

DOCKETED

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Project Title:	Lithium Valley Commission
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Filer:	Elisabeth de Jong
Organization:	California Energy Commission
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Docketed Date:	9/29/2021



Convening of the Lithium Valley Commission

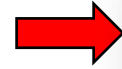
Convocatoria de la Comisión de Lithium Valley

September 30, 2021



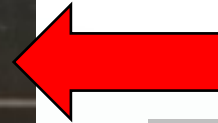
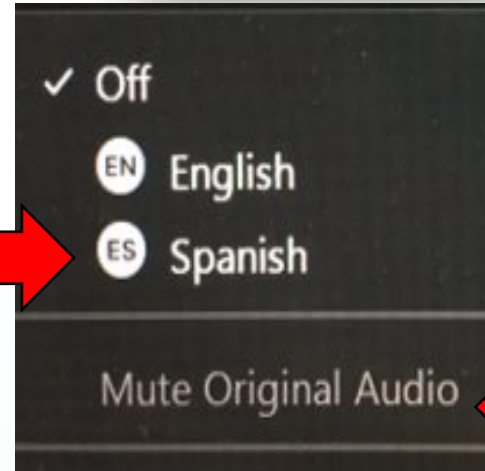
Interpretation / Interpretación

1) Click globe “Interpretation” icon.



2) Click “ES Spanish” option

3) Click “Mute Original Audio”



1) Haga clic en el icono del globo de interpretación

2) Haga clic donde dice “ES Spanish”

3) Haga clic en “Mute Original Audio”

NOTE: To access interpretation, download Zoom application on your device. Interpreter will relate everything from English to Spanish during meeting and will inform you when to make public comment. Speak in Spanish and interpreter will relate comments to English.

NOTA: Para utilizar la función de interpretación, descargue la aplicación Zoom en su aparato. El intérprete relacionará todo lo dicho en inglés al español durante la junta y le informará cuándo podrá hacer un comentario público. Hable en español y el intérprete relatará sus comentarios en inglés.

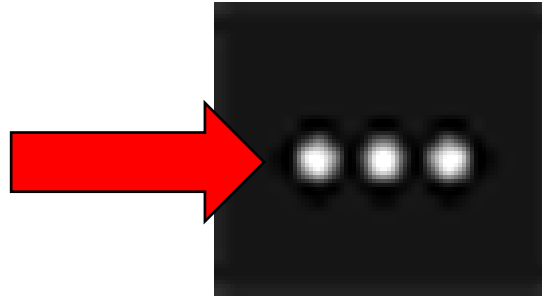


Interpreting on Tablet/Smartphone

Interpretación usando tableta o teléfono inteligente

To listen in Spanish, use controls to:

- 1) Tap for more options
- 2) Tap interpretation
- 3) Tap preferred language
- 4) Tap "Mute Original Audio"



Note: To use interpretation feature, download Zoom application on your device.

Para escuchar en español, use los controles para:

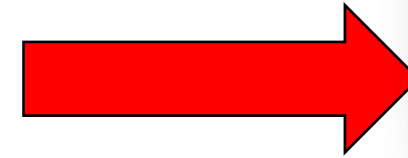
- 1) Tener más opciones
- 2) Hacer clic en interpretación
- 3) Escoger el idioma preferido
- 4) Hacer clic en "Mute Original Audio"

Nota: Para usar la opción de interpretación, descargue la aplicación Zoom en su aparato.

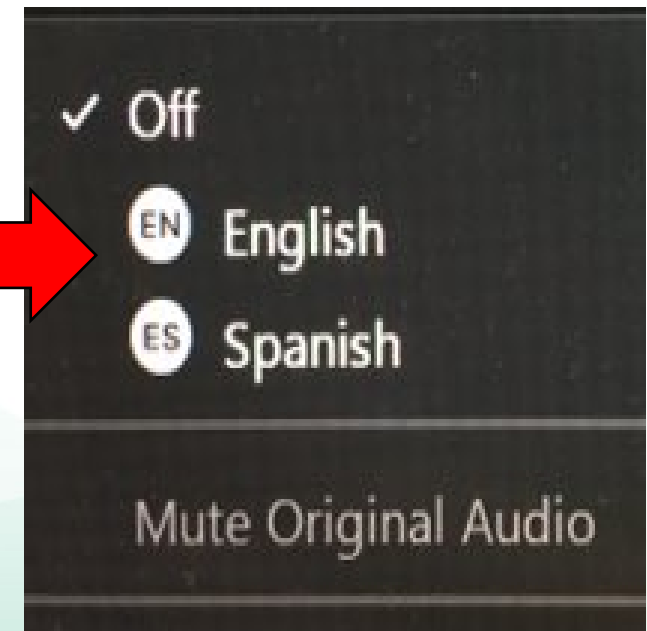


Steps to Select English Channel

1) Click “Interpretation” icon.



2) Click “EN English” option





Administrative Items / Temas Administrativos

- Meeting conducted remotely via Zoom
 - Recorded and transcribed by court reporter
- To participate in public comment...
 - By computer: use the “raise hand” feature in Zoom
 - By telephone: dial *9 to “raise hand” and *6 to mute/unmute your phone line
- Written comments
 - Submit through the e-commenting system at:
 - <https://efiling.energy.ca.gov/Ecomment/Ecomment.aspx?docketnumber=20-LITHIUM-01>
- Reunión realizada de manera remota a través de Zoom
 - Grabada y transcrita por un taquígrafo judicial
- Para participar en los comentarios públicos...
 - Por computadora: use la función de “levantar la mano” de Zoom
 - Por teléfono: marque *9 para “levantar la mano” y *6 para silenciar y activar el sonido
- Comentarios por escrito
 - Se deben enviar a través del sistema de comentarios electrónicos en: <https://efiling.energy.ca.gov/Ecomment/Ecomment.aspx?docketnumber=20-LITHIUM-01>



Welcome and Roll Call / Bienvenida y paso de lista



Agenda

- Welcome and Roll Call
- Administrative Items
 - Approval of August 26, 2021 Meeting Action Minutes
- Informational Items
 - Media and Legislation Updates
 - Lithium Valley Commissioner Updates
- Lithium Market Opportunities Workshop
 - State Policies and Investments
 - Lithium Market Overview
 - Lithium Valley Commissioner Q&A
 - Lithium Battery Life Cycle
 - Lithium Valley Commissioner Q&A
- Determination of Agenda Topics, Speakers, and Presentations for Future Meetings
- Public Comment
- Adjourn
- Bienvenida y paso de lista
- Temas administrativos
 - Aprobación del acta de la reunión del 26 de agosto de 2021
- Temas informativos
 - Actualización sobre medios y legislación
 - Actualización sobre el comisionado de Lithium Valley
- Taller sobre el desarrollo de la coproducción de energía geotérmica y litio
 - Presentación sobre impulsar el desarrollo geotérmico
 - Panel de discusión sobre el desarrollo de la coproducción de energía geotérmica y litio
- Determinación de los temas de la agenda, los oradores y las presentaciones para futuras reuniones
- Comentarios del público
- Levantar la sesión



Administrative Items / Temas administrativos

- Approval of Past Meeting Action Minutes
- Aprobación del acta de reuniones anteriores



Public Comment / Comentarios del público

Comment Instructions:

Limited to 3 minutes per comment

By computer: use “raise hand” feature in Zoom

By telephone: dial *9 to “raise hand” and *6 to mute/unmute your phone line

Instrucciones para los comentarios:

Límite de 3 minutos por comentario

Por computadora: use la función de “levantar la mano” de Zoom

Por teléfono: marque *9 para “levantar la mano” y *6 para silenciar y para activar el sonido





Media and Legislation Updates / Actualización sobre Medios y Legislación



Lithium Valley Commissioner Updates / Actualización sobre el comisionado de Lithium Valley



Lithium Market Opportunities Workshop / Taller sobre oportunidades del mercado de litio



State Policies and Investments / Políticas e inversiones estatales

- Jim McKinney, Fuels and Transportation Division
- Anthony Ng, Energy Research and Development Division
- Jim McKinney – División de combustibles y transporte
- Anthony Ng – División de investigación y desarrollo



California Leadership on Zero Emission Vehicle Policies and Funding

Presentation to the Lithium Valley Commission

Jim McKinney – Fuels and Transportation Division
California Energy Commission

September 30, 2021



California's Zero Emission Vehicle (ZEV) Policy Goals

Based on Climate Change and Air Quality Standards

AB 32 – Global Warming Solutions Act
Federal Clean Air Act – Severe Non-Attainment for Ozone and NOx

Light Duty Vehicles

- 2025: **1.5M ZEVs** (E.O. B-16-12)
- 2030: **5M ZEVs** (E.O. B-48-18)
- 2035: **100% of New Sales are ZEVs** (E.O. N-79-20)

Charging and Refueling Infrastructure

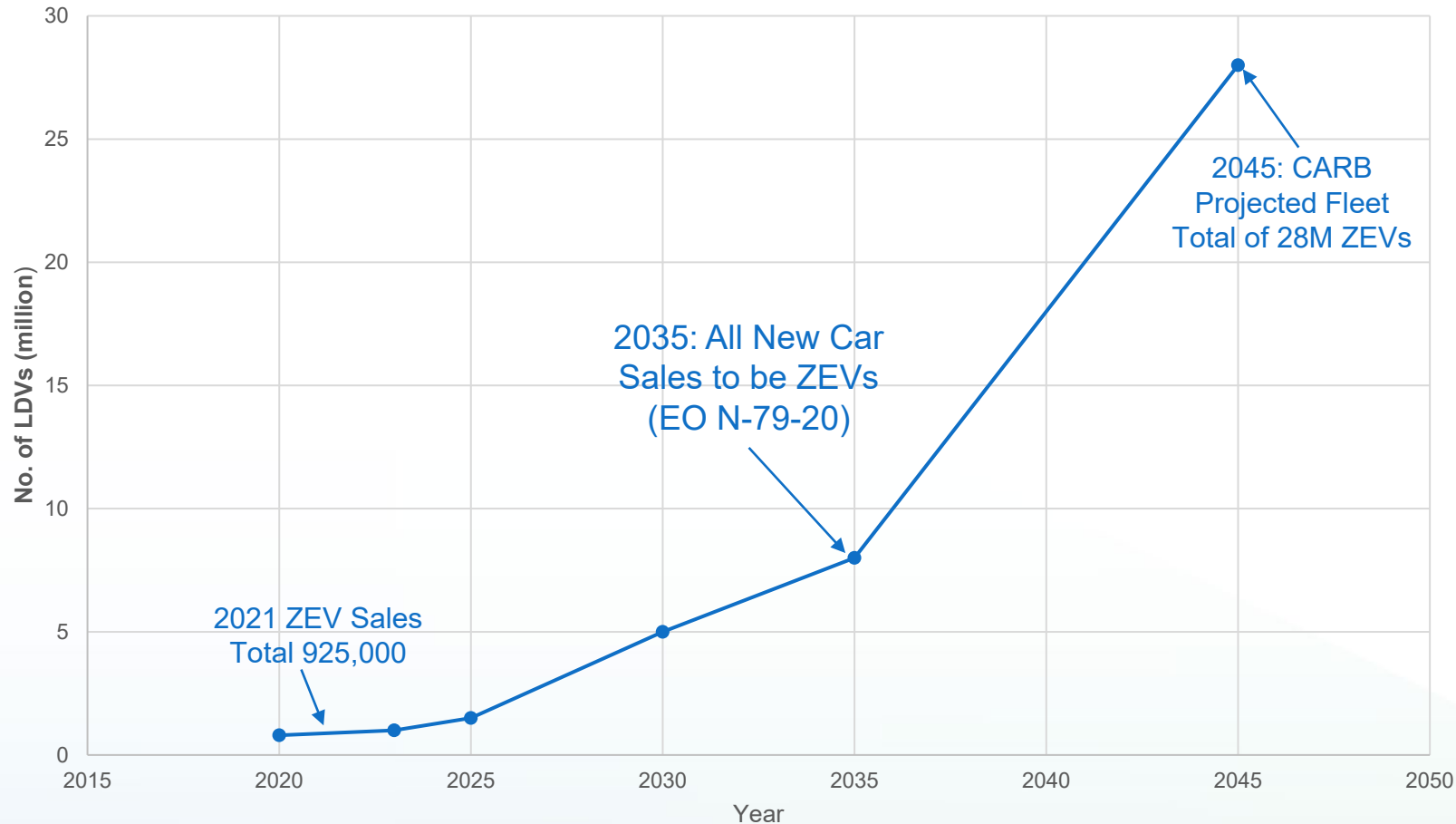
- 2025: 250,000 Chargers (inc. 10,000 DC Fast Chargers)
- 2025: 200 Hydrogen Refueling Stations

Medium- and Heavy-Duty Vehicles

- 2029: **100% of New Transit Bus Purchases are ZEVs** (CARB Regulation)
- 2035: **100% of All Drayage Trucks are ZEVs** (E.O. N-79-20)
- 2045: **100% of All Trucks and Buses are ZEVs** (E.O. N-79-20 and CARB Regulation)



California ZEV Policy Targets and Sales: Light Duty Vehicles 2021-2045



CA Policies Influence National and Global Policies and Markets

- CA ZEV sales account for 44% of Total 2 Million U.S. ZEV Sales
 - Account for 9% of 10 million global ZEV sales
- CA ZEV Policy Targets more aggressive than in Asia and most of Europe
- CA and the 14 Section 177 States account for 30% of all new US car sales
- CA vehicle fleet totals 28 million vehicles
 - 1 million trucks



California Energy Commission Clean Transportation Program

- **Over \$1 Billion Invested to Date**
 - \$192 Million for 15,000 LD Electric Vehicle Chargers
 - \$100 Million for 75 MD-HD Charger Projects
 - \$166 Million for 83 Hydrogen Refueling Projects
 - \$55 Million for 27 ZEV Manufacturing Projects
- **FY 2021-24 Funding of \$1.1 Billion***
 - \$332 Million – LD Charging Infrastructure
 - \$264 Million – MD-HD Charging Infrastructure
 - \$270 Million – Drayage Truck and Charging Infrastructure
 - **\$250 Million in Manufacturing Support Funding**

*Staff-proposed funding allocations in FY 2021-23 Draft Investment Plan. Not approved by Energy Commission.



California Air Resources Board

ZEV Funding

- **\$2 Billion Cumulative ZEV-Related Funding to Date**
 - CVRP Funding for Light Duty Vehicles
 - \$935 million for 410,000 vehicles
 - HVIP Funding for Trucks and Buses
 - \$486 million for 7,000 vehicles
 - FY 2021-22*
 - \$1.5 Billion
 - FY 2022-24*
 - \$2.3 Billion
- ZEV Truck and Bus Funding Targets
- 1,000 Drayage Trucks
 - 1,000 Transit Buses
 - 1,000 School Buses

* Staff-proposed funding allocations. Not approved by full Board.



Clean Transportation Program Manufacturing Grants

- **2021-22 Funding of \$118 Million**
 - Projects to scale up California's manufacturing supply chains for advanced battery materials and technologies are expected to be eligible
 - Pre-Solicitation Workshop to be announced for Q4 2021
 - *Monitor CEC Website Funding Page – energy.ca.gov/funding-opportunities*
- 2022-23 Funding of \$125 Million to be available next fiscal year

Previous Manufacturing Projects with Li-ion Battery Components

- Proterra Electric Bus and Battery Assembly - \$4.8 million
- Zero Motorcycles: Battery Pack Design and Assembly - \$2.8 million
- Quallion Lithium-Ion Cell Assembly Line - \$8.5 million

Strong Commitment to Equity and Diversity in All Grant Solicitations



California Support for Innovations in Battery Technology

Presentation to the Lithium Valley Commission

Anthony Ng – Research and Development Division
California Energy Commission

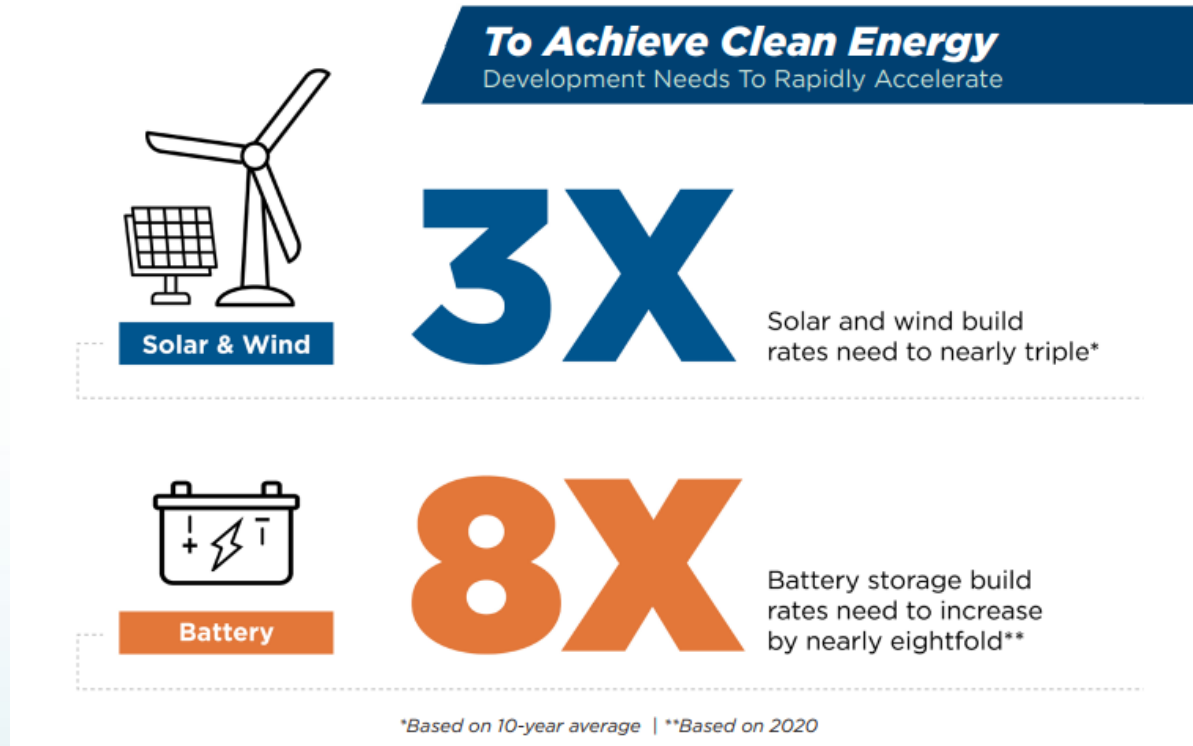
September 30, 2021



Energy Storage Policy

Senate Bill 100

All retail electricity in CA from renewable and zero-carbon sources by 2045





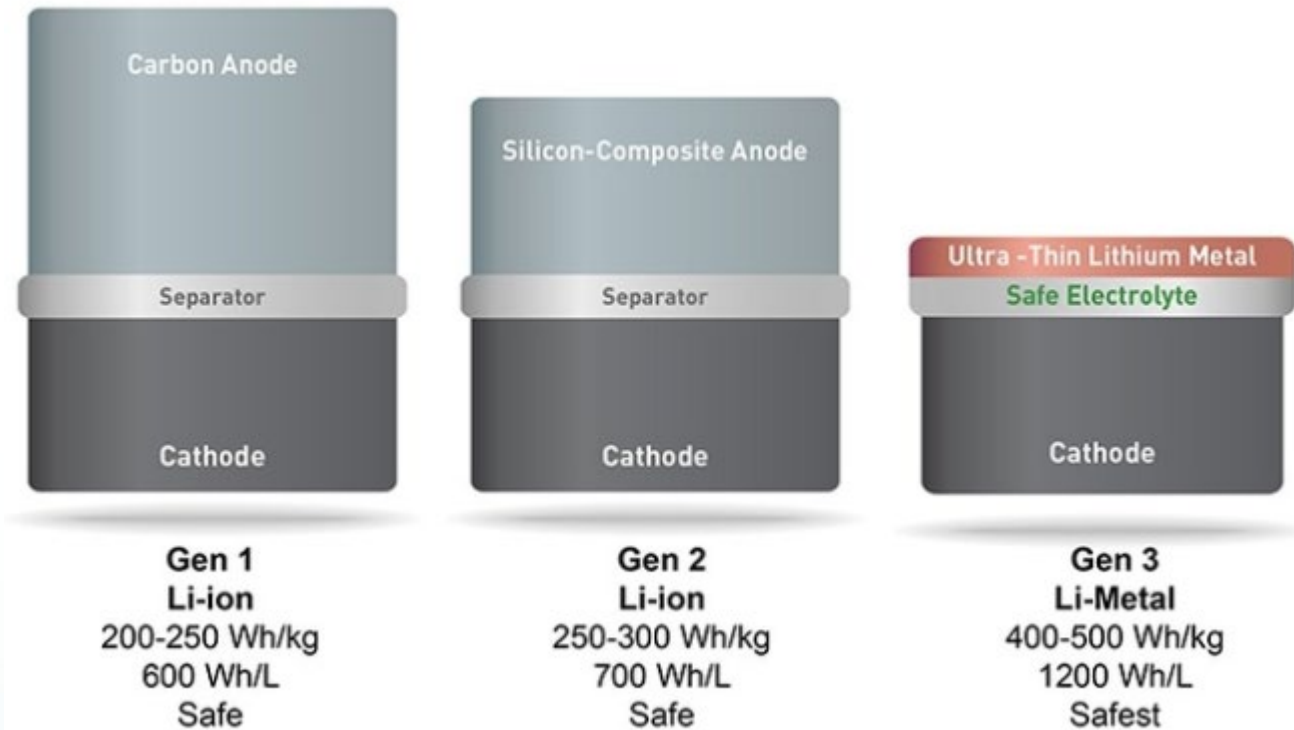
Next Generation Lithium Batteries

Primary Battery Components:

- Anode
- Cathode
- Electrolyte
- Separator

Graphite provides a stable structure to hold lithium during cycling

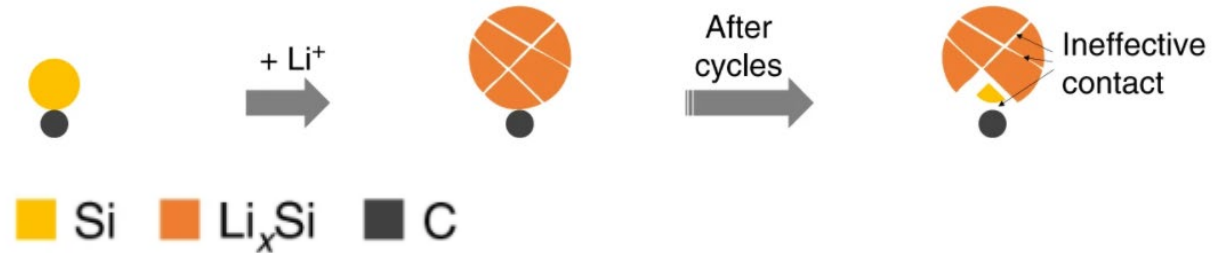
Silicon and Lithium Metal anodes offer the potential for significant increases in capacity and energy density





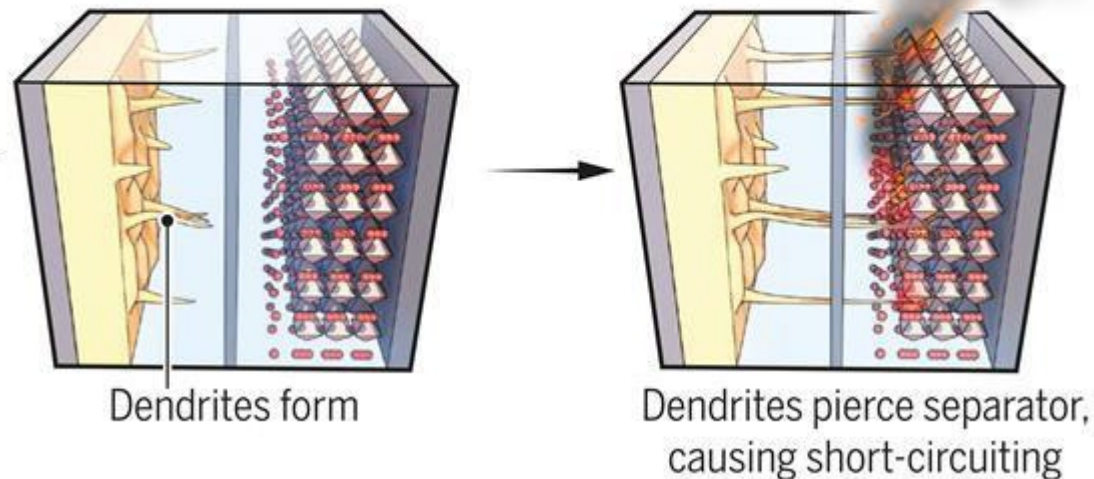
Challenges to Advanced Lithium Batteries

Silicon anodes expand and contract during charge and discharge



Lithium metal anodes form dendrites during charging

Normal charge-discharge cycles



Zhang, X., Wang, D., Qiu, X. et al. Stable high-capacity and high-rate silicon-based lithium battery anodes upon two-dimensional covalent encapsulation. Nat Commun 11, 3826 (2020). <https://doi.org/10.1038/s41467-020-17686-4>

https://www.chemistryworld.com/news/fire-starting-battery-dendrites-go-with-the-flow/3008867_article



CEC Funded Innovations



- Nano-porous membrane separator
- Demonstrated 350 Wh/kg energy density



- Liquified gas electrolyte
- Operating temperature -80 to +60 C



- Nonflammable liquid electrolyte
- DOE verified 369 Wh/kg



- Solid electrolyte for silicon anode
- Demonstrated 500 cycles to 80% capacity



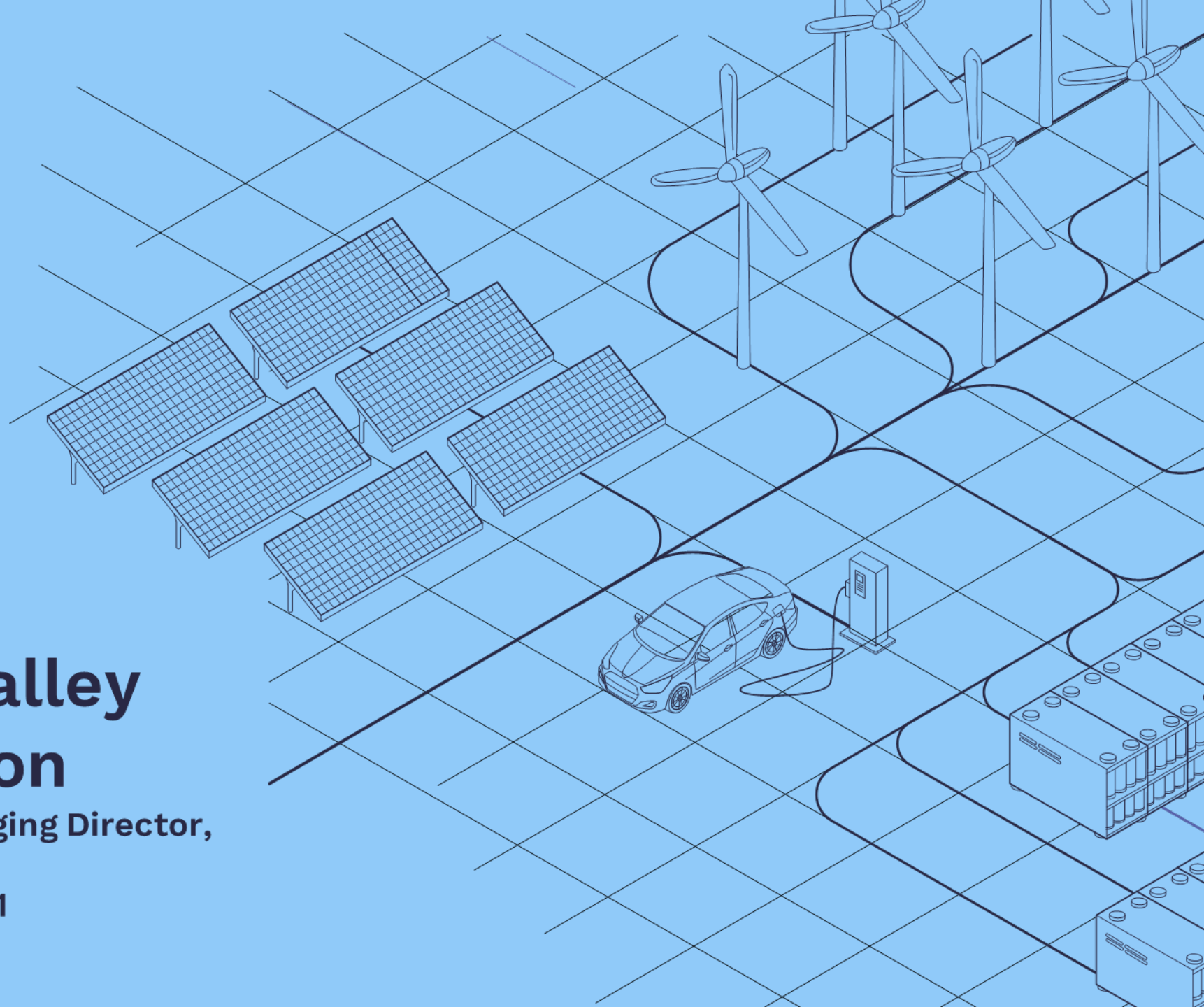
Lithium Market Overview / Resumen del mercado de litio

- Adam Panayi, Rho Motion
- Cameron Perks, Benchmark Mineral Intelligence
- Adam Panayi - Rho Motion
- Cameron Perks – Benchmark Mineral Intelligence

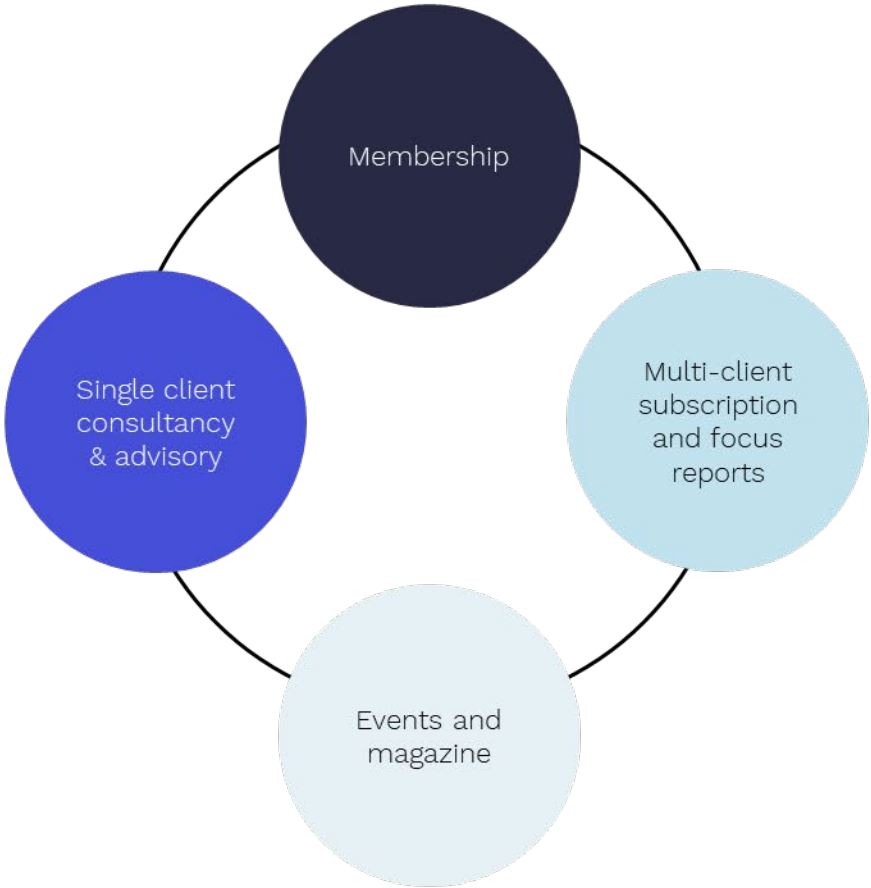
rho
motion

Lithium Valley Commission

Adam Panayi, Managing Director,
Rho Motion
30th September 2021



About Rho Motion



Adam Panayi,
Managing Director



Charles Lester, Senior
Research Analyst



Iola Hughes, Senior
Research Analyst



William Roberts,
Research Analyst



Mina Ha,
Research Analyst



Yu (Frank) Du,
Research Analyst



Terry Scarrott,
Principal Consultant



Crispin McCutcheon,
Business Development
Manager



Fred Keeling,
Business
Development
Executive



Alicia Bennett,
Marketing &
Membership
Manager



Louis Spice,
Marketing Executive



Josephine Kirwan,
Administration and
Accounts

Our suite of regular reports and data provide detail and context with long-term outlooks



Monthly Assessments & Databases

Quarterly Outlooks

Focus Reports

Monthly Electric Vehicle Battery Chemistry Assessment April 2020

Monthly EV Charging Assessment December 2020

Monthly Battery Energy Stationary Storage Assessment

Global Monthly PC & LOV EV Sales by Max Charging Capability

Project Spotlights this Month

- Project Spotlight 1: California Flats Electricity Storage**
- Project Spotlight 2: Hickory Park Solar Energy Storage US**

EV & Battery Quarterly Outlook

Global EV Charging Outlook

Battery Energy Stationary Storage Quarterly Outlook

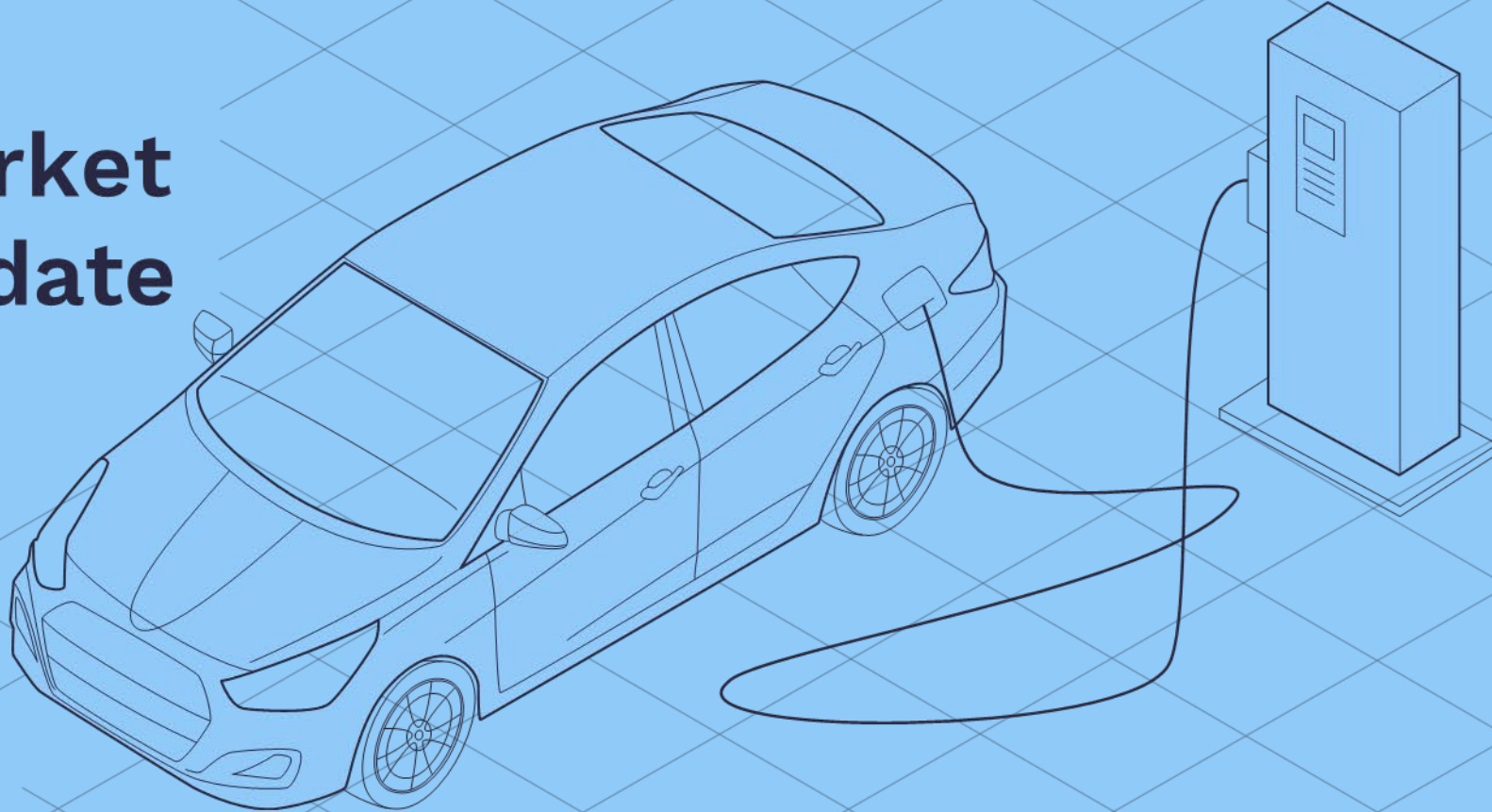
Electric 2 & 3 Wheeler

E-Micromobility Outlook

Fuel Cell Electric Vehicle Outlook 2020

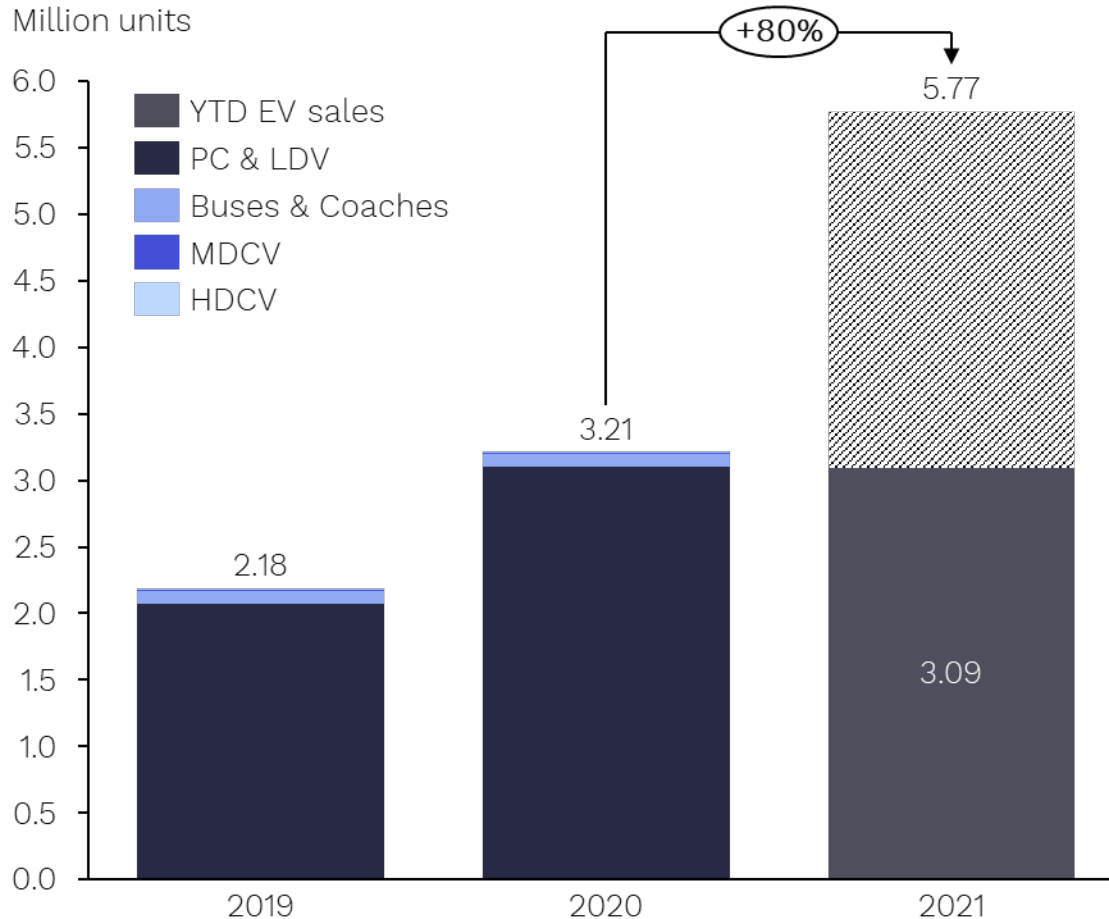
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EV Market Update

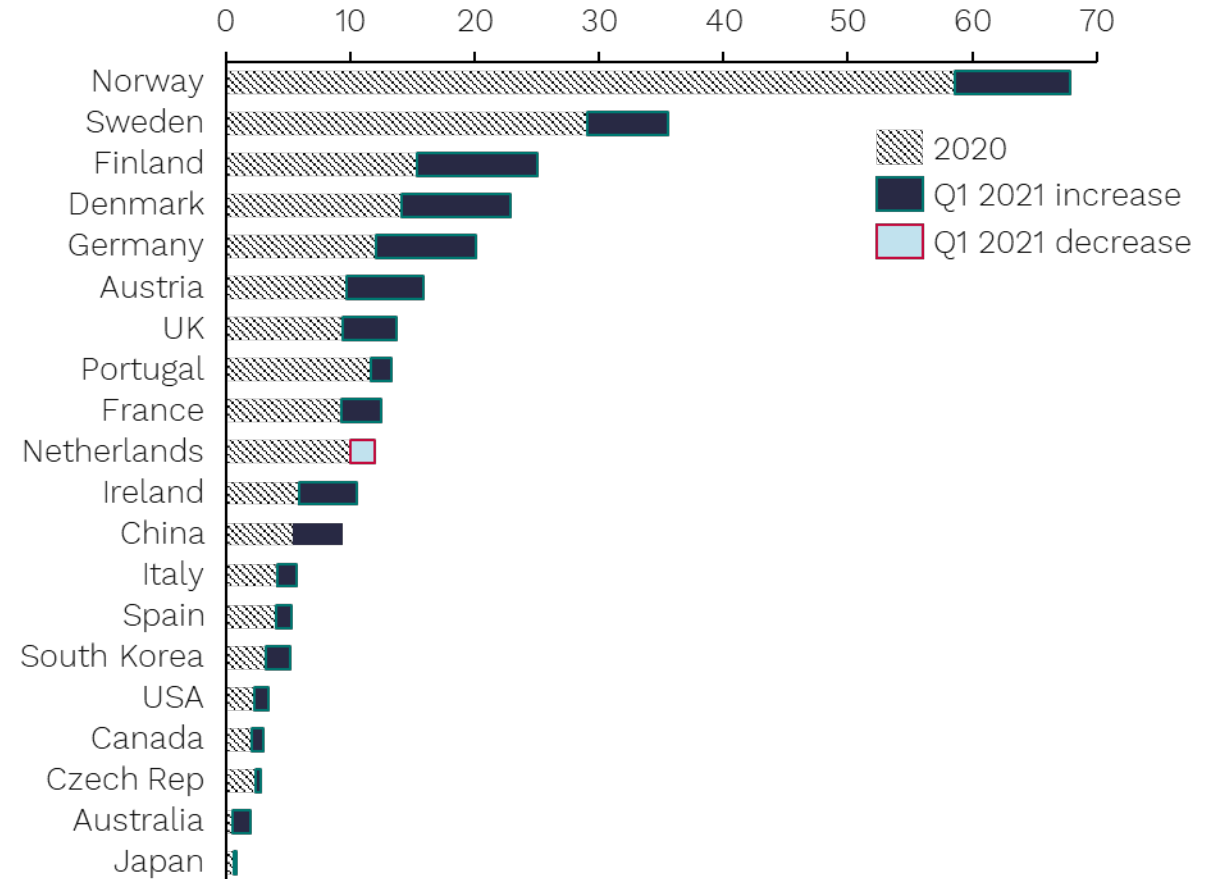


EV sales are up 150% YoY for the year to July as penetration rates rise in a recovering vehicle market

EV sales outlook by vehicle class



EV penetration rates, %, 2020 vs H1 2021

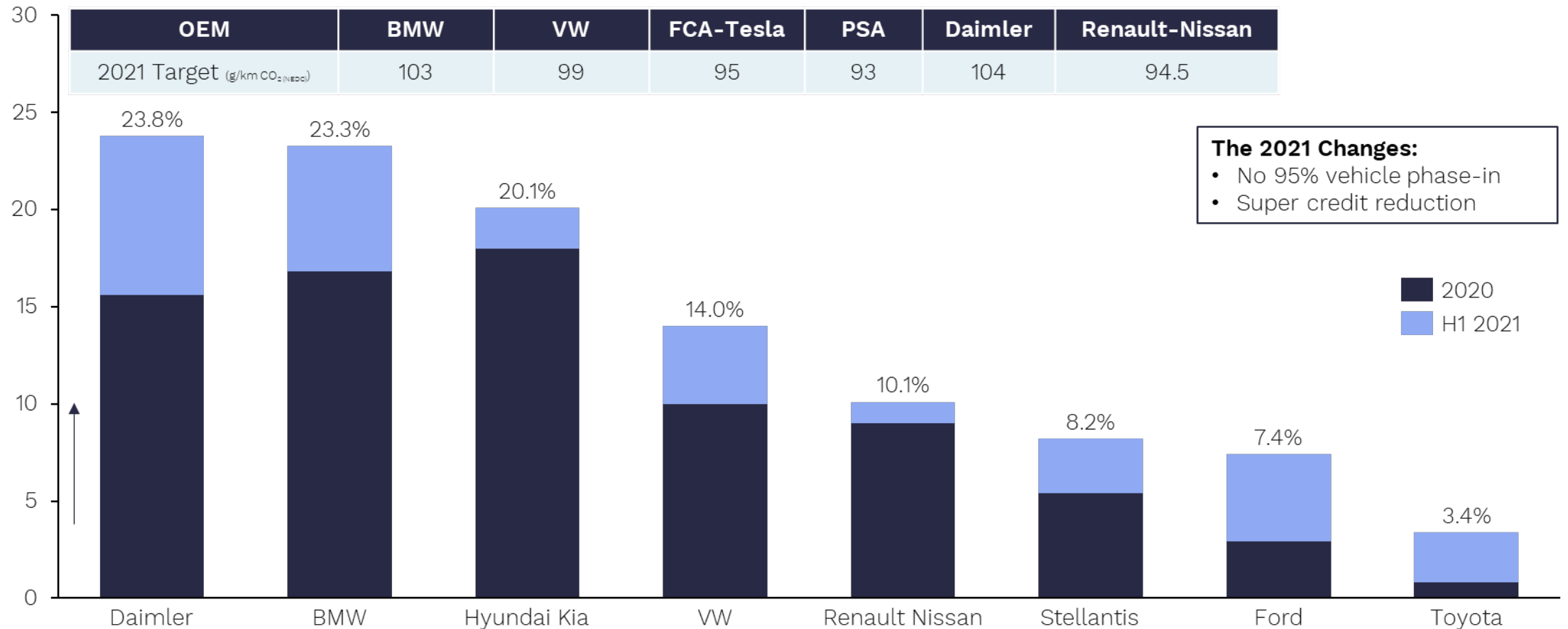


European OEMs are pushing hard to meet their 95gm per km target



EU & EFTA & UK PC & LDV OEM BEV & PHEV Penetration Rate H1 2021 vs 2020

% penetration rate



US plans are shaping up, with sales expected to rise sharply next year



US EV legislation update



American Jobs Infrastructure Plan

- Passed the senate and awaits house vote.
- What remained:
 - \$7.5 billion to aid the construction of 500,000 EV charging points
 - \$7.5 billion for the purchase of new electric school buses
 - \$6 billion for battery material processing manufacturing and recycling



Purchase incentives

- \$3.5 trillion budget framework bill – committees to write reconciliation legislation this month.
- EVs fall under a number of committees and may receive strong support.
- Clean Energy For America act has passed the senate finance committee on a party-lines vote, awaiting full senate vote.



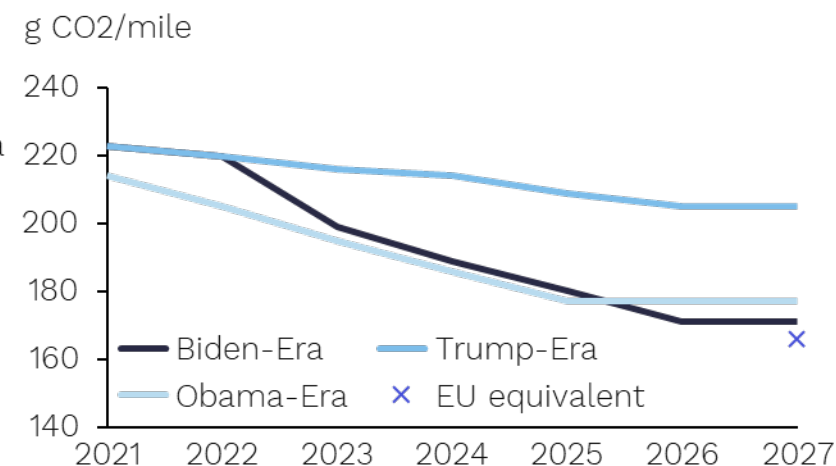
Emission Legislation

- EPA proposal would be the most stringent emission targets yet in the USA.
- Programme flexibilities leave some room to manoeuvre.

EV adoption target: 50% by 2030

- In early August President Biden signed an executive order targeting a 50% electric vehicle share in 2030.
- Stellantis, Ford and GM that are targeting 40-50% of sales to be electric by 2030.
- OEMs target aims to enable more support for EV adoption from the administration.
- Less aggressive than many European targets, both from a National and OEM perspective.

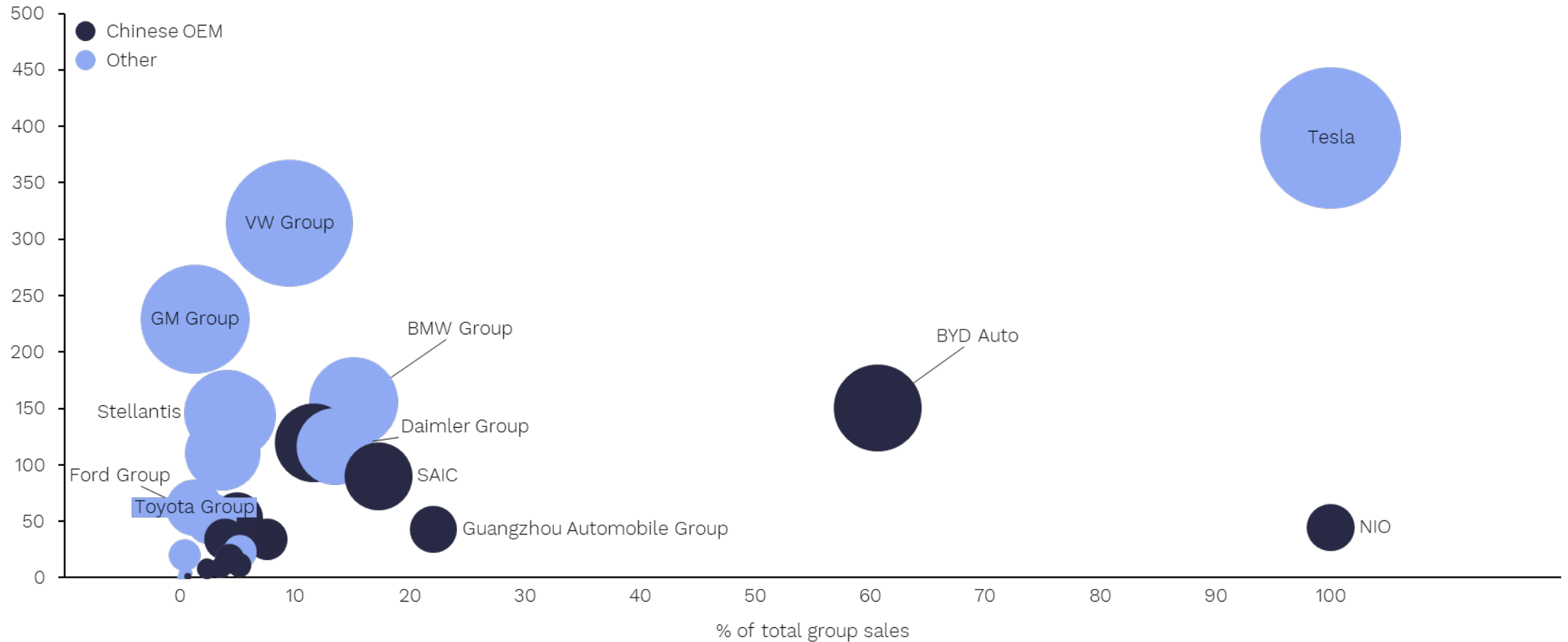
EPA emission projections comparison for combined fleet (50% Car, 50% Truck)



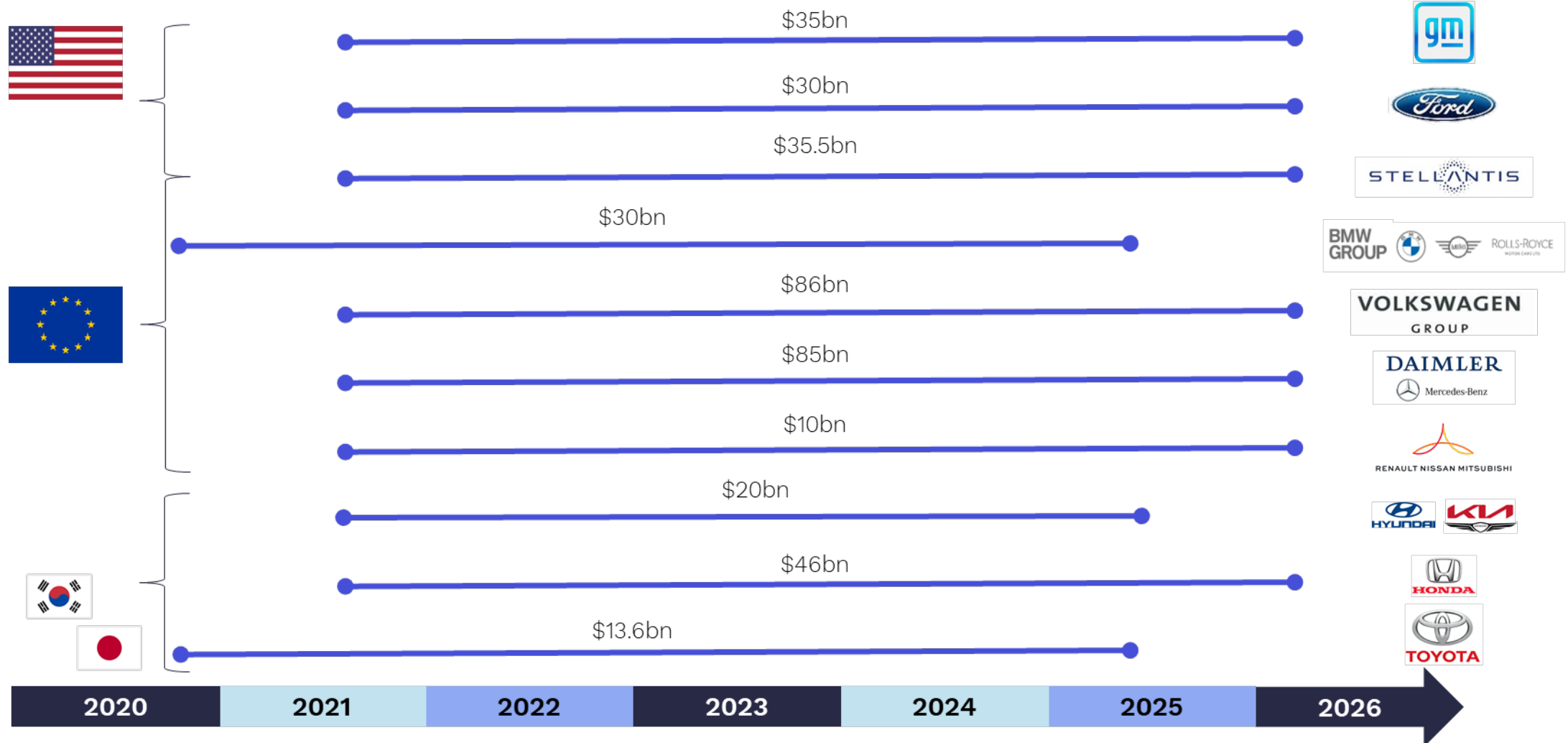
Western OEMs have hastened their move to electrification and are catching up to the Chinese

BEV & PHEV Sales by OEM, and % of total sales, H1 2021

'000 BEV/PHEV Sales

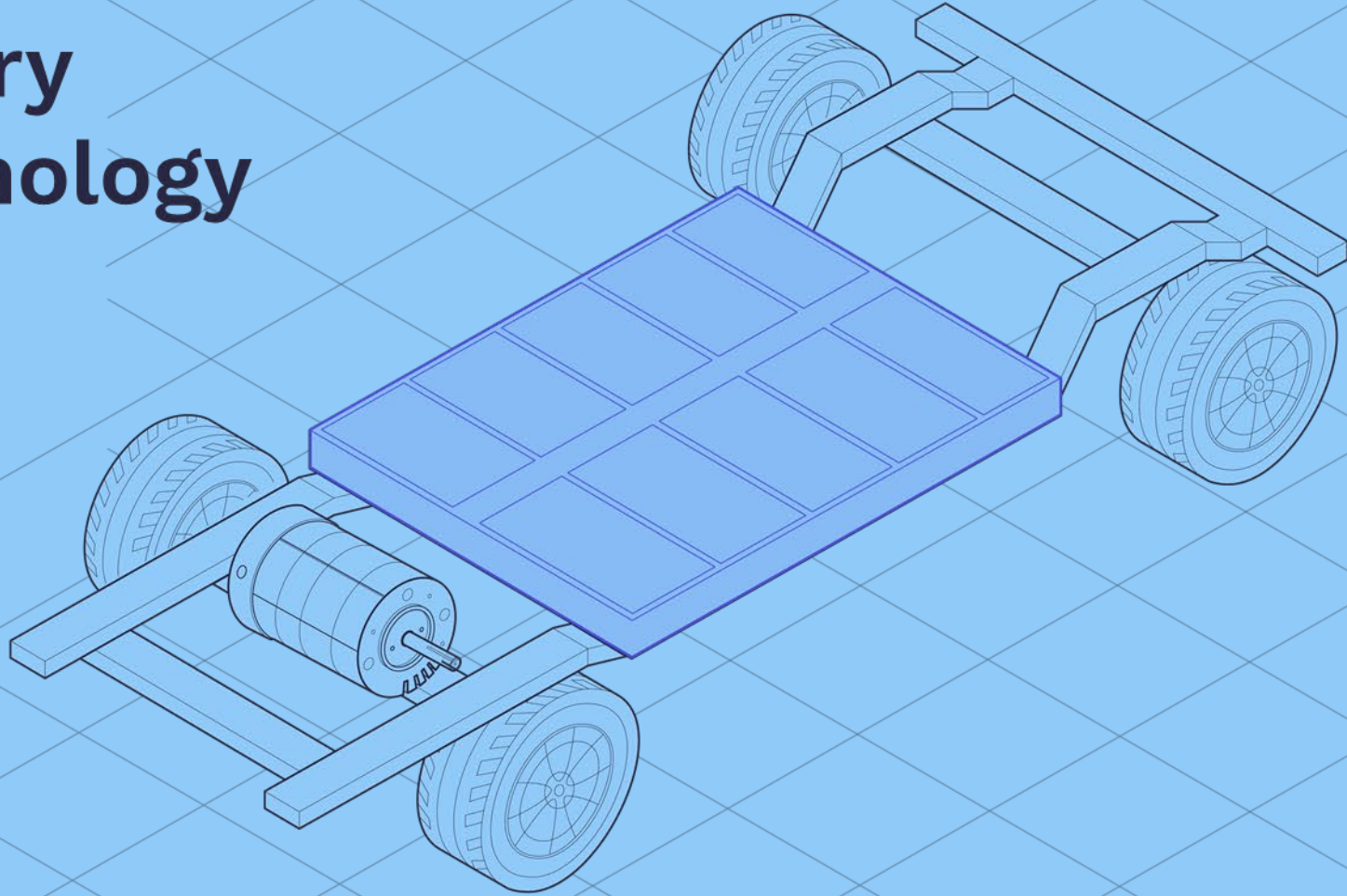


Electrification investments underline the scale of the commitment and challenge for OEMs



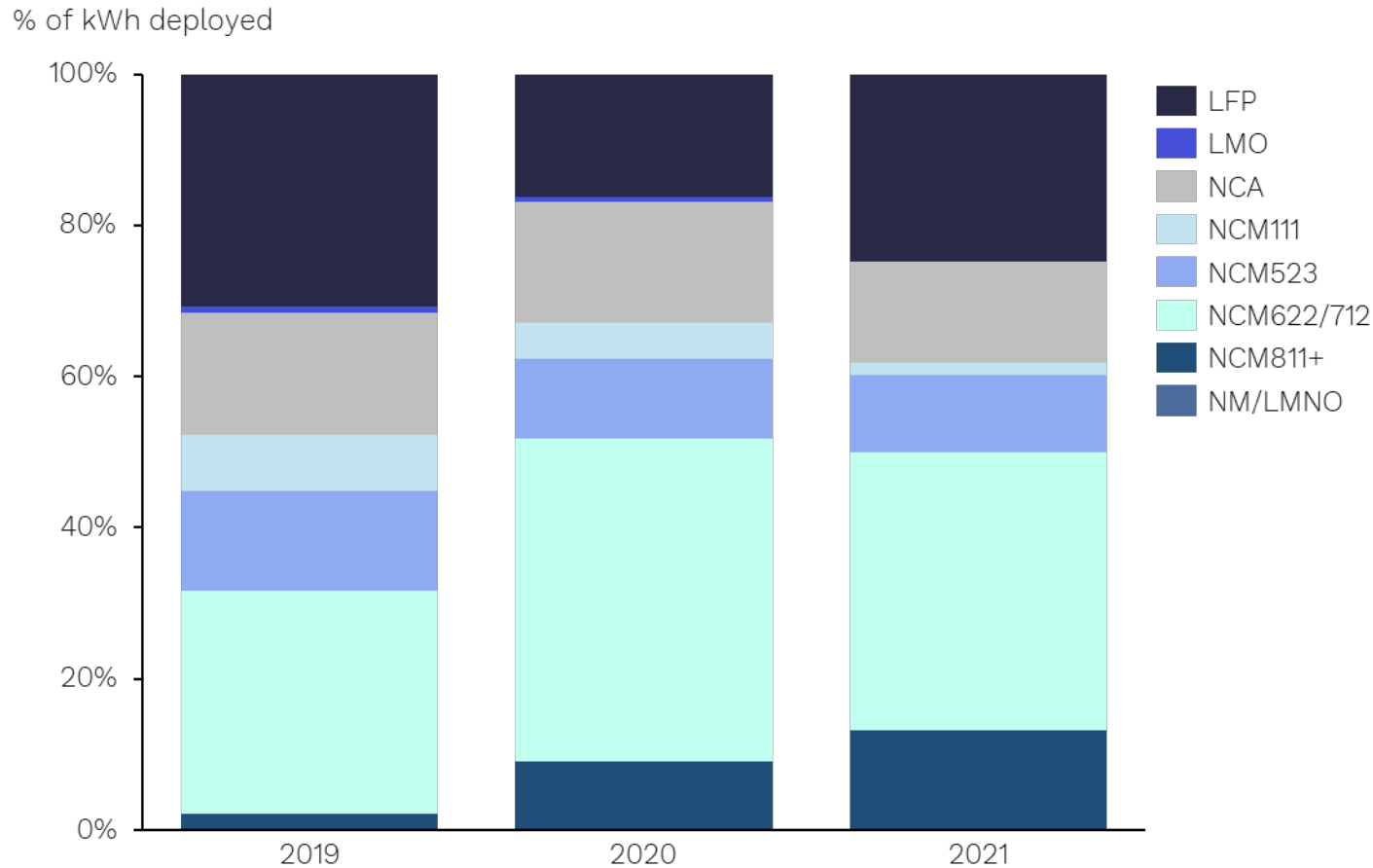
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Battery Technology

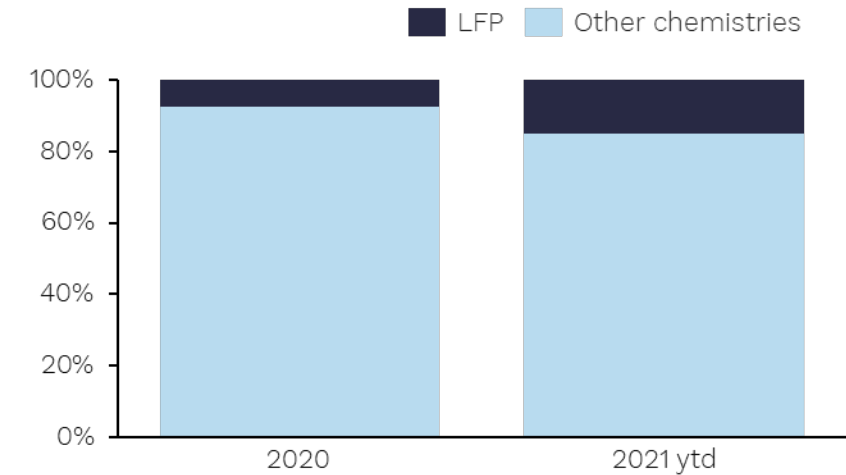


LFP share rises in PC & LDV in China, and multiple technologies are becoming available to OEMs

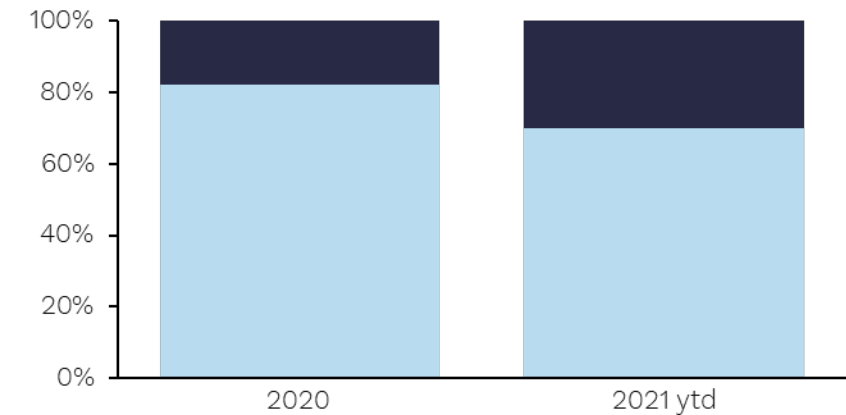
EV battery demand outlook by battery cathode chemistry (all vehicle classes)



Global PC & LDV chemistry share, kWh

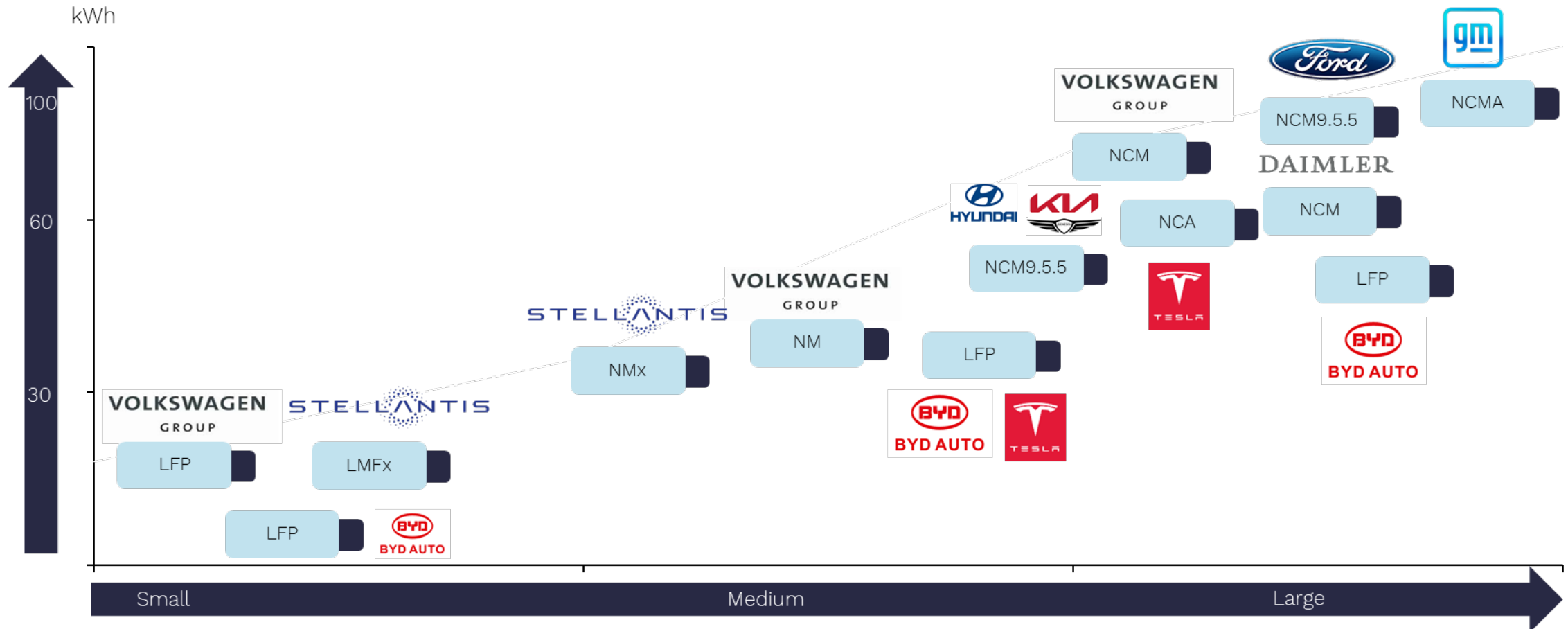


China PC & LDV chemistry share, kWh



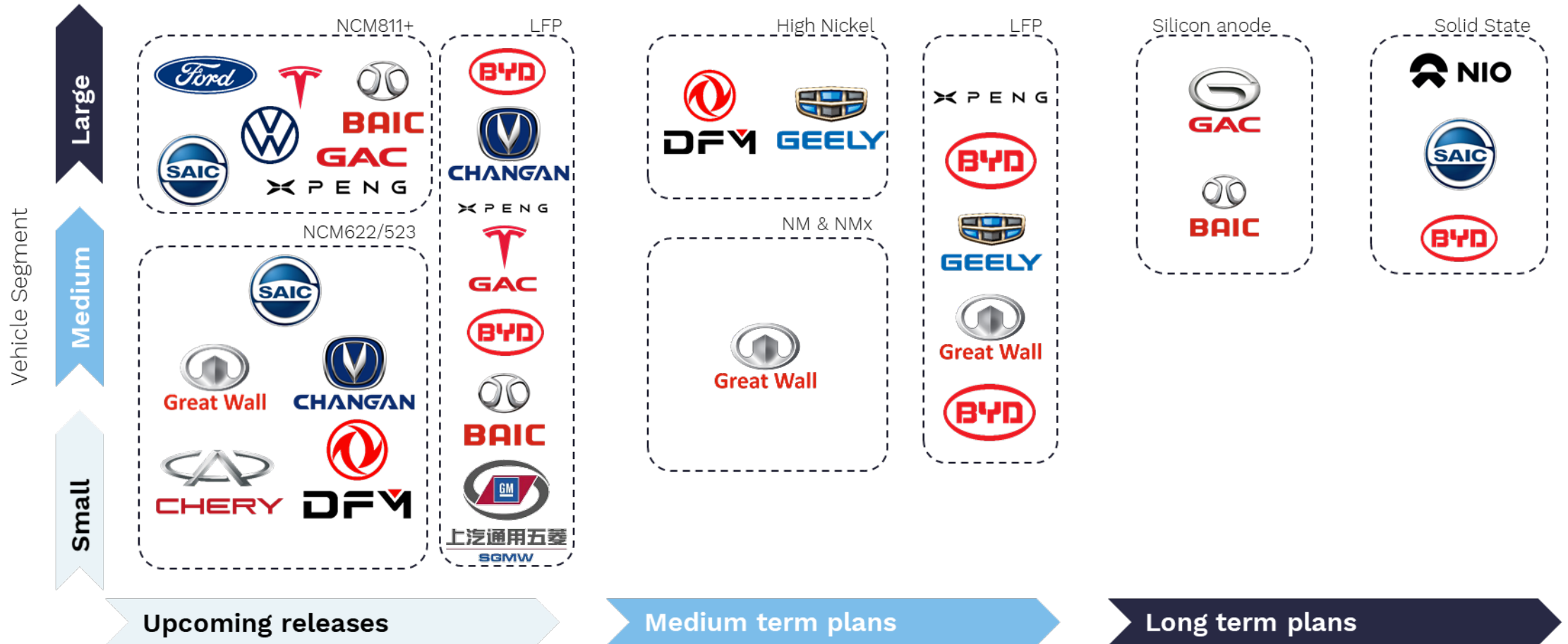
Chemistry choices are a function of use case and geography

OEM Battery Strategy By Segment



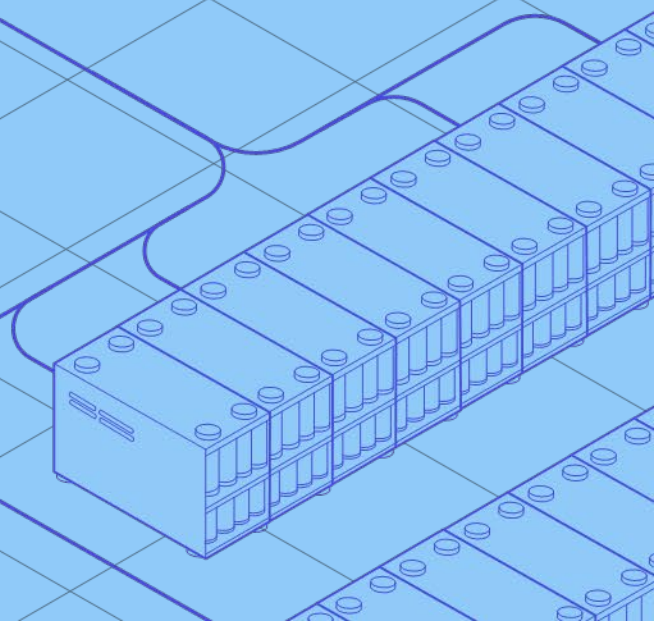
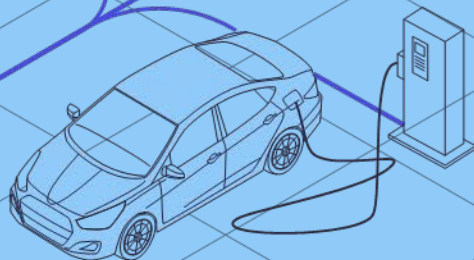
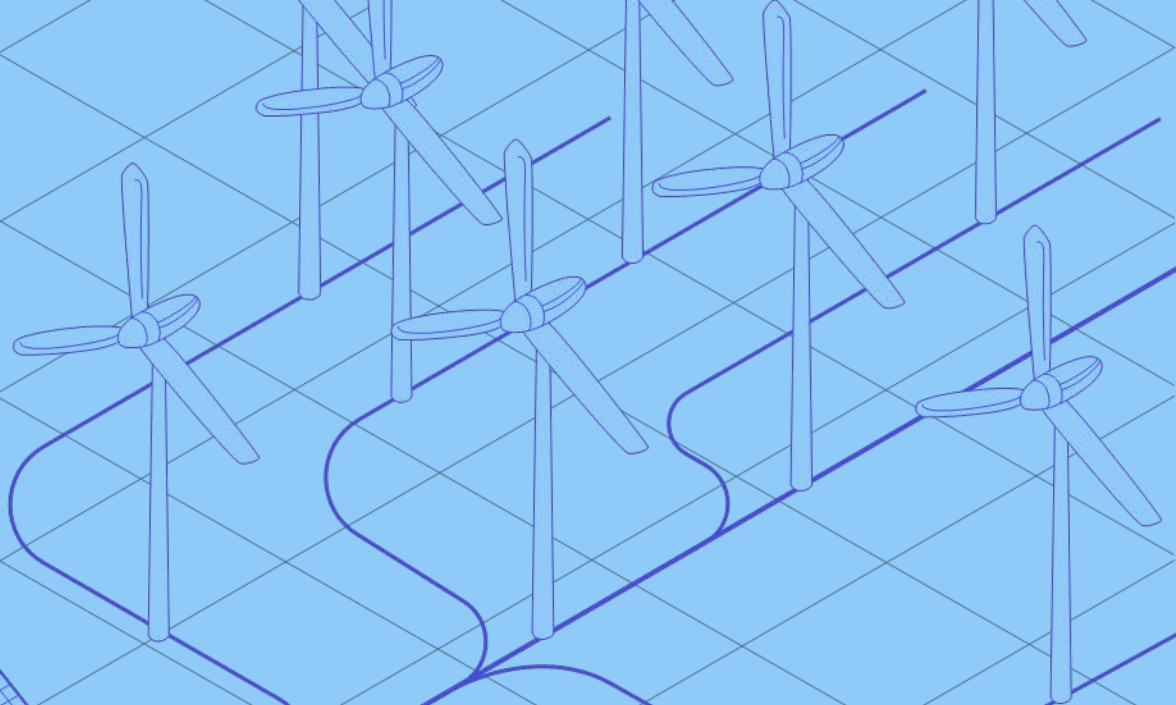
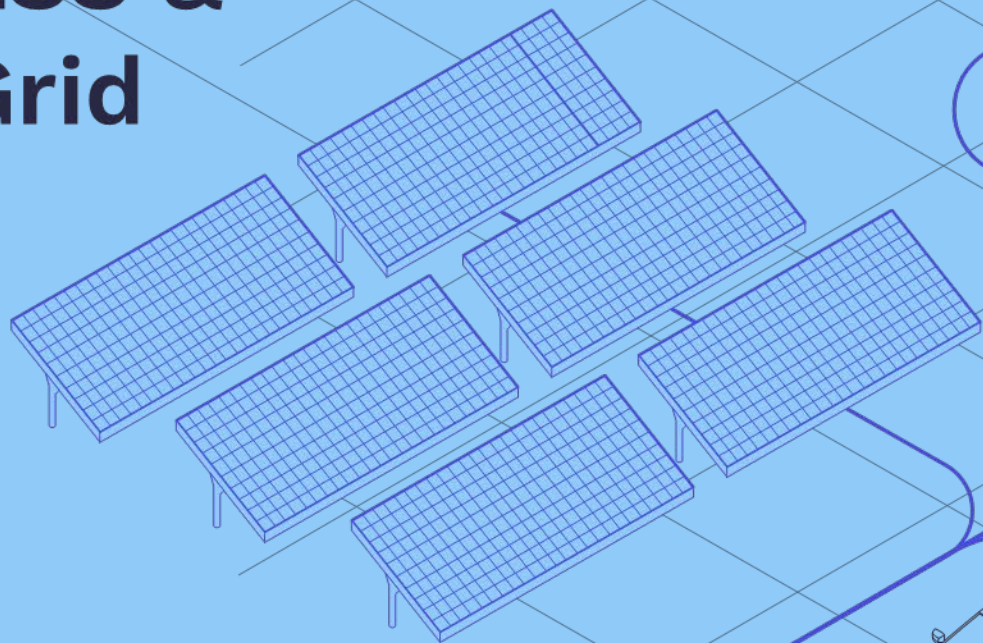
Where China leads, the rest of the world follows, which means a more varied battery outlook

OEM chemistry roadmap: China

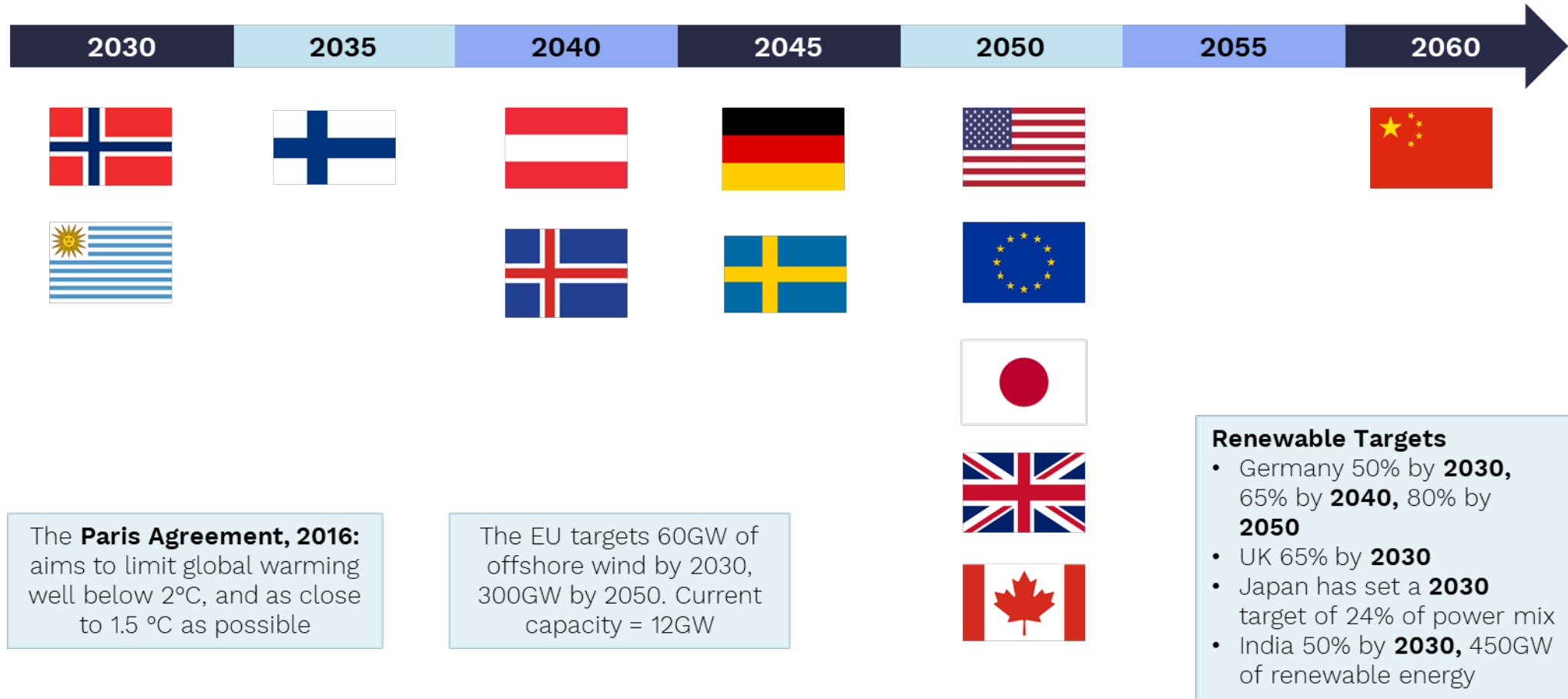


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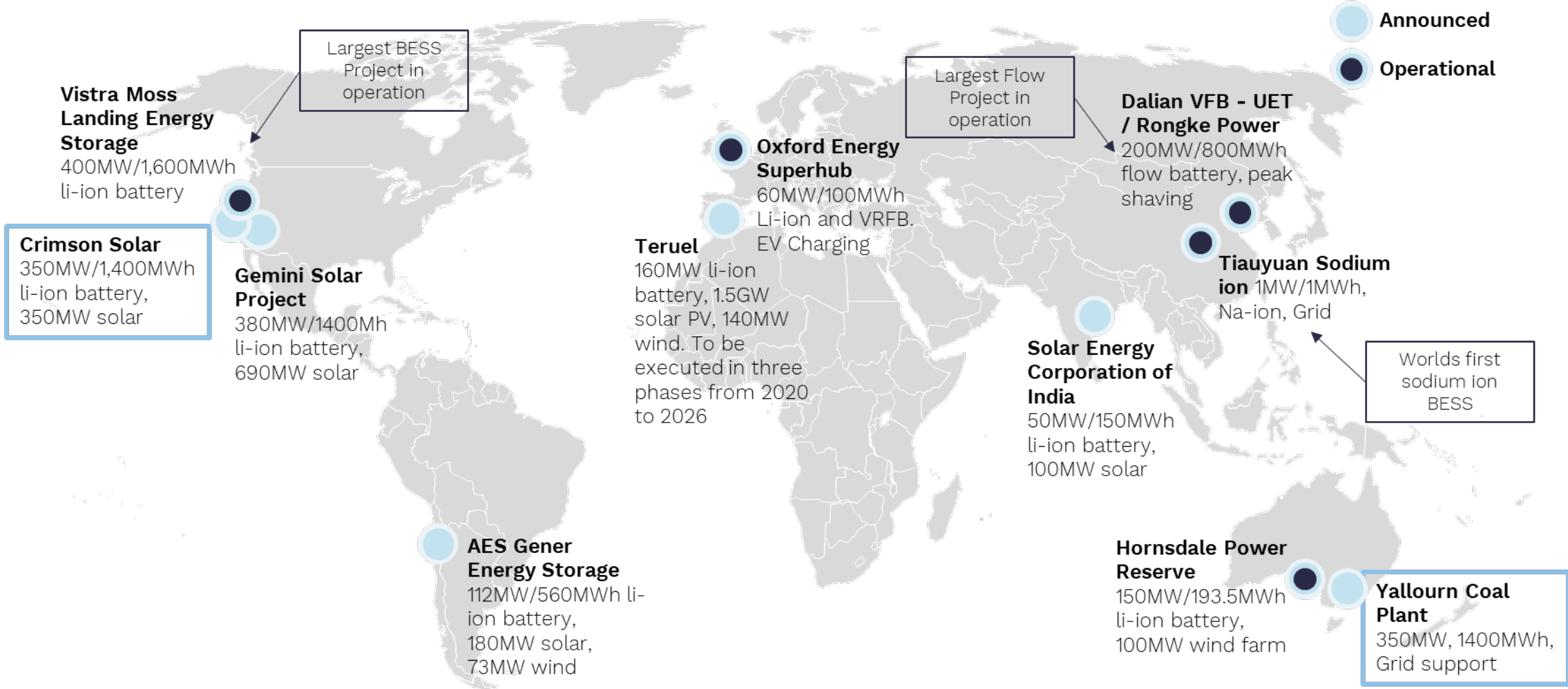
ESS & Grid



Net zero & renewable targets drives the ESS market



Large scale grid projects are increasingly being added to the market



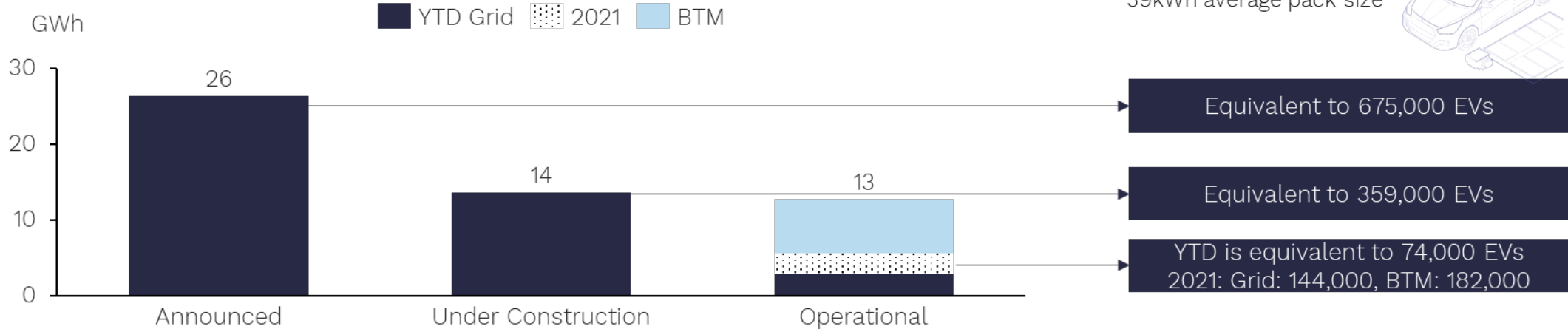
ESS Battery demand relative to the EV market

~10% by 2030

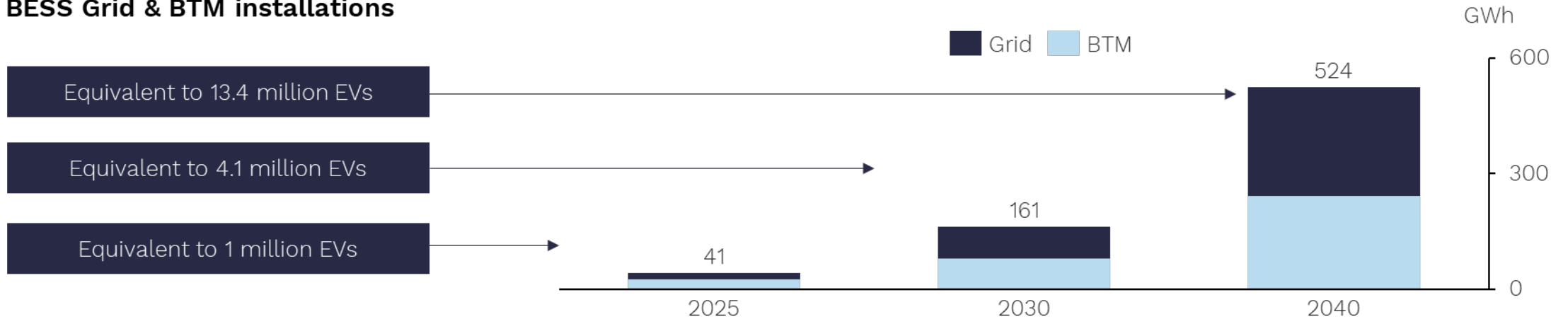


2021 YTD BESS Grid

*Calculations based on 39kWh average pack size



BESS Grid & BTM installations



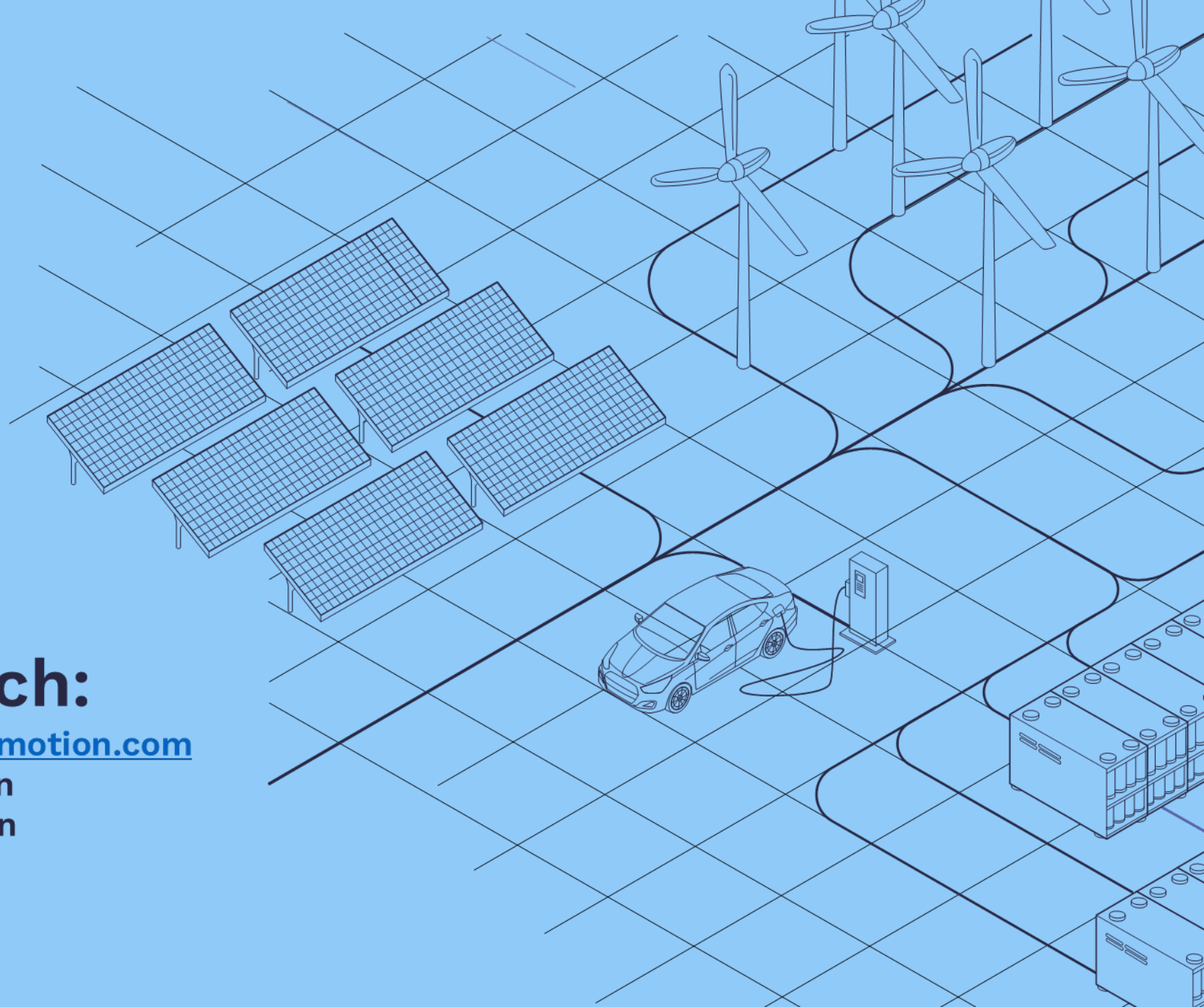
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Get in touch:

Email: apanayi@rhomotion.com

Twitter: @rhomotion

Linkedin: Rho Motion



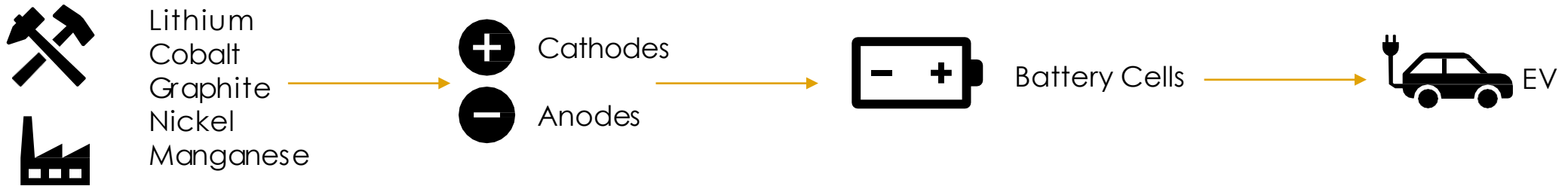


Lithium Market Overview

Cameron Perks, Senior Analyst, Benchmark Mineral Intelligence
cperks@benchmarkminerals.com; @CPBMI

Lithium Valley Commission 2021
30 September 2021

Benchmark's Market Coverage



Price assessments & market data

Lithium, cobalt, graphite, nickel, cathode, anode, battery cells

Forecasts

Lithium, cobalt, graphite, nickel, manganese, anode, cathode, battery cells, EV/ESS

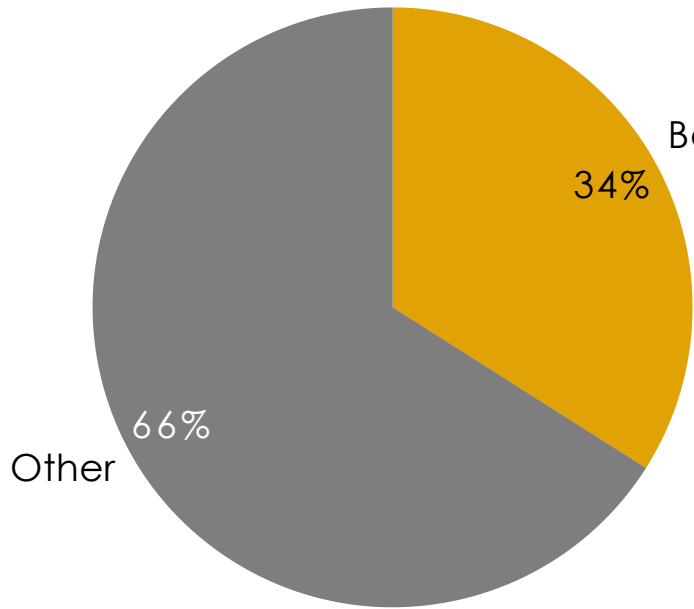
Consultancy and advisory

Supply chain studies, strategy and advisory, markets

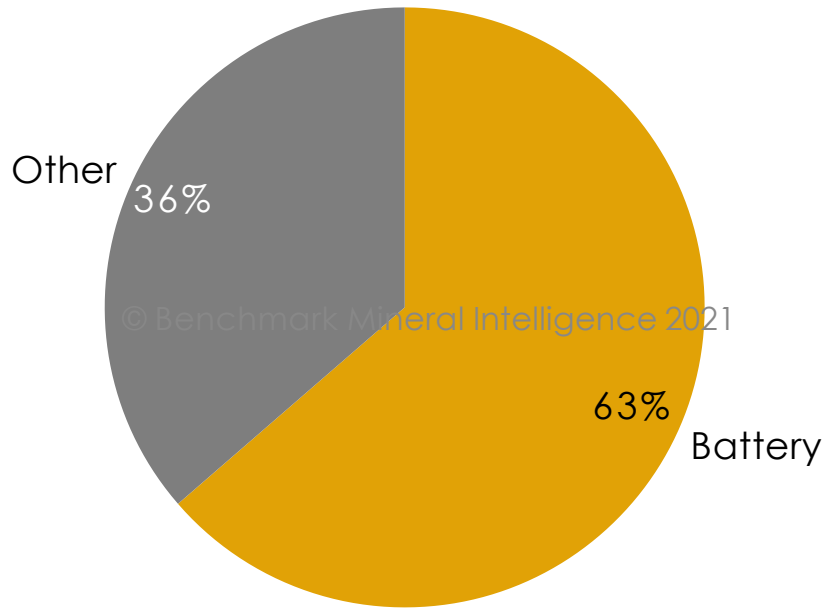
Events

EV supply chain, World Tour, cathodes, anodes, battery megafactories, online events

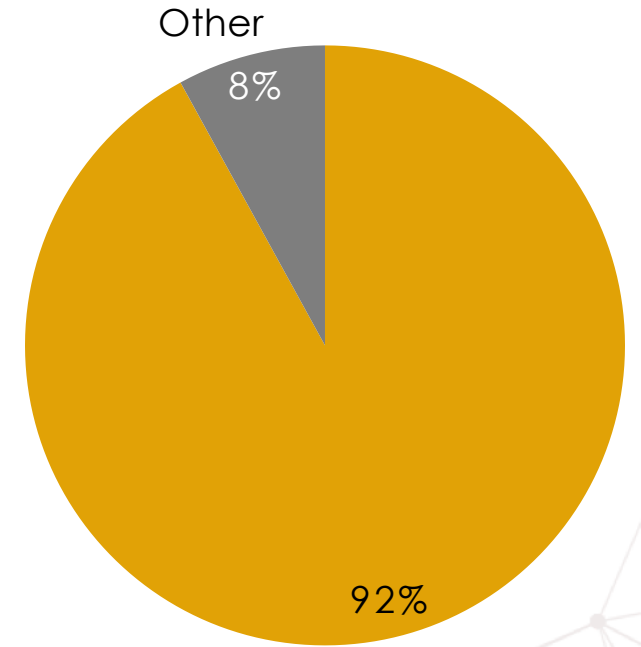
Li-ion now dictates the lithium industry



Demand for lithium in 2015



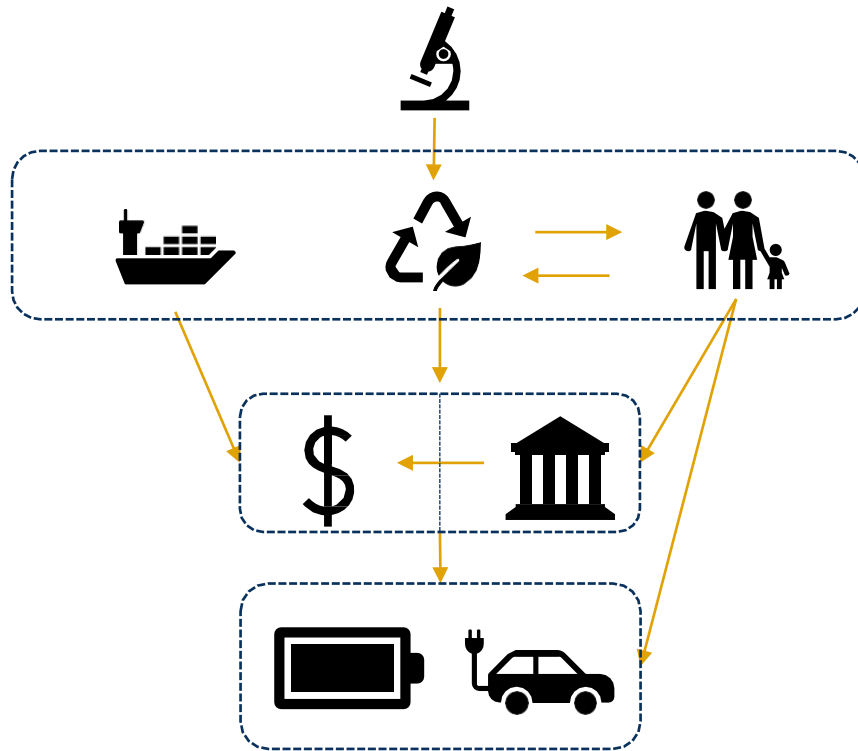
Demand for lithium in 2020



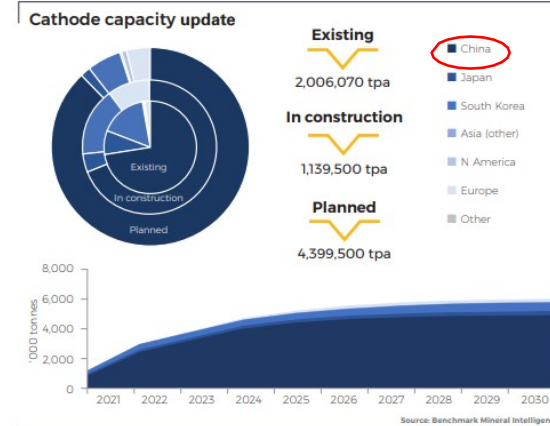
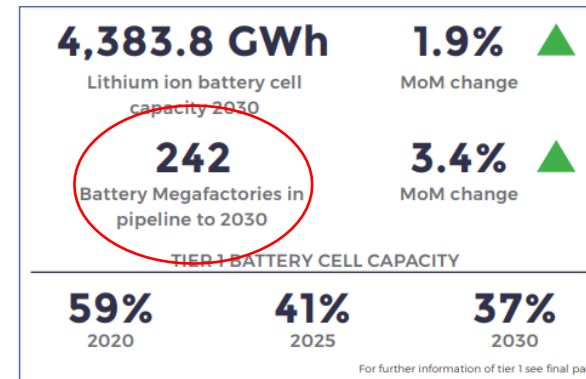
Demand for lithium in 2030(f)

EV battery demand represents the convergence of industry and policy

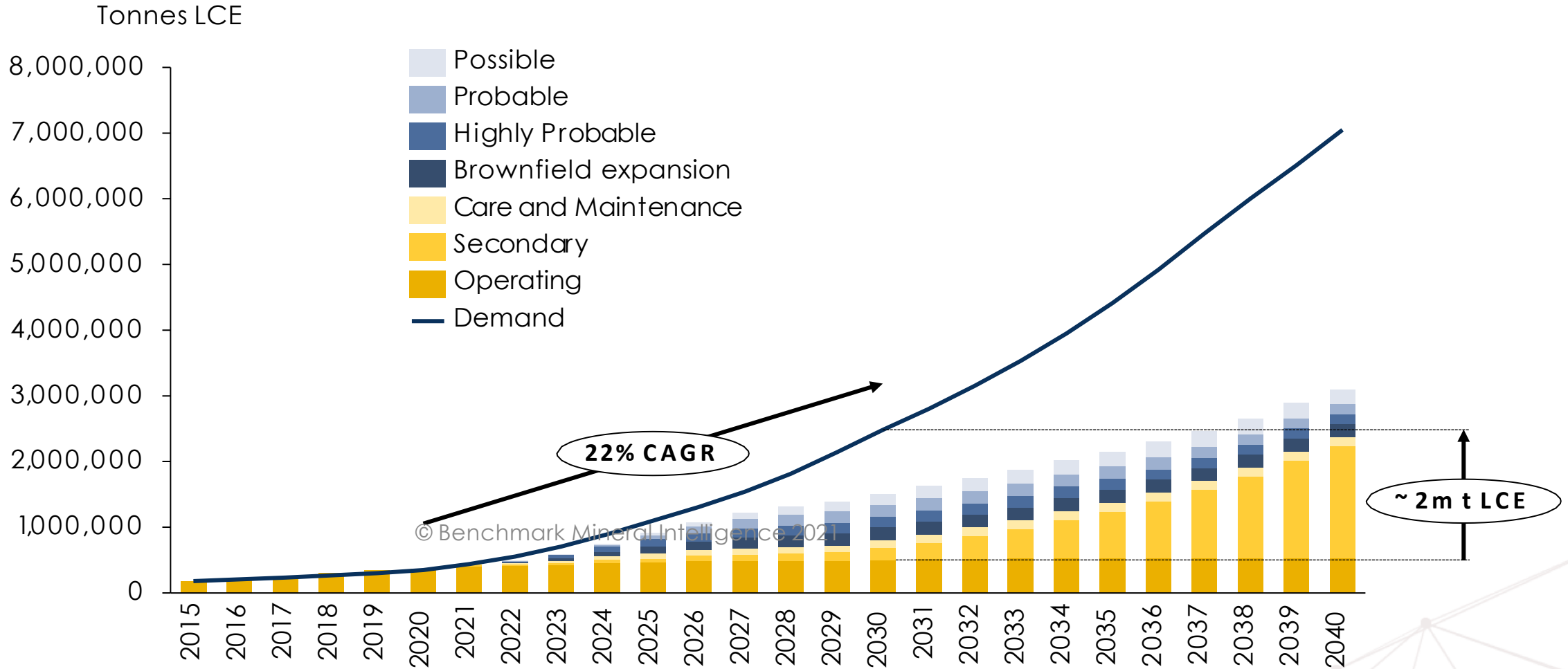
Influencing factors behind the lithium ion economy



The resulting demand



Lithium and the great raw material disconnect

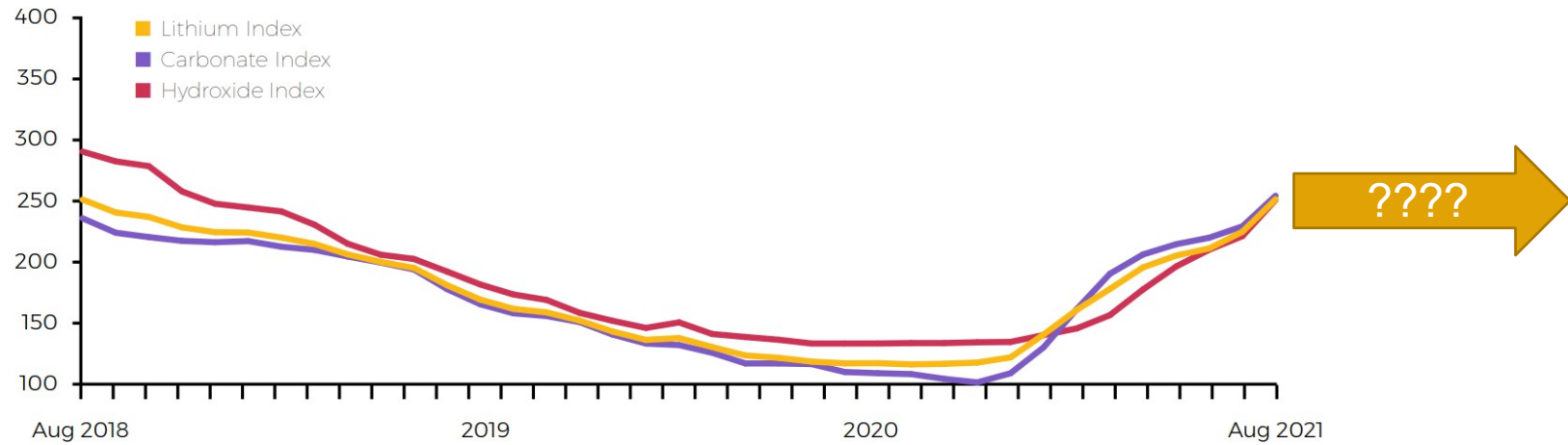


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What does it mean today?

Benchmark Lithium Price Index



Source: Benchmark Mineral Intelligence

	1M	Y-O-Y	YTD	TODAY	LAST
LITHIUM INDEX	11.9%	115.7%	107.3%	251.8	225.0
CARBONATE INDEX	11.0%	134.8%	135.0%	254.8	229.5
HYDROXIDE INDEX	13.5%	89.0%	87.3%	251.4	221.5

Where is it going to come from?

Nickel

Australia	China
Indonesia	?
Sulfide ore	Laterites
Ni Matte	HPAL
Ni Chemical	Ni Metal

Cobalt

DRC	?
© Benchmark Mineral Intelligence 2021	
Primary-Co	Ni-Co
Cu-Co	
Concentrate	Intermediate

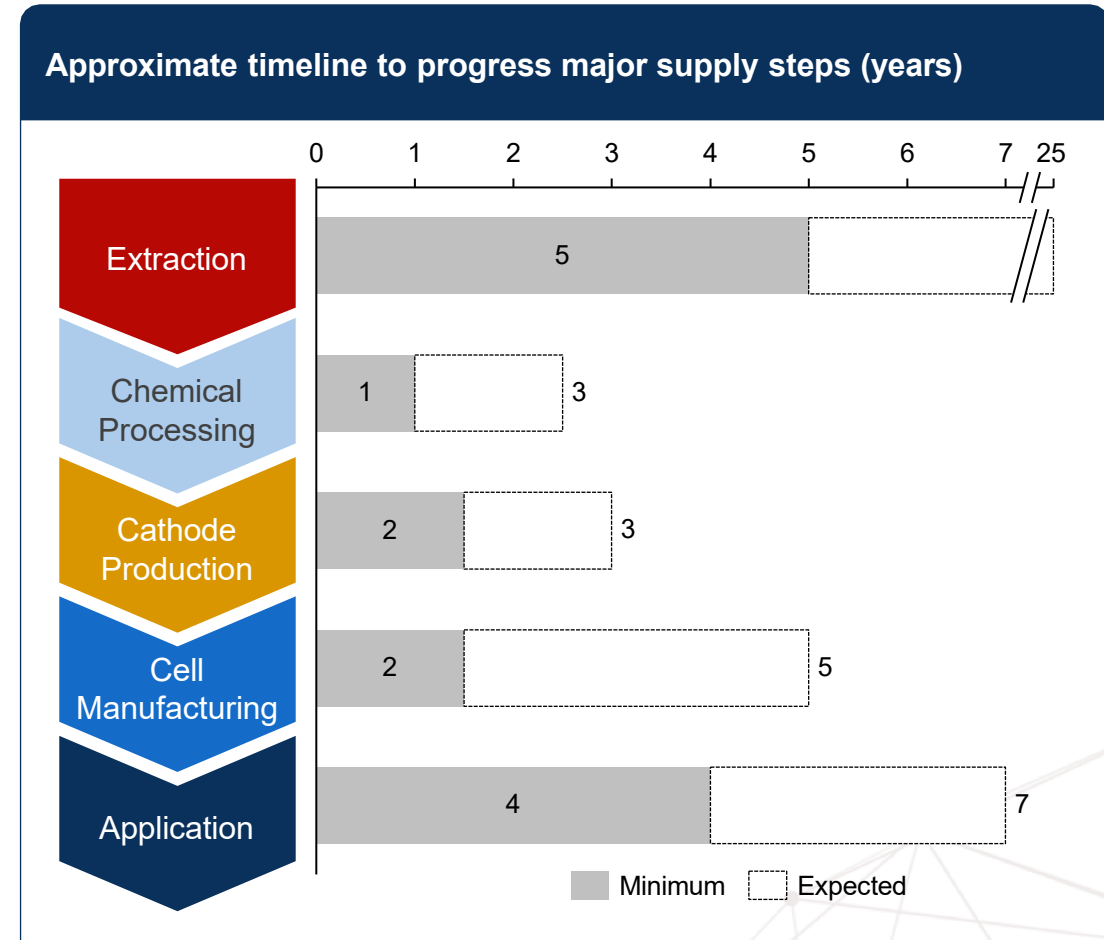
Lithium

Australia	S America
China	N America?
Brine	Spodumene
Clay	Geothermal
Mica	Jadarite
Carbonate	Hydroxide

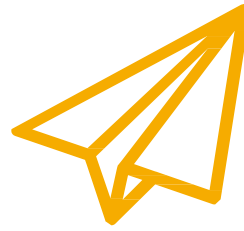
Cost essential, but supply chain security and ESG must also be considered

Battery raw material realities

- Scaling the supply chain in quality and quantity is THE challenge
- The slowest link in the chain is starved of investment (see graphic to right)
- The EV Revolution will happen but it will be slower than expected pre-2027
- No geological shortage of any key input
- Future battery tech to be lithium based
- The lithium ion battery is now geopolitical
 - China's aggressive expansion
 - American job plans
 - Biden's local supply chain commitment
- Future supply will need to consider other ESG factors:
 - Emissions, water impact, etc.
 - Social impacts



Benchmark's Market Coverage

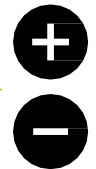


Thank you!

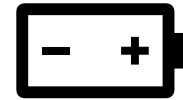
cperks@benchmarkminerals.com



Lithium
Cobalt
Graphite
Nickel
Manganese



Cathodes
Anodes



Battery Cells



EV

Price assessments & market data

Lithium, cobalt, graphite, nickel, cathode, anode, battery cells

Forecasts

Lithium, cobalt, graphite, nickel, manganese, anode, cathode, battery cells, EV/ESS

Consultancy and advisory

Supply chain studies, strategy and advisory, markets

Events

EV supply chain, World Tour, cathodes, anodes, battery megafactories, online events



Lithium Valley Commissioner Q&A / Preguntas y respuestas con la Comisión de Lithium Valley

- Presenters:

- Jim McKinney – Fuels and Transport Division
- Anthony Ng – Energy Research and Development Division
- Adam Panayi – Rho Motion
- Cameron Perks – Benchmark Mineral Intelligence

- Presentadores:

- Jim McKinney – División de combustibles y transporte
- Anthony Ng – División de investigación y desarrollo
- Adam Panayi - Rho Motion
- Cameron Perks – Benchmark Mineral Intelligence



Lithium Battery Ecosystem / Ecosistema de baterías de litio

- Danny Kennedy – CEO of New Energy Nexus & President of CalCharge
- Meg Slattery – University of California, Davis and Lawrence Berkeley National Lab
- Danny Kennedy - CEO de New Energy Nexus y Presidente de CalCharge
- Meg Slattery – Universidad de California, Davis y Lawrence Berkeley National Lab

A large graphic on the left side of the slide depicts two hands, one light blue and one white, holding a dark blue battery cell. The battery cell has a white top surface with a grid of white dots. The background is a gradient of orange and blue.

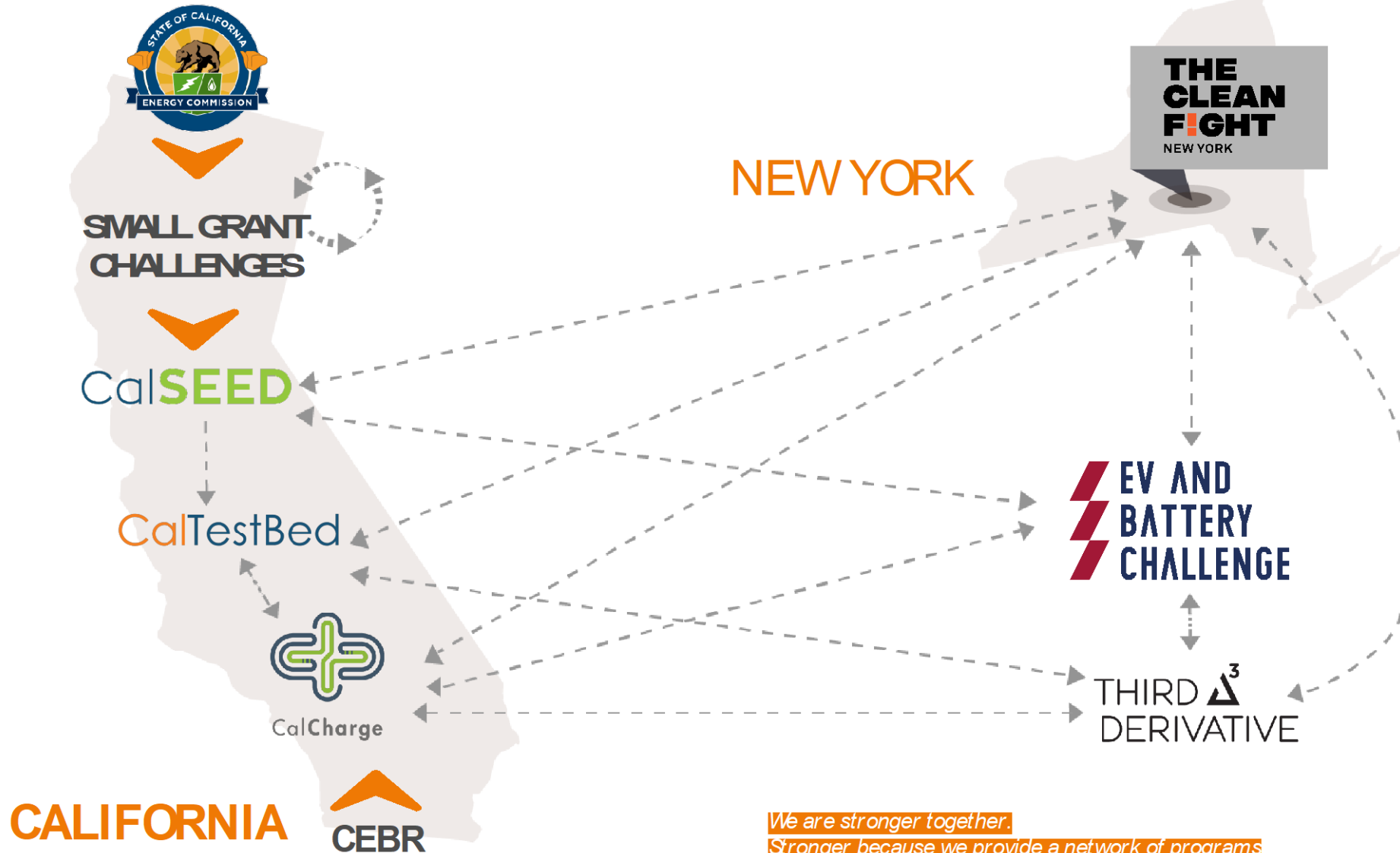
Overview of Innovation in Battery Technology and Manufacturing Opportunities in CA

Presentation to the Lithium Valley Blue Ribbon Commission

By Danny Kennedy, CEO, New Energy Nexus



USA Ecosystem map

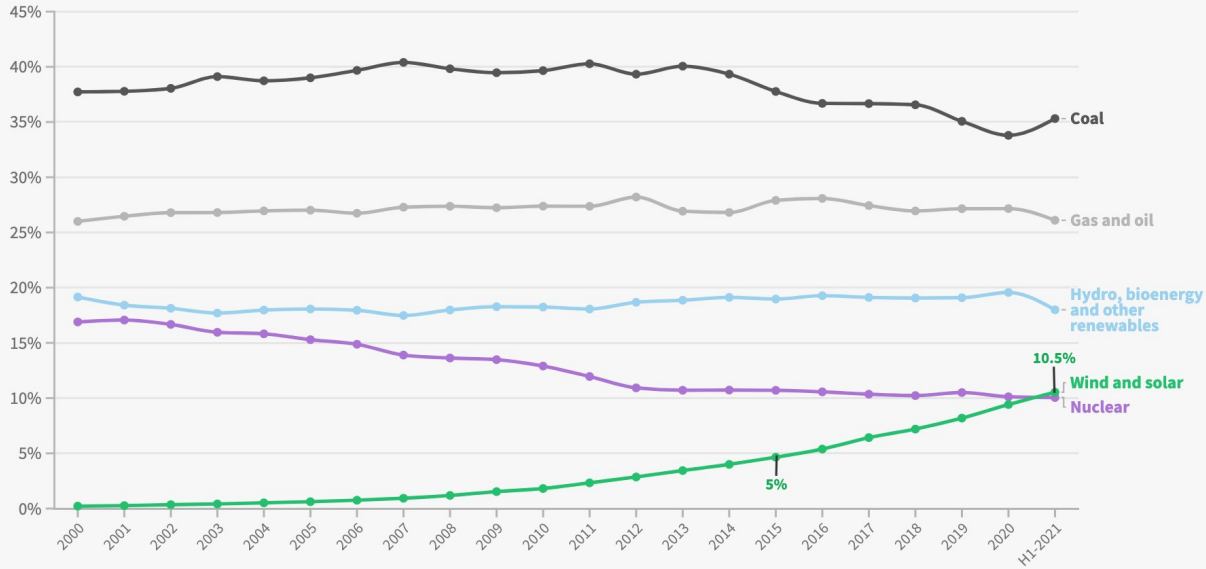


*We are stronger together.
Stronger because we provide a network of programs
accelerating clean energy entrepreneurs at all stages of their growth*

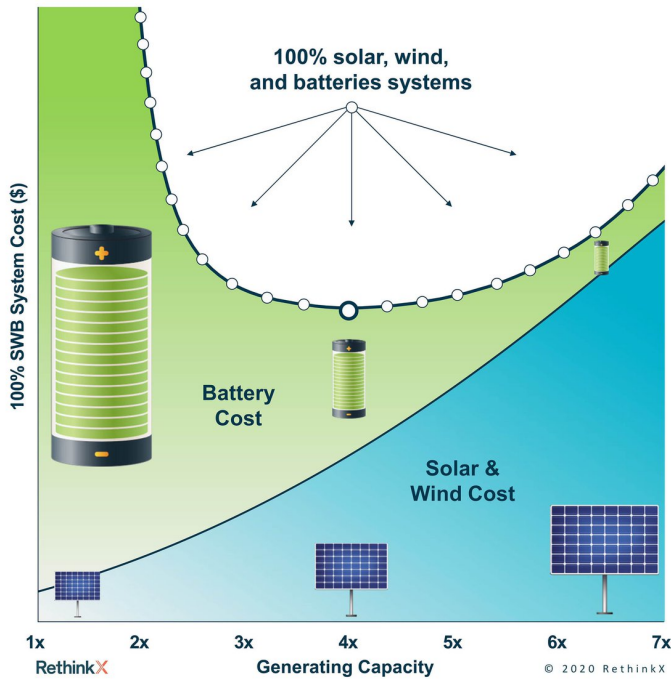
Wind and solar overtook nuclear in H1-2021



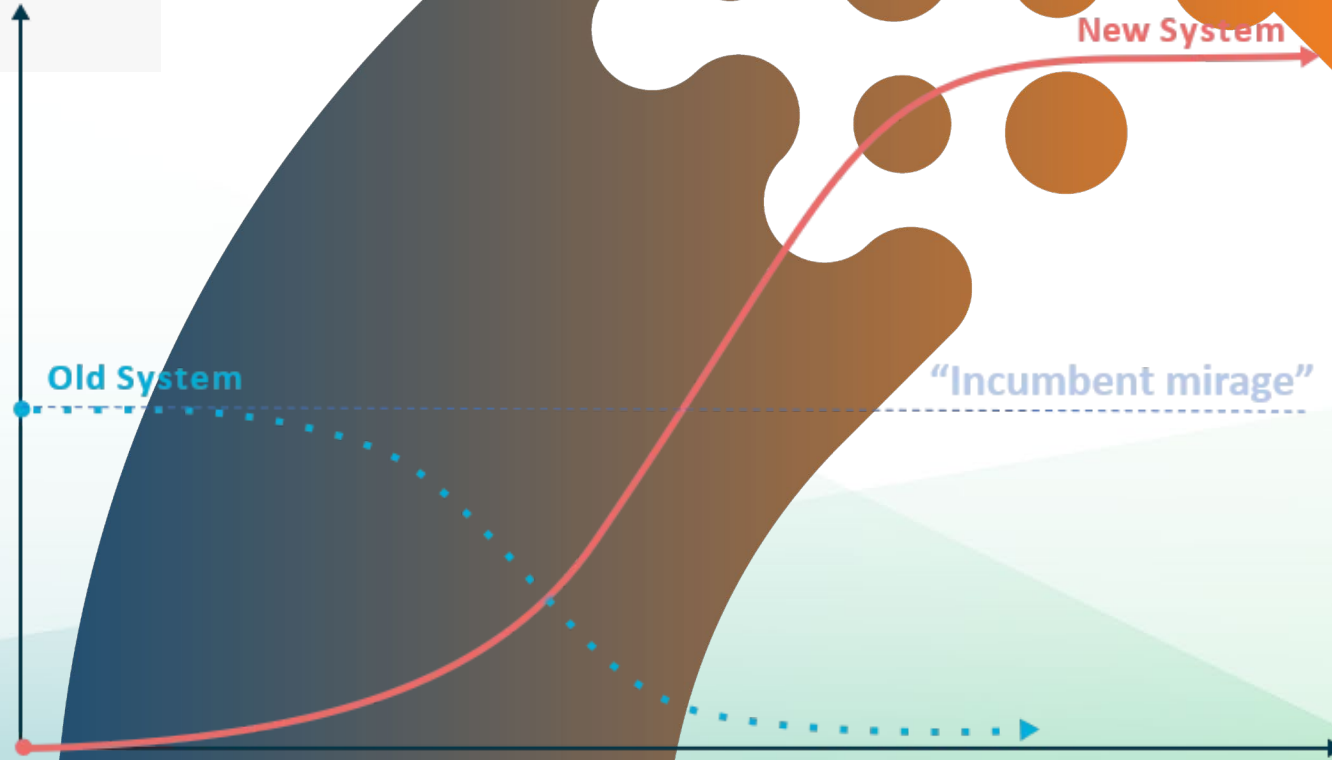
Global electricity mix



The Clean Energy U-Curve

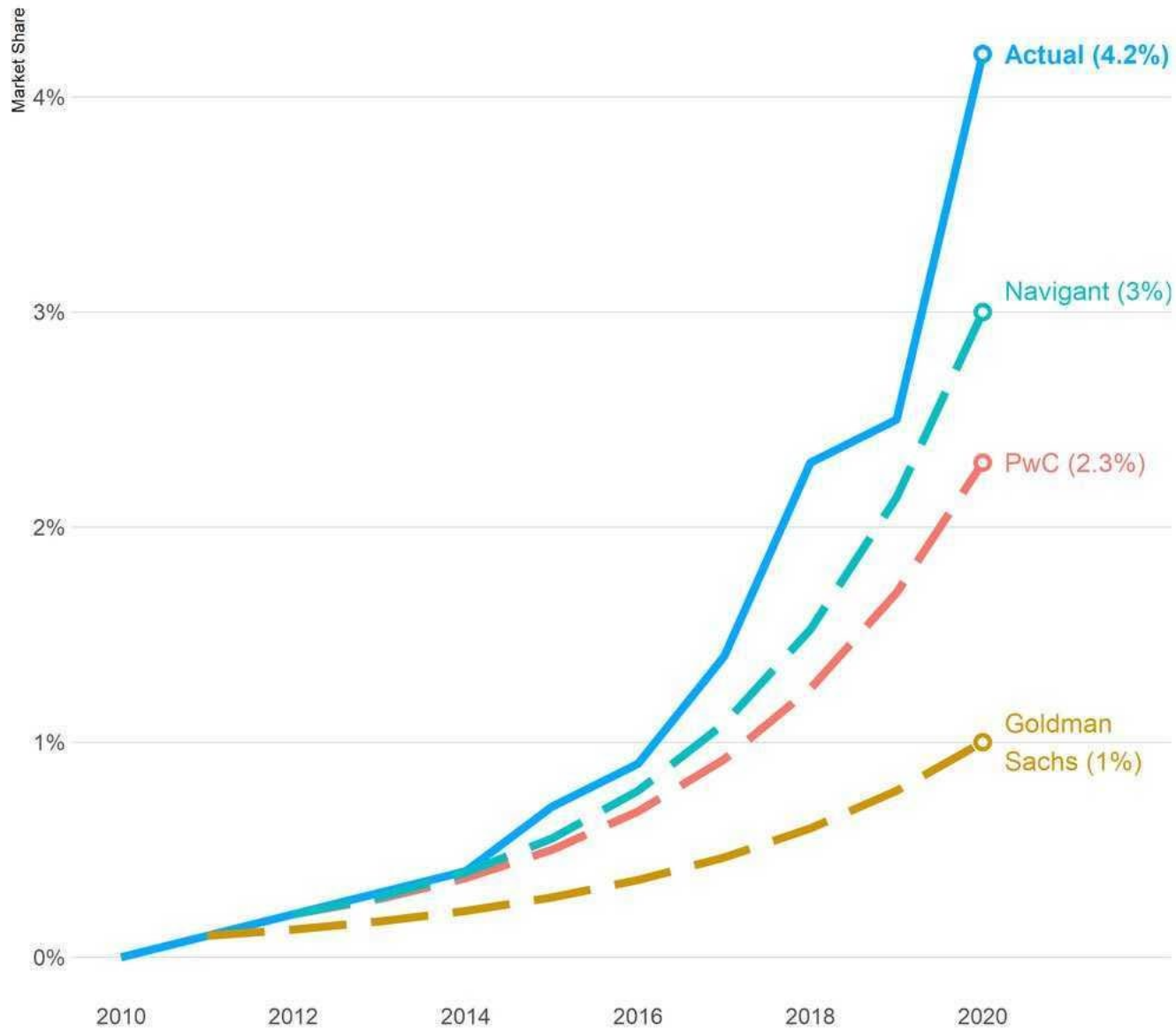


Disruption X-Curve



Electric Vehicles Have Easily Beaten Sales Forecasts

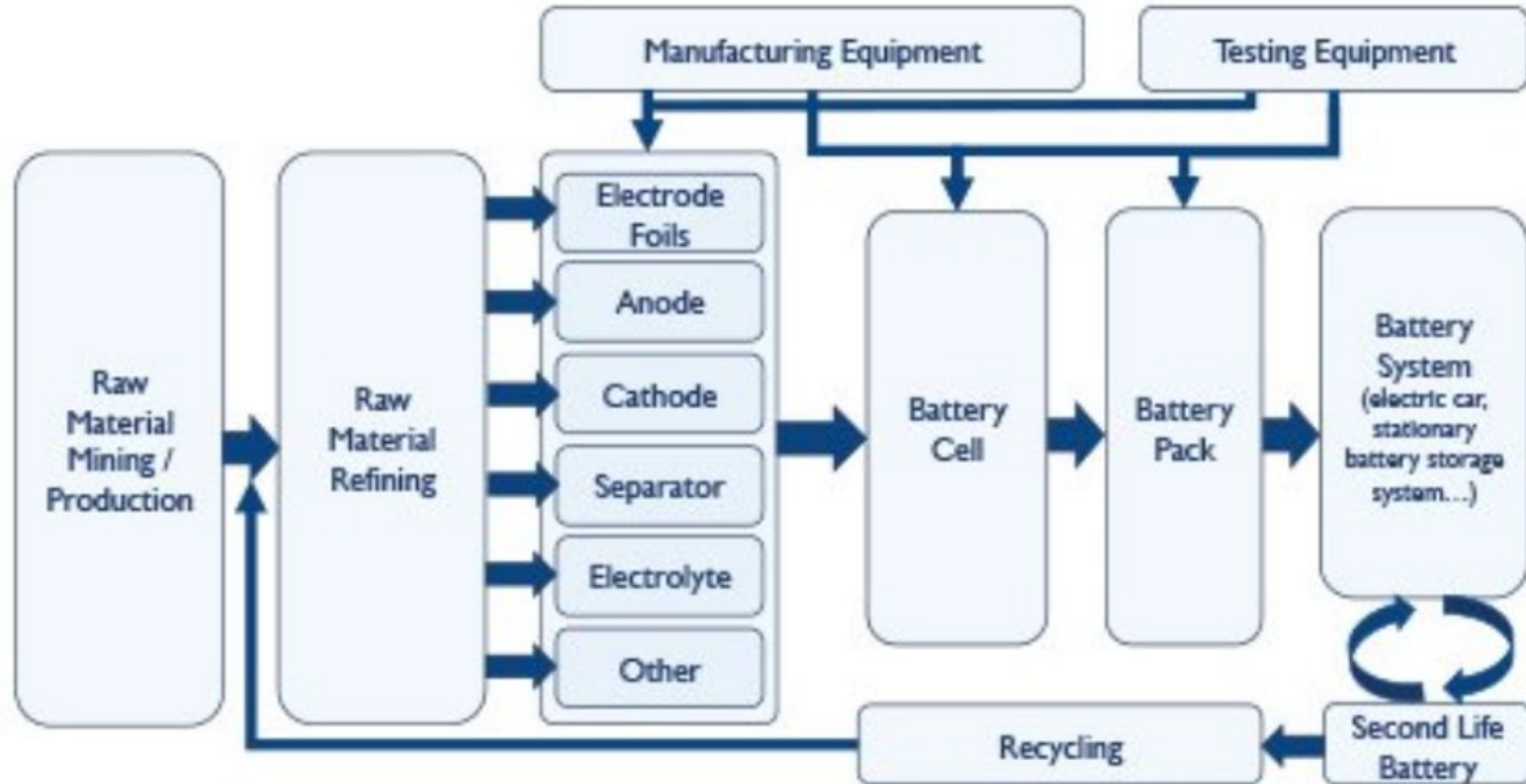
Dashed lines represent forecasts from different firms





Many business opportunities in the Li-ion battery supply chain

(Source: Status of the Rechargeable Li-ion Battery Industry, July 2017, Yole Développement)





Innovation in the battery value chain



Raw Materials
Extraction, processing

\$11b market, 8.3% CAGR [1]

- KoBold Metals
- Li-lac solutions
- VULCAN ENERGY RESOURCES
Zero Carbon Lithium™
- nanoOne
- the metals company



Cell Components
Electrode, electrolyte, etc

\$38b market, 4.9% CAGR [2]

- oxiS ENERGY EP + SES 24m nyobolt
- Echion Technologies CoreShell TECHNOLOGIES 6K ENERGY
- BATRION EPOWER volexion Soteria™
- CUBERG ADDIONICS Sion Power ENEVATE
- StoreDot Nanozamic LABORATORIES EONIX nHms TECHNOLOGIES
- SOUTH 8 TECHNOLOGIES SILA ENOVIX ampricus zenlabs
- ADVANO NANO GRAF TECHNOLOGIES GROUP14
- QuantumScape ProLogium ionic Factorial
- SEPION Solid Power



Battery Management
AI, BMS, power electronics

\$3.6b market, 19.0% CAGR [3]

- Feasible TWAICE
- BrillPower GBatteries
- voltaiq AIONICS
- GLOBAL BATTERY SOLUTIONS BREATHE BATTERY TECHNOLOGIES
- RELECTRIFY Rejoule
- ENERGSOFT ACCURE
- InoBat auto ZITARA Wildcat Discovery Technologies
- novo



Sustainability
Recycling, reuse

\$17.2b market, 6.1% CAGR [4]

- REDWOOD MATERIALS NTH CYCLE
- Li-Cycle®
- ReCell ADVANCED BATTERY RECYCLING
- BATTERY RESOURCERS Elkem

Intercalation Station's take on innovators in the battery space, CAGR refs: [1] [2] [3] [4]



Sample “startups” in California

Early stage examples

- Coreshell (**CaISEED**, **CalTestBed**)
- Sepion (**CaISEED**)
- Zenlabs
- Sylvatex
- South8 (**CaISEED**)
- Conamix
- Automat
- Feasible(**CalTestBed**),
- Rejoule (**CaISEED**, **CalTestBed**)
- EnZinc (**CaISEED**)

Later stage examples

Enovix

Sila Nanotechnology

Cuberg (CaISEED)

Quantumscape

Conamix



Meet a Clean Energy Innovator: Coreshell

Mission:

Coreshell Technologies is solving a fundamental issue in all rechargeable batteries: **electrode surface instability**.

Coreshell is solving the key degradation issue in rechargeable batteries with their nanolayer electrode coating technology. The goal of Coreshell technology is to reduce the battery's cost and increase battery's energy density to make the next generation of electric vehicles commercially competitive with traditional internal combustion engines. This would allow a major tipping point in the sale of EVs globally.

Support from New Energy Nexus' CalSEED Concept, CalTestBed and EV Battery Challenge:

Since receiving CalSEED funding Coreshell has researched the market and performed calculations on how their improvement in battery cost could influence ratepayer costs as well as metrics of reliability, job creation, and others. Coreshell is also a CalTestBed recipient and will begin their lab testing work soon. Through EV & Battery Challenge, Coreshell has been able to complete a Proof of Concept project with LG Energy Solution, a world-leading lithium ion battery manufacturer. This collaboration enables Coreshell to demonstrate the benefits of their technologies and get verified by a top industry leader. It will increase their technology readiness level and get their ready to demonstrate the role to role process.



“

New Energy Nexus has been instrumental in helping Coreshell build its company through numerous grant opportunities, corporate connections, and general startup mentorship. We're very fortunate to be a part of the New Energy Nexus community!”

CEO & Co-Founder Coreshell Technologies, Inc. - Jonathan Tan



Investment: 2020 VC Portfolio in Energy Storage

More than \$500 million allocated to battery related startups

Energy storage

- Form Energy: \$76M
- Highview Power: \$55.5M
- Quidnet Energy: \$10M
- Orison: \$8.5M
- Voltstorage: \$7.4M



Battery management, software, microgrids, EV chargers and more

- Demand Power: \$71M
- Skeleton: \$49M
- FreeWire: \$25M
- PowerUp: \$6M



Batteries

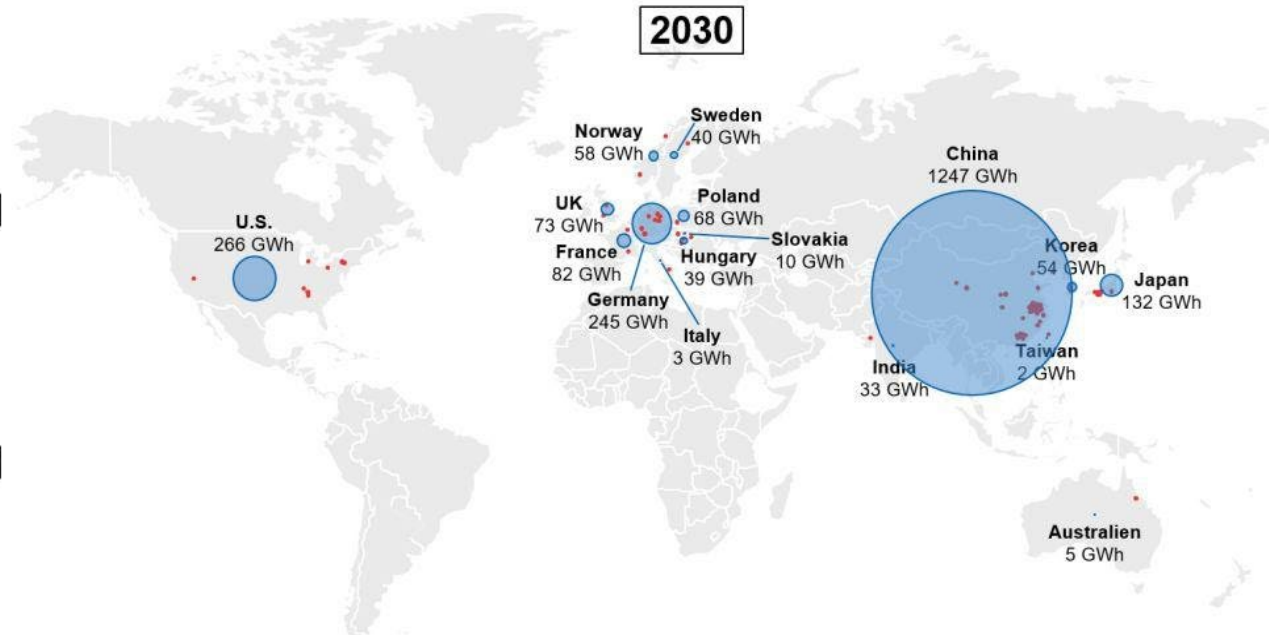
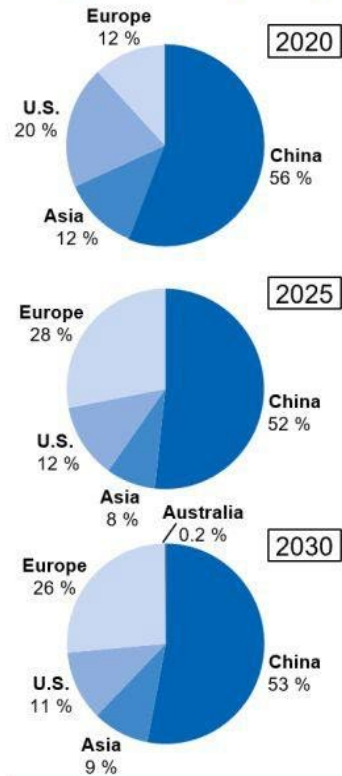
- QuantumScape (solid-state battery): SPAC IPO
- Eos Energy Storage (Zinc-based battery): SPAC IPO
- Redwood Materials (battery recycling): \$40M
- Natron (Na-ion battery): \$35M
- EnerVenue (Ni-H battery): \$12M



*Source: [pv-magazine](https://www.pv-magazine.com)

Manufacturing Map: Global Installed Capacity

China dominates global market in existing and planned production capacity
Gigafactory Capacities for Li-Ion Cells by Region



Capacity GWh	2020	2025	2030
CN	1247	704	1247
NA	65	165	266
EU	39	382	617
AS	41	110	219
Total	328	1360	2353

● Existing or planned gigafactory sites in 2030 are marked with a red dot.

Sources: Bloomberg New Energy Finance, Benchmark Mineral Intelligence, Citi Research, Reuters, Roland Zenn, press releases_Jan 2021



Three-phase strategy for U.S. advanced Li-ion battery leadership



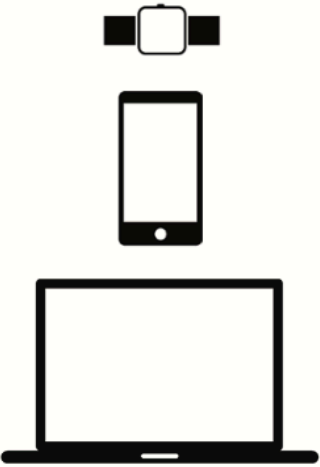
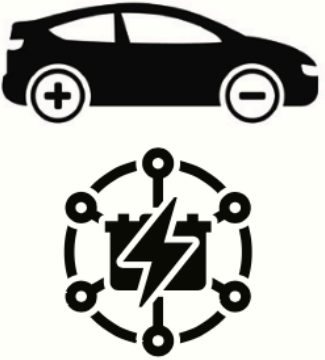
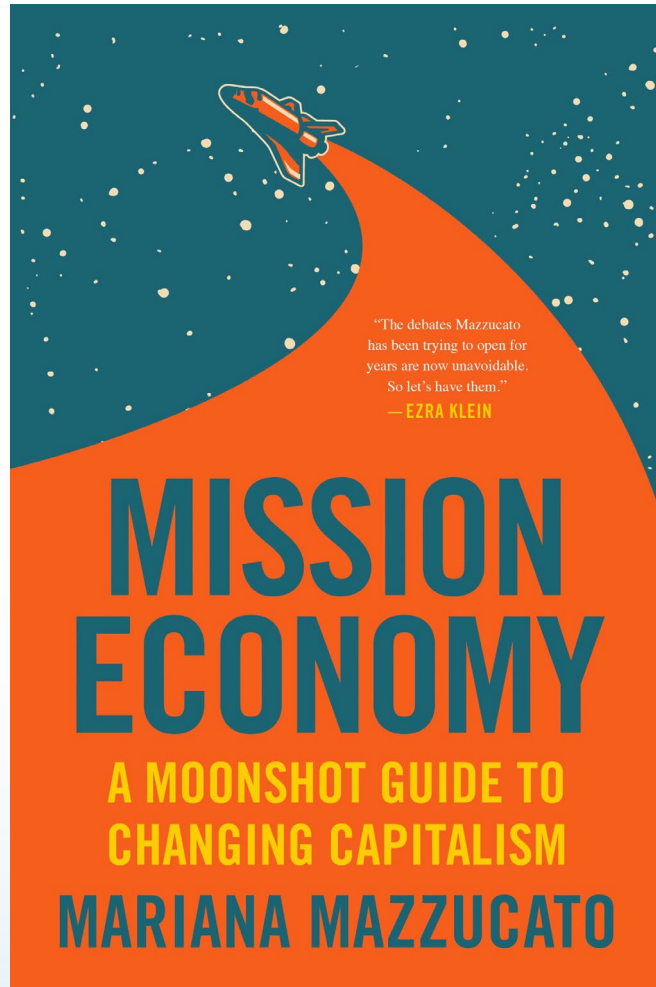
			PHASE 1	PHASE 2	PHASE 3
			2022	2023	2025
PORTABLE ELECTRONICS 	PRODUCTION		■	■	
	PARTNERSHIPS			■	
	LICENSING				
	STRATEGIC PURPOSE	Build New Factory Commercialization Validation Process-Driven Innovation	Build New Factory Retrofit Factories Process-Driven Innovation	Process-Driven Innovation	
EV & BESS 	PRODUCTION				
	PARTNERSHIPS				■
	LICENSING				■
	STRATEGIC PURPOSE	Development Process-Driven Innovation	Development Process-Driven Innovation	Retrofit Factories Process-Driven Innovation	

Illustration of the Enovix three-phase strategy to establish U.S. leadership in advanced Li-ion battery development and production
(source: Enovix Corporation)



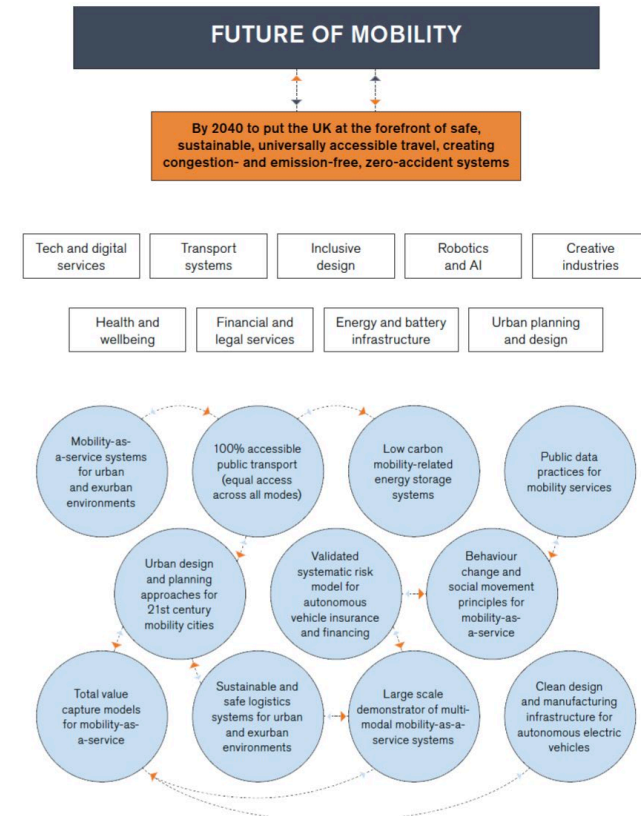
The Opportunity

Set the Mission Economy for 21st Century CA



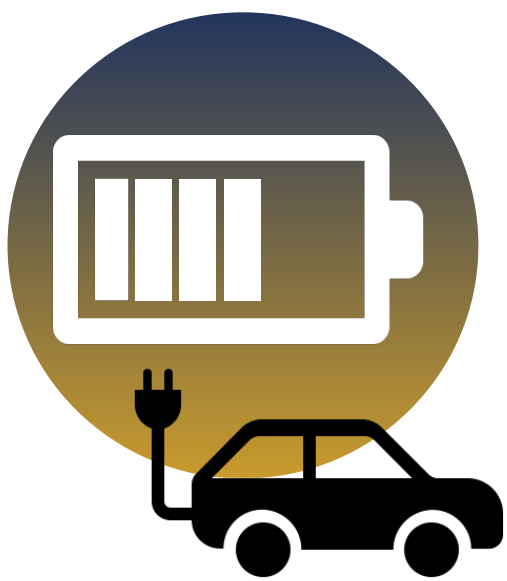
Example from the UK

Figure 2: The 'Future of Mobility' grand challenge (MOIIS Commission, 2019)



Critical success elements

- *Community engagement > IRMA*
- *High road jobs and labor agreements*
- *Mission-oriented Innovation Industrial Strategy*



Overview of Electric Vehicle Battery End-of-life

Meg Slattery

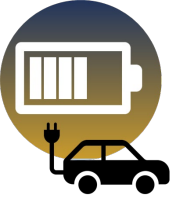
Lithium Valley Commission Meeting

9/30/2021



Agenda

- Introduce UC Davis Material Circularity Lab
- Overview of electric vehicle (EV) battery life cycle
- Lithium-ion Car Battery Recycling Advisory Group
 - Reuse
 - Recycling
 - Logistics
 - Policy options
- Alignment with Lithium Valley Commission



Material Circularity Lab



Alissa Kendall, PhD
Professor, Civil and
Environmental Engineering;
Chair, Energy Graduate Group



Jessica Dunn, MS
PhD Candidate, Energy
Systems



Meg Slattery, MS
PhD Student, Energy
Systems
Affiliate, Lawrence
Berkeley National Lab



Hanjiro Ambrose, PhD
Postdoc, UC Davis
Engineer, Air Resources
Board



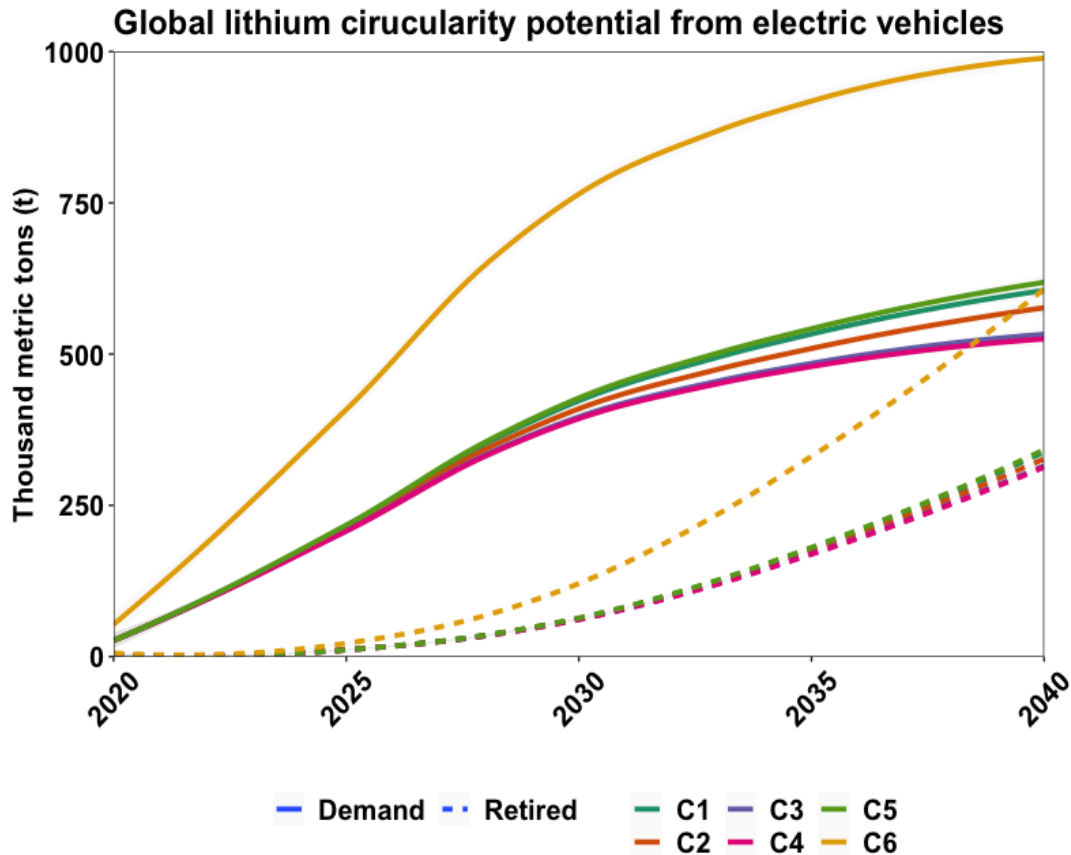
Motivation



Our strategy for meeting climate change mitigation goals depends on a battery-reliant energy system. How can we ensure it promotes equity, averts environmental damages, and avoids creating a new problem?



Anticipating future challenges



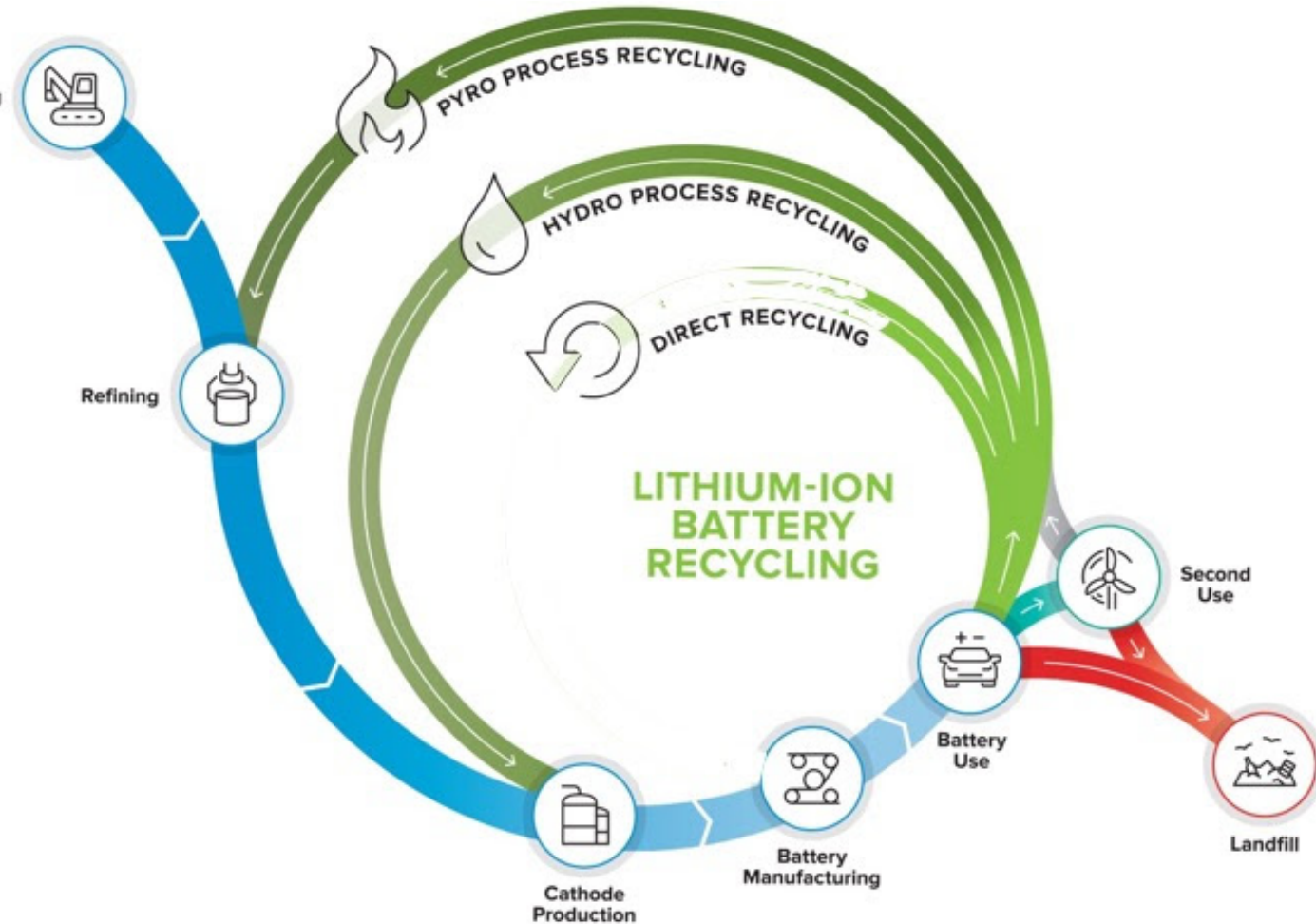
Estimated material demand and volume of recycled batteries under different cathode chemistry scenarios (Dunn et al., 2021)

- [Material flow analysis on material demand and potential for circularity](#)
 - What percentage of future material demand can be met by recovered material?
- Stakeholder analysis of vehicle afterlife market
 - Where do cars go when they die? Who will be affected? What is overlooked in academia?
 - Focus on [collection and transportation logistics](#)
- [AB 2832: Lithium-ion Car Battery Recycling Advisory Group](#)
 - Generating recommendations for the State of California's battery recycling policy

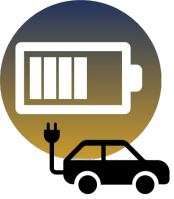


Electric Vehicle (EV) battery life cycle

- Batteries may be suitable for reuse in another vehicle or as stationary storage when the vehicle reaches end-of-life
- Quality and type of material recovered depends on recycling pathway
- Industry landscape is rapidly evolving



Original Image: <https://recellcenter.org/publications/>



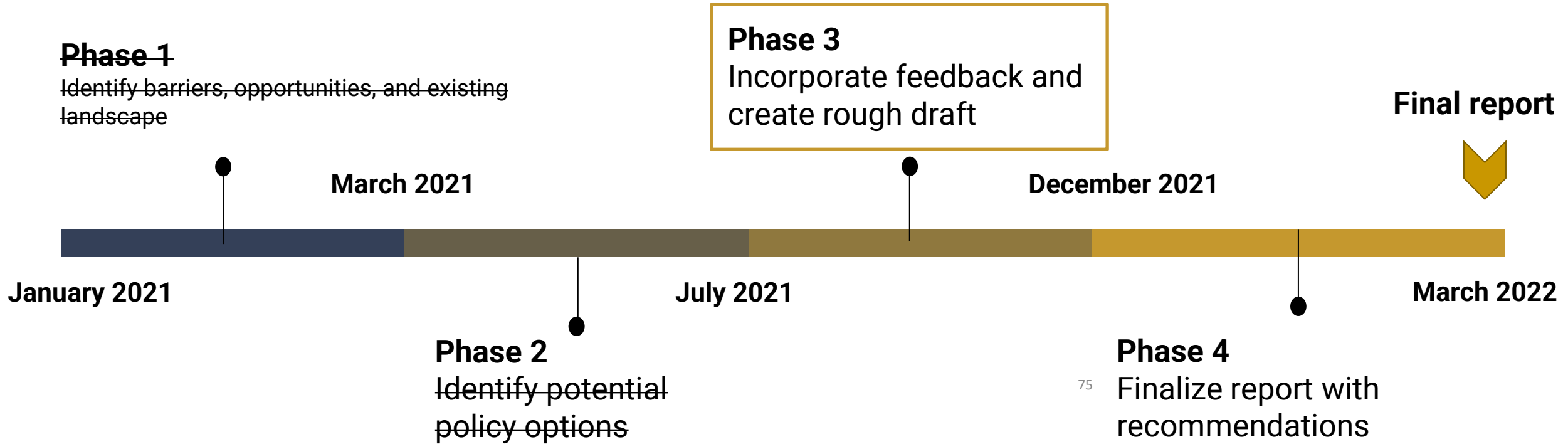
Lithium-ion Car Battery Recycling Advisory Group



- Mandated by AB 2832 to submit recommendations to the legislature “aimed at ensuring that **as close to 100 percent as possible** of lithium-ion vehicle batteries in the state are **reused or recycled at end-of-life** in a **safe and cost-effective** manner (emphasis added)”
- Advisory group consists of representatives from automobile and battery industries, environmental non-profits, and state agencies.
- Our group has provided background documents and presentations on battery composition, recycling pathways, reuse, and existing policy, and are now developing the group’s final report
- Recommendations were generated through facilitated discussions with subcommittees focused on reuse, recycling, and logistics



Lithium-ion Car Battery Recycling Advisory Group





Reuse

- Barriers identified:
 - Declining price of new batteries vs. cost of repurposing
 - Allocation of responsibility
 - Lack of transparent data about battery condition
 - Lack of volume
- Opportunities:
 - Provide affordable energy storage
 - Support grid decarbonization
 - Extend usable life
 - Reduce life cycle impact

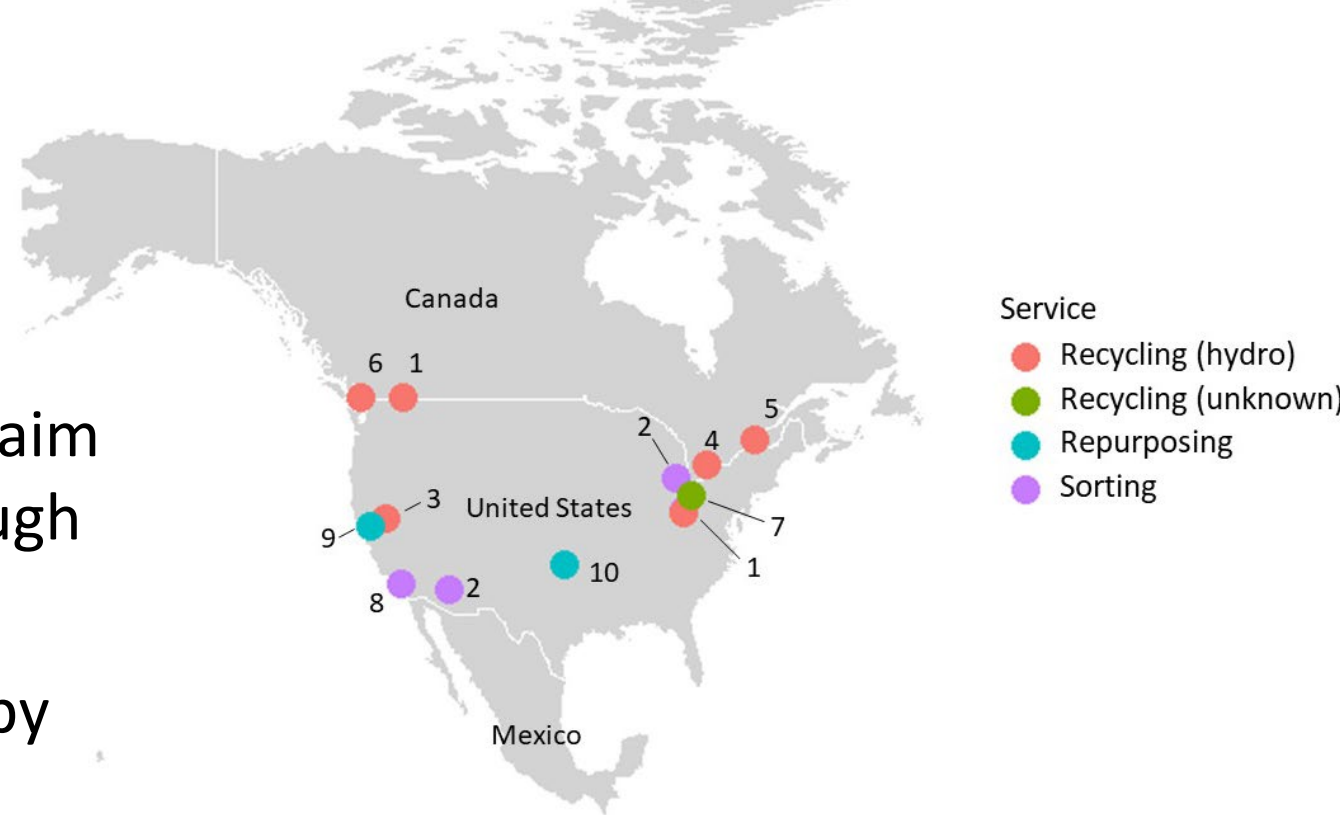


There are several startups in California and elsewhere in the United States, including demonstrations funded by the CEC. Pictured above is a reused battery stationary storage demonstration project in Davis, CA (RePurpose Energy)



Recycling

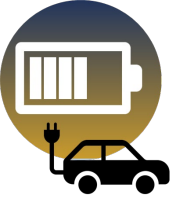
- Most companies in North America claim to recover 90-95% of materials through hydrometallurgical recycling
- Economics of recycling are dictated by material value, processing cost, and transportation cost
- Lithium has not historically been recovered commercially
- Recovered material must be exported



Battery end-of-life facilities (pilot and commercial) in the US and Canada (Slattery et al., 2021)

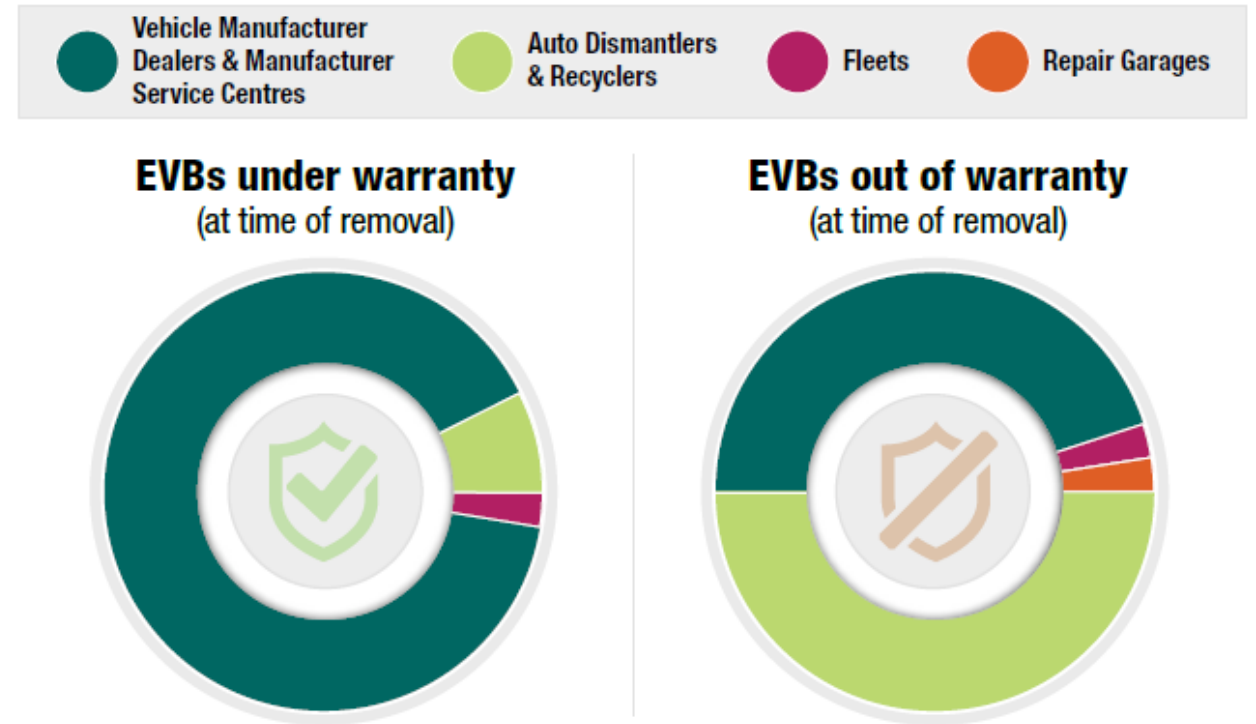


Image of “black mass” from Li-Cycle®



Logistics

- “Logistics” → removal of battery from vehicle, testing to determine appropriate next use, collection and sorting, transportation, and tracking
- Transportation represents an estimated 40-60% of recycling cost
- Capturing out-of-warranty batteries and safety are key challenges



Source: Call2Recycle®
Illustrations represent estimated proportions for comparison.

Above: Party removing an EV battery depending on warranty status. Figure taken from [this factsheet](#) from Canadian Vehicle Manufacturers Association and Call2Recycle



Policy options under discussion

- Determine responsibility and/or financing mechanism for end-of-life cost
- Reuse
 - Enable access to state-of-health data; make used battery systems eligible for energy storage incentives; generally incentivize repurposing industry
- Recycling
 - Labeling requirements including digital identifier; minimum material recovery rates; third-party verification of recycling process quality; reporting system; recycled content standards (parallel w/ AB 1397); design for reuse/recycling; streamlined permitting process
- Logistics
 - Enforce unlicensed dismantling laws; develop safety training materials; Universal Waste classification



Areas of alignment with LVC

- Motivation
- Role of domestic supply chain (or lack thereof)
- Tracking mechanisms
 - Some traceability solutions will include supply chain data



Salton Sea Recreational Area, Mecca, CA



Contact

- Meg Slattery: msslattery@ucdavis.edu
- Jessica Dunn: jadunn@ucdavis.edu
- Alissa Kendall: amkendall@ucdavis.edu
- [Advisory group website](#)
 - Next meeting will be in early November
 - Report is due March 2022



Lithium Valley Commissioner Q&A / Preguntas y respuestas con la Comisión de Lithium Valley

- Presenters:
 - Danny Kennedy – CEO of New Energy Nexus & President of CalCharge
 - Meg Slattery – University of California, Davis and Lawrence Berkeley National Lab
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Public Comment / Comentarios del público

Comment Instructions:

Limited to 3 minutes per comment

By computer: use “raise hand” feature in Zoom

By telephone: dial *9 to “raise hand” and *6 to mute/unmute your phone line

Instrucciones para los comentarios:

Límite de 3 minutos por comentario

Por computadora: use la función de “levantar la mano” de Zoom

Por teléfono: marque *9 para “levantar la mano” y *6 para silenciar y para activar el sonido





Future Meeting Discussion / Plática sobre la próxima reunión

- Determination of Agenda Topics, Speakers, Presentations
 - **September** – Market Opportunities for Lithium
 - **October** – Environmental Impacts
 - **December** – Incentives and Economic Impacts
 - **January** – Workforce Development

- Determinación de los temas de la agenda, los oradores y las presentaciones de la próxima reunión
 - **Septiembre** – Oportunidades para el mercado de litio
 - **Octubre** – Impactos al medio ambiente
 - **Diciembre** – Incentivos e impactos económicos
 - **Enero** – Desarrollo laboral



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Adjourn / Levantar la sesión



Webpage / Página Web: <https://www.energy.ca.gov/data-reports/california-power-generation-and-power-sources/geothermal-energy/lithium-valley>

List Serv / Lista de Correo Electronico: Lithium Valley Commission

Thank you!

¡Gracias!

LithiumValleyCommission@energy.ca.gov



Break / Tomar Receso

LithiumValleyCommission@energy.ca.gov