Direct Lithium Extraction 2.0

A note about this e-book

Abhirabh Basu

Senior Anlayst

This e-book is an abridged version of our popular webinar “Direct Lithium Extraction 2.0.”

For the full webinar, which provides more research and context, please visit our website here.

ANALYST PROFILE

Abhirabh Basu, Senior Analyst

Abhirabh Basu is a senior analyst at Lux Research, based in Detroit, where he has spent a decade advising on cutting-edge separation technologies, critical minerals extraction, and the future role of water in the energy transition and industrial decarbonization. With a deep know-how of membrane technology, extraction and purification processes, and materials innovation, he is a trusted adviser for hundreds of innovation leaders across the chemicals, oil and gas, manufacturing, and utilities sectors, spanning venture capital, R&D, and corporate strategy functions.

Abhirabh's journey started in India, where he trained as a chemical engineer at Panjab University, with hands-on experience in heat and mass transfer at Engineers India Limited and at Gannon Dunkerley Co. & Ltd., where he helped design water treatment plants. He'd soon move to the U.S. and pursue an MEng in environmental engineering from New York University's Polytechnic School of Engineering, where he specialized in biological wastewater treatment. As a policy fellow at Green Building Worldwide in New York, Abhirabh contributed to research on passive house and zero net energy buildings strategies.

Direct Lithium Extraction 2.0

DLE can expand global lithium supply, but no single extraction technology guarantees a commercially successful project.

PRODUCT DESIGN & INNOVATION

Design integrated flowsheets that combine proven extraction technologies with targeted innovations in concentration, purification, and refining.

BRAND

Position DLE commitments around credible performance, transparent resource use, and demonstrated progress toward commercial production.

SUPPLY CHAIN & OPERATIONS

Build end-to-end capabilities spanning pretreatment, extraction, refining, water management, reinjection, maintenance, and battery-grade qualification.

GROWTH POTENTIAL

Capture growth by commercializing advantaged brines today while preparing for geothermal and unconventional resources over time.

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rly 90s

Scaled up in the

DLE enters the execution era

***Key takeaway:** The central question is no longer whether DLE works, but which projects can operate economically across volatile lithium markets.*

Direct lithium extraction is not new. Commercial systems have operated since the 1990s, while Chinese producers have spent the past decade scaling established approaches. What has changed is the commercial environment. Resource owners, energy companies, water-treatment specialists, equipment suppliers, and engineering firms are entering the market.

Three factors will separate scalable projects from speculative ones:

1. **Resources:** Lithium concentration, impurities, and brine chemistry establish the project's economic starting point.
2. **Technoeconomics:** Capital intensity, operating costs, financing, and price resilience matter more than extraction cost alone.
3. **Execution:** Reliable integration and consistent production of battery-grade lithium ultimately determine bankability.

The winning projects will combine all three rather than depend on one breakthrough technology.

Lithium demand is reopening the opportunity for brine resources

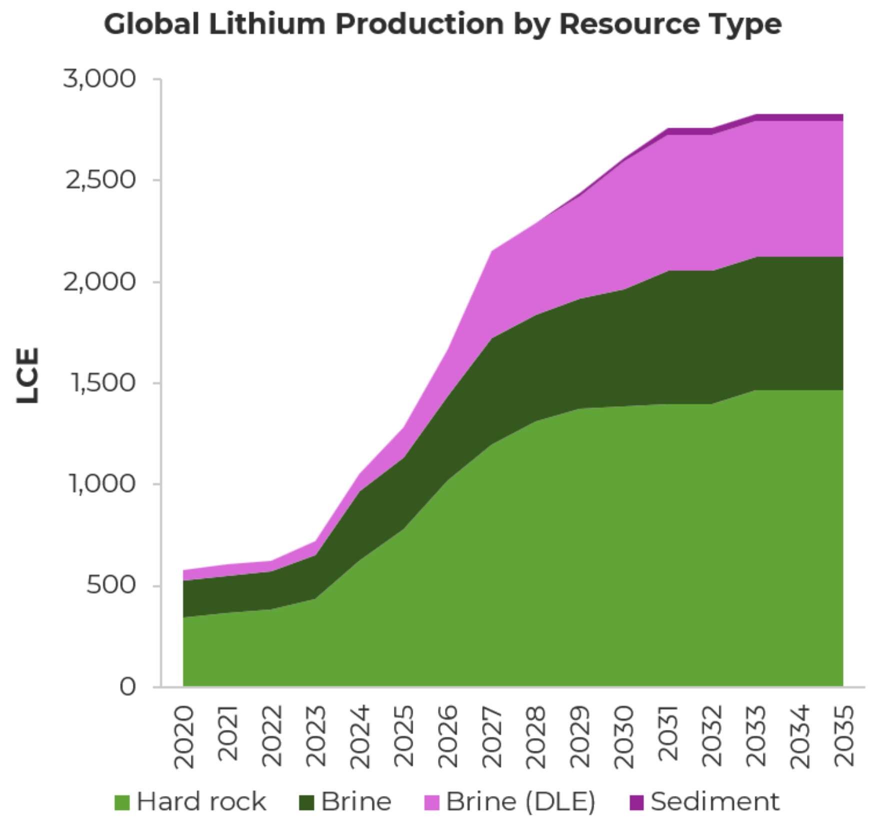
***Key takeaway:** Demand growth, supply-security policies, and improving recovery are making brine resources strategically important again.*

Global lithium demand is expected to reach approximately 3 million to 4 million tonnes of lithium carbonate equivalent by 2035. Meeting that demand will require substantial investment in mining, refining, and processing capacity.

Hard-rock resources have dominated recent supply growth, but DLE is improving the competitiveness of brines by:

- Increasing lithium recovery
- Shortening production timelines
- Reducing land requirements
- Potentially lowering water and energy use
- Enabling production from previously uneconomic resources

DLE will expand lithium supply rather than replace hard-rock mining. Lux Research estimates that it could deliver roughly one-third of global lithium supply by 2035.



POLICY AND MARKET ACCESS

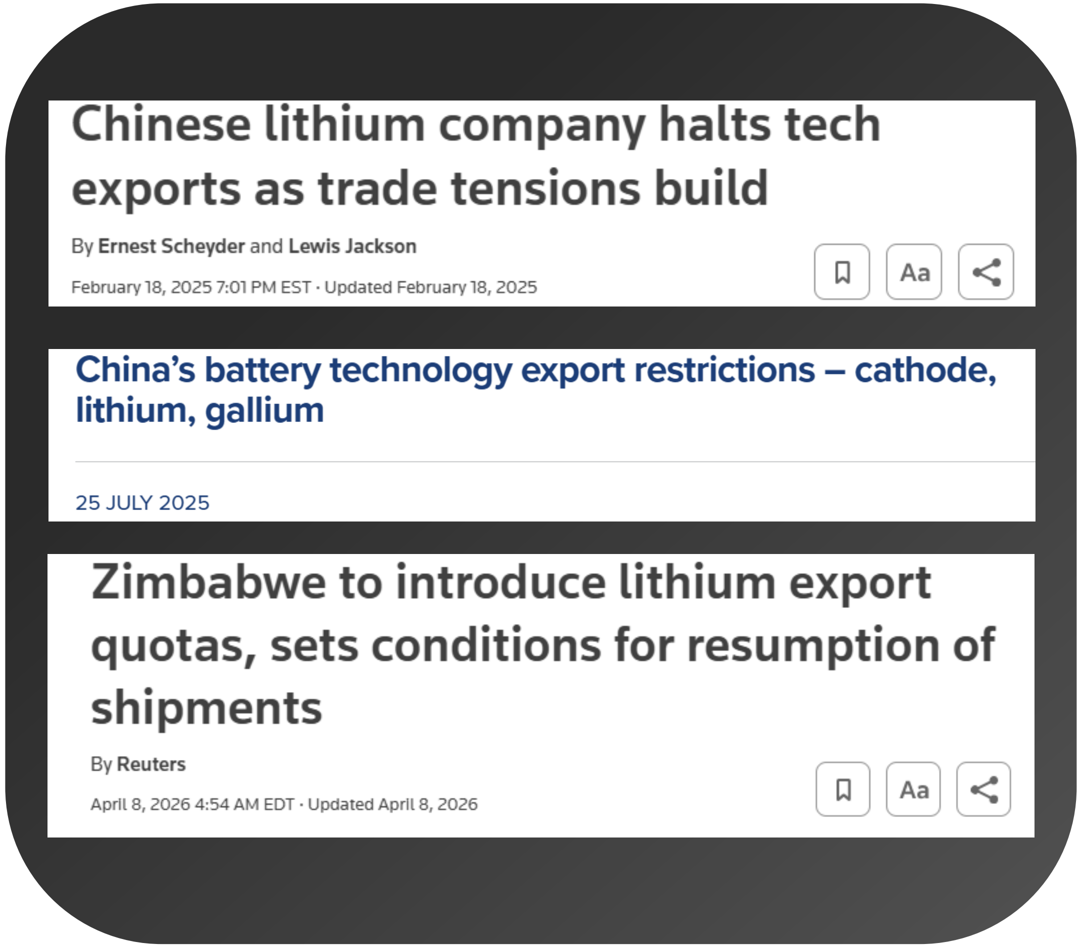
Onshoring is reshaping where lithium projects can scale

Key takeaway: *Lithium supply is becoming more regional as governments use incentives, ownership rules, and export controls to protect strategic resources and domestic industries.*

Policy is now a core driver of DLE investment. Governments are intervening across the lithium value chain to strengthen domestic supply, reduce dependence on foreign technology, and retain more economic value at home.

The policy landscape is moving in several directions:

- **The U.S. Inflation Reduction Act** supports domestic and allied critical-mineral supply chains.
- **The European Critical Raw Materials Act** aims to improve regional access to strategic materials.
- **Chile** is increasing state involvement in lithium production through partnerships with state-owned entities.
- **China** is restricting exports of lithium-processing and battery technologies.
- **Zimbabwe** is using export quotas and shipment conditions to encourage local processing.



price

Three factors determine whether projects reach commercial scale

Key takeaway: Resource quality establishes the starting point, economics determines resilience, and execution determines whether lithium is consistently produced.

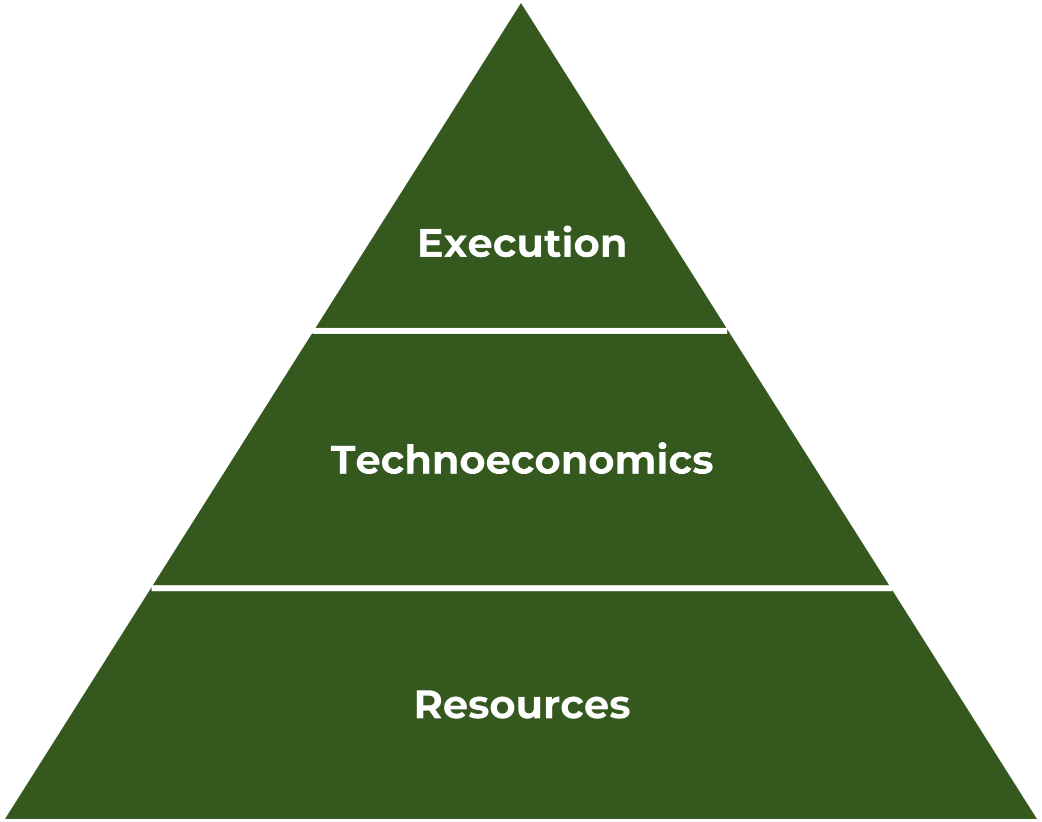
Lux Research evaluates DLE projects through three interconnected factors:

1. Resources: Lithium concentration, impurity levels, brine chemistry, and resource accessibility establish the project's fundamental advantage. No extraction technology can completely compensate for a poor resource.

2. Technoeconomics: Operating expenses alone are insufficient. Leaders must assess capital intensity, financing structures, annualized costs, payback, and returns across multiple lithium price environments.

3. Execution: Projects must integrate extraction, pretreatment, concentration, purification, and refining while reliably producing battery-grade lithium at scale.

Weakness in any one area can undermine the entire project. A technically impressive system attached to a challenging brine or poorly integrated flowsheet may remain uncompetitive.



Resource quality sets the economic starting point

Key takeaway: *The right technology-resource match matters more than applying the newest extraction method to every brine*

Continental brines

Salars are some of the highest-grade brines in the world — 0.04% to 0.15% Li.

Stage of development

Commercial

Geothermal brines

Low-grade sources contain as little as 0.01% to 0.04% Li.

Stage of development

Development

Oil field brines

O&G wastewaters are some of the lowest-grade brines, containing <0.01% Li.

Stage of development

Early pilot

Clay deposits

Lithium-bearing clays contain 0.1% to 0.4% Li, significantly higher than most brines.

Stage of development

Lab and early pilots in North America

At low lithium prices, only the most competitive salar projects generate compelling returns. More unconventional resources generally require sustained higher prices, policy support, strategic offtake, or corporate backing.

Low operating costs do not automatically create the best project

Key takeaway: All-in economics, rather than operating expenses alone, reveal which DLE projects can withstand market volatility.

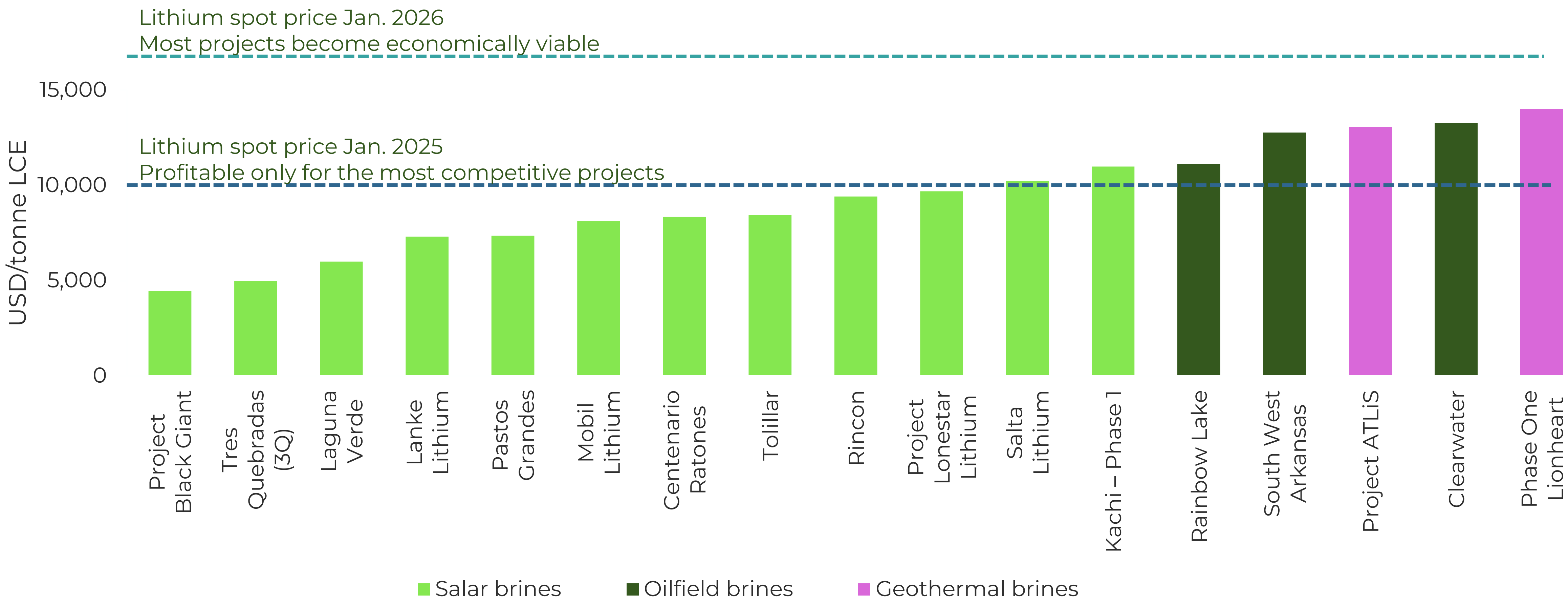
A project with attractive operating costs may still be uncompetitive if it requires high upfront investment, complex infrastructure, or expensive downstream refining.

Lux evaluates DLE competitiveness by combining operating expenses with annualized capital costs. This provides a more realistic view of the cost per tonne of lithium carbonate equivalent and enables comparison across different project lives and financing structures.

At low lithium prices, only the most competitive salar projects generate compelling returns. As prices rise toward long-term incentive levels, more projects become viable, but unconventional brines often remain at the higher end of the cost curve.

- Executives should test projects against:
- Low, base, and high lithium price scenarios
- Capital overruns and delayed ramp-up
- Sorbent and reagent replacement costs
- Refining and qualification expenses
- Financing and payback requirements

DLE Projects All-In Costs*



About Lux

Lux Research fuels innovators to not only imagine what’s possible in the future but also operationalize innovation success in the near term. We deliver research and advisory services to inspire, illuminate, and ignite innovative thinking that reshapes and grows businesses. Using quality data derived from primary research, fact-based analysis, and opinions that challenge traditional thinking, our experts focus on finding truly disruptive innovations that are also realistic and make good business sense.

The “Lux Take” is trusted by innovation leaders around the world, many of whom seek our advice directly before placing a bet on a startup or partner — our clients rely on Lux insights to make decisions that generate fantastic business outcomes. We pride ourselves on taking a rigorous, scientific approach to avoid the hype and generate unique perspectives and insights that innovation leaders can’t live without.

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EMAIL

questions@luxresearchinc.com

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