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Critical Minerals and Batteries

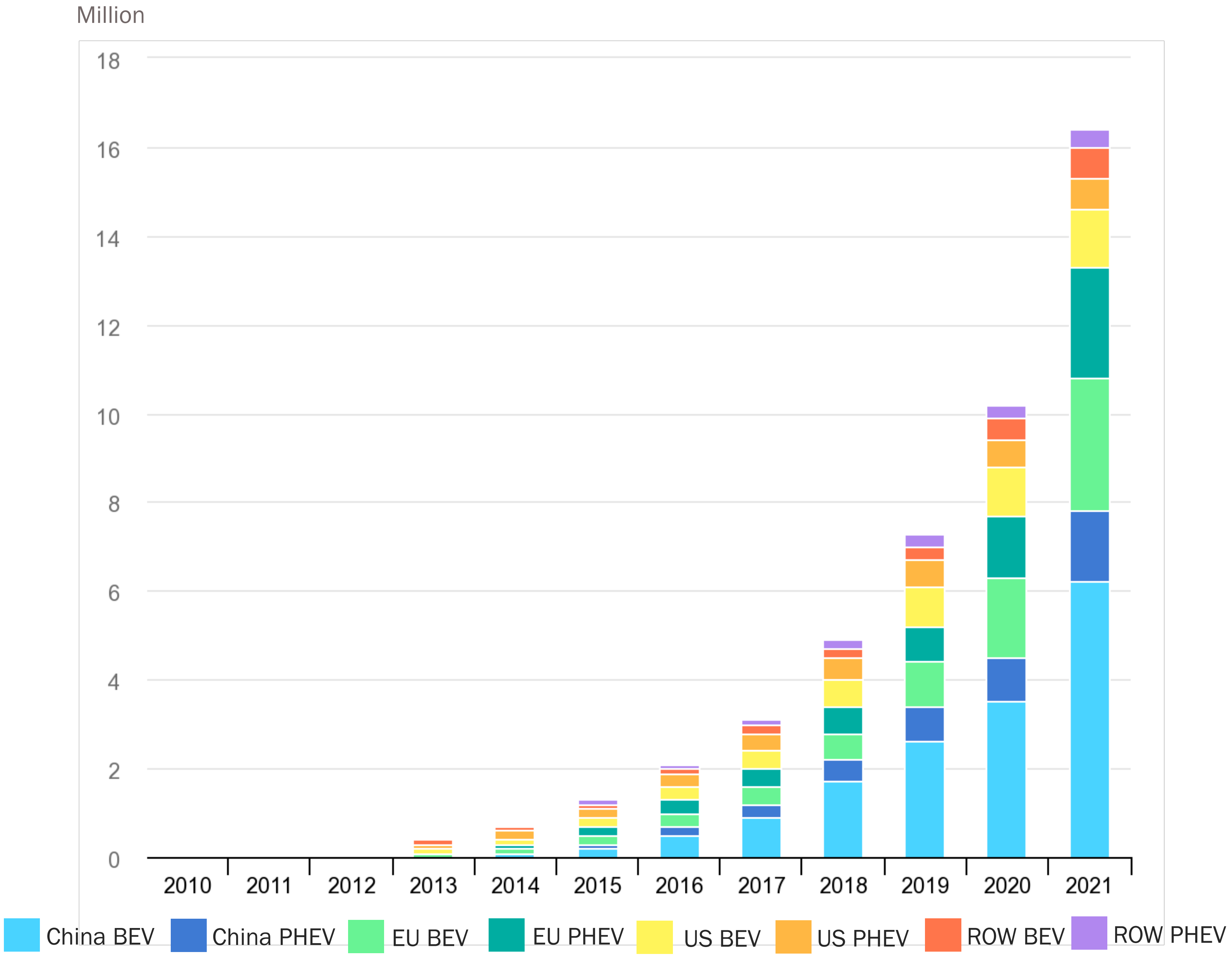
The Outlook for National Security and Economic Competitiveness

Abby Wulf, VP Critical Minerals Strategy, SAFE – February 2023

Betting on Batteries

- More than 20 countries and 70 subnational governments have announced 100% ZEV targets by 2050
- More than 16 million EVs on the road in 2021
- Bloomberg projects ~70% of new vehicles sold will be electric by 2040

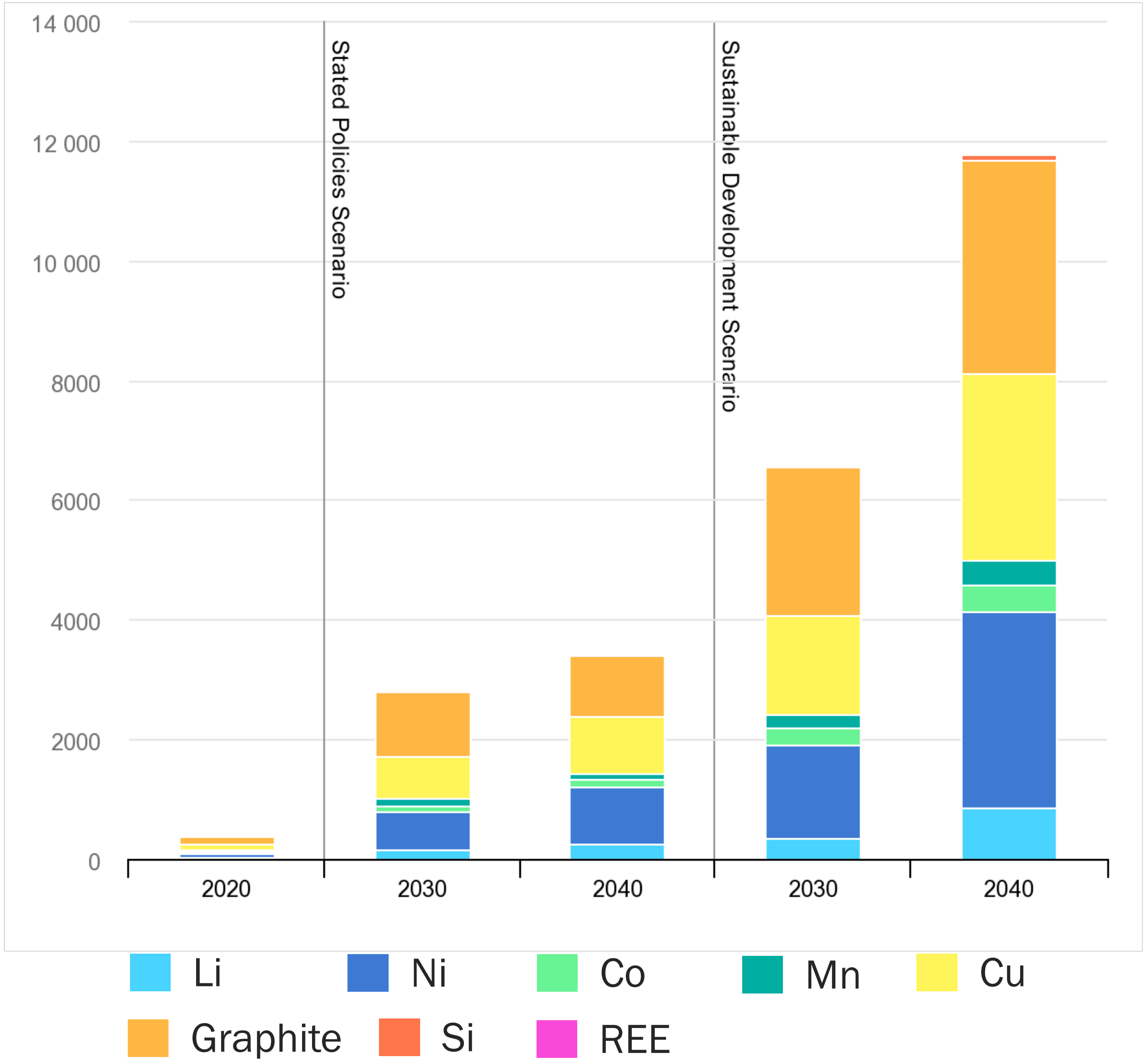
Global Electric Car Stock, 2010-2021 *(IEA, 2022)*



Examining EV Supply Chains

- A typical EV requires 6x the mineral inputs as an ICE vehicle
- EVs need Al and Fe for the body and chassis, Cu for electrical wiring, and Li, Co, Mn, Ni, and C (graphite) (currently) for batteries. They also need REE for motors

Total mineral demand from new EV sales by scenario, 2020-2040 *(IEA, 2021)*



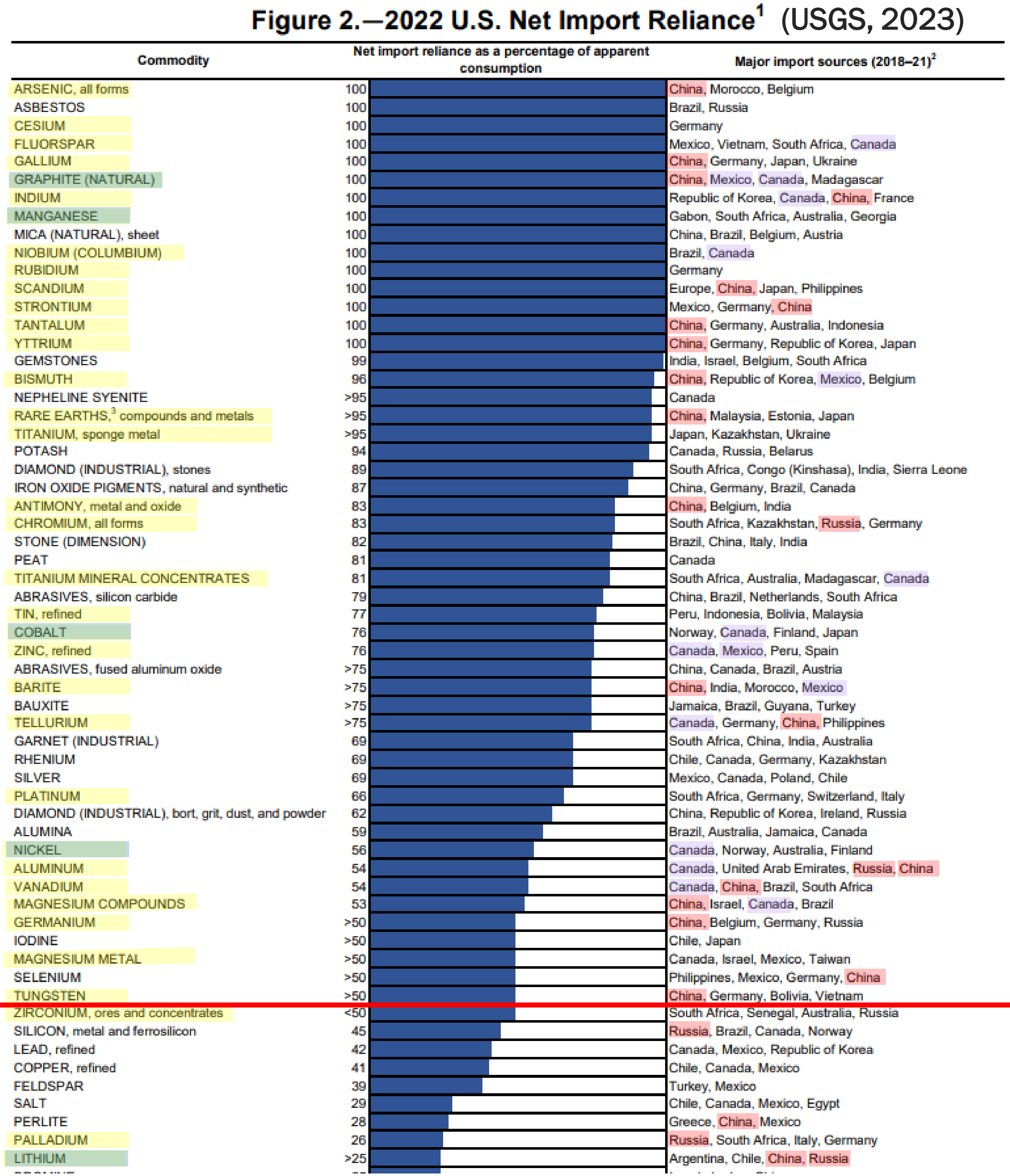


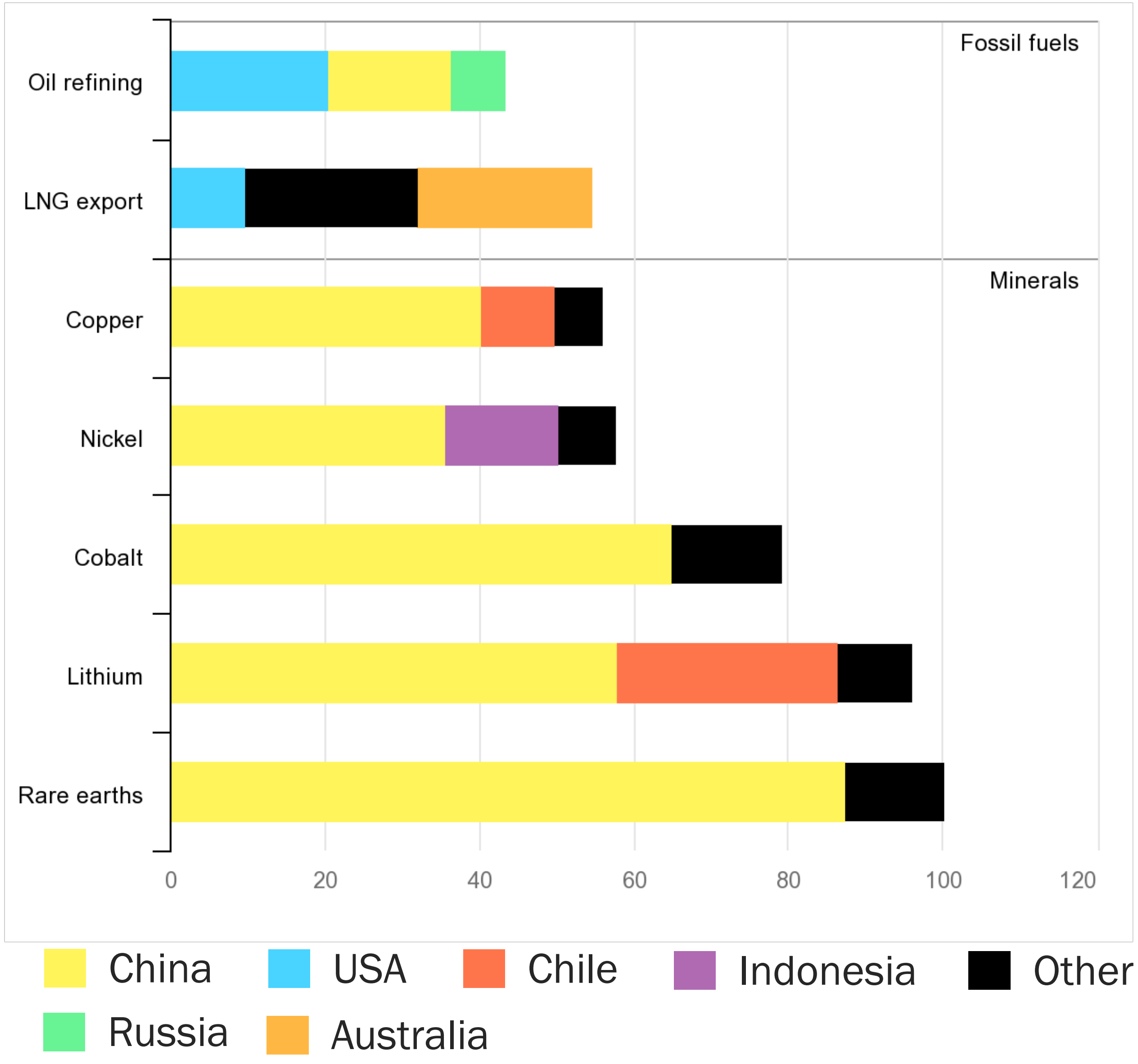
Figure 2.—2022 U.S. Net Import Reliance[1] (USGS, 2023)

Commodity	Net import reliance as a percentage of apparent consumption	Major import sources (2018–21)[2]
ARSENIC, all forms	100	China, Morocco, Belgium
ASBESTOS	100	Brazil, Russia
CESIUM	100	Germany
FLUORSPAR	100	Mexico, Vietnam, South Africa, Canada
GALLIUM	100	China, Germany, Japan, Ukraine
GRAPHITE (NATURAL)	100	China, Mexico, Canada, Madagascar
INDIUM	100	Republic of Korea, Canada, China, France
MANGANESE	100	Gabon, South Africa, Australia, Georgia
MICA (NATURAL), sheet	100	China, Brazil, Belgium, Austria
NIOBIUM (COLUMBIUM)	100	Brazil, Canada
RUBIDIUM	100	Germany
SCANDIUM	100	Europe, China, Japan, Philippines
STRONTIUM	100	Mexico, Germany, China
TANTALUM	100	China, Germany, Australia, Indonesia
YTTRIUM	100	China, Germany, Republic of Korea, Japan
GEMSTONES	99	India, Israel, Belgium, South Africa
BISMUTH	96	China, Republic of Korea, Mexico, Belgium
NEPHELINE SYENITE	>95	Canada
RARE EARTHS,[3] compounds and metals	>95	China, Malaysia, Estonia, Japan
TITANIUM, sponge metal	>95	Japan, Kazakhstan, Ukraine
POTASH	94	Canada, Russia, Belarus
DIAMOND (INDUSTRIAL), stones	89	South Africa, Congo (Kinshasa), India, Sierra Leone
IRON OXIDE PIGMENTS, natural and synthetic	87	China, Germany, Brazil, Canada
ANTIMONY, metal and oxide	83	China, Belgium, India
CHROMIUM, all forms	83	South Africa, Kazakhstan, Russia, Germany
STONE (DIMENSION)	82	Brazil, China, Italy, India
PEAT	81	Canada
TITANIUM MINERAL CONCENTRATES	81	South Africa, Australia, Madagascar, Canada
ABRASIVES, silicon carbide	79	China, Brazil, Netherlands, South Africa
TIN, refined	77	Peru, Indonesia, Bolivia, Malaysia
COBALT	76	Norway, Canada, Finland, Japan
ZINC, refined	76	Canada, Mexico, Peru, Spain
ABRASIVES, fused aluminum oxide	>75	China, Canada, Brazil, Austria
BARITE	>75	China, India, Morocco, Mexico
BAUXITE	>75	Jamaica, Brazil, Guyana, Turkey
TELLURIUM	>75	Canada, Germany, China, Philippines
GARNET (INDUSTRIAL)	69	South Africa, China, India, Australia
RHENIUM	69	Chile, Canada, Germany, Kazakhstan
SILVER	69	Mexico, Canada, Poland, Chile
PLATINUM	66	South Africa, Germany, Switzerland, Italy
DIAMOND (INDUSTRIAL), bort, grit, dust, and powder	62	China, Republic of Korea, Ireland, Russia
ALUMINA	59	Brazil, Australia, Jamaica, Canada
NICKEL	56	Canada, Norway, Australia, Finland
ALUMINUM	54	Canada, United Arab Emirates, Russia, China
VANADIUM	54	Canada, China, Brazil, South Africa
MAGNESIUM COMPOUNDS	53	China, Israel, Canada, Brazil
GERMANIUM	>50	China, Belgium, Germany, Russia
IODINE	>50	Chile, Japan
MAGNESIUM METAL	>50	Canada, Israel, Mexico, Taiwan
SELENIUM	>50	Philippines, Mexico, Germany, China
TUNGSTEN	>50	China, Germany, Bolivia, Vietnam
ZIRCONIUM, ores and concentrates	<50	South Africa, Senegal, Australia, Russia
SILICON, metal and ferrosilicon	45	Russia, Brazil, Canada, Norway
LEAD, refined	42	Canada, Mexico, Republic of Korea
COPPER, refined	41	Chile, Canada, Mexico
FELDSPAR	39	Turkey, Mexico
SALT	29	Chile, Canada, Mexico, Egypt
PERLITE	28	Greece, China, Mexico
PALLADIUM	26	Russia, South Africa, Italy, Germany
LITHIUM	>25	Argentina, Chile, China, Russia

Examining EV Supply Chains

- The U.S. is ≥ 50% Import reliant for approx. 30 of the 50 critical minerals.
- China and Russia are major import sources for 20 of those 30.
- North America is major import source for 14 of those 30.
- We are ≥ 50% import reliant for almost all the battery metals.

Share of top three producing countries in total processing of selected minerals and fossil fuels, 2019 *(IEA, 2021)*



Examining EV Supply Chains

- Processing is even more concentrated
- The U.S. processes <4% of all mineral commodities
- Processing leads to expertise in ability to produce and create battery precursor materials:
  - China produces
    > 70% of all cathodes
    > 89% of all anodes

Importance of the US Auto Sector

- Automotive manufacturing drives $1.1 trillion into the US economy each year through sales and servicing
- 10 million US jobs are directly associated with the auto sector
- The auto sector typically makes up 5.5% of US GDP

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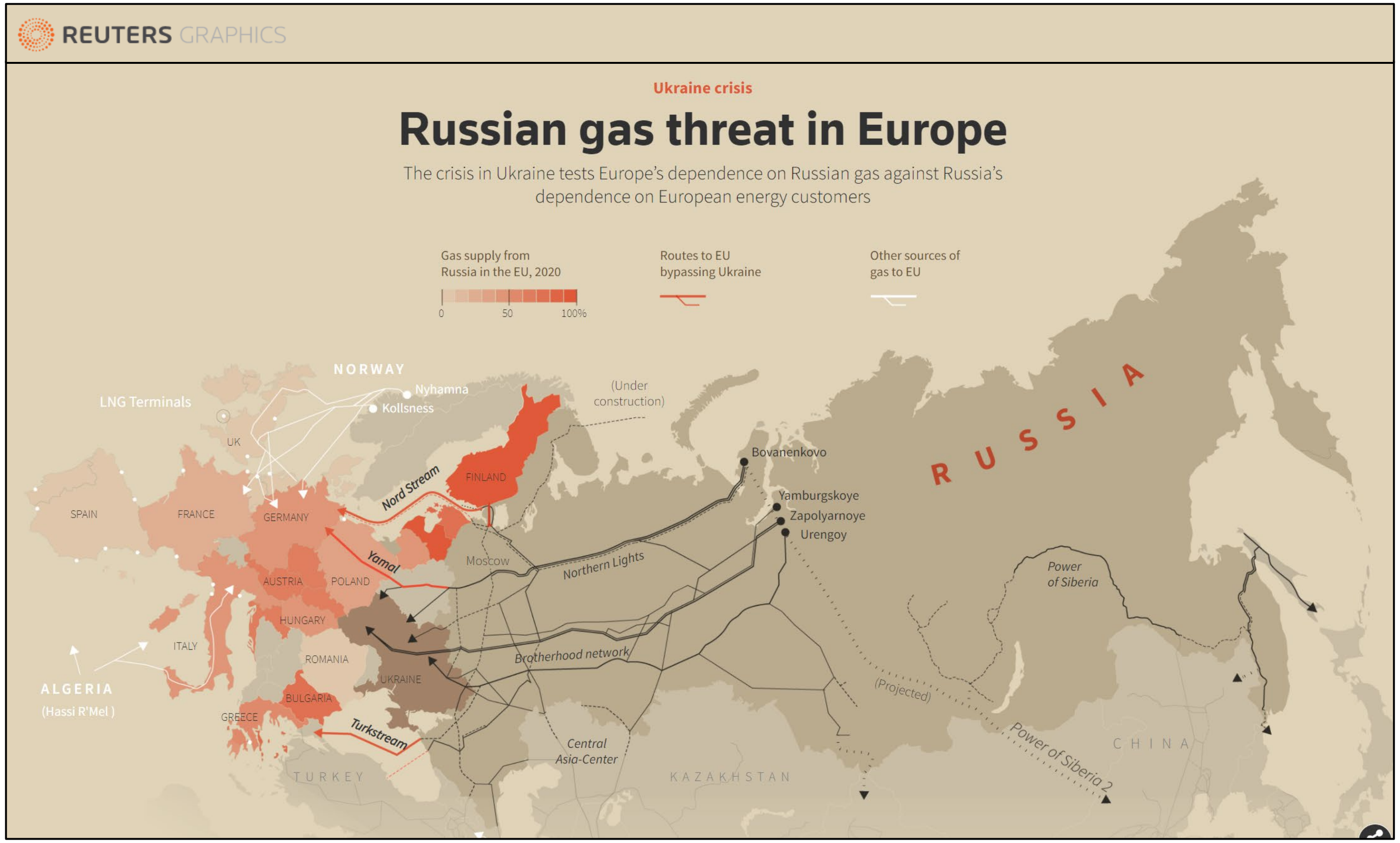
BECKY SULLIVAN JACKIE NORTHAM



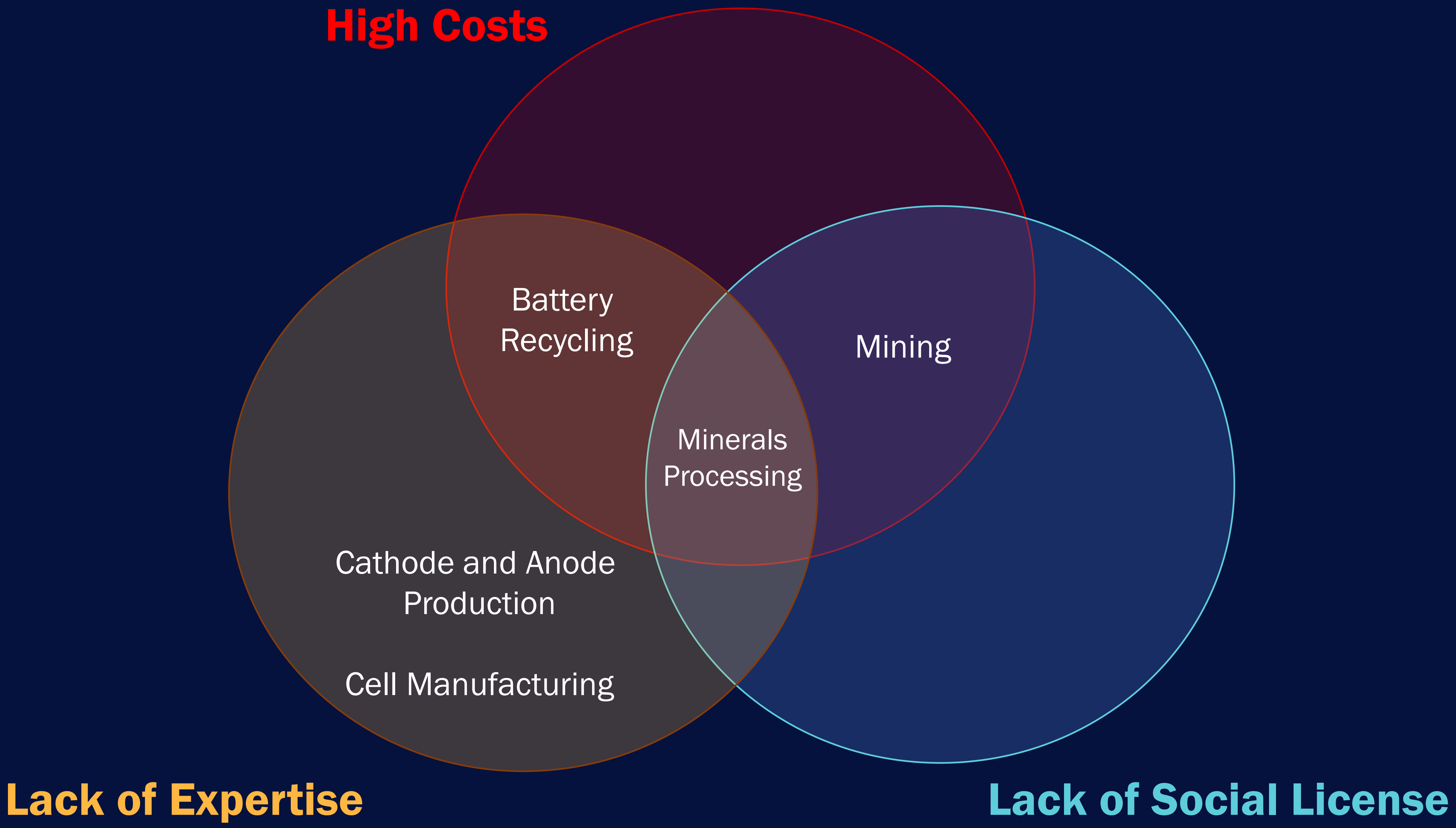
Examining EV Supply Chains

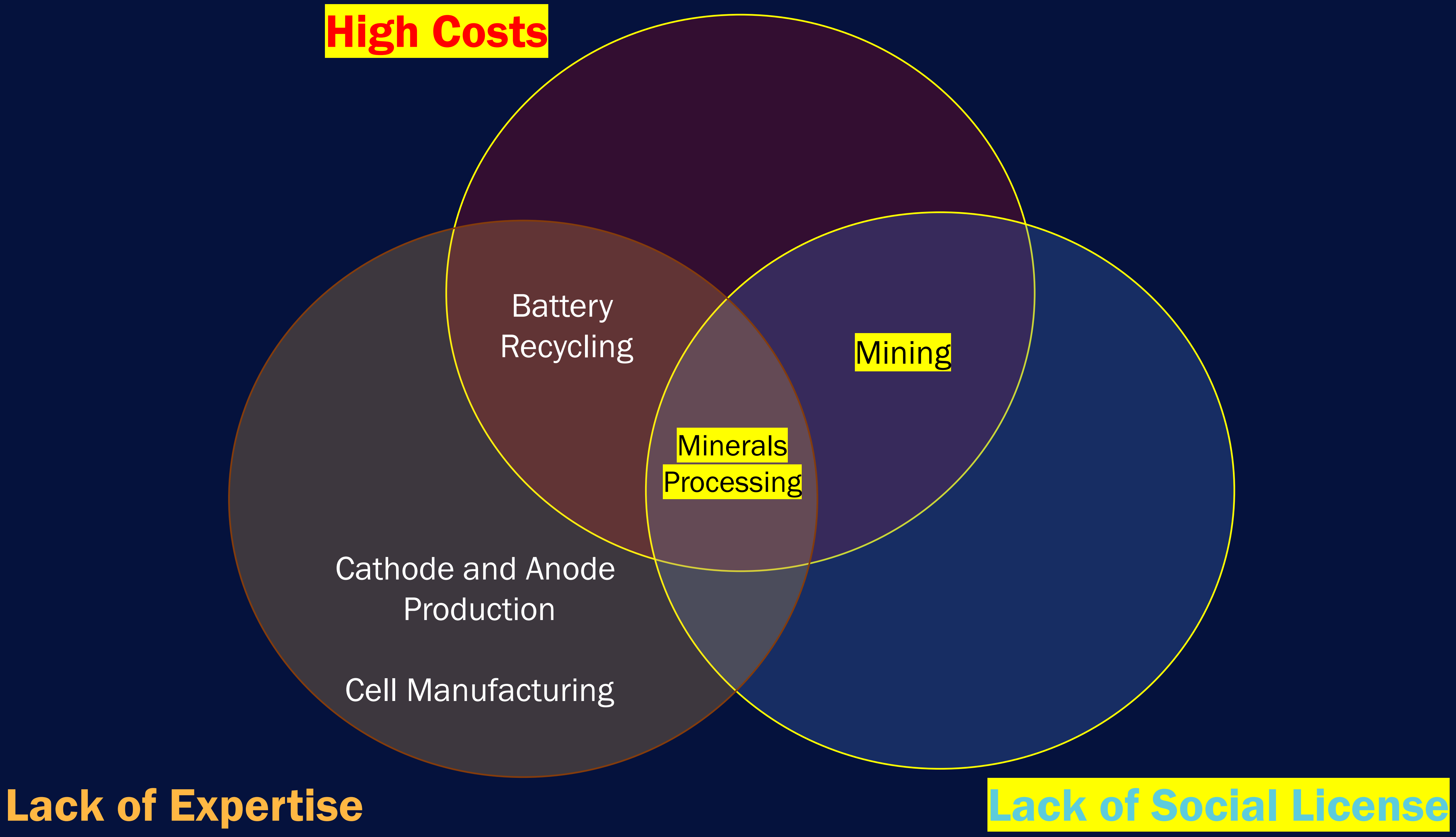
	Lithium (Li)	Nickel (Ni)	Cobalt (Co)	Manganese (Mn)	Graphite (C)
Used In The…	CAM	CAM	CAM	CAM	AAM
US Import Reliance	> 25%	56%	76%	100%	100%
Top US Import Sources	Argentina, Chile, China, Russia	Canada, Norway, Finland, Australia	Norway, Canada, Japan, Finland	Gabon, South Africa, Australia, Georgia	China, Mexico, Canada, India
US Reserves	4%	0.4%	1%	0	Withheld
US Production	Withheld	1%	0.4%	0	0
North American Reserves	7.4%	2.6%	3.5%	0.3%	1%
North American Production	0.4%	4.5%	2.5%	1.2%	1.3%
Top Global Reserves	Chile (36%)	Indonesia (21%), Australia (21%)	DRC (48%)	South Africa (37%)	Turkey (27%)
Top Global Producer	Australia (45%)	Indonesia (49%)	DRC (70%)	South Africa (36%)	China (65%)
Top Global Processor	China (58%)	China (72%)	China (75%)	China (93%)	China (100%)

Data from the U.S. Geological Survey 2023 Mineral Commodity Summary and Benchmark Mineral Intelligence

Most critical supply chain vulnerabilities are due to policy, not nature.

So, why aren't we diversifying our supply chains?


High Costs
Battery Recycling
Mining
Minerals Processing
Cathode and Anode Production
Cell Manufacturing
Lack of Expertise
Lack of Social License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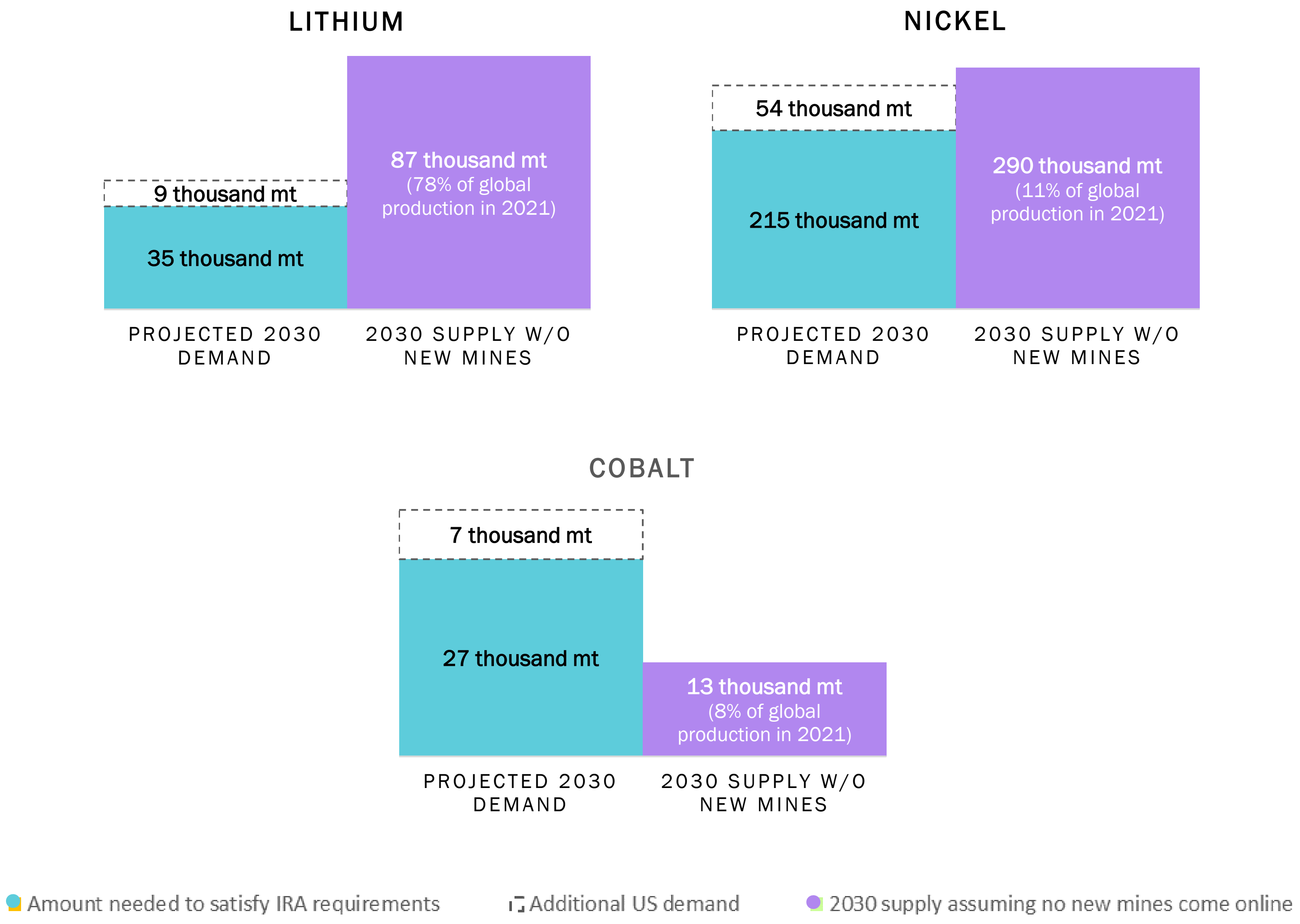
US Efforts to Diversify Supply: IRA

- Current US and FTA production of lithium and nickel is sufficient to satisfy IRA sourcing requirements for US demand

- However, US EV makers compete in a global market to secure access to FTA production.

- US and FTA processing of cobalt will be critical to satisfy IRA requirements.

SAFE analysis based on data from USGS, S&P Global, WoodMac and Roland Berger,



Global Efforts to Diversify Supply

- **US:** BIL, DPA Title III Funding, IRA, CHIPS and Science Act, Mineral Security Partnership
- **CAN:** Critical Minerals Strategy
- **EU:** Battery Regulation, Critical Raw Materials Act, Net-Zero Industry Act
- "Critical Minerals Club"

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Thank you

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