Rowow LLC, STRIDE Ventures Tech Metal Transformation Challenge application (public copy)

> Editor's note, November 2026: This is the application Rowow LLC submitted on December 25, 2025 to the STRIDE Ventures Tech Metal Transformation Challenge, a critical minerals challenge backed by the U.S. National Science Foundation and run by Start2 Group. The application was not selected for Pitch Day. Rowow LLC knew by February 11, 2026 that it had been declined, and it was not among the eight Stage 1 winners announced on March 24, 2026. Plans in the text describe the work as proposed; none of it was funded through this challenge. The public contact for Rowow LLC is info@rowow.net.
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> Editor's note on the name: the brand is now written S.E.M Technology (S.E.M Tech, Salt Electro Mining). This record keeps "SEM TECH" as submitted.
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> Editor's note on this copy: the original wording is kept. Text in square brackets beginning "Note, November 2026" was added for this public copy and marks statements of results or performance that the current record does not verify. The budget and some other passages are not reproduced; " section shortened " marks where a passage was cut. Headings were given heading formatting; their wording is unchanged.

Executive Summary

Our proposed solution, SEM TECH (salt electro mining technology), is an open-sourced, multi-modal, electrified, closed-loop "micro refinery", capable of extracting from diverse feedstocks and complex metal waste streams into an economically viable concentrate in a single step (coined "CEU" or "Continuous Extraction Unit"). Note, November 2026: claim as submitted in December 2025, before later work. Not a verified current result. Further available steps for refinement/conversion of concentrates to a manufacturable ready metal product through the "Continuous Refining Unit" (CRU) exists, with a credible path from lab validation to pilot scale operation.

Our technical edge is a low cost, tunable ion-exchange membrane integrated into a flow through electrochemical stack that enables tight control of ion transport and redox conditions. Instead of relying on large volumes of purchased acids/oxidizers and generating secondary waste, SEM TECH uses electricity and benign inputs (e.g. brines/fertilizer) to sustain regenerative extraction chemistry and drive staged separation. In Stage 1, we will target the standardized PCB and hard drive reference material and demonstrate selective recovery of high impact critical metals into at least one functional material output. Examples include, purified metal salts suitable for electroplating/battery precursor pathways, and/or rare earth bearing intermediates compatible with magnet materials processing. While quantifying yields to maximize the Challenge's Critical Materials Score.

The bold outcome we are pursuing is a scalable, multi-modal, low capex platform that turns today's fragmented, multi step e-waste processing into a single integrated, electrically driven system that (a) achieves high recovery and purity, (b) minimizes chemical consumption and hazardous byproducts

through closed loop regeneration, and (c) produces product forms that can plug directly into domestic manufacturing supply chains.

Our team is positioned to meet project deliverables due to previously completed development of our "Continuous Mining Unit" (CMU) for raw ore, and toxic heavy metal extraction. Note, November 2026: claim as submitted in December 2025, before later work. Not a verified current result. Working with natural rock exposed us to some of the most chemically challenging feedstocks (highly diverse and complex matrixes) which drove key lessons learned and the development of SEM TECH. The extremely low concentrations of platinum group metals (PGMs) in ore also created a demanding recovery problem that reinforced the need for a closed-loop process to preserve reagents and maximize yield. This past work enables our team to develop a clear TRL 3>7 pathway for the CEU, aligned with the Challenge stages. Note, November 2026: claim as submitted in December 2025, before later work. Not a verified current result.

TECHNICAL APPROACH

Overall system concept + target materials

Our system concept is a modular, continuous, closed-loop ion-exchange membrane electrolysis platform (SEM TECH) that integrates a Continuous Extraction Unit (CEU) for a single staged electrochemical extraction.

Based on the updated 2025 list of 60 critical minerals, the CEU is capable of extracting all but 4 minerals. Note, November 2026: claim as submitted in December 2025, before later work. Not a verified current result. 53 of those elements can be extracted and concentrated by the CEU in a single leaching solution. Note, November 2026: claim as submitted in December 2025, before later work. Not a verified current result. The remaining 3 elements can be extracted by the CEU utilizing the same components, only requiring a slight modification to which leaching solution is being utilized. Note, November 2026: claim as submitted in December 2025, before later work. Not a verified current result.

CEU is not designed to directly extract Barite, Fluorspar, Metallurgical Coal, and Graphite because these are primarily recovered as native mineral/compound resources rather than as extractable dissolved elemental species. Synthetic pure Fluorspar (CaF_2) may be created from elements extracted by SEM TECH.

Beyond those four, CEU is capable of extracting the remaining critical minerals listed in the following.

(Aluminum, Antimony, Arsenic, Beryllium, Bismuth, Boron, Cerium, Cesium, Chromium, Cobalt, Copper, Dysprosium, Erbium, Europium, Gadolinium, Gallium, Germanium, Hafnium, Holmium, Indium, Iridium, Lanthanum, Lead, Lithium, Lutetium, Magnesium, Manganese, Neodymium, Nickel, Niobium, Palladium, Phosphate, Platinum, Potash, Praseodymium, Rhenium, Rhodium, Rubidium, Ruthenium, Samarium, Scandium, Silver, Tantalum, Tellurium, Terbium, Thulium, Tin, Uranium, Vanadium, Ytterbium, Yttrium, Zinc, Zirconium)

Can be all extracted and concentrated by the CEU in one leaching solution. Note, November 2026: claim as submitted in December 2025, before later work. Not a verified current result. Rare earths do not plate from water; in

this process they come out as a precipitate (hydroxide) that becomes oxide only after calcining.

Silicon, Titanium, Tungsten, would require different solvents and solutions (Hydrofluoric acid, or alkaline leaching conditions) to be extracted by SEM TECH as the CEU utilizes chlorine based acids to digest minerals. Note, November 2026: claim as submitted in December 2025, before later work. Not a verified current result.

Functional forms and applications

The initial concentrate powder produced from extracting in the first stage with a chlorine based solution will result in either metal powders, metal oxide powders, or concentrated solution/gas depending on elemental types. Note, November 2026: claim as submitted in December 2025, before later work. Not a verified current result. section shortened

Primary manufacturing sectors/applications include:

Electronics & electrical; as metal salts or raw powders for plating, connectors, and conductive components.

Defense & advanced manufacturing; exotic metal streams feeding domestic manufacturing and high reliability electronics supply.

Magnet / critical materials with rare-earth intermediates positioned for domestic magnet-material pathways.

Differentiation: efficiency/selectivity, scalability, cost, accessibility, safety.

The cost and accessibility of our innovation is a novel low-cost ion-exchange membrane manufactured from consumer grade precursors, benchmarked in the technical volume as ~$100 for a commercial 40×40 cm sheet vs < $1 for the SEMTECH membrane material cost at the equivalent area. Note, November 2026: claim as submitted in December 2025, before later work. Not a verified current result. This addresses the historic barrier to deploying ion-exchange electrolysis at scale, especially in harsh, mixed-ion systems.

section shortened In one example the cost, primarily of electricity, was $50-400 to electrochemically extract/refine one ton of feedstock. Note, November 2026: claim as submitted in December 2025, before later work. Not a verified current result. Traditional chemical methods would require 3.5 tons of nitric acid costing thousands of dollars, in addition to management and waste produced.

Our scalable advantage is significant as we use continuous, closed-loop flow electrolysis cells. This architecture is inherently modular (cell/stack replication) and low footprint for maximized throughput scaling while preserving process control. The units are plug and play with changing of flow configurations requiring very simple modifications, in addition to critical components such as the membranes and electrodes being hot swappable.

Safety + waste minimization: The platform is explicitly positioned to eliminate toxic waste generation through closed-loop electrochemical processing, and the workplan emphasizes safety planning,

containment, and monitoring controls at scale. Note, November 2026: claim as submitted in December 2025, before later work. Not a verified current result.

Interdisciplinary integration + cost-effective operation:

Our approach integrates several of the disciplines STRIDE explicitly promotes, most notably electrochemistry and separation science by leveraging membrane enabled ion transport to achieve controlled, selective separations. Polymer and materials engineering are central to developing low cost membrane formulations and scalable manufacturing methods. This ensures electrolysis cells can reliably operate in the required acidic environments. We also plan to incorporate commercially available components to accelerate membrane optimization, such as lithium selective separators used in ion-exchange batteries, repurposed here to enable selective lithium ion transport for lithium recovery. section shortened

Cost effectiveness and sustainability come from replacing repeated bulk chemical purchasing with electrified regeneration in a closed loop process which reduces consumables and waste streams while keeping the core hardware low cost and simple for cheap manufacturability.

Domestic integration and realistic examples;

SEM TECH is designed to be built from domestically sourceable materials and explicitly targets strengthening U.S. supply chains by enabling recovery/refining of critical minerals into collectable product streams.

Practical integration examples and assumptions include co-location with U.S. e-waste processors (feedstock access) through CRU modules sited downstream of shredding/sorting lines to process PCB + hard-drive fractions that are otherwise exported or routed to limited domestic capacity. The produced concentrate can either be further refined on site or sent to a regional SEM TECH refining facility for final processing.

Additionally SEM TECH can be utilized in countless other industries to either optimize and increase primary yield efficiencies, or process the byproduct where traditional chemical process results in conventionally unusable waste either through technological or economical limitations, which would be overcome through SEM TECH high efficiency and low cost process to recover those minerals while cleaning up the waste. Note, November 2026: claim as submitted in December 2025, before later work. Not a verified current result. Various examples exemplify this challenge, such as mining tailings, coal or oil waste, manufacturing byproducts, and more, which are proven to consist of the required critical minerals of US domestic needs, but simply requires a technology capable of extracting them. https://www.science.org/doi/10.1126/science.adw8997

SYSTEM MATURITY

Over the past two years, Rowow LLC has developed and deployed ion-exchange membranes as the core enabling component of SEM TECH, initially to extract precious metals from ore. Note, November 2026: claim as submitted in December 2025, before later work. Not a verified current result. Working with natural

rock exposed us to some of the most chemically challenging feedstocks (highly diverse and complex matrixes) which drove key lessons learned and the development of SEM TECH. The extremely low concentrations of platinum group metals (PGMs) in ore also created a demanding recovery problem that reinforced the need for a closed-loop process to preserve reagents and maximize yield.

WORK PLAN

Workplan overview (TRL 3 > TRL 7 across STRIDE's 3 stages)

We will develop SEM TECH into an integrated, end-to-end system that can extract, transform, and deliver manufacturing-ready metals from STRIDE's standardized reference stream and many other feedstocks. Stage gates and deliverables are aligned to STRIDE's stage definitions (Stage 1: proof-of-concept, functional output, CM-Score. Stage 2: offtakers, manufacturing relevance. Stage 3: pilot-scale TRL 7 + cost/throughput + supply chain integration).

Stage 1 (10 months): Technical Validation

Demonstrate a proof-of-concept system that selectively and efficiently recovers metals from the reference stream and produces at least one functional material (e.g. metal salt/alloy/nanoparticle), with quantified recovery and selectivity and a preliminary CM-Score.

Month 1-2: Reference material intake/characterization.
Receive/handle reference material, (PCB and hard drives) establish SOPs for preprocessing, leach conditions, and sampling. Baseline analytics (XRF/third party) for mass balance inputs and for CM-Score inputs.

Month 2-4: TRL 3>4 integrated bench prototype.
Configure SEM TECH electrochemical cell for continuous extraction and first-pass separation. Downselect target metals/metal classes for optimized second pass refining to meet Stage 1 recovery and CM-Score impact.

Month 4-7: Material output demonstration
Produce multiple functional materials from the reference stream such as a metal salt solution or powder intermediate suitable for a defined manufacturing pathway.

Month 7-10: Quantified performance with preliminary CM-Score
Quantitative evidence of recovery efficiency, selectivity, and transformation performance under a closed-loop operation and repeatable across runs. Preliminary CM-Score computed using STRIDE's equation and required terms. Deliver "path to manufacturing integration" downstream process compatibility, handling, and QC plan.

Deliverables: product spec sheet of composition, impurities, and initial manufacturability mapping.

Stage 1 performance targets involve:
Recovery: >95% for at least one priority metal in the chosen class, and >90% for at least one additional co-target metal (measured by mass balance). Transformation of multiple output products

meeting a defined functional spec for a named manufacturing pathway. Operability stable in a continuous operation for multi day runs with closed-loop chemistry control and repeatable results, proving calculated costs of extraction as economically competitive.

Stage 2 (12 months): Market Validation

Prove the recovered/transformed materials are valuable, usable, and desirable in real manufacturing contexts and maintain an economically competitive edge to validate integration into supply chains.

Key milestones and deliverables:

(MS1): Offtaker alignment and application specific specs through at least 2 engaged offtakers (plating chemicals supplier, electronics materials recycler/refiner, magnet material intermediates buyer) to define and meet acceptance specs.

(MS2): Improved material processing validation delivering batches to partners for testing and update process design to meet partner specs.

(MS3): Commercialization and supply chain integration plan

Deliverables: updated CM-Score, unit economics (cost/kg product), scalability plan, and a partner backed integration plan (how materials flow into a domestic process).

Stage 2 performance targets
At least one material output meets offtaker acceptance specs and is validated in a relevant manufacturing test, with clear cost and throughput consistent for pilot scale.

Stage 3 (12 months): Scale-Up

Advance toward TRL 7 with a pilot-scale system, demonstrate readiness for deployment (throughput, cost model, reliability) and integrate with domestic supply chains and manufacturing partners.

Key milestones and deliverables:

(MS1): Pilot design and buildout of a scalable modular cell system for higher throughput and fully automated flow handling (pumps/filtration/controls), including safety instrumentation and containment.

(MS2): Sustained pilot operation runs demonstrating robustness, stable control, maintenance intervals, and reproducible product quality. Additional independent verification of performance.

(MS3): Collaborate with manufacturing partners to integrate SEM TECH into their operation, demonstrating TRL 7 achievement.

Deliverables: TRL 7 evidence package, cost model, throughput targets, reliability/uptime metrics, and documented integration into a partner manufacturing workflow.

Team structure and collaboration roles

Rowow LLC (Prime Recipient / Systems Integrator)

Mr. Robert Karas, Owner/Project Director, will be directly responsible for overall project management, primarily focusing on the fundamental research, material processing, and deliverables under the award.

Stage 1 budget

Note, November 2026: the budget is not reproduced in this public copy.

Resource and management strategy

Governance cadence through weekly internal technical standups, biweekly milestone reviews, and monthly budget/schedule burn review, allows the project team to re-evaluate stage readiness and shift focus to align with STRIDE evaluation criteria.

Risk management and adaptation:

Technical risks will be mitigated through parallel testing, modular cell swapping, and alternative chemistries. Target pathways would be continuously re-evaluated if they underperform, to pivot objectives with the goal of preserving CM-Score competitiveness, and overall project goals.

Scale risks will be mitigated by proactive standardized design choices (stackability, modularity, reusability), to ensure forward compatibility. This interoperability allows future testing to be derisked and costs reduced when approaching stage 3.

Market risk mitigation through stages 2 and 3 begins with early prioritization on alignments with partner intake specifications and includes rapid iteration loops to meet purity/form factor requirements.

BOLD VISION & RISK POSTURE

Rowow LLC sees SEM TECH in 5-10 years completely revolutionizing across multiple industries from mining to health, agriculture, energy storage, chemical production, and general manufacturing processes. From drastic improvement in yield efficiencies or overall reduction in energy usage/chemical cost and waste generation, these improvements are well documented in research but always limited by membrane costs.

Rowow LLC sees itself leading and creating an economically competitive critical mineral industry in the USA by developing and providing analysis, extraction, and refining services, which are desperately needed and currently critically underrepresented within the country.

The grandest potential of SEM TECH is in asteroid mining/interplanetary manufacturing infrastructure due to the recyclable and closed-loop design, with a low space and energy footprint allowing for the technology to be economically operated & transported to these remote parts of the solar system without requiring supply missions of reagents as all other open-loop processes do.