



On the Path Towards Domestic Production of Li-ion Batteries

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- Officer, MPSC
- Officer, NAATBatt
- Expert, SAE International



- Global leader in specialty chemicals via nano-coatings
- Technology improves Li-ion battery performance and safety, universally for any application (Additive, Magnetics, Propellants, Semiconductors, etc..)
- On track to become a US cell supplier to specialty markets (1GWh+ in 2026)



- Public private partnership positioned as industry-side of the Federal Consortium of Advanced Batteries (FCAB)
- 50+ companies addressing supply chain challenges for Li-ion batteries with ties to European Battery Alliance (EBA)



- Non-profit dedicated to supporting communication and effective collaboration between DoD and industry pertaining to energy and power
- Data collection and networking aimed at providing recommendations for funding and policy



- Industry trade-group composed of leaders in the Li-ion battery industry
- Promotes development and commercialization of energy storage technology



- World's leading authority in mobility standards development
- Advanced Battery Concepts Committee developing standards, ratings, vocabulary, ect... Li-ion standardization

NDIS Strategic Priorities

- Resilient supply chains that can securely produce the products, services, and technologies needed now and in the future at speed, scale, and cost.
- Workforce readiness will provide for a sufficiently skilled, and staffed workforce that is diverse and representative of America.
- Flexible acquisition will lead to the development of strategies that strive for dynamic capabilities while balancing efficiency, maintainability, customization and standardization in defense platforms and support systems. Flexible acquisition strategies would result in reduced development times, reduced costs, and increased scalability.
- Economic deterrence will promote fair and effective market mechanisms that support a resilient defense industrial ecosystem among the U.S. and close international allies and partners and economic security and integrated deterrence. As a result of effective economic deterrence, fear of materially reduced access to U.S. markets, technologies, and innovations will sow doubt in the mind of potential aggressors.



The National Defense Industrial Strategy (NDIS)

Enabling a Modernized Defense Industrial Ecosystem



Outline

State of the Li-ion Battery Industry

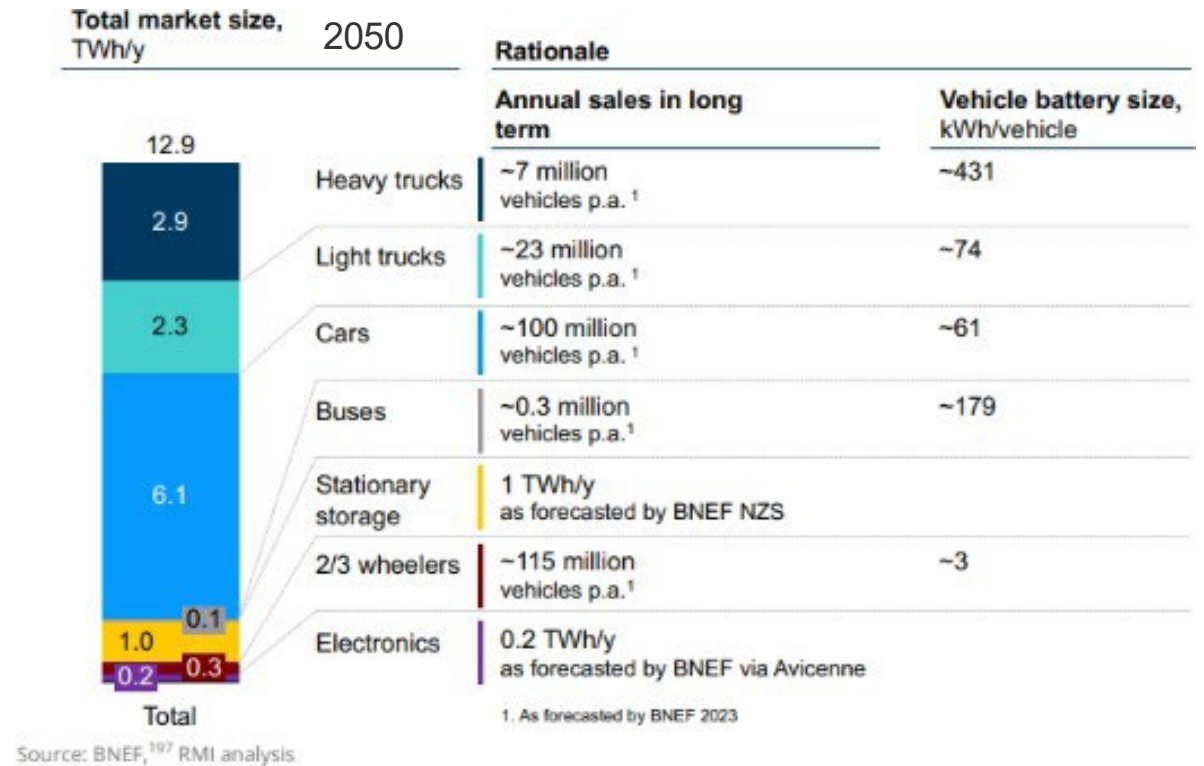
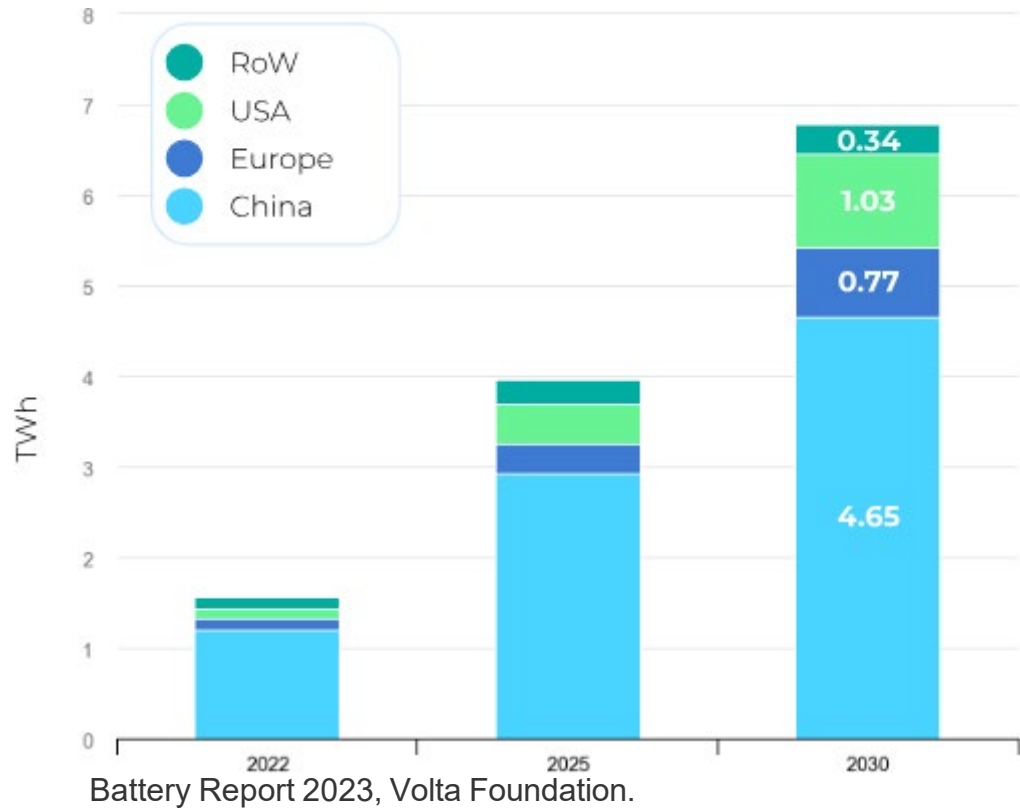
Challenges

More Challenges

Progress Towards Domestic Production

Next Steps

Energy Storage in the US



US Li-ion energy storage needs are growing, led by transportation

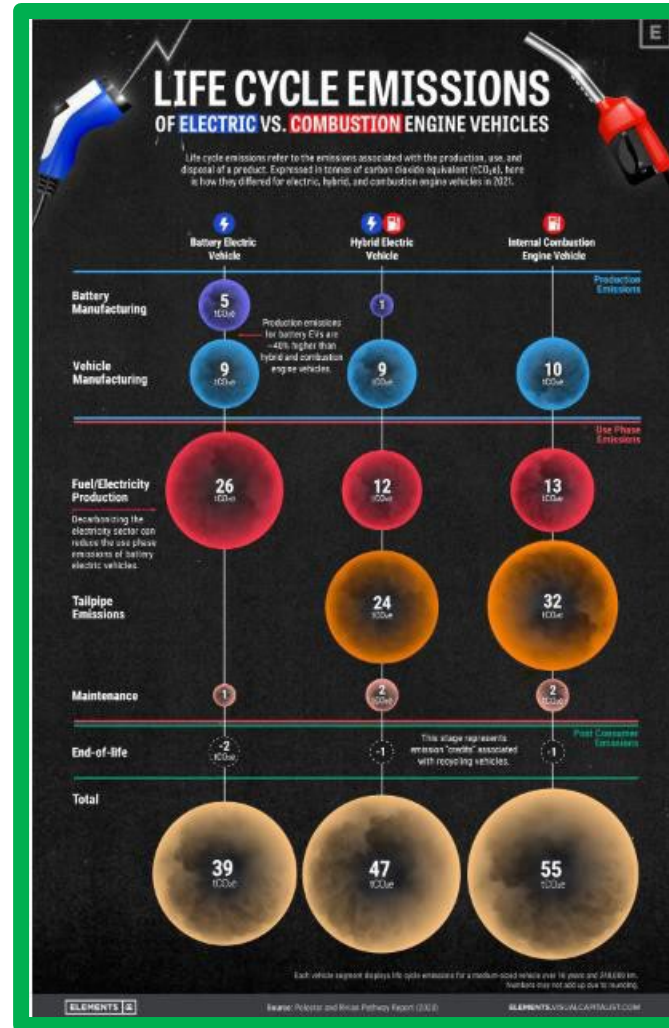
Pros and Cons of Li-ion

Societal Improvements

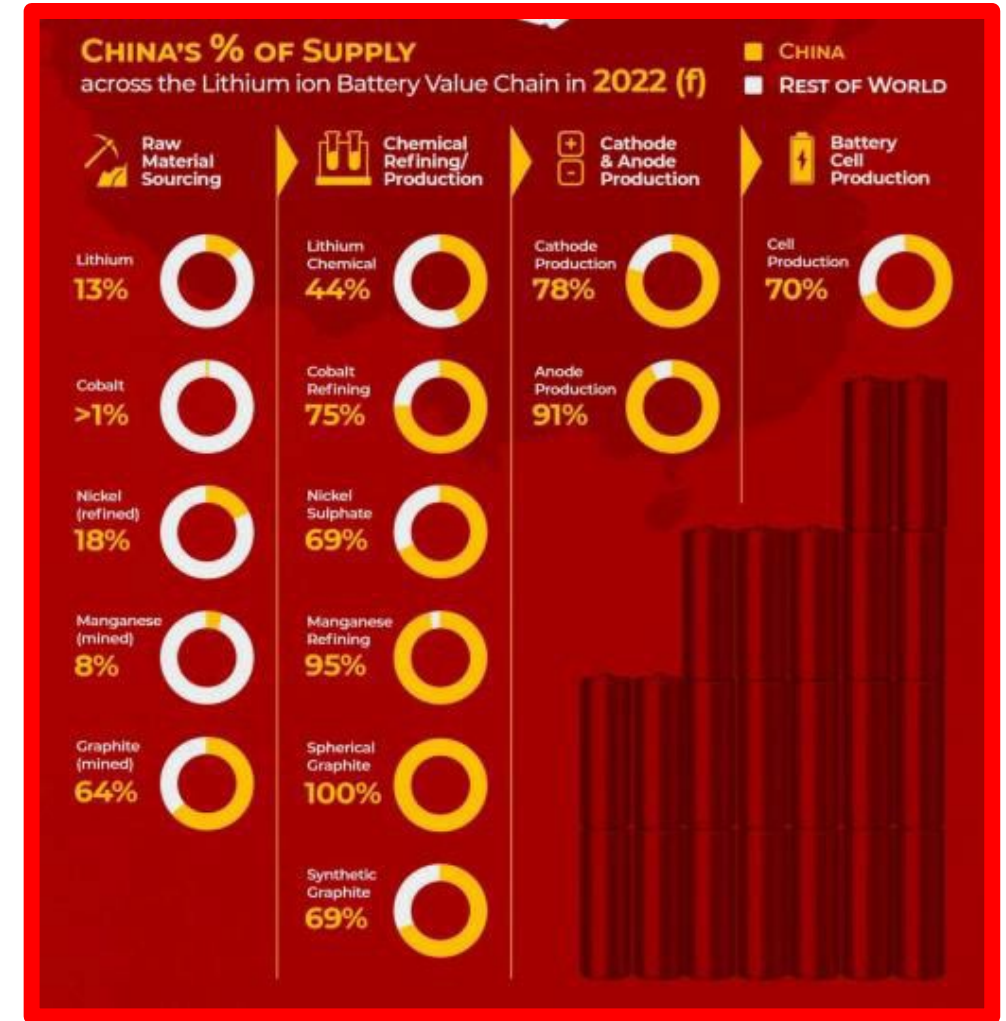
- Environmental improvements
- New Opportunities (drones)
- Consumer Savings (and fun!)

Problem

- US has created a supply chain dependency on China for Li-ion



Visual Capitalist, 2023.

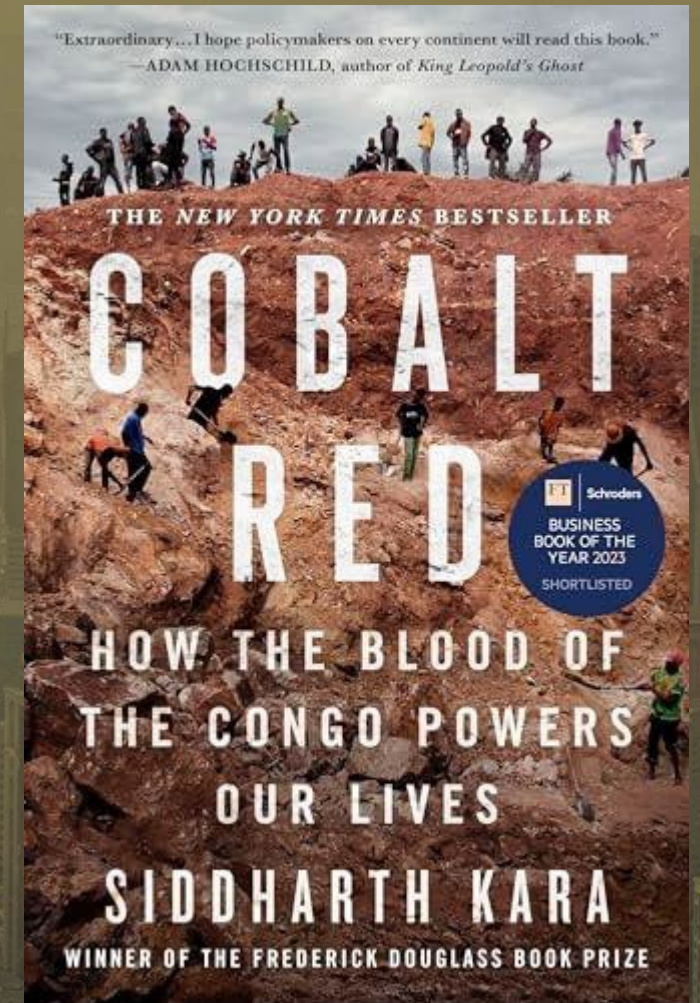


Benchmark Mineral Intelligence, 2022.

The US Has Stumbled Into A Significant Reliance Upon China For Lithium-ion Batteries Which is a Resiliency Risk

Why is a Chinese supply chain a problem?

- FEOC in control of the on/off switch for Lithium-ion Batteries is a national security risk
- US usage of FEOC fuels it, loosing value capture, new technology opportunities, and jobs
- China puts zero value on worker safety, responsible sourcing, and pollution



A Chinese-dominant supply chain creates national security risk and supports an unethical supply chain

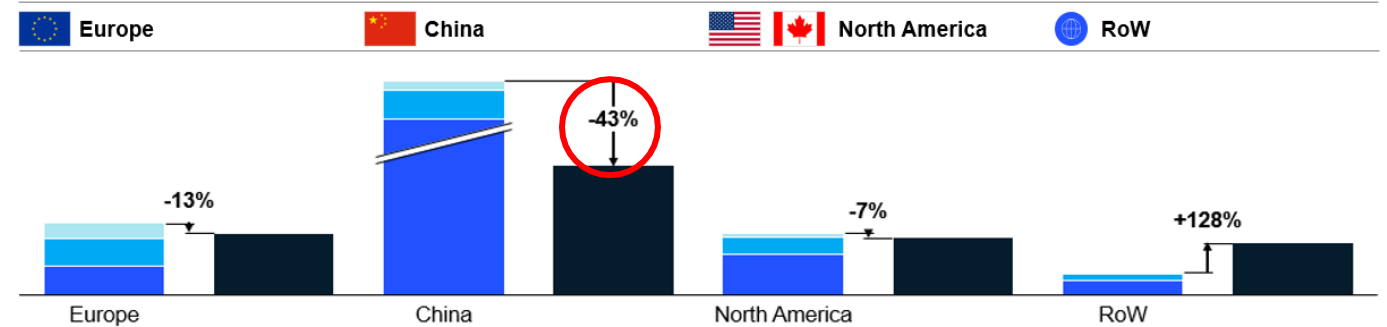
What is the US doing to course correct?



- **Government Reports**
 - EO14017, 100-day, National Blueprint, NDIS
- **Alignment with Industry**
 - Li-Bridge, MPSC, NAATBatt, Companies
- **Long Term Strategy**
 - **BIL, IRA, Title III**

- **US has a long way to go to address all the challenges**

Adjusted supply and Demand of Li-ion battery cells, GWh, 2030



McKinsey at NAATBatt, 2024.

The US is doing a great job gaining alignment between government and industry, but has a long way to go

Challenges

Flexible Acquisition

Resilient Supply Chain

Workforce Readiness

Economic Deterrence

■ Government action
■ PPA action
■ Industry action
 [L] Legislative action needed
 [E] Executive action needed

Primary Challenges

- Capital Investment (Risk)
- Permitting
- Workforce
- Government Industry alignment
 - Difficult because industry doesn't have a consistent voice
- Getting off the ground in the wake of global over-supply

Objective	Jumpstart investment		Support ramp			Position for economic security				2030 targets	
	2022	2023	2024	2025	2026	2027	2028	2029	2030		
① Improve investment attractiveness	1.1. Capex incentives: Expand incentives to offset capex for upstream, midstream, and next-gen downstream capacity [L]										>15% ROCE
	1.2. Production incentives: Expand incentives to offset production-related costs (e.g., production tax credit) [L]										+\$100B+ investment through 2030
	1.3. R&D incentives: Study incentive options [E,L]		1.3. R&D incentives: Implement incentives to encourage private R&D investment take place in the US [L]								>10% market share for cell mfg. equipment
							1.4. Demand incentives: Expand point-of-sale incentives beyond light-duty vehicles [L]				
							1.5. Government procurement: Support demand signal for next-gen tech [L]				
② Support innovation and accelerate pathway to commercialization	2.1. R&D investment: Expand R&D investment related to lithium battery technology, materials, and manufacturing equipment and processes [L]										<1 month lead time from lab to pilot ⁸
	2.2.a. Pre-industrial-scale production lines: Define industry needs & existing inventory		2.2.b. Pre-industrial-scale production lines: Launch scale-up ecosystem (e.g., shared pilot line network) [L]			2.2.c. Pre-industrial-scale production lines: Expand scale-up ecosystem					
	2.3. Standards: Promote the creation and codification of industry standards to reduce operating complexity										
	2.4. Commercialization support: Support early-stage U.S. firms with access to commercial and technical advisors and assist with patent filing [L]										
③ Secure access to critical minerals and low-carbon infrastructure	3.1.a. Improve predictability and speed of upstream permitting ² [E]		3.1.b. Permitting reform: Harmonize federal, state, and local permitting processes [E]								<2 years to secure permit approval
	3.2. Critical minerals database: Expand/accelerate nat'l database of critical mineral resources [E]										-380 kt LCE
	3.3. Buying consortium: Support industry consortium with purchasing battery-related critical materials from domestic and foreign sources										>95% collection of lithium batteries
	3.4. Foreign partnership: Support resource exploration & extraction in foreign countries through financing and partnership [E]			3.5.a. Circularity: Establish regulatory framework for EOL responsibility ⁴ [E]							
	3.5.b. Circularity: Harmonize regulations for transporting waste batteries [E]			3.5.c. Circularity: Support recovery and use of domestically recycled content [L]							
	3.6. Trade control: Recalibrate ² [E]		3.7. Critical minerals sea mining: Study and remove uncertainty [L]			3.8. Stockpile: Bolster critical mineral stockpile [L]					
	3.9. Infrastructure: Invest in more clean energy generation and upgrade port and rail systems [L]										
	3.10.a. Industrial zones: Define industry criteria		3.10.b. Industrial zones: Select and designate industrial zones for financial support and streamlined permitting ⁶ [L]								
	3.11.a. Develop handbook... ⁷		3.11.b. Community engagement: Deploy community engagement teams to build support and accelerate approval								
④ Address know-how gaps	4.1. Curricula development: Assess skills gap & build curriculum [E]		4.2. Curricula deployment: Implement workforce training/educational curricula for schools and upskilling for oil & gas and autoworkers [L]								>100 k jobs
	4.3. Training support: Support training & educational programs to expand talent pipeline (e.g., scholarships, apprenticeship, etc.)										
⑤ Establish U.S. public-private alliance (PPA)	4.4. Technical exchange: Implement international technical exchange program ⁸ [E]										
	5.1. Execute PPA: Coordinate recommendations and facilitate industry / federal battery initiatives										

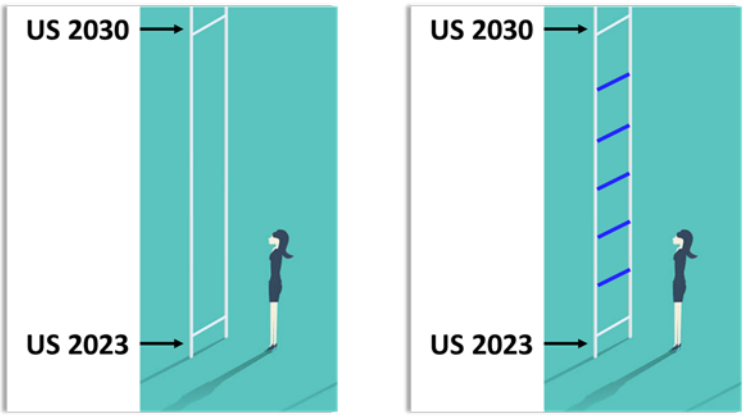
1. Include incentives for MHDV EVs, ESS, aviation, etc. and attach domestic content requirements to incentives to support US mid-stream and upstream suppliers 2. Increase LIB export limit on Wassenaar Agreement 3. E.g., set deadlines, enhance transparency, reform appeals process 4. Regulatory framework is industry-led (proposed) but requires government adoption to implement 5. Targeted and time-limited visa expansion and attaching additional requirements for knowledge transfer 6. Through permitting pre-approval, infrastructure build out, etc. 7. ... for community engagement best practices 8. Time delay to find suitable pilot line and wait for available capacity to make and test material/cell of interest; target value based on China benchmark, according to expert interview
 Note: Initiative timelines are approximate, Government financial support subject to sunset provisions in mid-2030

The US must define and achieve a wholistic solution and prepare for some 'pain' in order to 'gain'

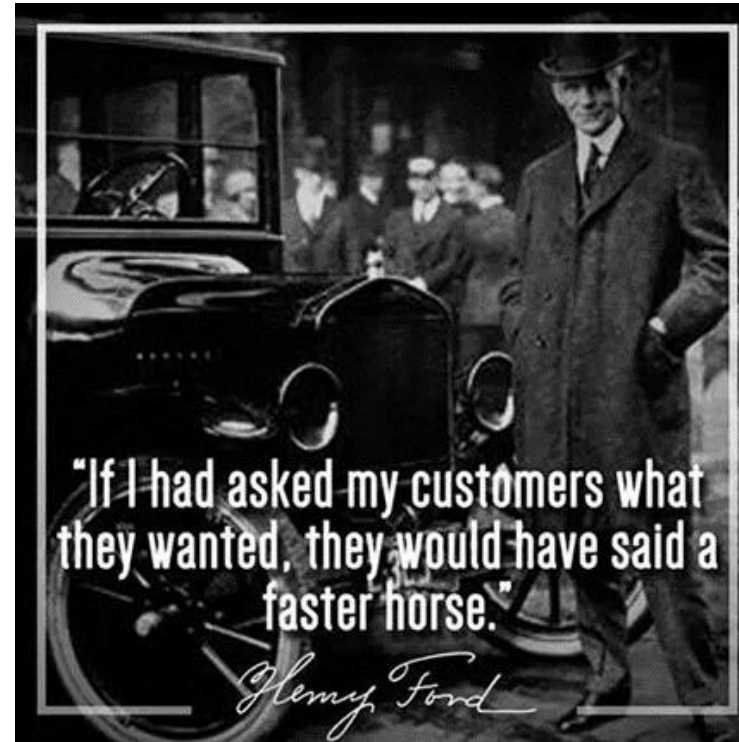
Challenges Continued

- The US can't 'lead' by copy/pasting (leadership undefined still)
- Only way to lead is to innovate, or, "leapfrog"
- 55% of innovators in Li-ion space are looking to offshore partners due to lacking US infrastructure to properly demonstrate scaling success
 - Li-Bridge Pilot Line Focus

Achieving US leadership



The US is lacking the underlying infrastructure necessary to keep and utilize new innovations in energy storage.



**55%
Innovation
Leakage**

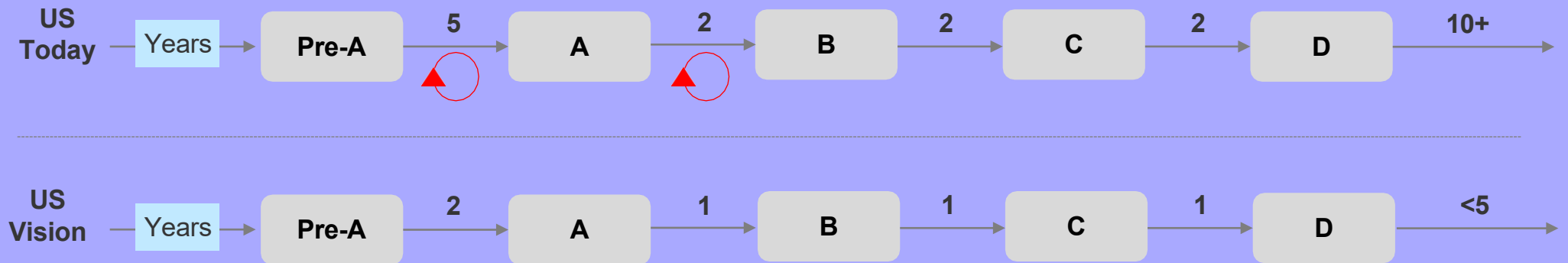
Beyond the industry-government alignment issues, the US needs to build a framework for success

A Key Issue Under the Radar: Noise

Class	Stage	Cell form factor	Scale	Note
Pre-A	Demo	Any	10's	Basic R&D, TRL 1-3
A	Concept validation	Close/Final	100's	Pilot R&D, TRL 3-4
B	Design validation	Final	1000's	Pilot Manufacturing, TRL 5-6
C	Production validation	Final	10's MWh+	Lite Manufacturing, TRL 6-8
D	High volume manufacturing	Final	10's GWh+	Large Scale Manufacturing, TRL 9



Goal to keep and implement US innovation faster to achieve global leadership

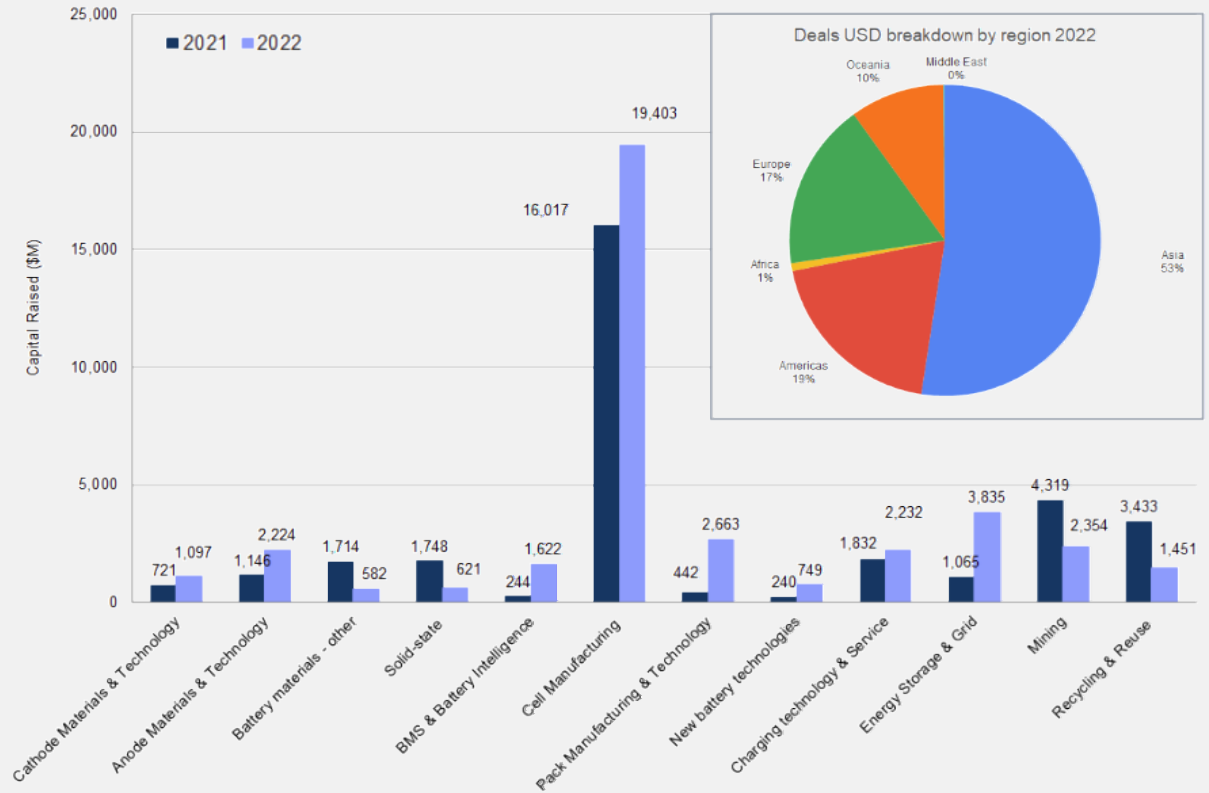


Noise is causing high risk and government-industry misalignment

Where to Focus?

- Cell Pilot Lines
 - Cells are the pinch point even though entire supply chain needs attention
- Workforce
- Recycling

Total investment in the battery sector continues to grow year on year



SUPPLY CHAINS WILL NEED TO BE DEVELOPED TO HIGHER ESG STANDARDS, ADDING COMPLEXITY & TIME



Geopolitical



Environmental



Social



Technological

Doing things the right way, will add hurdles to supply chain scaling, and change the shape of global trade...



... it also runs the risk of stunting growth, narrowing trade opportunities, and worsening EV economics...

Initial focus on pilot line processing, workforce, and recycling

Key Insights from Recent Li-Bridge Study

1

Support for expanding current providers and regional COEs

2

Distribution of demand throughout US (but quality first and foremost)

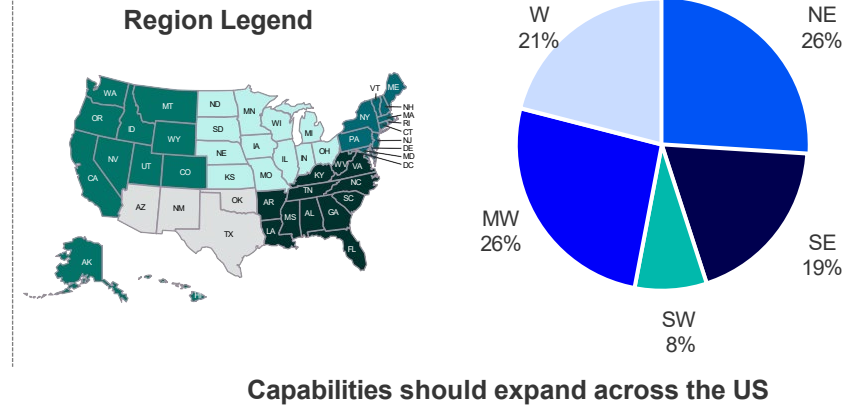
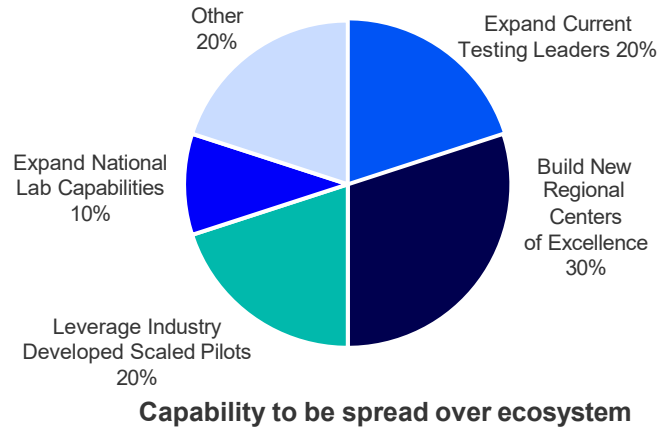
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Focus on final-format cylindrical and prismatic cell formats

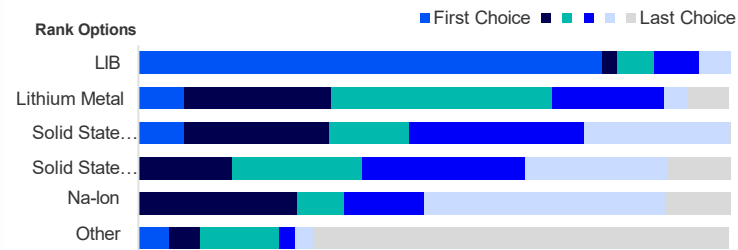
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Diverse chemistry interest, but focus still on Li-ion & Li metal

What does success look like?

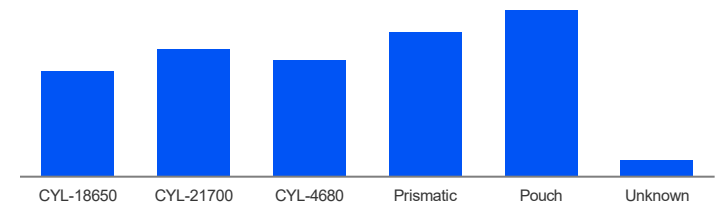


Which Battery Technologies Are Most Relevant For Your Company's Developments Over the Next 7 Years?



Focus on Li-ion and Li-metal battery types

Survey Question: Which format(s) would be most relevant for your efforts and your customers?



Focus on cylindrical and prismatic cell types

Survey results indicate lowest-risk pathway to leadership, Li-ion, high quality, and final format processing

Workforce: Skill Gaps

INDUSTRY-WIDE GAPS

Electrochemistry / Battery Chemistry

Manufacturing

Battery management systems (BMS)

Product & system design

Safety

Battery Recycling

UPSTREAM GAPS

Chemistry/ Chem. Engineering,

Extraction / Mining,
Metallurgical/ Mineral Processing

DOWNSTREAM GAPS

Electrochemistry/ Battery Chemistry

Battery Materials

(Chem. Eng. & Materials science)

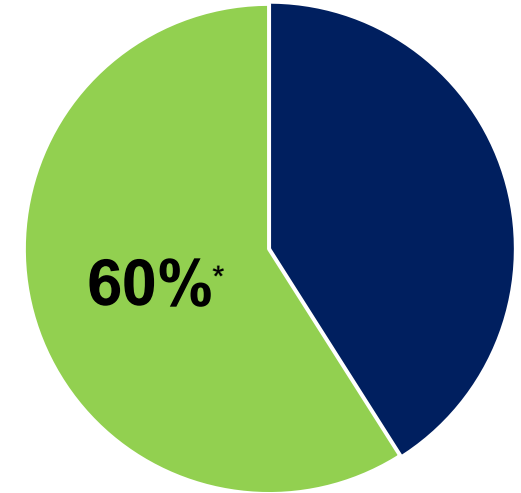
Battery Management (BMS)

ADVANCED MANUFACTURING

Materials science,

Chemistry/ Electrochemistry,

Managing / operating automated tools



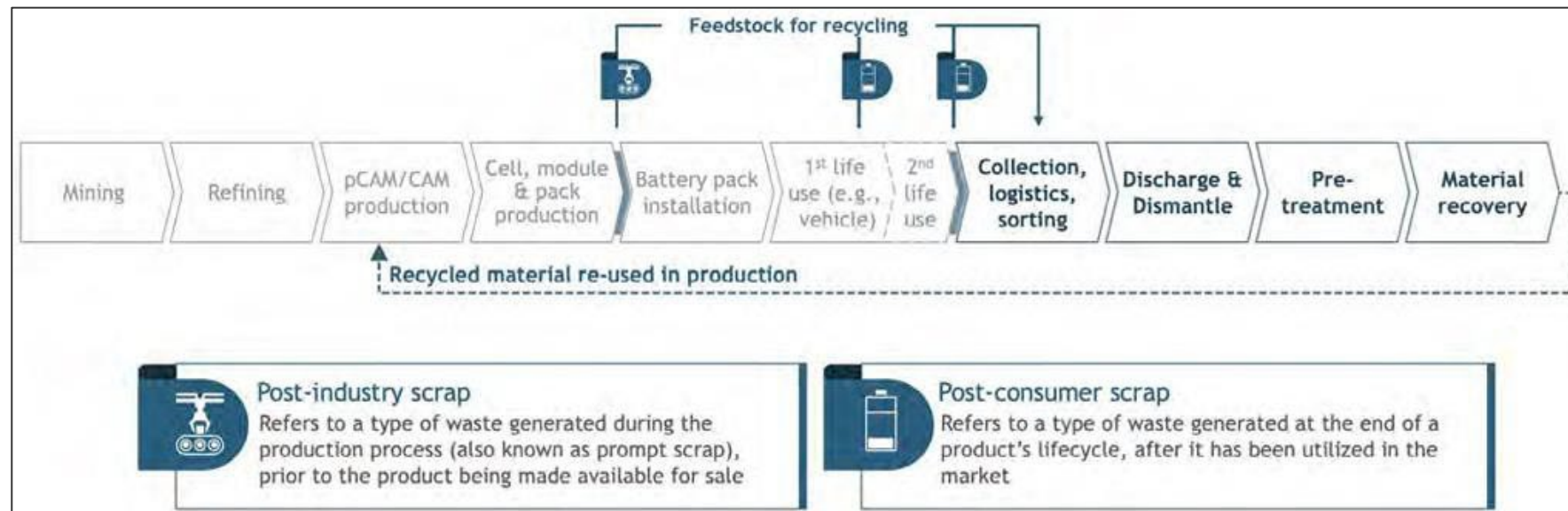
**Percent reporting 25-100% of employees with outdated skills*

<https://nabwc.org/>

All sectors of workforce need support, need on-the-job training and long-term education

Key End-of-Life Burdens

- **High processing costs** relative to the intrinsic value of certain battery chemistries and cell components
- **Nascent pathways to recycle batteries in sufficiently large volumes** for a fully domestic circular economy
- **High labor intensity** in collection, sorting, and disassembly
- **Lack of customized classification** frameworks for lithium-based battery storage and transport
- **Lack of knowledge of occupational and environmental health risks** and the absence of occupational health and safety best practices



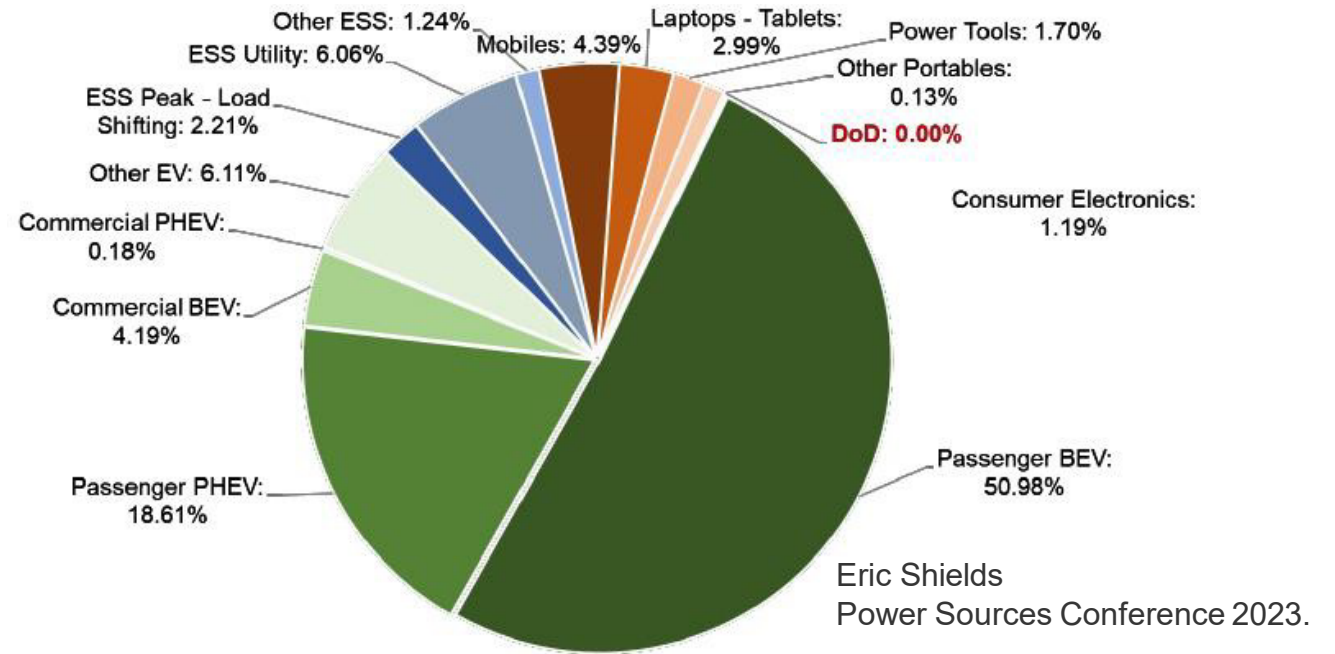
What about the DOD?

Challenges

- Small demand in grand scheme
- Bad customer
- Want to feed off industry but have dissimilar needs (18650 as best-case)
- Primes

Opportunities

- Positioned well to catalyze early scaling efforts (the pilot line network) with low-volume demand
- Existing funding vehicles can accelerate future developments on the pilot line network



Need standards for form factor, quality, and/or performance

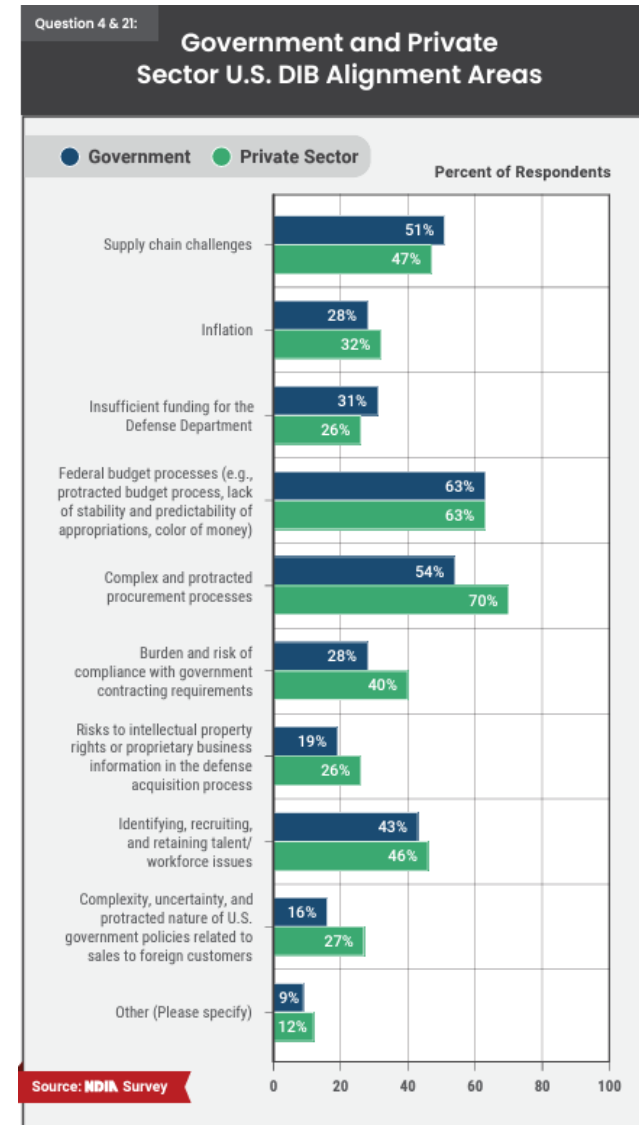
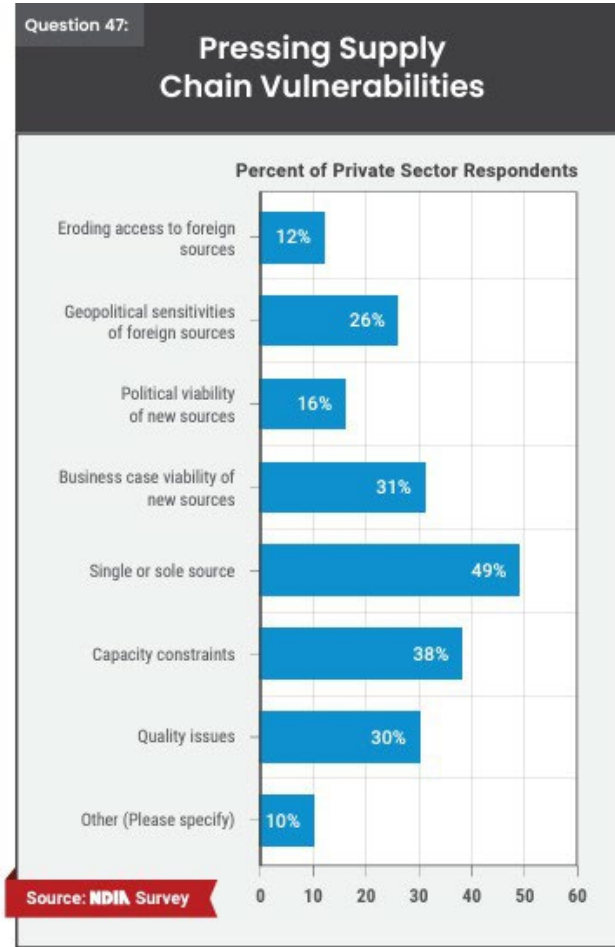
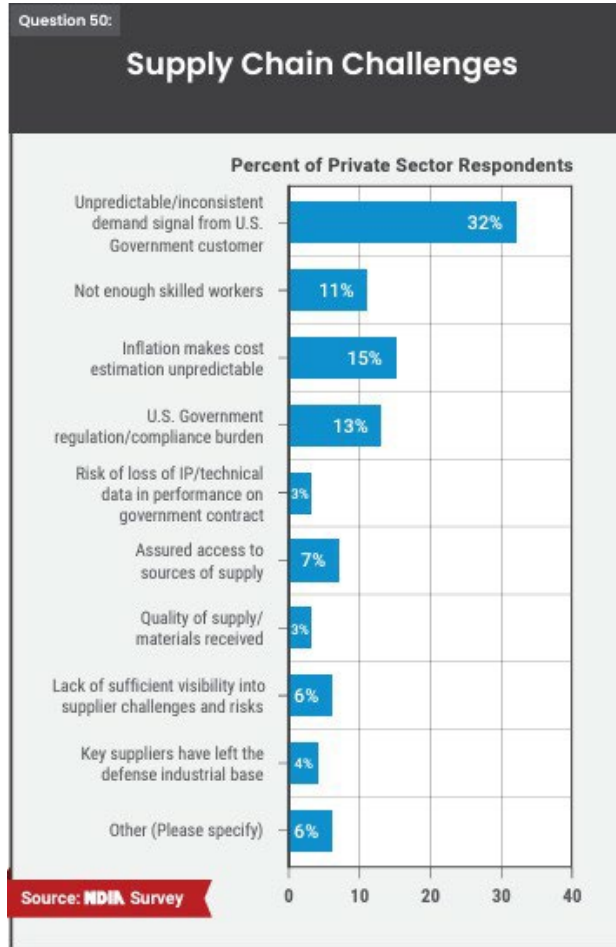
Need a clear demand signal (*cells or investment*)

Need immediate access/capability for next-gen performance

Need a network of cell providers

The DOD has some unique challenges but is well positioned to support US leadership long-term

Familiar?



Is the US government its own biggest enemy?

NDIA Vital Signs shows consistency of issues outside of Li-ion (US much-needed return to manufacturing)

Next Steps to Address Li-ion as Part of Maturing US Manufacturing

- Government-Industry Alignment is Critical
 - Policy to Prevent Mindful Oversupply (need to overcome procurement managers)
 - Identifying and Capitalizing on Strengths of Government Services and Industry Organizations
 - Early Focus on Specialty Markets (thanks BIL)
- Support of Supply Chain Localization and Partnerships
 - Maximize value capture while reducing risk and cost
- Supporting a Framework for Success
 - Cell-Focused Complete Pilot Line Network
 - Reduced Risk
 - Workforce Training Pipeline
 - Investment Attractiveness
 - New Technology Investment and Retention

NDIS Strategic Priorities

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The US is making great progress but must continue working towards long-term alignment to be successful



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Food for Thought

- When factoring in population estimates for 2030 the TWh per person for China and US are nearly equivalent (~3 TWh/Billion).
- Has China already achieved the US 2030 goal (~\$50/kWh)? Or is it a shell/marketing game (example, solid-state)?
- Can we bear the pain to turn China's strength into a weakness?
- Is there an acceptable amount/type of risk when it comes to China? Is it physical goods only, or all-encompassing?