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Coreshell Response to EPIC 5 Concept Proposal

Additional submitted attachment is included below.

August 7th, 2025

Coreshell

Coreshell Technologies Response to EPIC 5 Concept Proposal

1. Please provide the name, email, and phone number of the best person to contact should the CEC have additional questions regarding the research concept::

Daniel Chadwick
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2. Please provide the name of the contact person's organization or affiliation:

Coreshell Technologies, Incorporated

3. Please provide a brief description of the proposed concept that you would like the CEC to consider as part of the EPIC 5 Investment Plan. What is the purpose of the concept, and what would it seek to do? Why are EPIC funds needed to support the concept?

The CEC should investigate and fund the development of earth-abundant, high energy-density active materials for batteries, as these materials are critical to reducing supply risk, lowering costs, and enabling large-scale energy storage deployment. Current battery chemistries often rely on exotic or constrained materials such as nickel, cobalt, or graphite, which face significant price volatility, geographic concentration of supply, and environmental challenges. By focusing on abundant elements—such as silicon, iron, manganese, or sulfur—California can catalyze a shift toward more sustainable, resilient, and ethically sourced storage technologies that align with the state's long-term clean energy goals.

In addition, advancing high energy-density materials from earth-abundant sources can accelerate the adoption of batteries in both grid and transportation sectors, enabling longer range for EVs, reduced footprint for stationary storage, and lower lifecycle costs. This research area demands coordinated investment in materials science, scalable manufacturing processes, and supply chain development to bridge the gap from laboratory breakthroughs to commercial-scale products. Strategic funding from the CEC can position California as a leader in next-generation, resource-secure energy storage solutions, supporting both climate targets and economic resilience.

4. In accordance with Senate Bill 96i, please describe how the proposed concept will "lead to technological advancement and breakthroughs to overcome barriers that prevent the achievement of the state's statutory energy goals." For example, what technical and/or market barriers or customer pain points would the proposed concept address that would lead to increased adoption of clean energy technology or innovation? Where possible, please provide specific cost and performance targets that need to be met for increased industry and consumer acceptance. For scientific analysis and tools, provide more information on what data and information gaps the proposed concept would help fill, and which specific parties or end users would benefit from the results, and for what purpose(s)?

Today's dominant battery chemistries rely heavily on materials with constrained supply chains—such as nickel, cobalt, and graphite—which create cost volatility, geopolitical risk, and environmental concerns. By focusing on abundant elements, California can enable more sustainable and scalable storage solutions that reduce material cost, improve supply security, and lower lifecycle environmental impact. Meeting performance targets such as >300 Wh/kg for EVs or <$.05/kWh used for stationary storage will be key for broad market acceptance, enabling greater EV adoption, more affordable renewable integration, and reliable grid services.

From a technical perspective, research in this area would help overcome performance limitations such as cycle life degradation, low round-trip efficiency, and insufficient energy density that currently hinder the use of abundant materials in commercial systems. It would also address cost and manufacturing barriers by developing scalable processes and validated supply chains for these chemistries. Scientifically, the work would close data gaps on material stability and degradation mechanisms under real-world cycling conditions—data that is currently sparse for many promising abundant-material chemistries. The results would be valuable to battery manufacturers, EV OEMs, utilities, and policymakers, enabling evidence-based decision-making and faster commercialization of next-generation storage technologies that can accelerate California's transition to a carbon-neutral energy system.

5. Please describe the anticipated outcomes if this research concept is successful, either fully or partially. For example, to what extent would the research reduce technology or ratepayer costs and/or increase performance to improve the overall value proposition of the technology? What is the potential of the innovation at scale? How will the innovation lead to ratepayer benefits in alignment with EPIC's guiding principles to improve safety, reliability, affordability, environmental sustainability, and equity?

If successful, research into earth-abundant, high energy-density active materials could deliver a new class of batteries with substantially lower material costs—potentially reducing total pack costs compared to today's chemistries. Higher energy density would extend EV driving range, reduce the size and weight of storage systems, and enable more efficient use of space in grid installations. These advancements would improve the value proposition by lowering the cost per kilowatt-hour stored, increasing system lifetime, and reducing dependence on volatile, geopolitically constrained supply chains.

At scale, this innovation could transform both transportation and grid sectors by enabling widespread deployment of affordable, long-duration, and resource-resilient storage. Ratepayers would benefit from more reliable and flexible grid operations, reduced reliance on peaker plants, and lower electricity costs as storage smooths renewable generation variability. Environmental sustainability would improve through reduced mining impacts and a smaller carbon footprint for battery manufacturing. Equity goals would be supported by making EVs and distributed storage systems more affordable for low-income communities, while safety could be enhanced through chemistries with lower thermal runaway risk. Overall, these outcomes align with EPIC's guiding principles by delivering a cleaner, more resilient, and more affordable energy future for all Californians.

6. Describe what quantitative or qualitative metrics or indicators would be used to evaluate the impacts of the proposed research concept.

The CEC should evaluate the impacts of research into earth-abundant, high energy-density active materials using a combination of quantitative performance metrics and qualitative market indicators. Key quantitative metrics include:

- Cost targets: Achieving substantial reductions in both stationary storage and EV pack costs to enable broad market adoption.
- Performance targets: Significant improvements in specific energy for EV applications, increased volumetric energy density for stationary systems, and extended cycle life for long-term durability.
- Material metrics: Major reductions in the use of critical minerals (e.g., nickel, cobalt, graphite) compared to baseline chemistries.
- Sustainability indicators: Meaningful decreases in life cycle greenhouse gas emissions per unit of energy stored compared to conventional lithium-ion technologies.

Qualitative indicators would assess supply chain resilience, including the diversity and availability of raw material sources; market readiness, such as the number of OEMs and utilities engaged in pilot programs; and equity impacts, including the accessibility of lower-cost systems for disadvantaged communities. Collectively, these metrics would provide a clear picture of technical success, market viability, and societal benefit, ensuring the research delivers measurable progress toward California's clean energy and equity goals.

7. Please provide references to any information provided in the form that supports the research concept's merits. This can include references to cost targets, technical potential, market barriers, equity benefits, etc.

Key references that support the merits of investigating earth-abundant, high energy-density active materials include:

1. U.S. Department of Energy, Energy Storage Grand Challenge Roadmap (2020) – Establishes long-term cost targets for stationary storage and highlights the need for abundant, domestically available materials to reduce supply risks.
2. DOE Vehicle Technologies Office, EV Battery Targets – Sets cost targets for EV packs and energy density targets to enable broader market adoption.
3. DOE Critical Minerals Assessment – Analyzes current and projected demand for minerals such as graphite, nickel, cobalt, and manganese, identifying supply vulnerabilities and the importance of diversifying to abundant alternatives.
4. National Renewable Energy Laboratory (NREL), Supply Chain Analysis of Lithium-Ion Battery Materials – Documents geographic concentration, price volatility, and environmental impacts of critical materials like cobalt and nickel.
5. California Energy Commission, SB 100 Joint Agency Report (2021) – Identifies long-duration, affordable storage as essential for a 100% clean electricity system, with equity considerations for access in disadvantaged communities.
6. Argonne National Laboratory, BatPaC Model – Provides life cycle cost and performance modeling tools that support the technical and economic feasibility of abundant-material chemistries.

These sources collectively highlight both the market barriers and the transformative potential of abundant-material battery research, reinforcing its alignment with California's statutory energy, equity, and climate goals.

8. The EPIC 5 Investment Plan must support at least one of five Strategic Goals:

- **a. Transportation Electrification**
- **b. Distributed Energy Resource Integration**
- **c. Building Decarbonization**
- **d. Achieving 100 Percent Net-Zero Carbon Emissions and the Coordinated Role of Gas**
- **e. Climate Adaptation**

Please describe in as much detail as possible how your proposed concept would support these goals.

The strongest alignment is with Transportation Electrification, where reducing reliance on nickel, cobalt, and graphite can lower battery costs, improve performance, and diversify supply chains. These advances would enable more affordable electric vehicles (EVs) across passenger, commercial, and heavy-duty segments, accelerating market penetration and reducing transportation-related greenhouse gas and particulate emissions.

The concept also advances Distributed Energy Resource Integration by enabling stationary storage systems that are both lower cost and higher performance, supporting broader deployment of solar, wind, and other distributed generation while maintaining grid stability. Through improved cycle life and enhanced safety profiles, abundant-material chemistries can reduce the total cost of ownership for utilities, microgrids, and community energy systems.

Furthermore, these materials contribute to Achieving 100 Percent Net-Zero Carbon Emissions by facilitating large-scale renewable energy adoption and reducing the embedded carbon footprint of battery manufacturing. Climate Adaptation is also supported by providing durable, long-duration storage solutions that improve grid resilience during extreme weather events, wildfire-related outages, and other disruptions. By making energy storage more affordable and less resource-constrained, this research ensures equitable access for disadvantaged communities, aligning with California's goals for environmental justice and