Lithium GVCs in the China-LAC-Japan context (101)

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Japan Foundation Visiting Researcher at ISS, The University of Tokyo (2021-2022)

Daily Mail, By Chris Pleasance for MAILONLINE , 19 Oct 2021

Global Dimension

1. **US - China dispute**
2. **BRI, Energy + Financing** (Energy - LAC is rich in energy sources [eg. Brazil among world's 12 top exporters, just after Norway and Angola (growing); Mexico is 15th]).
3. **Soft Power** (including education and science; Nikkei-jin in LAC)
4. **Rare earth minerals** - 1. China (44 MT), then Vietnam, Brazil and Russia (21 to 22 MT, each > USGS), 3. Brazil (Niobium, Neodymium, Praseodymium, Dysprosium, and others)
5. **Biodiversity** (the Amazon and other biomes), **Water and arable land**
6. **5G**

Huawei's 5G smart warehouse in Brazil

https://newsus.cgtn.com/news/2021-11-14/Huawei-s-5G-smart-warehouse-in-Brazil-15azLjpabQs/index.html

HETEROGENEOUS REGION

China > LatAm’s second-biggest trading partner

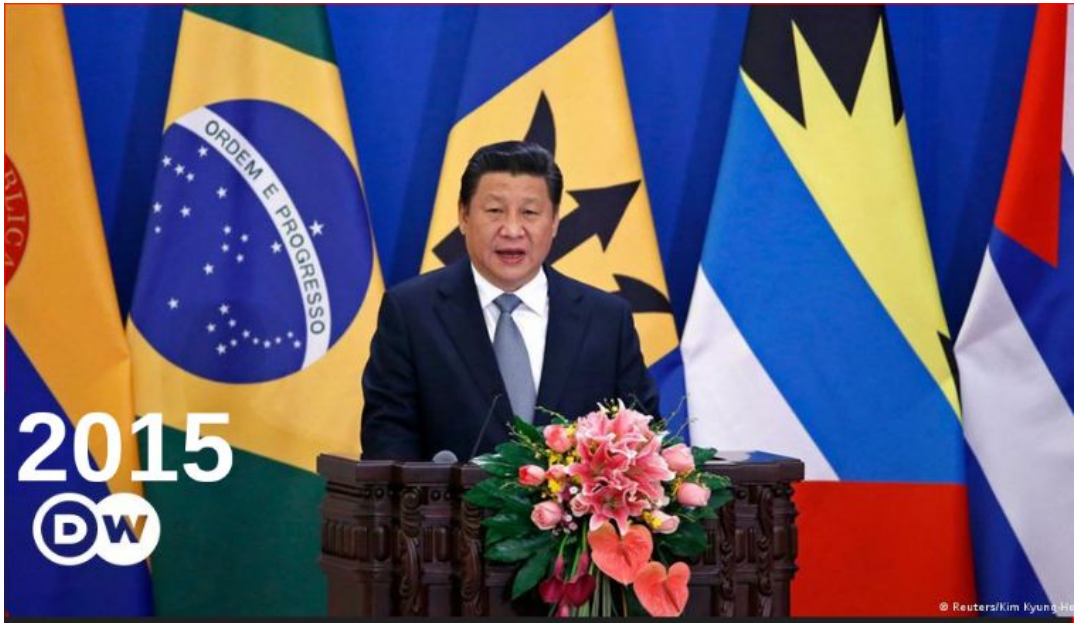
#1 for years in many countries ($ 315 bi in 2020)

Colombian and Venezuelan oil, Brazilian iron ore

Invests in dams, railroads and electrical grids.

Chinese cell phones and SUVs are popular.

Thousands of Latin Americans students, including in technology and the arts



China wants to double bilateral trade with South America to $500 billion by 2025 and increase total investment to $250 billion.

AQ

China's Economic Footprint

Chinese trade with Latin America was surprisingly resilient despite the pandemic

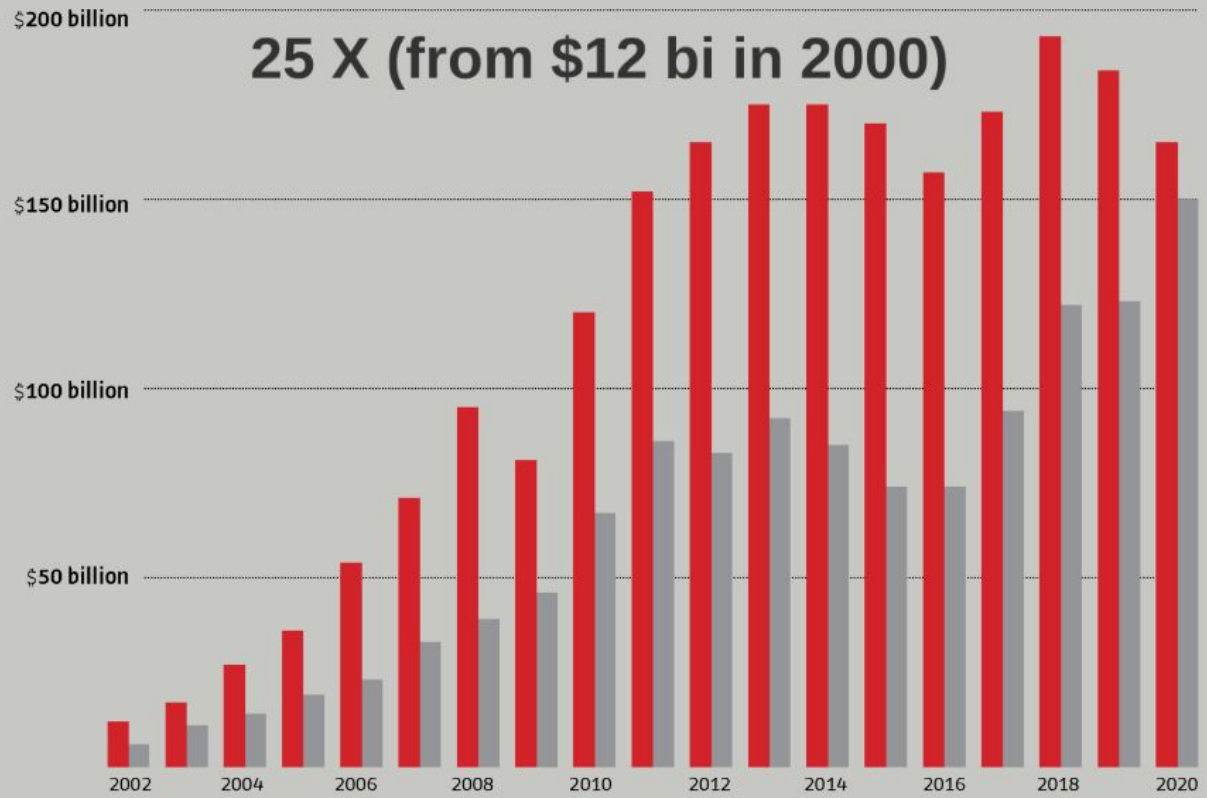
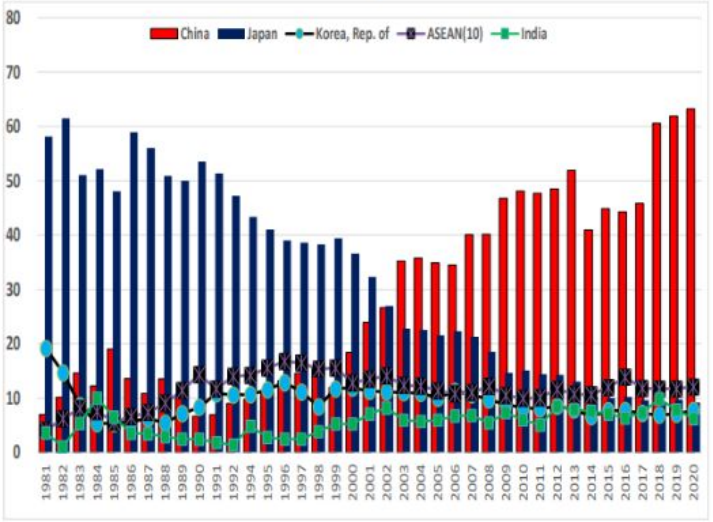


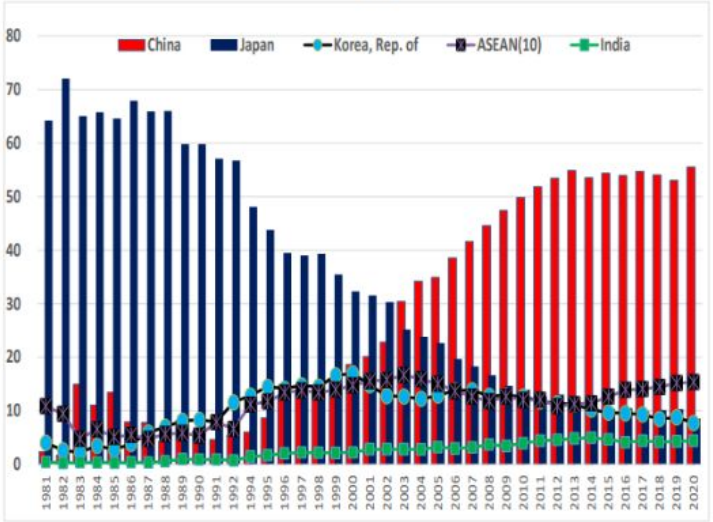
Figure 2: Exports and imports shares of selected Asian countries in LAC (33) and the Asia-Pacific (18) trade, 1981-2020

(Percentages)

B. Exports



C. Imports

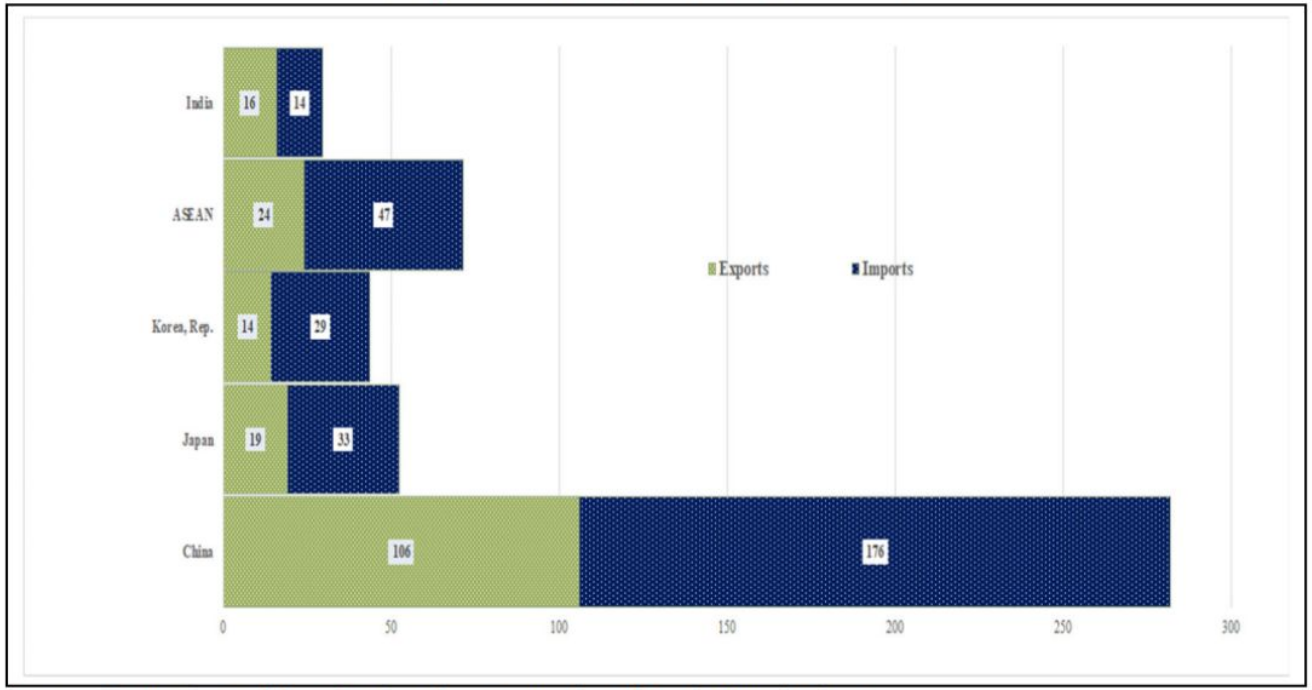


Source: Elaborated by the author based on Comtrade and ITC Trade Map database.

Mikyo Kuwayama (2021). Globalized business of Japanese Multinationals in Latin America

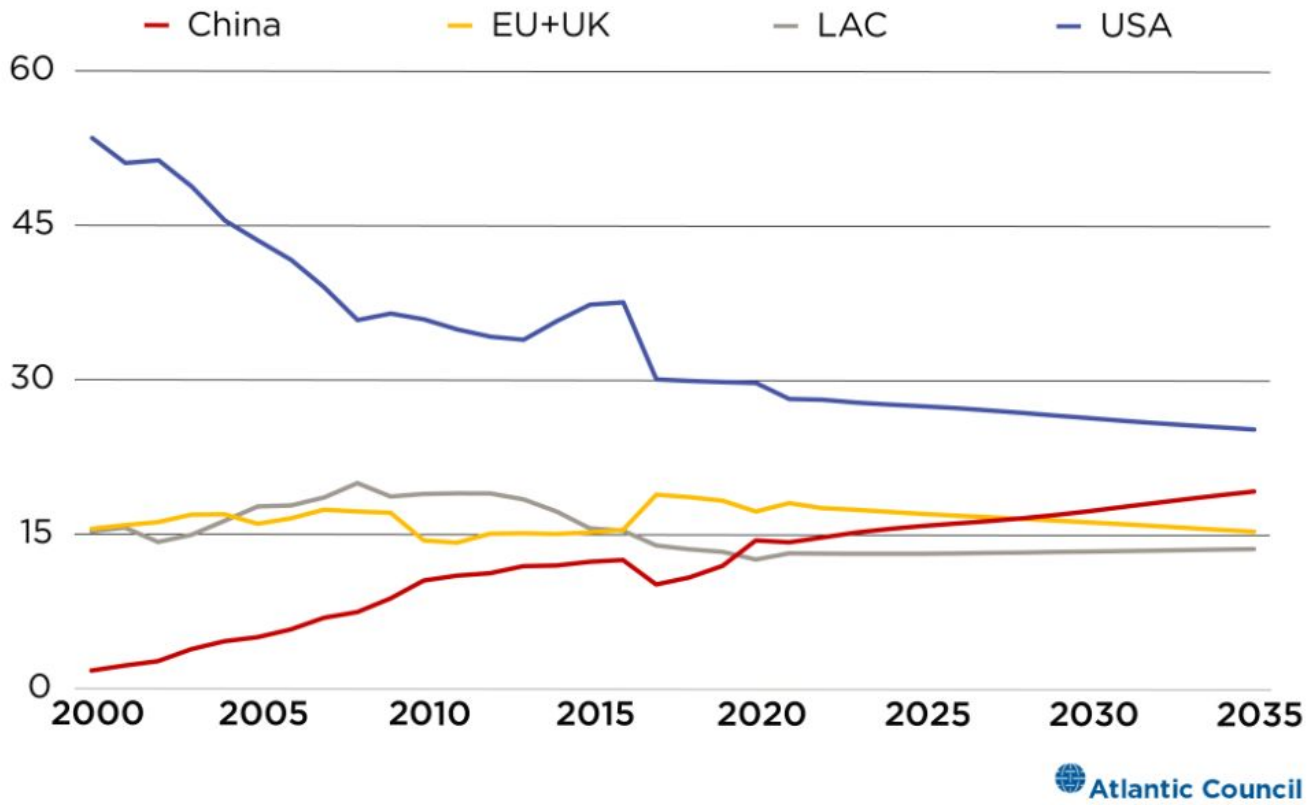
Figure 3: LAC's trade with major trading partners in Asia, annual average CY2016-CY2019

(Exports and Imports, US$ billions)



Source: The Author's elaboration based on Comtrade and Trade Map database.

LAC's Main Trade Partners through 2035




THE WORLD BANK
INTERNATIONAL MONETARY FUND
OECD
BETTER POLICIES FOR BETTER LIVES
UNITED STATES - CHINA ECONOMIC AND SECURITY REVIEW COMMISSION
CONGRESSIONAL-EXECUTIVE COMMISSION ON CHINA
Congressional Research Service
CSIS
CENTER FOR STRATEGIC & INTERNATIONAL STUDIES
BROOKINGS
IDB
Inter-American Development Bank
Atlantic Council
THEDIALOGUE
Leadership for the Americas
BU
Global Development Policy Center
Wilson Center
IDE-JETRO
IDE-JETRO
ORF
OBSERVER RESEARCH FOUNDATION
Ideas · Forums · Leadership · Impact

CONGRESSIONAL-EXECUTIVE
COMMISSION ON CHINA

CONTENTS

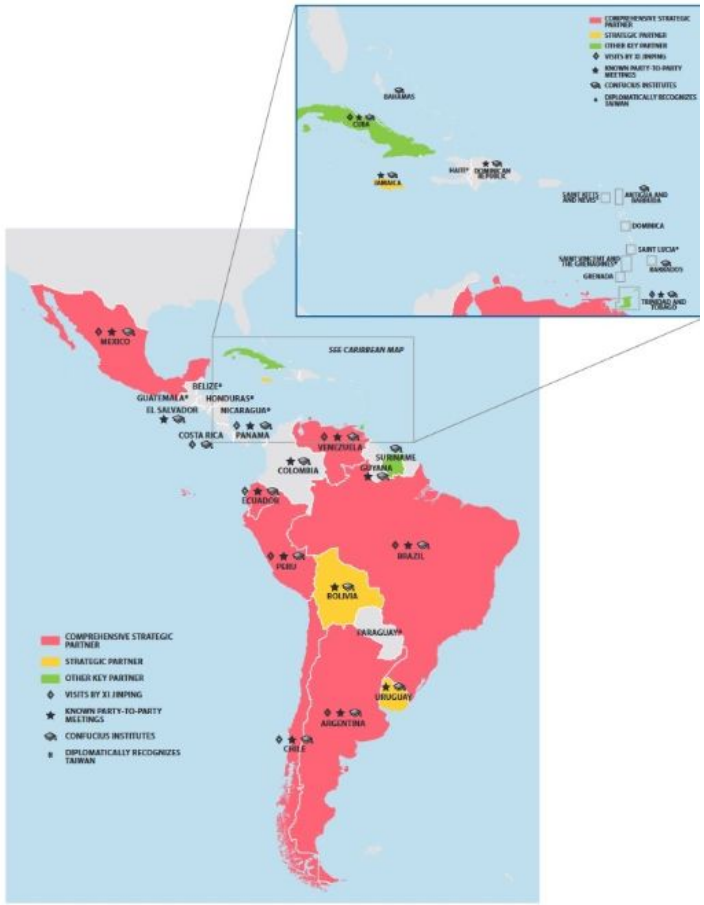
A few key findings:

> economic interests are main driver but increasing pursuit of political & security objectives (including Taiwan and military)

> influence in political and social structures through national & subnational governments, & NGOs.

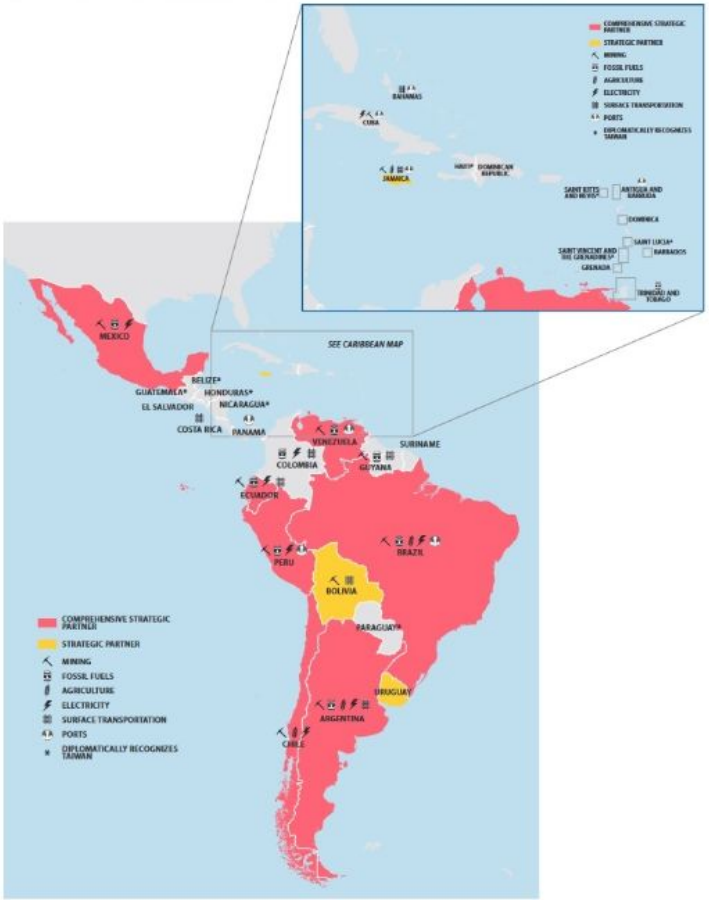
> democratic backsliding

FIGURE 1: CHINA'S MAIN DIPLOMATIC PARTNERS IN LATIN AMERICA AND THE CARIBBEAN



Note: China refers to Suriname as a "Strategic Cooperative Partner," to Trinidad and Tobago as a "Comprehensive Cooperative Partner," and to Cuba as "Good Brother, Good Comrade, Good Friend." Data for "Known Party-to-Party Meetings" are collected for the years 2019–2021.
Source: See the full Annual Report for complete list of sources.

FIGURE 2: SELECT CHINESE INVESTMENTS AND FINANCING IN LATIN AMERICA AND THE CARIBBEAN (2005-2020)



Source: See the full Annual Report for complete list of sources.


THEDIALOGUE
Leadership for the Americas


BU
Global Development
Policy Center


Global Economic
Governance
Interactives


Global China
Databases

China-Latin America Finance Databases

Since 2005, China Development Bank and China-Export Import Bank have provided more than $138 billion in loan commitments to Latin American and Caribbean (LAC) countries and state-owned firms. The China-Latin America Finance Database, co-produced by the Inter-American Dialogue and Boston University Global Development Policy Center, provides up-to-date information on Chinese policy bank loans by country, lender, sector, and year.

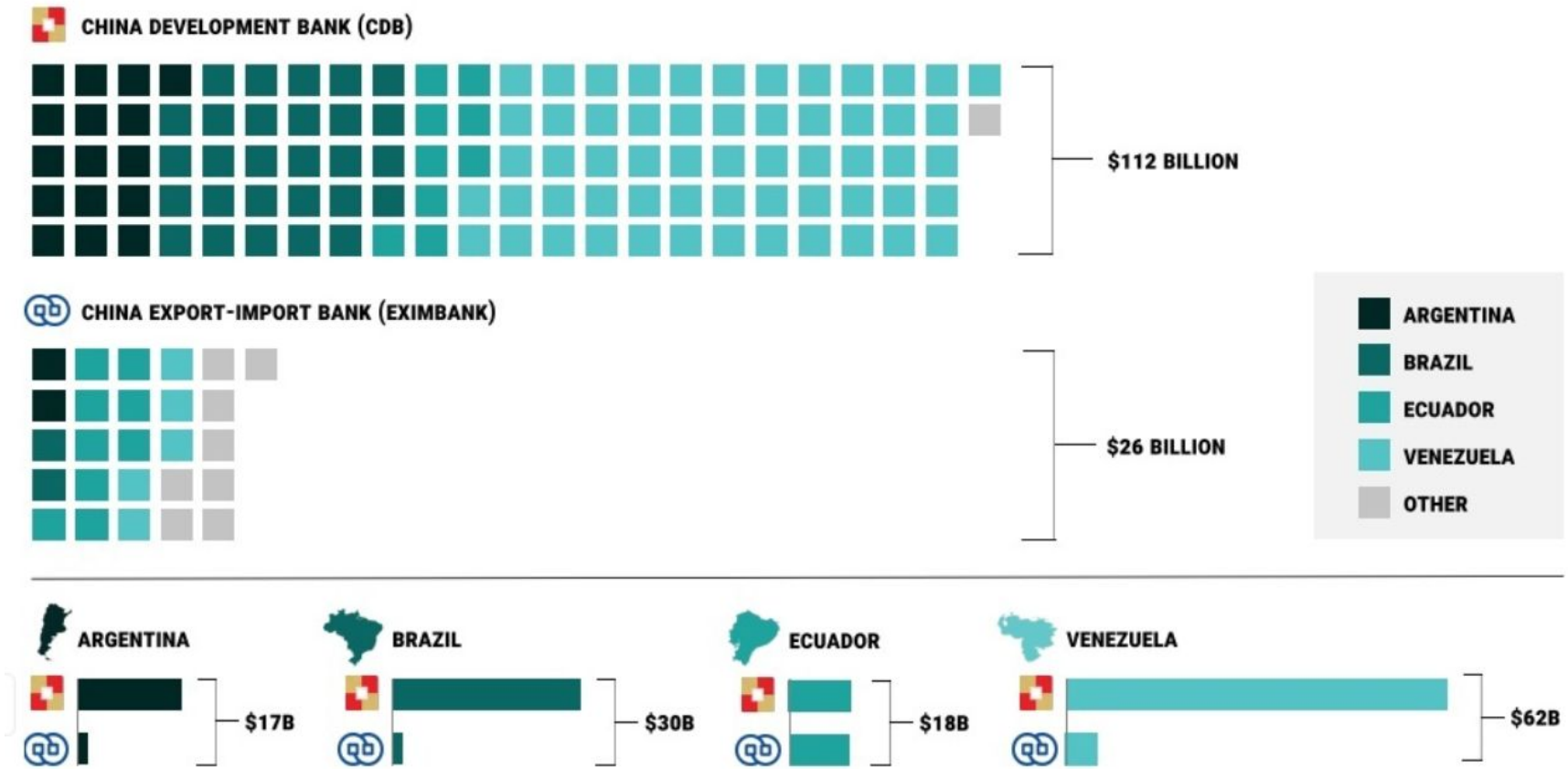
China-Latin America Finance Database

In addition to China's policy banks, China's commercial banks are also active in LAC, having provided dozens of loans in the region since 2012. The Commercial Loans Tracker, developed by the Inter-American Dialogue, classifies key instances of Chinese commercial bank finance by country, lender, sector, and year.

China-Latin America Commercial Loans Tracker

FIGURE 3: DISTRIBUTION OF POLICY BANK LENDING BY COUNTRY, 2005–2020

Source: Gallagher, Kevin P. and Margaret Myers (2021), "China-Latin America Finance Database," Washington, DC: Inter-American Dialogue.



Belt & Road and Latin America

What is the Belt and Road Initiative (BRI)?

The BRI aims to expand China's overseas investment by establishing land ("Belt") and maritime routes ("Road").

China has promoted the BRI as an opportunity for nations to develop infrastructure and create new trade opportunities with Chinese enterprises.

LAC countries currently with BRI agreements:

- Antigua & Barbuda
- Barbados
- Bolivia
- Chile
- Costa Rica
- Cuba
- Dominican Republic
- Ecuador
- El Salvador
- Guyana
- Jamaica
- Panama
- Peru
- Trinidad& Tobago
- Venezuela
- Uruguay

Timeline of key events:

2013 — Chinese president Xi Jinping launches the 'One Belt, One Road' initiative

Nov 2016 — China releases a 2nd policy paper on LAC at the APEC summit in Lima, Peru

May 2017 — Beijing hosts the 1st BRI Forum. Presidents Mauricio Macri (Argentina) and Michelle Bachelet (Chile) attend.

Jun 2017 — Panama becomes the first LAC country to endorse the BRI

Jan 2018 — Chinese foreign minister Wang Yi invites LAC countries to participate in the BRI at the CELAC-China forum

Dec 2018 — Xi fails to secure Argentina's participation in the BRI after a meeting with Macri at the G20 Summit

May 2019 — Beijing hosts the 2nd BRI Forum

Criticisms:

There are concerns over the debt burdens that small or weak economies take on when borrowing for BRI projects and the economic benefits these will deliver

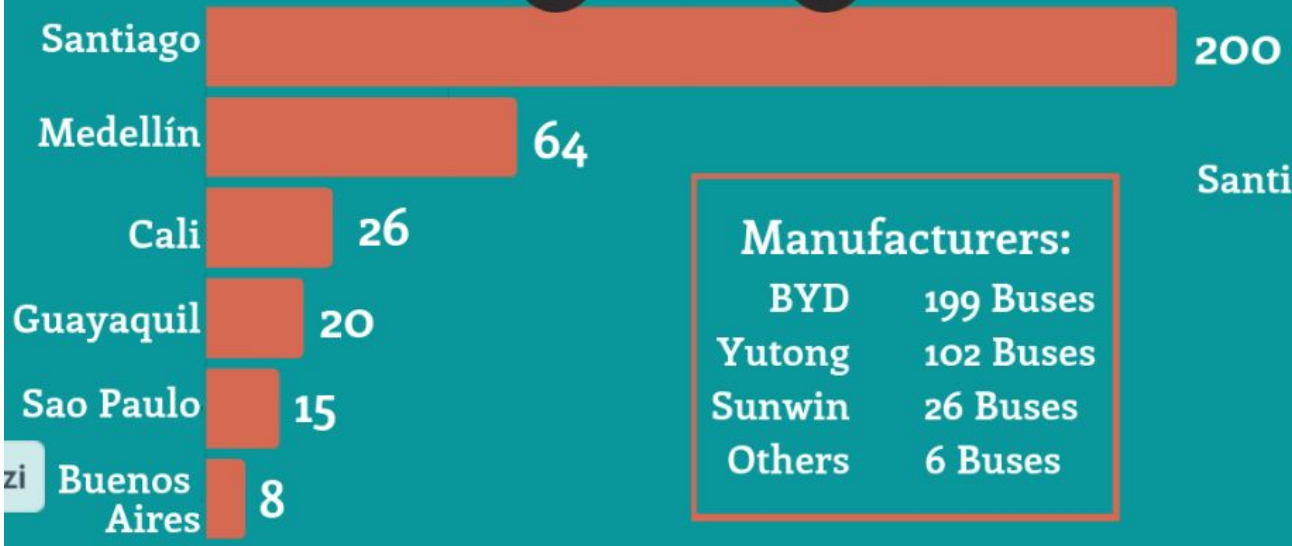
Some fear China's aim to control every link in supply chains and its growing portfolio of key sectors such as energy

BRI investments mostly focus on projects and sectors that carry big risks for the environment and the rights of indigenous communities

Diálogo Chino

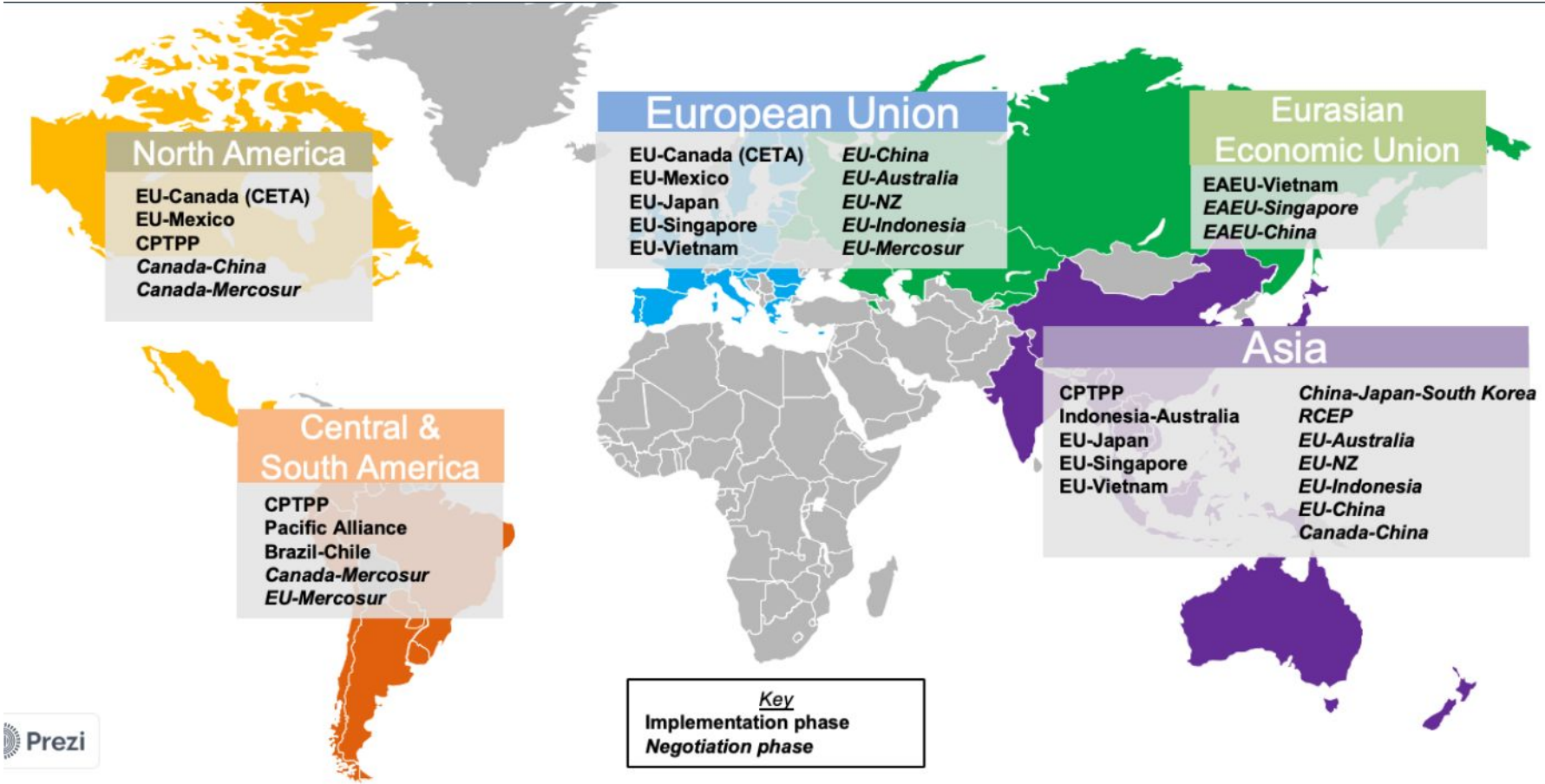

KUKA
KUKA
KUKA
KUKA

Chinese electric buses on the road in Latin America 2019



Manufacturers:	
BYD	199 Buses
Yutong	102 Buses
Sunwin	26 Buses
Others	6 Buses

Diálogo Chino


North America
EU-Canada (CETA)
EU-Mexico
CPTPP
Canada-China
Canada-Mercosur
European Union
EU-Canada (CETA)
EU-Mexico
EU-Japan
EU-Singapore
EU-Vietnam
EU-China
EU-Australia
EU-NZ
EU-Indonesia
EU-Mercosur
Eurasian Economic Union
EAEU-Vietnam
EAEU-Singapore
EAEU-China
Asia
CPTPP
Indonesia-Australia
EU-Japan
EU-Singapore
EU-Vietnam
China-Japan-South Korea
RCEP
EU-Australia
EU-NZ
EU-Indonesia
EU-China
Canada-China
Central & South America
CPTPP
Pacific Alliance
Brazil-Chile
Canada-Mercosur
EU-Mercosur
Key
Implementation phase
Negotiation phase


Lenovo Brasil
Silvio Stagni
Presidente da Lenovo Brasil
Março de 2016
Lenovo


CNPC


Carrier
Midea
DO A UM NOVO MUNDO DE INOVAÇÃ E CONFORTO.
Midea
Carrier

Smart City – In a Nutshell

GOVERNMENT
→ Digital public administration
→ Participatory governance
→ E-services

BUILDINGS
→ Connected facility management
→ Smart home
→ Smart construction

HEALTH
→ Telemedicine
→ Integrated health information systems
→ Ambient assisted living

MOBILITY
→ Intelligent traffic management systems
→ Smart services for public transport
→ Smart urban logistics

EDUCATION
→ Urban education platforms
→ Digital learning formats
→ Digital skills

ENERGY AND ENVIRONMENT
→ Smart energy
→ Smart water management
→ Smart waste management

Source: Roland Berger, Think:Act 2017

MOBILITY

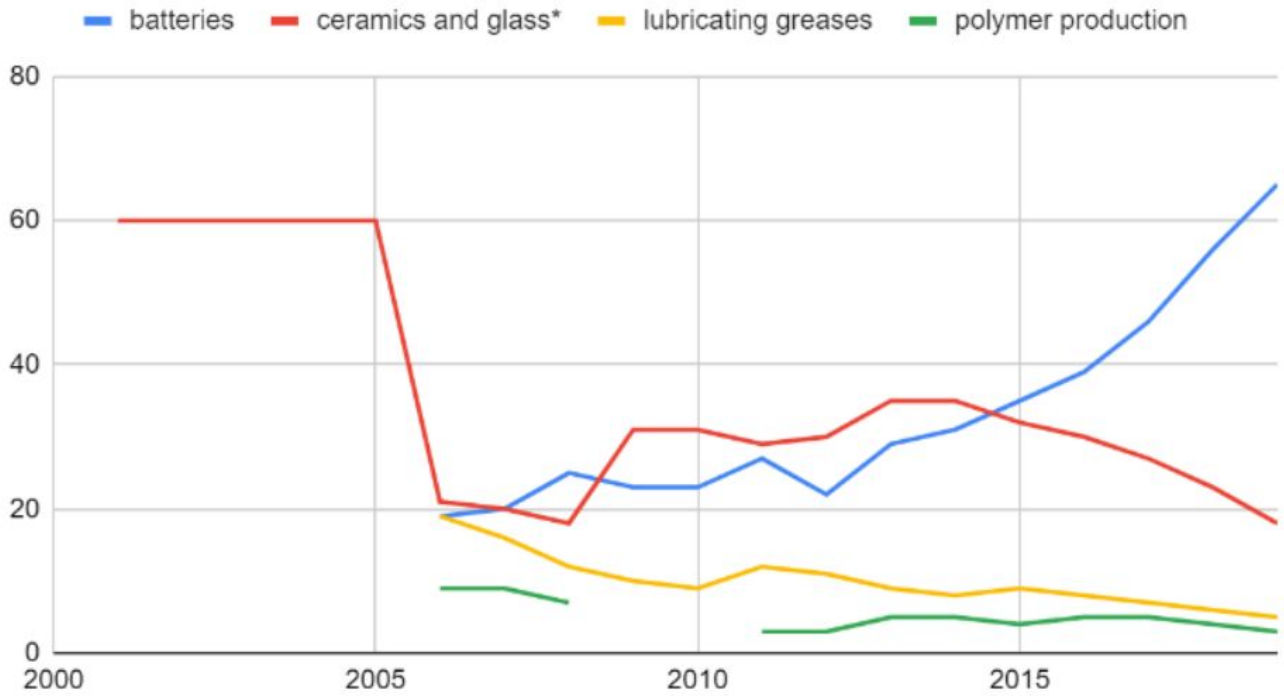
→ Intelligent traffic management systems
→ Smart services for public transport
→ Smart urban logistics

ENERGY AND ENVIRONMENT

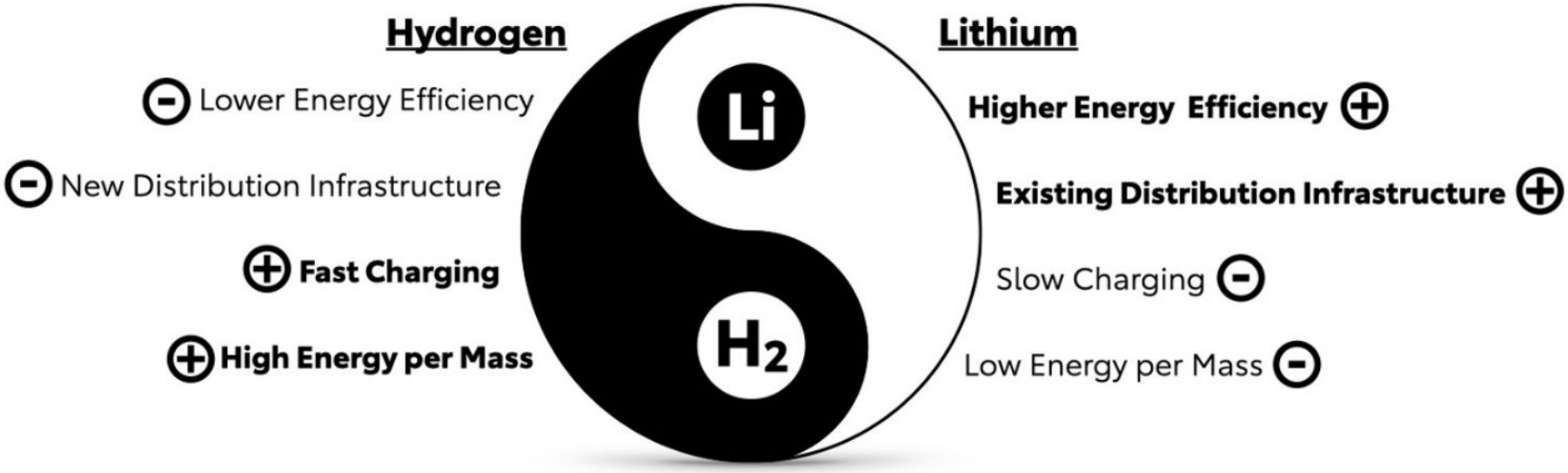
→ Smart energy
→ Smart water management
→ Smart waste management

Source: Roland Berger, Think:Ac

Graph 1 Estimation of main global end-use markets for Lithium (%)



Source: Plotted by the author based on USGS data available at https://www.usgs.gov/centers/nmic/lithium-statistics-and-information. * - Until 2005 60% of global end-use of lithium compounds estimated for ceramics and glass, also included primary aluminum production.



https://medium.com/toyotaresearch/the-misguided-war-of-the-elements-44bb4bd68f38

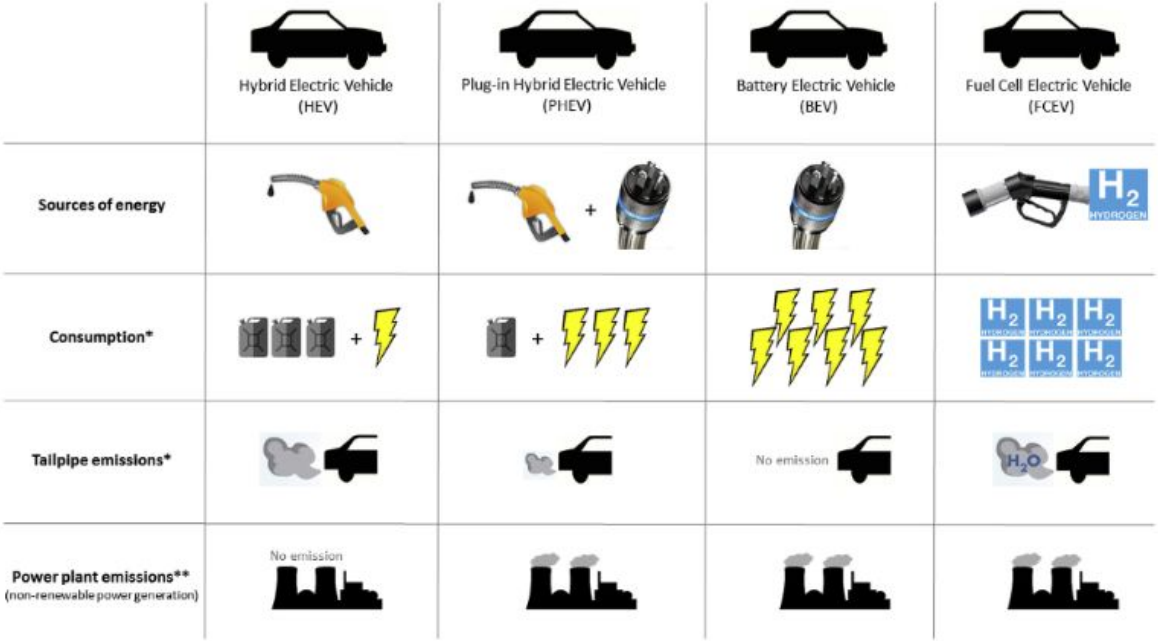


Fig. 2. Schematic of different types of Electric Vehicles (EVs) and their sources and consumption of energy and emission from tailpipe and energy generation. (*) The quantitative information presented here is for visual purposes only. This information is not standardized or quantitative.(**) Since technology may vary between power plants, we did not present quantitative information for visual purposes.

Range, Durability and Cost

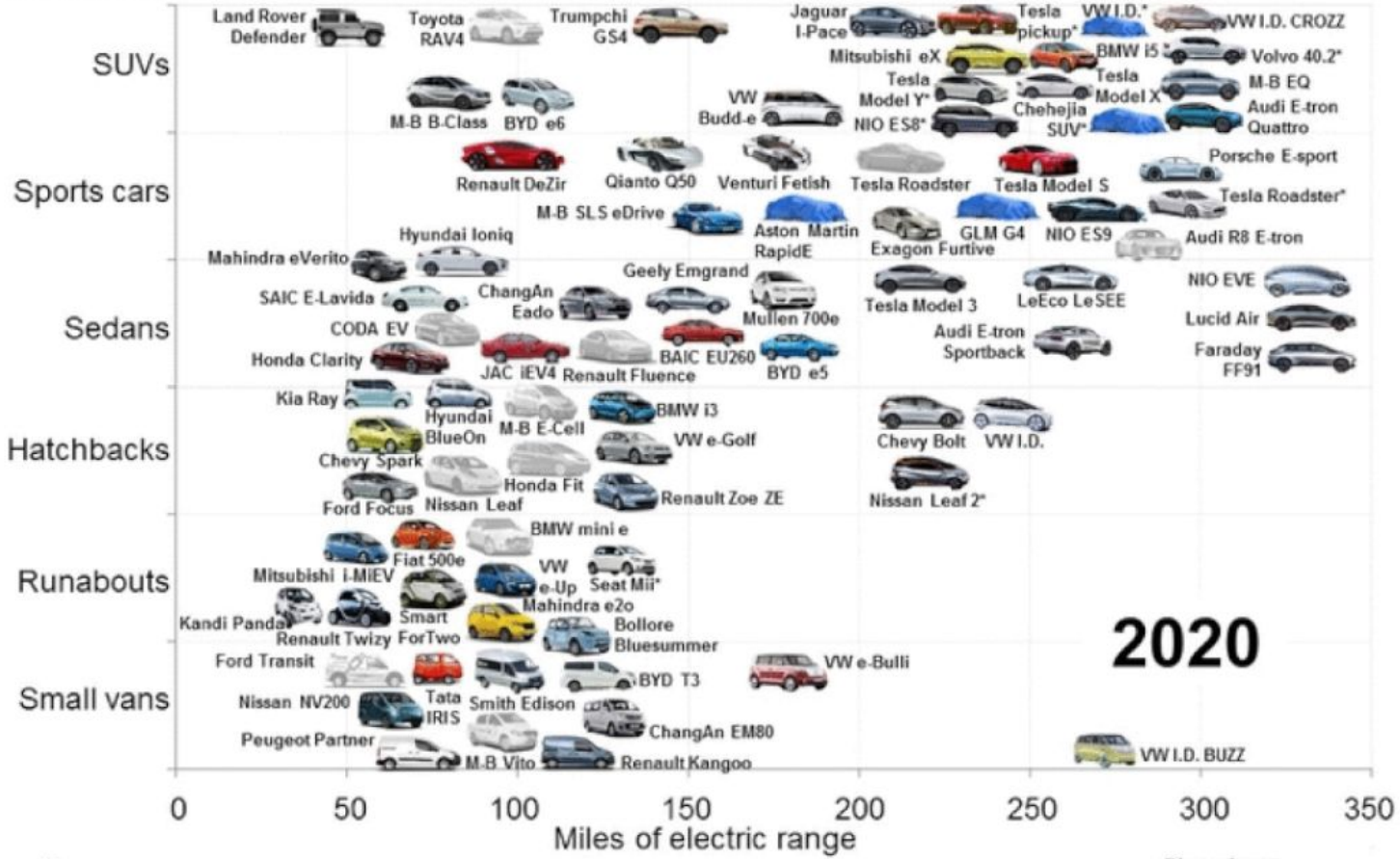
Requia, W. J., Mohamed, M., Higgins, C. D., Arain, A., & Ferguson, M. (2018). How clean are electric vehicles? Evidence-based review of the effects of electric mobility on air pollutants, greenhouse gas emissions and human health. Atmospheric Environment, 185, 64–77. https://doi.org/10.1016/J.ATMOSENV.2018.04.040

Full lineup of batteries

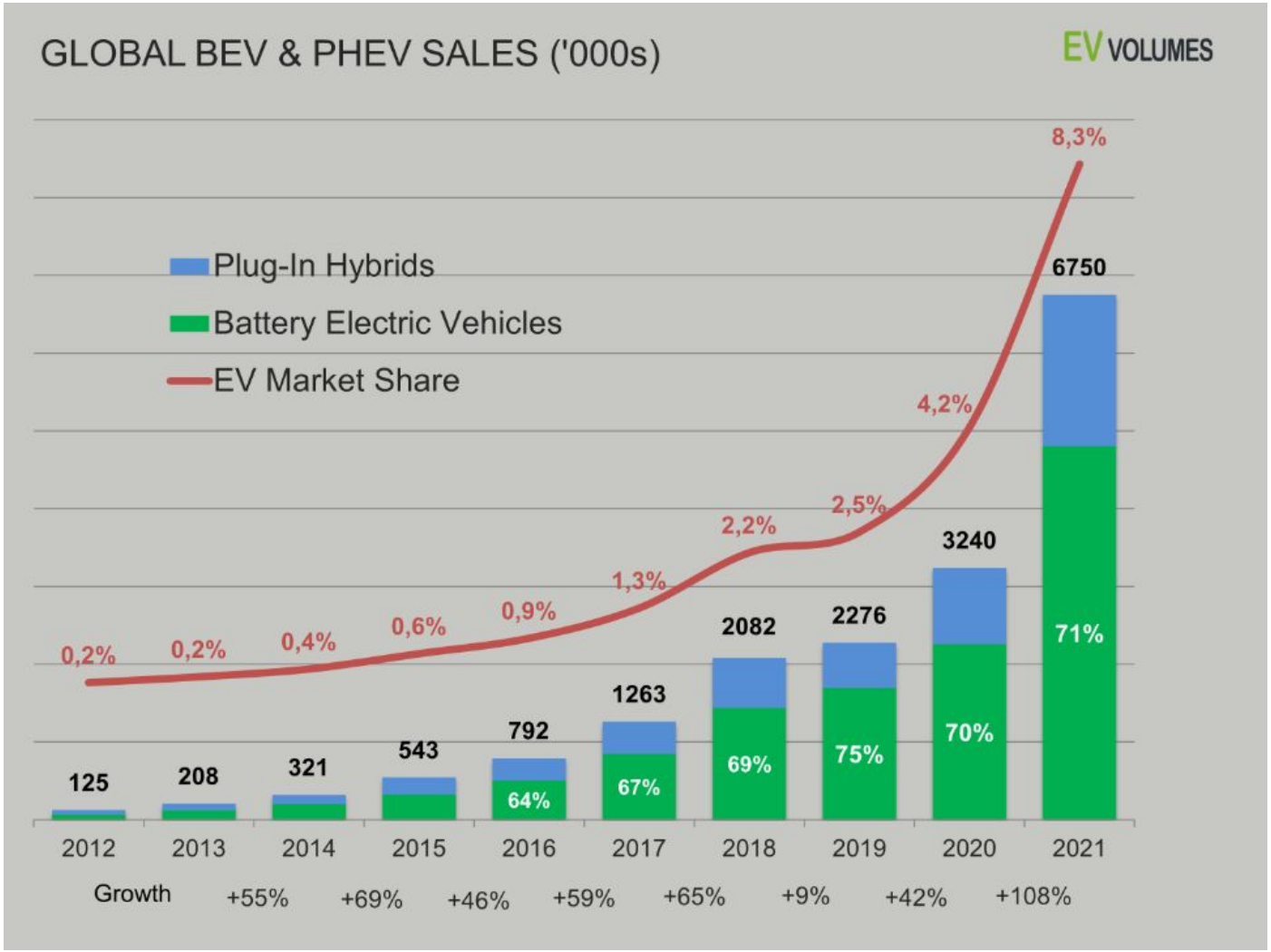
	1997	2011	2021	2025	2030
HEVs Focused on instantaneous power	Toyota Group and partners				
	 1st-gen. Prius			Evolution of nickel-metal hydride batteries	
		 Prius α	 Yaris	Evolution of lithium-ion batteries	
	Toyota Group				
			 Aqua	Expanded use of bipolar nickel-metal hydride batteries featuring new structure	
				Increased instantaneous power	
PHEVs・BEVs Focused on endurance	Toyota Group and partners				
		 1st.-gen. Prius PHV	 C-HR/IZOA	 bZ4X	Evolution of lithium-ion batteries
					Practical BEV development based on BEV-dedicated platform
	Toyota Group				
					New lithium-ion batteries
			Increased endurance Affordable, high-quality products		➢ Evolution of current lithium-ion batteries ➢ Innovation in battery structure ➢ Solid-state batteries

Electric-Car Boom

Models by style and range available through 2020

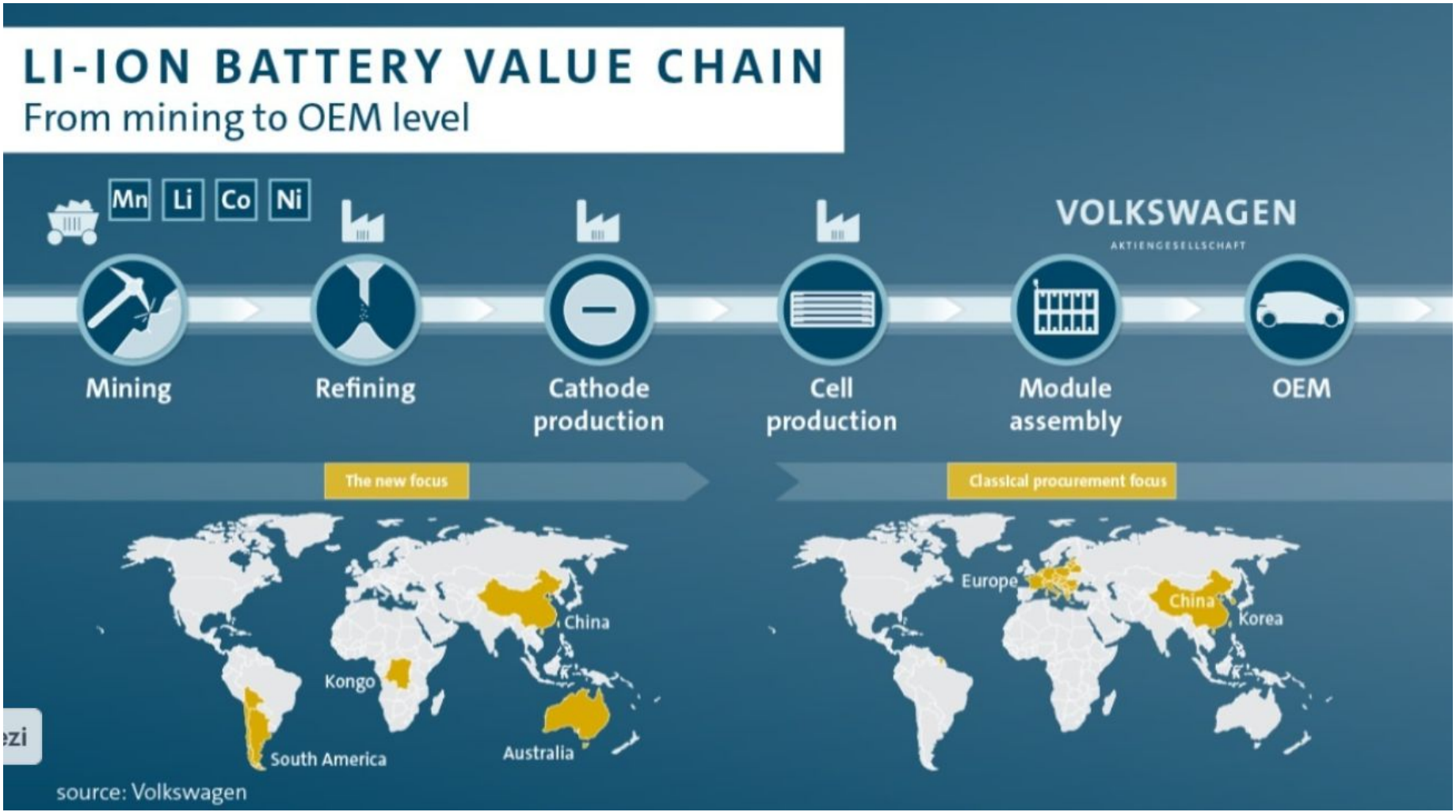


Bloomberg
New Energy Finance


GLOBAL BEV & PHEV SALES ('000s)
EV VOLUMES
Plug-In Hybrids
Battery Electric Vehicles
EV Market Share
0,2%
0,2%
0,4%
0,6%
0,9%
1,3%
2,2%
2,5%
4,2%
8,3%
125
208
321
543
792
1263
2082
2276
3240
6750
64%
67%
69%
75%
70%
71%
2012
2013
2014
2015
2016
2017
2018
2019
2020
2021
Growth
+55%
+69%
+46%
+59%
+65%
+9%
+42%
+108%

LI-ION BATTERY VALUE CHAIN

From mining to OEM level



source: Volkswagen

Lithium SC

> Mining and Refining
> Batteries
> Patents
> EVs (OEM)

Figure 2
Global Lithium (Li) mines, deposits and occurrences (Nov 2021)

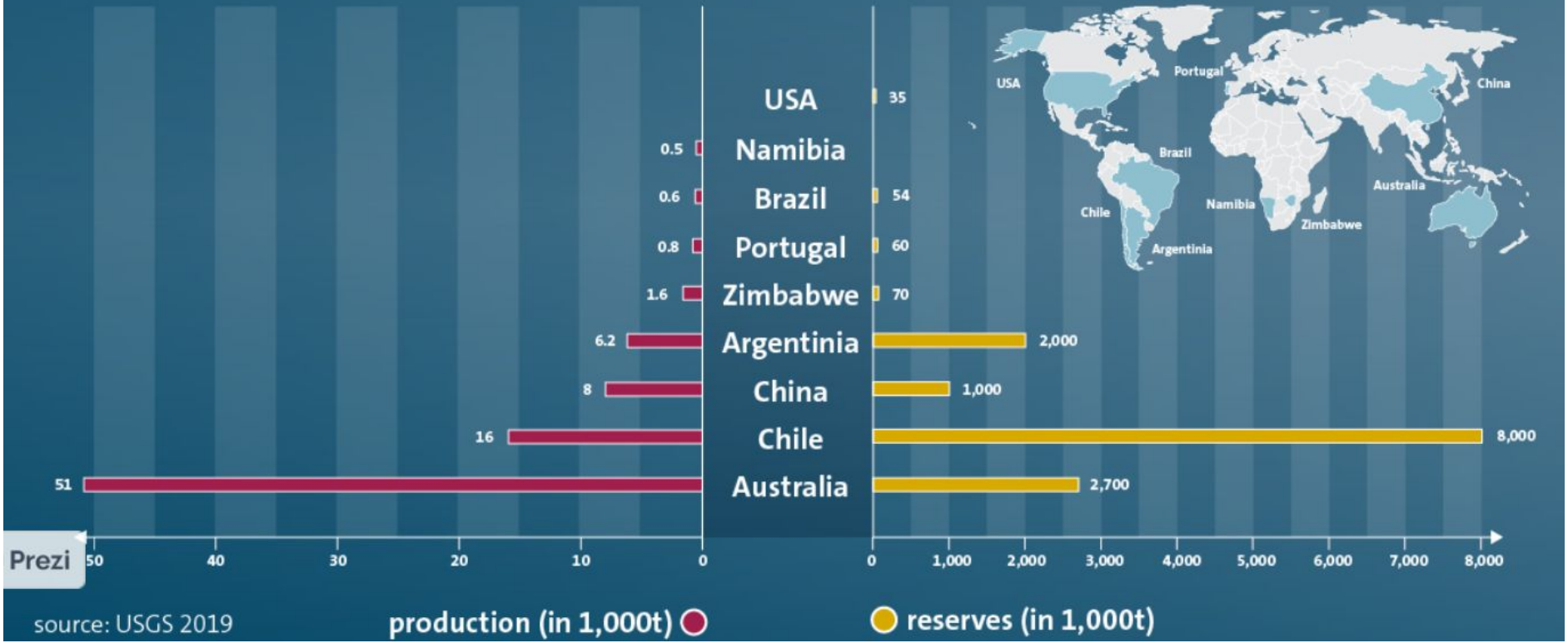
1 Tanco, Canada
2 Separation Rapids, Canada
3 James Bay, Canada
4 Rose, Canada
5 Whabouchi, Canada
6 Val-d'Or, Canada
7 McDermitt, USA
8 Kings Valley, USA
9 Silver Peak, USA
10 Bonnie Claire, USA
11 Boron, USA
12 Salton Sea, USA
13 Clayton North, USA
14 Magnolia, USA
15 Kings Mountain, USA
16 Sonora, Mexico
17 Falchani, Peru
18 Salar de Coipasa, Bolivia
19 Salar de Uyuni, Bolivia
20 Salar de Pastos Grandes, Bolivia
21 Salar de Atacama (2 operators), Chile
22 Salar de Aguilera, Chile
23 Salar de Pedernales, Chile
24 Salar de Maricunga, Chile
25 Salar de Olaroz, Argentina
26 Salar de Cauchari (2 projects), Argentina
27 Salar del Rincón (3 projects), Argentina
28 Salar de Pozuelos, Argentina
29 Salar de Pastos Grandes, Argentina
30 Salar de Ratones, Argentina
31 Salar de Diablillos, Argentina
32 Salar del Hombre Muerto (3 projects), Argentina
33 Mibra, Brazil
34 Mina da Cachoeira, Brazil
35 Jequitinhonha, Brazil
36 Volta Grande, Brazil
37 Länttä (and 5 others), Finland
38 Glenbuchat, United Kingdom
39 Aclare, Ireland
40 United Downs, United Kingdom
41 St Austell, United Kingdom
42 Chédeville (and 4 others), France
43 Rittershoffen, France
44 Upper Rhine Valley, Germany
45 Zinnwald (and 4 others), Germany
46 Cínovec, Czech Republic
47 Wolfsberg, Austria
48 Jadar, Serbia
49 Polokhovskoe (and 2 others), Ukraine
50 Mina do Barroso (and 3 others), Portugal
51 Alijó, Portugal
52 Valdeflórez/San José, Spain
53 Alberta I, Spain
54 Bougouni, Mali
55 Goulamina, Mali
56 Ewoyaa, Ghana
57 Kenticha, Ethiopia
58 Manono-Kitotolo, Democratic Republic of Congo
59 Uis, Namibia
60 Karibib, Namibia
61 Orange River Area, South Africa
62 Kamativi, Zimbabwe
63 Zulu, Zimbabwe
64 Bikita, Zimbabwe
65 Arcadia, Zimbabwe
66 Parun area, Afghanistan
67 Nuristan area, Afghanistan
68 Zhabuye Salt Lake, China
69 Dangjiongcuo, China
70 West Taiji Nai'er, China
71 East Taiji Nai'er, China
72 Qinghai Salt Lake, China
73 Sichuan Aba, China
74 Maerkang, China
75 Jiajika, China
76 Ningdu, China
77 Finniss, Australia
78 Pilgangoora, Australia
79 Wodgina, Australia
80 Kathleen Valley, Australia
81 Mount Holland, Australia
82 Greenbushes, Australia
83 Mount Cattlin, Australia
84 Mount Marion, Australia
85 Bald Hill, Australia
86 Buldania, Australia
87 Narraburra, Australia
88 Ohaaki, New Zealand

How to cite: Shaw, R.A. (2021) Global lithium (Li) mines, deposits and occurrences (November 2021). British Geological Survey.

http://lithiumfuture.org/map.html

AUSTRALIA AND CHILE IN THE FRONT ROW

Countries with major Lithium production and reserves

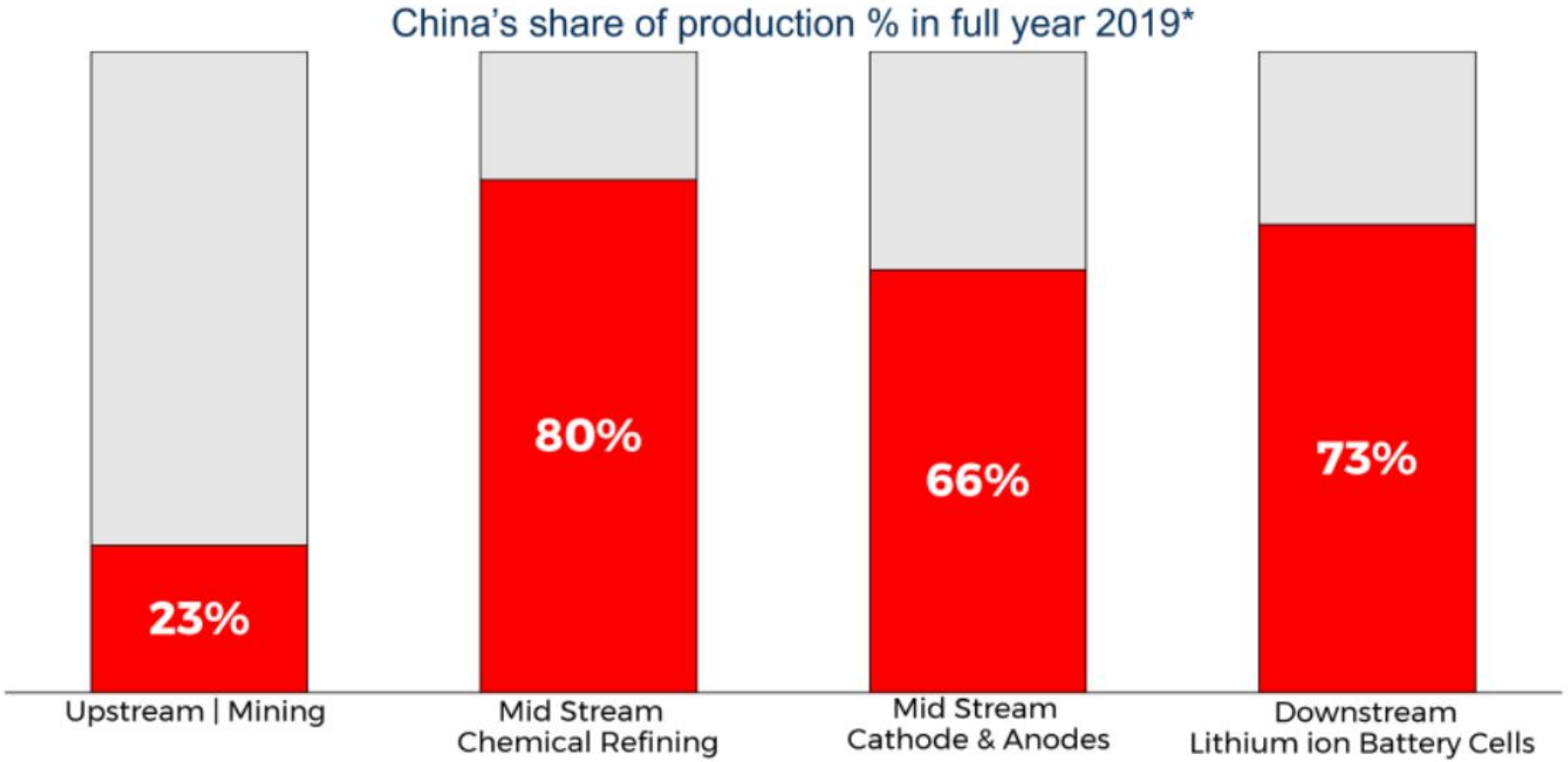


Prezi

source: USGS 2019

Where does China's dominance lie in the lithium ion battery to EV supply chain?

BENCHMARK MINERAL INTELLIGENCE

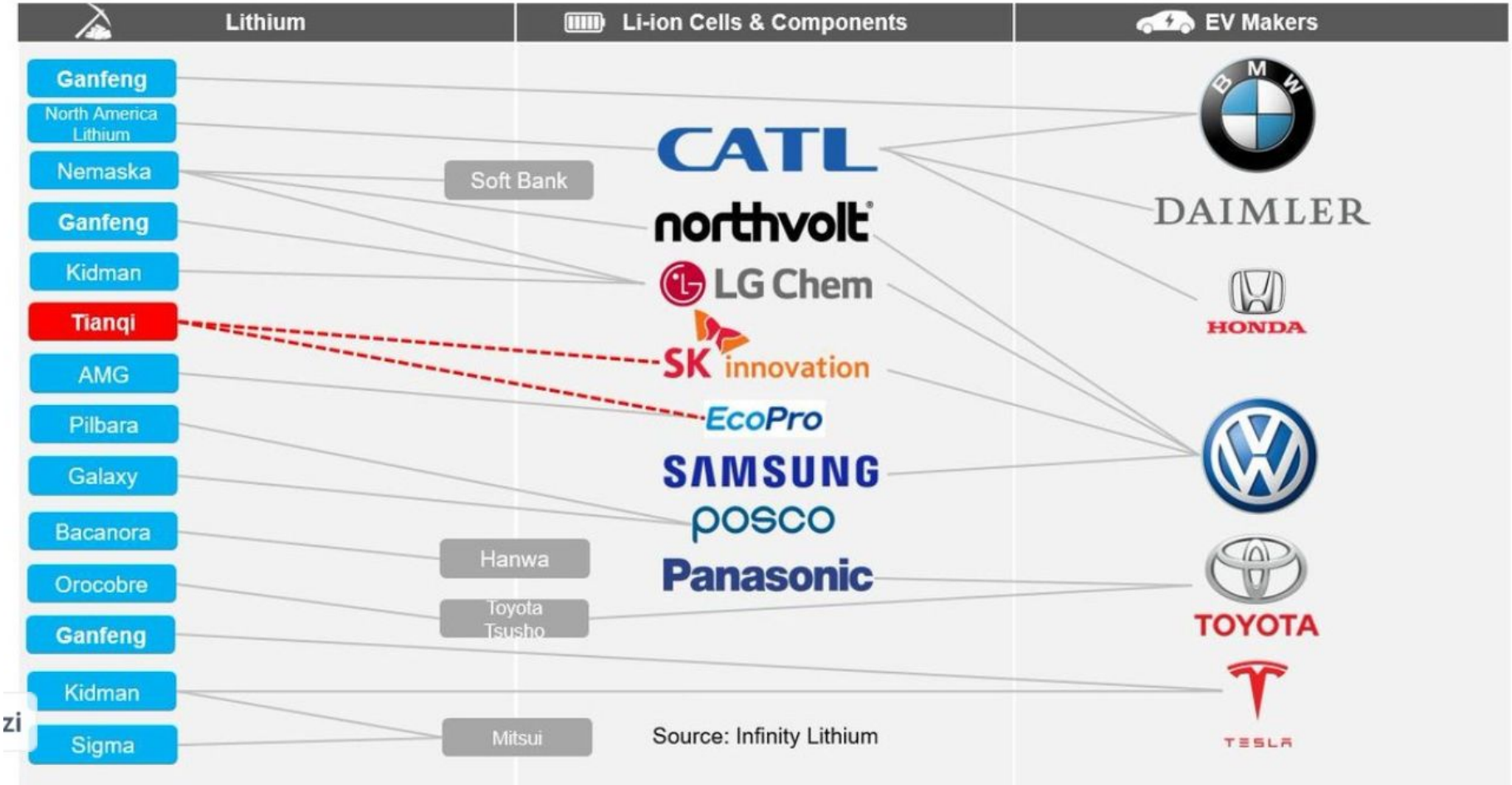


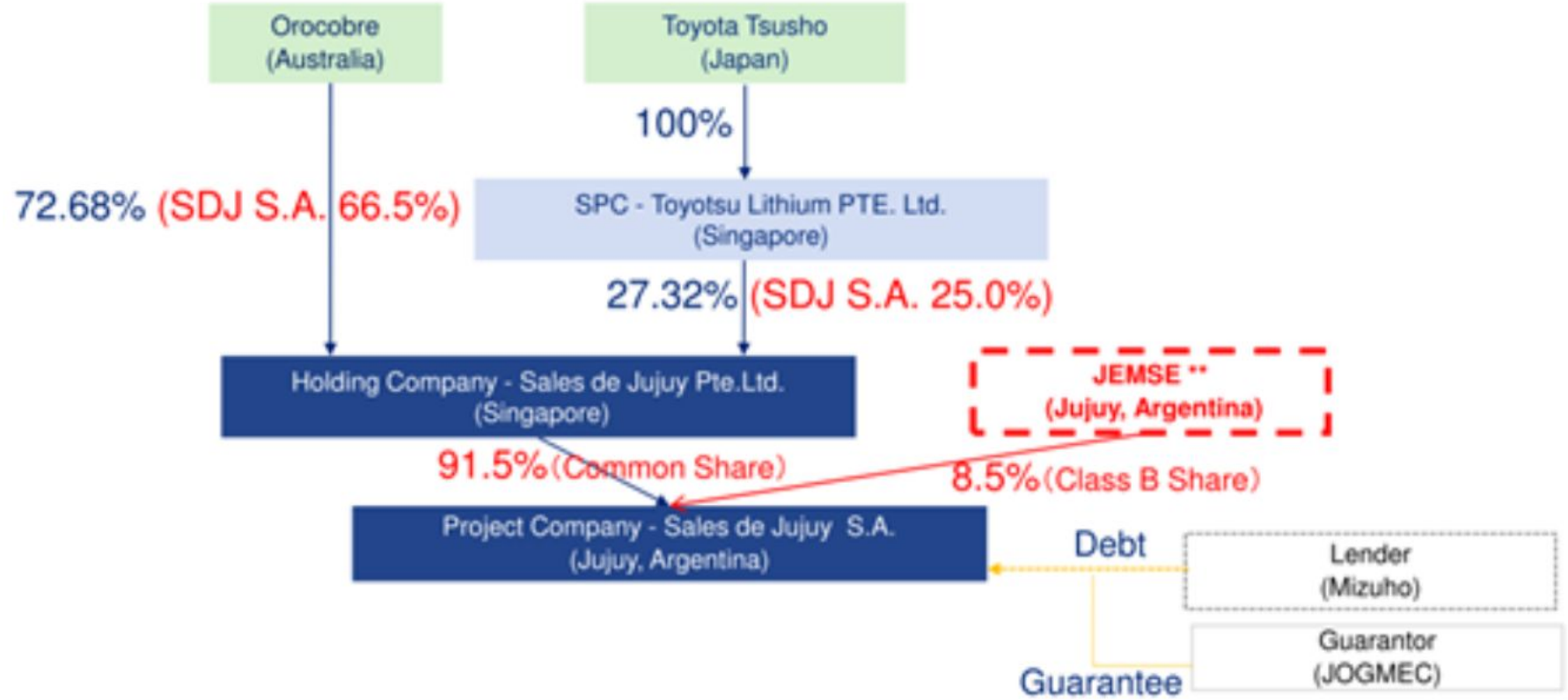
*Lithium, Cobalt, Nickel, Graphite, Manganese, Cathode, Anode, Cells accounted for in calculations

Source: Benchmark Mineral Intelligence

2018-2019 Key Agreements & Investments in the Lithium-ion Battery Supply Chain

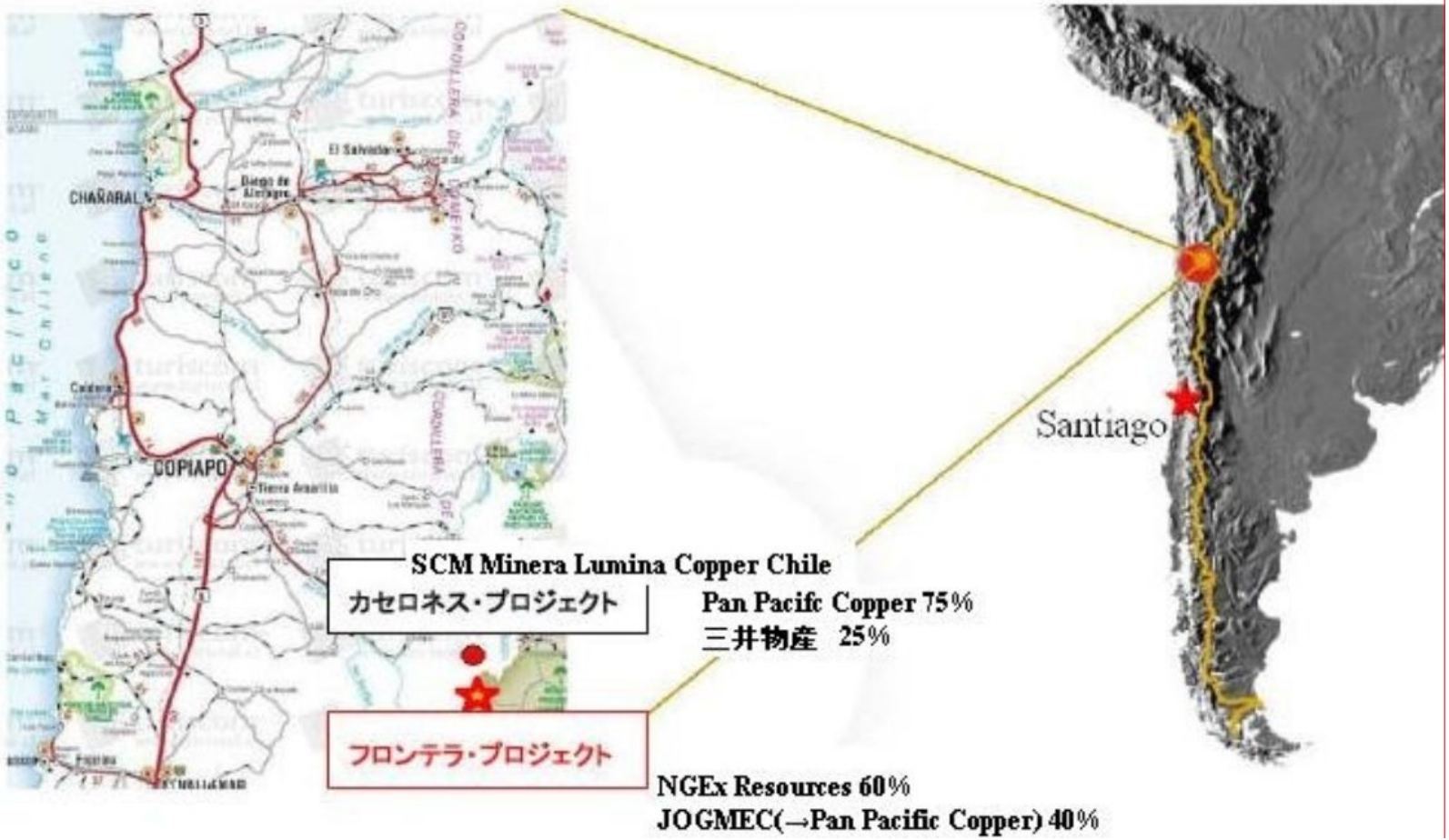
ASX: INF

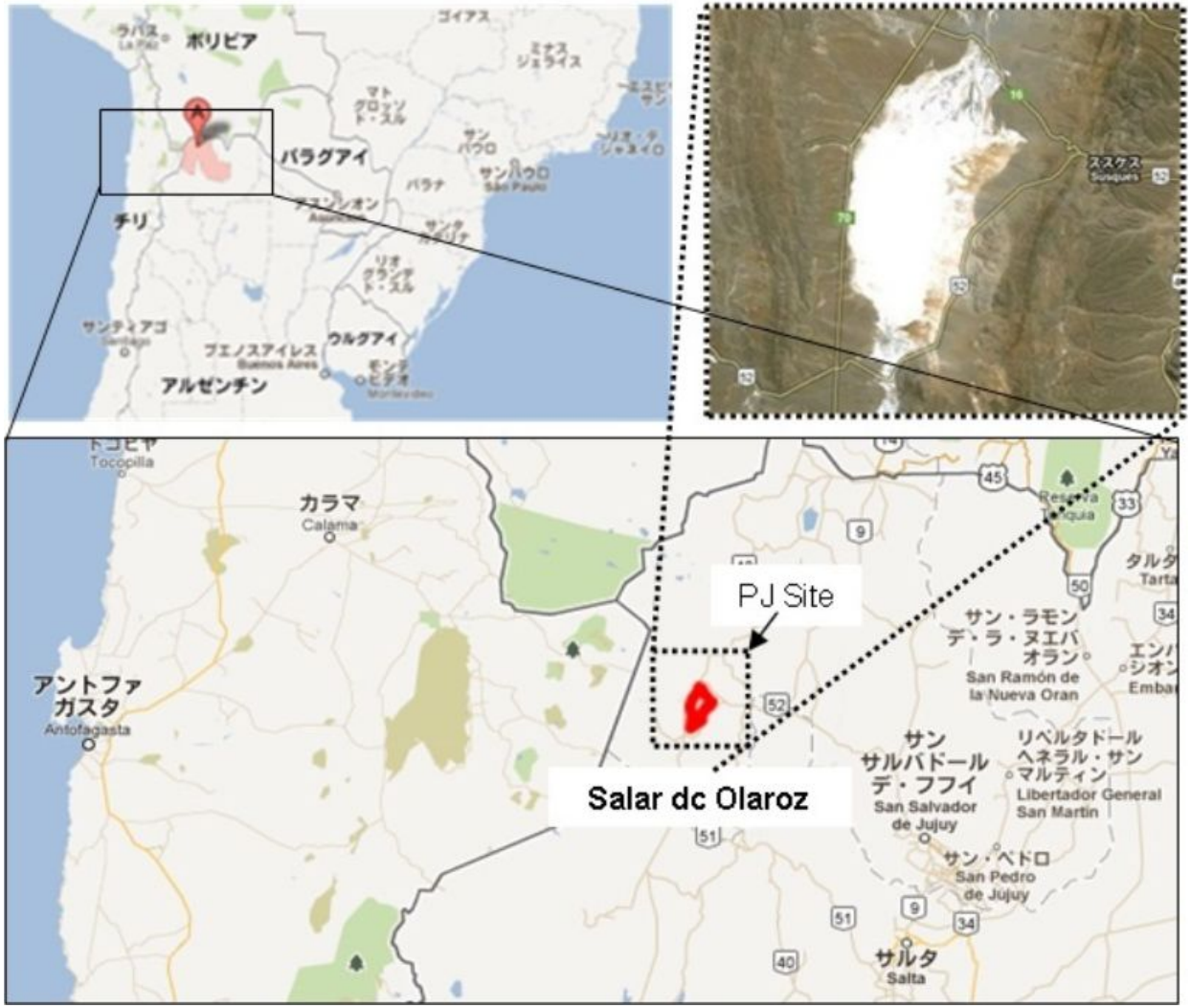




https://www.toyota-tsusho.com/english/press/detail/120926_001855.html

フロンテラ地域位置図


CHAÑARAL
COPIAPO
Santiago
SCM Minera Lumina Copper Chile
カセロネス・プロジェクト
Pan Pacifc Copper 75%
三井物産 25%
フロンテラ・プロジェクト
NGEx Resources 60%
JOGMEC(→Pan Pacific Copper) 40%


ボリビア
パラグアイ
チリ
アルゼンチン
ウルグアイ
ブエノスアイレス
Buenos Aires
サンティアゴ
Santiago
トコピヤ
Tocopilla
カラマ
Calama
アントファガスタ
Antofagasta
PJ Site
Salar dc Olaroz
サン・ラモン・デ・ラ・ヌエバ・オラン
San Ramón de la Nueva Oran
サン・サルバドール・デ・フフイ
San Salvador de Jujuy
リベルタドール・ヘネラル・サン・マルティン
Libertador General San Martin
サン・ペドロ
San Pedro de Jujuy
サルタ
Salta
タルタ
Tartagal
ススケス
Susques

2020 H1 Top 10 EV battery suppliers

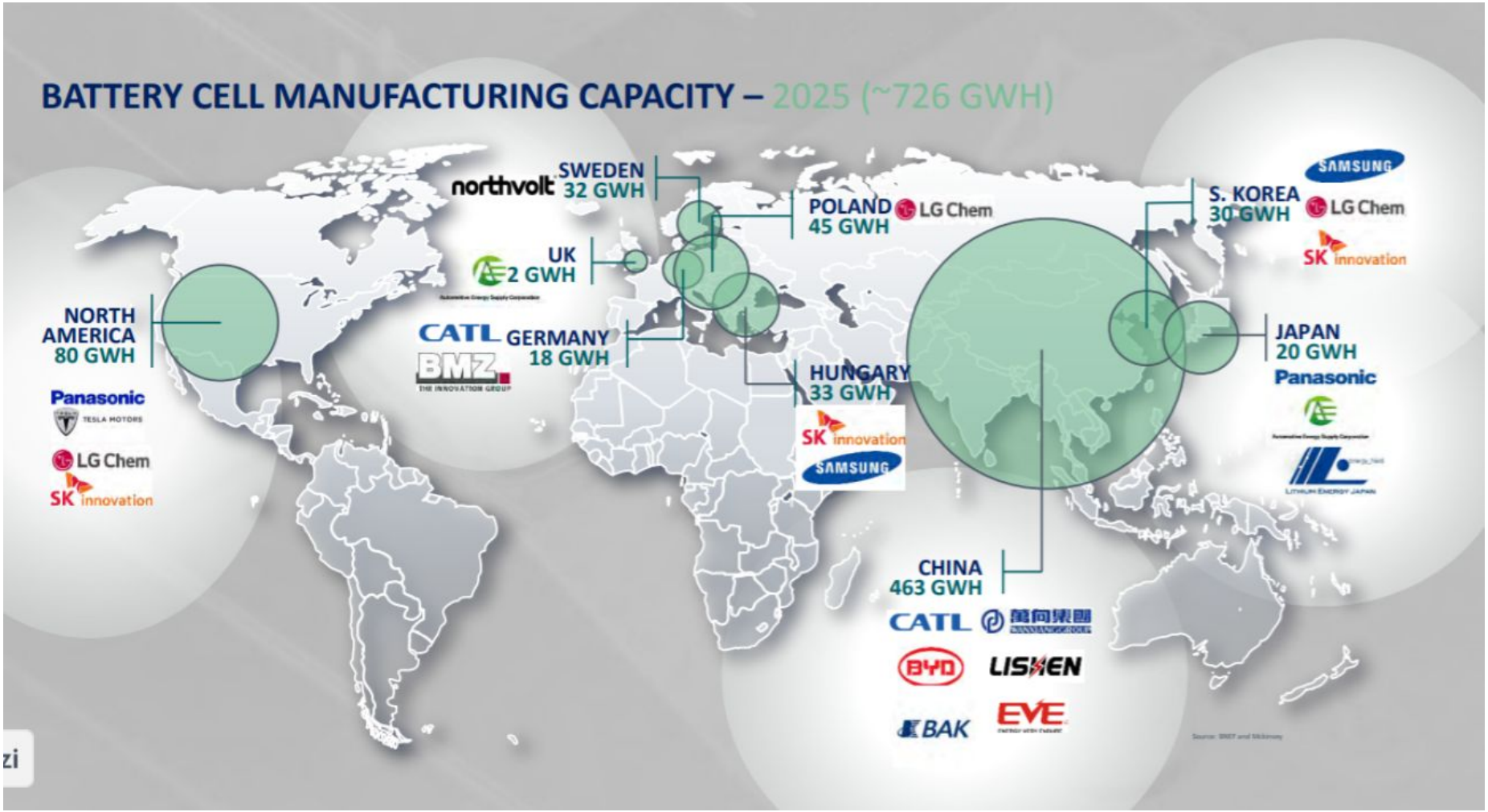
*Based on EV sales between January and June 2020

Unit: %

Rank	Company	Headquartered in	Market share	On-year growth rate
1	LG Chem	Korea	24.6	82.8
2	Contemporary Amperex Technology (CATL)	China	23.5	-28.1
3	Panasonic	Japan	20.4	-31.5
4	Samsung SDI	Korea	6.0	34.9
5	BYD	China	6.0	-65.7
6	SK Innovation	Korea	3.9	66.0
7	Automotive Energy Supply Corporation (AESC)	Japan	3.9	-10.5
8	Primearth EV Energy (PEVE)	Japan	2.1	-19.1
9	China Aviation Lithium Battery (CALB)	China	1.8	53.7
10	Guoxuan	China	1.6	-62.3

Source: SNE Research

BATTERY CELL MANUFACTURING CAPACITY – 2025 (~726 GWH)



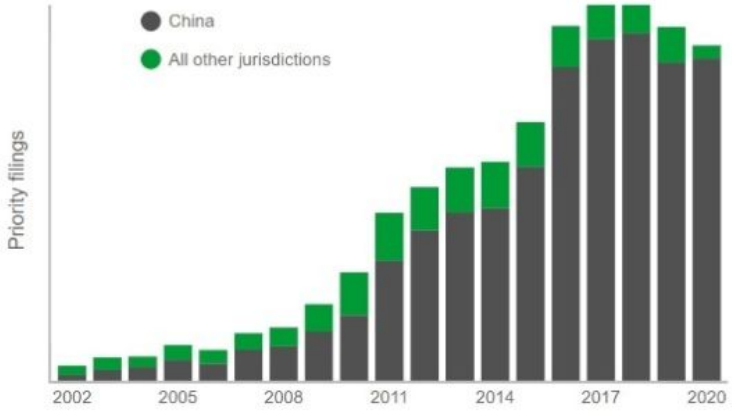
Solid-state battery: main industrial players – geographical overview

(Source: Solid-State Battery 2021 report, Yole Développement, 2021)

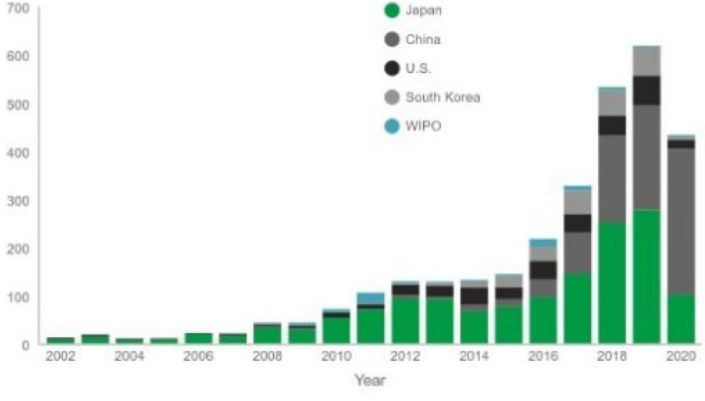
Non exhaustive list of companies

Companies working on key technology building blocks such as Li-metal anodes are also included here.

20-year priority patent filing (China v. rest of world), Li-ion battery tech



20-year priority patent filing (top 5 jurisdictions), SSD battery tech



Source: https://appleyardlees.foleon.com/igipr/inside-green-innovation-progress-report-2021/5-short-term-energy-storage/.
Note by *Appleyardlees*: "Due to an 18-month lag between patent application and full publication of patent data, data from 2021 has not been reported, and data from 2020 includes data through May 2020."

電動車市場は2030年には約5倍、電池としては数十倍規模に

各種調査データより当社まとめ

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テーマ１　資源～材料製造までのプロセス革新

Ni
ニッケルの例

現状

工程が多くリードタイムも長い（平均約１２か月）、CO_2排出量も多い

採掘 → 鉱石 → 精鉱 → 中間原料 → 精錬 → Ni金属 → 硫酸溶解 → Ni二次製品 → 析出 → 前駆体 → 焼成 → 正極材




ニッケルのメインはステンレス・合金用途のため、電池用に最適化されていない

狙い

低コスト・低CO_2のプロセスに革新（△50%）

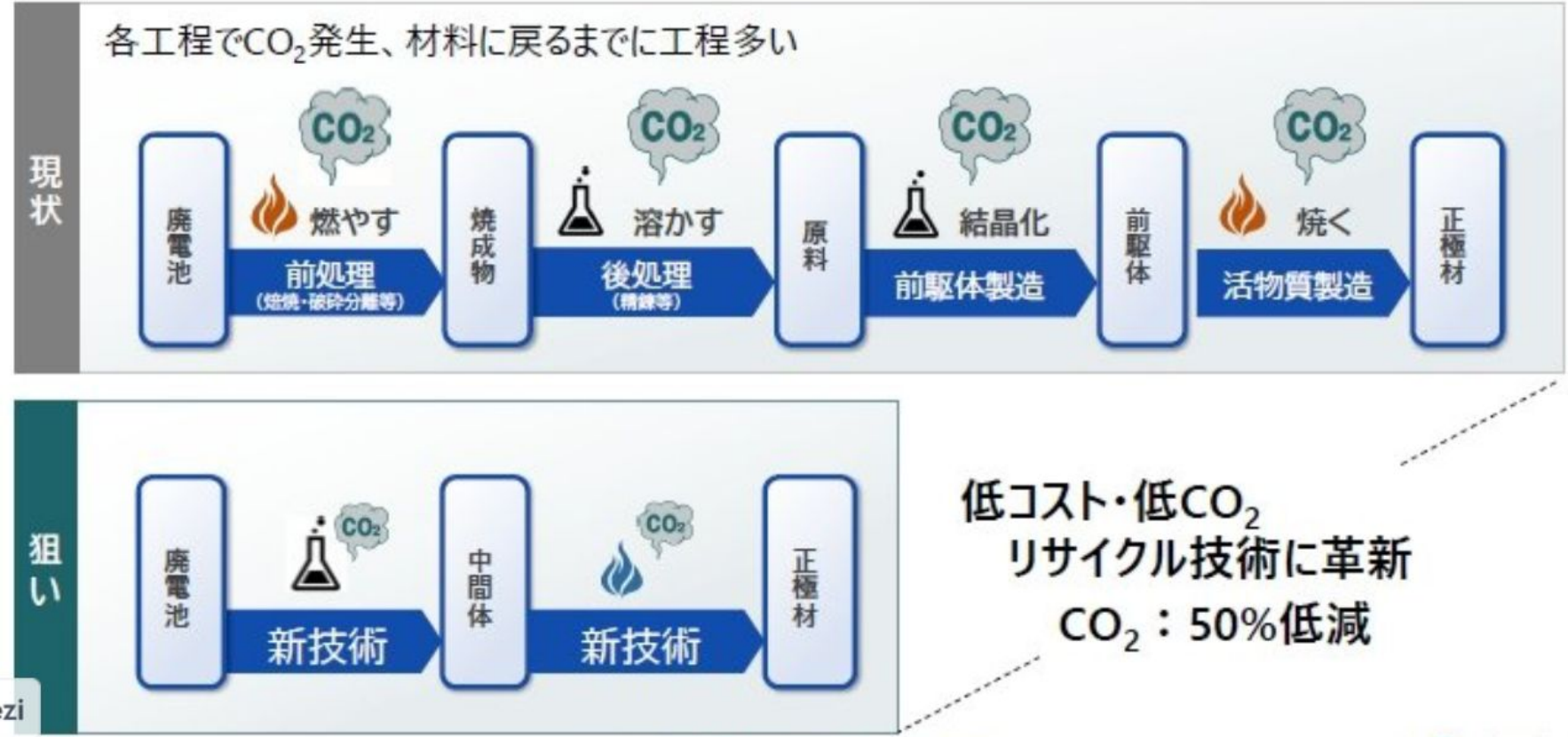
採掘 → 鉱石 → 新技術 → 中間体 → 新技術 → 正極材

電池用に最適化・要求仕様の適正化

工程短縮による背反を電池材料への最適化を図ることで抑え込む

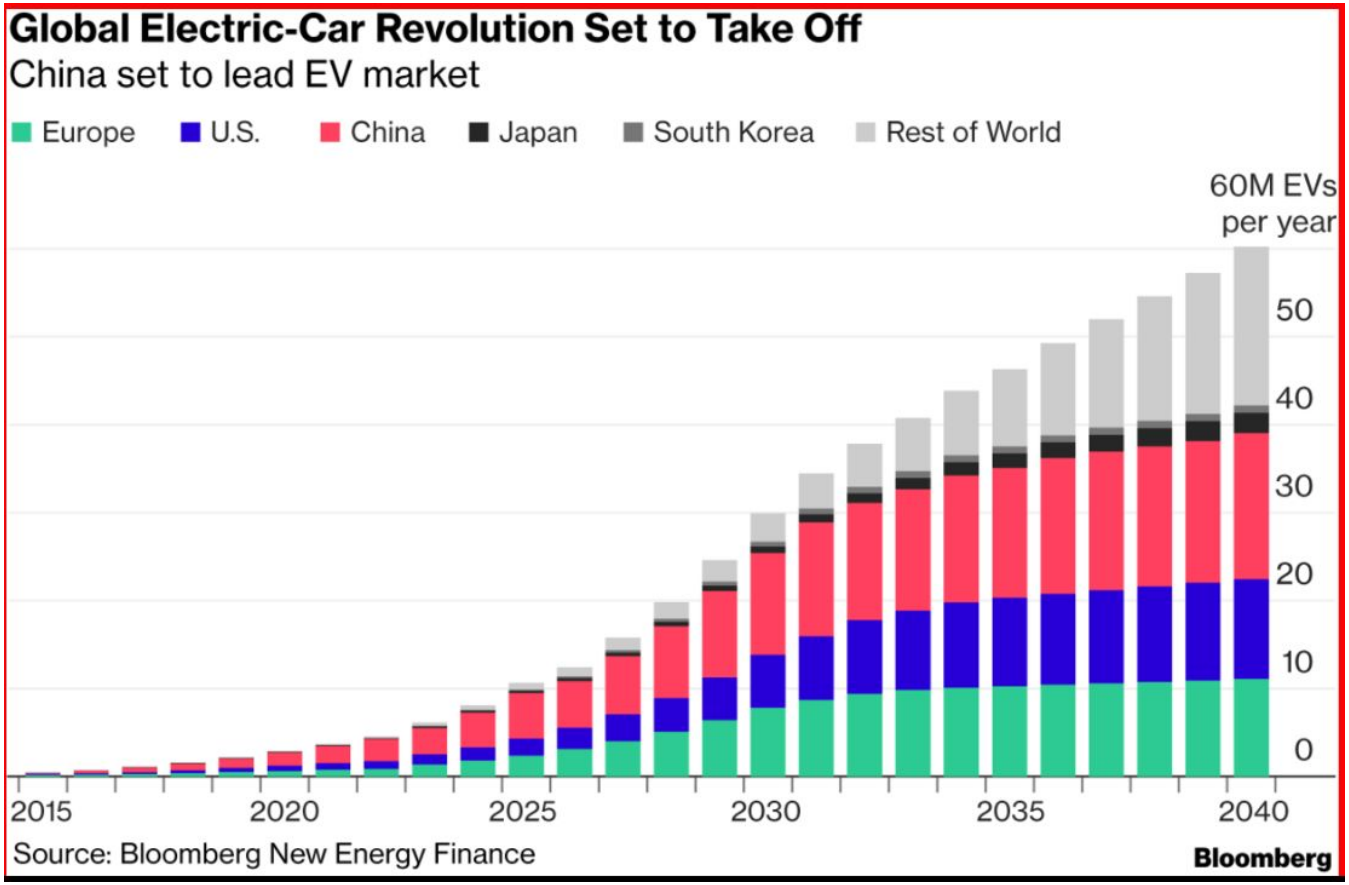
prime planet energy & solutions

テーマ２　リサイクルのプロセス革新

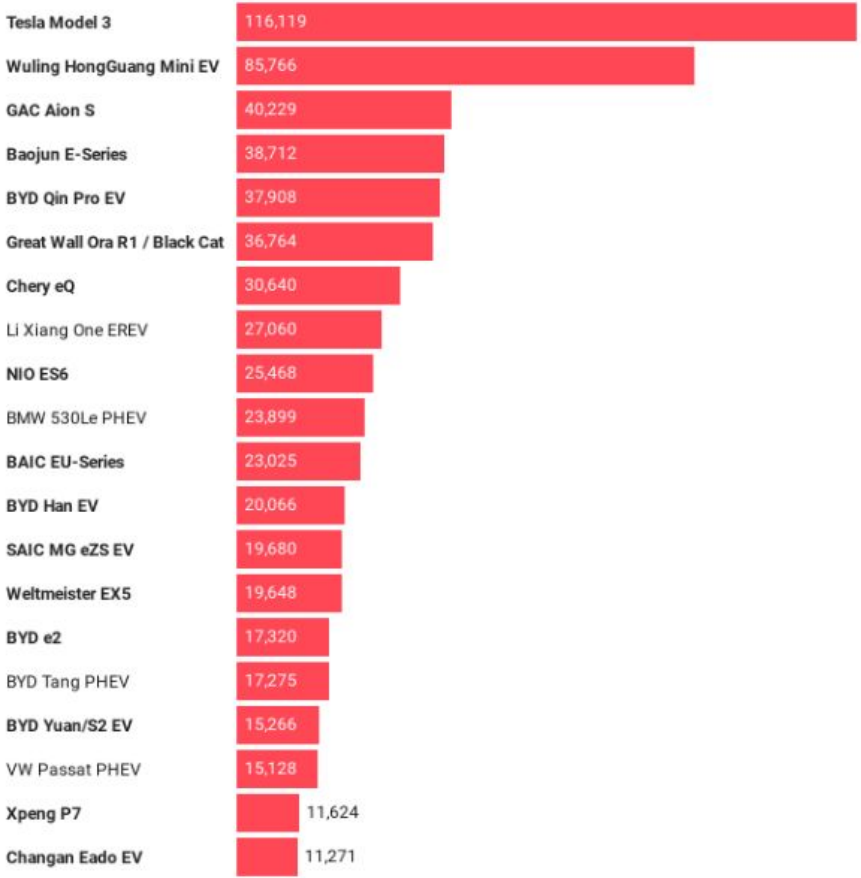


低コスト・低CO_2
リサイクル技術に革新
CO_2：50%低減

One Teamで電池産業全体の強化

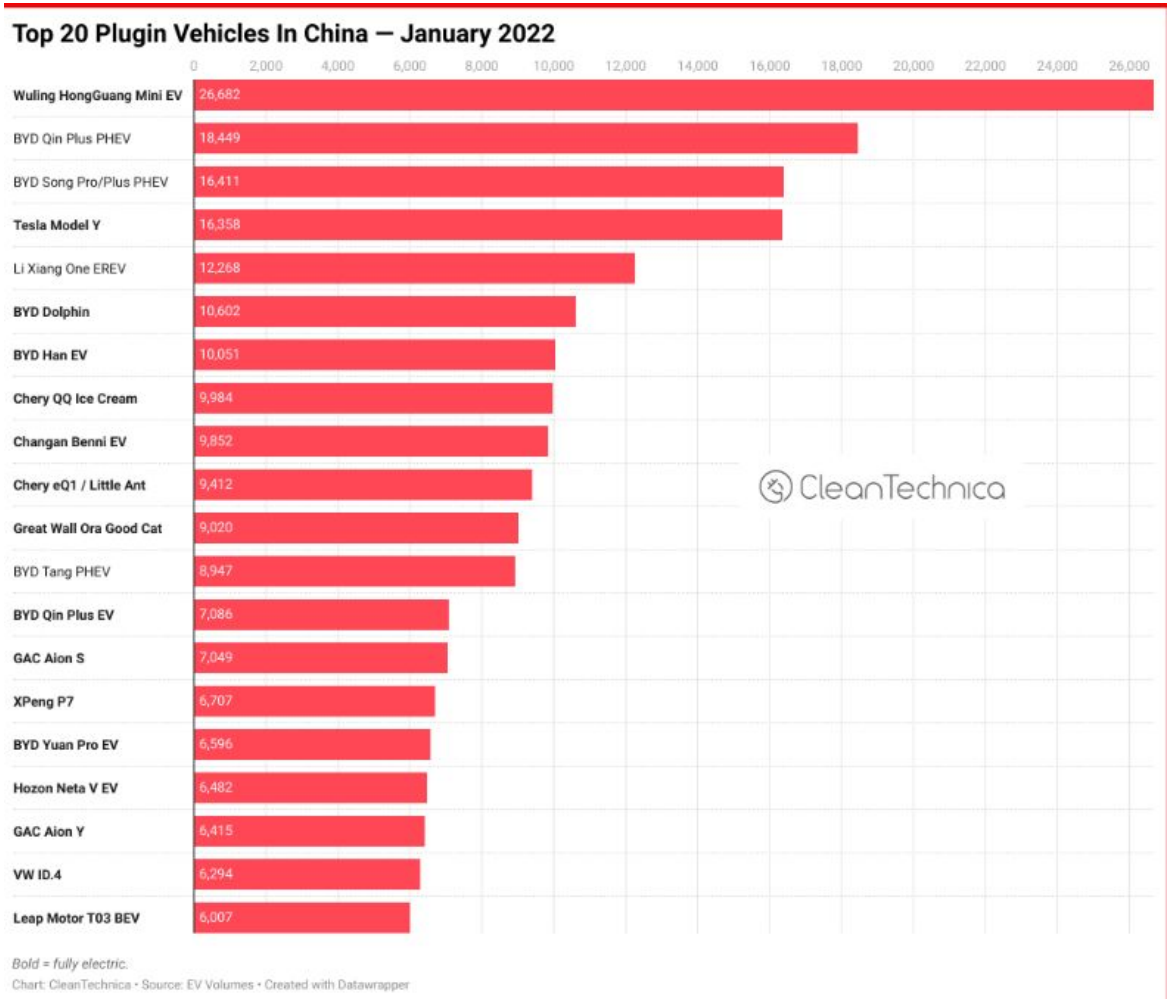

Global Electric-Car Revolution Set to Take Off
China set to lead EV market
Europe
U.S.
China
Japan
South Korea
Rest of World
60M EVs per year
50
40
30
20
10
0
2015
2020
2025
2030
2035
2040
Source: Bloomberg New Energy Finance
Bloomberg

Top 20 Plugin Vehicles In China — January–November 2020



Bold = fully electric.

Chart: CleanTechnica • Source: EV Volumes • Created with Datawrapper


Top 20 Plugin Vehicles In China — January 2022
0
2,000
4,000
6,000
8,000
10,000
12,000
14,000
16,000
18,000
20,000
22,000
24,000
26,000
Wuling HongGuang Mini EV
26,682
BYD Qin Plus PHEV
18,449
BYD Song Pro/Plus PHEV
16,411
Tesla Model Y
16,358
Li Xiang One EREV
12,268
BYD Dolphin
10,602
BYD Han EV
10,051
Chery QQ Ice Cream
9,984
Changan Benni EV
9,852
Chery eQ1 / Little Ant
9,412
Great Wall Ora Good Cat
9,020
BYD Tang PHEV
8,947
BYD Qin Plus EV
7,086
GAC Aion S
7,049
XPeng P7
6,707
BYD Yuan Pro EV
6,596
Hozon Neta V EV
6,482
GAC Aion Y
6,415
VW ID.4
6,294
Leap Motor T03 BEV
6,007
CleanTechnica
Bold = fully electric.
Chart: CleanTechnica • Source: EV Volumes • Created with Datawrapper

TOP 25 NATIONS FOR MINING IN THE

EV BATTERY SUPPLY CHAIN

Here are the top 25 countries for raw materials in the lithium-ion battery supply chain in 2020 and 2025p based on BloombergNEF's rankings. Countries are ranked according to resource availability, mining capacity, and refining capacity.

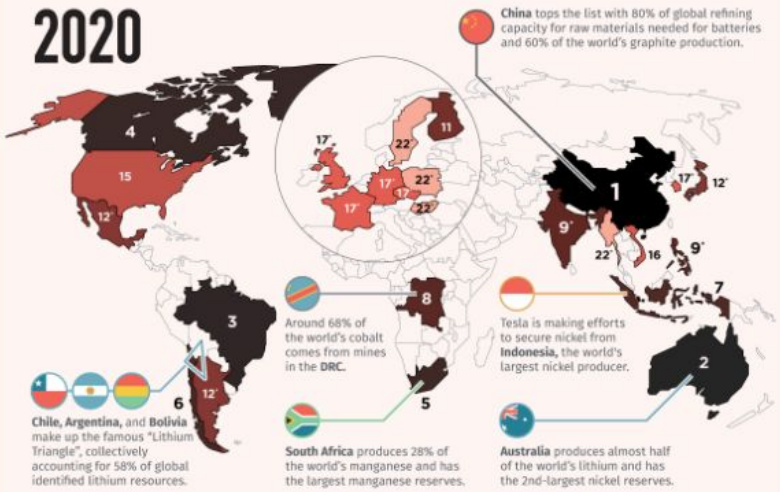
Five critical minerals required for lithium-ion batteries:

- Lithium
- Cobalt
- Manganese
- Graphite
- Nickel

LI-ION BATTERY RAW MATERIAL SUPPLY RANKINGS

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25

2020



China tops the list with 80% of global refining capacity for raw materials needed for batteries and 60% of the world's graphite production.

Around 68% of the world's cobalt comes from mines in the **DRC.**

Tesla is making efforts to secure nickel from **Indonesia,** the world's largest nickel producer.

Chile, Argentina, and **Bolivia** make up the famous "Lithium Triangle", collectively accounting for 58% of global identified lithium resources.

South Africa produces 28% of the world's manganese and has the largest manganese reserves.

Australia produces almost half of the world's lithium and has the 2nd-largest nickel reserves.

*represents countries that are tied

Source: BloombergNEF, Reuters, USGS Mineral Commodity Summaries (2021)

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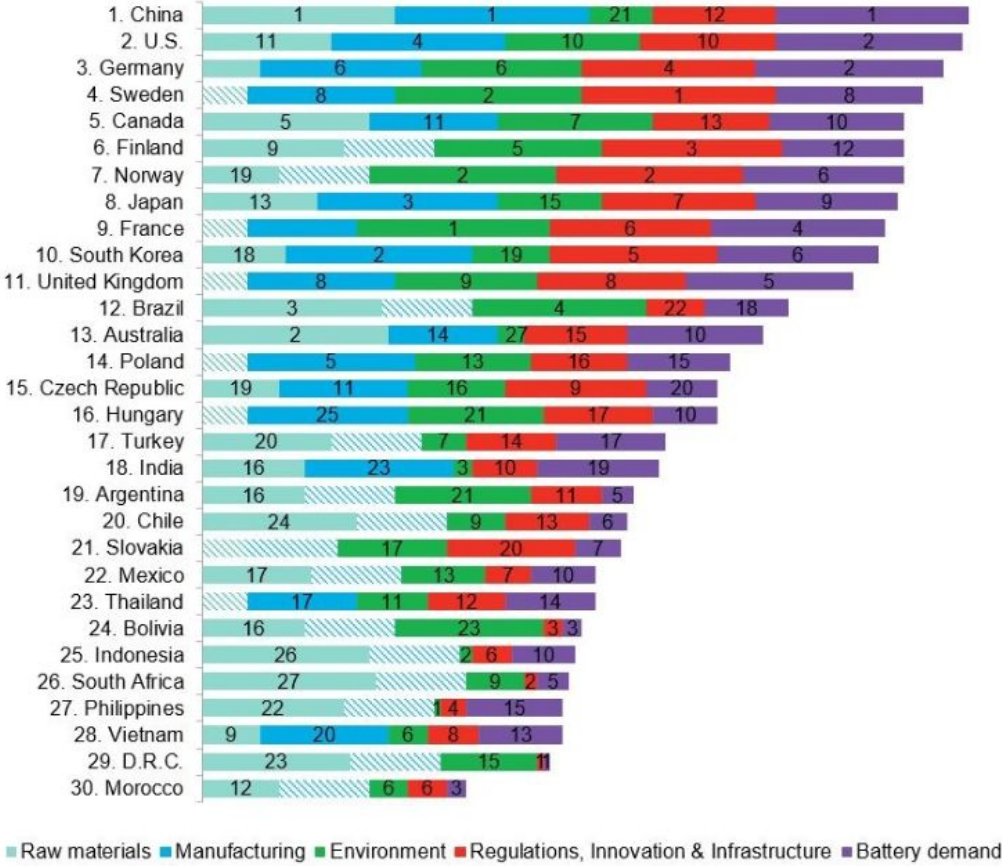
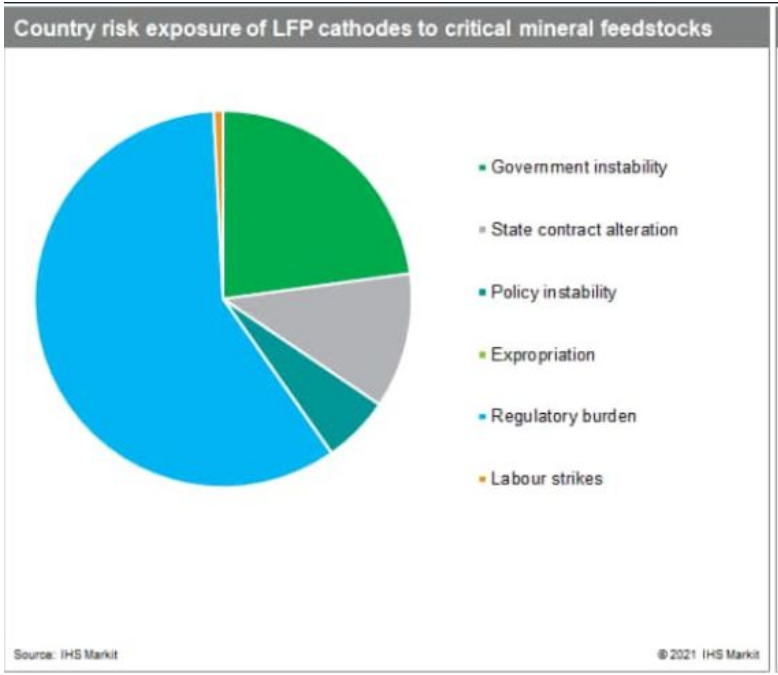
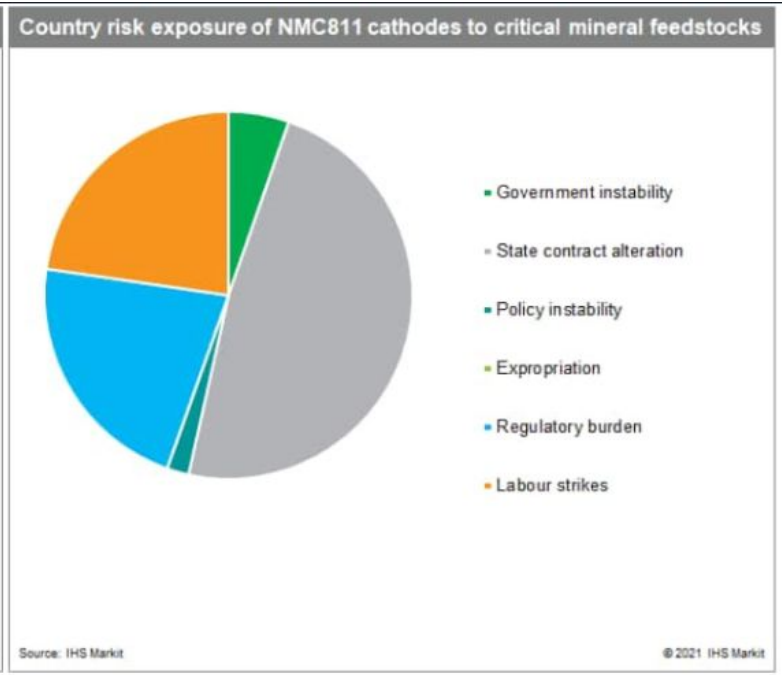
We live in a **material world.**

Figure 1: BNEF 2021 global lithium-ion battery supply chain ranking



Source: BloombergNEF. Note: Shaded areas for manufacturing and/or raw materials indicate that the country has no capacity and comes joint last in the rankings with other countries.

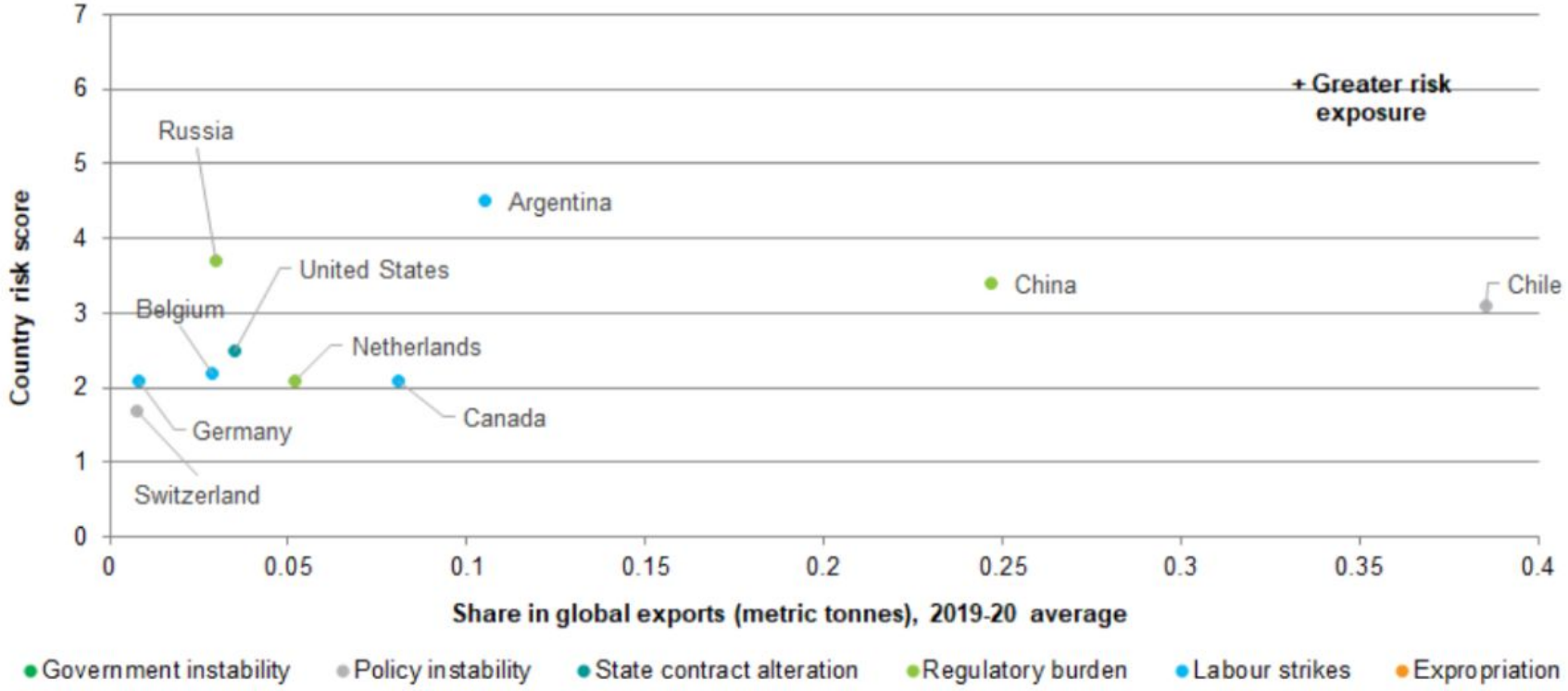




- Nickel-manganese-cobalt oxide (NMC) cathodes are among the most exposed to country risks because of their high cobalt and nickel content. Cobalt and nickel exports are highly concentrated in countries with above average country risk scores, particularly legal and regulatory risks that can result in the revocation of production contracts and prohibitive regulatory costs to producers. A vulnerability affecting all cathode technologies relates to the lithium sourced from Latin America and lithium that is processed in Mainland China, where policy instability and regulatory uncertainty can disrupt supply.

- Lithium-iron-phosphate (LFP) supply chains are relatively resilient since these cathodes do not contain cobalt or nickel. Instead, they use two diversely sourced inputs, phosphate and iron, that are supplied by lower risk countries. Although LFP cathodes are less energy-dense and less recyclable than NMCs, they are cheaper to produce and the risks to cobalt and nickel supply chains are motivating EV original equipment manufacturers (OEMs) to explore battery production with these cathodes.

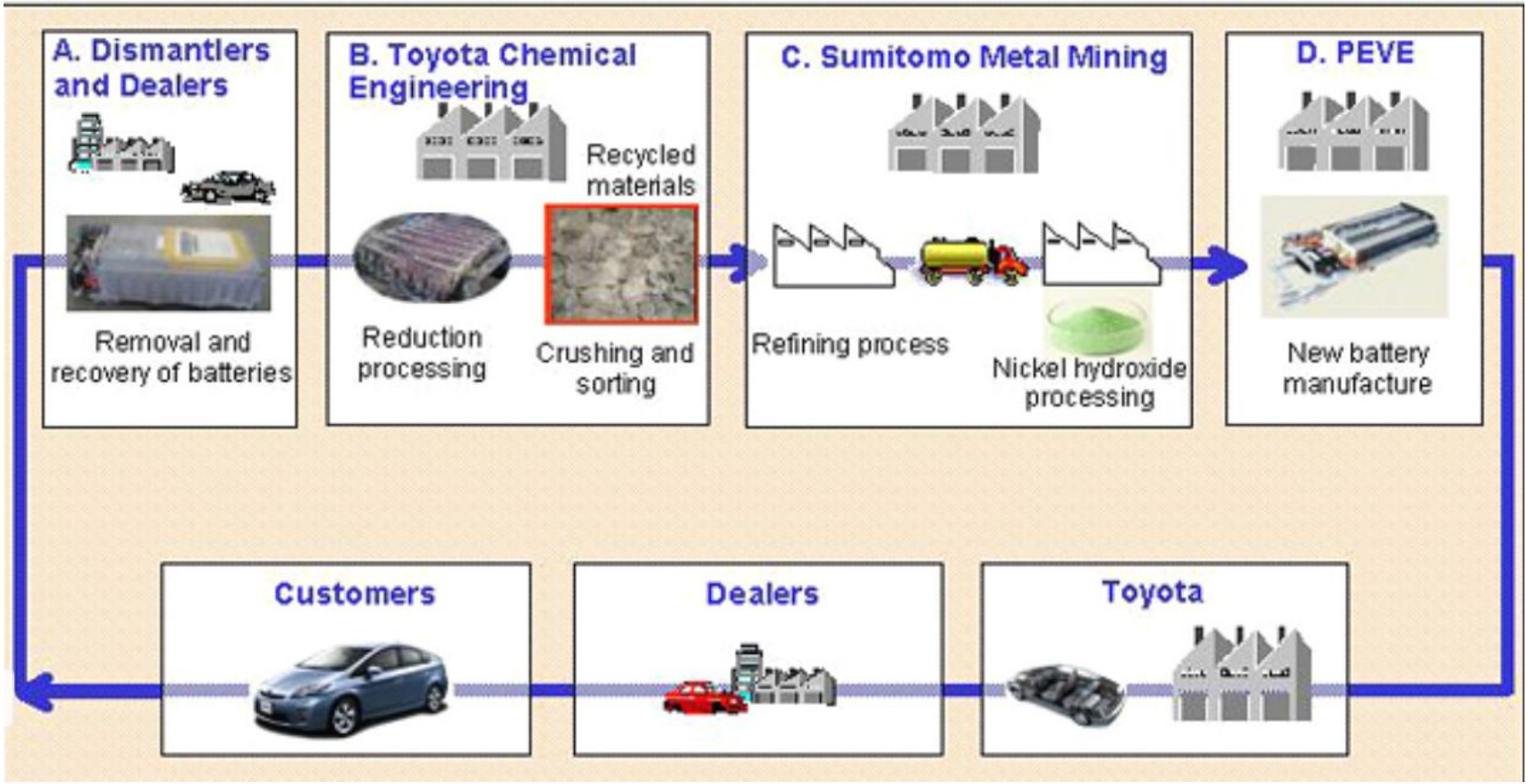
Dominant country risk exposure of the 10 largest exporters of lithium carbonate, oxide and hydroxide



Notes:
1. Trade data products selected (HTS codes): 282520 (Lithium oxide and hydroxide), 283691 (Lithium carbonates). Where export data were poor/ missing, exports were approximates by trading partners' equivalent imports ('mirror exchanges'). (Outturns may vary significantly between well-established sources due to such adjustments.)
2. Marker colours denote dominant, not only, country risk score.

Source: IHS Markit. Trade data from IHS Markit Global Trade Atlas, from national customs data, 2020 data (latest available), Country Risk Scores as at 27 August 2021, full methodology here.

Battery Material Recycling Business Structure



All the Metals We Mined

IN ONE CHART

Total Metals 3,248,814,334 tonnes

Metals are the building blocks of the global economy, From iron ore to rare earths, here are all the metals we mined in 2019.

Metals vs. Ores

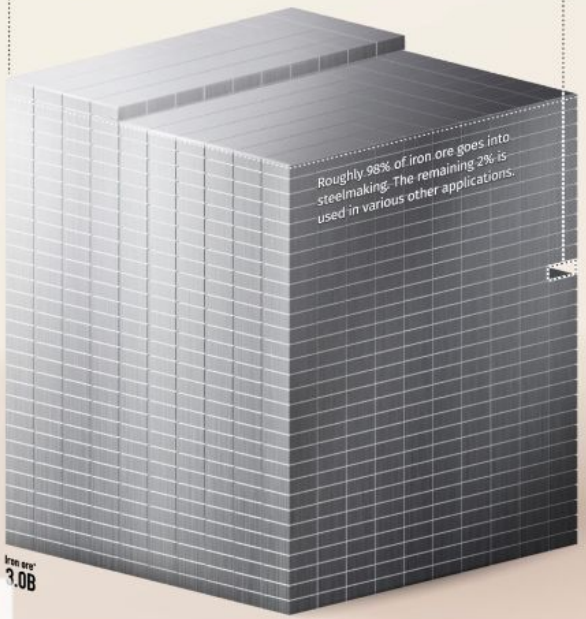
Ores are naturally occurring rocks that contain metals or metal compounds.

Metals are the valuable parts of ores that can be extracted and sold.

Iron ore*
3,040,000,000 tonnes

Iron ore made up roughly 94% of the 3.2 billion tonnes of metals mined in 2019.

= 1,000,000 tonnes



Industrial metals
207,478,486 tonnes

Aluminum is the world's second-most used metal after iron, found in everything from electronic devices to aircraft parts.

Copper production is one-third that of aluminum, though it has several uses ranging from wiring to construction.

Manganese is mainly used in iron and steel manufacturing and is a key ingredient in lithium-ion batteries.

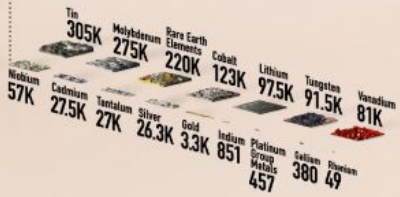
Chromium enhances the hardenability and corrosion resistance of stainless steel.

Tech and precious metals
1,335,848 tonnes

Niobium is a rare metal used in superalloys for jet and rocket engines.

Lithium and cobalt are critical ingredients of lithium-ion batteries for electric vehicles.

Indium is used to make indium tin oxide, an important part of touch screens, TVs, and solar panels.



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elements.visualcapitalist.com

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Source: *British Geological Survey (2019), USGS Mineral Commodity Summaries (2021)*

**Ore production does not reflect actual metal production as metals only make up a certain portion of ores. Graphic excludes semi-metals and metalloids. Hafnium is contained in Zircon.*

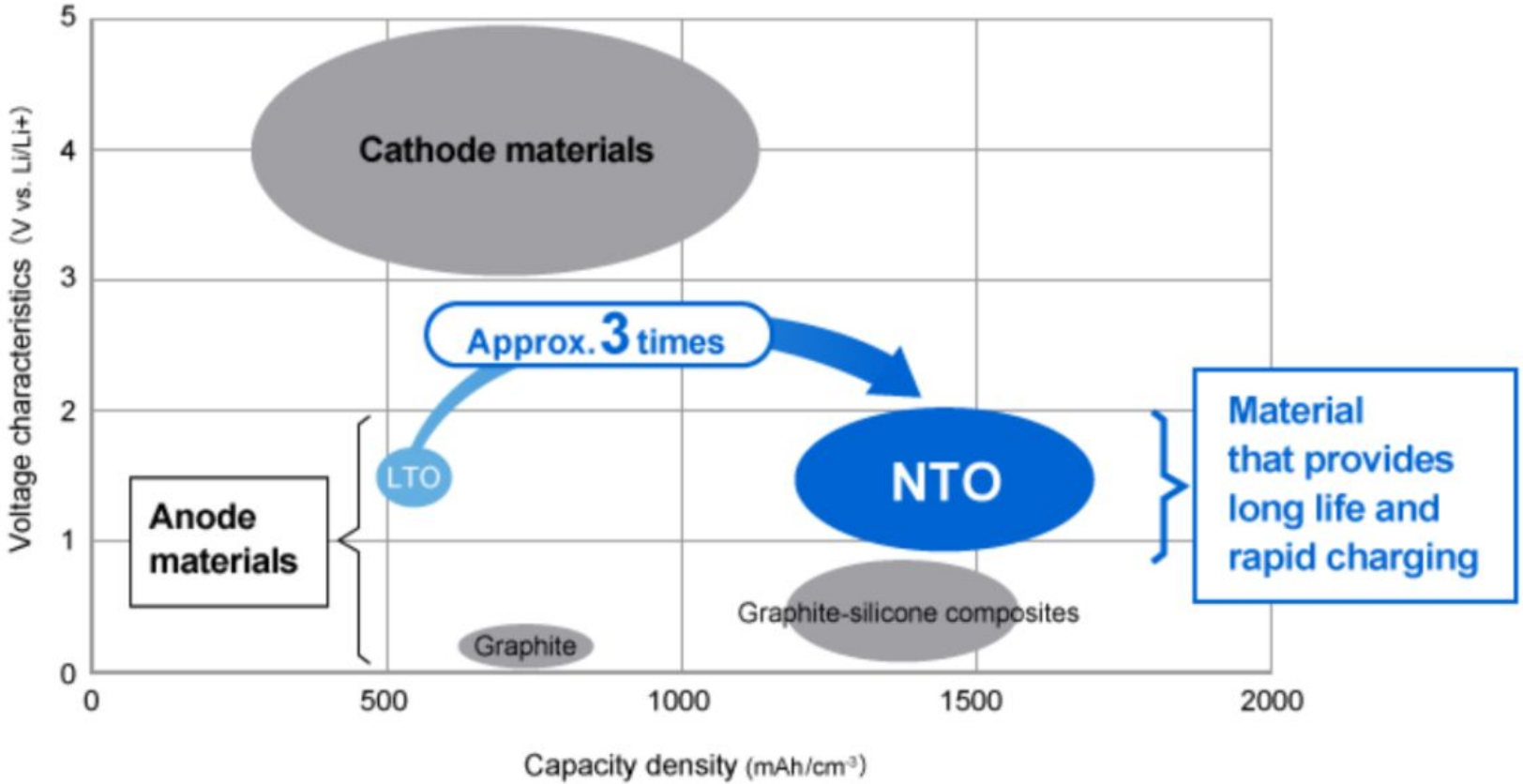
We live in a **material world.**

Niobium is poised to be a DISRUPTIVE element for advanced lithium-ion battery materials:

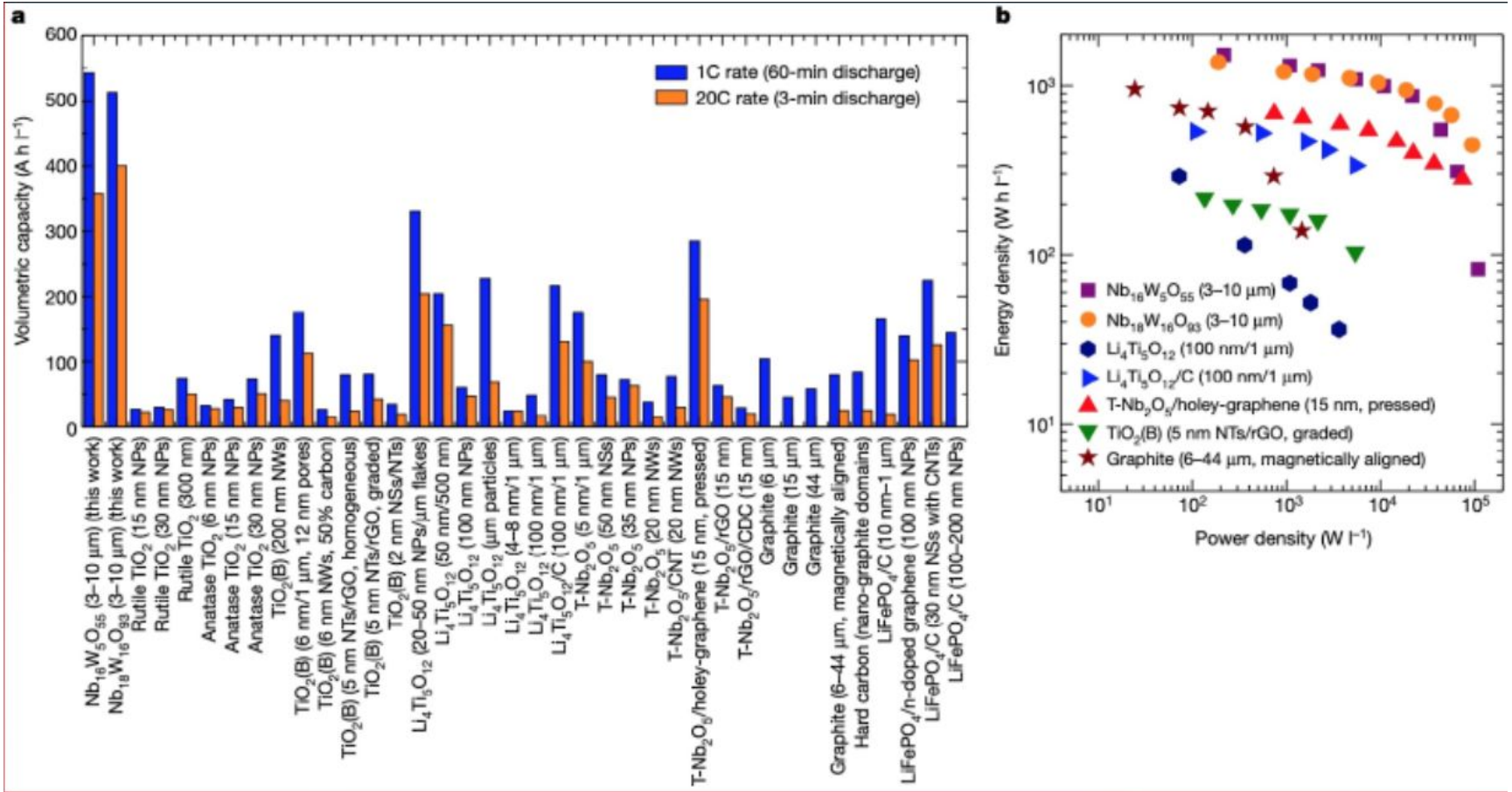
- ✓ Cobalt-free, high-energy, disordered rock-salt (DR) structures for cathodes;
- ✓ Doping to improve capacity retention upon cycling;
- ✓ High power and fast charging Nb-based mixed oxides for anodes;
- ✓ Coating for improving rate capability and ionic conductivity;
- ✓ Improved safety and long battery life.

...

https://assets.niobium.tech/-/media/NiobiumTech/Documentos/2019-Formula-E---Berlin/NT_Battery-innovation-niobium-as-disrupting-element.pdf



https://www.global.toshiba/ww/products-solutions/battery/scib/next/nto.html



Griffith, K.J., Wiaderek, K.M., Cibin, G. et al. (2018) "Niobium tungsten oxides for high-rate lithium-ion energy storage." Nature 559, 556–563 doi: 10.1038/s41586-018-0347-0

Tokyo University of Science - Next Generation Na-Ion Batteries & Safer Li-Ion Batteries. Professor Shinichi Komaba, Ph.D.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> JAPAN for Connoisseurs
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Thank you!
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Nepal
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North Korea
South Korea
Japan
India
Bangladesh
Myanmar
(Burma)
East China Sea
Bay of Bengal
Sri Lanka
Taiwan
Thailand
Andaman Sea
Cambodia
South
China Sea
Philippine Sea