Responsible resourcing for renewable energy

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University of Technology Sydney

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Enhancing ecosystem integrity and livelihoods by incorporating perceptions, values and practices into decision-making

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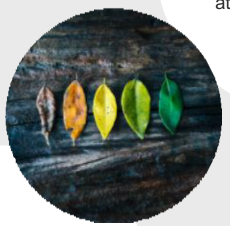


RESOURCE FUTURES

Advancing responsible and efficient production and consumption by fostering stewardship and circular resource flows

TRANSPORT

Providing solutions for quality transport services that maximise productivity at least cost and lowest impact

WATER FUTURES

Developing restorative, sustainable and resilient water management solutions

20 YEARS

Creating change towards sustainable futures

Research team

Dr Sven Teske

- Key expertise: Renewable energy system and market analysis
- Led global study on 100% renewables for 1.5 and 2 degree scenarios (One Earth Climate Model funded by Leonardo DiCaprio foundation)

https://oneearth.uts.edu.au/

Elsa Dominish

- Key expertise: Social and environmental impacts of resources and supply chain, circular economy
- Modelling scenarios and social research

Dr Nick Florin

- Key expertise: Circular economy, recycling, product stewardship for PV and battery systems
- Deputy leader of Wealth from Waste Cluster, 3 year project on e-waste

Research objectives

- Project commissioned by Earthworks to inform the **Making Clean Energy Clean, Just and Equitable** campaign

- Model projected **demand for metals** used in key renewable energy technologies
  - High cumulative demand compared to reserves/resources
  - Rapid increases in production

- Model **potential to offset demand** through substitution, efficiency and/or recycling

- Review associated **supply risks**
  - Concentration of producers and reserves
  - Share of end-use for clean energy

- Review **supply impacts of mining** (environmental and human rights)

Key findings

- Under a 100% renewable energy scenario **metal requirements could rise dramatically**
- **Recycling can reduce demand** but not meet all demand, new **mines are already under development** (e.g. cobalt, copper, lithium, rare earths, nickel)
- **Cobalt, lithium and rare earths** are the metals of most concern considering projected demand, supply risks and impacts
- **Electric vehicles** are the main driver of demand for key metals rather than stationary storage or wind power
- **Responsible sourcing** is needed when supply cannot be met by recycled sources

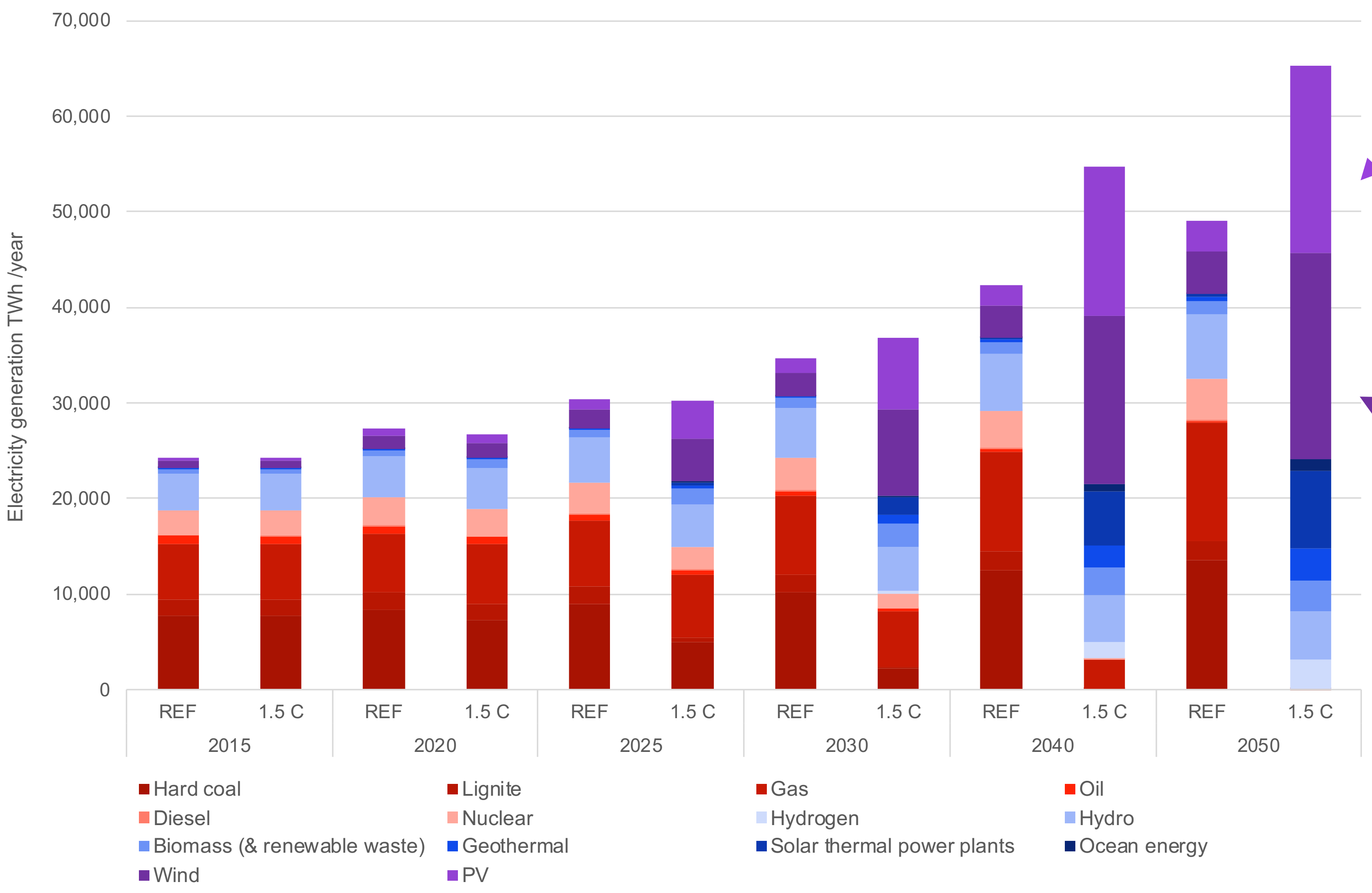
1.5°C Energy scenario

One Earth Climate model

100% renewable electricity 2050

100% renewable transport 2050 (>50% electric)

Battery demand calculated for cars, buses, commercial vehicles & storage



Solar PV 30% of electricity generation by 2050

Wind 28% of electricity generation by 2050

Key metals for clean energy technologies

14 metals & 3 technologies

Batteries & electric vehicles (EVs)

- Lithium-ion (Li-ion) – current tech
- Lithium-Sulfur (Li-S) – potential 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

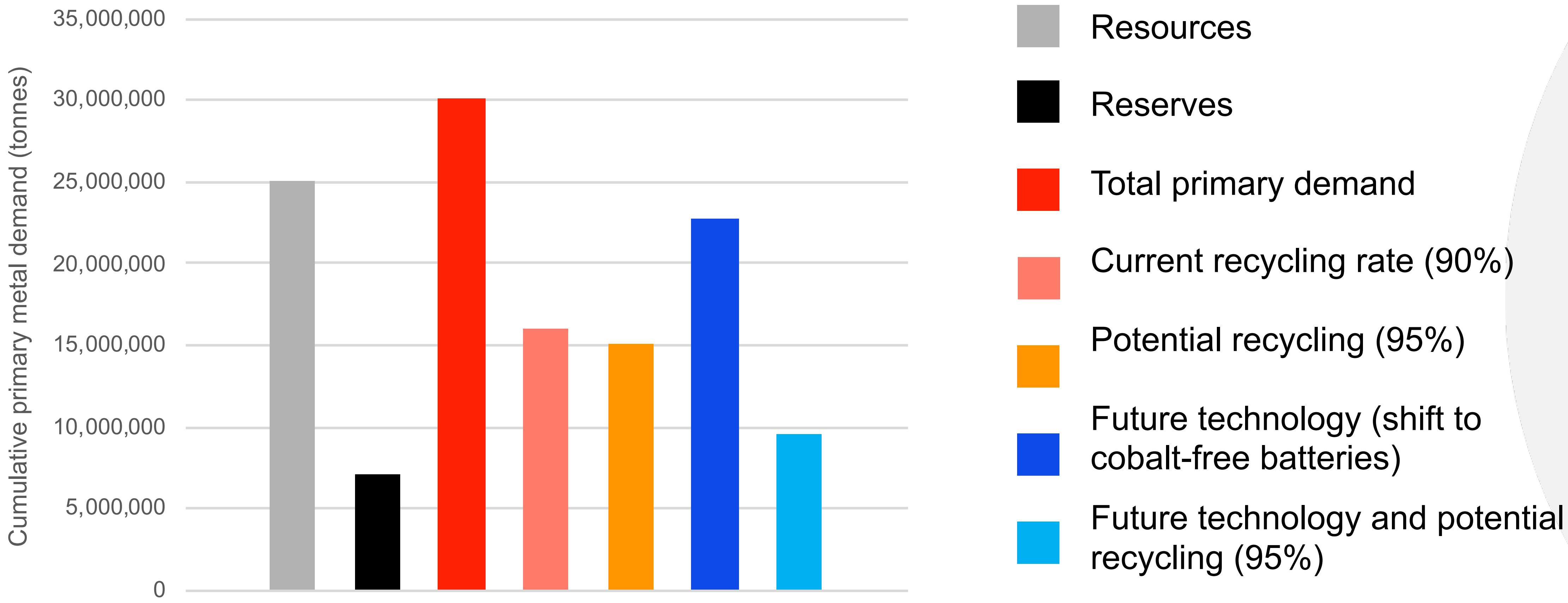
	Batteries			Solar PV			Wind Power	
	Li-ion	Li-S	EV	c-Si	CIGS	CdTe	PMG	Non-PMG
Aluminium	X	X		X	X	X	X	X
Cadmium						X		
Cobalt	X							
Copper	X	X		X	X	X	X	X
Dysprosium			X				X	
Gallium					X			
Indium					X			
Lithium	X	X						
Manganese	X							
Neodymium			X				X	
Nickel	X							
Silver				X				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

Cumulative Demand

	Cumulative demand in 2050 compared to reserves		Cumulative demand in 2050 compared to resources	
	Maximum scenario	Minimum scenario	Maximum scenario	Minimum scenario
Aluminium	2%	1%	1%	1%
Cadmium	4%	2%	0%	0%
Cobalt	423%	135%	120%	38%
Copper	18%	13%	4%	3%
Dysprosium	19%	12%	11%	7%
Gallium	2%	1%	0%	0%
Indium	51%	28%	16%	9%
Lithium	280%	86%	85%	26%
Manganese	14%	5%	0%	0%
Neodymium	13%	8%	7%	5%
Nickel	136%	43%	77%	25%
Selenium	11%	7%	7%	4%
Silver	52%	29%	21%	12%
Tellurium	75%	42%	48%	27%

Cumulative primary demand in 2050: cobalt

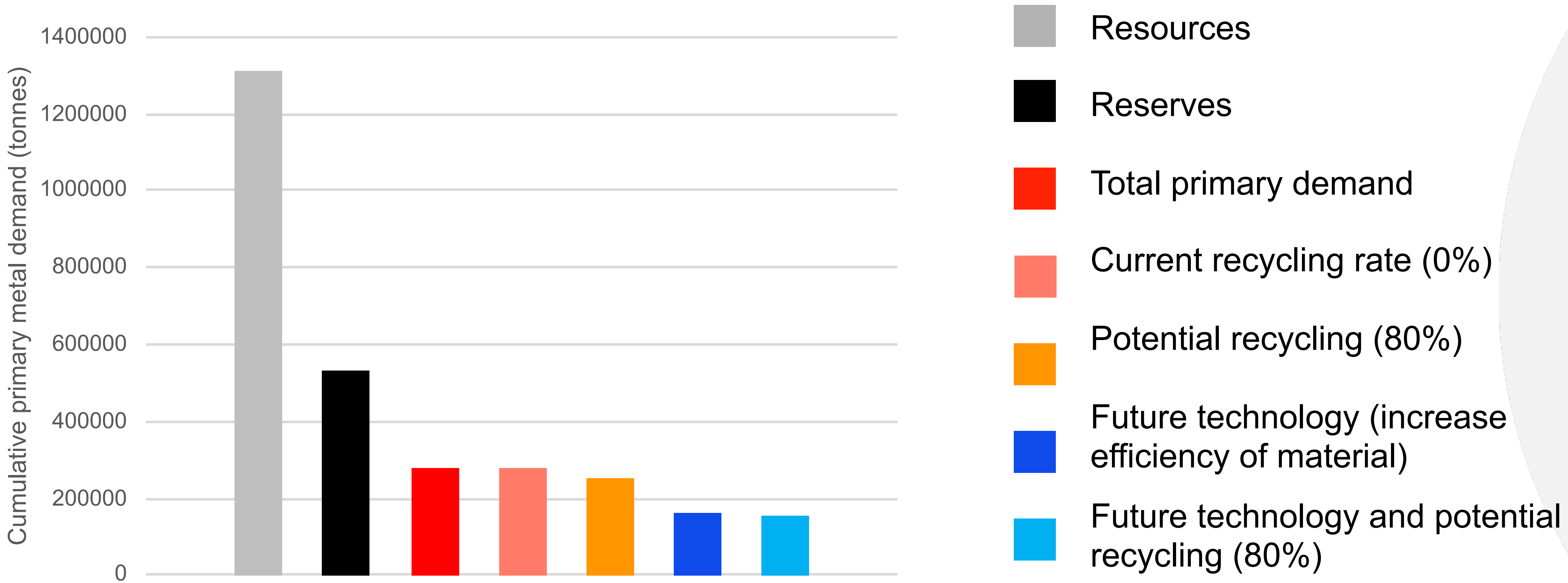
Cumulative primary demand for cobalt for EVs and storage by 2050



Recycling has greatest potential to reduce primary demand for battery metals

Cumulative primary demand in 2050: silver

Cumulative primary demand for silver for solar PV (c-Si) by 2050



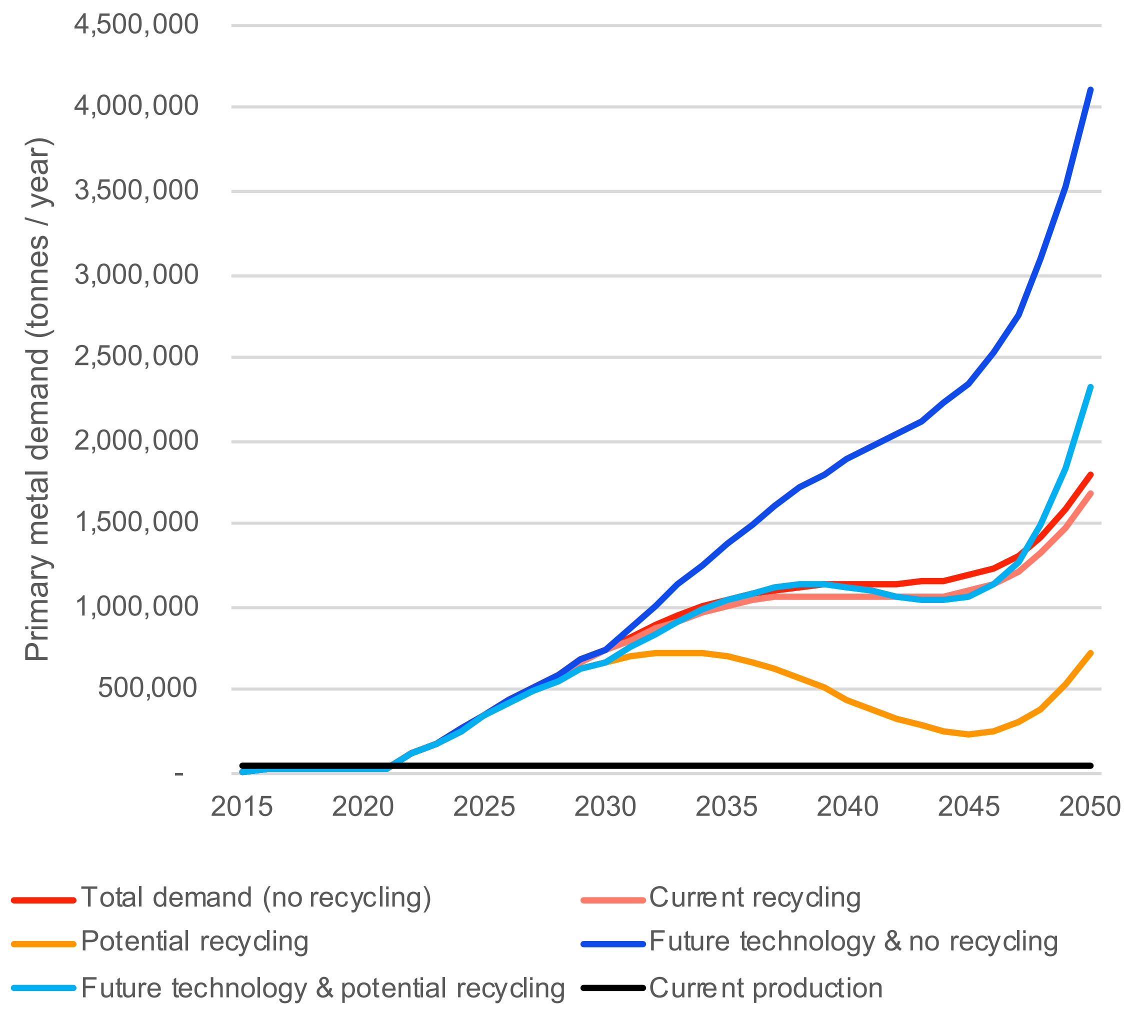
Efficiency has greatest potential to reduce primary demand for Solar PV metals

Increases in Production

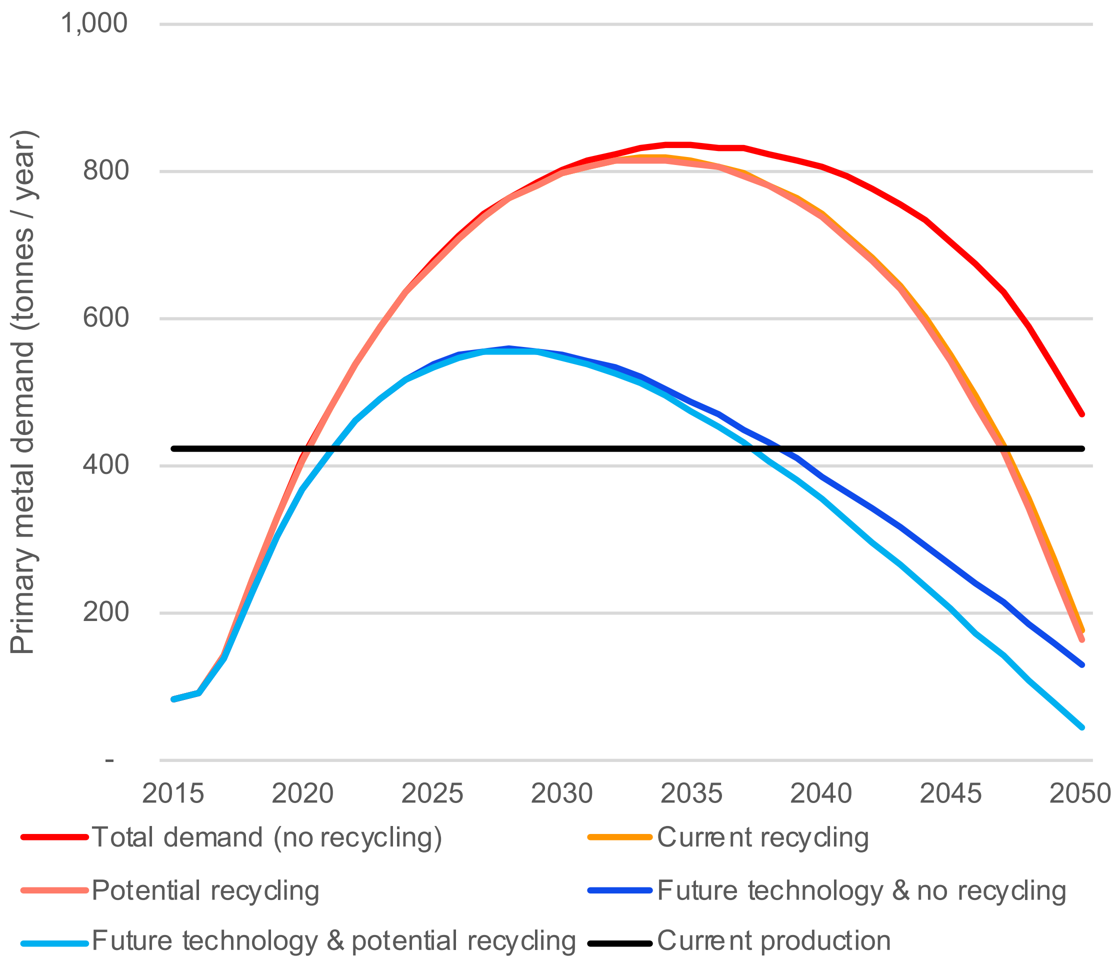
	Peak annual demand (tonnes)		% of demand compared to current production	
	Maximum scenario	Minimum scenario	Maximum scenario	Minimum scenario
Aluminium	18,852,177	17,822,832	3%	3%
Cadmium	700	479	3%	2%
Cobalt	1,966,469	747,427	1788%	679%
Copper	5,626,579	4,493,216	29%	23%
Dysprosium	11,524	7,299	640%	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%

Increases in production: lithium and tellurium

Annual primary demand for lithium for EVs and storage



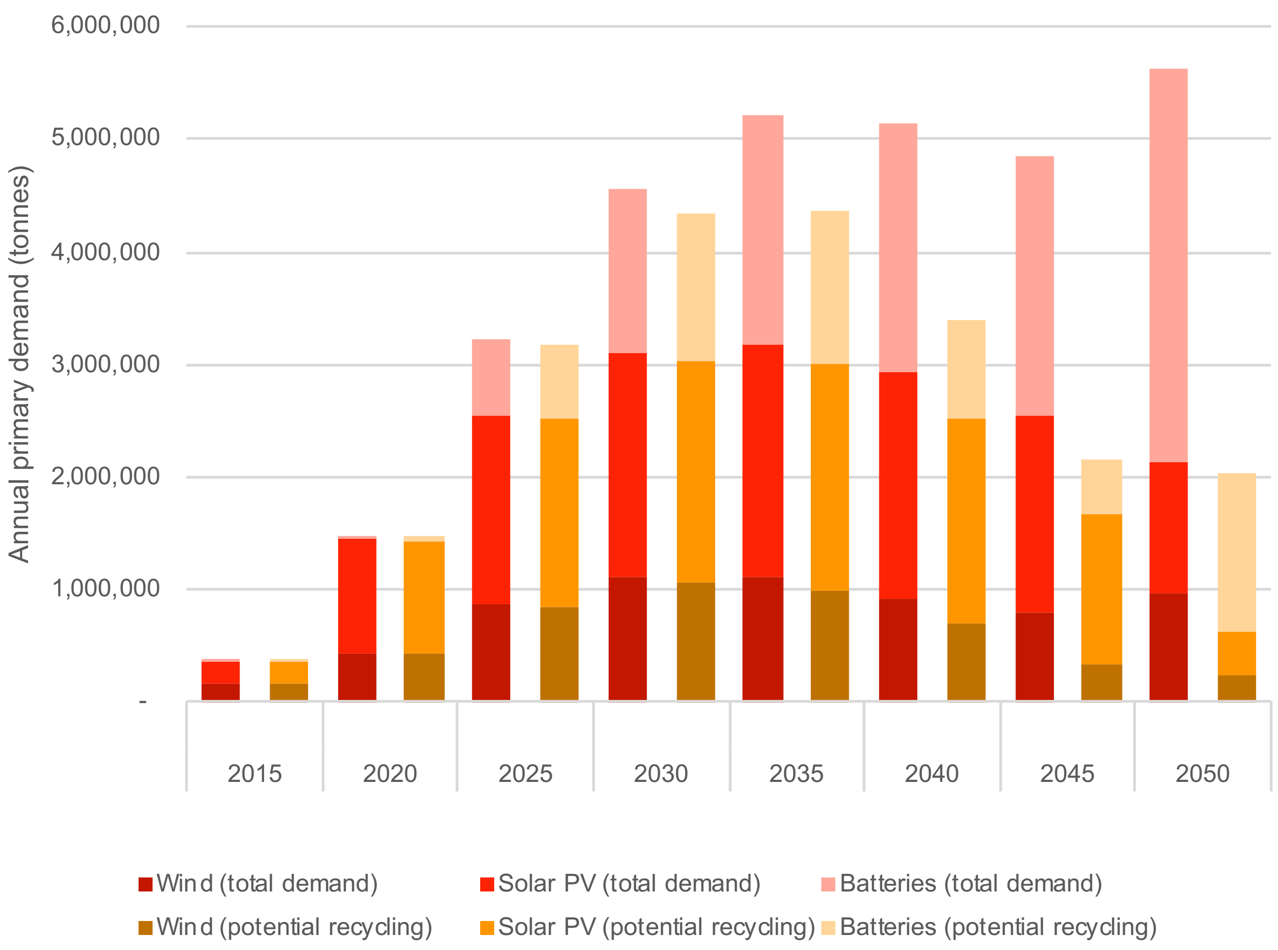
Annual primary demand for tellurium for PV



Demand for battery metals continues to grow but slows down for PV metals

Share of demand: copper

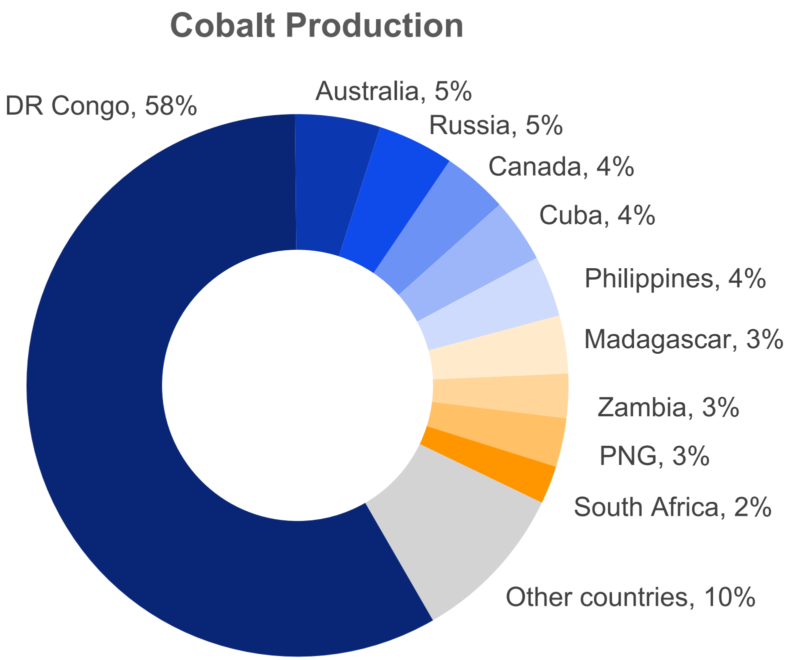
Annual primary demand for copper for wind, solar PV, EVs and storage

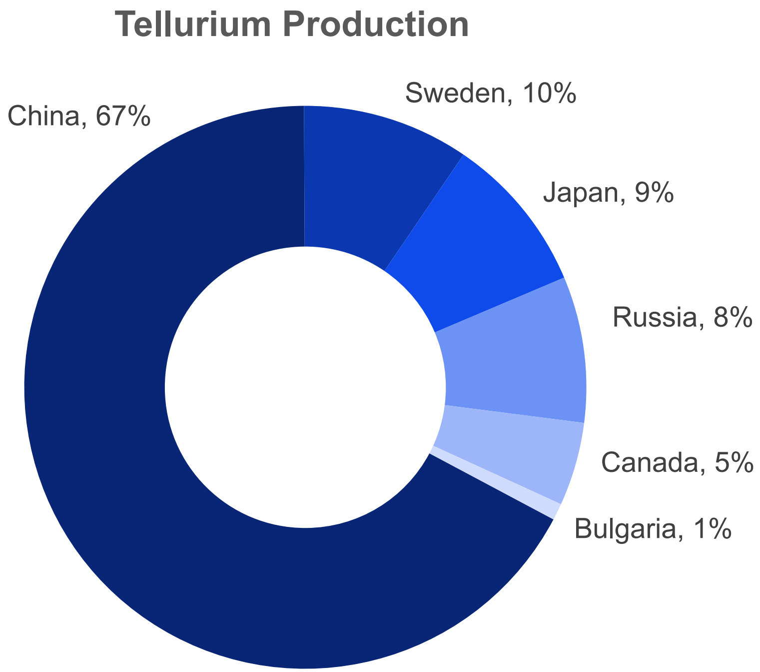


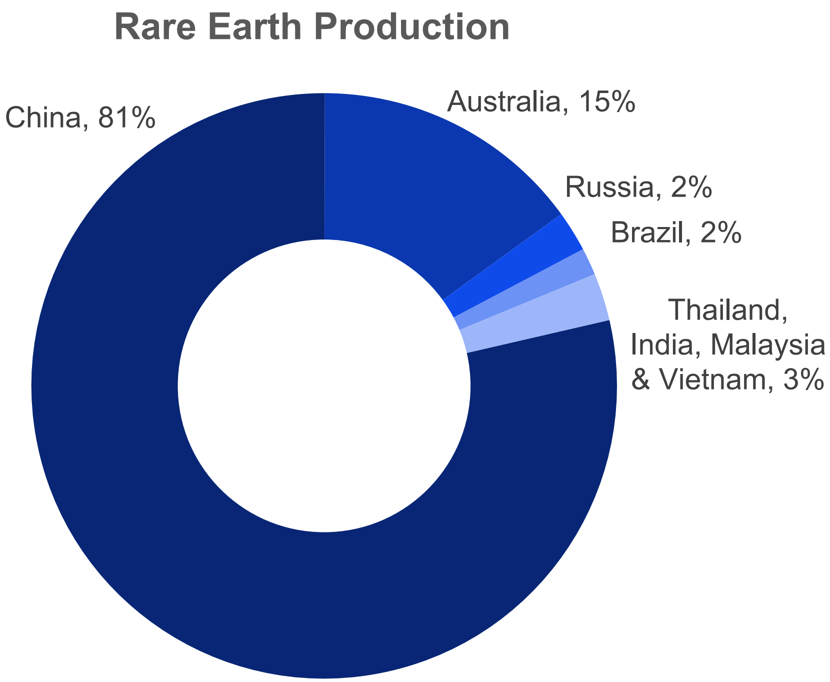
Batteries for EVs and storage are the largest share of demand for copper

Supply risks

High concentration of production: cobalt, rare earths and tellurium







High share of end-use for renewable energy:
cobalt (43% by 2020), lithium (50% by 2020), rare earths (32%) and tellurium (40%)

China dominates supply chain including for mining of specialty metals, processing of lithium and cobalt, manufacturing of solar PV, batteries and EVs, also largest end market

Supply side impacts

47 Ag Silver 107.868

- Heavy metal contamination soil & water in US, Mexico, Peru and Bolivia
- Social conflicts in Guatemala

27 Co Cobalt 58.933

- Severe health impacts from heavy metal contamination in DR Congo
- Dangerous working conditions, child labour

29 Cu Copper 63.546

- Risk of tailings dam failure e.g. US
- Heavy metal contamination in Chile, China, India, Brazil
- Health impacts on workers in Zambia & China

3 Li Lithium 6.941

- Water contamination and shortages and community conflict in the lithium triangle of Argentina, Bolivia and Chile

60 Nd Neodymium 144.242

- Rare earth processing produces large amounts of waste & wastewater, impacts in China & Malaysia

28 Ni Nickel 58.693

- Mining dust can lead to respiratory illnesses and cancer
- Damage to freshwater & marine ecosystems

Industry responses: security of responsible supply

- Industry are very **aware of risks of supply availability** for key metals
- Main concern guaranteed **long-term supply of key metals at a stable price**, particularly for cobalt and lithium
- Auto manufacturers are **looking to secure long-term contracts** for raw materials, getting involved with these agreements rather than leaving it to cell manufacturers
- Industry **aware of key human rights and environmental impacts**, but mainly cobalt from DRC
- One response is to look for **supply from ”low risk” countries** (e.g. Australia, Canada, Finland)
- Concerned about the ability to secure **adequate volumes of supply** from responsibly sourced mines.

Responsible sourcing essential to reduce potential negative social and environmental impacts

Recycling & efficiency to offset demand

- Industry is already focused on improving efficiency, current recycling infrastructure remains underdeveloped and/or not optimised for high value metal recovery

- **Batteries and EVs:**
  - Recycling of batteries happening to a degree because of economic value in the materials.
  - Not all types of metals are being recovered in recycling process (e.g. only highest value metals Co & Ni but not Li & Mn)
  - Potential for reuse in stationary storage applications (but not all automanufacturers interested)

- **Solar PV:**
  - Recycling is a challenge for solar PV (technological difficulties in recycling & longer lifetimes)
  - Recycling focused on glass; silver and other trace metals not being recovered

- Policy interventions will be needed to encourage recycling to recover all metals

- Recycling also **not without social and environmental impacts** if not done responsibly (especially rare earths)

Recycling is the most important strategy to reduce primary demand

Potential for new mining

- Under a 100% renewable energy scenario **metal requirements are projected to rise dramatically**
- Most likely to see mining in short term are **metals that have only been mined in small amounts previously** and where renewable energy is a large share of demand (lithium, cobalt, rare earths)
- Recycling can reduce demand for these metals but there is a time delay, so **new mining is likely to take place** to meet demand in short term.
- New **mines are already under development** linked to renewable energy demand (e.g. cobalt, copper, lithium, rare earths, nickel).
- **Deep sea mining** is under exploration, an emerging risk for ecosystems and communities

Where is new mining likely to happen?

- **Cobalt:** Australia, Canada, DRC, Indonesia, US, Panama, Vietnam
- **Nickel:** Indonesia, Zambia
- **Lithium:** Argentina, Australia, Bolivia, Chile, Canada, Mexico, Serbia, US
- **Rare earths:** Australia, Canada, Greenland, Malawi, South Africa, Uganda

Conclusion

EV and battery industries have the most urgent need to avoid negative impacts through **offsetting demand for primary metals** and **responsible sourcing**

Recycling is the most important strategy to reduce demand for battery metals, but new mining is already underway

When supply cannot be met by recycled sources, **responsible sourcing** is essential to promote environmental stewardship and the respect of human rights in the supply chain

Thank you

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