CLEAN REPUBLIC SODO LLC

DAKOTA LITHIUM

November 1, 2023

North Dakota Industrial Commission
ATTN: Clean Sustainable Energy Authority
State Capitol – 14th Floor
600 East Boulevard Avenue
Bismarck, ND 58505

Dear Clean Sustainable Energy Program:

Subject: Proposal No. 2024-0055 Entitled "Demonstration and Scale-Up of a Low-Cost Long-Duration Energy Storage Technology for Lithium-Ion Batteries"

Clean Republic SODO LLC (Clean Republic) doing business as Dakota Lithium Materials (DLM) is pleased to submit the subject proposal to the Clean Sustainable Energy Authority. DLM is committed to completing the project as described in the proposal if the Commission makes the requested grant.

If you have any questions, please contact me by telephone at (218) 791-3746 or by email at hou@dakotalithium.com.

Sincerely,

DocuSigned by:
Yong Hou
455745E54FF245E...

Yong Hou
Director of Research and Development

Approved by:

DocuSigned by:
Andrew Jay
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Andrew Jay/CEO
Dakota Lithium Materials

YH/br

Attachments

Clean Sustainable Energy Authority
North Dakota Industrial Commission

Application

Project Title: Demonstration and Scale-Up of a Low-Cost Long-Duration Energy Storage Technology for Lithium-Ion Batteries

Applicant: Dakota Lithium Materials

Date of Application: November 1, 2023

Amount of Request
Grant: $4,000,000
Loan: $0

Total Amount of Proposed Project: $10,250,000

Duration of Project: 3 years

Point of Contact (POC): Dr. Yong Hou

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ABSTRACT

Objective: The primary objective of the project is to construct a 1000 tons/year production line facility at the University of North Dakota (UND) in Grand Forks to demonstrate and scale-up a novel dry-process technology based on resonant acoustic mixing (RAM) for large-scale manufacture of lithium iron phosphate (LFP) cathode materials suitable for use in lithium-ion battery (LIB) cell manufacturing. This objective is in furtherance of the Clean Sustainable Energy Authority's (CSEA's) mission to support production of large-scale clean sustainable energy technologies in North Dakota. The dry-process technology is easily scalable, highly sustainable, energy-efficient, cost-competitive, and has the potential to revolutionize the manufacturing process for LIB materials to mitigate U.S. domestic supply chain challenges for battery materials that are the core piece of state-of-the-art (SOTA) clean energy technologies. This project will be jointly conducted by Clean Republic SODO LLC, doing business as (DBA) Dakota Lithium Materials (DLM), and the Energy & Environmental Research Center (EERC) to leverage the synergistic capabilities of the EERC and DLM to rapidly advance the scale-up and commercialization of the dry-process technology for manufacturing LFP materials in North Dakota. If successfully commercialized, this technology not only has the potential to be a ground-breaking technology for large-scale LIB cathode materials manufacture in North Dakota but could also meet the U.S. Department of Energy's (DOE's) goal to develop long-duration energy storage (LDES) systems capable of 10+ hr at $0.05/kWh levelized cost of storage (LCOS).

Expected Results: The primary result of this project would be a successful demonstration of a production line based on the proposed dry-process technology, which is expected to deliver low costs and environmental sustainability to potentially revolutionize the manufacturing process for LIB electrode materials and facilitate achievement of DOE's LDES shot goal of 90% reduction in storage cost by 2030, with North Dakota serving as the base from which such a technology is propagated. Additional anticipated beneficial outcomes of the proposed dry-process technology include up to 99% reduction in water use, up to 51% reduction in electricity use, up to 47% reduction in labor and/or operational costs, a safer product, up to 51% reduction in CO_2 emissions, and about 15%–23% reduction in overall product market price per ton. These savings are calculated relative to current SOTA technologies based on wet-processing methods. Accomplishing these results also greatly advances the CSEA's mission to develop and deploy large-scale technologies that reduce environmental impacts and increase sustainability of energy production and delivery in North Dakota.

Duration: The anticipated project duration is 3 years or 36 months.

Total Project Cost: The proposed total cost is $10,250,000, with $4,000,000 from the North Dakota Industrial Commission (NDIC) CSEA program, $5,000,000 from DOE, and $1,250,000 from DLM.

Participants: The project includes DLM, EERC, DOE, and NDIC's CSEA program.

PROJECT DESCRIPTION

Objectives: The primary objective of the project is to construct a 1000 tons/year production line facility at the University of North Dakota (UND) in Grand Forks to demonstrate and scale-up a novel dry-process technology based on resonant acoustic mixing (RAM) for large-scale manufacture of lithium iron phosphate (LFP) cathode materials suitable for use in lithium-ion battery (LIB) cell manufacturing. This objective is in furtherance of the Clean Sustainable Energy Authority's (CSEA's) mission to support production of large-scale clean sustainable energy technologies in North Dakota. The dry-process technology is easily scalable, highly sustainable, energy-efficient, cost-competitive, and has the potential to revolutionize the manufacturing process for LIB materials to mitigate U.S. domestic supply chain challenges for battery materials that are the core piece of state-of-the-art (SOTA) clean energy technologies. This project will be jointly conducted by Clean Republic SODO LLC, doing business as (DBA) Dakota Lithium Materials (DLM), and the Energy & Environmental Research Center (EERC) to leverage the synergistic capabilities of the EERC and DLM to rapidly advance the scale-up and commercialization of the dry-process technology for manufacturing LFP materials in North Dakota. If successfully commercialized, this technology not only has the potential to be a ground-breaking technology for large-scale LIB cathode materials manufacture in North Dakota but could also meet the U.S. Department of Energy's (DOE's) goal to develop long-duration energy storage (LDES) systems capable of 10+ hr at $0.05/kWh levelized cost of storage (LCOS).

Methodology: The proposed project involves fabrication and operation of a production line facility to demonstrate and scale-up a novel dry-process technology for large-scale manufacture of LFP cathode materials. The methodology to accomplish this objective has been divided into separate task structures with specific activities described below.

Task 1.0 – Project Management, Planning, and Reporting [M1–M36]: The objective of this task is to conduct proper management and coordination of project activities and timely reporting to enable successful implementation and completion of proposed project goals and objectives. DLM will work closely with the EERC to oversee most of the reporting and planning activities. The EERC will also assist DLM with overall project management. Project management activities will include arranging a kickoff meeting, scheduling monthly project updates with the CSEA project manager, coordinating planning meetings and communications with project team personnel, financial management, data management, management of supplies and/or equipment, and risk management as well as fulfilling the reporting requirements set forth by the CSEA program.

Task 2.0 – Procurement of Equipment and System Design [M1–M6]

The objective of Task 2.0 is to procure additional equipment items and fabrication materials to support the project. Specific items to purchase will include accessory equipment for process control, data monitoring and acquisition, and fabrication pieces and fittings. Engineering design activities will include pipe and identification diagrams (P&IDs), process flow diagrams (PFDs), and overall system drawings of the production line. The expected outcomes of this task will include detailed system drawings and completed orders for various equipment, accessory parts, and fittings.

Task 3.0 – Fabrication of 1000 tons/year Production Line Facility [M7–M12]

The primary objective of Task 3.0 is to assemble and build a production line facility with 1000 tons/year capacity. The assembly line will include a dry-mixing unit, calcination unit, carbon coating unit, grinding/classification unit, and packaging unit as well as associated accessories for process control, monitoring, and data acquisition. The individual units will be integrated so that they operate in a semicontinuous mode for a complete production line capable of producing about 1000 tons/year of LFP material. The key result of this task will be a completely fabricated production line facility with power turned on and ready for shakedown testing.

Task 4.0 – Shakedown Testing [M13–M16]
The objective of Task 4.0 includes shakedown testing of the production line system for the ability to successfully produce LFP cathode materials. Shakedown testing on the integrated system shall be conducted to verify proper operation and functionality of the different units of the assembly lines and to demonstrate system ability to operate in a semicontinuous mode. Various system controls, data acquisition, and process monitoring equipment shall be tested. During shakedown testing, the LFP raw material subsamples will be preprocessed by crushing to a suitable size range before feeding to the system. The results from this task will provide data to demonstrate that the production line facility can operate well in a semicontinuous mode.

Task 5.0 – Process Optimization Testing [M17–M24]
Additional testing will be performed in Task 5.0 to focus primarily on optimization of process parameters such as temperatures, pressure, flowrates, process gas and environment variables, system stability, etc. During this testing, raw material input streams, product output stream, and product quality will be optimized for steady production of up to 1000 tons/year LFP cathode materials. The production line will be operated for at least 7 months to fine-tune process parameters and product quality and optimize the system to maximize energy savings, CO_2 emission reduction, and overall product cost savings. The raw materials and product will be evaluated by a suitable combination of analytical techniques available at the EERC such as scanning electron microscopy (SEM), x-ray diffraction (XRD), x-ray fluorescence (XRF) spectroscopy, Fourier transform infrared (FTIR) spectroscopy, Raman spectroscopy, and other methods that may be deemed necessary during project implementation. Additional equipment will be purchased to augment the existing analytical capabilities at the EERC to focus on specific properties of the LFP manufacturing process. The primary outcome from this task will include processing data to demonstrate operability of the facility for manufacturing LFP by the new dry-process technology.

Task 6.0 – Product Evaluation and Marketing Plan [M25–M36]
Task 6.0 will focus primarily on evaluation of the LFP materials for their electrochemical performance attributes through testing of various LIB test articles from 2032 half-coin cells up to and including full cell configurations such as cylindrical 18650, pouch, or prismatic cells to optimize the full utility of the produced LFP materials in large-scale LIB cell manufacturing. Standard cell performance parameters, such as initial coulombic efficiency (ICE), galvanostatic charge–discharge profiles with specific charge capacities, etc., will be obtained to demonstrate electrochemical performance and suitability for use in LIB cell manufacture at large-scale. Additionally, an initial marketing plan will be developed to engage potential customers and establish a market for the produced LFP materials. Specific emphasis will be placed on applications in energy storage such as in electric grid systems and micro-electric grids for rural areas and isolated point consumption to include military bases. Additional markets in heavy-duty transportation vehicles where battery weight and size may be less consequential will be explored, especially given that the proposed batteries are expected to have LDES capability of up to 10+ hours at minimal cost of about $0.05/kWh or less LCOS.

Anticipated Results: The primary result of this project would be a successful demonstration of a production line based on the proposed dry-process technology, which is expected to deliver ultra-low costs and environmental sustainability to potentially revolutionize the manufacturing process for LIB electrode materials and facilitate achievement of DOE’s LDES shot goal of 90% reduction in storage cost by 2030, with North Dakota serving as the base from which such a technology is propagated. Additional anticipated beneficial outcomes of the proposed dry-process technology include up to 99% reduction in water use, up to 51% reduction in electricity use, up to 47% reduction in labor and/or operational costs, a safer product, up to 51% reduction in CO_2 emissions, and about 15%–23% reduction in overall product market price per ton. These savings are calculated relative to current SOTA technologies based on wet-processing methods. Accomplishing these results also greatly advances the CSEA's mission to develop and deploy large-scale technologies that reduce environmental impacts and increase sustainability of energy production and delivery in North Dakota.

Facilities: This project will be hosted at UND and will have access to the available exceptional laboratory facilities, analytical capabilities, and demonstration facilities at the EERC. The EERC currently occupies a research complex consisting of 254,000 square feet of laboratories, fabrication facilities, technology demonstration facilities, a specialized machine shop, and offices. It houses eight analytical laboratories dedicated to research on coal combustion and utilization; coal by-product utilization; water resource characterization; conventional/unconventional petroleum resources; alternative fuels; environmental chemistry; and carbon capture, utilization, and storage.

DLM has an existing office complex in Seattle, Washington, where management of the current business activities is conducted, but also maintains a small factory in Grand Forks where battery pack manufacture takes place. Previous research and development (R&D) activities that have been conducted in collaboration with UND Institute for Energy Studies (IES) using its laboratory space have recently been relocated to the EERC facilities to provide better opportunities for rapid scale-up and commercialization. The production line facility being proposed in this project will serve as a dedicated R&D laboratory and demonstration facility for this project and for future developments to speed up commercialization of this technology. Existing equipment at DLM that will be used for the proposed project is listed in Table1.

Table 1. Existing DLM-Owned Equipment for the Proposed Project

Equipment	Quantity	Purpose/Use
Resodyn Mixer, Lab RAM-II	1	Material mixing and grinding
MSK-AFA-L Coater (MTI Corporation [MTI])	1	Coin-cell fabrication
YLJ-24TS Calendaring (MTI)	1	Coin-cell fabrication
MSK- 180SC Disk Cutter (MTI)	1	Coin-cell fabrication
MSK-160E Cell Sealer (MTI)	1	Coin-cell fabrication
MSK-110D Cell Breaker (MTI)	1	Coin-cell fabrication
16-200-412 Glove Box (Labconco)	1	Coin-cell fabrication
Coin-Cell Tester	20	Electrochemical performance testing
SP88850100 Stir Plate (Thermo Scientific)	1	Material synthesis
2-215-422 Vortex Mixer (Fisher)	1	Material synthesis
15-341-100 Homogenizer (Omni International)	1	Material synthesis
14-388-100 Pipette (Fisher Brand)	1	Material synthesis
01-919-151 Scale (Mettler Toledo)	1	Material synthesis

Proposed New Equipment/Facilities: To successfully build and demonstrate the proposed production line facility for LFP cathode powder manufacturing, additional equipment items beyond fabrication materials and fittings have been identified that are needed to support the effort. These items are listed in Table 2. The demonstration space will need to be retrofitted to accommodate the production line equipment and the necessary utilities. Process gas lines for nitrogen and compressed air will be plumbed and additional power transformers and connections will be installed for the project. Dust control and air circulation systems will be added.

Table 2. Proposed New Equipment and Justification

Equipment	Quantity	Justification
MSKAFAIIH B110 Coaster (MTI)	1	Enables precise electrode slurry casting onto the current collector.
MSK180 Die Cutter (MTI)	1	Provides accurate shaping of the electrode post-coating.
MSK111A-E Stacking Machine	1	Streamlines the integration of the anode, cathode, and separator in cell preparation.
MSK120 Pouch Cell Case/Cup Forming Machine	1	Facilitates the creation of laminated aluminum cell cases specifically for pouch cells.
MSK115III11 Hot Sealer	1	Ensures a secure seal on the laminated aluminum case after electrode insertion and electrolyte injection.
MSK E2300A Calendaring (MTI)	1	Achieves higher compact density by pressing the electrode.
MSK540 Slitting Machine	1	Allows precise slitting of both the electrode and the separator.
MSK30000w Welder	1	Facilitates the welding of nickel and aluminum tabs onto the anode and cathode respectively.
Interface 1010E Potentiostat	1	Empowers detailed electrochemical analyses, such as cyclic voltammetry and impedance spectroscopy, for various cell types.
Criterion Benchtop Temperature Chambers	1	Assesses cell performance under varying temperature conditions.
Full Cell Tester	5	Enables extensive testing of full cells under high current and voltage conditions.
Resodyn Mixer, RAM 5		Optimizes the mixing and milling process for cathode active material precursors.
Synthesis/Coating Furnace	1	Supports calcination of active material precursors and facilitates chemical vapor deposition of the active materials.
Jet Mill, LNJ-36A	1	Streamlines the milling and classification of the active material product.
Glove Box, 16-200-412	1	Ensures a controlled environment for cell assembly and electrolyte injection, minimizing contamination risks.

Resources: DLM will be the lead organization for this project and will work closely with the EERC to ensure the overall success of the proposed objectives. With assistance from the EERC, DLM will be responsible for effective communication with all project partners and sponsors to ensure that the project is carried out within budget, schedule, and scope. DLM and the EERC will collaboratively work to implement the technical aspects of the proposed project. DLM will oversee the whole project as the prime applicant, with about 91% commitment toward the project, while the EERC will serve as a collaborator and subrecipient with about 9% commitment to the project. During the development of this proposal, DLM has led the effort to seek and secure the necessary cost share, while the EERC led the effort to write the proposal with input from DLM personnel. During project implementation, DLM will be responsible for the overall design of the production line facility, with assistance from the EERC as needed. DLM will also lead the efforts to perform the technological process optimization and LFP cathode material manufacture. The EERC will provide R&D support during the implementation of the proposed scope of work and for future developments and scale up if the project is awarded. The EERC will provide the necessary oversight in process and product quality assurance and control via analytical characterization and testing. The EERC and DLM have also mutually agreed to work closely on overall project management and integration of the various components of the project, including any laboratory work and setting up of the production line facility. The EERC will also assist with reporting and engineering, procurement, and construction (EPC) to facilitate overall project success and fulfillment of the CSEA program objectives.

Techniques To Be Used, Their Availability and Capability: This project involves assembly and fabrication of a LFP cathode material production line as well as analytical characterization and testing of electrochemical performance of the produced materials. The EERC has several trained and certified professional engineers to work in collaboration with DLM staff for design, fabrication, and assembly of the components needed to build and test a complete production line facility.

The EERC currently has advanced analytical equipment and analysis techniques that are suitable and available for the proposed activities. A summary of key analytical techniques/equipment available for this project includes field emission SEM (FESEM), XRD, XRF spectroscopy, FTIR spectroscopy, Raman spectrometer, proximate/ultimate/CHN analyzers, thermogravimetric analyzer (TGA), surface area analyzer, and a controlled atmosphere glovebox. DLM has an existing electrochemical testing workstation, a 40-slot battery-testing system for battery test articles of various sizes from small CR2032 half coin-type cells to full-size 18650 cylindrical cells and for making battery packs up to 48 V as needed.

Environmental and Economic Impacts while Project is Underway: There are no anticipated environmental and economic impacts associated with the proposed work as all the R&D activities will occur on the UND campus in Grand Forks. The raw materials and finished products for the process such as lithium carbonate (Li_2CO_3), iron (II) phosphate ($Fe_3(PO_4)_2$), carbon coating additive, and lithium iron phosphate ($LiFePO_4$) are all environmentally benign chemicals, which is why the LFP chemistry for LIBs is considered the safest in the industry. However, the EERC has dedicated environmental, health, and safety (EH&S) personnel that oversee all R&D activities to ensure that any potentially environmentally harmful or toxic species are properly handled and disposed of according to local, state, and federal regulations.

Ultimate Technological and Economic Impacts: Preliminary estimates show that a successful deployment of the proposed dry-process technology is expected to deliver low costs and environmental sustainability to potentially revolutionize the manufacturing process for LIB technology materials and facilitate achievement of 90% reduction in storage cost by 2030, as stipulated in the DOE's LDES shot. Anticipated specific beneficial outcomes of the proposed dry-process include up to 99% reduction in water use, up to 51% reduction in power consumption, a safer product, up to 51% reduction in CO_2 emissions, up to 47% reduction in labor and/or operational costs, and about 15%–23% reduction in overall product market price per ton. These advantages suggest that a successful commercial deployment of the proposed technology could lead to substantial economic benefits to Americans desiring to transition to clean and sustainable energy options for electric vehicles (EVs) and energy storage for electric grid applications. Thus, the proposed technology holds great promise as a key technological solution for sustainable, cost-effective, large-scale manufacture of LFP materials in North Dakota for the LIB industry to mitigate U.S. domestic supply chain challenges.

Why the Project Is Needed: This project is needed to begin building the energy storage capacity to support the clean energy transition for North Dakota, where recovered energy from wind turbines and solar collectors can be stored in batteries for sustained power supply to local micro-electric grids and/or national electric grid systems where possible. The LIB is currently a critical connecting tissue for the clean energy transition grand challenge from fossil fuel-based to renewable energy options such as solar and wind as well as playing a critical role in technologies that are increasingly revolutionizing the way of life via emerging technologies for cell phones, next-generation medical devices, and the electronics application industry in general. Low-cost, high-capacity, and long-duration storage solutions could have been helpful for preventing or limiting the catastrophic impacts of the Electric Reliability Council of Texas (ERCOT) grid system failure in 2021 by providing a turnkey backup storage safeguard. Despite these dire needs and impending demand for LIBs, the U.S. supply chain has lagged that of other countries such China, thus posing a national security risk as LIBs and their components are manufactured abroad in potentially adversarial nations. Thus, development of the proposed technology, which is sustainable, scalable, and cost-competitive, is needed to provide an efficient large-scale manufacturing process for LIB materials to mitigate U.S. domestic supply chain challenges for battery materials needed for clean energy transition. Funding from the CSEA will provide the opportunity for this potentially ground-breaking technology to be developed and built in North Dakota and potentially place the state as a world leader in the production of clean, sustainable LIB energy technology, which also helps to diversify and grow the state’s economy.

STANDARDS OF SUCCESS

The proposed project is a demonstration of a dry-process technology that is expected to perform better than the conventional wet-processing approaches. Preliminary estimates based on comparing the SOTA wet-processing method and the proposed dry-process method show that the following metrics can be used to measure the success of the technology:

- ***Emissions Reduction***: Implementation of this technology is anticipated to cut CO_2 emissions by up to 51% and wastewater discharge by up to 99%.

- ***Reduced Environmental Impact***: There will be little to no waste discharge and raw and product materials and chemicals are environmentally benign.

- ***Increased Energy Sustainability and Efficiency***: The technology is expected to be highly sustainable and energy efficient, with up to 51% savings in electricity consumption and no hazardous waste streams.

- ***Value to North Dakota***: If the proposed production line demonstration is successful, it will place North Dakota on top of the world for a potentially revolutionary technology for large-scale manufacture of LIB cathode materials when they are commercialized in the next step of their development. A new LIB plant in North Dakota would help boost the economy, create good-paying jobs, and help to diversify North Dakota’s energy portfolio and build capacity for storage and use of renewable energy such as wind and solar generated in North Dakota.

- ***Explanation of How the Public and Private Sector Will Make Use of the Project's Results, and When and in What Way:*** This project will help create public and private sector awareness about this potentially game-changing technology for manufacturing LIB cathode materials. When commercialized, increased production of LIBs will lead to cheaper LIB-based devices because of cheaper LIB costs, which will be a benefit to public and private sectors.

- ***Potential Commercialization of the Project's Results***: It is expected that a successful demonstration of the dry-process method at full scale would place the technology on a fast-track to full commercial deployment in the next 5–10 years.

- ***How the Project Will Enhance the Research, Development and Technologies that Reduce Environmental Impacts and Increase Sustainability of Energy Production and Delivery of North Dakota's Energy Resources***: If successful, the dry-process technology would alleviate supply chain issues for LIB cathode materials and provide more opportunities to manufacture LIB batteries that are central to all clean and sustainable energy technologies with reduced environmental impacts.

- ***How It Will Preserve Existing Jobs and Create New Ones***: This project will create about 11 new jobs, including one salesperson, one warehouse attendant, one business manager, five operators, two engineers, and one technician.

- ***How It Will Otherwise Satisfy the Purposes Established in the Mission of the Program***: The proposed pilot-scale project satisfies the CSEA's mission to advance development of large-scale technologies to produce clean sustainable energy and delivery in North Dakota.

BACKGROUND/QUALIFICIATIONS

Background: DLM began development of LFP cathode materials for LIBs in 2008. During the initial stages of R&D, it was observed that the commercial LFP materials purchased from China had inconsistent compositions and sometimes possessed unacceptable levels of impurities and a specific capacity that was lower than 120 mAh/g. This sparked initial investigations into these issues, and a new synthetic procedure was developed that combines the simplicity of solid-phase and the homogeneity of liquid-phase reaction routes. To improve particle stability and electrochemical performance, North Dakota lignite-derived humic acid was used as the carbon source for coating the LFP particles. Recent and continuing development includes the use of food-grade agricultural products as a source of carbon used to coat the LFP particles after synthesis.

Based on literature review of $LiFePO_4$ performance attributes, reaching high-performance technical targets such as high energy density, cycling and calendar life, rate capacity, and low production cost requires developers and manufacturers to focus on controlling particle size and optimizing a synthesis route and carbon-coating techniques to improve conductivity. Accordingly, DLM engaged in a collaborative research effort with UND to develop its own LFP cathode material with improved performance attributes. Between 2015 and 2018, much of the development work sought to improve two key challenges: high purity and batch-to-batch quality consistency. The results were very promising, and the main technical objectives were achieved, with greater than 99% purity of the LFP powder, specific capacity higher than 120 mAh/g, and the relative standard deviation of other physical and electrochemical properties less than 15% and 5%, respectively.

With additional financial support from the North Dakota Department of Commerce, a scalable, environmentally benign, reproducible, lower-cost, and higher-performance process was developed to achieve a target specific capacity of 120–130 mAh/g, which is comparable to or better than that of commercial LFP materials. Attention then turned to improvement of the electrochemical performance, with specific emphasis on energy density, cycling life, rate capacity, and other physical properties. The results demonstrated good-quality LFP powders with crystalline purity of 99.5%, combined impurities (Ni, Cu, Zn, Mn, Ca, Mg, Cd, Na, and K) of about 0.07%–0.2%, carbon content of ~2%–5%, particle-size distribution of 363–474 nm, and first-cycle discharge capacity at a 0.1C cycling rate of ~140–150 mAh/g after 1000 cycles. The discharge capacity remained at 120–130 mAh/g, with first-cycle irreversible capacity loss of about 4%–8%.

Despite the progress made in previous efforts based on wet-processing methodology, there is a continuous desire to improve on utilities consumption, environmental sustainability, and cost, especially considering the new DOE LDES shot goal of 90% reduction in LFP cost by 2030 and to achieve a LCOS of $0.05/kWh for LDES systems with capability of 10+ hr. Thus, recent investigations to further cut costs, improve sustainability, and to achieve a more robust large-scale manufacturing process for LFP cathode materials let to the development of a dry-mixing process (Figure 1) based on RAM principles[1]. Compared to conventional state-of-the-art (SOTA) approaches that are based on wet mixing, a dry-mixing method was applied to mix LFP precursors in dry, solid form to achieve a more homogeneous mixture. RAM mixing involves rapid vibratory movements at about 60 Hz and up to 100× the acceleration due to gravity, which causes random collisions of dry LFP precursor particles, resulting in particle-size

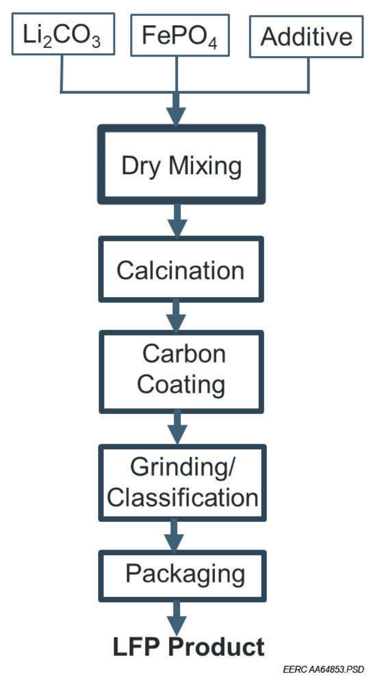

Figure 1. Simplified block flow diagram of the proposed LFP process.

[1] Resodyn Acoustic Mixers. Powders and Solids. https://resodynmixers.com/applications/powders/ (accessed January 30, 2023).

reduction, shaping, mixing, and homogeneous coating in a very short duration, on the order of a few minutes. The relatively short duration of such a scalable mixing process can greatly reduce production times for manufacture of LFP materials at scale.

In the industry, the LFP charge capacity density is often considered to be about 120 mAh/g. Results of samples prepared by the dry-process method have achieved a charge capacity density of 140 mAh/g after 250 cycles in half coin cells with remarkable stability (Figure 2). The results in Figure 2 further demonstrate that there is no loss of quality and performance between materials made by the SOTA wet process and new dry-process technology. However, cost estimates based on the dry-process baseline LFP material (Table 3) show $115/kWh and 5840 cycles, which equates to about $0.02/kWh LCOS. Thus, it is anticipated that optimization and plant scale-up of the dry-process technology would potentially reach DOE's storage innovation 2030 target of $0.05/kWh LCOS for LDES systems capable of 10+ hr, even when costs associated with other battery assembly parameters are accounted for. These preliminary results are the technological basis for this project seeking to scale-up the process. Table 3 shows the technology baseline metrics, SOTA technology, and anticipated reduction/increase in specific parameters between the proposed process and SOTA technology.

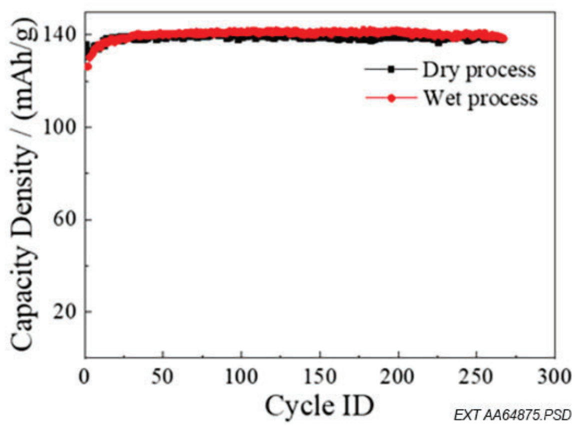

Figure 2. Electrochemical performance of LFP at C/3.

Table 3. Proposed Technology Performance Target Metrics Levels

Property	Proposed Technology	SOTA Technology	Reduction/ Increase
Cost, $/kWh	115	126	-9%
LFP Product Cost, $/ton	8460	10,000	-15.4%
LCOS, $/kWh	0.020	0.035	-43%
Cycle Life, cycles	5840	3650	+60%
Energy Consumption*, MWh/yr	286.2	5,806.5	-51%
CO_2 Emissions*, Mtons/yr	202	4096	-51%
Water Use*, tons/yr	12	1302	-99%
Labor/Operation Time**, hrs	19	36	-47%
Safety (low, medium, high)	High	Medium	N/A

* Calculation is based on 1000 metric tons LFP production per year.

** Calculation is based on one batch LFP cathode material production.

DLM Experience and Qualifications: DLM was founded in 2008 in Grand Forks, North Dakota. DLM (DakotaLithium.com) is the leading consumer lithium battery brand in the United States and Canada, with over 100,000 customers annually. In addition, DLM is a leading manufacturer of lithium batteries for EVs, the maritime industry, and the agricultural industry.

As an expert in lithium battery technology, DLM established a research center at UND in 2012 for the purpose of developing LFP cathode materials. Investments by DLM in R&D activities at UND focused on developing a cost-competitive cathode powder using U.S.-sourced inputs. Graphene was replaced with a low-cost and higher-performance carbon structure, particle coatings were replaced with a low-cost and higher-performance by-product from agricultural food processing, and multiple steps in the production process were consolidated, allowing for a product with superior performance at a lower manufacturing cost.

DLM has deep commercial relationships in the lithium battery cell-manufacturing industry. As a customer, DLM purchases millions of $LiFePO_4$ cells a year that are used to manufacture lithium battery packs (finished batteries). DLM has leveraged its technology and commercial relationships to manufacture a cathode material that is made in America, with manufacturing inputs from U.S. sources, including lithium and carbon coating materials from North Dakota. Cathode powder-manufacturing output has been sold to U.S. cell suppliers that DLM currently sources cells from. The unique relationship where DLM both sells $LiFePO_4$ cathode material to U.S. cell manufacturers and buys $LiFePO_4$ cells from the same cell manufacturers ensures this project's commercial success and stability. DLM's 15 years of combined experience and successes will be utilized to implement the proposed project to achieve success and fulfill CSEA objectives.

EERC Experience and Qualifications: The EERC has worked with more than 1300 clients in all 50 states and 53 countries around the world, with 76% of contracts with private industry. The EERC has a long and successful history of working with NDIC and private industry on large, multimillion-dollar projects and consortia, e.g., CO_2 capture and sequestration projects in western North Dakota, various oil and gas related projects, the Bakken Petroleum Optimization Program (BPOP), among others. The EERC is also a global leader in research, development, demonstration, deployment, and commercialization of technologies from the laboratory scale to full scale and has multiple research portfolios in coal and coal utilization, oil and gas, renewal energy, environmental remediation, etc. These experiences are expected to be of relevance to the proposed project.

Experience and Qualifications of Key Project Personnel: Dr. Yong Hou, DLM Director of Research and Development, will be the principal investigator (PI) for the proposed project. Dr. Hou will oversee the technical development of the LFP cathode materials and testing in the fabricated production line facility. Dr. Hou has 40 years of experience in the lithium battery industry, specifically lithium battery materials research, development, and production. He holds a Ph.D. degree in Systems Engineering from the University of Shanghai for Science & Technology, China. From 2008 to 2022, Dr. Hou worked at UND as a research scientist on cathode material manufacturing. He left UND in the spring of 2022 to join DLM full time as the Director of Research and Development. Prior to his work at UND (before 2007), Dr. Hou was the factory director of a cathode-manufacturing facility in Shenzen, China, where he developed deep relationships with cathode-manufacturing equipment suppliers and deep knowledge of the cathode materials industry.

Dr. Xin Zhang, Senior Engineer at DLM, is a core member of the LFP R&D team. Dr Zhang obtained a B.Sc. degree in Chemical Engineering from Qingdao University of Science and Technology, Qingdao, China; an M.Sc. degree in Chemical Engineering from Guizhou University, Guiyang, China; and a Ph.D. degree in Chemical Engineering from UND. He has been part of the team developing the LFP materials at UND for the past 6 years and has hands-on experience with LIB electrode materials development that includes electrode materials synthesis, characterization, electrochemistry, and battery cell fabrication and testing.

Dr. Alexander Azenkeng, EERC Assistant Director for Critical Materials, will assist the PI (Dr. Hou) in overall project management and reporting (Task 1.0). Dr. Azenkeng has an academic background in physical chemistry and has been project manager for numerous EERC research activities, including several funded by DOE and NDIC. He has 15 years of experience with characterization and assessment of coal materials and recently has been leading EERC efforts to make high-value carbon materials from coal and coal wastes such as graphene and high-quality graphite for the LIB anode manufacture.

Mr. Andrew Jay, CEO of DLM, will be co-advisor for the project. Mr. Jay has 15 years of C-Suite executive-level experience in operations, project management, sales, marketing, and business development. He will leverage this diversity of experience in providing advice to ensure project success.

Mr. Jason Laumb, EERC Director of Advanced Energy Systems Initiatives, will serve also as co-advisor for the project advisor. Mr. Laumb has 22 years of experience in coal science, techno-economic modeling, environmental control systems, supercritical CO_2 power cycles, and advanced gasification technologies.

MANAGEMENT

Overall Project Management: DLM is the lead organization for this project and will work closely with the EERC to oversee all tasks, management, and reporting activities associated with the project. Regular planning meetings will be scheduled with project personnel and advisors to ensure proper project implementation to meet the stated objectives and to adhere to the budget, schedule, deliverables, and milestone requirements. Additionally, regular progress update meetings and/or communications via email, phone calls, or WebEx conference meetings will be conducted with the NDIC/CSEA project manager to discuss any potential challenges and find appropriate remedies in a timely manner. Resumes of key personnel can be found in Appendix D.

The project organizational chart is presented in Figure 3. The lead applicant organization is DLM and Dr. Yong Hou, Director of Research and Development at DLM, is the PI. Dr. Hou will lead Tasks 1.0, 5.0, and 6.0. Dr. Alexander Azenkeng, EERC Assistant Director for Critical Materials, will assist Dr. Hou in leading Task 1.0 in addition to leading Tasks 3.0 and 4.0. Dr. Xin Zhang, Senior Engineer at DLM, will lead Task 2.0 and assist in Tasks 4.0 and 6.0. Mr. Andrew Jay (CEO of DLM) and Mr. Jason Laumb (EERC's Director of Energy Systems Initiatives) will serve as project advisors. Regular communications will be maintained among the key personnel team members by email, phone calls, scheduled meetings, and/or online meetings to ensure smooth implementation of the various tasks on time, schedule, and budget.

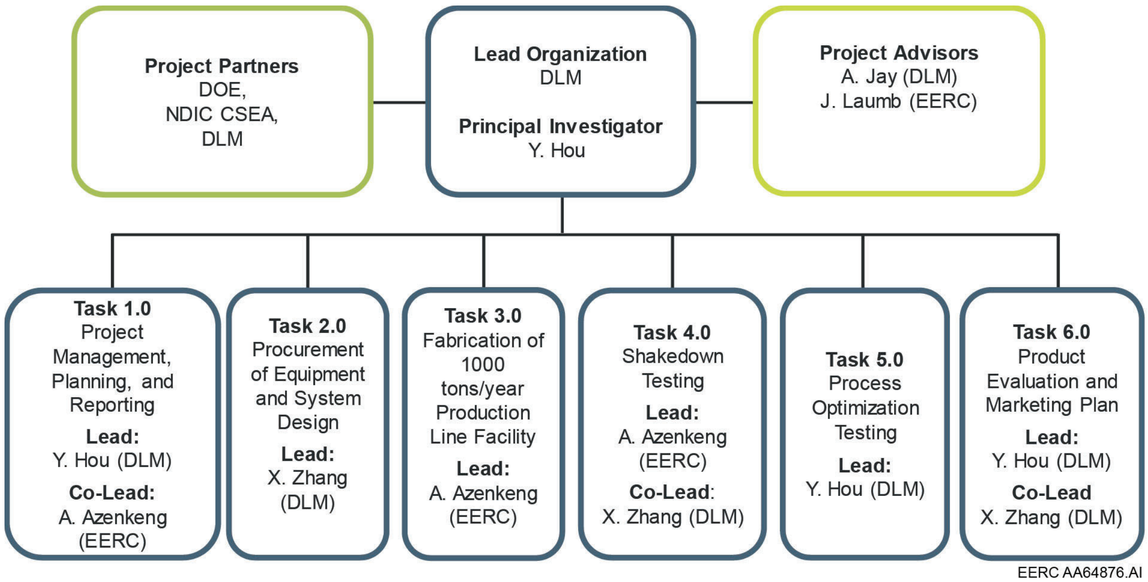

Figure 3. Project organization chart.

Evaluation Points: The project progress will be tracked and measured by completion of identified milestones and/or deliverables as stated in the project timeline in Figure 4 and Table 4. The milestones or deliverables are structured such that project progress will be monitored at various stages during the period of performance to include procurement of equipment and fabrication materials, assembly and fabrication of the production line facility, shakedown testing, process optimization, product evaluation and performance testing, and overall project management and planning.

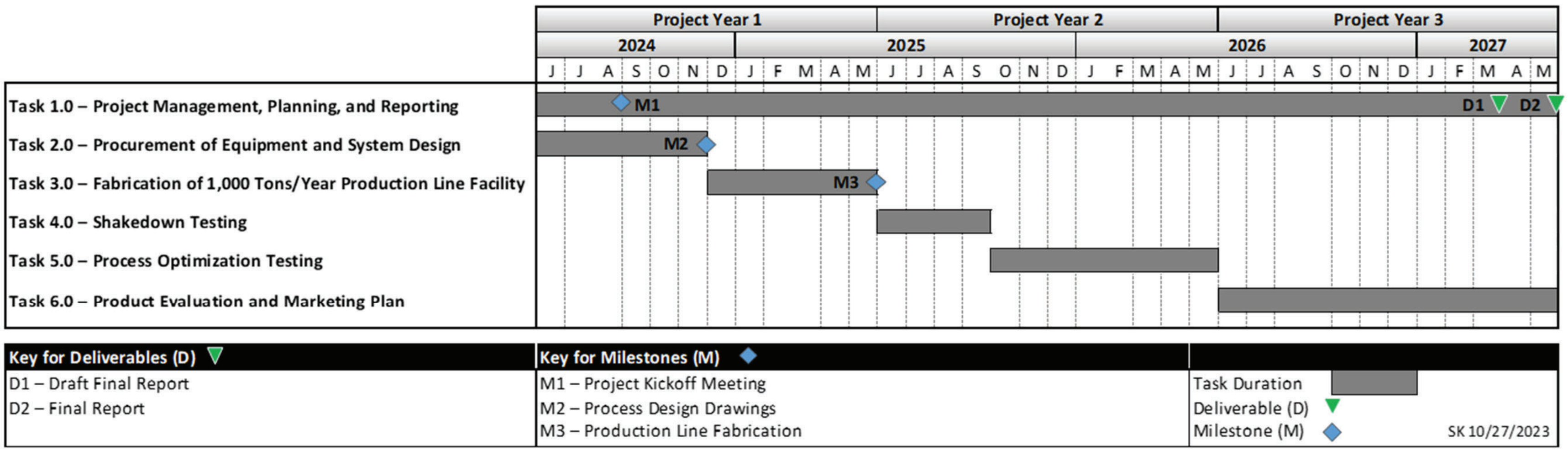

Figure 4. Project timeline.

TIMETABLE

The project timeline is presented in Figure 4 for a total project duration of 3 years, with a projected start date of June 1, 2024. The start date may be adjusted depending on when the award contract is signed or authorized.

BUDGET

The total budget for this proposal is $10,250,000 for a project duration of 3 years beginning from when the contract is signed. The total amount requested from NDIC's CSEA program is $4,000,000. There is a $5,000,000 cash cost-share portion that is anticipated to come from DOE through a proposal in response to Funding Opportunity Announcement (FOA) DE-FE0003020 and another $1,250,000 cash cost share from DLM. The detailed breakdown is presented in Table 4.

Table 4. Itemized List of Project Costs

Project-Associated Expense	NDIC Grant	DOE Share (cash)	DLM Share (Cash)	Total Project
Labor	$1,418,964	$500,000	$1,136c364	$3,055,328
Travel	$0	$6,000	$0	$6,000
Equipment > $5000	$874,718	$2,246,700	$0	$3,121,418
Supplies	$578,722	$1,997,000	$0	$2,575,722
Subcontractor – EERC	$925,327	$0	$0	$925,327
Total Direct Costs	$3,797,731	$4,749,700	$1,136,364	$9,683,795
Facilities and Administration	$202,269	$250,300	$113,636	$566,205
Total Project Costs	**$4,000,000**	**$5,000,000**	**$1,250,000**	**$10,250,000**

TAX LIABILITY

DLM, a small for-profit business, is a taxable entity. The signed Tax Liability form is contained in Appendix I.

CONFIDENTIAL INFORMATION

Appendix A contains a confidential information request. DLM would like to keep all information about its historical financial statements (provided in Appendix G) confidential and only to be used for proposal review as necessary.

PATENTS/RIGHTS TO TECHNICAL DATA

There are no patents or rights that are disclosed in this application that need to be protected.

STATE PROGRAMS AND INCENTIVES

There are no programs or incentives from the State of North Dakota that the applicant has participated in within the last 5 years.

APPENDIX B

SUBCONTRACTOR PROPOSAL

EERC

Energy & Environmental Research Center

15 North 23rd Street, Stop 9018 • Grand Forks, ND 58202-9018 • P. 701.777.5000 • F. 701.777.5181
www.undeerc.org

October 31, 2023

Mr. Andrew Jay
CEO
Dakota Lithium Materials
225 South Lucile Street
Seattle, WA 98108

Dear Mr. Jay:

Subject: EERC Proposal No. 2024-0055 Entitled "Project Support for Demonstration and Scale-Up of a Low-Cost Long-Duration Energy Storage Technology for Lithium-Ion Batteries"

On behalf of the Energy & Environmental Research Center (EERC), I would like to express our commitment to the proposal being sent to the North Dakota Industrial Commission (NDIC) Clean Sustainable Energy Authority (CSEA) program as it paves the way to a clean and secure energy future for North Dakota and the United States. The EERC strongly believes that this is a key step in ensuring clean sustainable energy will remain an important resource to meet the future energy needs of the United States and the world.

Should this project be accepted for award, the EERC stands ready to provide over 60 years of experience in developing, demonstrating, and commercializing clean and efficient energy technologies. The EERC's long history of teaming with industry, state, and government is key to developing the scientific and engineering understanding required to move energy technologies forward into the marketplace. This understanding is critical to building acceptance from both industry, state, and the public for future clean energy efforts.

The EERC looks forward to being a valuable partner in Dakota Lithium Materials demonstration and production line facility. This facility will manufacture lithium-ion battery cathode materials and be located at the UND/EERC premises in Grand Forks, North Dakota. The EERC is committed to working with the team to make a North Dakota-based facility a success should this work be funded.

The EERC scope of work, detailed budget, and project team resumes are included as attachments. If you have any questions regarding the proposed work scope or schedule, please contact me by phone at (701) 777-5051 or by email at aazenkeng@undeerc.org.

Sincerely,

DocuSigned by:
Alex Azenkeng
048DB552AD204BF...
Alexander Azenkeng
Assistant Director for Critical Materials

Approved by:

DocuSigned by:
29499751F2B84D7...

Charles D. Gorecki, CEO
Energy & Environmental Research Center

AA/bjr

Attachments

EERC SCOPE OF WORK
EERC Proposal No. 2024-0055
for
Clean Sustainable Energy Authority

Subrecipient: University of North Dakota Energy & Environmental Research Center (EERC)
Prime Recipient: Dakota Lithium Materials (DLM)
Project Title: Project Support for Demonstration and Scale-Up of a Low-Cost Long-Duration Energy Storage Technology for Lithium-Ion Batteries
Technical Point of Contact: Alexander Azenkeng, EERC, 15 North 23rd Street, Stop 9018, Grand Forks, North Dakota 58202-9018; phone: (701) 777-5051, aazenkeng@undeerc.org

Technical Approach

The proposed scope of work includes support for engineering design, fabrication, facilities, laboratory analyses, and management and reporting. The Energy & Environmental Research Center (EERC) will be responsible for reporting on the progress of these activities. Detailed descriptions of the activities broken into six tasks across two budget periods (BPs) are provided below.

Task 1.0 – Project Management and Planning (all BPs)

The EERC will provide project management support to Dakota Lithium Materials (DLM) for the proposed project. The EERC has well-established business systems in place and extensive experience working with government and state agencies. EERC personnel will work closely with DLM to administer the financial and contractual responsibilities related to the project, offering quick access to decision-makers and quick resolution of issues.

The EERC project team will assist in all aspects of project management, including tracking expenditures and deliverables, including subcontractors. Subcontractors will be reviewed and approved by EERC staff for technical progress at the request of DLM. Support will also be provided to DLM in negotiating and administering sponsored agreements. This may include preparing correspondence and requesting modifications, approvals, and revisions as needed. EERC contracts staff will also prepare and negotiate subcontract/consultant and other purchase agreements as required by the project as well as monitor the agreements and facilitate the receipt and processing of associated invoices. Other activities may include tracking and reporting of equipment.

Other project management activities to be performed will include the development and production of quarterly progress reports, BP reports, a project management plan, and a comprehensive final technical report. EERC activities will include the planning and execution of project status meetings. Technology transfer activities are anticipated to include, at DLM's request, the presentation of results through these meetings and reports as well as presentations at relevant technical conferences and facilitating the involvement of a CSEA designee in project meetings.

Project activities will be accomplished with a team including project management personnel, senior management, budgeting and contracts personnel, and the EERC accounting department. Results of all tasks described above will be provided in project meetings and reports. All additional deliverables will be summarized in project status and final report(s).

Task 2.0 – Procurement of Equipment and System Design (BP1)
The activities of Task 2.0 will include assisting DLM to procure additional equipment items and fabrication materials to support the project. Specific items to purchase will include accessory equipment for process control, data monitoring and acquisition, and fabrication pieces and fittings. EERC design engineers will be involved in an advisory capacity in the engineering design activities to include pipe and identification diagrams (P&ID), process flow diagrams (PFDs), and overall system drawings of the production line. DLM will be responsible for all P&IDs and design drawings that meet all applicable codes for implementation at the EERC or UND facilities. The expected outcomes of this task will include detailed system drawings and completed orders for various equipment, accessory parts, and fittings that are needed for fabrication of the production line facility. The EERC will provide support to track the activities and monitor the status of purchase orders for equipment and accessories as well as the progress of design activities. The progress will be documented and reported to DLM for transmission to CSEA.

Additional technical assistance will include assisting DLM with materials costing for the fabrication work as needed. The EERC will assist DLM in addressing technical issues as necessary and as the issues arise. The EERC will aid in selection of process equipment, redundancy philosophy, selection of materials of construction, effluent identification and disposition, means of process heat recovery, and to make arrangements for adequate facility space and the necessary utilities.

Task 3.0 – Fabrication of 1000 tons/year Production Line Facility (BP1)
The EERC will assist DLM in assembling and building a production line facility to include a preprocessing unit, dry-mixing unit, calcination unit, carbon coating unit, grinding/classification unit, and packaging unit, as well as associated accessories for process control, monitoring, and data acquisition. The individual units will be integrated so that they operate in a semicontinuous mode for a complete production line capable of producing about 1000 tons/year of lithium iron phosphate (LFP) material. The key result of this task will be a completely fabricated production line facility with power turned on and ready for shakedown testing. The EERC will provide limited analytical support for feedstock samples at the initial stages of the project and troubleshooting of issues arising during construction. The EERC's shops and operations group and the capabilities of the machine shop will be available as needed.

Additional technical assistance will be provided by the EERC for project design, hazard and operability (HAZOP) review, and costing efforts for the production facility. The EERC will assist DLM's project team in addressing technical issues that may arise during installation and operation of the system. The EERC will aid in installation and validation of process equipment as needed to ensure successful completion of construction and operation of the system.

Task 4.0 – Shakedown Testing (BP2)
Shakedown testing activities will involve both EERC and DLM personnel. The activities to perform include shakedown testing of the production line system for the ability to produce up to 1000 tons/year LFP cathode materials. Shakedown testing on the integrated system shall be conducted to verify proper operation and functionality of the different units and to demonstrate system ability to operate in a semicontinuous mode. During shakedown testing, the LFP raw material subsamples will be preprocessed by crushing to a suitable size range before feeding to the system. The results from this task will provide data to demonstrate that the production line facility can operate well in a semicontinuous mode. The EERC will provide analytical support for samples produced at various stages during the project for product quality verifications and for troubleshooting of issues arising during shakedown testing.

Task 5.0 – Process Optimization Testing (BP2)

The EERC will assist DLM in carrying out the activities of Task 5.0 to include optimization of process parameters such as temperatures, pressure, flowrates, process gas and environment variables, system stability, etc. During this testing, raw material input streams, product output stream, and product quality will be optimized for steady production of up to 1000 tons/year LFP cathode materials. The production line will be operated for about 7 months to fine-tune process parameters and product quality and optimize the system to maximize the energy savings, CO_2 emission reduction, water use reduction, and overall product cost savings. The raw materials and product will be analyzed on a limited basis with a suitable combination of analytical techniques available at the EERC such as scanning electron microscopy (SEM), x-ray diffraction (XRD), x-ray fluorescence (XRF) spectroscopy, Fourier transform infrared (FTIR) spectroscopy, Raman spectroscopy, and other methods that may be deemed necessary during project implementation. The primary outcome from this task will include process data to demonstrate operability of the facility for manufacturing LFP by the new dry-mixing approach.

Task 6.0 – Product Evaluation and Marketing Plan (BP2)

The EERC will provide assistance as needed and laboratory facilities for evaluation of the LFP materials for its electrochemical performance attributes through testing of various lithium-ion battery (LIB) test articles by DLM personnel. Additionally, the EERC will provide input to DLM as needed for the development of an initial marketing plan to engage potential customers and to establish a market for the produced LFP materials. Specific emphasis will be placed on applications in energy storage such as in electric grid systems and micro-electric grids for rural areas and isolated point consumption to include military bases. Additional markets in heavy-duty transportation vehicles where battery weight and size may be less consequential will be explored, especially given that the proposed batteries are expected to have long-duration energy storage capability of up to 10+ hours at minimal cost of about $0.05/kWh levelized cost of storage (LCOS).

BUDGET

The cost-reimbursable amount for this project is $925,327 for a total project duration of 3 years beginning from the time the contract is signed. A detailed project budget (Table 1) is provided as a table in a format requested by the CSEA program. The proposed work will be initiated upon execution of a contract between our organizations.

Table 1. EERC Project Budget

Project-Associated Expense	NDIC Share (cash)	Total Project
Labor	$420,617	$420,617
Travel	$11,300	$11,300
Supplies	$5,000	$5,000
Communications	$60	$60
Printing and Duplicating	$120	$120
Laboratory Fees and Services		
Natural Materials Analytical Research Lab	$65,187	$65,187
Combustion Test Service	$16,620	$16,620
Document Production Service (Graphics, Editing, and Workflow)	$48,863	$48,863
Shop and Operations	$13,944	$13,944
Technical Software Fee	$8,258	$8,258
Engineering Services Fee	$7,830	$7,830
Outside Lab	$15,000	$15,000
Total Direct Costs	$612,799	$612,799
Facilities and Administration	$312,528	$312,528
Total Project Costs	**$925,327**	**$925,327**

BACKGROUND/QUALIFICATIONS

The project will be managed by Dr. Alexander Azenkeng, who is Assistant Director for Critical Materials at the EERC. Dr. Azenkeng has over 15 years of experience in the management of several large projects at the EERC as well as leading the development of coal-derived high-value carbon products and synthetic graphite for LIB anodes. Additional staff from the EERC's accounting, workflow, and budget analyst groups will be included in the project team as well as technical and senior management personnel to provide oversight during the implementation of the project.

APPENDIX A

BUDGET NOTES

BUDGET NOTES

ENERGY & ENVIRONMENTAL RESEARCH CENTER (EERC)

BACKGROUND

The EERC is an independently organized multidisciplinary research center within the University of North Dakota (UND). The EERC is funded through federal and nonfederal grants, contracts, and other agreements. Although the EERC is not affiliated with any one academic department, university faculty may participate in a project, depending on the scope of work and expertise required to perform the project.

INTELLECTUAL PROPERTY

The applicable federal intellectual property (IP) regulations will govern any resulting research agreement(s). In the event that IP with the potential to generate revenue to which the EERC is entitled is developed under this project, such IP, including rights, title, interest, and obligations, may be transferred to the EERC Foundation, a separate legal entity.

BUDGET INFORMATION

The proposed work will be done on a cost-reimbursable basis. The distribution of costs between budget categories (labor, travel, supplies, equipment, etc.) and among funding sources of the same scope of work is for planning purposes only. The project manager may incur and allocate allowable project costs among the funding sources for this scope of work in accordance with Office of Management and Budget (OMB) Uniform Guidance 2 CFR 200.

Escalation of labor and EERC recharge center rates are incorporated into the budget when a project's duration extends beyond the university's current fiscal year (July 1 – June 30). Escalation is calculated by prorating an average annual increase over the anticipated life of the project.

The cost of this project is based on a specific start date indicated at the top of the EERC budget. Any delay in the start of this project may result in a budget increase. Budget category descriptions presented below are for informational purposes; some categories may not appear in the budget.

Salaries: Salary estimates are based on the scope of work and prior experience on projects of similar scope. The labor rate used for specifically identified personnel is the current hourly rate for that individual. The labor category rate is the average rate of a personnel group with similar job descriptions. Salary costs incurred are based on direct hourly effort on the project. Faculty who work on this project may be paid an amount over the normal base salary, creating an overload which is subject to limitation in accordance with university policy. As noted in the UND EERC Cost Accounting Standards Board Disclosure Statement, administrative salary and support costs which can be specifically identified to the project are direct-charged and not charged as facilities and administrative (F&A) costs. Costs for general support services such as contracts and IP, accounting, human resources, procurement, and clerical support of these functions are charged as F&A costs.

Fringe Benefits: Fringe benefits consist of two components which are budgeted as a percentage of direct labor. The first component is a fixed percentage approved annually by the UND cognizant audit agency, the Department of Health and Human Services. This portion of the rate covers vacation, holiday, and sick leave (VSL) and is applied to direct labor for permanent staff eligible for VSL benefits. Only the actual approved rate will be charged to the project. The second component is estimated on the basis of historical data and is charged as actual expenses for items such as health, life, and unemployment insurance; social security; worker's compensation; and UND retirement contributions.

Travel: Travel may include site visits, fieldwork, meetings, and conferences. Travel costs are estimated and paid in accordance with OMB Uniform Guidance 2 CFR 200, Section 474, and UND travel policies, which can be found at https://campus.und.edu/finance/procurement-and-payment-services/travel/travel.html (Policies & Procedures, A–Z Policy Index, Travel). Daily meal rates are based on U.S. General Services Administration (GSA) rates unless further limited by UND travel policies; other estimates such as airfare, lodging, ground transportation, and miscellaneous costs are based on a combination of historical costs and current market prices. Miscellaneous travel costs may include parking fees, Internet charges, long-distance phone, copies, faxes, shipping, and postage.

Supplies: Supplies include items and materials that are necessary for the research project and can be directly identified to the project. Supply and material estimates are based on prior experience with similar projects. Examples of supply items are chemicals, gases, glassware, nuts, bolts, piping, data storage, paper, memory, software, toner cartridges, maps, sample containers, minor equipment (value less than $5000), signage, safety items, subscriptions, books, and reference materials. General purpose office supplies (pencils, pens, paper clips, staples, Post-it notes, etc.) are included in the F&A cost.

Communications: Telephone, cell phone, and fax line charges are included in the F&A cost; however, direct project costs may include line charges at remote locations, long-distance telephone charges, postage, and other data or document transportation costs that can be directly identified to a project. Estimated costs are based on prior experience with similar projects.

Printing and Duplicating: Page rates are established annually by the university's duplicating center. Printing and duplicating costs are allocated to the appropriate funding source. Estimated costs are based on prior experience with similar projects.

Operating Fees: Operating fees generally include EERC recharge centers, outside laboratories, and freight.

EERC recharge center rates are established annually and approved by the university.

Laboratory and analytical recharge fees are charged on a per-sample, hourly, or daily rate. Additionally, laboratory analyses may be performed outside the university when necessary. The estimated cost is based on the test protocol required for the scope of work.

Document production services recharge fees are based on an hourly rate for production of such items as report figures, posters, and/or images for presentations, maps, schematics, website design, brochures, and photographs. The estimated cost is based on prior experience with similar projects.

Shop and operations recharge fees cover specific expenses related to the pilot plant and the required expertise of individuals who perform related activities. Fees may be incurred in the pilot plant, at remote locations, or in EERC laboratories whenever these particular skills are required. The rate includes such items as specialized safety training, personal safety items, fall protection harnesses and respirators, CPR certification, annual physicals, protective clothing/eyewear, research by-product disposal, equipment repairs, equipment safety inspections, and labor to direct these activities. The estimated cost is based on the number of hours budgeted for this group of individuals.

Engineering services recharge fees cover specific expenses related to retaining qualified and certified design and engineering personnel. The rate includes training to enhance skill sets and maintain certifications using Webinars and workshops. The rate also includes specialized safety training and related physicals. The estimated cost is based on the number of hours budgeted for this group of individuals.

Technical software is a use fee for an advanced project management tool. Costs are associated with software, data entry, maintenance, and enhancement of the system.

Facilities and Administrative Cost: The F&A rate proposed herein is approved by the U.S. Department of Health and Human Services and is applied to modified total direct costs (MTDC). MTDC is defined as total direct costs less individual capital expenditures, such as equipment or software costing $5000 or more with a useful life of greater than 1 year, as well as subawards in excess of the first $25,000 for each award.

APPENDIX B

RESUMES OF KEY PERSONNEL

DR. ALEXANDER AZENKENG
Assistant Director for Critical Materials
Energy & Environmental Research Center (EERC), University of North Dakota (UND)
15 North 23rd Street, Stop 9018, Grand Forks, North Dakota 58202-9018 USA
701.777.5051, aazenkeng@undeerc.org

Education and Training

Ph.D., Theoretical Physical Chemistry, University of North Dakota, 2007.

Dissertation: Theoretical Studies of Low-Lying Electronic States of Lithium, Titanium, and Mercury Compounds; supervised by Prof. Mark R. Hoffmann.

M. Sc., Chemistry, University of Buea, Cameroon, 1998.

Thesis: Preparation of Iron (III) and Nickel (II) Oxide Thin Films from the Corresponding Metal Acetylacetonates via Pyrolysis.

B.Sc., (magna cum laude) Chemistry, University of Buea, Cameroon, 1996; with professional minor in Chemical Processing Technology.

Research and Professional Experience

May 2021–Present: Assistant Director for Critical Materials, EERC, UND.

- Applies chemistry principles to studies involving multiple research portfolios, including computational simulations to elucidate reaction mechanisms of coal combustion and chemical processes at the molecular level; chemical transformations in low-rank coal upgrading; coal–biomass gasification technologies; characterization of materials by spectroscopic and microscopic techniques; CO_2–amine reaction chemistry of CO_2 capture, utilization, and sequestration (CCUS) technologies; reservoir geochemistry of CO_2 sequestration; nuclear magnetic resonance (NMR) spectroscopy study of unconventional oil and gas reservoirs; improved methods for extraction and isolation of critical minerals (rare-earth elements [REEs] and platinum group metals [PGMs]) from coals; and development of approaches for production of high-value carbon materials such as graphene and graphite from coal feedstocks.

Current research interests include development of approaches for making high-value products (graphene and graphite) from coal, critical mineral research for REEs and PGMs, carbon capture technologies for coal combustion and gasification systems, and carbon storage/sequestration in geological sinks.

2008–April 2021: Senior Research Scientist, EERC, UND.

- Applied chemistry principles to studies involving multiple research portfolios, including chemical analysis of materials by scanning electron microscopy (SEM), material corrosion evaluation in oil and gas applications, CO_2 capture using aqueous amine solvents, CO_2 sequestration in geologic formations, and chemical transformations in low-rank coal upgrading.
- Involved in developing analytical approaches to better characterize organic shale and tight rock formations for potential CO_2 storage and improved methods for analyzing REEs in coals, geologic samples, and produced water from oil and gas operations.

2007–2008: Temporary Researcher, EERC, UND.

- Worked on NO_x emission control technologies, CO_2 capture technologies, and gasification technologies.

2005–2007: Graduate Research Assistant, EERC, UND.

- Worked on quantum mechanical modeling of Hg oxidation reactions on activated carbon surfaces.

Professional Activities

Member, Microscopy Society of America, 2010–Present
Member, North Dakota Academy of Sciences, 2004–Present
Member, American Chemical Society, 2002–Present

Publications and Presentations

Books and Book Chapters

Ralston, N.V.C.; Azenkeng, A.; Raymond, L.J. Mercury-Dependent Inhibition of Selenoenzymes and Mercury Toxicity. In *Methylmercury and Neurotoxicity*; Ceccatelli, S., Aschner, M., Eds.; Current Topics in Neurotoxicity 2; Springer: New York, 2012; pp 91–99.

Peer-Reviewed Publications

Azenkeng, A.; Mibeck, B. A.F.; Kurz, B. A.; Gorecki, C. D.; Myshakin, E. M.; Goodman, A. L.; Azzolina, N. A.; Eylands, K.E.; Butler, S.K.; Sanguinito, S. An Image-Based Equation for Estimating the Prospective CO_2 Storage Resource of Organic-Rich Shale Formations. *International Journal of Greenhouse Gas Control* **2020**, *98*, 103038.

Laumb, J.D.; Glazewski, K.A.; Hamling, J.A.; Azenkeng, A.; Watson, T.L. Wellbore Corrosion and Failure Assessment for CO_2 EOR and Storage: Two Case Studies in the Weyburn Field. *International Journal of Greenhouse Gas Control* **2016,** *54*, 479–489.

Olson, E.S.; Azenkeng, A. Laumb, J.D.; Jensen, R.R.; Benson, S.A.; Hoffman, M.R. New Developments in the Theory and Modeling of Mercury Oxidation and Binding on Activated Carbons in Flue Gas. In *Air Quality VI: Mercury, Trace, Elements, SO_3, Particulate Matter, and Greenhouse Gases*, Special Issue of *Fuel Process. Technol.* **2009**, *90* (11), 1360–1363.

Conference and Other Presentations

Azenkeng, A.; Mibeck, B.A.F.; Eylands, K.E.; Butler, S.K.; Kurz, B.A.; Heebink, L.V. Advanced Characterization of Unconventional Oil and Gas Reservoirs to Enhance CO_2 Storage Resource Estimates – Organic Structure and Porosity of Organic-Rich Shales. Presented at Mastering the Subsurface Through Technology Innovation, Partnerships & Collaboration: Carbon Storage & Oil & Natural Gas Technologies Review Meeting, Pittsburgh, PA, Aug 1–3, 2017.

Klenner, R.C.L.; Braunberger, J.R.; Sorensen, J.A.; Eylands, K.E.; Azenkeng, A.; Smith, S.A. A Formation Evaluation of the Middle Bakken Member Using a Multimineral Petrophysical Analysis Approach. Paper presented at the SPE/AAPG/SEG Unconventional Resources Technology Conference, Denver, CO, Aug 25–27, 2014; URTeC Paper No. 1922735.

Laumb, J.D.; Azenkeng, A.; Heebink, L.V.; Jensen, M.D.; Raymond, L.J. CO_2 Utilization Technologies for Lignite-Based Generation. Poster Abstract in *Proceedings of Air Quality IX: An International Conference on Environmental Topics Associated with Energy Production*; Arlington, VA, Oct 21–23, 2013.

Laumb, J.D.; Kay, J.P.; Holmes, M.J.; Cowan, R.M.; Azenkeng, A.; Heebink, L.V.; Hanson, S.K.; Jensen, M.D.; Letvin, P.A.; Raymond, L.J. Economic and Market Analysis of CO_2 Utilization Technologies – Focus on CO_2 Derived from North Dakota Lignite. *Energy Procedia* **2013**, *37*, 6987–6998.

Laumb, J.D.; Kay, J.P.; Holmes, M.J.; Cowan, R.M.; Azenkeng, A.; Heebink, L.V.; Hanson, S.K.; Jensen, M.D.; Letvin, P.A.; Raymond, L.J. Economic and Market Analysis of CO_2 Utilization Technologies –

Focus on CO_2 Derived from North Dakota Lignite. Paper presented at the 11th International Conference on Greenhouse Gas Control Technologies (GHGT-11), Kyoto, Japan, Nov 18–22, 2012.

Azenkeng, A. Development of an Improved CCSEM Technique for Quantitative Coal Mineralogy. Presented at the 28th Annual International Pittsburgh Coal Conference, Pittsburgh, PA, Sept 12–15, 2011.

Technical Reports

Azenkeng, A. *Evaluation of Lime Kiln Ash Ring Samples for Environmental Energy Services, Inc.*; Final Report for Environmental Energy Services, Inc.; EERC Publication 2018-EERC-08-03; Energy & Environmental Research Center: Grand Forks, ND, Aug 2018.

Azenkeng, A.; Kurz, B.A.; Gorecki, C.D. *An NMR-Based Method for Fluid Typing and Proportion Estimation for the Potential for CO_2 Storage or CO_2 EOR in the Middle Bakken Formation*; Final Report included in *Subtask 4.1 – Strategic Studies* Final Report (Aug 10, 2015 – May 31, 2017) for U.S. Department of Energy National Energy Technology Laboratory Cooperative Agreement No. DE-FE0024233; EERC Publication 2017-EERC-05-13; Energy & Environmental Research Center: Grand Forks, ND, May 2017.

Azenkeng, A.; Pavlish, B.M.; Lentz, N.B.; Galbreath, K.C.; McCollor, D.P. *Feasibility of Hydrothermal Dewatering for the Potential to Reduce CO_2 Emissions and upgrade Low Rank Coals*; Final Report (June 25, 2008 – Dec 31, 2009) for the University of Wyoming; EERC Publication 2010-EERC-02-02; Energy & Environmental Research Center: Grand Forks, ND, Feb 2010.

Hanson, S.K.; Azenkeng, A.; Laumb, J.D.; McCollor, D.P.; Pavlish, B.M.; Buckley, T.D.; Botnen, L.S. *Subtask 3.7 – Beneficiated Lignite Market Study*; Final Report (Aug 1, 2009 – June 30, 2010) for U.S. Department of Energy National Energy Technology Laboratory Cooperative Agreement No. DE-FC26-08NT43291; EERC Publication 2010-EERC-06-09; Energy & Environmental Research Center: Grand Forks, ND, June 2010.

JASON D. LAUMB
Director of Advanced Energy Systems Initiatives
Energy & Environmental Research Center (EERC), University of North Dakota (UND)
15 North 23rd Street, Stop 9018, Grand Forks, ND 58202-9018 USA
701.777.5114, jlaumb@undeerc.org

Education and Training
M.S., Chemical Engineering, University of North Dakota, 2000.
B.S., Chemistry, University of North Dakota, 1998.

Research and Professional Experience
May 2021–Present: Director of Advanced Energy Systems Initiatives, EERC, UND. Laumb provides leadership on projects related to advanced energy systems and leads a multidisciplinary team of scientists and engineers working on advanced energy technologies from pollution control to new energy platforms. Principal areas of interest and expertise include renewable energy, CO_2 capture, techno-economic modeling, extraction of critical materials, environmental control systems, supercritical CO_2 power cycles, and advanced gasification technologies. Experience includes biomass and fossil fuel conversion for energy production, with an emphasis on ash effects on system performance; trace element emissions and control for fossil fuel combustion systems, with a particular emphasis on air pollution issues related to mercury and fine particulates; and design and fabrication of bench- and pilot-scale combustion and gasification equipment.

September 2019–April 2021: Assistant Director of Advanced Energy Systems, EERC, UND. Laumb assisted the EERC executive team by providing leadership on projects related to advanced energy systems. Laumb led a multidisciplinary team of scientists and engineers working on advanced energy technologies from pollution control to new energy platforms. Specific areas of interest included CO_2 capture, techno-economic modeling, environmental control systems, supercritical CO_2 power cycles, and advanced gasification technologies. Research activities focused on low-carbon-intensity power cycles for fossil fuel-fired systems.

2008–August 2019: Principal Engineer, Advanced Energy Systems Group Lead, EERC, UND. Laumb led a multidisciplinary team of 30 scientists and engineers to develop and conduct projects and programs on power plant performance, environmental control systems, the fate of pollutants, computer modeling, and health issues for clients worldwide. Efforts focused on development of multiclient jointly sponsored centers or consortia funded by government and industry sources. Research activities included computer modeling of combustion/gasification and environmental control systems, performance of SCR technologies for NO_x control, mercury control technologies, hydrogen production from coal, CO_2 capture technologies, particulate matter analysis and source apportionment, the fate of mercury in the environment, toxicology of particulate matter, and in vivo studies of mercury–selenium interactions.

2001–2008: Research Manager, EERC, UND. Laumb led projects involving bench-scale combustion testing of various fuels and wastes as well as a laboratory that performs bench-scale combustion and gasification testing. Laumb served as principal investigator and managed projects related to the inorganic composition of coal, coal ash formation, deposition of ash in conventional and advanced power systems, and mechanisms of trace metal transformations during coal or waste conversion and wrote proposals and reports focused on energy and environmental research.

2000–2001: Research Engineer, EERC, UND. Laumb assisted in the design of pilot-scale combustion equipment and wrote computer programs to aid in the reduction of data, combustion calculations, and prediction of boiler performance. Laumb was also involved in the analysis of combustion control technologies' ability to remove mercury and the suitability of biomass as boiler fuel.

1998–2000: SEM Applications Specialist, Microbeam Technologies, Inc., Grand Forks, North Dakota. Laumb gained experience in power system performance including conventional combustion and gasification systems; knowledge of environmental control systems and energy conversion technologies; interpreting data to predict ash behavior and fuel performance; assisting in proposal writing to clients and government agencies such as the National Science Foundation and the U.S. Department of Energy; preparing and analyzing coal, coal ash, corrosion products, and soil samples using scanning electron microscopy (SEM)/energy-dispersive spectroscopy (EDS); and modifying and writing FORTRAN, C+, and Excel computer programs.

Professional Activities

Member, American Chemical Society

Publications

Has coauthored numerous professional publications.

APPENDIX C

LETTERS OF SUPPORT

October 12, 2023

To Whom it May Concern,

It is the intent of Shenzhen FBTech Electronics Ltd to source lithium iron phosphate (LiFePO4) battery cathode powder from Dakota Lithium to be used for manufacturing LiFePO4 cells, the building blocks of lithium batteries.

Shenzhen FBTech Electronics Ltd has the capacity to manufacture 2GWH of LiFePO4 cells and plans to expand capacity to manufacture 5GWH by 2026. To manufacture these cells Shenzhen FBTech Electronics Ltd will require 2000 metric tons of LiFePO4 battery cathode powder supplied by Dakota Lithium by 2026.

Shenzhen FBTech Electronics Ltd manufacture cells that qualify as grade A, of the highest quality, and are cost competitive. Shenzhen FBTech Electronics Ltd intends to source LiFePO4 battery cathode powder from Dakota Lithium with the goal to further our company's innovation and growth as a world leader in lithium iron phosphate battery manufacturing.

LiFePO4 battery cathode powder supplied by Dakota Lithium shall meet the supplier and engineering requirements of Shenzhen FBTech Electronics Ltd.

Please note this letter is the intent of Shenzhen FBTech Electronics Ltd and is not a purchase order. It reflects a forecast of future sales based on the best available data and is non-binding.

Together Shenzhen FBTech Electronics Ltd and Dakota Lithium will help to build a lithium battery supply chain in the US. We look forward to this partnership.

Sincerely,

Tommy Zeng
Chief Executive Officer
Shenzhen FBTech Electronics Ltd

SHENZHEN FBTECH ELECTRONICS LTD.
深圳市防泰洋电子有限公司

independent boat builders, inc

WWW.IBBI.COM

To Whom It May Concern,

Independent Boat Builders, Inc. supports the efforts of Dakota Lithium to build a lithium battery materials factory in North Dakota and believes that a high-quality, cost-competitive lithium-ion battery manufacturing supply chain in the USA is imperative for national defense, electric vehicle production, solar & wind energy storage, and the many industries and products that are powered by lithium battery technology.

IBBI currently manufactures almost **25% of all boats** sold in the United States. We would like to start installing lithium batteries in our boats. We think it is very important for those batteries to be manufactured in the United States.

Lithium cathode battery materials production is the missing link the US lithium battery supply chain. Recognizing this, our office supports the Department of Energy's efforts to partner with local industry to build lithium cathode materials factories here in the United States. It is our hope that this grant process identifies and supports industry leaders in each US geographical region, including the great plains. It is our belief that Dakota Lithium is uniquely prepared to build a factory in the Great Plains region, and we support their efforts and encourage your consideration of their application.

Building a lithium cathode materials factory in North Dakota will support not just one community, but help to create a lithium battery technology cluster in the Great Plains region. The great plains leads the nation in energy production and innovation. For the last decade Dakota Lithium has partnered with the University of North Dakota to support research into lithium battery technology. Dakota Lithium is now commercializing that research and aims to build a 300,000 SF factory, creating 280 highly technical and well-paid jobs in North Dakota. This factory will be manufacturing lithium iron phosphate cathode materials – Dakota Lithium will be sourcing iron from Minnesota, carbon from North Dakota, and phosphate from the Great Plains region, creating thousands of jobs in the region. In addition, it is our hope that by building the first lithium cathode battery materials factory in the US in the Great Plains region that lithium cell manufacturers and lithium battery pack assembly companies will follow, creating thousands more highly paid jobs.

Sincerely,

Tom Broy

Tom Broy
President

October 7, 2022

To Whom it May Concern,

It is the intent of American Battery Factory to source lithium iron phosphate {LiFePO4) battery cathode powder from Dakota Lithium to be used for manufacturing LiFePO4 cells, the building blocks of lithium batteries.

American Battery Factory will have the capacity to manufacture 3 gigawatts of LiFePO4 cells by 2024, with aggressive plans to expand that capacity in the following years. To manufacture these cells American Battery Factory will require 5,300 metric tons of LiFePO4 battery cathode powder in 2024, which requirement will increase in the years following as American Battery Factory's manufacturing capacity increases.

American Battery Factory intends to manufacture cells that qualify as Made in America for use in Dakota Lithium battery packs and intends to source LiFePO4 battery cathode powder from Dakota Lithium that is Made in America.

Dakota Lithium is sourcing Made in America cells from American Battery Factory for the intent of building Made in America battery packs to power Made in America tractors that will be sold in the US and global agricultural markets.

Please note this letter is the intent of American Battery Factory and is not a purchase order. It reflects a forecast of future sales based on the best available data and is non-binding. As the LiFePO4 battery cathode powder supplied by Dakota Lithium meets the supplier and engineering requirements of American Battery Factory, American Battery Factory and Dakota Lithium will engage in further discussions with the intent to enter into a definitive agreement for the purchase and supply of LiFePO4 battery cathode powder.

Together American Battery Factory and Dakota Lithium will help to build a domestic lithium battery supply chain and transform the United States economy. We look forward to this partnership.

Sincerely,

Paul Charles
Chief Executive Officer
American Battery Factory

Mike Davidson
Chief Operations Officer
American Battery Factory

APPENDIX D

QUALIFICATIONS OF KEY PERSONNEL

DR. YONG HOU
Director of Research and Development
218.791.3746 (phone), hou@dakotalithium.com

Education and Training
Ph.D., Systems Engineering, University of Shanghai for Science & Technology, China, 2007.
M.S., Systems Engineering, University of Shanghai for Science & Technology, China, 1992.
B.S. Electronics Engineering, Hunan University of Art & Science, China 1983.

Research and Professional Experience
Oct 2008–Present: Cofounder and VP of Research, Dakota Lithium Materials, Grand Forks, ND. Research includes nano-sized LiFePO4 powder as ideal cathode materials for lithium-ion batteries, battery packs for electric vehicles, and energy storage.

Apr 2017–Apr 2022: Research Engineer, IES, University of North Dakota, half-time. Research focused on battery materials and energy storage including "A Low-Cost and Reproducible Synthetic Procedure for Mass Production of Lithium Iron Phosphate (LFP) Cathode Materials for Lithium-Ion Batteries," "Preparation of Graphene-Modified $LiFePO_4$ Cathode for Li-Ion Battery," "Advanced Integrated Solar–LFP Battery-Powered Pump System for Remote Farm Fields," " The Preparation of a High-Capacity Graphene Modified Graphite/SiOx Anode Electrode," "Porous Silicon/Lignite-Derived Graphene Composite Anodes for Lithium-Ion Battery," "Improve Electrical Conductivity of Substrate Materials for Bipolar Plate Lead-Acid Battery," and "Lignite-Derived Graphene/Si Nanocomposite Anode for Lithium-Ion Battery" projects. Expertise includes electrochemical enhancement of battery electrode; energy storage and conversion; advanced BMS; battery packs; distributed microgrid systems; and modeling of renewable energy systems.

Aug 2008–Jul 2012: Adjunct Professor, Department of Technology, University of North Dakota, part-time. Taught Renewable Energy Economics, Energy Systems and Sustainability, Product Research and Development, Technology and Innovation Management, and Operations Management; managed and negotiated to order for lab equipment; assisted in lab maintenance and organization; and mentored graduate and undergraduate in research design and problem-solving toward their energy-related research.

2007–2008: VP of Product Development, Neosonic Li-Polymer Energy (Zhuhai) Corporation, China. Worked on "The Design and Development of New Lithium Polymer Battery Use for Light Electric Vehicles"; directed enterprise resource planning (ERP) system and testing laboratory of the company.

1995–2002: Founder/General Manager, Shanghai Zhongdian International, China. Managed wholesale of Compaq computer and service business and led product design and maintenance of management information system (MIS) software project.

1992–1995: Engineering Manager, Shanghai Branch Company of Chinese Electronics Group, China. Worked on hardware and software service and distribution of AST and Tatun computers.

Awards and Honors
Recipient, *Innovate ND Award*, North Dakota Commerce, 2010.
Recipient, *National Torch Plan Award*, project of MIS of Commerce Bank's Loan Management, China, 2000.

First Place, *Mathematics Competition*, Hunan University of Art and Science, China 1981.

Relevant Publications

Xu, S.; Hou, X.; Wang, D.; Zuin, L.; Zhou, J.; Hou, Y.; Mann, M. Insights into the Effect of Heat Treatment and Carbon Coating on the Electrochemical Behaviors of SiO Anodes for Li-Ion Batteries. *Advanced Energy Materials* Feb **2022**.

Zhu, H.; Gao, Y.; Hou, Y., Wang, Z.; Feng, X. Real-Time Pricing Considering Different Type of Smart Home Appliances Based on Markov Decision Process. *International J of Electrical Power and Energy Systems,* May **2019**.

Zhu, H.; Gao, Y.; Hou, Y.; Tao, L. Multi-Time Slots Real-Time Pricing Strategy with Power Fluctuation Caused by Operating Continuity of Smart Home Appliances. *Engineering Applications of Artificial Intelligence,* May **2018**, *71*, 166–174.

Zhu, H.; Gao, Y.; Hou, Y. Real-Time Pricing for Demand Response in Smart Grid Based on Alternating Direction Method of Multipliers. *Mathematical Problems in Engineering.* **2018**, doi:10.1155/2018/8760575.

Wu, W.; Peng, L.; Hou, Y.; Su, L.; Zhang, H. An Experimental Investigation on the Solubility Characteristics of CO_2-Ionic Liquids as New Working Pairs Used for Absorption Refrigeration Systems. *The Journal of Chemical Thermodynamics*, Jan **2018**.

Wu, W.; Hou, Y.; Wu, J.; Su, L. Predicting Phase Behavior of CO_2 and Imidazole Ionic Liquids as New Working Pairs in Absorption Refrigeration System Using GC-EOS Method. *International Journal of Thermal Sciences,* June **2016**.

Hou, Y.; Peng, Y.; Johnson, A.L.; Shi, J. Empirical Analysis of Wind Power Potential at Multiple Heights for North Dakota Wind Observation Sites. *Energy Science and Technology,* Aug **2012**, *4*(1), ISSN 1923-8460.

Hanson, S.M.; Johnson, A.L.; Hou, Y.; Hellwig. Recharging Centers for Disease Control Light Trap Batteries with Solar Panel. *International Journal of Applied Science and Technology*, Sep **2012,** *2*(7).

Hou, Y.; Xu, F.; Chen, W. A Sustainable Growth Model Based on the Substitution of Renewable Energy. *Systems Engineering – Theory & Practice*, Sep **2008,** *28*(9), 67–72.

Hou, Y.; Xu, F.; Chen, W. A Sustainable Growth Model with the Utilization of Renewable Energy. *IEEE International Conference on Communications, Services, Knowledge and Engineering*, Sep **2007,** 5012–5015, ISBN: 1-4244-1311-7.

Synergistic Activities

Reviewer: *Sustainable Energy, Grids and Network; Technological Forecasting and Social Change; Sustainable Cities and Society; Waste and Biomass Valorization; Colloids and Surfaces A: Physicochemical and Engineering Aspects; ACS Omega, ACS Sustainable Chemical & Engineering.*

XIN ZHANG
Senior Engineer
701.739.4090, xin@cleanrepublic.com

Education and Training
Ph.D. in Chemical Engineering, University of North Dakota, Grand Forks, ND, (May 2023)
M.S. in Chemical Engineering, Guizhou University, Guiyang, China, (June 2017)
B.S. in Chemical Engineering, Qingdao University of Science and Technology, Qingdao, China, (June 2013)

Research and Professional Experience
September 2023–Present: Senior Engineer, Clean Republic doing business as Dakota Lithium Materials, Seattle, Washington.

- Leading the development of advanced lithium-ion battery materials, focusing on optimizing both cathode and anode components for enhanced performance and efficiency.
- Collaborated with cross-functional teams, including research and development, production, and quality assurance, to ensure the successful integration of new materials into product lines.
- Conducted comprehensive testing and analysis of new material formulations, utilizing state-of-the-art laboratory equipment and techniques.

May 2023–August 2023: Research Associate, CEM Energy Studies, University of North Dakota, ND.

- LFP cathode, silicon anode development for advanced lithium-ion batteries.
- Proposal drafting.

September 2018–May 2023: Graduate Research Associate, CEM Energy Studies, University of North Dakota, ND.

- Silicon-based anode, LFP cathode development for advanced lithium-ion batteries.
- Proposal drafting and manuscript preparation.

September 2018–December 2018: Internship, Pack Lithium-Ion Batteries Production, Clean Republic LLC, Grand Forks, ND.

- Lithium-ion battery pack design and fabrication.

July 2018–September 2018: Internship, Button Lithium-Ion Batteries Production, Mic-Power LLC, China.

- Button lithium-ion battery cell electrode design and fabrication.
- Button cell electrolyte injection.

March 2013–April 2013: Internship, Petrochemical Plant, Qilu Petrochemical Co., Ltd, China.

- Catalyst design and regeneration.

January 2010–February 2010: Internship, Polyvinyl Alcohol Chemical Plant, Anhui Wanwei Group CO. Ltd, China.

- Process design and distributed control system operation.

Research Projects

- A Low-Cost and Reproducible Synthetic Procedure for Mass Production of LFP Cathode Materials for LIBs. 2022–2023.

- Preparation of Graphene-Modified $LiFePO_4$ Cathode for LIBs. 2018–2022 (Phase I, II).
- Preparation of Graphene-Modified $LiFePO_4$ Cathode for LIBs (ND-REC). 2019–2020.
- Production of Battery-Grade Iron Phosphate (Plant Design). 2023.
- The Preparation of Nano-silicon Enveloped Graphite Composite for High-Performance Lithium-Ion Batteries. 2021–2023.
- Electrochemical Performance Improvement for Carbon Coated SiO_x and Graphite Composite LIB Anode by Chemical Pre-Lithiation Process (DOE DE-FE0031984). 2021–2022.
- The Preparation of a High-Capacity Graphene Modified Graphite/SiO_x Anode Electrode for Commercial Button Batteries. 2020–2022.
- Porous Silicon/Lignite-Derived Graphene Composite Anodes for LIBs (UCFER). 2019–2020.
- Freestanding Lignite-Derived Graphene-Based Foam Anode for LIBs (ND EPSCoP). 2019–2020.

Patents

Lu, Y., Zhang, X., Wang, P., Zhao, G., Liu, Y., and He, M. "Catalyst for Oxidative Coupling of Methane, Preparation Method thereof and Application thereof." U.S. Patent No. 11,298,684. 12 Apr. 2022.

Publications

Chen, Z., Pan, H., Lin, Q., Zhang, X., Xiao, S., and He, S. 2017, The Modification of Pd Core–Silica Shell Catalysts by Functional Molecules (KBr, CTAB, SC) and their Application to the Direct Synthesis of Hydrogen Peroxide from Hydrogen and Oxygen. *Catalysis Science and Technology*, 7, p. 1415–1422.

Li, F., Zhang, X., and Ji, Y. 2023, Decision Tree Model to Classify Wastewater Evaporation. *Industrial and Engineering Chemistry Research*.

Li, F., Zhang, X., and Ji, Y. 2023, Influence of Air Velocity and Solid Concentration on Water Evaporation during Sewage Sludge Air-Drying. Under Review.

Pan, H., Zhao, J., Zhang, X., Yi, Y., Liu, F., and Lin, Q. 2018, Catalytic Combustion of Styrene over the Binary Mixture of Manganese and Copper-Based Catalyst in the Absence and Presence of Water. *Kinetics and Catalysis*, p. 296–303.

Pushparaj, R.I., Cakir, D., Zhang, X., Xu, S., Mann, M., and Hou, X. 2021, Coal-Derived Graphene/MoS_2 Heterostructure Electrodes for Li-ion Batteries: Experiment and Simulation Study. *ACS Applied Materials and Interfaces*, 59950.

Pushparaj, R.I., Hou, X., Zhang, X., and Abdelmalek, B. 2023, Coal-Derived Porous Carbon Anodes for Na-Ion Batteries. Under review.

Saha, S., Kiran, K., Zhang, X., Hou, X., and Roy, S. 2023, Investigating the Tribological and Corrosion Behavior of Co–Cr Alloy as an Implant Material for Orthodontic Applications. *Wear*, 204755.

Saha, S., Kiran, K., Zhang, X., Hou, X., and Roya, S. 2023, Investigating the Tribological and Corrosion Behavior of Co-Cr Alloy as an Implant Material for Orthodontic Applications. 24th International Conference on Wear of Materials. Banff, Canada.

Wan, J., Pan, H., Lin, Q., Zhao, J., Zhang, X., Hu, P. 2017, Activated Carbon Preparation from Different Raw Materials and Its Separation and Enrichment of CH_4 from Coalbed Methane. *Natural Gas Chemical Industry*, 42(2) p. 34–39.

Wang, P., Zhang, X., Zhao, G., Liu, Y., and Y. Lu. 2018, Oxidative Coupling of Methane: MO_X-modified (M=Ti, Mg, Ga, Zr) Mn_2O_3-Na_2WO_4/SiO_2 Catalysts and Effect of MO_X Modification. *Chinese Journal of Catalysis*, 39(8) p. 1395–1402.

Xu, S., Zhou, J., Wang, J., Pathiranage, S., Oncel, N., Pushparaj, R.I., Zhang, X., Mann, M., and Hou, X. 2021, In-Situ Synthesis of Graphene-Coated Silicon Monoxide Anodes from Coal-Derived Humic Acid for High-Performance Lithium-Ion Battery. *Advanced Functional Materials*, 2101645.

Ye, B., Zhang, X., Gao, H. Salehfar, Y., Wu, N., and Hou, Y. 2023, Deep Neuro-Dynamic Programming for Real-Time Control Strategy Optimization of an Integrated Power System. Under review.

Zhang, R., Hou, X., Zhang, X., and Ji, Y. 2022, Chemical Pre-Lithiation of Lignin-Derived Hard Carbon Aimed for Lithium-Ion Battery Anode with High Rate Performance. Presentation, AIChE Annual Conference, AZ, USA.

Zhang, X., Hou, X., and Mann, M. 2021, Coal-Derived Graphene as a 3D Free-Standing Lithium-Ion Battery Anode. Poster and Podium Presentation, ND EPSCoR State Conference, ND, USA.

Zhang, X., Hou, X., and Mann, M. 2021, Coal-Derived Graphene-Based Freestanding Si@G Foam Anode for Lithium-Ion Battery. Podium Presentation, 3rd AIChE Battery and Energy Storage Conference. Podium Presentation, USA.

Zhang, X., Hou, X., Hou, Y., and Mann, M. 2019, Improving Electrical Conductivity of Carbon Fiber for Flexible Battery by Metal Electrodeposition Method. Poster Presentation. AIChE Annual Conference, FL, USA.

Zhang, X., Hou, X., Hou, Y., and Mann, M. 2022, Electrochemical Performance Improvement for Carbon Coated SiO_x and Graphite Composite Lithium-Ion Battery Anode by Chemical Pre-Lithiation Process. Poster Presentation, 4th AIChE Battery and Energy Storage Conference, NY, USA.

Zhang, X., Hou, X., Hou, Y., Zhang, R., Xu, S., and Mann, M. 2023, Insights into Chemical Pre-Lithiation of SiO_x/Graphite Composite Anodes through Scanning Electron Microscope Imaging. *ACS Applied Energy MaterialX.s*, 6, p. 7996–8005.

Zhang, X., Hou, Y., Mann, M., and Hou, X. 2023, Electrode Optimization of SiO_x/Graphite Anode for Lithium-Ion Batteries Using a Taguchi Design Method. Under review.

Zhang, X., Mann, M., Hou, Y., and Hou, X. 2023, Non-Woven Carbon Fiber Substrate for Bipolar High-Energy Density Lithium-Ion Batteries. Under review.

Zhang, X., Pan, H., Lin, Q., Chen, Z, Wang, J. 2017, Effect of Pd-Based Catalysts Prepared by Different Methods on Performance of Direct Synthesis of H_2O_2. *Inorganic Chemicals Industry*, 49(6) p. 85–89.

Zhang, X., Wang, H., Pushparaj, R.I., Mann, M., and Hou, X. 2022, Coal-Derived Graphene Foam and Micron-Sized Silicon Composite Anodes for Lithium-Ion Batteries. *Electrochimica Acta*, 141329.

ANDREW AUGUSTINE JAY
Chief Executive Officer
206.200.7469, andrew@andrewjay.org

Education and Training
Master of Nonprofit Leadership, Albers School of Business, Seattle University, 2009.
Bachelor of Arts, Political Science and Cultural Anthropology, New College of Florida, 2003.

Research and Professional Experience
2018–Present: Chief Executive Officer, Dakota Lithium. Dakota Lithium (Dakotalithium.com) creates practical, clean tech energy products to help people across the planet with long-lasting energy storage.

- Increased battery sales and revenue by 2180% between 2018 and 2022 to create the number one consumer lithium battery brand in United States and Canada.
- Established Dakota Lithium as a premium brand by scaling exceptional customer service, high-quality product development, digital marketing excellence, and extensive social media partnerships.
- Invested in research and development (R&D) partnership with a leading research university to develop a patented lithium cathode battery materials production process. Built pilot-scale chemical-manufacturing assembly line to turn this R&D into new line of business: Dakota Lithium Materials.
- Negotiated and finalized contracts valued at US$500+ million with leading electric vehicle manufactures to purchase lithium batteries manufactured by Dakota Lithium, including lithium battery cells manufactured using Dakota Lithium's cathode material.

2018–Present: Chief Executive Officer, Hilltopper Electric Bike Company. Hilltopper is an original e-bike company, with a decade of high-voltage adventures in the Seattle area (Hilltopperbikes.com). Owned by a parent company of Dakota Lithium, Clean Republic.

2014–2018: Chief Executive Officer, Tiny Trees Preschool. As founding CEO, built Tiny Trees into the largest outdoor preschool in United States. Tiny Trees uses outdoor classrooms to make quality education in reading, math, and science affordable for families and give kids glorious childhoods—one full of play, exploration, and wonder of the natural world.

- Opened ten schools in Washington State, with 270 children attending daily.
- Developed brand, website, social media, and marketing collateral that fueled exponential customer growth and long wait lists. For example, in 2018, Tiny Trees received over 5000 applications for only 300 spaces.
- Passed legislation in Washington State that created a friendlier regulatory environment. New legislation created health and safety standards for outdoor preschool that allowed for full-day classes.
- Partnered with 30+ nature-based and outdoor preschools to create Washington Nature Preschool Association (WaNPA.org) to advocate for and successfully pass legislation.
- Built a high-performing team of 40+ teachers and staff and raised $1.1. million in start-up capital.

2013–2014: Director of Seward Park Audubon Center, National Audubon Society. Directed environmental learning center serving 4000 youth and 10,000 adults a year, including marketing, fundraising, staff leadership, finance, and operations.

2007–2013: National Director of BOLD & GOLD, YMCA of Greater Seattle. Built BOLD & GOLD – Boys/Girls Outdoor Leadership Development from a small program serving 30 youth a year to a national brand with over 1500 youth attending 72 different wilderness expeditions across the United States and Canada.

- Managed and led team of 60 staff.
- Raised $1.6 million in major gifts and institutional investors.
- Directed BOLD & GOLD national expansion to YMCAs across country.
- Developed partnerships with historically black colleges and University of Washington affinity groups to create a diverse and equitable workforce that resulted in 40% of 60 staff identifying as people of color.
- Directed a successful multistate advocacy campaign that pushed for changes to federal regulations, allowing nonprofits like YMCA to access federal lands for youth outdoor trips.
- Developed brand, website, social media, and marketing collateral that fueled exponential customer growth (>80% annually) and long wait lists.

2003–2007: Course Director, Instructor, and Trainer, Outward Bound USA and South Africa. Used outdoor adventure as tool to help people build the leadership and life skills needed to thrive in business, school, and life. Deployments included helping incoming MBA students with Stanford School of Business build team leadership and communication skills through student-led wilderness expeditions (WA), helping at-risk youth learn anger management and decision-making skills (FL, CO, WA, AK), and training staff in South Africa how to deliver quality youth development programs.

2005–2007: Course Leader, National Outdoor Leadership School. Taught undergraduate students leadership, management, and communication skills on 30- to 90-day wilderness expeditions in North America. Students received college credit from the University of Utah.

1999–2003: Executive Director, New College Bike Shop. Operated on-campus bike shop. Recruited, trained, and supervised all-volunteer staff of student mechanics and managed bike share program with fleet of 50+ community bicycles.

Awards and Honors

- Winner of Social Venture Partners Fast Pitch Award for Best Nonprofit Start-Up
- Winner of Sustainable Seattle Leadership Award
- Winner of Washington Women's Foundation Award

RYAN ELLISON
Director of Business Development and Investor Relations
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Education and Training

B.S. (Cum Laude), Commercial Aviation, University of North Dakota.

- Commercial/Instrument SEL and MEL (July 2003)
- Flight Instructor, SEL
- Flight Instructor, Instrument (March 2004)

Research and Professional Experience

January 2009–Present: Director of Business Development and Investor Relations – Founder and Chairman, Clean Republic doing business as Dakota Lithium Materials, Seattle, Washington. Helped establish Clean Republic, a clean energy company focused on providing green solutions to everyday people. For the past 5 years been focused on the development of new business lines and raising capital to support the ever-growing business. In addition to main duties, provide an interface between investors and the company to ensure proper information flow and ideas.

May 2016–Present: Principal, Ellison Group AB, Stockholm, Sweden. Provides consultancy services to a number of clients in the aviation domain with a focus on NextGen/SESAR concepts, time- and performance-based operations and next-generation navigation/surveillance systems. Additional clients outside the aviation domain include those focused on bringing new technology to market, including electric vehicles, lithium batteries, and others.

May 2014–May 2016: Senior Vice President – Aventus Business Development, AVTECH Sweden AB, Stockholm, Sweden. Developed a comprehensive sales strategy for the Aventus product group. Worked directly with the CEO, CFO, and Board of Directors in communicating needs of the clients, overall strategy, and detailed sales plans for customers. Coordinated with the technical team in developing a forward-looking business development strategy to meet the future needs of customers. Developed technical material to disseminate key aspects of the Aventus product.

June 2013–May 2014: Vice President, Global Consultancy, AVTECH Sweden AB, Stockholm, Sweden. Worked directly for the CEO during a period of company reconstruction while developing and implementing strategies and business lines for AVTECH's Consultancy Group. Provided technical consultation to AVTECH's partners and customers in the area of time- and performance-based operations and weather uplinks.

February 2010–June 2013: Key Account Manager, PBN Technical Expert, AVTECH Sweden AB, Stockholm, Sweden. Provided consultancy expertise within performance-based operations, trajectory- and time-based operations, and flow management both internally and externally to AVTECH. Participated in a number of European and U.S.-based airspace modernization programs (SESAR, NextGen) while maintaining close relationships with customers throughout the projects' life cycles.

February 2009–February 2010: System Engineer, CSSI Inc., Washington, D.C. Developed concepts for NextGen with the FAA/ATO-P. Fostered client relationships and provided timely services, development of concept papers, and support.

August 2007–November 2008: Business Development/Technical Pilot, Naverus, Inc., Kent, Washington. Developed concepts and techniques to identify benefits of Performance-Based Navigation (PBN) Program. Cultivated strong client relationships, identified client needs, and resolved all client issues. Key PNB consultant on design and procedures.

DR. ALEXANDER AZENKENG
Assistant Director for Critical Materials
Energy & Environmental Research Center (EERC), University of North Dakota (UND)
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Education and Training

Ph.D., Theoretical Physical Chemistry, University of North Dakota, 2007.
Dissertation: Theoretical Studies of Low-Lying Electronic States of Lithium, Titanium, and Mercury Compounds; supervised by Prof. Mark R. Hoffmann.
M. Sc., Chemistry, University of Buea, Cameroon, 1998.
Thesis: Preparation of Iron (III) and Nickel (II) Oxide Thin Films from the Corresponding Metal Acetylacetonates via Pyrolysis.
B.Sc., (magna cum laude) Chemistry, University of Buea, Cameroon, 1996; with professional minor in Chemical Processing Technology.

Research and Professional Experience

May 2021–Present: Assistant Director for Critical Materials, EERC, UND.

- Applies chemistry principles to studies involving multiple research portfolios, including computational simulations to elucidate reaction mechanisms of coal combustion and chemical processes at the molecular level; chemical transformations in low-rank coal upgrading; coal–biomass gasification technologies; characterization of materials by spectroscopic and microscopic techniques; CO_2–amine reaction chemistry of CO_2 capture, utilization, and sequestration (CCUS) technologies; reservoir geochemistry of CO_2 sequestration; nuclear magnetic resonance (NMR) spectroscopy study of unconventional oil and gas reservoirs; improved methods for extraction and isolation of critical minerals (rare-earth elements [REEs] and platinum group metals [PGMs]) from coals; and development of approaches for production of high-value carbon materials such as graphene and graphite from coal feedstocks.

Current research interests include development of approaches for making high-value products (graphene and graphite) from coal, critical mineral research for REEs and PGMs, carbon capture technologies for coal combustion and gasification systems, and carbon storage/sequestration in geological sinks.

2008–April 2021: Senior Research Scientist, EERC, UND.

- Applied chemistry principles to studies involving multiple research portfolios, including chemical analysis of materials by scanning electron microscopy (SEM), material corrosion evaluation in oil and gas applications, CO_2 capture using aqueous amine solvents, CO_2 sequestration in geologic formations, and chemical transformations in low-rank coal upgrading.
- Involved in developing analytical approaches to better characterize organic shale and tight rock formations for potential CO_2 storage and improved methods for analyzing REEs in coals, geologic samples, and produced water from oil and gas operations.

2007–2008: Temporary Researcher, EERC, UND.

- Worked on NO_x emission control technologies, CO_2 capture technologies, and gasification technologies.

2005–2007: Graduate Research Assistant, EERC, UND.

- Worked on quantum mechanical modeling of Hg oxidation reactions on activated carbon surfaces.

Professional Activities

Member, Microscopy Society of America, 2010–Present
Member, North Dakota Academy of Sciences, 2004–Present
Member, American Chemical Society, 2002–Present

Publications and Presentations

Books and Book Chapters

Ralston, N.V.C.; Azenkeng, A.; Raymond, L.J. Mercury-Dependent Inhibition of Selenoenzymes and Mercury Toxicity. In *Methylmercury and Neurotoxicity*; Ceccatelli, S., Aschner, M., Eds.; Current Topics in Neurotoxicity 2; Springer: New York, 2012; pp 91–99.

Peer-Reviewed Publications

Azenkeng, A.; Mibeck, B. A.F.; Kurz, B. A.; Gorecki, C. D.; Myshakin, E. M.; Goodman, A. L.; Azzolina, N. A.; Eylands, K.E.; Butler, S.K.; Sanguinito, S. An Image-Based Equation for Estimating the Prospective CO_2 Storage Resource of Organic-Rich Shale Formations. *International Journal of Greenhouse Gas Control* **2020**, *98*, 103038.

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Olson, E.S.; Azenkeng, A. Laumb, J.D.; Jensen, R.R.; Benson, S.A.; Hoffman, M.R. New Developments in the Theory and Modeling of Mercury Oxidation and Binding on Activated Carbons in Flue Gas. In *Air Quality VI: Mercury, Trace, Elements, SO_3, Particulate Matter, and Greenhouse Gases*, Special Issue of *Fuel Process. Technol.* **2009**, *90* (11), 1360–1363.

Conference and Other Presentations

Azenkeng, A.; Mibeck, B.A.F.; Eylands, K.E.; Butler, S.K.; Kurz, B.A.; Heebink, L.V. Advanced Characterization of Unconventional Oil and Gas Reservoirs to Enhance CO_2 Storage Resource Estimates – Organic Structure and Porosity of Organic-Rich Shales. Presented at Mastering the Subsurface Through Technology Innovation, Partnerships & Collaboration: Carbon Storage & Oil & Natural Gas Technologies Review Meeting, Pittsburgh, PA, Aug 1–3, 2017.

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Laumb, J.D.; Azenkeng, A.; Heebink, L.V.; Jensen, M.D.; Raymond, L.J. CO_2 Utilization Technologies for Lignite-Based Generation. Poster Abstract in *Proceedings of Air Quality IX: An International Conference on Environmental Topics Associated with Energy Production*; Arlington, VA, Oct 21–23, 2013.

Laumb, J.D.; Kay, J.P.; Holmes, M.J.; Cowan, R.M.; Azenkeng, A.; Heebink, L.V.; Hanson, S.K.; Jensen, M.D.; Letvin, P.A.; Raymond, L.J. Economic and Market Analysis of CO_2 Utilization Technologies – Focus on CO_2 Derived from North Dakota Lignite. *Energy Procedia* **2013**, *37*, 6987–6998.

Laumb, J.D.; Kay, J.P.; Holmes, M.J.; Cowan, R.M.; Azenkeng, A.; Heebink, L.V.; Hanson, S.K.; Jensen, M.D.; Letvin, P.A.; Raymond, L.J. Economic and Market Analysis of CO_2 Utilization Technologies –

Focus on CO_2 Derived from North Dakota Lignite. Paper presented at the 11th International Conference on Greenhouse Gas Control Technologies (GHGT-11), Kyoto, Japan, Nov 18–22, 2012.

Azenkeng, A. Development of an Improved CCSEM Technique for Quantitative Coal Mineralogy. Presented at the 28th Annual International Pittsburgh Coal Conference, Pittsburgh, PA, Sept 12–15, 2011.

Technical Reports

Azenkeng, A. *Evaluation of Lime Kiln Ash Ring Samples for Environmental Energy Services, Inc.*; Final Report for Environmental Energy Services, Inc.; EERC Publication 2018-EERC-08-03; Energy & Environmental Research Center: Grand Forks, ND, Aug 2018.

Azenkeng, A.; Kurz, B.A.; Gorecki, C.D. *An NMR-Based Method for Fluid Typing and Proportion Estimation for the Potential for CO_2 Storage or CO_2 EOR in the Middle Bakken Formation*; Final Report included in *Subtask 4.1 – Strategic Studies* Final Report (Aug 10, 2015 – May 31, 2017) for U.S. Department of Energy National Energy Technology Laboratory Cooperative Agreement No. DE-FE0024233; EERC Publication 2017-EERC-05-13; Energy & Environmental Research Center: Grand Forks, ND, May 2017.

Azenkeng, A.; Pavlish, B.M.; Lentz, N.B.; Galbreath, K.C.; McCollor, D.P. *Feasibility of Hydrothermal Dewatering for the Potential to Reduce CO_2 Emissions and upgrade Low Rank Coals*; Final Report (June 25, 2008 – Dec 31, 2009) for the University of Wyoming; EERC Publication 2010-EERC-02-02; Energy & Environmental Research Center: Grand Forks, ND, Feb 2010.

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JASON D. LAUMB
Director of Advanced Energy Systems Initiatives
Energy & Environmental Research Center (EERC), University of North Dakota (UND)
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Education and Training
M.S., Chemical Engineering, University of North Dakota, 2000.
B.S., Chemistry, University of North Dakota, 1998.

Research and Professional Experience
May 2021–Present: Director of Advanced Energy Systems Initiatives, EERC, UND. Laumb provides leadership on projects related to advanced energy systems and leads a multidisciplinary team of scientists and engineers working on advanced energy technologies from pollution control to new energy platforms. Principal areas of interest and expertise include renewable energy, CO_2 capture, techno-economic modeling, extraction of critical materials, environmental control systems, supercritical CO_2 power cycles, and advanced gasification technologies. Experience includes biomass and fossil fuel conversion for energy production, with an emphasis on ash effects on system performance; trace element emissions and control for fossil fuel combustion systems, with a particular emphasis on air pollution issues related to mercury and fine particulates; and design and fabrication of bench- and pilot-scale combustion and gasification equipment.

September 2019–April 2021: Assistant Director of Advanced Energy Systems, EERC, UND. Laumb assisted the EERC executive team by providing leadership on projects related to advanced energy systems. Laumb led a multidisciplinary team of scientists and engineers working on advanced energy technologies from pollution control to new energy platforms. Specific areas of interest included CO_2 capture, techno-economic modeling, environmental control systems, supercritical CO_2 power cycles, and advanced gasification technologies. Research activities focused on low-carbon-intensity power cycles for fossil fuel-fired systems.

2008–August 2019: Principal Engineer, Advanced Energy Systems Group Lead, EERC, UND. Laumb led a multidisciplinary team of 30 scientists and engineers to develop and conduct projects and programs on power plant performance, environmental control systems, the fate of pollutants, computer modeling, and health issues for clients worldwide. Efforts focused on development of multiclient jointly sponsored centers or consortia funded by government and industry sources. Research activities included computer modeling of combustion/gasification and environmental control systems, performance of SCR technologies for NO_x control, mercury control technologies, hydrogen production from coal, CO_2 capture technologies, particulate matter analysis and source apportionment, the fate of mercury in the environment, toxicology of particulate matter, and in vivo studies of mercury–selenium interactions.

2001–2008: Research Manager, EERC, UND. Laumb led projects involving bench-scale combustion testing of various fuels and wastes as well as a laboratory that performs bench-scale combustion and gasification testing. Laumb served as principal investigator and managed projects related to the inorganic composition of coal, coal ash formation, deposition of ash in conventional and advanced power systems, and mechanisms of trace metal transformations during coal or waste conversion and wrote proposals and reports focused on energy and environmental research.

2000–2001: Research Engineer, EERC, UND. Laumb assisted in the design of pilot-scale combustion equipment and wrote computer programs to aid in the reduction of data, combustion calculations, and prediction of boiler performance. Laumb was also involved in the analysis of combustion control technologies' ability to remove mercury and the suitability of biomass as boiler fuel.

1998–2000: SEM Applications Specialist, Microbeam Technologies, Inc., Grand Forks, North Dakota. Laumb gained experience in power system performance including conventional combustion and gasification systems; knowledge of environmental control systems and energy conversion technologies; interpreting data to predict ash behavior and fuel performance; assisting in proposal writing to clients and government agencies such as the National Science Foundation and the U.S. Department of Energy; preparing and analyzing coal, coal ash, corrosion products, and soil samples using scanning electron microscopy (SEM)/energy-dispersive spectroscopy (EDS); and modifying and writing FORTRAN, C+, and Excel computer programs.

Professional Activities
Member, American Chemical Society

Publications
Has coauthored numerous professional publications.

APPENDIX E

BUDGET NOTES

BUDGET NOTES

DAKOTA LITHIUM MATERIALS (DLM)

BUDGET INFORMATION

The proposed work will be done on a cost-reimbursable basis. The distribution of costs between budget categories (labor, travel, supplies, equipment, etc.) and among funding sources of the same scope of work is for planning purposes only.

The cost of this project is based on a specific start date indicated at the top of the Dakota Lithium Materials (DLM) budget. Any delay in the start of this project may result in a budget increase. Budget category descriptions presented below are for informational purposes; some categories may not appear in the budget.

Salaries: Salary estimates are based on the scope of work and prior experience on projects of similar scope. The labor rate used for specifically identified personnel is the current hourly rate for that individual. The labor category rate is the average rate of a personnel group with similar job descriptions. Salary costs incurred are based on direct hourly effort on the project. Costs for general support services such as contracts and intellectual property (IP), accounting, human resources, procurement, and clerical support of these functions are charged as facilities and administrative (F&A) costs.

Fringe Benefits: Fringe benefits are budgeted as a percentage of direct labor. The rate of 25% is estimated on the basis of historical data and is charged as actual expenses for items such as health and unemployment insurance, social security, and worker's compensation.

Travel: Travel may include site visits, meetings, and conferences. Travel costs are estimated on a U.S. Department of Energy (DOE) example per trip with three trips planned:

Depart From	Destination	No. of Days	No. of Travelers	Lodging per Traveler	Flight per Traveler	Vehicle per Traveler	Per Diem Per Traveler	Cost per Trip	Basis for Estimating Costs
Budget Period 1									
		2	2	$250	$500	$100	$150	$2,000	Current GSA rates

Equipment: If equipment (value of $5000 or more) is budgeted, it is discussed in the text of the proposal and/or identified more specifically in the accompanying budget detail.

Item	Unit	Cost/unit	Cost	Justification
Resodyn Mixer, RAM 5	1	$1,300,000	$1,300,000	Dry mixing raw materials
2 in 1 Synthesis and Carbon Coating Furnace	1	$1,214,000	$1,214,000	sinter LFP cathode and CVD carbon coating
Jet Mill, LNJ-36A	2	$ 118,000	$ 236,000	Materials milling and classification
Glove box, 16-200-412	1	$ 49,000	$ 49,000	Inject electrolyte, cell vacuum and case sealing
01-9191-149 Scale	1	$ 10,520	$ 10,520	Material synthesis
Feeding System	1	$ 25,000	$ 25,000	Handling of material throughout the process
51-014-540 Vacuum Oven	1	$ 16,650	$ 16,650	Material synthesis
01-184-214 Vacuum Pump	1	$ 6,350	$ 6,350	Material synthesis
MSKAFAIIH B110 Coaster (MTI)	1	$ 12,000	$ 12,000	Full-cell fabrication
MSK180 Die Cutter (MTI)	1	$ 9,989	$ 9,989	Full-cell fabrication
MSK111A-E Stacking machine	1	$ 36,000	$ 36,000	Full-cell fabrication
MSK120 Pouch cell case/cup forming machine	1	$ 12,986	$ 12,986	Full-cell fabrication
MSK115III11 Hot Sealer	1	$ 10,998	$ 10,998	Full-cell fabrication
MSK E2300A Calendaring (MTI)	1	$ 30,975	$ 30,975	Full-cell fabrication
MSK540 Slitting Machine	1	$ 38,750	$ 38,750	Full-cell fabrication
MSK30000w welder	1	$ 22,000	$ 22,000	Full-cell fabrication
Interface 1010E Potentiostat	1	$ 21,700	$ 21,700	Electrochemical performance testing
Full cell tester	5	$ 4,700	$ 23,500	Electrochemical performance testing
Forklift	1	$ 30,000	$ 30,000	Material handling
Warehouse Racking Equipment	2	$ 5,000	$ 10,000	Material Storage
Pallet Jack	1	$ 5,000	$ 5,000	Material Handling
Total			**$3,121,418**	

Supplies: Supplies include items and materials that are necessary for the project and can be directly identified to the project. Supply and material estimates are based on market plot prices and prior experience. Examples of supply items are chemicals raw materials, gases, nuts, bolts, piping, containers, minor equipment (value less than $5000), signage, safety items.

Subcontractor: The EERC will be a subrecipient of this proposal. The EERC budget justification is attached as Appendix B.

Facilities and Administrative Cost: The F&A rate proposed herein is the de minimis rate prescribed by DOE and is applied to modified total direct costs (MTDC). MTDC is defined as total direct costs less individual capital expenditures, such as equipment or software costing $5000 or more with a useful life of greater than 1 year as well as subawards in excess of the first $25,000 for each award.

APPENDIX F

BUSINESS PLAN

BUSINESS PLAN

COMMERCIAL OPPORTUNITY

The transition to clean energy is happening worldwide and it's unstoppable. It is not a question of "if," it is just a matter of how soon. The annual Institute for Energy Studies (IES) report estimates that in 2030 there will be 10 times as many electric vehicles on the road worldwide and 50% of the cars sold in the Unites States will be electric. The agency says solar panels installed across the globe will generate more electricity at the end of the decade than the United States power system produces now. Renewable energy, such as wind and solar, will supply 50% of the world's electricity needs, up from 30% now (World Energy Outlook, International Energy Agency, 2023). The war in Ukraine has increased demand for wind, solar, and other renewables as an alternative to Russian oil and gas. This has led to a scramble to build the lithium batteries needed to store electricity from wind and sunlight for variable use at any time.

Lithium iron phosphate (LFP) cathode materials were invented in the United States and the inventors received a Nobel prize for their work. But according to the U.S. Department of Energy (DOE), 0% of the world's LFP battery material manufacturing now takes place in North America. Greater than 90% of lithium cathode material manufacturing is in Asia, mostly in China. With 0% of the world's LFP cathode production in the United States, battery cell factories must import the materials at a higher cost than a Chinese cell factory. The result is United States cell factories cannot manufacture a cost-competitive product and remain small, with limited production. This impacts industries down the supply chain, with utilities, electric car makers, consumer energy storages, and even the United States defense industry dependent on China to supply their lithium batteries.

Dakota Lithium Materials (DLM) is the leading consumer battery brand in North America, with over 50,000 individual customers each year, over $33 million in revenue in 2022, and an estimated $55 million revenue in 2023. In addition, DLM is a leading original equipment manufacturer (OEM) for the agricultural industry, maritime boat builders, electric cars and trucks, and grid energy storages. The company's business case for LFP cathode material has the company producing profits once the full 10,000-tons/yr facility gets online after 3 years of the project. The majority of the losses will be related to setup time, factory optimization, and quality control. This project will allow for a stabilized start-up period to ensure the LFP cathode meets industry and customer specifications.

DLM leverages the need for millions of lithium battery cells annually to secure sales contracts and supplier agreements with United States cell manufacturers. For example, DLM will commit to ordering cells if the cell manufacturer commits to ordering lithium battery materials from DLM. The result is made-in-America cells built from DLM's battery material technology that can be assembled into made-in-America batteries. This provides a competitive edge for government contracts and for the hearts and minds of American consumers. A number of letters of intent from potential customers have been included within this application package, both from United States and Asian companies.

INNOVATION AND VALUE POSITION

Innovation

DLM began joint research with the University of North Dakota (UND) in 2012. Led by Dr. Yong Hou, DLM has been providing funding for a team of researchers to develop a manufacturing process for LFP cathode material production. The work has been in partnership with UND and received grant funding from the state of North Dakota. The result of this 10 years of research was a successful pilot line for cathode material that this grant will be bring to a mass production scale.

Innovation in lithium-ion batteries (LIBs) is driven by innovation in lithium battery materials. In lab testing, the LFP powder made from the newly developed dry-process technology exceeded the highest industry standard for LFP cathode material, and after laboratory testing has been approved for use by both cylindrical and prismatic cell customers. Product performance characteristics include:

- Exceptionally long lifespan: 3600–6000 recharge cycles, which allows for batteries that last 15–20 years. When combined with innovations in electrolyte, this lifespan can be increased an extra 20%–40%.

- Significantly more than 15.4% cost reduction. DLM has developed a novel dry-process production technology for United States-made LiFePO4 material. Compared with the conventional wet-processing method, the proposed produce process reduces 51% of energy consumption and CO_2 emissions, 99% of water consumption, along with 47% of operating time, which results in 60% less costs in operation and at least 15.4% of total cost reduction for LFP powder product.

Supply Chain Advantages

The United States accounts for 0% of the world's LFP cathode material production. Thus, as a United States company with market-leading technology, DLM has unique advantages that allow for scaling production at low cost. Other approaches to maintain a steady supply of raw materials of good quality for a sustained large-capacity manufacture of LFP cathode materials include use of North Dakota-sourced food-grade glucose products made from corn, with North Dakota being one of the largest producers of glucose products in the United States. Supply chain advantages include the following:

- The United States has 0% of the world's cathode material production. As a United States company with market-leading technology, and a first-to-market opportunity, DLM has unique supply chain advantages that allow for scaling production at low cost.

- The novel dry-process technology is based on unique resonant acoustic mixing RAM equipment made by Resodyn Mixer, a designated manufacturer in Montana.

- DLM has replaced the particle coating, one of the more expensive inputs for cathode materials, with a glucose structure from North Dakota agricultural corn products. North Dakota is one of the major producers of corn in the United States, providing a low-cost and widely available alternative.

Market and Value Position

The global LFP battery market size in 2020 was valued at $8.37 billion. Demand is expected to reach $49.6 billion by 2028, which is a relatively short period for that amount of growth. Furthermore, as advancements continue in LFP cathode materials, the selection of LFP for use in long lifespan energy storage will increase as advancement in lowering costs continues. Currently, there is no LFP cathode production in the United States. Many more sectors will require energy storage in the renewable energy industry, so there is a need for more LFP cathode material supply and not a lack of market. This puts DLM in a unique position to generate material for a wider market.

ESTIMATION OF NEAR-TERM MARKET PROJECTIONS

Internal Demand

DLM has been experiencing rapid growth since it started in 2008. The LFP cathode production can meet DLM's internal demands for LIB cells and battery pack manufacture. For example, in 2022, the company had a demand for more than 700 tons of LFP powder for its LFP battery products. Following the company's growth of 30%-40% annually since it started, it is estimated that the internal demands for LFP cathode materials will continuously grow by 30%–40% annually in the near-term future. Driven by the rapidly growing demand for DLM products and electric grid energy storage applications, there will be a sharp increase by folds in the coming years.

Broader Market Need

There are huge demands for LIB cathode materials for electric vehicle (EVs) and grid energy storage applications in the United States besides DLM's own need.

Production and Sales Projection

To meet the internal and broader market demands in the United States, the objective of this proposed project is to set up a demonstration plant for making LFP material in Grand Forks, North Dakota. Table F-1 provides current projections for 2028. It is anticipated that commercialization of this technology will make DLM even more profitable in the near-to-long-term.

Table F-1. Near-Term Estimates and Sales Projections

Annual Sales and Production Goals			
	2026	**2027**	**2028**
Revenue (USD)	$1,035,000	$11,499,540	$16,560,000
Tons Produced	90	1000	1440
Average Selling Price per Ton (ASP)	$11,500	$11,500	$11,500
Monthly Tons Produced		83	120
New Jobs Generated by DLM	10	27	38

Key Risks to Market

- Regulatory Issues: Currently, there are no major regulatory issues that would affect the production of this material.

- Intellectual Property (IP): DLM owns the IP required for this project. This includes patents, trade secrets, and industry knowledge. In the development of LFP materials-manufacturing technology, DLM chose to operate silently and grow the development privately. Funded with grants from the state of North Dakota and cash contributions made by DLM's profitable battery business, the research performed remained secret. The result is an information advantage, no staff turnover, and a team of researchers who are rooted in the community and the Great Plains. Thus, the IP of the proposed work is wholly American-owned. UND provides additional R&D support for this project. Future IP developed at UND may be licensed to DLM if applicable to this project.

- Market Prices' Uncertainty: The global demand for LFP is rapidly increasing. Therefore, not only are new ventures likely going to enter this LFP market in the United States, but the existing big suppliers are extending their production capability. That will increase the risk of a falling market price of LFP material if the supply is much greater than the demand in the United States. Alternately, one of the main raw material prices, such as lithium carbonate, could increase suddenly.

The ultimate objective of this proposed project is to set up a demonstration plant for making LFP material in Grand Forks, North Dakota. With support from the North Dakota Industrial Commission and DOE, this project will establish a production capacity of 1000 tons upon completion of this project in 2026. By extension, DLM will produce and sell 1440 tons of LFP material by 2028. With government funds invested of approximately $9 million, the DLM project anticipates a result in 1440 tons annual production, $16.56 million revenue, and 38 new jobs generated in business in 5 years.

REFERENCE

International Energy Agency, 2023, World Energy Outlook 2023: https://www.iea.org/reports/world-energy-outlook-2023 (accessed October 2023).

APPENDIX H

BUDGET PROJECTIONS

Dakota Lithium Materials Financial Projections

All numbers in USD		2024	2025	2026	2027	2028	2029	2030	2031	2032	2033
LiFePO4 Powder		0	140,300	1,035,000	11,499,540	16,560,000	16,560,000	47,520,000	47,520,000	47,520,000	47,520,000
Others											
Total Revenue		**0**	**140,300**	**1,035,000**	**11,499,540**	**16,560,000**	**16,560,000**	**47,520,000**	**47,520,000**	**47,520,000**	**47,520,000**
Lithium Carbonate (mTon)		52,200	208,800	914,400	3,744,000	5,391,360	5,391,360	16,174,080	16,174,080	16,174,080	16,174,080
Iron Phosphate (mTon)		40,000	160,000	800,000	3,272,000	4,711,680	4,711,680	14,135,040	14,135,040	14,135,040	14,135,040
Glucose (mTon)		2,000	8,000	40,000	163,000	234,720	234,720	704,160	704,160	704,160	704,160
Dispersal (mTon)		1,200	4,800	24,000	98,000	141,120	141,120	423,360	423,360	423,360	423,360
Total Material Cost		**95,400**	**381,600**	**1,778,400**	**7,277,000**	**10,478,880**	**10,478,880**	**31,436,640**	**31,436,640**	**31,436,640**	**31,436,640**
Gross Profit		**-95,400**	**-241,300**	**-743,400**	**4,222,540**	**6,081,120**	**6,081,120**	**16,083,360**	**16,083,360**	**16,083,360**	**16,083,360**
Payroll		-735,000	-867,500	-1,414,765	-1,664,765	-1,964,765	-2,063,003	-3,006,153	-3,156,461	-3,314,284	-3,479,998
Advertising and Promotion			-9,000	-18,000	-18,000	-36,000	-36,000	-54,000	-54,000	-54,000	-54,000
Travel		-6,000	-6,000	-6,000	-12,000	-12,000	-12,000	-12,000	-12,000	-12,000	-12,000
Shop and Office Rents		-60,000	-60,000	-60,000	-60,000	-60,000	-60,000	-180,000	-180,000	-180,000	-180,000
Liability Insurance		-12,000	-12,000	-24,000	-24,000	-24,000	-24,000	-72,000	-72,000	-72,000	-72,000
Nitrogen		-5,600	-16,128	-32,256	-112,000	-161,280	-161,280	-483,840	-483,840	-483,840	-483,840
Electricity & Other Utilities		-9,750	-19,500	-39,000	-195,000	-280,800	-280,800	-842,400	-842,400	-842,400	-842,400
Equipment Depreciation			-216,667	-216,667	-216,667	-216,667	-216,667	-400,000	-400,000	-400,000	-400,000
Shipment		-5,000	-5,000	-7,000	-12,000	-15,000	-15,000	-50,000	-50,000	-50,000	-50,000
Legal Services		-6,000	-6,000	-6,000	-12,000	-12,000	-12,000	-12,000	-12,000	-12,000	-12,000
Product R&D			-100,000	-100,000	-100,000	-300,000	-300,000	-500,000	-500,000	-500,000	-500,000
Others			0	0	0	0	0	0	0	0	0
Total Operating Cost		**-839,350**	**-1,317,795**	**-1,923,688**	**-2,426,432**	**-3,082,512**	**-3,180,750**	**-5,612,393**	**-5,762,701**	**-5,920,524**	**-6,086,238**
Interest costs					-400,000	-240,000	-240,000	-640,000	0		
Finance net											
Net Profit		**-934,750**	**-1,559,095**	**-2,667,088**	**1,796,108**	**2,998,608**	**2,900,370**	**10,470,967**	**10,320,659**	**10,162,836**	**9,997,122**

Cash holdings EOP	**250,000**	**250,000**	**2,270,695**	**19,408**	**-199,162**	**706,986**	**2,075,356**	**842,323**	**17,418,982**	**41,837,818**	**66,090,939**
Net cash flow from operations			-1,559,095	-2,667,088	1,796,108	2,998,608	2,900,370	10,470,967	10,320,659	10,162,836	9,997,122
Changes in working capital 1 (build up)			-98,210	-724,500	-8,049,678	-11,592,000	-11,592,000	-33,264,000	-33,264,000	-33,264,000	-33,264,000
Changes in working capital 2 (received)			0	140,300	1,035,000	11,499,540	16,560,000	16,560,000	47,520,000	47,520,000	47,520,000
Subcotract -EERC		-400,000	-597,000		0	0	0				
Down payment of loans											
Investment - equipment		-3,000,000	-225,000				-6,500,000	0			
CSEA Grant		2,000,000	2,000,000								
DOE Grant		2,500,000	2,500,000								
Adding capital or Financing				1,000,000	5,000,000	-2,000,000		5,000,000	-8,000,000		
Cash flow		**1,350,000**	**2,020,695**	**-2,251,288**	**-218,570**	**906,148**	**1,368,370**	**-1,233,033**	**16,576,659**	**24,418,836**	**24,253,122**

APPENDIX I

TAX LIABILITY

Industrial Commission

Tax Liability Statement

Applicant:

Dakota Lithium Materials

Application Title:

Demonstration and Scale-Up of a Low-Cost Long-Duration Energy Storage Technology for Lithium-Ion Batteries

Program:

☐Lignite Research, Development and Marketing Program
☐Renewable Energy Program
☐Oil & Gas Research Program
☑Clean Sustainable Energy Authority

Certification:

I hereby certify that the applicant listed above does not have any outstanding tax liability owed to the State of North Dakota or any of its political subdivisions.

DocuSigned by:
Andrew Jay
1DB8F066FE6145C...
____
Signature

CEO
____
Title

11/1/2023
____
Date

DocuSign

Certificate Of Completion

Envelope Id: 8115B7C02F274AAF85E625D5C3467886		Status: Completed
Subject: Complete with DocuSign: 2024-0055_NDIC_CSEA-Oct2023.pdf		
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Document Pages: 75	Signatures: 4	Envelope Originator:
Certificate Pages: 5	Initials: 0	Bobbie Rakoczy
AutoNav: Enabled		15 North 23rd Street
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		brakoczy@undeerc.org
		IP Address: 65.74.100.113

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Andrew Jay andrew@dakotalithium.com Security Level: Email, Account Authentication (None)	 Signature Adoption: Pre-selected Style Using IP Address: 67.168.130.20	Sent: 11/1/2023 9:52:10 AM Viewed: 11/1/2023 12:42:04 PM Signed: 11/1/2023 12:42:14 PM

Electronic Record and Signature Disclosure:
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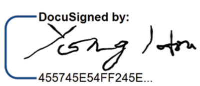
ID: e2458ea0-8912-4467-84b7-023970d9eae7

Signer Events	Signature	Timestamp
Dr. Yong Hou hou@cleanrepublic.com Security Level: Email, Account Authentication (None)	 Signature Adoption: Drawn on Device Using IP Address: 24.124.96.174	Sent: 11/1/2023 9:52:10 AM Viewed: 11/1/2023 10:01:02 AM Signed: 11/1/2023 10:01:48 AM

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Editor Delivery Events	Status	Timestamp

Agent Delivery Events	Status	Timestamp

Intermediary Delivery Events	Status	Timestamp

Certified Delivery Events	Status	Timestamp

Carbon Copy Events	Status	Timestamp
Ryan Ellison ryan@dakotalithium.com Security Level: Email, Account Authentication (None)	COPIED	Sent: 11/1/2023 12:42:16 PM

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Witness Events	Signature	Timestamp

Notary Events	Signature	Timestamp

Envelope Summary Events	Status	Timestamps
Envelope Sent	Hashed/Encrypted	11/1/2023 9:52:10 AM
Certified Delivered	Security Checked	11/1/2023 10:01:02 AM
Signing Complete	Security Checked	11/1/2023 10:01:48 AM
Completed	Security Checked	11/1/2023 12:42:16 PM

Payment Events	Status	Timestamps

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