Direct Lithium Extraction Demonstration Plant

Litus LiNC Technology

ERA Project ID: FF0162223

Program: ERA Industrial Transformation Challenge

Company: Litus Inc.

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EXECUTIVE SUMMARY

Litus is unlocking new energy sources, with its patented Litus LiNC, a one-step, environmental nanotechnology that efficiently and effectively extracts lithium from brines previously deemed uneconomical.

Litus successfully executed a pilot-scale Direct Lithium Extraction (DLE) project using its proprietary LiNC process and nanomaterial technology. The system was operated under continuous flow conditions with real brines, demonstrating strong performance and confirming the scalability of the technology.

The pilot consistently achieved lithium extraction and recovery above 99%, with the eluate stream enriched to more than 20 times the lithium concentration of the feed brine while maintaining a small eluate volume. The process showed strong selectivity to lithium, producing a high-purity product stream, while operating with low water, reagent, and power consumption.

These outcomes validate LiNC as a cost-effective and sustainable alternative to conventional lithium recovery methods, particularly for low-concentration brine resources. The technology's skid-mounted, plug-and-play pilot configuration, combined with full automation and remote control, further supports its readiness for deployment and scale-up.

In addition to technical performance, independent modeling highlights the significant greenhouse gas (GHG) reduction potential of LiNC compared to traditional hard-rock or evaporation pathways. **At commercial scale, the process is expected to achieve an emissions intensity reduction of approximately 60%, avoiding more than 15,000 tCO_2e annually under reference production scenarios.**

The project established a strong foundation for Litus to advance toward commercial readiness, strengthen partnerships, and contribute to building a secure and sustainable lithium supply chain in Alberta, Canada, and globally.

ABOUT LITUS

Litus is a critical minerals and battery metals company developing patented nanotechnology solutions to meet global energy demands. Its flagship product, Litus LiNC, is a patented, one-step lithium extraction system that economically harvests lithium from low-concentration brines. With operations in North America, Europe, and the Middle East, Litus is accelerating the transition to clean, secure energy systems.

The company was formed in 2019 on research originally conducted at the University of Calgary. Located in the heart of the energy sector, the Litus team is led by an exceptional group of professional chemists, nanotechnologists, and chemical process engineers, as well as experienced entrepreneurial business professionals, with a proven track record of success with scientific achievements and scaling new technologies to become industrial and commercially successful solutions.

In 2023, Litus designed and built its laboratory and manufacturing facility in Calgary, to ensure access to its proprietary nanocomposite, optimized for each brine. Capable of scaling 500 times per day, the facility has been validated over a twenty-four period.

Litus's first product, LiNC^{TM,} is positioned as the most environmentally friendly and efficient solution for unlocking the lithium required for the global energy transition!
Litus is working with lithium producing companies in North America, South America, and Europe to provide them with its uniquely efficient lithium extraction solution. Currently Litus is engaging in contracts to validate and configure its solution for its customers' specific brine sources. In addition, Litus is in the process of deploying a pilot plant in Texas, which is a step forward in demonstrating its exceptional performance at commercially viable volumes.

Solving Major Industry Challenges

Litus was created by a team of experienced nanochemists at the University of Calgary who had discovered a set of game changing nanomaterials for the direct extraction of lithium ("DLE") from brine sources.

Through the investigation of the industry's current and proposed lithium extraction solutions, the team at Litus saw that these technologies had two main problems; 1. the inability to quickly and cleanly extract just lithium ions in brines that typically contain far more competing ions (such as calcium, magnesium, and sodium) than lithium ions, and 2. that the materials these technologies used were far too fragile to withstand the high volumes and harsh conditions required at industrial scale.

Through addressing the lithium industries supply challenges head-on, Litus has developed a novel and patent-pending solution that is uniquely able to both selectively extract lithium ions, and that is strong enough to scale efficiently to industrial volumes without major degradation or constant replacement.

INTRODUCTION

The global shift toward decarbonization driven by the rising demand for electric vehicles, renewable energy storage, and secure critical mineral supply chains has created a strong need for sustainable and scalable lithium extraction technologies. Lithium-ion batteries remain the cornerstone of energy storage, yet conventional methods of lithium recovery (such as evaporation ponds and complex chemical precipitation) face significant limitations. These include inefficiency, large land and water requirements, and limited applicability to brines with lower lithium concentrations or high impurity levels.

Such inefficiencies present barriers to the rapid expansion of lithium supply. With growing global demand and the strategic importance of establishing secure North American supply chains, there is an urgent need for advanced extraction technologies that combine performance, scalability, and environmental sustainability.

In response, Litus has developed the LiNC process, a proprietary nanomaterials-based technology that enables highly selective adsorption and efficient recovery of lithium ions from aqueous sources. This technology is designed to work effectively with brines containing lithium concentrations as low as a few tens of mg/L. The process operates under ambient conditions without requiring elevated pressure or temperature, minimizing water and chemical inputs while reducing waste generation. Its modular cartridge-based configuration enables straightforward integration with existing brine handling systems and allows adaptation to a wide range of resource compositions.

PROJECT BACKGROUND

Litus Inc. entered into a funding agreement with Emissions Reduction Alberta (ERA) to advance the demonstration of its proprietary LiNC nanomaterials-based Direct Lithium Extraction (DLE) process. The project was designed to showcase the ability of LiNC to efficiently and selectively extract lithium from challenging brine resources, including those with relatively low lithium concentrations and high impurity levels.

The core objective was to demonstrate that LiNC can deliver:

- **High lithium extraction and recovery (>99%) under continuous operation,**
- **Strong selectivity against interfering ions such as magnesium, calcium, and sodium,**
- **Low consumption of water, reagents, and power, aligning with economic and environmental sustainability goals,**
- **Robust material performance across multiple operating cycles, supporting scalability and long-term durability.**

A critical dimension of this project is its contribution to Alberta's climate and clean technology objectives. Independent GHG modeling indicates that compared to traditional hard-rock mining or evaporation pond methods, LiNC offers a significant reduction in lifecycle emissions. At commercial scale, the process has the potential to reduce over 10 tonnes of CO_2e for every tonne of lithium carbonate equivalent (LCE) produced, representing a pathway to annual reductions of more than 15,000 tonnes CO_2e when fully deployed on commercial scale.

While this pilot demonstration was not intended to generate measurable reductions at scale, it served to validate the efficiency of the process and highlight the future climate benefits that could be realized through commercial deployment.

LINC™ OVERVIEW

Litus developed the LiNC process to enable the highly selective extraction of lithium, including from sources with relatively low concentrations. The process methodology is illustrated in Figure 1.

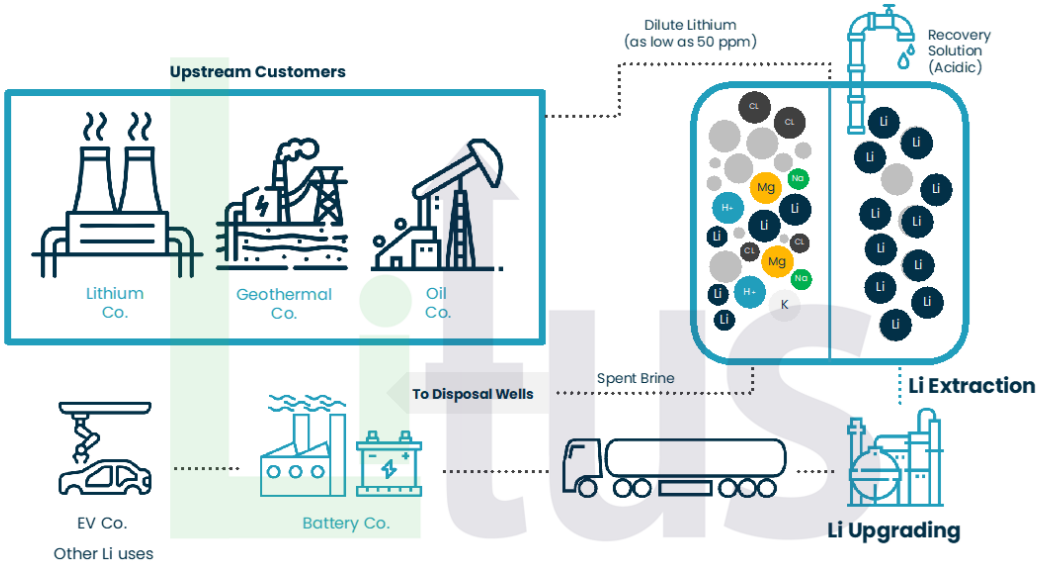

Figure 1: Litus LiNC Direct Lithium Extraction Process and Value Chain Integration.

In the extraction stage, the brine is passed through the system where lithium ions are selectively adsorbed onto the nanomaterial surface. This step captures lithium efficiently while rejecting other ions present in the brine. Continuous monitoring and control systems ensure stable conditions, supporting consistent and reliable performance.

Following extraction, the nanomaterial contains the adsorbed lithium. Recovery is achieved by introducing an acidic solution, which triggers an ion-exchange reaction that releases the lithium into a concentrated eluate stream. At the same time, the nanomaterial is regenerated, enabling reuse across multiple operating cycles. This cyclical design reduces material demand and supports long-term scalability.

PILOT TESTING

Litus constructed a pilot-scale system designed to replicate the key steps of the commercial LiNC technology in an industrially relevant environment. The unit is built on modular skids, making it portable and plug-and-play, and enabling rapid deployment to different sites as required.

The pilot is fully automated and remotely controlled, allowing real-time monitoring, data acquisition, and process adjustments without the need for continuous manual intervention. This digital integration enhances safety, consistency, and operational reliability while also providing high-quality datasets to validate performance.

Figure 2: Litus LiNC Pilot Unit Installed in the Field with Feed Tanks

Figure 3: Pilot unit transportation to the field (July 2025).

Key features of the pilot system include:

- Automated process control for all major operations, ensuring stable and repeatable conditions.

- Remote monitoring and control capability, enabling operators and technical staff to supervise and optimize performance from any location.
- Skid-mounted, plug-and-play design, simplifying transport, setup, and integration.
- Minimal pretreatment requirements, limited to solids removal (TSS), eliminating the need for extensive upstream processing.
- Low power consumption, supporting both cost-effectiveness and emission reduction objectives.

This configuration allows Litus to run large-scale operations under continuous flow conditions, validate performance metrics, and demonstrate the technology's readiness for commercial deployment.

GREENHOUSE GAS (GHG) EMISSION REDUCTION POTENTIAL

Baseline Scenario

In the absence of advanced lithium extraction technologies such as LiNC, lithium is typically sourced through conventional hard-rock mining or evaporation pond methods. These pathways are known to be energy-intensive and carbon-intensive, with significant emissions from mining and ore processing having to expose the ores to very high temperature and also although small but from transportation emissions.

Industry benchmarks indicate that conventional lithium production generates approximately 17 tCO_2e per tonne of lithium carbonate equivalent (LCE) produced.

Commercial Project Scenario – LiNC Process

The LiNC process uses low-temperature, ambient-pressure adsorption with minimal pretreatment and low power consumption. Major improvements relative to the baseline include:

- Reduced electricity demand due to optimized pumping and automated operation,
- Lower chemical use, with minimal acid and base dosing
- Minimal pretreatment requirements, if any, and addresses solids removal
- In-house nanomaterial regeneration and recycling of the material

- Portable, skid-mounted design, reducing infrastructure footprint.

Independent modeling indicates the LiNC process reduces lifecycle emissions by an average of 10.7 tCO_2e per tonne of LCE compared to conventional pathways as presented in Table 1.

Table 1: Emissions Intensity of Conventional vs. LiNC Direct Lithium Extraction

Scenario	**Emissions Intensity (tCO_2e per tonne LCE)**	**Reduction vs. Conventional**
Conventional Hard-Rock / Evaporation	~17	–
LiNC DLE (Modeled Commercial Case)	~6	~10.7 (~60% reduction)

At a future commercial facility producing on the order of thousands of tonnes of LCE annually, this differential translates to tens of thousands of tonnes of CO_2e avoided per year. For example, modeled scenarios suggest that scaling the LiNC process could deliver 15,000 tCO_2e or more in annual reductions, positioning it as a meaningful contributor to provincial and national decarbonization objectives.

The detailed projection in Table 2 outlines modeled greenhouse gas (GHG) emissions for a full commercial facility operating under three illustrative production scenarios: Low, Reference, and High. Each trajectory compares the baseline emissions expected from conventional lithium production methods with the reduced intensity achieved through the LiNC process. The results highlight how avoided emissions accumulate over time, with even the conservative Low case delivering material reductions, while the Reference and High cases demonstrate the potential to avoid hundreds of thousands of tonnes of CO_2e cumulatively over a decade. This long-term perspective underscores the climate value of deploying LiNC technology at scale.

Table 3 summarizes the annual avoided emissions for the same scenarios, providing a clear comparison of climate benefits on a year-to-year basis. The projections show that under the Reference case, annual avoided emissions surpass 15,000 tCO_2e within the early years of operation consistent with the modeling reviewed under the MMV plan. In

the High case, avoided emissions exceed 50,000 tCO_2e annually by the mid-2030s, illustrating the significant contribution that commercial-scale deployment of LiNC could make toward meeting provincial and national decarbonization targets.

Table 2: Projected GHG Emissions for a Full Commercial Facility (2026–2035)

Scenario	Year	LCE (t/yr)	Baseline Emissions (tCO_2e/yr)	Project Emissions (tCO_2e /yr)	Avoided Emissions (tCO_2e /yr)	Cumulative Avoided (tCO_2e)
Low	2026	800	13680	5120	8560	8560
Low	2027	1000	17100	6400	10700	19260
Low	2028	1100	18810	7040	11770	31030
Low	2029	1200	20520	7680	12840	43870
Low	2030	1300	22230	8320	13910	57780
Low	2031	1400	23940	8960	14980	72760
Low	2032	1500	25650	9600	16050	88810
Low	2033	1600	27360	10240	17120	105930
Low	2034	1700	29070	10880	18190	124120
Low	2035	1800	30780	11520	19260	143380
Reference	2026	1200	20520	7680	12840	12840
Reference	2027	1400	23940	8960	14980	27820
Reference	2028	1500	25650	9600	16050	43870
Reference	2029	1600	27360	10240	17120	60990
Reference	2030	1800	30780	11520	19260	80250
Reference	2031	2000	34200	12800	21400	101650
Reference	2032	2200	37620	14080	23540	125190
Reference	2033	2400	41040	15360	25680	150870
Reference	2034	2600	44460	16640	27820	178690
Reference	2035	2800	47880	17920	29960	208650
High	2026	2000	34200	12800	21400	21400
High	2027	2300	39330	14720	24610	46010
High	2028	2600	44460	16640	27820	73830
High	2029	2900	49590	18560	31030	104860
High	2030	3200	54720	20480	34240	139100
High	2031	3500	59850	22400	37450	176550
High	2032	3800	64980	24320	40660	217210
High	2033	4100	70110	26240	43870	261080
High	2034	4400	75240	28160	47080	308160
High	2035	4700	80370	30080	50290	358450

Table 3. Projected Annual Avoided Emissions for a Full Commercial Facility (2026–2035)

Year	High	Low	Reference
2026	21400	8560	12840
2027	24610	10700	14980
2028	27820	11770	16050
2029	31030	12840	17120
2030	34240	13910	19260
2031	37450	14980	21400
2032	40660	16050	23540
2033	43870	17120	25680
2034	47080	18190	27820
2035	50290	19260	29960

Beyond direct GHG reductions, the LiNC process supports climate objectives by:

- Enabling secure supply of low-carbon lithium, critical for electric vehicles and renewable energy storage,
- Lowering production costs through reduced energy and reagent use, increasing economic feasibility of sustainable lithium supply,
- Providing a replicable and scalable solution that can be rapidly deployed due to its skid-based, plug-and-play design.

Project Timeline and Milestones

The project was structured around a series of clear milestones, beginning with engineering design and moving through material production, pilot construction, and operational testing. This staged approach ensured steady progress, reduced technical risks, and generated the data needed to validate performance and prepare the process for future commercial deployment. **Figure 4** shows the completed project timeline from design to validation.

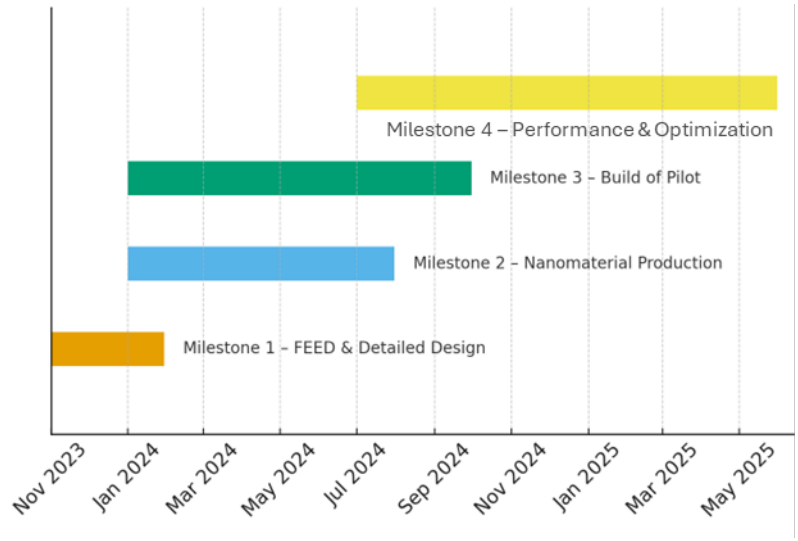

Figure 4. Completed Project Timeline and Milestones (Nov 2023 – May 2025)

The pilot unit was initially operated in-house, where it successfully mimicked field conditions and full operational parameters. The project was formally completed in May 2025, with all milestones delivered and performance targets achieved. However, Litus continued development beyond the project's close by transporting the pilot unit to the field in July 2025 for further demonstration and optimization. These extended activities reinforced the robustness of the LiNC technology under real-world conditions and provided additional validation of its scalability and commercial readiness. Table 4 details the milestones, goals, and deliverables achieved by May 2025.

Table 4: Project Timeline and Key Milestones

Milestone	Timeline	Key Goals & Deliverables
Milestone 1: FEED & Detailed Design	Nov 2023 – Jan 2024	Complete front-end engineering and detailed demo plant design, 3D modeling, finalize custom connectors, and draft commercialization plan.

Milestone 2: Nanomaterial Production	Jan 2024 – Jul 2024	Order and receive reagents, produce required quantities of nanocomposite material for operation.
Milestone 3: Build of Pilot	Jan 2024 – Sep 2024	Procure components, construct cartridges, assemble pilot system, and prepare for integration.
Milestone 4: Performance & Optimization	Jul 2024 – May 2025	Conduct pilot operations, optimize performance, validate GHG MMV plan, and prepare final reporting.

CLOSING REMARKS AND CONCLUSIONS

The project successfully demonstrated the technical performance and scalability of the LiNC process for sustainable lithium extraction. Operating under continuous flow conditions, the pilot consistently achieved >99% lithium extraction and recovery, while maintaining low water, reagent, and power consumption. These outcomes confirm the potential of LiNC to provide a cost-effective and environmentally superior alternative to conventional extraction methods, particularly for lower-concentration brine resources.

With the project completed in May 2025, Litus has continued moving forward by deploying the pilot unit to the field to further validate its performance under real-world operating conditions. This next step reinforces confidence in the robustness of the technology and supports its readiness for broader commercial application. The results also highlight the process's GHG reduction potential, with modeled commercial facilities showing an approximate 60% reduction in emissions intensity compared to conventional operations.

"These achievements position Litus LiNC process as a leading Canadian innovation in the clean tech sector and a key enabler of the global energy transition. Litus has established a strong foundation not only for scaling the technology but also for building strategic partnerships that will accelerate its path to commercialization. Moving forward, Litus is well-positioned to advance a secure, sustainable, and competitive lithium supply chain driving economic growth in Alberta and across North America while showcasing homegrown innovation on the international stage."

— Ghada Nafie, CEO, Litus Inc.