project/fast-41-covered-projects/south32-hermosa-critical-minerals-project

Resupply – Proposed Solutions

- Enact legislation that authorizes occupation of federal land for tailings and waste rock storage
- Why?
  - *Ctr. for Biological Diversity v. United States Fish & Wildlife Serv.*, 33 F.4th 1202 (9th Cir. 2022)
  - Facts: Rosemont Copper proposed to store 1.9 billion tons of waste rock near its pit, on 2,447 acres of National Forest land in perpetuity.
  - Holding: U.S. Forest Service's approval of open-pit copper mining operation without considering whether claimant held a valid unpatented mining claim to 2,447 acres of land that it intended to use to store its waste was arbitrary and capricious.
  - Under Mining Law of 1872, the discovery of valuable minerals is essential to the right to any occupancy, temporary or permanent, beyond occupancy necessary for exploration; as soon as exploration on a claim is finished, the right to continue to occupy that claim is contingent on discovery of valuable minerals, whether or not occupation will be permanent.



Source: Created by CRS using data from ESRI, the Protected Area Database of the U.S. (PADUS), and Hudbay Minerals, Inc. (see Hudbay Minerals, Inc., *Preliminary Economic Analysis, Copper World Complex, Pima County, Arizona, USA*, 2022, p. 16-124).

Resupply – Proposed Solutions

- *See* S. 4864— 118th Congress (2023-2024)
  - Provides for the location of multiple hardrock mining mill sites, to establish the Abandoned Hardrock Mine Fund, and for other purposes.
    - Sec. 2(c)
    - (1)(A) MILL SITE.—The term ‘mill site’ means a location of public land that is reasonably necessary for waste rock or tailings disposal or other operations reasonably incident to mineral development on, or production from land included in a plan of operations.
    - (2) IN GENERAL.—Notwithstanding subsections (a) and (b), where public land is needed by the proprietor of a lode or placer claim for operations in connection with any lode or placer claim within the proposed plan of operations, the proprietor may—
    - (A) locate and include within the plan of operations as many mill site claims under this subsection as are reasonably necessary for its operations; and
    - (B) use or occupy public land in accordance with an approved plan of operations.
    - (5) MILL SITE AND LODE OR PLACER CLAIMS ON SAME TRACTS OF PUBLIC LAND.—A mill site may be located under this subsection on a tract of public land on which the claimant or operator maintains a previously located lode or placer claim.

Resupply – Proposed Solutions

- Support research that minimizes environmental impacts from mining and processing
  - Critical Minerals Innovation (CMI) Hub – a U.S. Department of Energy (DOE) Energy Innovation Hub led by Ames National Laboratory to secure critical mineral supply chains.

Resupply – Proposed Solutions

- CMI Hub Research Example
  - MELLT - mechanochemical extraction of lithium at low temperatures.
    - Solid spodumene chunks and a solid reactant chemical, such as sodium carbonate, are placed into a chamber with steel balls. The chamber is moved in different ways, causing impact stresses among the materials. Repeated stress eventually leads to high-energy states within the chemicals, causing them to react with each other. These reactions result in water-soluble lithium compounds. Higher quality product than lithium from brines.
  - Support continued CMI Hub funding in 2028
- Remove impediments to commercialization
  - Create more funding like Section 1603 Grants
    - Further discussed in Retreat (sort of) section

Credit: U.S. Department of Energy, Ames National Laboratory

Recycle

Recycle - Why?

- Current US capacity to process is about 100,000 metric tons of material per year (black mass)
- By 2030, roughly 650,000 metric tons (1.3 million end of life EV batteries) will need to be recycled per year, and that number could rise to 14 million metric tons per year by 2040
- Most of the US black mass is exported to Asia because of the lack of domestic post-processing and better profits
- Battery recycling firms are competing for limited feedstock
  - Mainly recycling battery facility waste product
  - ~87,000 metric tons of battery scrap available in 2024
- Companies are more hesitant to enter the market due to a few high-profile examples of delays, spiraling costs and closures to refining projects
- Non-battery critical minerals will face similar challenges

Recycle – Recent Incentives

- Bipartisan Infrastructure Law
  - **Battery Manufacturing and Recycling Grants** for demonstration projects, commercial scale, and retrofit/expansion of facilities - $3,000,000,000 for the period of fiscal years 2022 through 2026
    - Prioritize entities that utilize feedstock produced in the US, will not export recovered critical materials to a foreign entity of concern
  - **Battery Recycling Research, Development, and Demonstration Grant** - $60,000,000 for the period of fiscal years 2022 through 2026.
    - For projects addressing recycling; dismantling, reuse, recovery, and recycling of battery components and materials; extraction or recovery of critical minerals from recycled batteries
  - **Wind Turbine Materials Recycling Prize** - $5,100,000

Recycle – Recent Incentives

- Inflation Reduction Act of 2022
  - **Section 48C Qualifying Advance Energy Project Tax Credit**
  - **Section 45X Advanced Manufacturing Production Tax Credit**
    - Reminder
      - ❑ Some minerals require 99% by mass purity
      - ❑ Critical minerals can be sold to non-US buyer
  - **Clean Vehicle Tax Credit**
    - $3,750 credit for each requirement satisfied
      - ❑ Critical Mineral Requirement – a certain "applicable percentage" of the battery must comprise critical minerals that were 1) extracted or processed in the U.S. or in any country with which the U.S. has a free trade agreement or 2) recycled in North America.
      - ❑ Battery Components Requirement - certain "applicable percentage" of the battery components must have been manufactured or assembled in North America.
  - **Title XVII Loan Guarantee Program**

Recycle – Are the incentives working?

- Attracting Recyclers
  - Critical Materials Recycling was selected by DOE to receive a $500,000 cash prize and $100,000 in assistance from national laboratories to apply an acid-free dissolution recycling to wind turbine magnets
    - Process produces little to no waste
  - Cirba Solutions expanded its battery recycling plant in Lancaster, Ohio after receiving funding from the Bipartisan Infrastructure Law. Cirba Solutions snagged more than $82 million in total federal grants to help scale its operation and meet the nation's rising demand for key battery ingredients.
- Remaining Hurdles
  - Again, politics targeting the Green New Deal
  - Maintaining feedstock
  - Supporting a circular economy

Recycle – Proposed Solutions

- Increase Feedstock by Creating the Need to Recycle
- Modify Tax Credits to Support a Circular Economy

Recycle – Proposed Solutions

- Increase Feedstock by Creating the Need to Recycle
  - Mimic lead-acid battery recycling
    - Most successful domestic recycling program - 98% collected and recycled
  - Lead-Acid Battery Recycling Features
    - Instituted uniform regulations for management, labeling
    - Required a consumer education program
    - Prohibited landfill disposal
    - Banned exportation
- Similar Actions in the European Union – Critical Raw Materials Act
  - Sets battery recycling targets
  - Sets mineral recovery targets
  - Sets targets for usage of recycled minerals that increase over time
  - Labels permanent magnets

Recycle – Proposed Solutions

- Modify Tax Credits to Support a Circular Economy
  - Section 45X Advanced Manufacturing Production Tax Credit
    - Certain REEs (Lanthanum, Praseodymium, Samarium) and Gallium must have a minimum purity of 99% by mass to be eligible
    - Other critical minerals are eligible if either a certain compound or purity
    - Does not require purchaser to be an entity in the US
- Suggested Modifications
  - Additional tax credit percentages
    - Give additional credits to those that sell to domestic producers
    - Give additional credits to recyclers/processors that produce a production ready mineral
      - ❑ Further disincentivizes the need to sell overseas

Replace

Replace - Why?

- Lithium Batteries
  - Supply chain risk
  - Fire risk
    - Hard to extinguish
    - Two runaway storage facility incidents in Arizona
    - Recent fire at world’s largest storage facility in California
  - High cost per kilowatt hour at 8 to 10-hour duration
  - Future pricing uncertain

Replace - Current Incentives

- Inflation Reduction Act
  - **Clean Electricity Production Tax Credit**
    - Tech-neutral production tax credit
    - Qualified facility and energy storage technology placed in service after Dec. 31, 2024.
    - The Clean Electricity Production Credit phase-out starts for the later of 2032 or when U.S. greenhouse gas emissions from electricity are 25% of 2022 emissions or lower
    - The credit starts at a base rate of 0.3 cents with opportunities for an increase when satisfying certain conditions
  - **Clean Electricity Investment Tax Credit**
    - Tech-neutral production tax credit
    - The Clean Electricity Investment Credit phase-out starts for the later of 2032 or when U.S. greenhouse gas emissions from electricity are 25% of 2022 emissions or lower.
    - up to 30% for facilities meeting prevailing wage and registered apprenticeship requirements opportunities for an increase when satisfying certain conditions

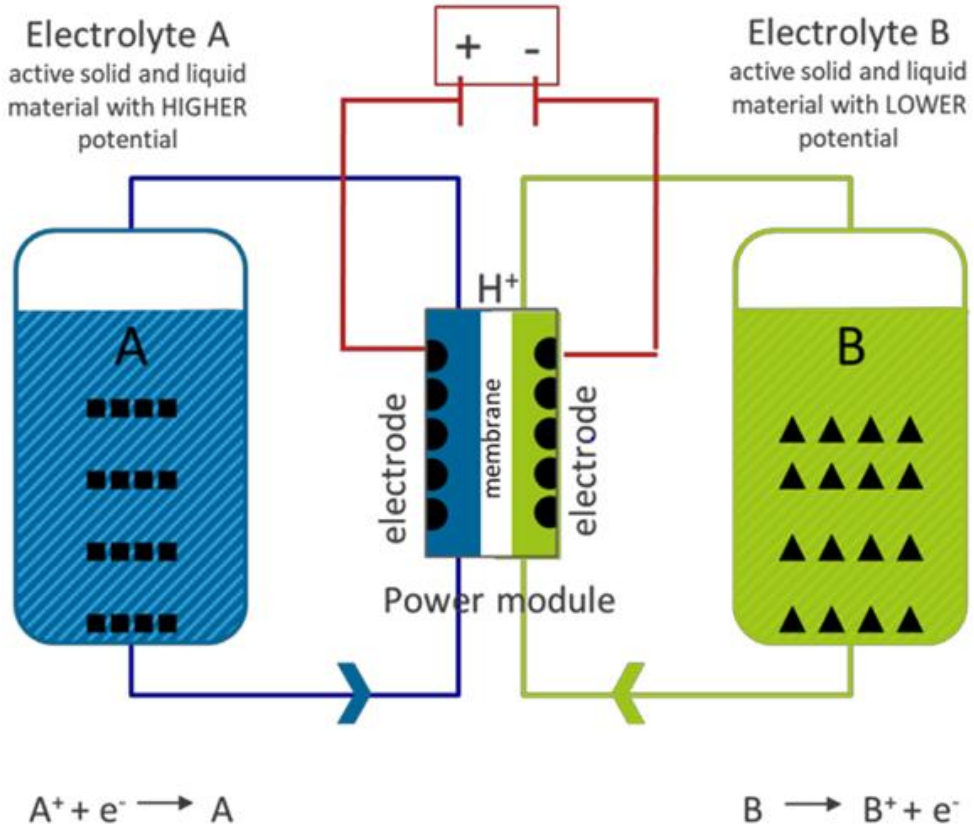
Resupply – Are the incentives working?

- Attracting development of non-lithium long duration energy storage
  - Pumped Thermal Energy Storage from Westinghouse ($54M from DOE)
  - Columbia Energy Storage Project compressed carbon dioxide (CO2) gas into a liquid to power a turbine ($30M from DOE)
- Remaining Hurdle
  - Politics targeting the Green New Deal
  - Traditional Electric Power Company
    - Slow to adapt
    - Pilot projects last around 10 years to recover investment and learn the project
    - Need to make large investments to balance renewable energy and compensate for fossil fuel retirement in the early 2030s

Credit: SRP

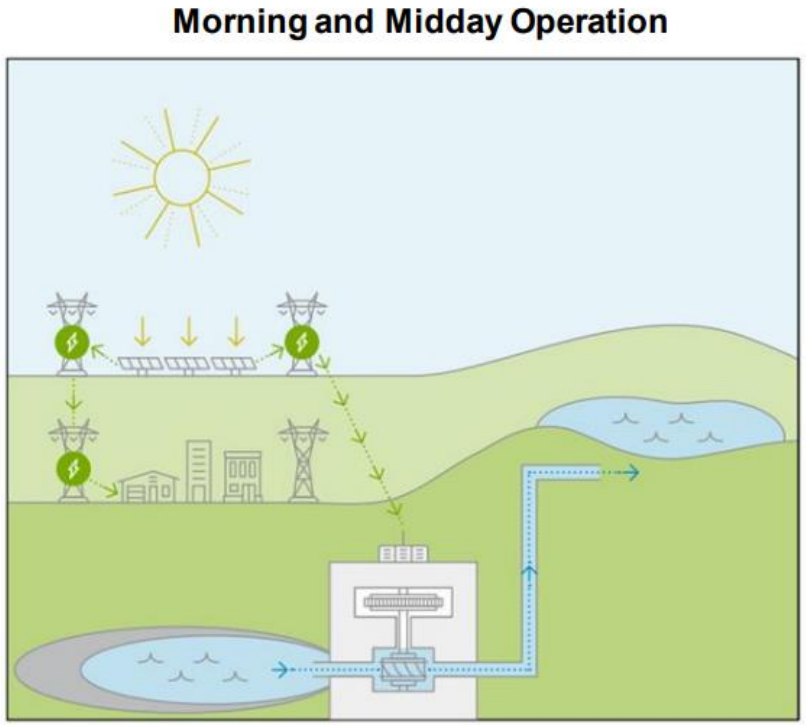
Replace – Current Issues

- Organic redox flow battery
  - No metals, polymer based
  - Aqueous, non-flammable electrolyte
  - Low cost material
  - 30-year life, low degradation
- Pilot project
  - 5 MW, 10-hour duration
  - Comes on line Q1 of 2026
  - No DOE funding
- Hurdles to upscaling
  - Can only operate for 2-3 years, if tax credits used for larger facility
  - Scale up manufacturing process for cell, stack, and electrolyte production



Replace – Current Issues

- Pumped Storage Hydrogeneration
  - 1000 – 2000 MW
  - 10-hour duration
  - 100-year life span
  - 2032+ online date
- Hurdles
  - Expensive
  - Permitting
  - Limited locations



Replace – Proposed Solutions

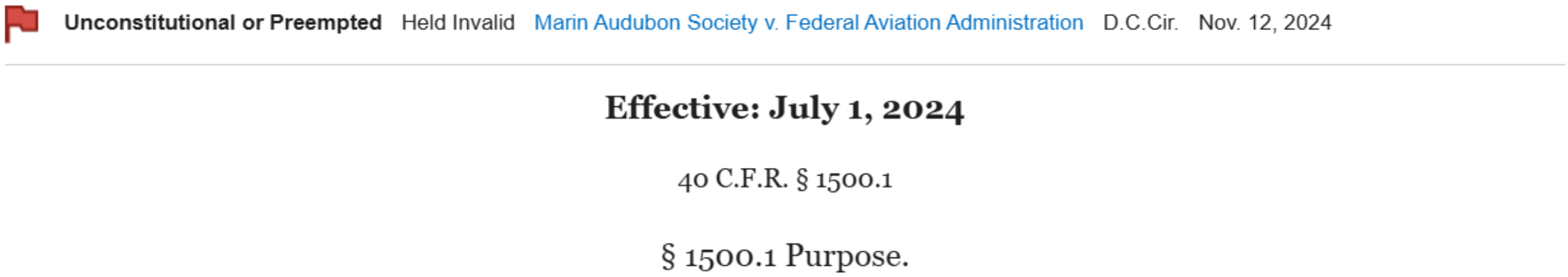
- Extend Both Tax Credits to 2040
  - Current energy tax credits expire in 2032
  - Allows more time to fully investigate pilot projects to potentially save on cost/kilowatt hour
    - Lithium 10-hour storage may be the default choice due to lack of demonstration projects by the expiration of the tax credits
      - ❑ Lithium storage at 10-hour duration is expensive
  - Removes hurdle to scaling up to utility scale
  - Gives time to complete permitting, if necessary, and address any litigation

Retreat

(sort of)

Retreat (sort of) - Why?

- Federal Permitting Process Instability
  - NEPA Statutory Changes – Fiscal Responsibility Act
  - NEPA Regulatory Changes – 2020, 2022, and 2024
  - *Marin Audubon Soc'y v. Fed. Aviation Admin.*, 121 F.4th 902 (D.C. Cir. 2024)
    - D.C. Circuit Court held promulgation of NEPA regulations by CEQ was “ultra vires”



Retreat (sort of) - Why?

- Federal Permitting Process Instability
  - Unleashing American Energy - Sec. 5(c) Directs the Chairman of CEQ to propose rescinding CEQ's NEPA regulations. A working group will convene coordinate the revision of agency-level implementing regulations for consistency
  - Secretarial Order No. 3415 (Jan. 20, 2025)
    - 60 day pause of authority to Department of Interior Bureaus and Offices:
    - To grant rights of way, easements, or any conveyances of property or interests in property, including land sales or exchanges, or any notices to proceed under previous surface use authorizations that will authorize ground-disturbing activities
    - To approve plans of operation, or to amend existing plans of operation under the General Mining Law of 1872

Retreat (sort of) – Proposed Solutions

- Retreat from any major federal action
  - Location! Location! Location!
  - Create State Financing Authorities
  - Federal Tax Credits
  - Certain Federal Grants

Retreat (sort of) – Proposed Solutions

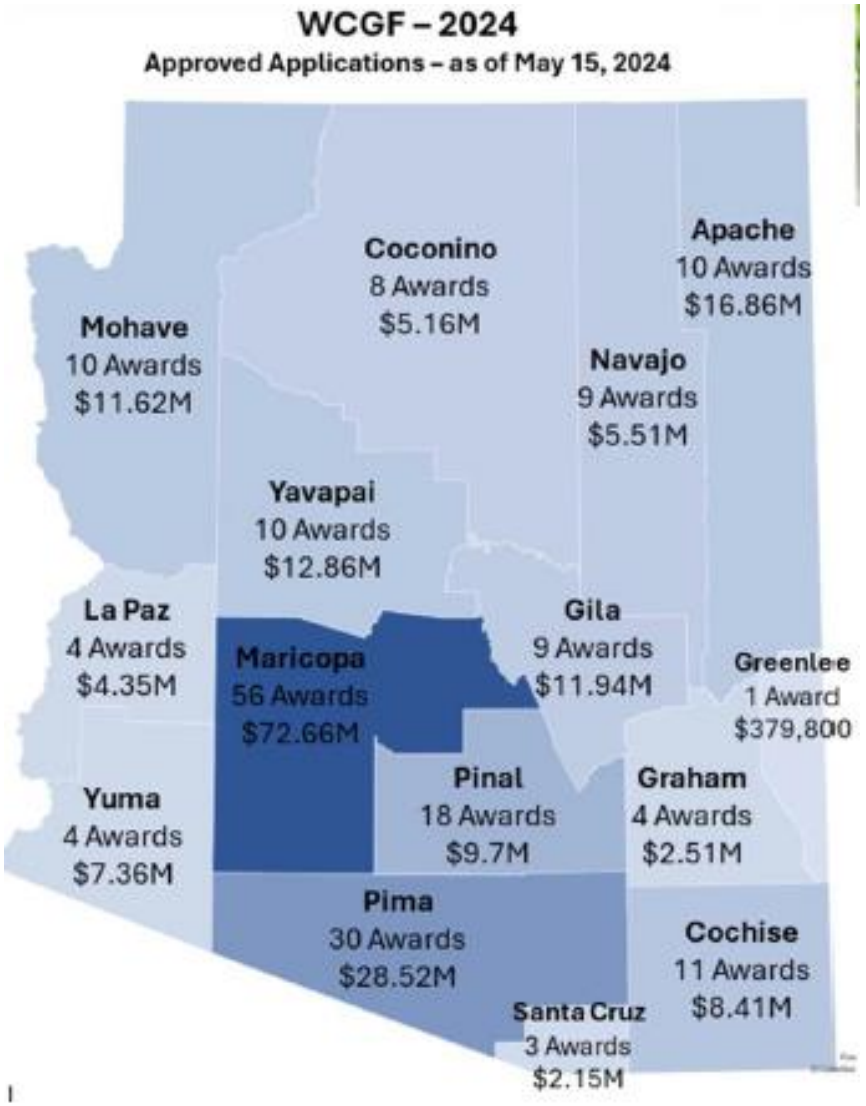
- Location! Location! Location!
  - Locate facilities on State or private land
  - Aim for States that have primacy for required permits
  - Best suited for recycling and processing, maybe mining
  - *See* Redwood Materials, NV
    - The sole major federal action was the loan from DOE

The battery intake field, where 30 acres of old batteries await the recycler at Redwood Materials in Nevada. *Photographer: Emily Najera/Bloomberg*

Source: Tom Randall, Tesla Co-Founder JB Straubel Built an EV Battery Colossus to Rival China, Bloomberg (Apr. 18, 2024) https://www.bloomberg.com/news/features/2024-04-18/redwood-material-s-nevada-ev-battery-recycling-facility-attempts-to-rival-china.

Retreat (sort of) – Proposed Solutions

- Create State Financing Authorities
  - Ex. Arizona Water Financing Authority
    - Provides financial investments in effective augmentation, conservation, reuse, and water quality actions in the form of loans and grants
    - Low-cost financing
      - Forgivable principal
      - Below-market interest rates
      - Design loan
      - Grants
    - Flexible application window
    - Individualized assistance from project managers
    - Opportunity for free technical assistance



Retreat (sort) - Proposed Solutions

- Create or extend federal tax credits
  - Tax Credits do not trigger a NEPA analysis
    - Various Production Tax Credits
    - Various Investment Tax Credits
- Create grants that do not trigger NEPA
  - Propose legislation for grants like Section 1603 Grants
  - Section 1603 Grants
    - Part of the American Recovery and Reinvestment Tax Act of 2009 to increase investment in domestic clean energy production
    - Payments in lieu of investment tax credits to eligible applicants for specified energy property used in a trade or business or for the production of income
    - Disbursed over $26 billion to help fund 109,766 clean energy projects
    - Did not trigger NEPA compliance

Summary

- Resupply
  - Become a FAST41 covered project
  - Enact legislation that authorizes occupation of federal land for tailings and waste rock storage
  - Support research and remove impediments to commercialization
- Recycle
  - Increase feedstock by creating the need to recycle
  - Modify tax credits to support a circular economy
- Replace
  - Extend both tax credits to 2040
- Retreat (sort of)
  - Avoid a major federal action
    - Location! Location! Location!
    - Create state financing authorities
    - Federal tax credits
    - Certain federal grants

Questions?

thank you!