

Expeditionary Power- and Energy-Dense Implementations (ExPEDitions)

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ExPEDitions Proposers Day

May 14, 2026





Start	End	Duration	Item
11:30 PM	12:00 PM	0:30	Check-In/Arrival
12:00 PM	12:10 PM	0:10	Welcome and Logistics
12:10 PM	12:40 PM	0:30	ExPEDitions Technical Program Overview <i>Dr. Keith Whitener</i>
12:40 PM	12:55 PM	0:15	Working with DARPA <i>DARPA/Contracts Management Office</i>
12:55 PM	1:15 PM	0:20	<i>Break</i>
<i>All questions submitted to ExpEDitions@darpa.mil by 12:55 PM</i>			
1:15 PM	3:00 PM	1:45	Lightning Talks <i>Teaming presentations (5 min. each)</i>
3:00 PM	3:15 PM	0:15	<i>Break</i>
3:15 PM	4:00 PM	0:45	Q & A <i>Only questions submitted by 12:55 PM will be answered</i>
4:00 PM Meeting Adjourns			

**Proposers submit questions prior to 12:55 PM for Q&A at 3:15 PM
(All attendees: please email ExpEDitions@darpa.mil to submit questions today)**



- Meeting Classification Level
 - Unclassified Information
- The meetings participants list is being closely monitored
 - Only registered meeting participants are approved
 - We will admit, mute, and remove participants as needed throughout the event
- Mute yourself when not speaking
 - Moderators will mute participants as needed
 - Call in numbers *6 to unmute (if necessary)
- Screen captures of the data presented is not permitted
 - Please reach out to the DARPA team if you have questions on the information being presented

This Meeting is Being Recorded for Data Archive Purposes



- The Proposers Day briefing is intended to provide an orientation to the ExPEditions Program Solicitation (PS) and is solely for information purposes
- The solicitation supersedes anything presented or said by DARPA at the Proposers Day: In the event of a PS posting, if there is any discrepancy between what is presented today and the anticipated PS, the PS takes precedence.
- Examples in this briefing (e.g., technologies, use cases) are chosen for ease of illustration only and do not constitute endorsement of any particular approach
- Interested performers are expected to be able to articulate a clear and compelling vision for their technology, proposed course of research, and transition potential
- We need your help to make this program a success!

H2: Fuel-based drivetrain endurance currently beats electric systems but requires complex logistics

Electric System benefits:

- Efficient
- Silent
- Rechargeable without fuel supply
- *The overlooked factor: High specific power of the full drivetrain*

So why don't we use it already?

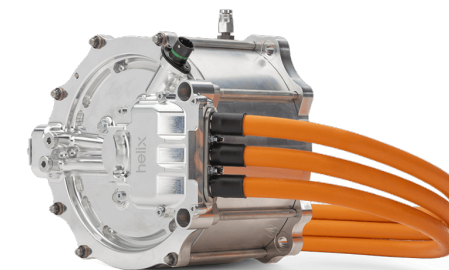
*Bulky batteries with low energy density
= limited mission endurance and range*

Electric motors are much lighter than ICE engines

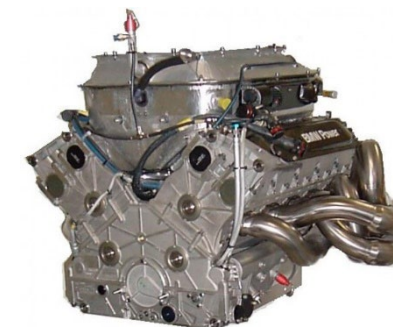
Electric systems are direct drive, while engines often use heavy transmissions

Summing up: if batteries could reach a threshold of $\sim 2 \text{ kWh/kg}$, they would surpass fuel-powered drivetrains in power, energy, and endurance.

**880 hp motor:
Electric vs ICE.**

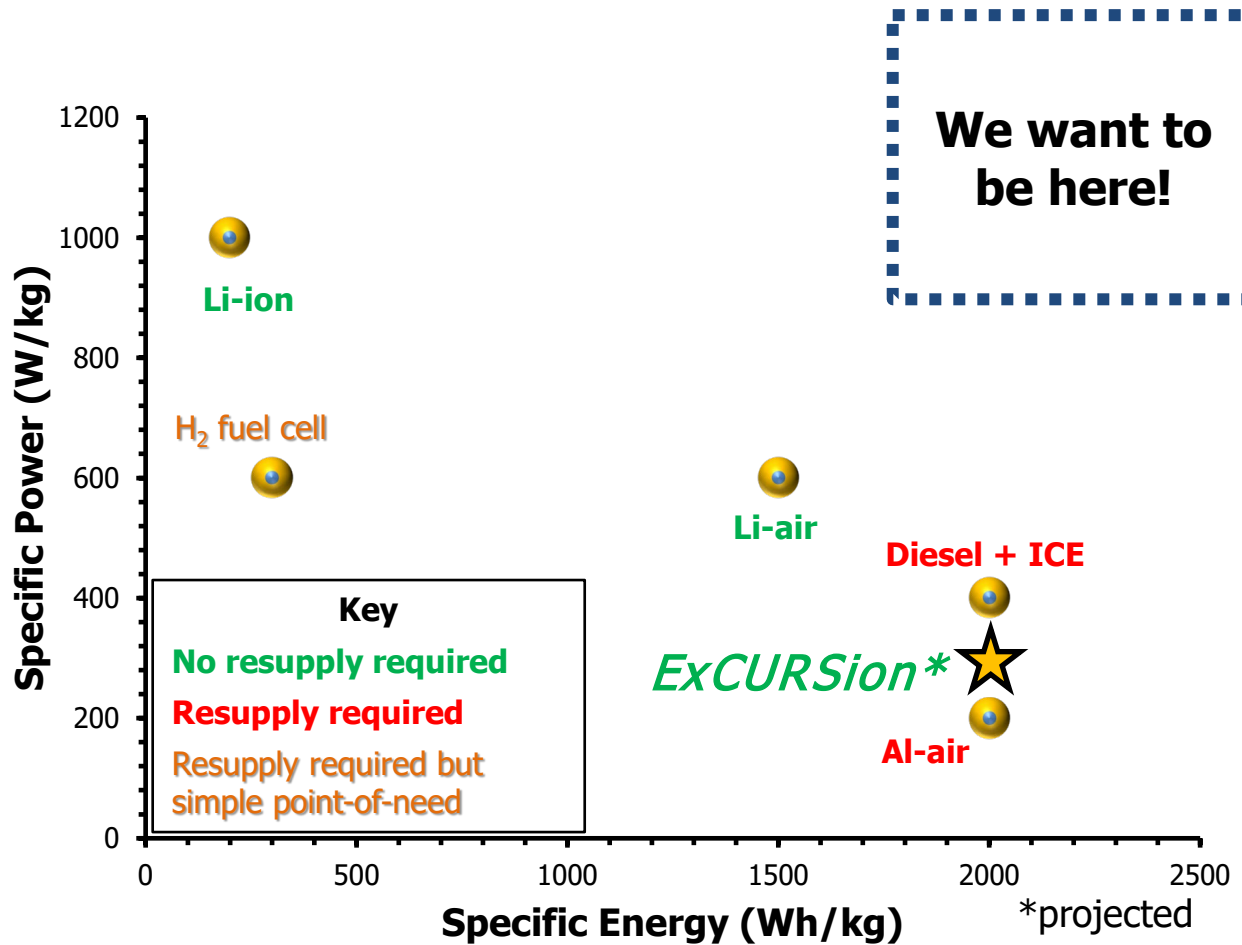


Helix SPM-177 (electric)
P/W ratio: 25.3 kW/kg



BMW P80 (ICE)
P/W ratio: 6.5 kW/kg

Full system energy and power analysis (including full motor/drivetrain/fuel source)



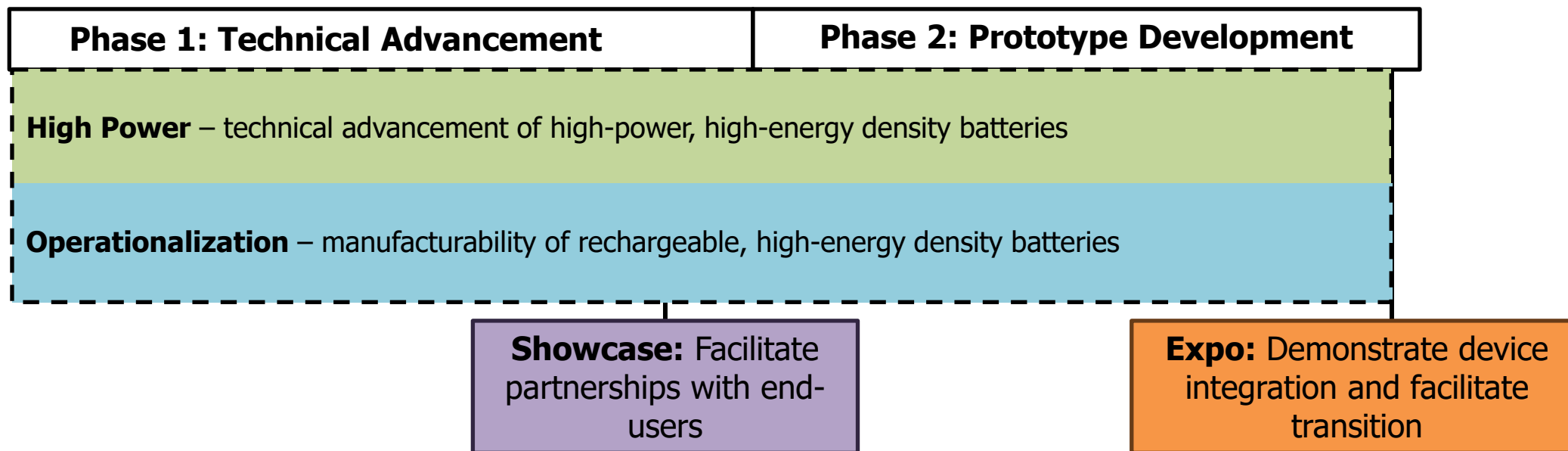
- Energy density comparable to fuel**
ExCURSion demonstrated
- Ability to electrically recharge energy without reliance on fuel supply**
ExCURSion demonstrated
- Power density comparable to batteries**
Unsolved: this is the technical focus of ExPEDitions
- Manufacturability and form factor**
Unsolved: this is the operational focus of ExPEDitions

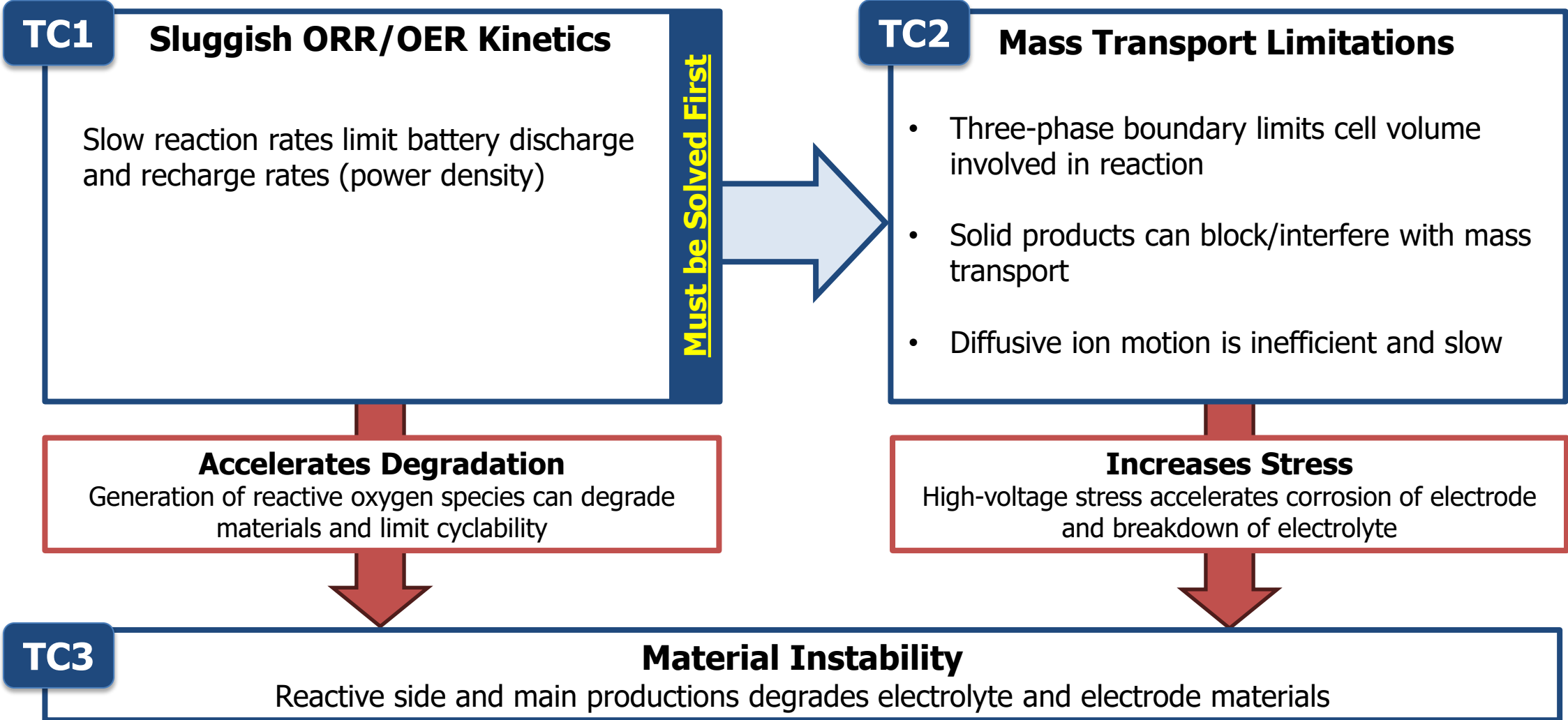


Parallel efforts in high-power density and operationalization to achieve scalable, field-ready battery solutions for industry and military needs.

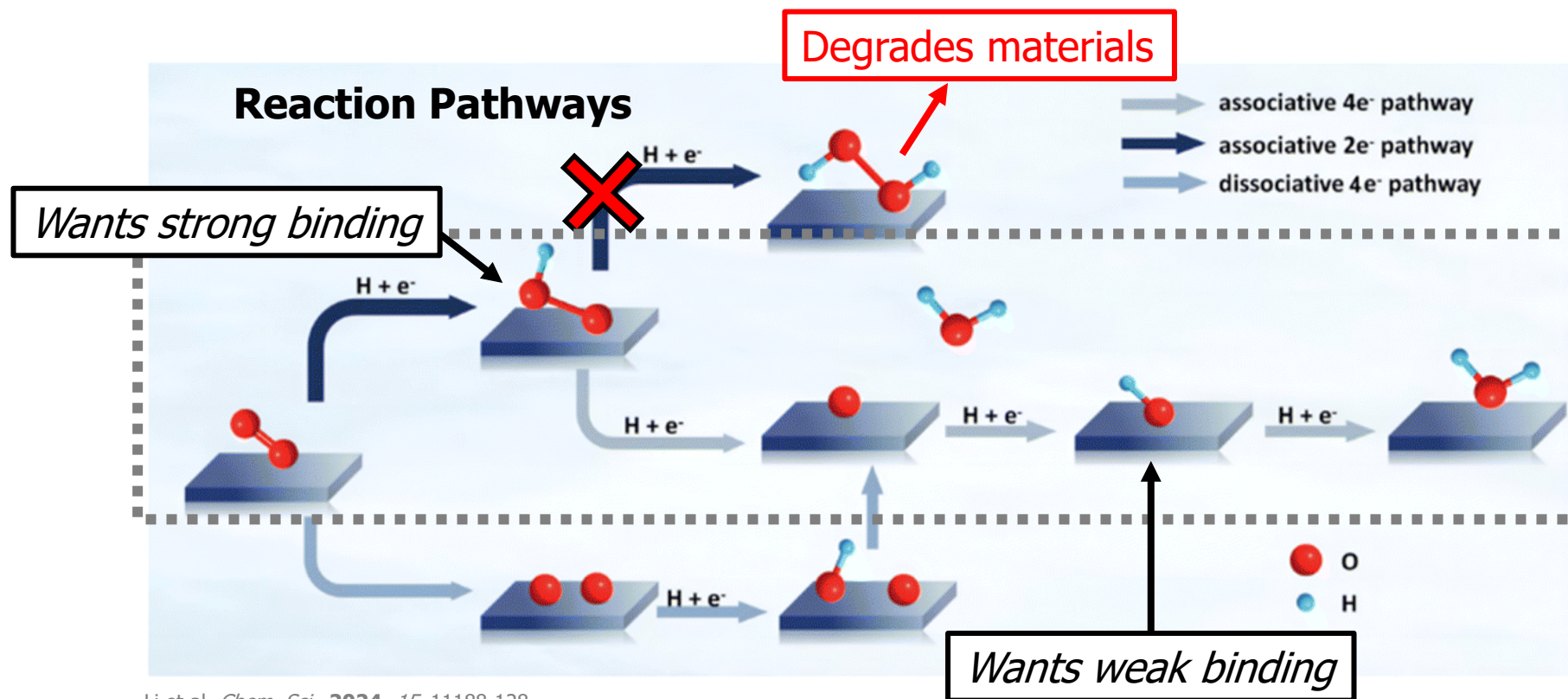
Two complementary goals will be pursued simultaneously by each performer

- **High Power: metrics-driven**
- **Operationalization: program structure-driven**





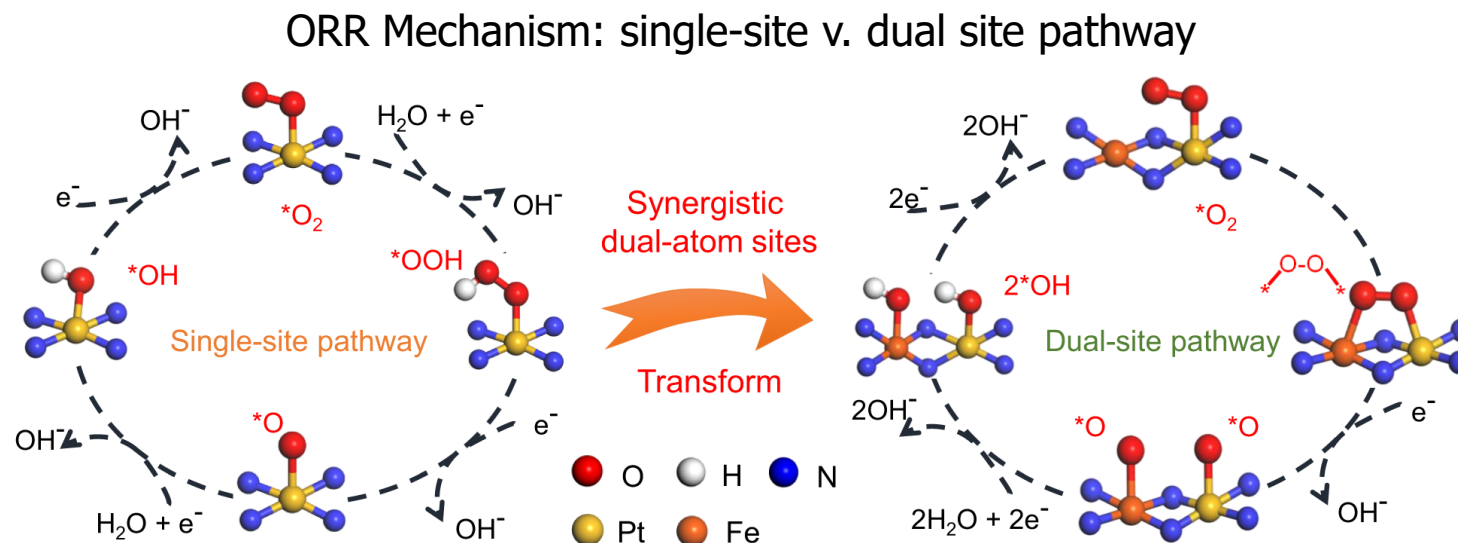
Discharge and recharge power/speed are limited by ORR/OER kinetics



Li et al. *Chem. Sci.*, 2024, 15, 11188-128

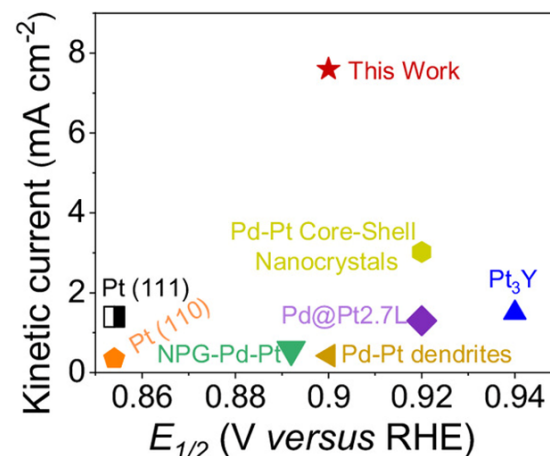
*High-T and non-aqueous batteries such as ExCURSion are less directly affected

Dissociative pathway avoids problematic side products, increases mass activity by $\sim 60x$

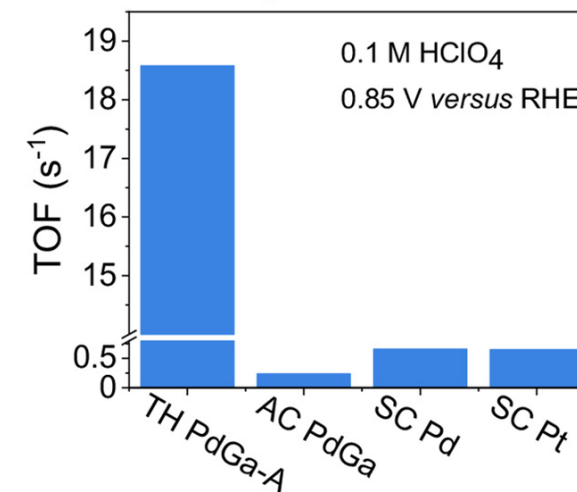


Wang et al. *Proc. Natl. Acad. Sci.* **2025**, 2, e24136092

Spin-polarized electron currents can activate molecular oxygen: TOF increased by $\sim 100x$

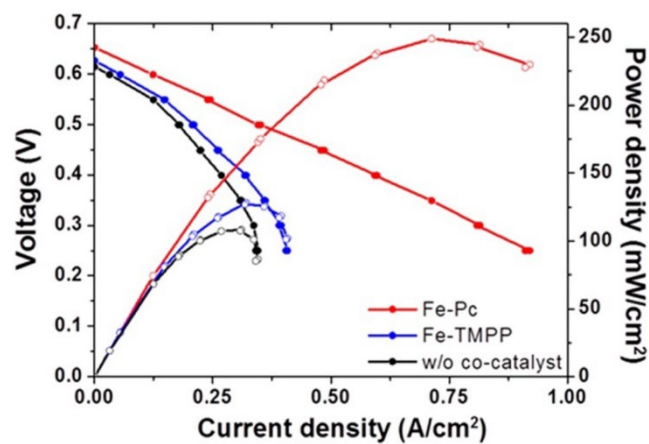
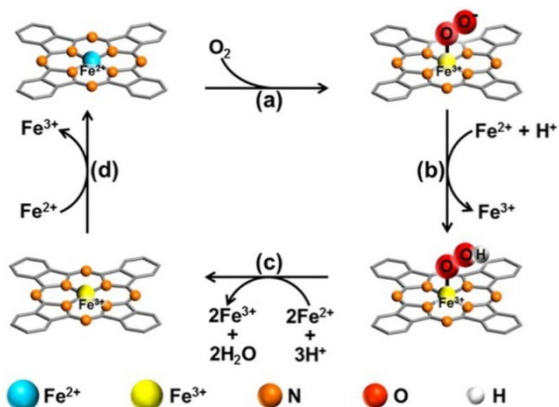


Zhou et al. *Nat. Commun.*, **2022**, 13, 6414



Rate improvement in the transport-limited regime requires maximizing three-phase boundary

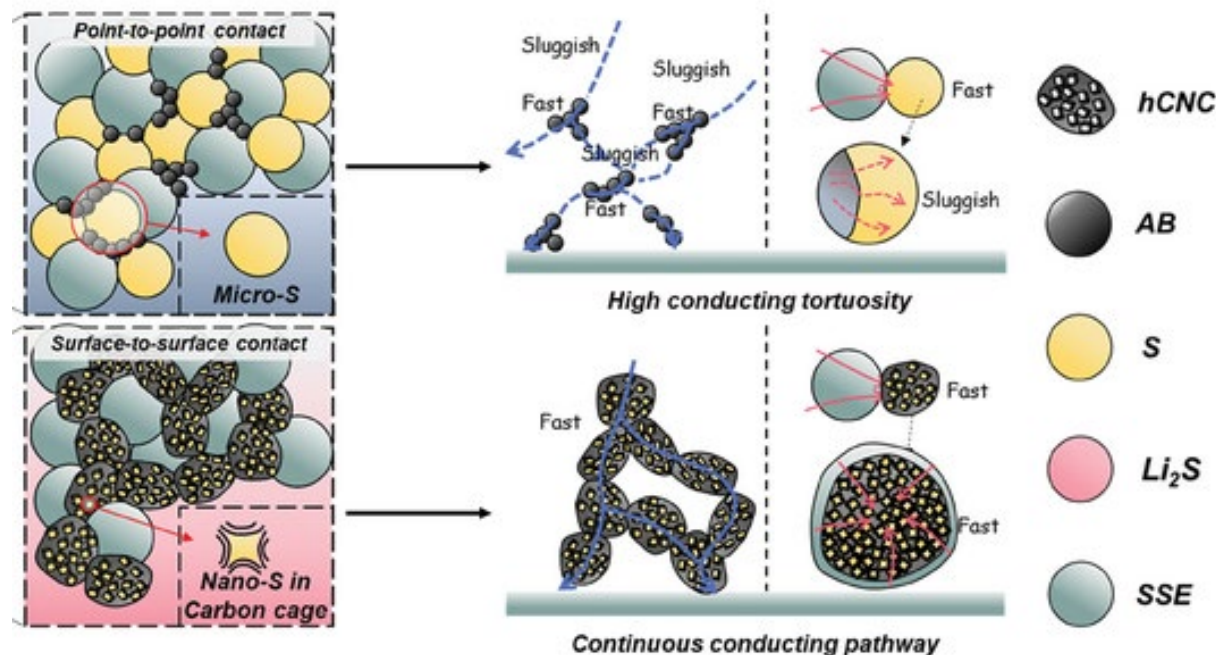
Mediate redox to effectively increase reaction volume



Anson & Stahl *Chem. Rev.*, **2020**, *120*, 3749–3786

Practical results show **5-10x** improvement—
Potential for order of magnitude higher rate

Minimize flooding and pore clogging



Luo et al. *Adv. Mater.*, **2024**, *36*, 2413325.

Porous hierarchical cathodes: **5-10x** improvement

Addressing material stability is a priority that must be tackled in parallel with solving ORR/OER kinetics and mass transport limitations

TC1 Sluggish ORR/OER Kinetics

TC2 Mass Transport Limitations

Electrode and Electrolyte Degradation
 Generation of reactive oxygen species
Degrades materials and limit cyclability

Electrolyte Degradation

Cathode Degradation

Aurbach et al. *Nat. Energy*, 2016, 1, 1-11.

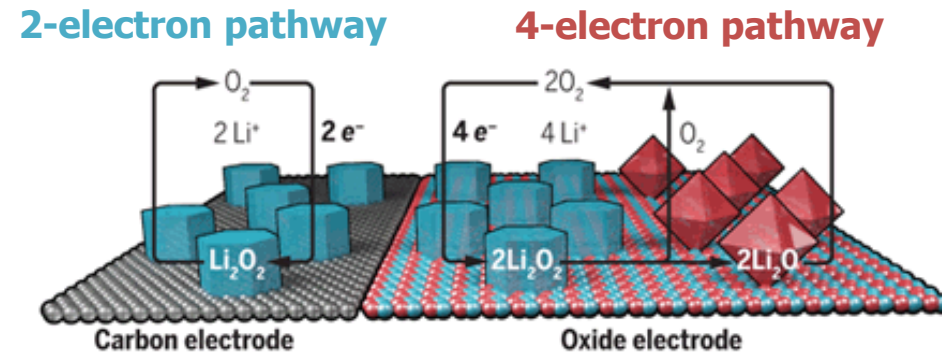
Unwanted Product Formation
 Solid formation in Al-air, C-air batteries
Limits cyclability and efficiency

TC3 Overarching constraint: Material Instability

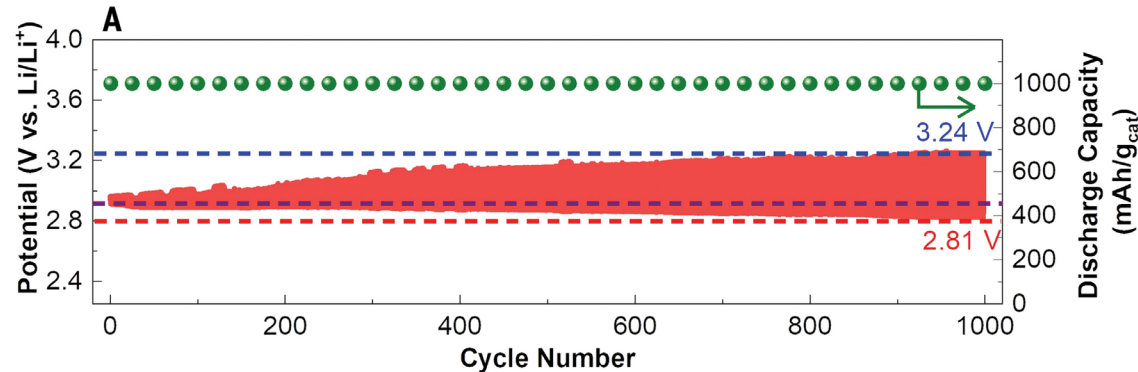
Reactive side and main productions degrades electrolyte and electrode materials

Chemistries with less corrosive products

Li_2O instead of Li_2O_2 , dissociative ORR/OER pathways that avoid peroxide formation



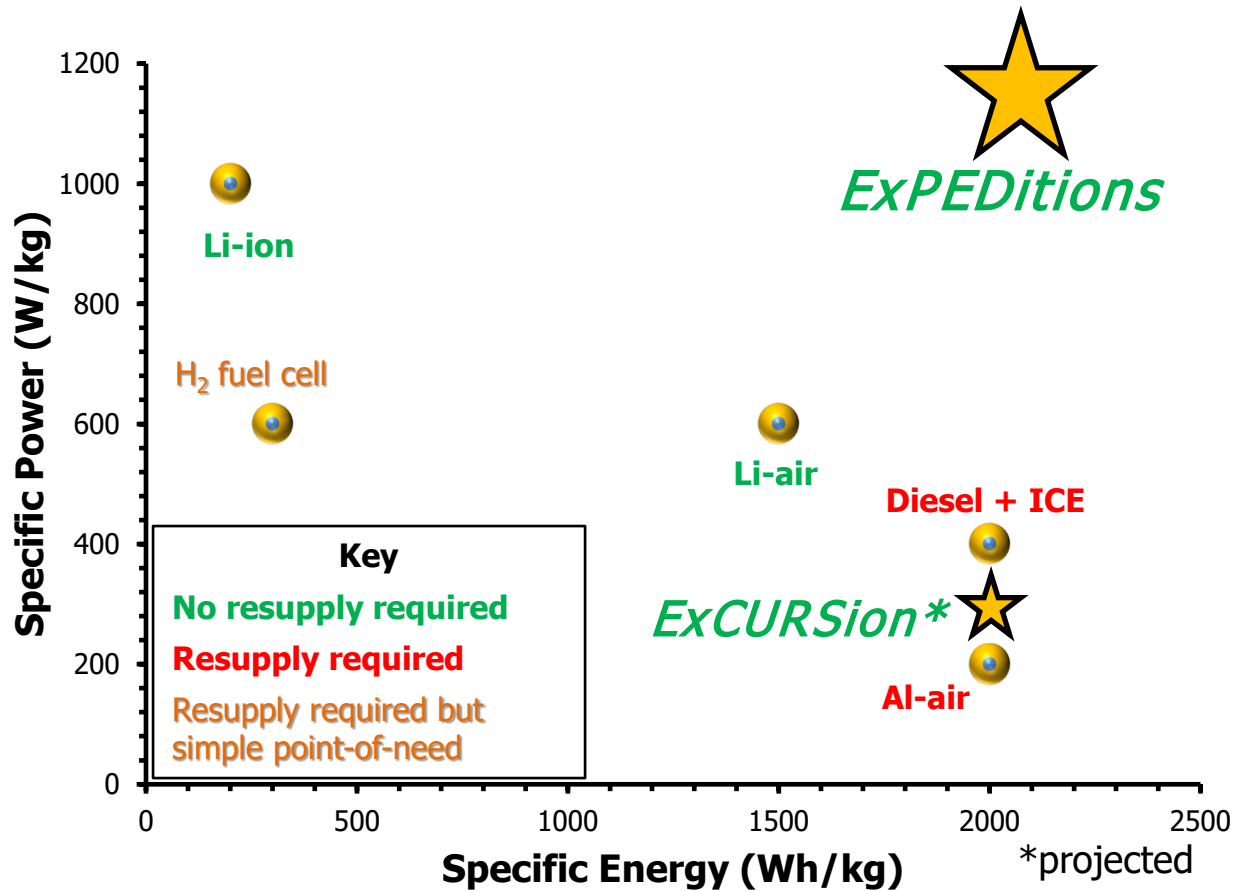
Feng et al. *Science*, 2018, 361, 758.



Kondori et al. *Science*, 2023, 379, 499-505.

>1000 cycles observed at low currents

Full system energy and power analysis (including full motor/drivetrain/fuel source)



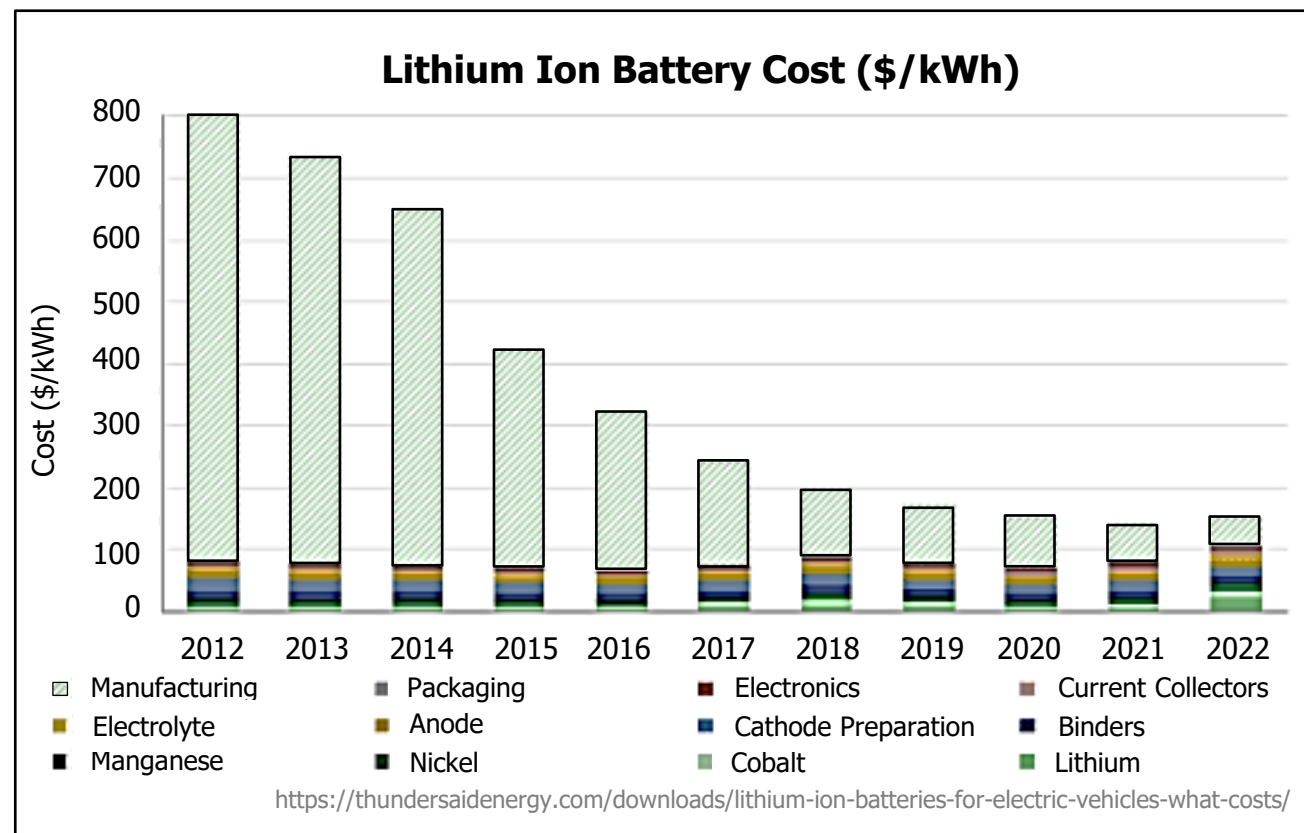
Oxygen Kinetics: 10-100x improvement in intrinsic kinetics – system is no longer kinetically limited

Mass Transport: 10x power density improvement above kinetically limited regime, possibly much more

Material stability: >1000 cycles with significant charge retention

Li-ion cost reductions are nearing their limit

- Manufacturing efficiencies drove the dramatic cost reduction in Li-ion batteries over the last 15 years
- A "cost floor" set by raw materials now strongly limits further Li-ion price drops
- C-air batteries offer a breakthrough, with a material cost floor over 75% lower than Li-ion



Parity with Li-ion then allows manufacturing of C-air to be 75% of total cost of the battery — and this should improve as the technology scales

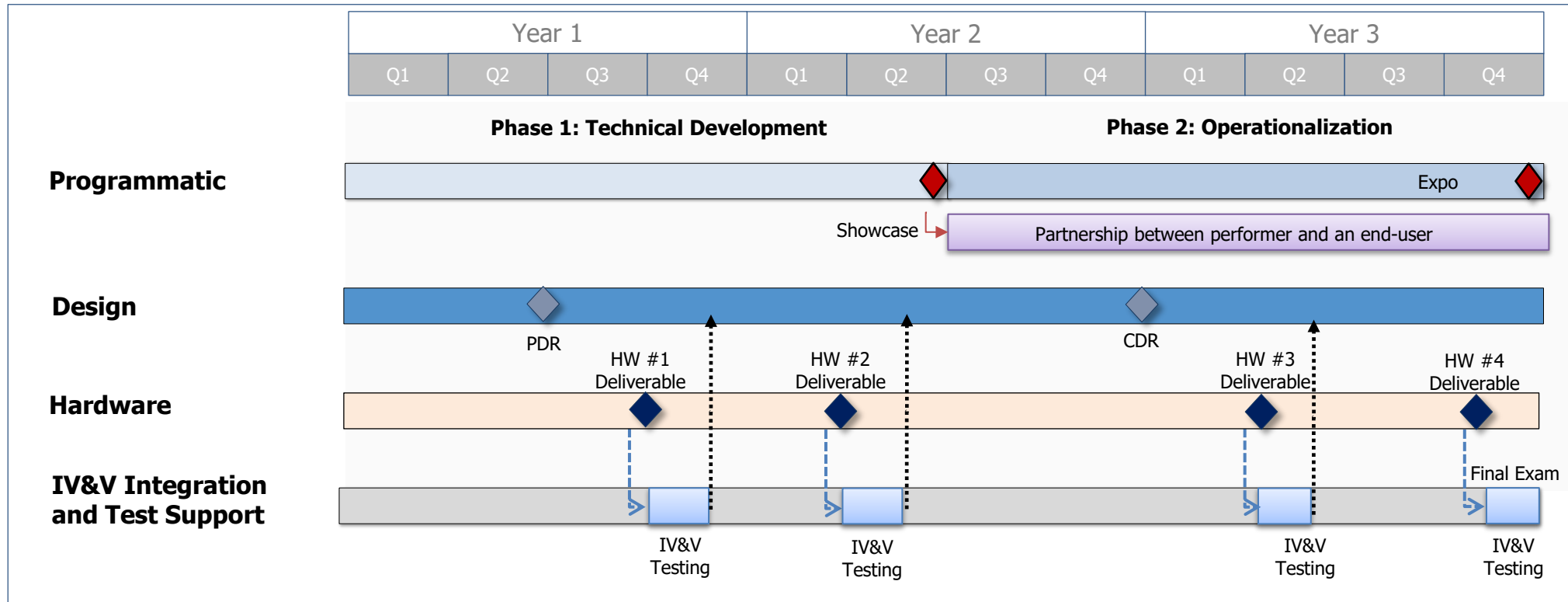


Metric	Unit	Phase 1 (18 Mo.)	Phase 2 (18 Mo.)
Specific Energy	kWh/kg	>1	>2
Peak Specific Power	kW/kg	>1	>3
Rechargeability	# cycles with >80% capacity	>500	>5000
Cost	\$/kWh	Path towards 100	Materials cost floor of 50

Constraints	Unit	Value
Recharge rate	W/L	>625
Round trip efficiency	%	>90
Standard Form Factor (e.g., 18650 cylinder, prismatic, or pouch)		

Proposals **MUST** explicitly address each of these metrics and constraints, with a detailed justification for how the proposers will meet the metrics stated in the table above, using calculations, theory, and data.

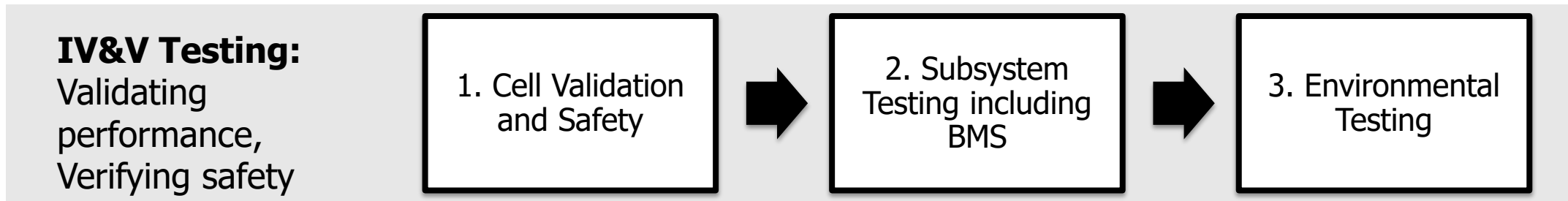
Proposals that **do not** have sufficient data, analyses, referenced proof, or other forms of evidence to support their plans to meet the metrics will be **considered non-conforming** and will not be evaluated.



Building the right team:

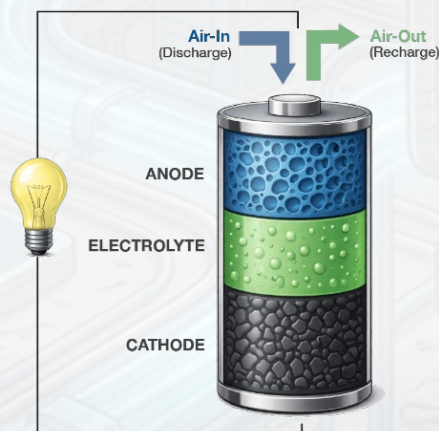
- All contracts are OT-P: require cost-share or teaming for large primes
- PDR includes market analysis + sales/transition strategy
- CDR includes manufacturing plan

OT-P: Other transaction for prototype
 CDR: Critical design review
 GFE: Government furnished equipment
 HW: Hardware
 IV&V: Independent verification and validation
 PDR: Preliminary design review



Phase & Objective	Delivery Months	Deliverables (Per Month)
Phase 1: Validate Cell Performance	9 & 15	16 Cell Prototypes
Phase 2: Validate Integrated Subsystems & Battery Management System	27 & 33	8 Optimized Battery Packs 8 Optimized Cells

ExPEDitions Battery Technology

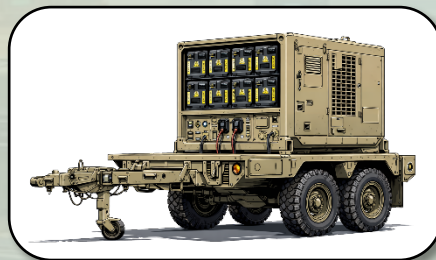


Plugged In: Connecting Our Battery to Your Mission



Phase 1 (Month 18): Showcase

Facilitate partnerships between ExPEDitions performers and end-use technologies



Phase 2 (Month 36): Expo

Demonstrate developed technologies resulting from partnerships ready for commercialization and military adoption



Showcase Pitch Day (Month 18)

DARPA will host an event to connect performers with DARPA-selected end-users

- **Month 16 Preliminary Pitch:** Performers will pitch to a Government panel to receive feedback and refine their value proposition
- **Post-Showcase (Matched):** Performers will collaborate with their end-user partners to integrate and evaluate the battery in specific applications
- **Post-Showcase (Unmatched):** Performers forfeit the ability to invoice for Milestone 17

Expo (Month 36)

A culminating demonstration of technology capabilities for all ExPEDitions performers

- **Presentation Structure:** Matched performers will co-present with end-users; unmatched performers will present independently
- **Transition Focus:** Designed to facilitate technology transfer by connecting performers with Government and commercial stakeholders



Proposers must submit an abstract in response to this solicitation to be considered for participation in the ExPEDitions program. Proposers will not be invited to submit a full proposal package without participating in the abstract phase of the solicitation.

- Abstracts shall be submitted as specified in Section 4.1 of the program solicitation
- The Government will review all submitted abstracts for Technical Rationale and Approach and Technical Ability
- Selected abstract proposers will be invited to provide a full proposal package to the Government

Abstracts shall:

- **Provide Technical Rationale:** Justify how the proposed solution meets program metrics. All quantitative claims must be supported by empirical data, mathematical theory, or literature citations
- **Identify Use-Cases:** Identify and justify potential applications for the developed technology
- **Roughly Define Performance Specifications:** Define the baseline capabilities (starting energy and power densities without future improvements) and operational constraints (e.g., temperature, pressure)



This slide is provided for informational purposes only. Specific Proposal Instructions issued in conjunction with Abstract responses shall supersede any guidance contained within this brief

Proposals must include:

- Technical Rationale & Design
 - Provide a technical justification for the proposed method, supported by data and calculations
 - Present an initial concept design for the high-density battery prototype
- Analysis & Materials
 - Preliminary analysis of the manufacturability and materials costs for the proposed solution
 - Conduct a supply chain analysis for key materials, identifying and mitigating high-risk or long-lead items
- Specifications & Use Case
 - Define a specific use case and provide a rationale for its selection
 - Present a baseline "starting value" for battery performance, assuming no further technological advancements
 - Detail the plan for the Battery Management System (BMS), whether customized or commercial off the shelf (COTS)
 - Analyze the fully-packaged battery to ensure it achieves at least 80% of the single-cell's specific energy
- Define Physical Form Factor
 - You must either identify a standard cell format (e.g. 18650, 21700) or state a bounding box for the external dimensions (L, W, H) of a cell that aligns with an end-use case
- Execution & Management
 - Describe the team's technical capabilities for fabricating prototypes
 - Provide a staffing plan with relevant expertise for all project phases
 - Outline the management approach and a risk mitigation plan with clear success criteria



ExPEDitions does not solicit:



- Primary battery proposals
- Fuel cell proposals without a fuel regeneration component
- Partial solutions to the problem posed in the solicitation



Phase 1 Milestones



- **Milestone 1 (Month 1):** Attend an in-person kick-off meeting and present initial concept from proposal and path for development.
- **Milestone 2 (Month 4):** Quarterly performance report (QPR) that documents the current battery prototype design and any modification or optimizations to the design that occurred since the beginning of Phase 1 and their rationale.
- **Milestone 3 (Month 6):** PDR that includes a simulation or technical validation of design for battery prototype delivered in Month 9.
- **Milestone 4 (Month 7):** QPR #2. Validate all technical progress to date and provide an execution plan for the next two months. The report must confirm that the current development path ensures the successful Month 9 IV&V delivery.
- **Milestone 5 (Month 9):** Deliver a total of 16 battery cells and data package to IV&V team. The IV&V team will verify the fundamental performance and safety of battery chemistry at the individual cell level.
- **Milestone 6 (Month 10):** QPR #3. Execute a critical review of the Month 9 prototype delivery. Performers must deliver a self-assessment of the IV&V build process, identify core vulnerabilities, and present a formalized risk-reduction strategy to guarantee performance targets for the subsequent Month 15 iteration.
- **Milestone 7 (Month 13):** QPR #4. Demonstrate the effectiveness of recent design upgrades and verify system readiness for the Month 15 delivery. Performers must submit a report with an execution plan outlining the steps needed to improve upon previous IV&V results.
- **Milestone 8 (Month 15):** Deliver a total of 16 battery cells and updated data package to IV&V team. The IV&V team will verify the fundamental performance and safety of battery chemistry at the individual cell level.
- **Milestone 9 (Month 16):** QPR #5. Document all changes and progress since the previous reporting period. Present a preliminary showcase pitch to assist with preparing for the Showcase. The Government will provide feedback to assist with finalizing the pitch for end users.
- **Milestone 10 (Month 18):** Showcase participation to highlight the advanced capabilities of the battery prototype and secure a partnership with an end-user.

Additional details on milestones in the Program Solicitation



Phase 2 Milestones



- **Milestone 11 (Month 19):** Phase 2 Kickoff. Present the plan for battery optimization, and if an end-user partnership was made, integration plan with the end-user platform.
- **Milestone 12 (Month 19):** Partnership formalization with Showcase end-user. Deliver a fully executed Associate Contractor Agreement (ACA) with a Showcase end-user partner and a Joint Development Plan documenting the integration roles and responsibilities of both parties. Upon Government approval, performers may invoice a fixed, non-negotiable payment of \$250,000.
- **Milestone 13 (Month 22):** QPR #6. Establish the Phase 2 technical baseline by validating post-Phase 1 design modifications. Performers must present a risk-adjusted plan that definitively outlines the pathway to successfully executing the Critical Design Review (CDR) in Month 24.
- **Milestone 14 (Month 24):** CDR. Design review for battery prototype to be delivered at Month 27. This will consist of a review meeting to go over a CDR document.
- **Milestone 15 (Month 25):** QPR #7. Validate the implementation of CDR feedback and confirm readiness for battery pack delivery. This review requires a comprehensive report detailing all final technical tasks necessary to ensure the on-time delivery of the Month 27 test battery cells and packs to the IV&V team.
- **Milestone 16 (Month 27):** Deliver test battery packs and updated data package to IV&V team. The IV&V team will test the fully assembled prototype sub-system, including the BMS.
- **Milestone 17 (Month 27):** Confirmed delivery of devices to end-user satisfying the terms in the ACA and Joint Development Plan. Upon Government approval, performers may invoice a fixed, non-negotiable payment of \$250,000.
- **Milestone 18 (Month 28):** QPR #8. Execute a critical review of the ongoing end-user platform integration. Performers must identify all technical and logistical challenges encountered during integration and present a formal mitigation plan to address each.
- **Milestone 19 (Month 31):** QPR #9. Assess the results of the Month 27 IV&V testing and finalize the engineering parameters for the final IV&V deliverable. Performers must present a optimization strategy to ensure the Month 33 final battery system meets all environmental readiness requirements.
- **Milestone 20 (Month 33):** Deliver fourth test battery system and updated data package to IV&V team. The IV&V team will test the fully assembled prototype sub-system, including the BMS. The IV&V team will also execute environmental testing to test for operational readiness.
- **Milestone 21 (Month 34):** QPR #10. Validate the final system's transition readiness by delivering a preliminary Expo pitch. This critical gate allows the Government to assess the performer's transition strategy and refine the final presentation for maximum impact with government and commercial stakeholders.
- **Milestone 22 (Month 36):** Expo participation to demonstrate the battery prototype integrated into the end-user's platform. This will include a presentation to Government and commercial stakeholders to facilitate additional transition of the technology developed.

Additional details on milestones in the Program Solicitation



- EXPEDitions may generate information subject to CUI controls
- Review the CONTROLLED UNCLASSIFIED INFORMATION (CUI) GUIDE attached to the solicitation (Attachment K) to assist in proposal preparation



- **Read the PS carefully**
- Email questions to: EXPEDitions@darpa.mil
- FAQ: <https://www.darpa.mil/work-with-us/opportunities>
- Select presentation materials will be made available after clearing public release
- Form complete teams with comprehensive expertise & capabilities
 - Teaming is strongly encouraged
 - Teams should include a program coordinator/project manager (financial management experience is recommended)
 - There is no bias for teams internal to one institution or across multiple institutions, but effective communication and collaboration between team members is expected



DOW Capabilities	
Endurance	5x greater endurance vs. current battery-powered assets >50% greater range vs. fuel-based UxVs
Logistics	Independent of fuel supply lines
Enabled Tech	Supports energy-intensive edge AI computing & directed energy weapons
Dual-Use Impact	
Enabled Capabilities	<ul style="list-style-type: none">• Regional Electric Aviation: High-energy batteries for short haul electric aircraft• Commercial Drones & Vehicles: Eliminates “range anxiety” and enhanced endurance• Heavy Machinery & Data Centers: Enables electrification of power-hungry applications



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