MAKING CLEAN ENERGY CLEAN, JUST & EQUITABLE

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HOW WE CAME TO THIS WORK

- Earthworks has over 30 years experience supporting communities on the frontlines of extractive industries in the US, and around the world.
- In recent years we have seen an uptick in copper, nickel, lithium, cobalt and other mining projects described as "critical" for the energy transition.
- This powerful greenwashing narrative is used as justification to expand mining from Alaska to the salt flats of Argentina and Chile, the coastal and rainforests regions of Indonesia and PNG, and even the depths of the ocean.

Bristol Bay watershed, Alaska – threatened by the proposed Pebble copper/gold mine

OPPORTUNITY FOR A JUST TRANSITION

- Earthworks supports the transition to a renewables-powered future – one that is just and equitable, and doesn't harm communities and the environment through increased mining impacts
- This must be be an ***opportunity moment*** – to not only transition to a low-carbon economy but also reduce our dependence on irresponsible mining.
- Can't replicate the mistakes of the dirty fossil fuel based energy system we're seeking to replace.
- Early interventions needed to ensure this doesn't happen.

Families protesting impacts of Ramu nickel mine, Papua New Guinea

WHY MINING IS A THREAT TO COMMUNITIES, CLIMATE AND ECOSYSTEMS

- Potential impacts of increased minerals demand on frontline communities, climate and ecosystems:
  - Human rights abuses: forced displacement, conflict, and pollution for workers and communities
  - Disproportionate threats to indigenous rights and livelihoods
  - Toxic waste and deadly tailings disasters
  - Freshwater pollution & use reduces water access and quality for ecosystems and communities
  - Carbon-intensive - metals mining is responsible for 10% of global carbon emissions
  - Risks to marine environment from seabed mining

Brumadinho mine waste disaster, Brazil, January 2019: an estimated 250 people killed

2 REPORTS BY THE UNIVERSITY OF TECHNOLOGY SYDNEY FOR EARTHWORKS

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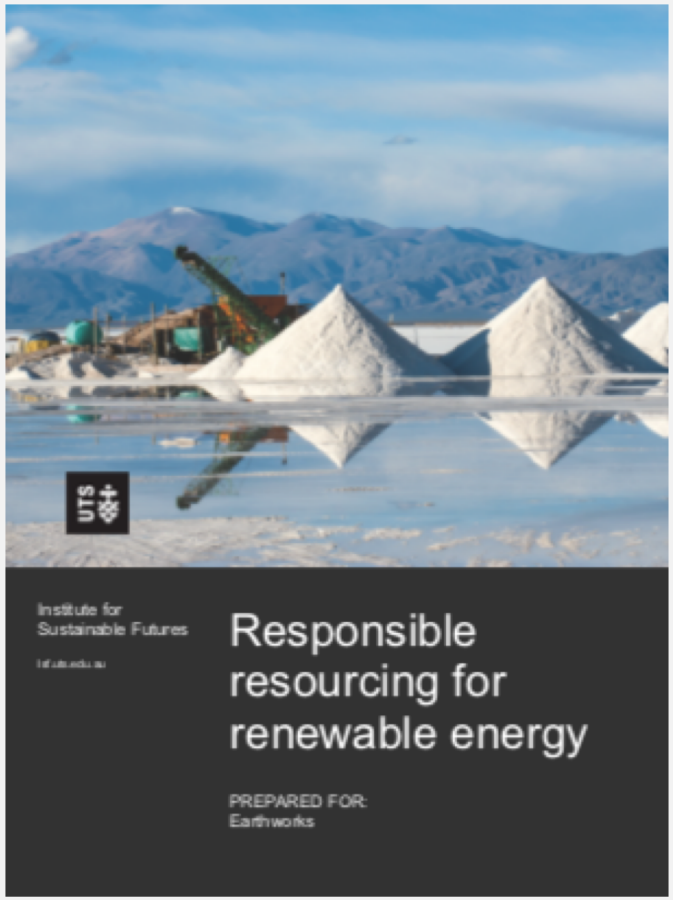


KEY METALS FOR CLEAN ENERGY TECHNOLOGIES

Batteries & electric vehicles (EVs)
- Lithium-ion (Li-ion) – current tech
- Lithium-Sulfur (Li-S) – new tech
- Lifetime: 10 years (battery) 15 years (vehicle)

Solar PV
- Silicon (c-Si) – 95% of market
- Copper Indium Gallium Selenium (CIGS)
- Cadmium Telluride (CdTe)
- Lifetime: 30 years

Wind Power
- Permanent magnet (PMG) – 20% of market
- Without permanent magnet (non-PMG)
- Lifetime: 30 years

	Batteries			Solar PV			Wind Power	
	Li-ion	Li-S	EV	c-Si	CIGS	CdTe	PMG	Non-PMG
Aluminium	X			X	X	X	X	X
Cadmium						X		
Cobalt	X							
Copper	X			X	X	X	X	X
Dysprosium			X				X	
Gallium					X			
Indium					X			
Lithium	X	X						
Manganese	X							
Neodymium			X				X	
Nickel	X							
Silver				X				
Selenium					X			
Tellurium						X		

Minerals Demand Projections for Battery and Renewables Technologies Under 100% Scenarios

	Peak annual demand (tonnes)		% of demand compared to current production	
	Maximum scenario	Minimum scenario	Maximum scenario	Minimum scenario
Aluminium	18,852,177	17,822,832	3%	3%
Cadmium	700	479	3%	2%
Cobalt	1,966,469	747,427	1788%	679%
Copper	5,626,579	4,493,216	29%	23%
Dysprosium	11,524	7,299	640%	406%
Gallium	89	57	28%	18%
Indium	276	181	38%	25%
Lithium	4,112,867	727,682	8845%	1565%
Manganese	6,438,599	2,447,220	40%	15%
Neodymium	94,687	59,118	592%	369%
Nickel	6,581,326	2,501,469	313%	119%
Selenium	404	289	12%	9%
Silver	9,926	6,646	40%	27%
Tellurium	834	555	199%	132%

WHY THE FOCUS ON BATTERY METALS?

- Electric vehicles are the main driver of demand for key metals
- Projected rate of growth
- Nascent point in this sector's growth – opportunity to make substantial improvements
- Importance of EVs in climate policy
- Impact of private EVs vs. public transit – opportunity for a shift in transportation
- Opportunity to get the ball rolling on early interventions in policy, design, efficiency

NICKEL

- Nickel used in electric vehicle battery cathodes is of a higher quality than the nickel pig iron used in the stainless steel industry. To produce high-quality nickel products from the laterite ores found in Indonesia, PNG, the Philippines and other countries, a process known as High-Pressure Acid Leaching is being increasingly adopted.
- This process is highly toxic, polluting, energy-intensive, and leaves a massive amount of waste material to be disposed of. Devastating cases of damage to freshwater and marine ecosystems (through ocean mine waste dumping) have been documented in Canada, Russia, Australia, Philippines, Indonesia, Papua New Guinea and New Caledonia due to nickel mining and refining practices.

COBALT

- The majority of global cobalt production is concentrated in the southern DRC, where decades of water and air pollution from to industrial-scale copper-cobalt mines is responsible for serious health impacts and the loss of vegetation and farmland.
- Cases of corruption, tax evasion and other improprieties by large mining companies have reduced what little economic benefits the sector offers the country and affected communities.
- While only producing an estimated 20 percent of Congolese cobalt, the artisanal cobalt mining sector has attracted the greatest international scrutiny--primarily over child labor. Meanwhile, artisanal miners cooperatives are developing solutions and calling for the formalization of the sector.

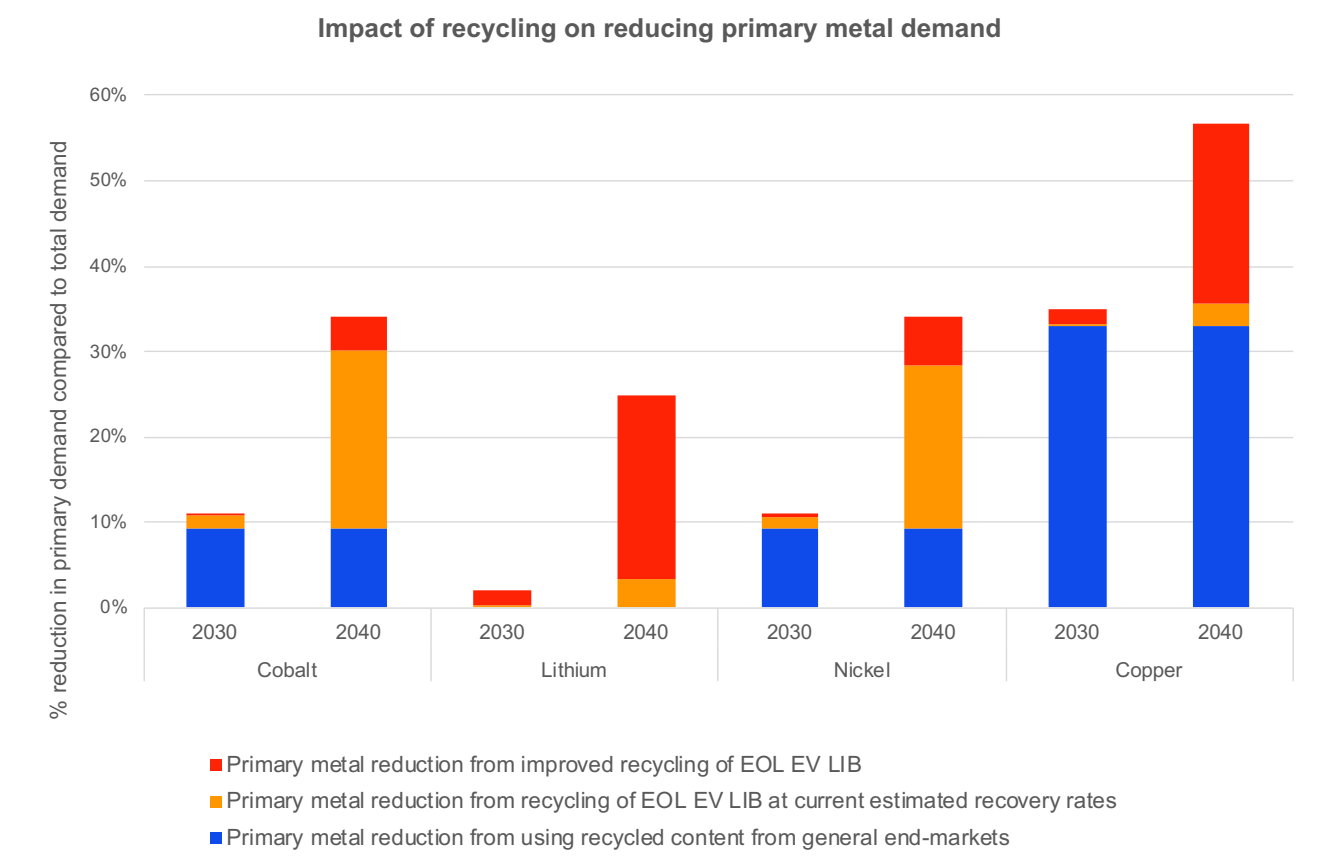
LITHIUM

- Large lithium deposits are found underneath the salt flats of Chile, Bolivia and Argentina. Current operations, and a massive wave of exploratory work, are a source of disputes throughout this region. Conflicts in the other parts of the world brewing, including in US
- Water impacts on the fragile desert ecosystem of evaporative brine extraction and a lack of respect for indigenous rights are the primary drivers of these disputes.

Non-recycling options for reducing demand for lithium-ion batteries in electric vehicles

	Current situation	Potential	Limitations
Extending battery lifetimes	Current lifetimes estimated between 8 years (current warranties) and 15 years.	Some manufacturers proposing potential 20 year battery lifetimes.	Consumers are more likely to upgrade vehicles before end-of-battery life.
Reuse	'second-life' applications, include **stationary storage**, use in other types of **vehicles** and potentially **EV-to-EV applications**.	The most likely market is the use of EOL EVs in **grid storage applications**, with potential lifetimes of 12 years (second life).	The variation between battery design and chemistries limits refurbishment and reuse, unless initiated by manufactures.
Shifts away from private car ownership	Car sharing schemes have the potential to reduce the number of privately-owned cars, but there are very few applications in operation.	Vehicles used in sharing schemes may be used more intensively, however they may also allow for best practice battery management.	Consumer preferences and a lack of policy support remain major limitations to further expansion of car sharing.
Improved public and bike transit	Access to public and bike transit options could significantly reduce private car use, but remain limited in many contexts.	Well-connected and incentivised electric buses, trains and the improved provision of bike infrastructure could reduce demand for private cars.	Lack of policy actively promoting public and bike transit infrastructure.

IMPACT OF RECYCLING ON REDUCING PRIMARY METAL DEMAND



- **25%** for **lithium**
- **35%** for **cobalt and nickel**, and
- **55%** for **copper**

LEVERS FOR CHANGE

Boost Recycling and Minimize Toxicity

- Scale up use of recycled minerals:
  - Policy interventions will be needed to encourage recycling to recover all metals and remove barriers that tilt the balance in favour of new extraction
  - Extending product life and repurposing
  - Product take-back requirements, design for disassembly, and standardization of battery technologies
- Prioritize health and safety for workers and communities to ensure no new sacrifice zones or injustices

- **Ensure Responsible Minerals Sourcing**
  - Where sourcing from new mining is absolutely necessary, operations must adhere to stringent environmental and human rights standards, such as those developed by the multi-stakeholder Initiative for Responsible Mining Assurance (www.responsiblemining.net), with independent, third-party assurance of compliance and civil society oversight.
  - Shift from mining companies to materials service providers?

- **Shift Consumption and Transportation**:
  - Rethink how we consume products and transport goods and people
  - Prioritize investments in electric-powered public transit
  - Circular economy strategies that reduce battery demand and ensure second life uses
  - Equity in access to benefits of clean energy and transit

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Alaskan wild salmon imperiled by Pebble mine