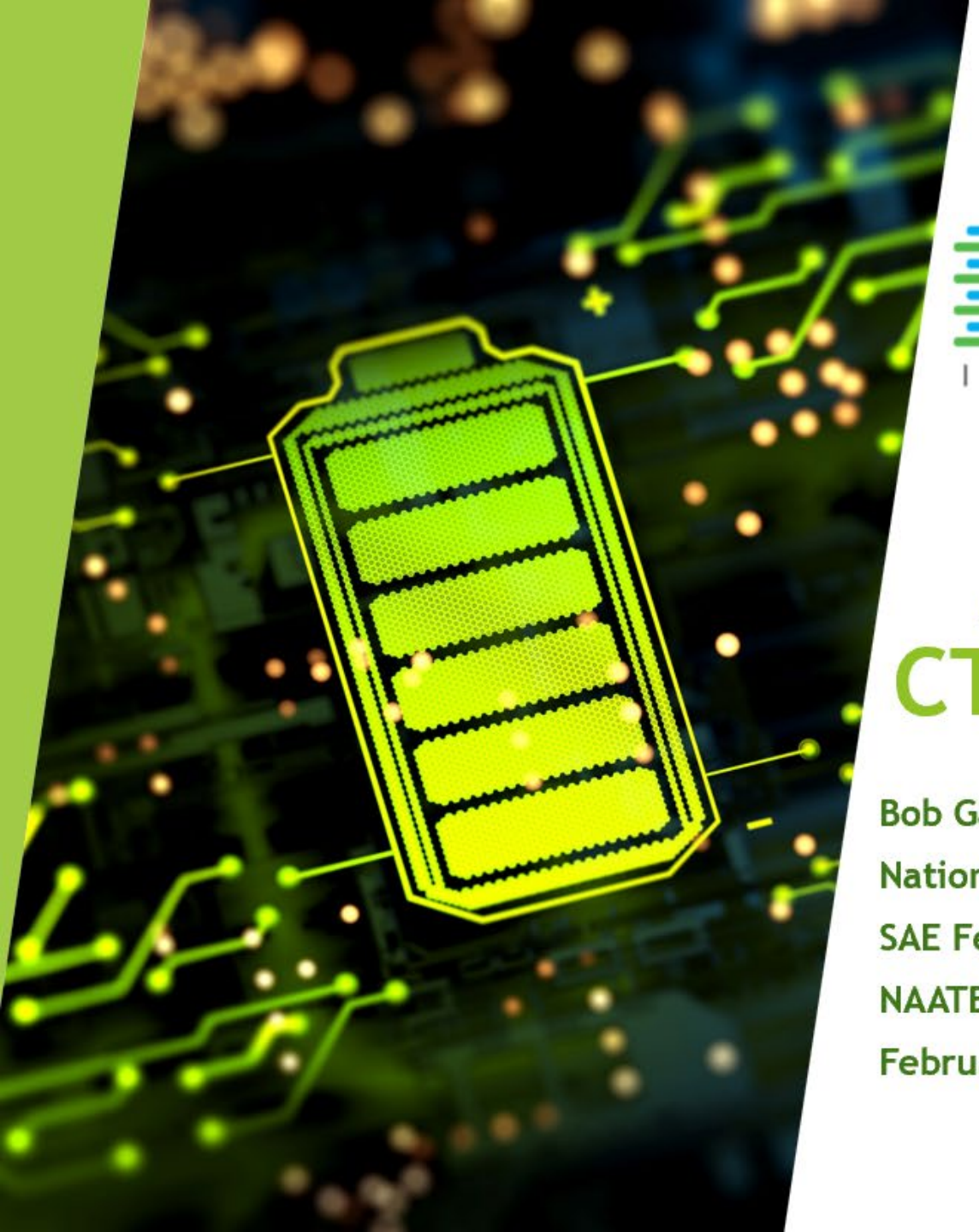


NAATBatt INTERNATIONAL

GALYEN ENERGY

NAATBatt Annual Meeting CTO's Address 2024

Bob Galyen

National Distinguished Expert

SAE Fellow

NAATBatt CTO and Chairman Emeritus

February 20, 2024 Carlsbad, California

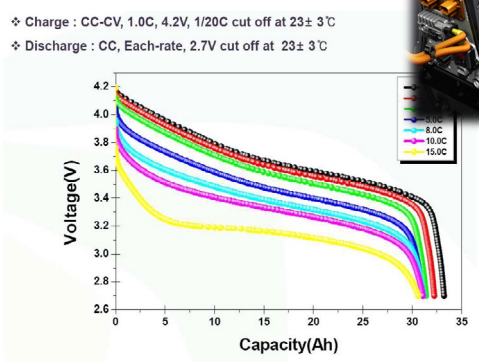
2020

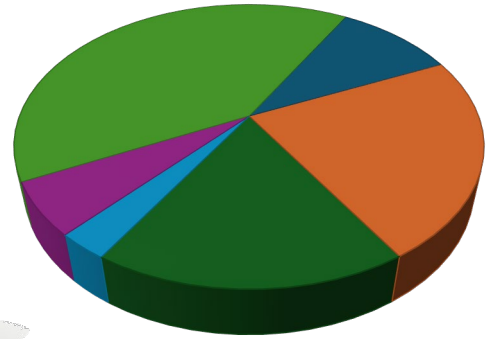
CTO Update: Applications for the Electrification Era


PROTERRA
BATTERY ELECTRIC
ZERO EMISSIONS
E-FAN X
AIRBUS
SIEMENS
Rolls-Royce
Caltrain
TOYOTA
KYOKUTO
HYBRID

5 GOLDEN RULES OF ELECTRIFICATION

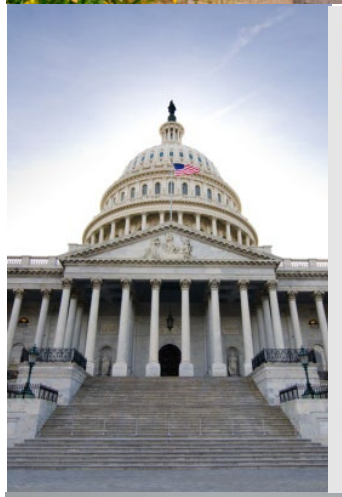
- Safety
- Performance
- Life
- Cost
- Environmental



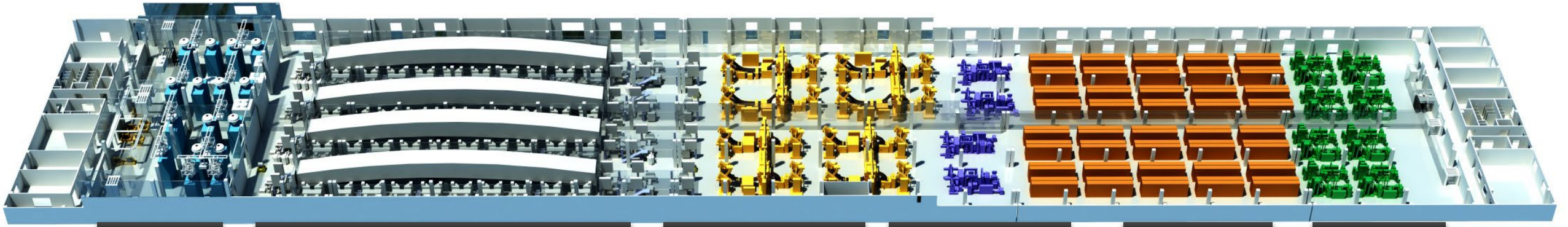


ADOPTION SUCCESS FACTORS HAVE NOT CHANGED!

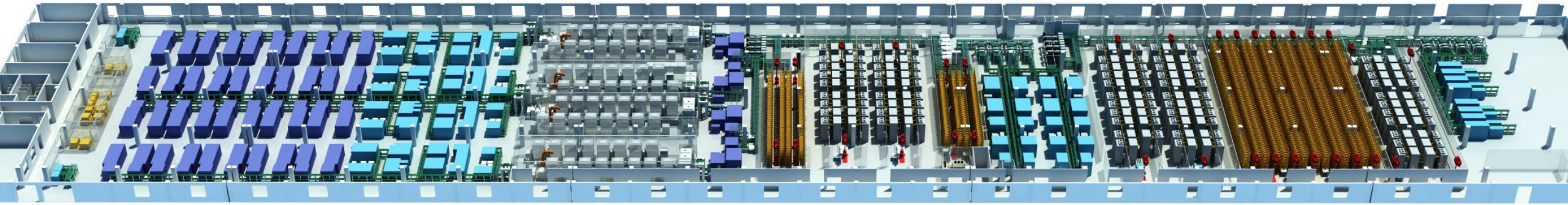
- Consumer Acceptance
- New Infrastructures
- Technology
- Governmental Support



MANUFACTURABILITY IS KEY TO SUCCESS!



Mixing | Coating | Calendaring | Pre-Slitting | EFM | Slitting



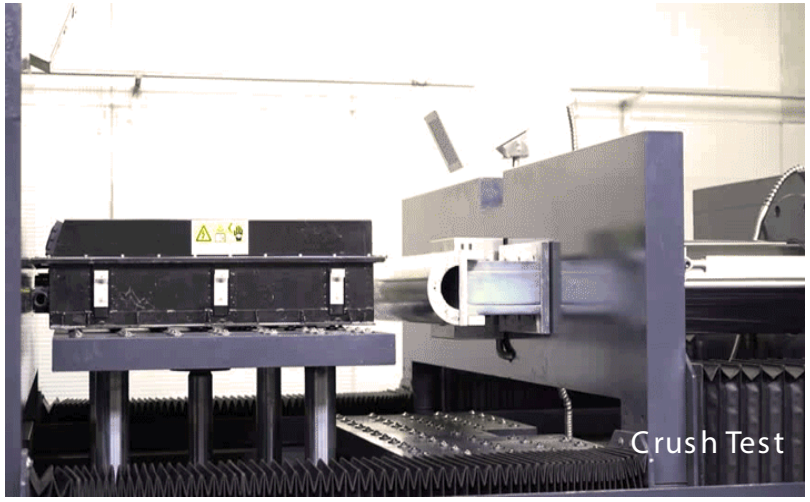
Winding | Assembly | Baking | E.L. Filling | Formation | Capacity testing | K-Value Test

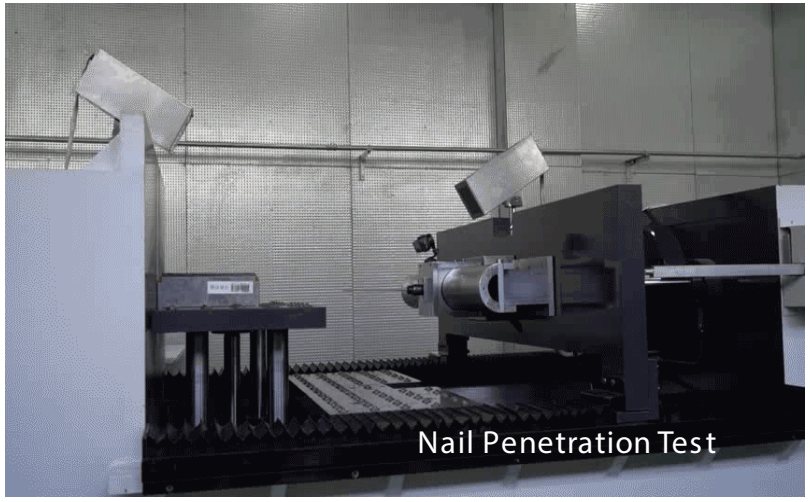
BATTERY TECHNOLOGY MUST BE VALIDATED!


Mechanical Shock Test


External Fire Test


IP Test


Crush Test


Nail Penetration Test


Vibration Test

GALYEN ENERGY

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2021 NAATBatt CTO Presentation: State of Technology

Bob Galyen

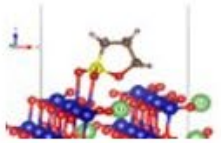
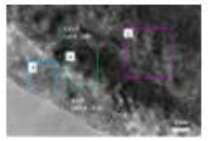
NAATBatt CTO

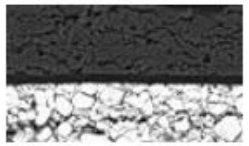
February 9, 2021

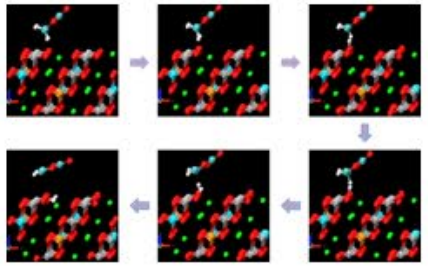
What is Technology?

- Technology: **Technology** refers to methods, systems, and devices which are the result of scientific knowledge being used for practical purposes. https://www.collinsdictionary.com/
- STEM: Science, Technology, Engineering and Mathematics
- The "Technology of Batteries" cuts across many aspects of our lives





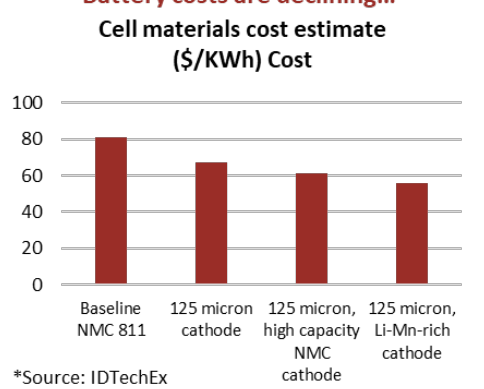



Megatrends

- Electrification is one of the biggest megatrends worldwide and transforming industries all over the world.

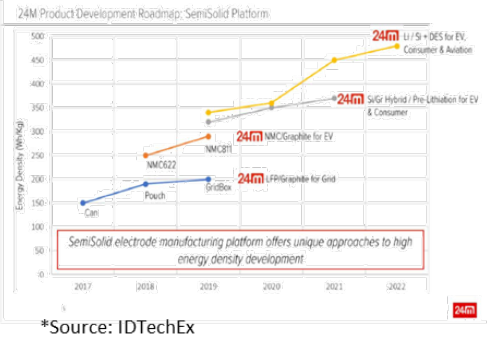
Improved Battery Economics

Battery costs are declining…



*Source: IDTechEx

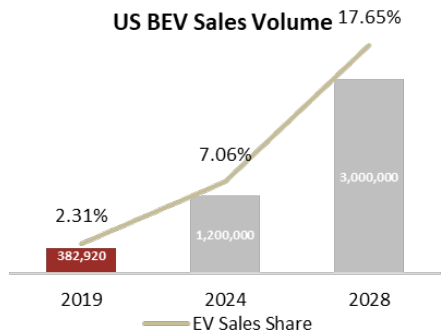
And battery energy storage is becoming more efficient



*Source: IDTechEx

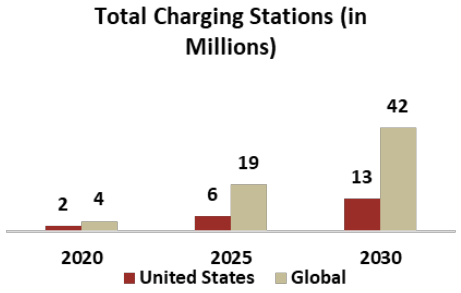
Increasing EV Adoption

US EV Sales are expected to grow…



*Source: Evadoption.com

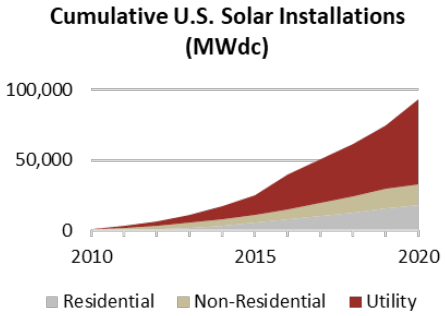
As the BEV Charging infrastructure becomes more prevalent



*Source: Mckinsey Report

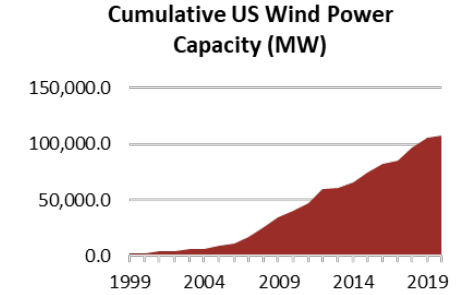
Increased Renewable Usage

In the last decade alone, Solar has grown at a 49% CAGR…



*Source: SEI & Wood Mackenzie 2020 Report

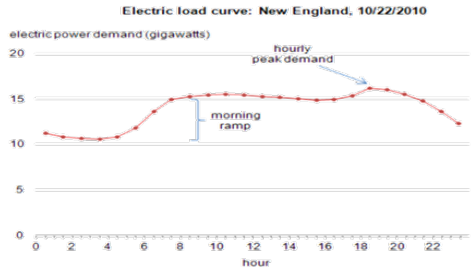
With Wind power generation capacity growing at an equally notable rate…



*Source: Department of Energy

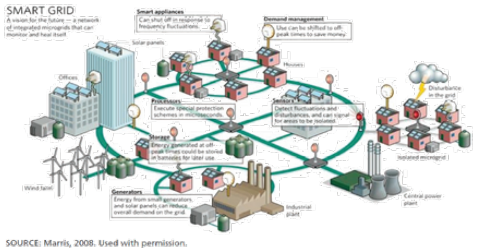
Smart Grid Demands

The supply and demand of energy generation is not constant



Traditional electricity generation methods generate electricity as it is demanded, regardless of its availability at a given time

How lithium-ion powered ESS systems solve this issue



SOURCE: Marris, 2008. Used with permission.

Smart Grids combine technology with battery powered ESS systems that allow us to deliver energy that was saved during low-demand to the grid during high-demand periods

NAATBatt Annual Meeting
CTO's Address 2022

Bob Galyen

NAATBatt CTO and Chairman Emeritus

SAE Battery Standards Steering Committee Chairman

February

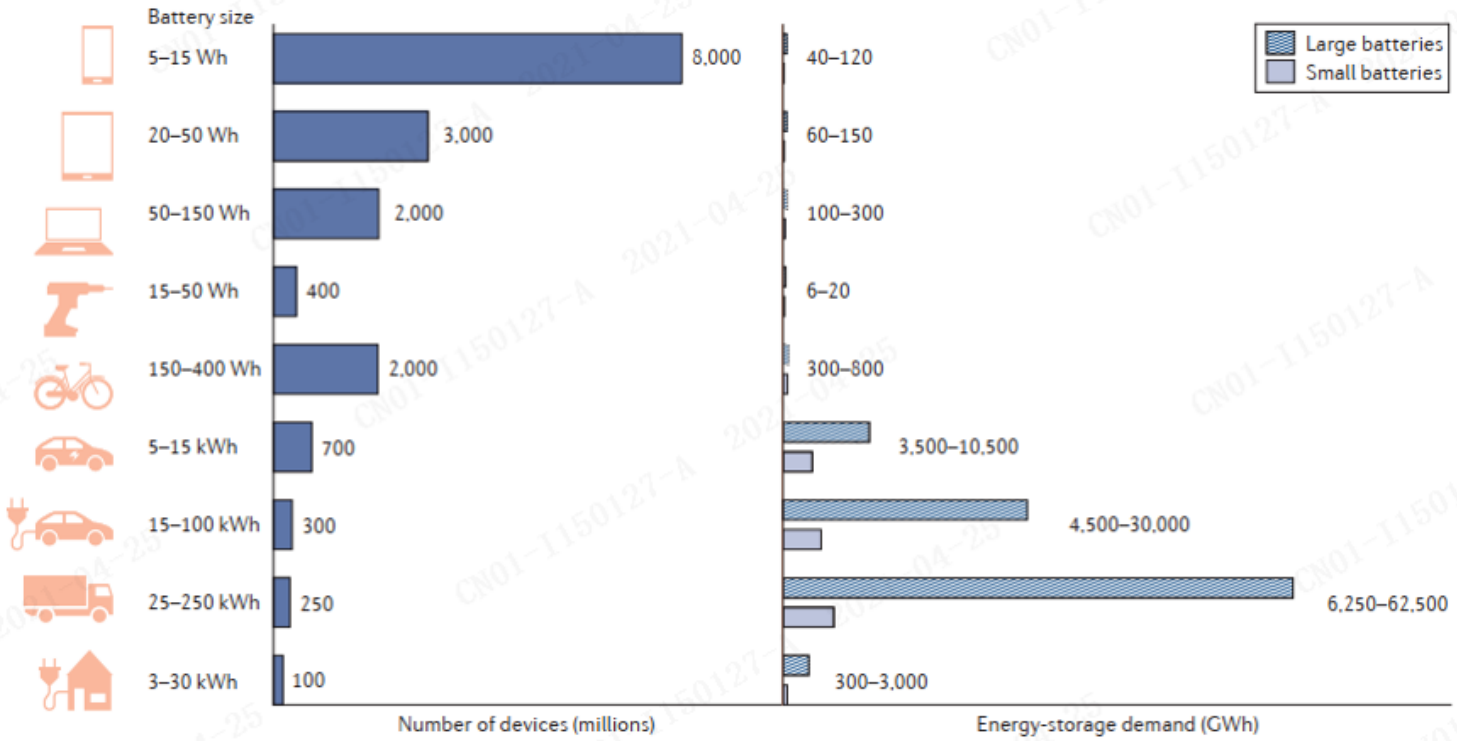
4 Key Success Factors for Rapid Rise of Chinese Battery Manufacturing

- Available Technology
- Available Capital Investment Money
- Development of the Man and Machine
- Government Support

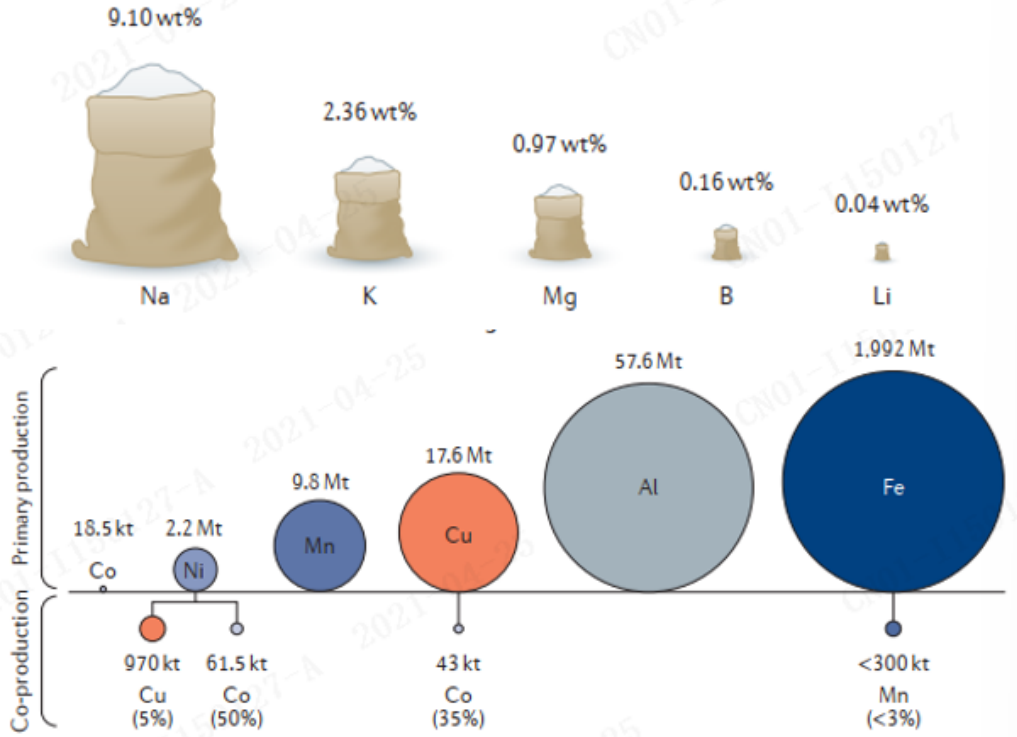
Supply Chain

- Mining
- Conversion
- Logistics
- Industry Direction

Na-ion Battery Development --- Alternatives of Li-ion battery



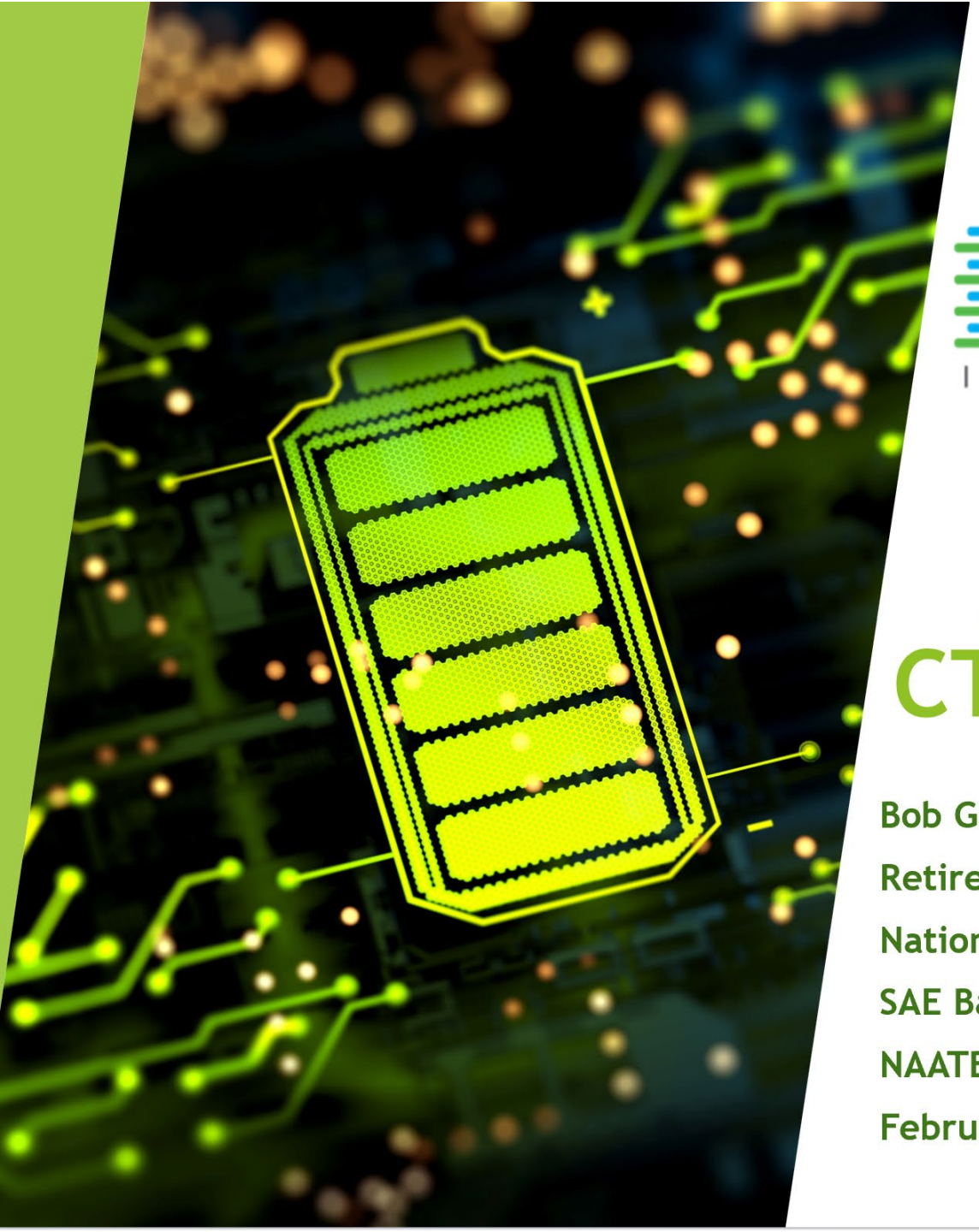
Estimated number of devices and related energy demand for 2016–2050



Production scale of elements for battery materials.

- **Advantage:**
  - More abundant elements Na, Fe, Mn (vs. Li, Co, Ni, Mn);
  - Al foil as collector (vs. Cu foil for Li-ion battery);→more abundant elements & 0V transportation;
  - Lower electrolyte concentration because of weaker solvent effect;
  - Better compatibility with the existing production line of Li-ion battery;
  - ……

Vaalma, Christoph, et al. Nature reviews materials 3.4 (2018): 1-11.



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Bob Galyen

Retired CTO of CATL

National Distinguished Expert

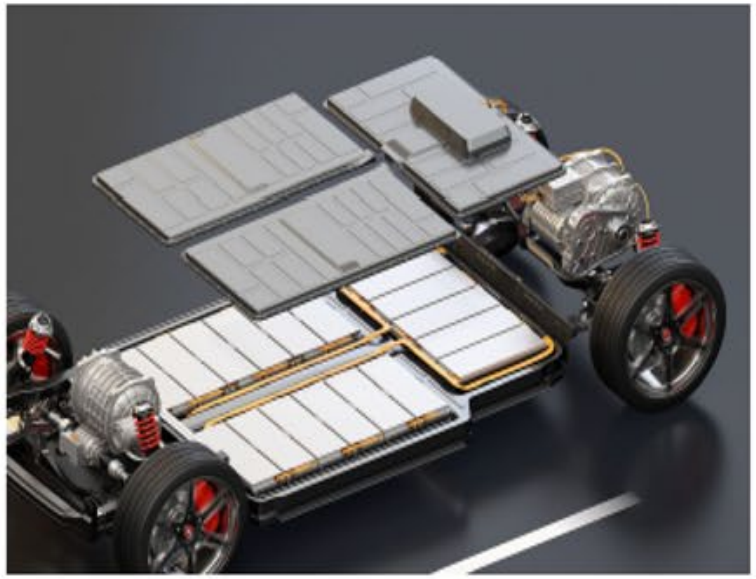
SAE Battery Standards Steering Committee Chairman

NAATBatt CTO and Chairman Emeritus

February 21, 2023 Phoenix, Arizona

Mobility Sector: Fully Integrated Battery Systems As Part of the Structure

Prismatic Cell –
Structural Pack



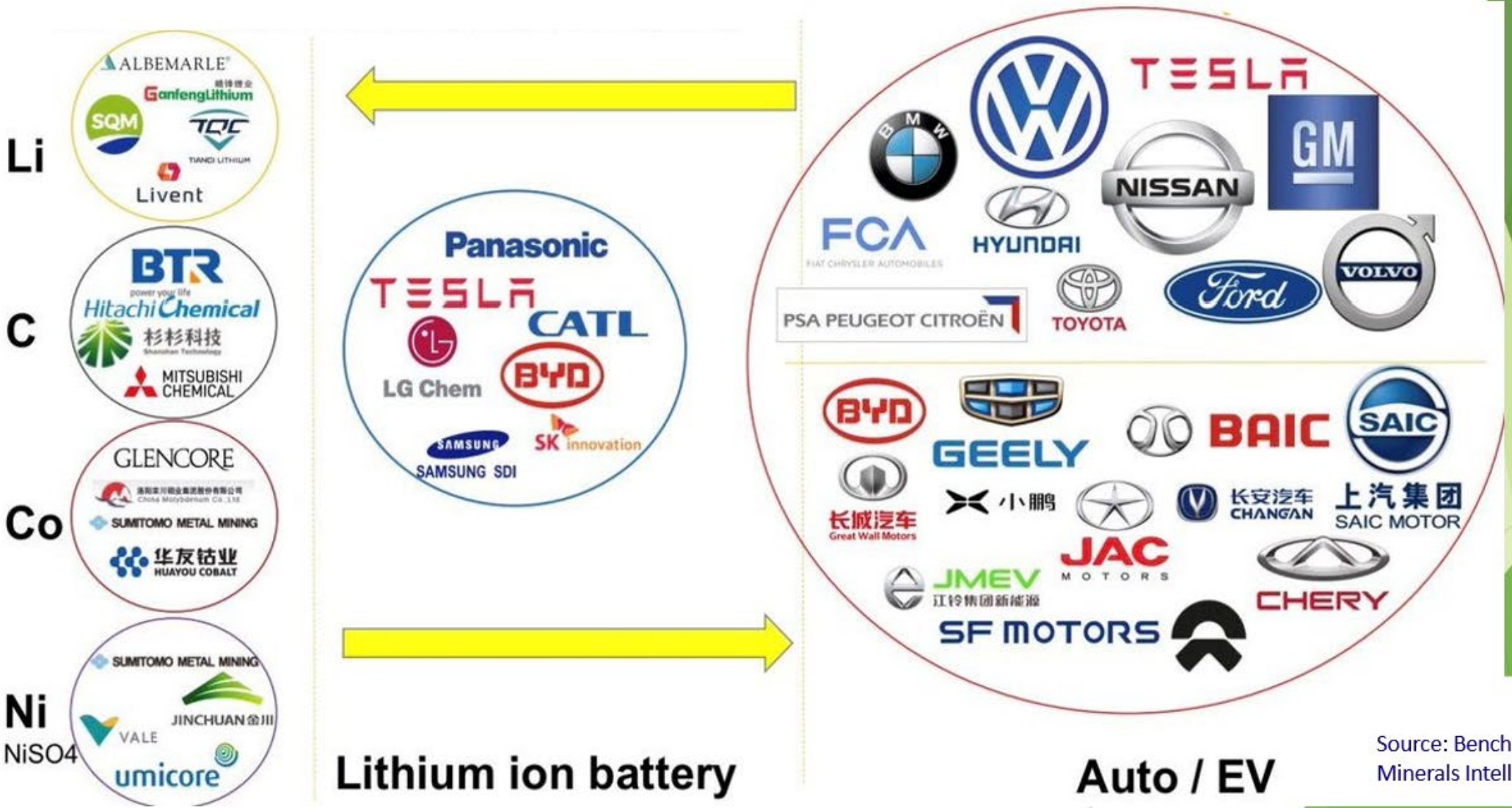
Cylindrical Cell –
Structural Pack

Pouch Cell –
Structural Pack

Predominate Packaging Schemes in Mobility Sector

- First Generation: Module to Pack
- Second Generation: Cell to Pack
- Third Generation: Cell to Chassis (future)

New Era of Vertical Integration and Strategic Partnerships



Source: Benchmark Minerals Intelligence

Bob's Top 10 List

- Remarkable Growth
- Government Engagement
- Key Decision Making
- Infrastructure Required
- Industrialization
- Fire Concerns
- Materials
- Recycling
- Corporate Structure
- STEM

2024

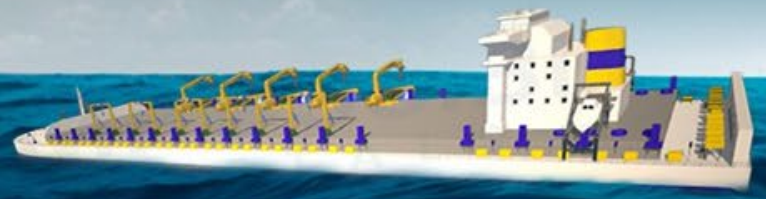

IMPOSSIBLE
METALS

Dredge & Riser Based Systems (1st Gen)

IMPOSSIBLE METALS

No Single point of failure
Minimised Environmental Impacts

Port Transport



No ship-to-ship transfer required; a new ship arrives to continue operations

Vertical transport

Uses a fleet of AUVs, each transporting its own payload to the surface

Collection

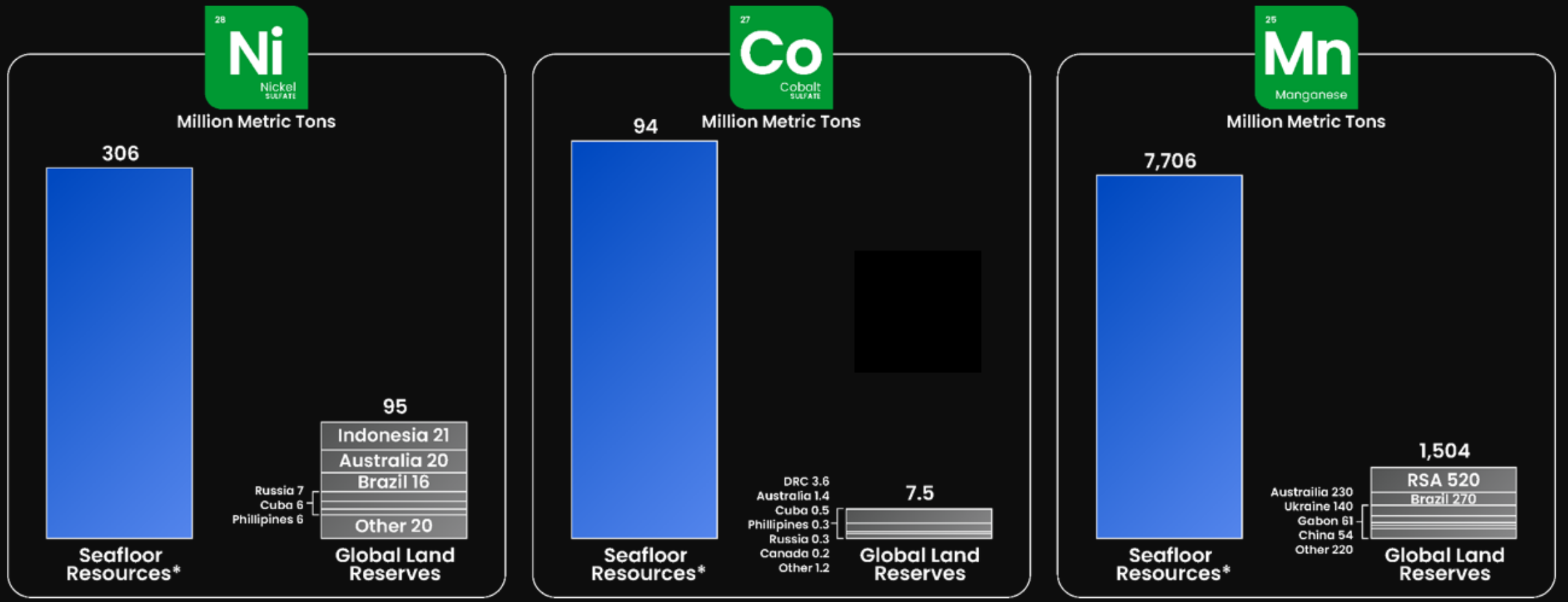
Hovers over the seafloor, picking up nodules individually, avoiding macrofauna & minimizing sediment disturbance

Click Here to Watch Now!

ESG Impacts of Land Mining

Why Deep Sea Harvesting is the Solution?

That's where most of the planet's nickel, cobalt & manganese is!



*Combined estimates for Clarion-Clipperton Zone polymetallic nodules and Prime Crust Zone cobalt crusts.

Source: USGS 2021 commodity summaries for terrestrial resources; James R. Hein, Kira Mizell, Andrea Koschinsky, Tracey A. Conrad, Deep-ocean mineral deposits as a source of critical metals for high- and green-technology applications: Comparison with land-based resources, Ore Geology Reviews, Volume 51, 2013, Pages 1-14, ISSN 0169-1368, doi.org/10.1015/j.oregeorev.2012.12.001 for CCZ nodules and PCZ crusts.

COMPARING OPTIONS

	LAND BASED MINING HARD ROCK	DEEP SEA MINING DREDGING	DEEP SEA MINING SELECTIVE HARVESTING
Technology			
Nickel Costs (AISC)	**$4.65-$1.54/lbs**	$1.23/lbs[2]	$0.69/lbs[3]
Human Rights Impacts	None to Huge	None	None
Environmental Impacts	Medium to Huge	Small	Tiny

[2] The Metals Company: Company Mineral Resource Estimation Report for NORI Area D
[3] Impossible Metals: Public Concept TechnoEconModel

We make IRA compliance possible.

Building an Efficient Critical and Rare Earth Element Circular Life Cycle

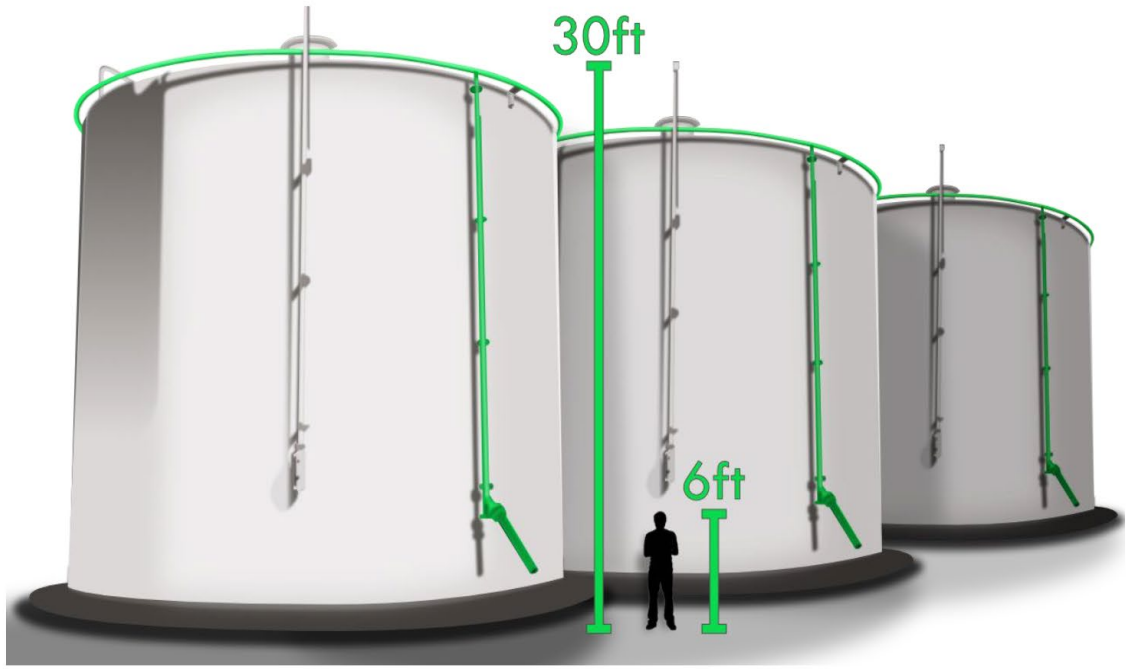
99.9%+ Pure (Neodymium · Dysprosium · Praseodymium · Lithium · Cobalt · Nickel · Manganese)

Chromatography Separation

A novel approach to a proven and longstanding technology platform achieving high-performing results.

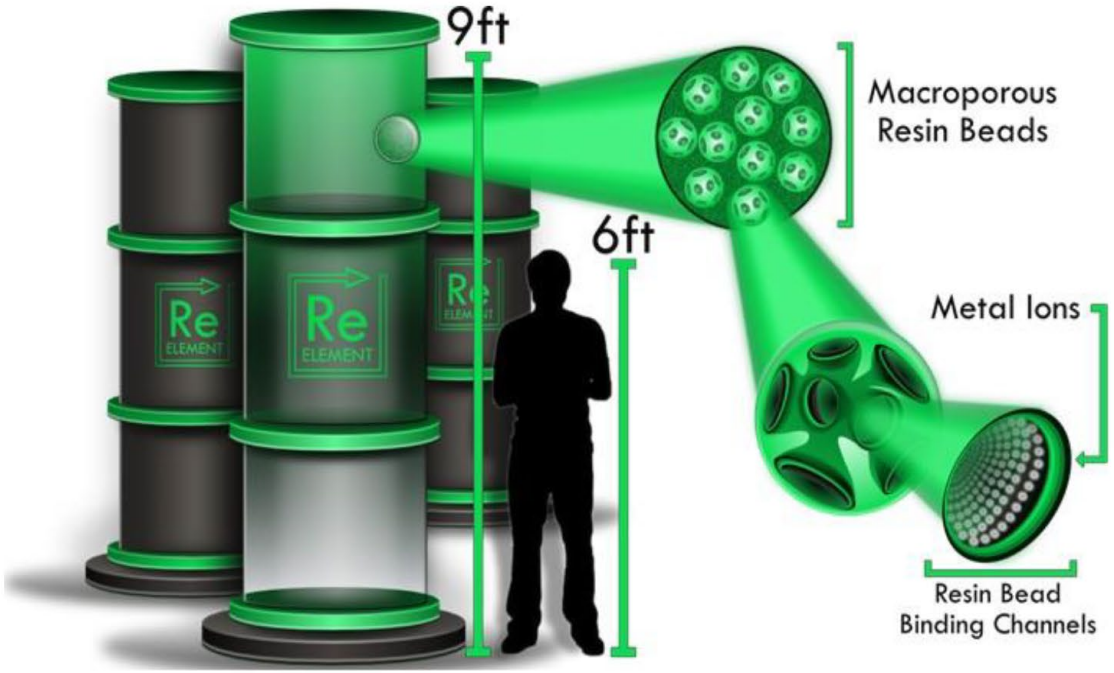
Solvent Extraction

requires > 100 mixer settlers with a large amount of toxic waste discharged creating some of the most polluted sites in the world.



Chromatography Separation

uses a much higher interfacial area utilizing low-cost inputs with almost zero waste for high-throughput production of ultra-pure materials



1 meter ~ 1 stage ⟷ **1 meter ~ 100 stages**

Success in Battery and Magnet Element Isolation & Purification

Battery Materials

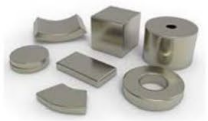
Separation and Purification of Battery Minerals to > 99.99% Purity from End-of-Life Lithium-Ion Batteries from EVs

Waste Lithium-Ion Battery from EV

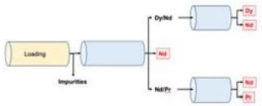
Black Mass

Multi-Mode Chromatographic Separation & Purification

Isolated and Purified Battery Elements



End-of-Life Permanent Magnets



Two-Zone LAD Chromatographic Separation and Purification

Isolated and Purified Magnet Elements

Magnet Materials

Isolation and Purification of Rare Earth Magnet Metals to > 99.5% Purity and 95% Yield from End-of-Life Permanent Magnets from Wind Turbines and EVs

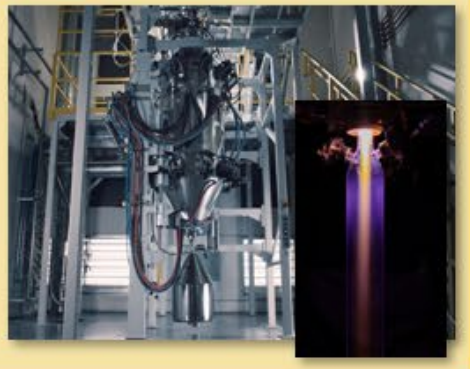
Re ELEMENT

6K is headquartered in Boston, MA with 4 operating divisions and 4 production sites throughout the USA

6K

Corporate HQ & Microwave plasma (UniMelt®) technology development

BOSTON, MA



6K ENERGY

Cathode active material

- 65% CO_2 Reduction
- 68% Less Energy

6K ADDITIVE

Premium metal 3D powders

- 92% Less Carbon Emissions
- 91% Less Energy

6K NEXT

In-house incubation

- Possible Future Markets
- PFAS Destruction
- CN Tubes

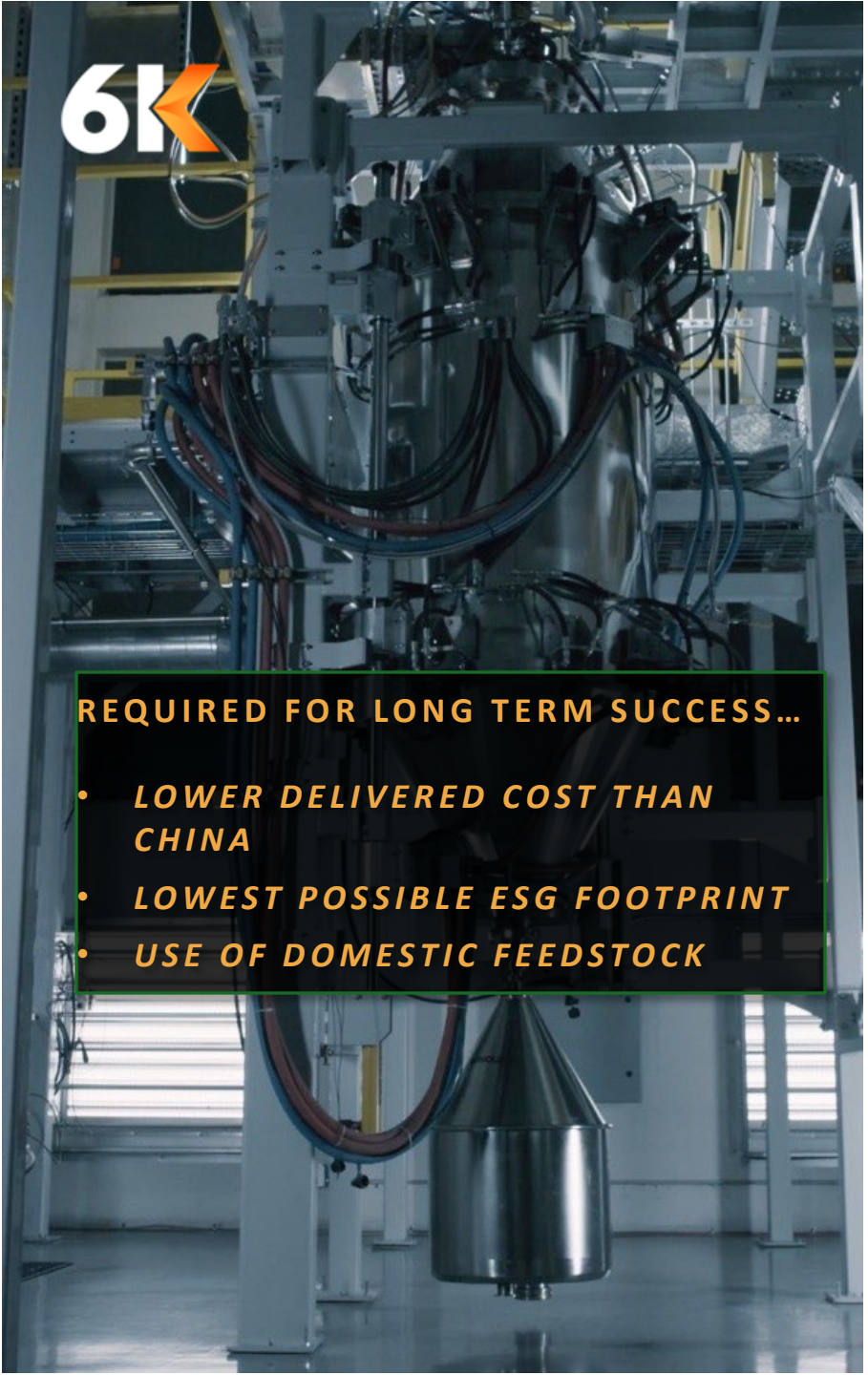
250
EMPLOYEES

4
BUSINESS DIVISIONS

>$350M
FUNDING SECURED & COMMITTED

220
PATENT FAMILIES

4
PRODUCTION SITES THROUGHOUT THE USA



REQUIRED FOR LONG TERM SUCCESS…

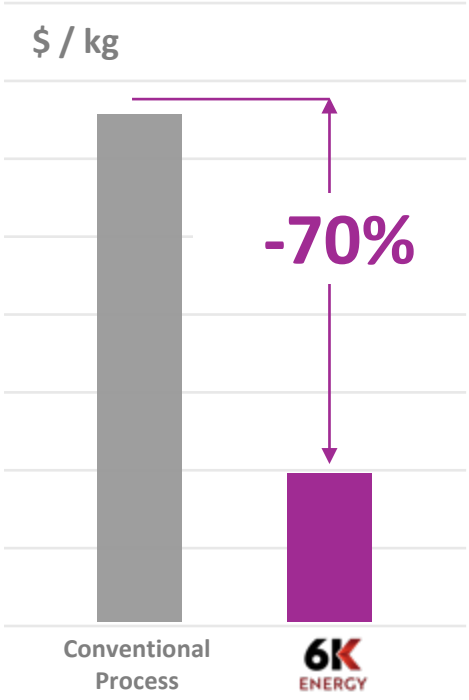
- *LOWER DELIVERED COST THAN CHINA*
- *LOWEST POSSIBLE ESG FOOTPRINT*
- *USE OF DOMESTIC FEEDSTOCK*

Cathode is the Highest Value Component of Battery, Dominating the Cost and ESG Economics

BATTERIES ARE 40% OF THE VEHICLE CO_2 FOOTPRINT AND 30% OF COST

Lower Cost

Processing Cost



ESG Benefits

ZW Zero Waste

0
Hazardous waste (ammonia/sulfates)

10x
Reduction in water usage

2x or more
Reduction in power usage & CO2 emissions

- 6K collapses production process time by 95% and 70% lower cost

WE FACE AN IMBALANCE OF SUPPLY AND DEMAND

Localization of lithium-ion battery cathode production is critical to ensuring a secure supply chain

6K's Solution will have profound economic and environmental benefits to industry

BY 2030 IF 6K'S SOLUTION IS ADOPTED:

- **360 billion tons CO_2 savings***

  360 tons CO_2 saves the equivalent of planting 3 billion trees

- **Save 1.8B Olympic pools of waste***

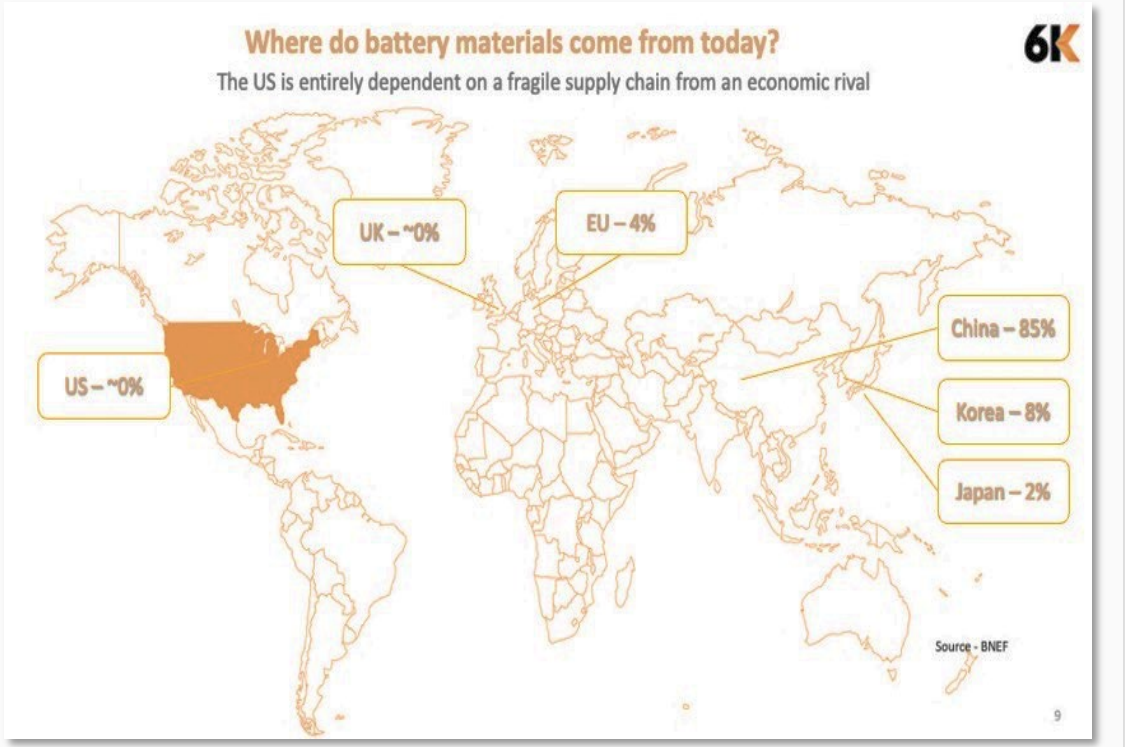
  Today's sodium sulfate effluents are often dumped in rivers/oceans

- **Save Industry $26B**

  Save >$500 per car, enabling billions of dollars of savings for car manufacturers, direct to bottom line

*over a 5 year period

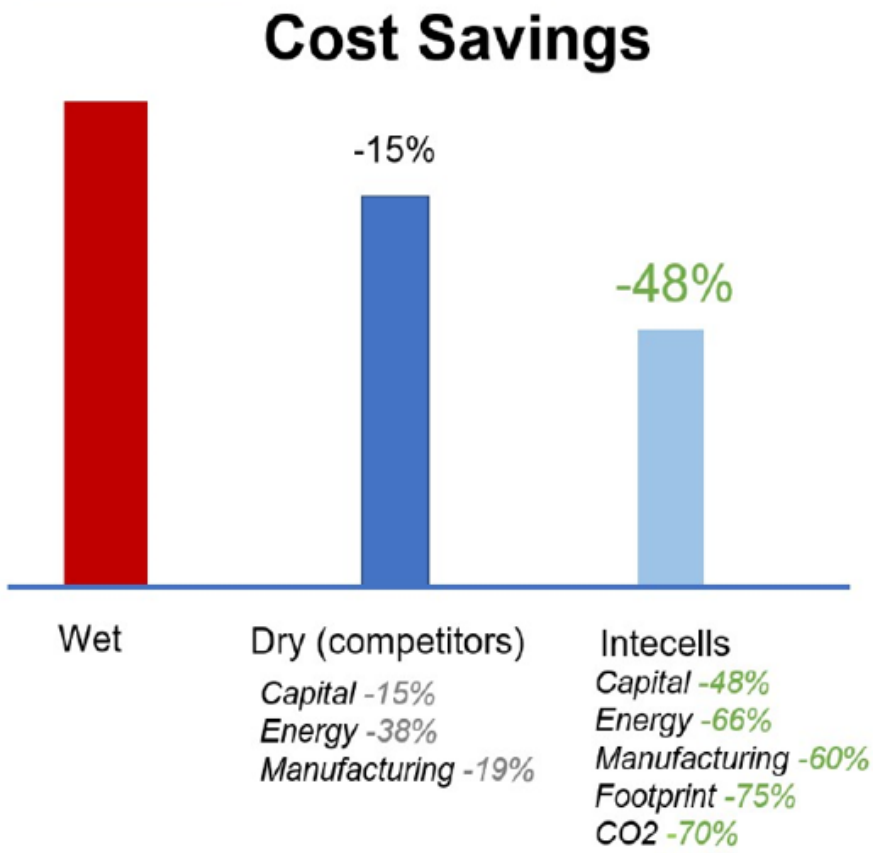
96% of Cathode Supplied by ASIA Today
0% Produced in the US

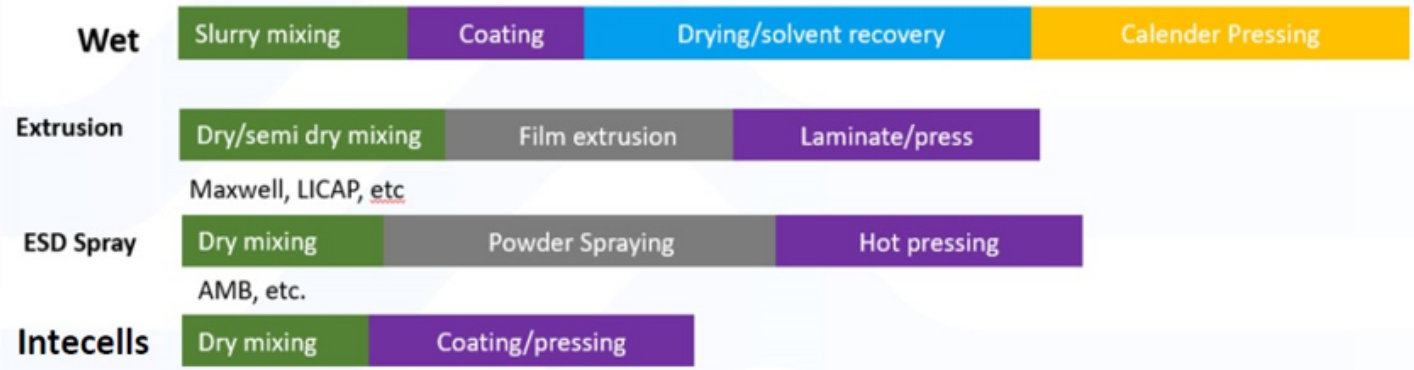


If we simply copy China, we will establish a domestic cathode capability that will never be competitive
The solution: don't try to beat them at their own game, change the game

INTECELLS®

Intecells: Significant costs and CO2 savings





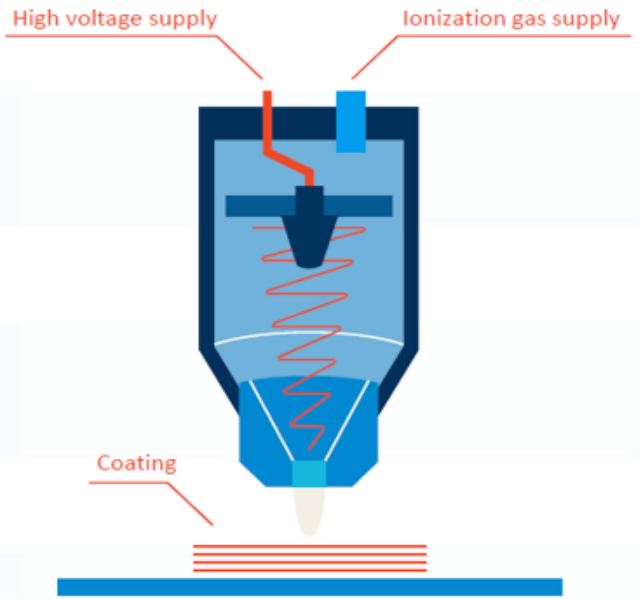
INTECELLS®

High-performance dry electrode technology

Conventional process

Source: iScience

Intecells 1-step process

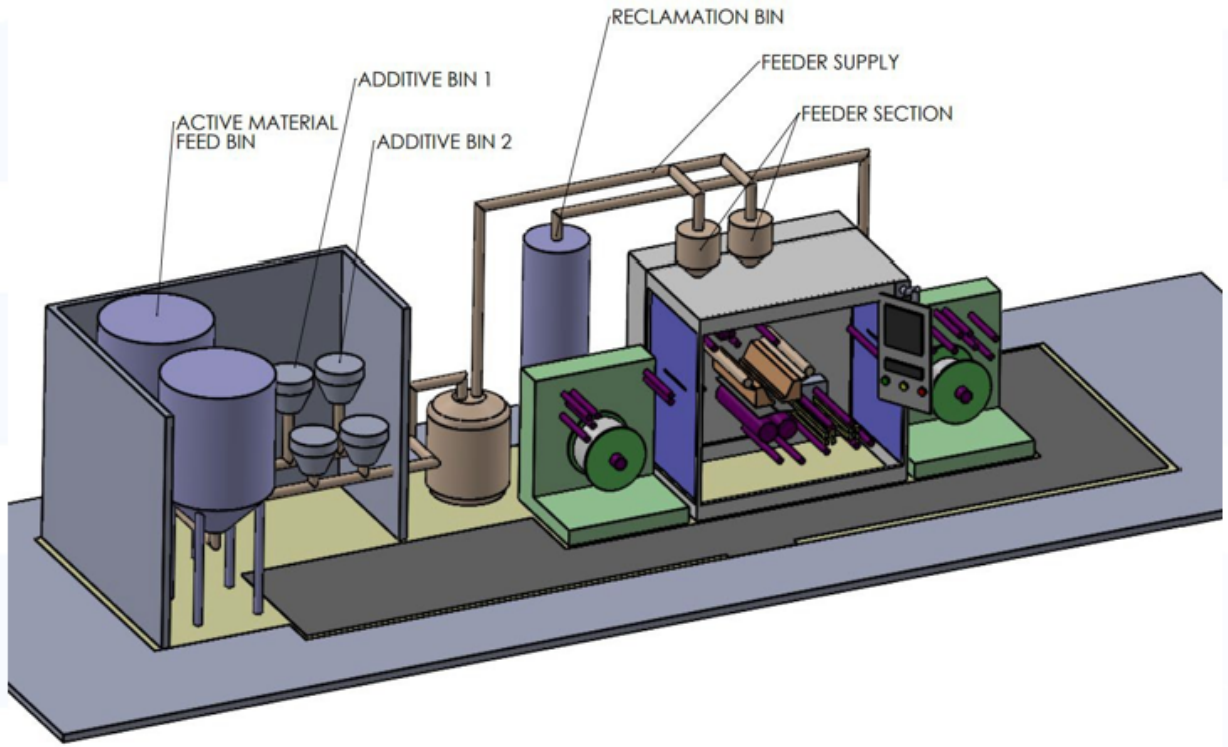


Process steps : **-30%**

Manufacturing cost: **-60%**

INTECELLS®

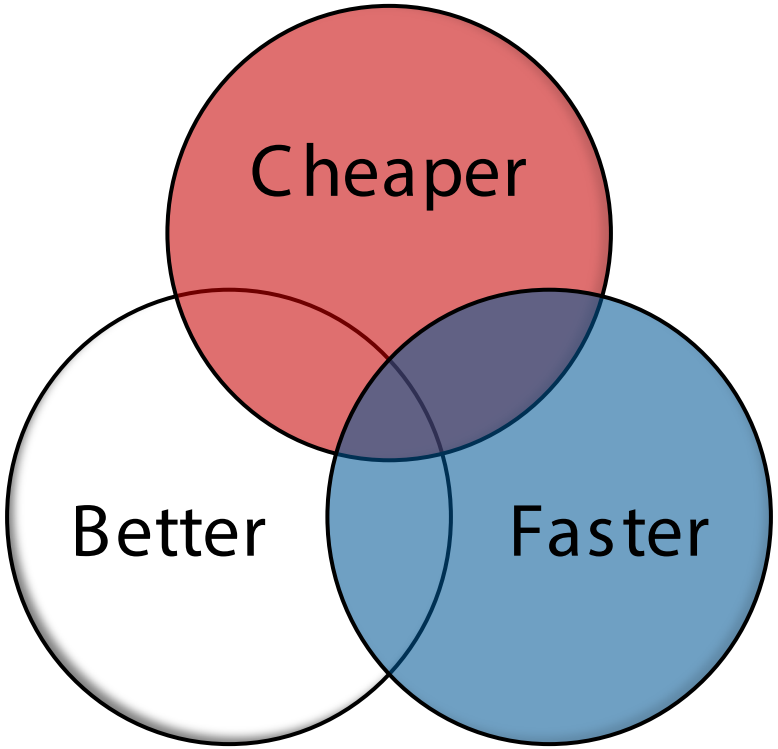
Electrode coating equipment for production



- Intecells designs and builds dry electrode production systems
- This technology will be applied to making solid-state batteries in the future

GIM DC: How do we compete globally?

Unified Theme



Vertical Stack Concept

	Cheaper	Better	Faster
Harvesting	$	Q	T
Processing	$	Q	T
Creation	$	Q	T
Process N	$	Q	T

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