RENEWABLE ENERGY AND DEEP-SEA MINING:

SUPPLY, DEMAND AND SCENARIOS

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RATIONALE

The report examines the intersection of future demand for metals and available supply in the context of a renewable energy future. The different metals considered include:

- Copper
- Cobalt
- Nickel
- Lithium
- Silver
- Specialty metals (tellurium)
- Rare earths (neodymium, dysprosium)

The report focuses on copper, cobalt, nickel, lithium and silver as these are all needed in the renewable energy technologies likely to be important and potentially mined in deep-sea operations.

RESEARCH METHOD (1)

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The modelling approach developed for this study to evaluate future metal demand and supply involved three main steps:

1. Compiling data for metal resources listed above in terms of current global mine production rates, global reserves and resources, and estimated recycling rates (Chapter 2)
2. Estimating the metal resource use intensity by technology and application based on published data (Chapter 3)
3. Applying resource intensity to published future global energy supply and demand scenarios considering different renewable energy technologies and storage devices (Chapter 4)

A limitation with this approach is that for some metals the development of renewable energy technology is not the principal driver of future demand, and actual future demand will also depend on various other factors.

RESEARCH METHOD (2) - SCENARIOS

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- The **Reference scenario (REF)** is based on the Current Policies scenarios published by the International Energy Agency (IEA) in World Energy Outlook 2014 (WEO 2014)1F. It only takes into account existing international energy and environmental policies.
- The **Energy [R]evolution scenario (ER)** has the key target to reduce worldwide carbon dioxide emissions from energy use down to a level of around 4 giga-tonnes per year by 2050 in order to hold the increase in global temperature under +2°C. A second objective is the global phasing out of nuclear energy. The general framework parameters for population and GDP growth remain unchanged from the Reference Scenario.
- The new **Advanced Energy [R]evolution scenario (ADV ER)** assumes much stronger efforts to transform the energy systems of all world regions towards a 100% renewable energy supply. The consumption pathways remain basically the same as in the ER; however, a much faster introduction of new technologies leads to a complete decarbonisation of the power, heat and especially the transportation sector. The ADV ER has a significantly higher possibility that global mean temperature will remain between 1.5°C to 2°C than the basic ER.

RESEARCH METHOD (3) – RESOURCE INTENSITIES

Technology	Component	Copper [t/MW]	Cobalt [t/MWh]	Nickel [t/MWh]	Lithium [t/MWh]	Silver [t/MW]	Specialty metals / rare earths [t/MW]
Wind	On-shore/ off-shore	3.0					
	Direct drive turbines	3.0					0.198 Nd, 0.027 Dy
Solar PV	Silicon solar cell	5.4				0.08	
	CdTe	5.4				0.08	0.16 Te
	CIGS	5.4				0.08	0.03 In, 0.01 Ga, 0.16 Se
CSP	Mirror	4.0					
Hydro		0.4					
Electric Vehicles							695 t/million cars Nd, 83 t/million cars Dy
Lithium batteries	Li(NMC)		0.21	0.41	0.13		
	Li(NCA)		0.29	1.57	0.24		
	Li(NFP)				0.16		
	Li/S				0.41		
	Li/air				0.13		

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RESEARCH METHOD (4) – BATTERY TECHNOLOGY

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Material demand for Lithium ion batteries

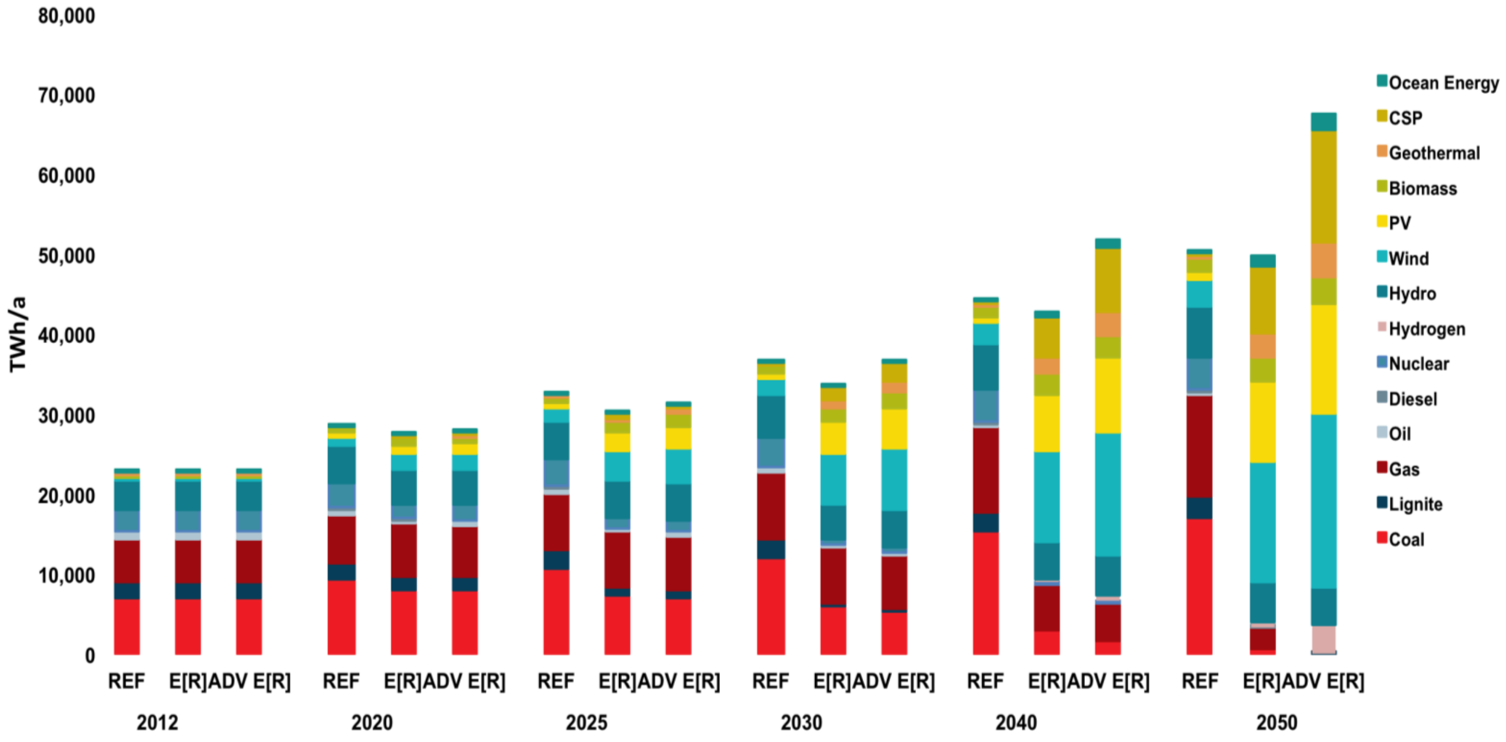
Battery chemistry	Cobalt (t/MWh)	Nickel (t/MWh)	Lithium (t/MWh)	Manganese (t/MWh)	Iron (t/MWh)	Aluminium (t/MWh)
NMC/C	0.021	0.41	0.13	0.41		
NCA/C	0.29	1.57	0.24			0.04
LFP/C			0.16		1.23	
Li/S8			0.41			
Li/O2			0.13			

Assumed relative share of five Li-ion battery types for different years

Battery chemistry	2015-2020	2020-2025	2020-2030	2030-2035	2035-2040	2040-2045	2045-2050
NMC/C	50	33	20				
NCA/C	15	33	25				
LFP/C	35	21	15				
Li/S8		13	40	90	90	90	90
Li/O2				10	10	10	10

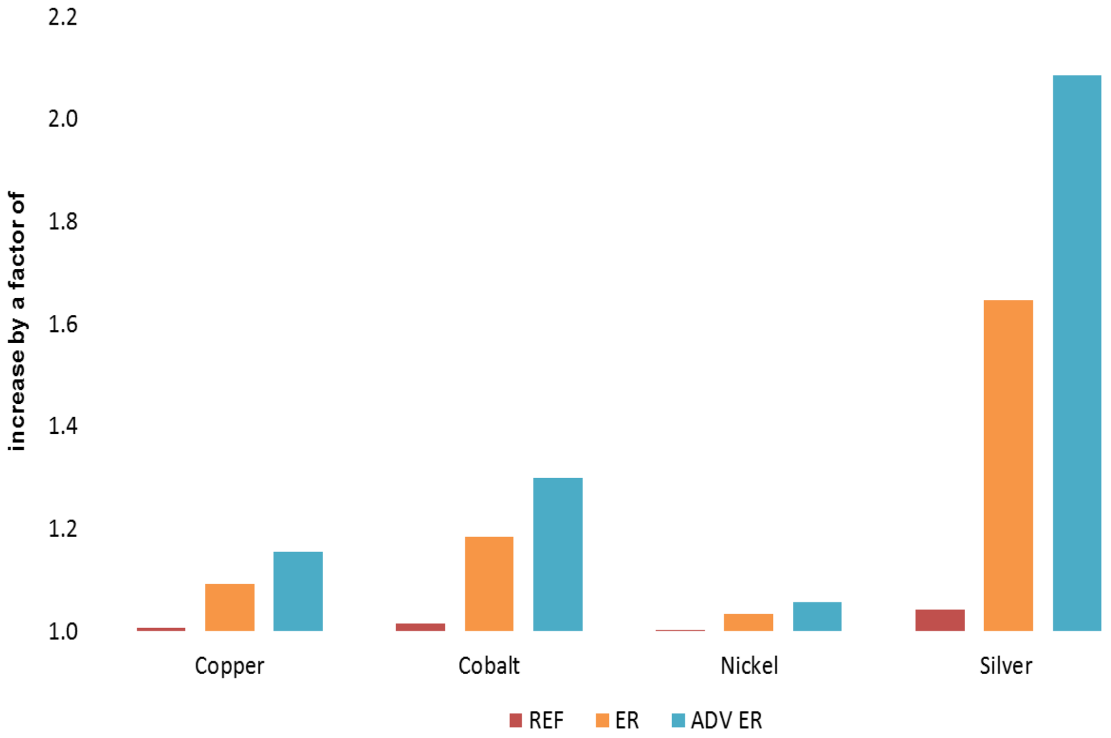
RESEARCH METHOD (5) – ENERGY SCENARIOS

Energy scenarios and market projections



KEY RESULTS (1)

Projected annual demand in 2030 relative to current production volumes (in 2014) for copper, cobalt, nickel and silver. (The annual demand is an average volume based on projected outputs for the 5-year period 2025-2030 without recycling.)



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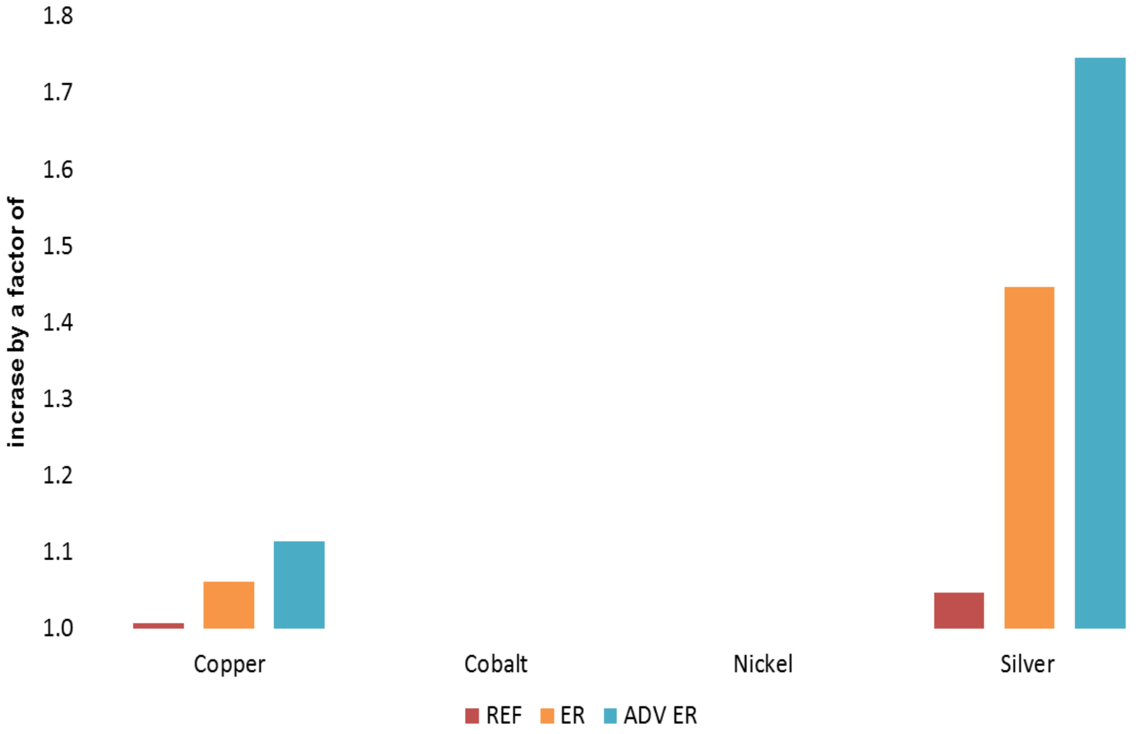
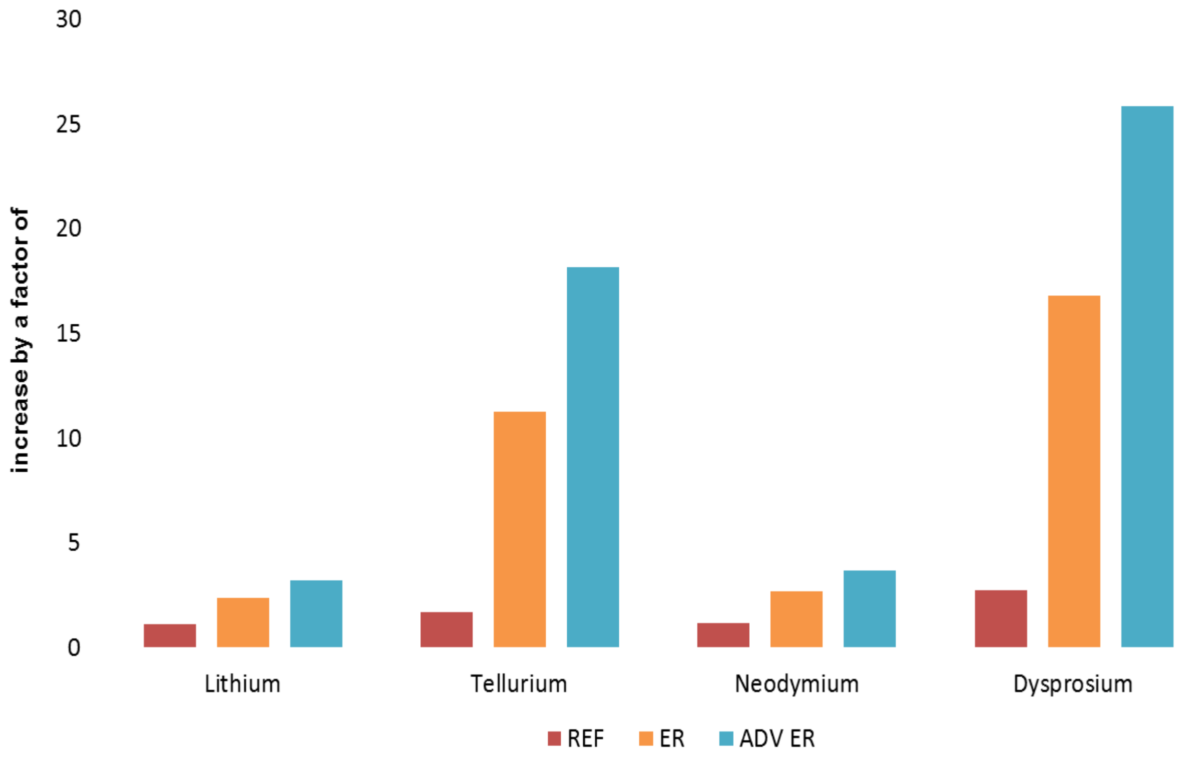
KEY RESULTS (2)

Projected annual demand in 2050 relative to current production volumes (in 2014) for copper, cobalt, nickel and silver. (The annual demand is an average volume based on projected outputs for the 5-year period 2045-2050 without recycling.)



KEY RESULTS (3)

Projected annual demand in 2030 relative to current production volumes (in 2014) for lithium, tellurium, neodymium and dysprosium



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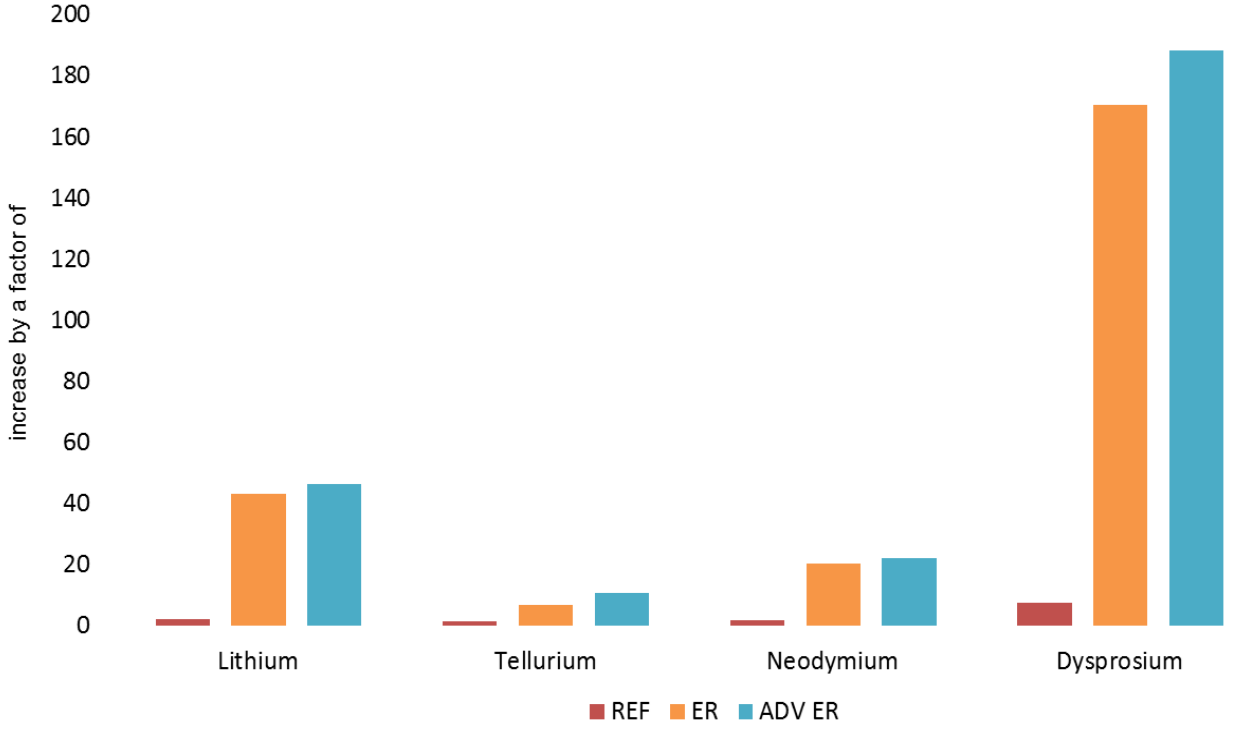
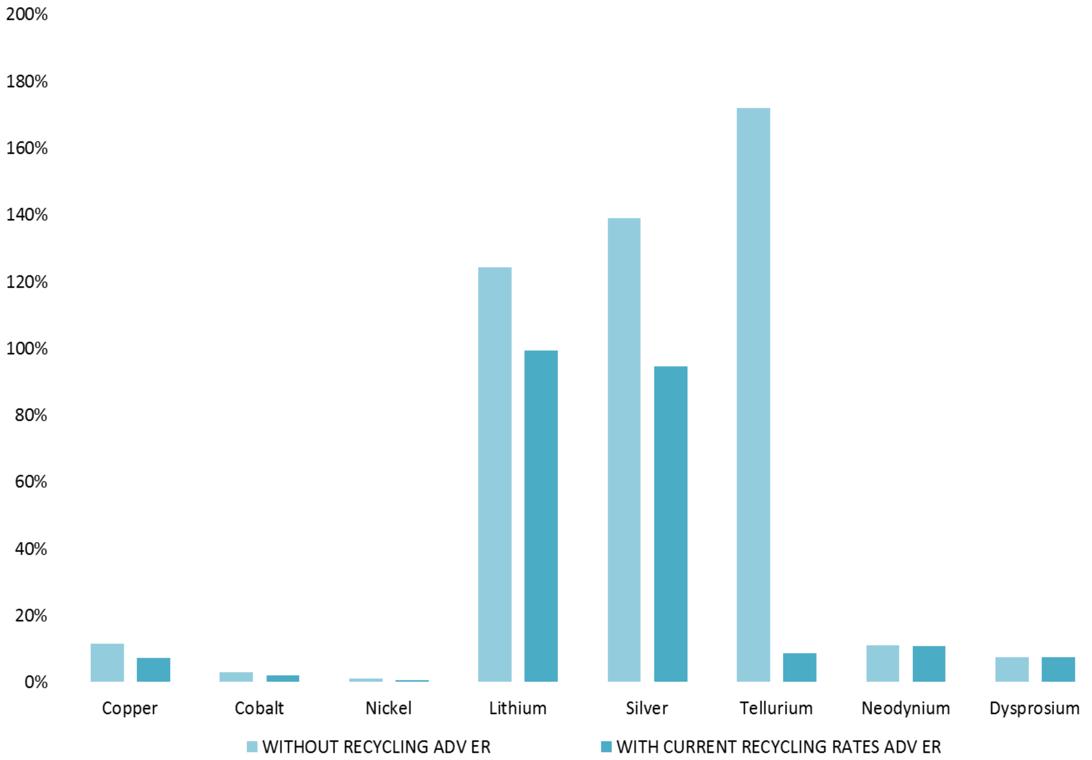
KEY RESULTS (4)

Projected annual demand in 2050 relative to current production volumes (in 2014) for lithium, tellurium, neodymium and dysprosium



KEY RESULTS (5)

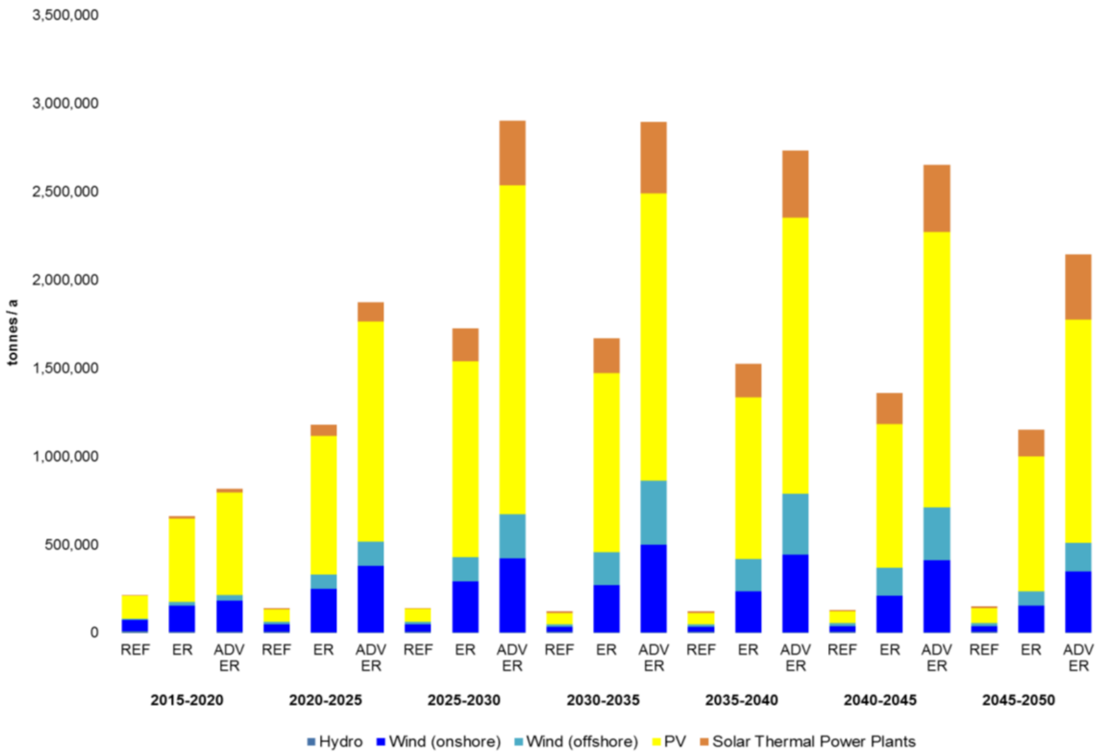
Cumulative resources required relative to current reserves, with and without recycling under the advanced scenario



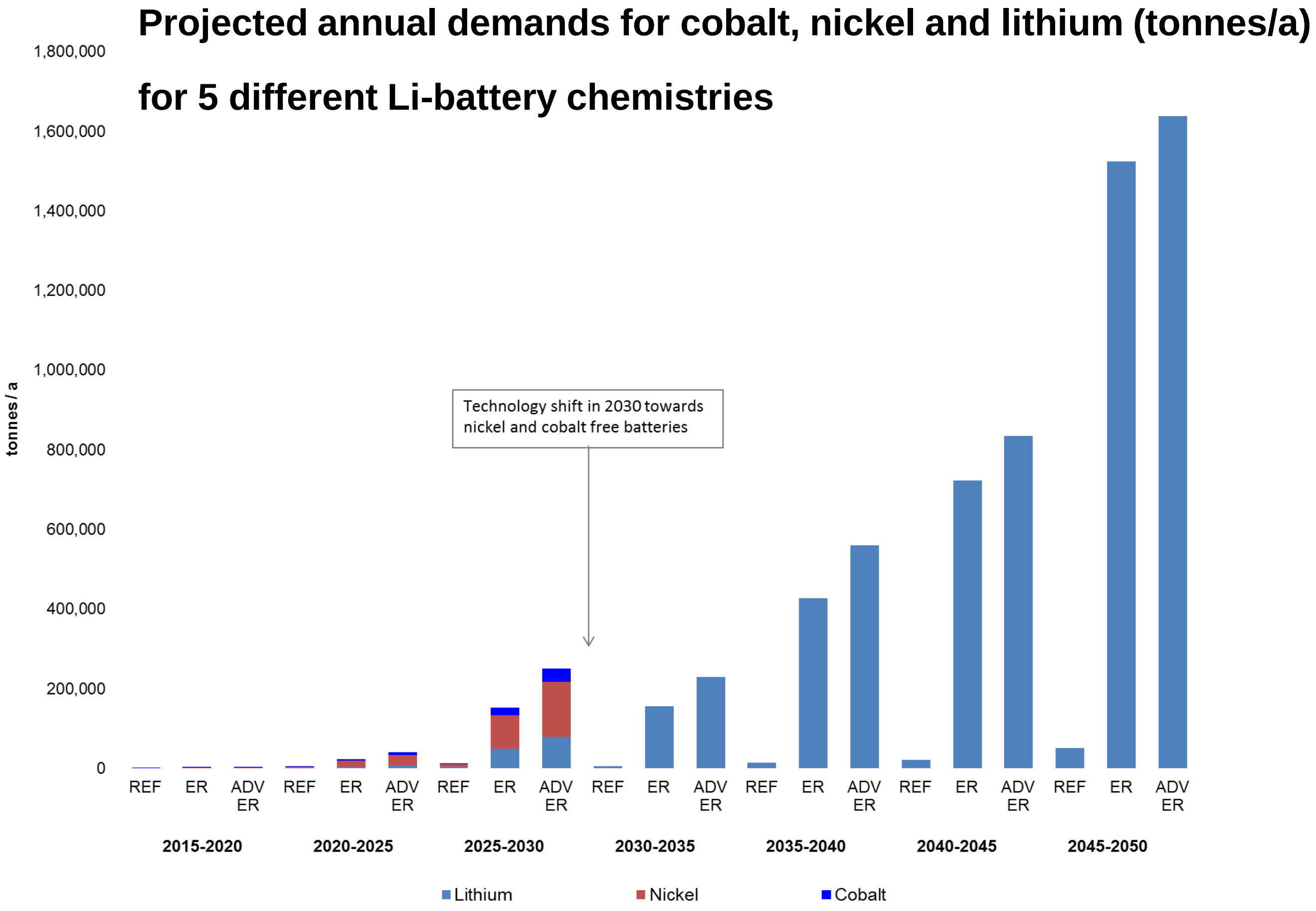
KEY RESULTS (5)

Projected annual demand for copper - selected renewable power & storage technologies.

(Average annual demand volumes are based on projected outputs averaged over 5-years)



KEY RESULTS (5)



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CONCLUSION

- Metal demand associated with the dominant renewable technologies evaluated in this report, even assuming very aggressive growth rates under the most ambitious future energy scenarios, do not require deep-sea mining activity.
- This is combined with the potential to increase recycling rates and sustained research and development into alternative technologies that reduce, or eliminate, the use of supply-constrained metals.
- The significant increase in production demands for neodymium and dysprosium, and the projected volumes of lithium and silver relative to current reserves suggests these metals require special attention.
- Increasing recycling rates is a very important part of the solution to securing the supply of metals for renewable power generation technologies and electric vehicle components.
- Future recycling efficiencies will ultimately be impacted by technology design, including ‘design for recycling’, and future investment in efficient collection and sorting systems
- A focus on improving material productivity in parallel to the renewable energy market expansion is of significant importance.

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RECOMMENDATIONS

- Recycling of raw materials is essential for renewables and – especially – storage technologies
- Recycling concepts required
- Product design is key
- Establish policies and regulations

  in the early market phase

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Thank you

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