BATTLE OF MINDS 2024

TEAM NEUTRINO

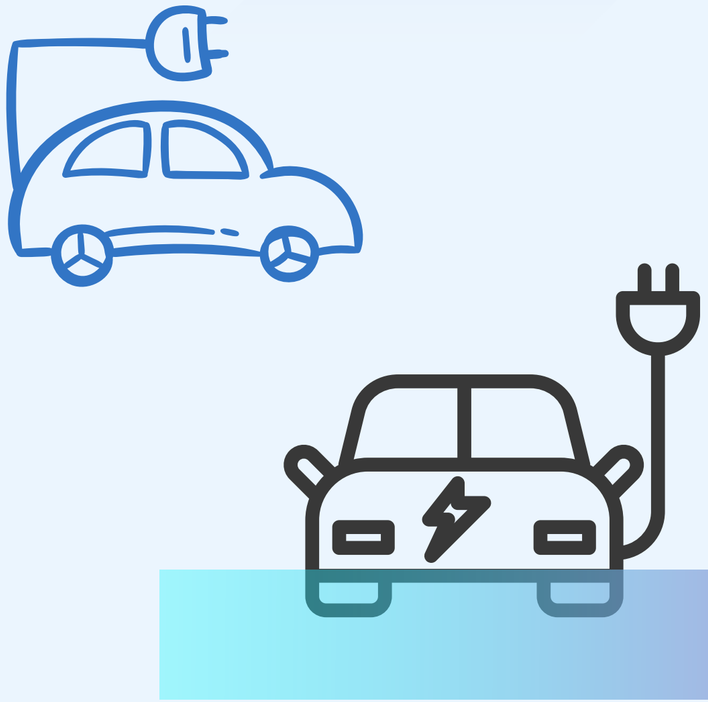
CALCIUM ION BATTERIES

LEADING THE SHIFT TO SUSTAINABLE ENERGY SOLUTIONS

Explore Team Neutrino's innovative technology solutions and their potential to drive transformation in Energy storage industries

BACK TO THE FUTURE: THE ELECTRIFYING RISE OF EVS.

- According to forecasts, by 2030, around **23 million** people in the world will own electric vehicles.
- **General Motors** decided they will stop selling gasoline-powered vehicles by 2035.
- **Audi**'s goal is to close their production by 2033.
- By **2040**, two-thirds of car sales will be EV, according to Bloomberg NEF
- UK, Iceland, Belgium, China, Singapore, Germany, South Korea, and many other countries have committed to ban the sales of gasoline-powered vehicles by the next decade.
- Electric vehicles, from production to use to scrapping, are responsible for **75% less** emission than IC engine counterparts



THE SUSTAINABILITY CRISIS: CHALLENGES IN ENERGY STORAGE TODAY

- Lithium is abundant but the problem is Extraction and Recycling
- Extracting lithium is a dangerous process involving several issues.
- The process of recycling Li-ion batteries is harder and costlier than mining and making new ones. Which makes it uneconomical to recycle.
- With the current trends, most of the used lithium-ion batteries will be thrown into landfills, causing environmental hazards.
- There is a growing demand for more sustainable, affordable, and reliable energy solutions.

LI-ION BATTERIES RECYCLING RATE

USA: LESS THAN 5%

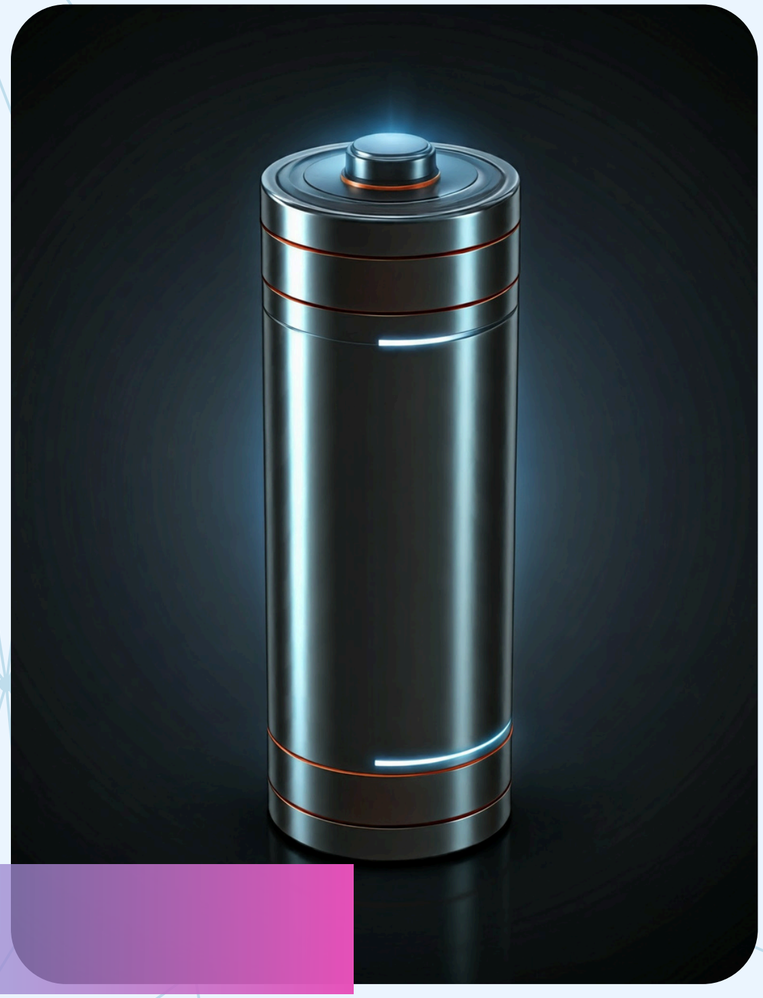
EUROPE: LESS THAN 5%

AUSTRAILIA: 2 TO 3%

The only solution is making batteries better.

Rather than searching for more raw materials and recycling with inefficiencies, it's better to use fewer resources or discover alternative methods.

INTRODUCING PROJECT HENKA



About Henka

We are redefining energy storage by introducing non-lithium-based solutions such as calcium and sodium batteries. Our mission is to create a sustainable future by tackling the environmental challenges posed by lithium extraction and recycling. Through innovation, we aim to provide efficient, eco-friendly alternatives that ensure a cleaner, greener energy landscape for generations to come.

What We Want to Achieve:

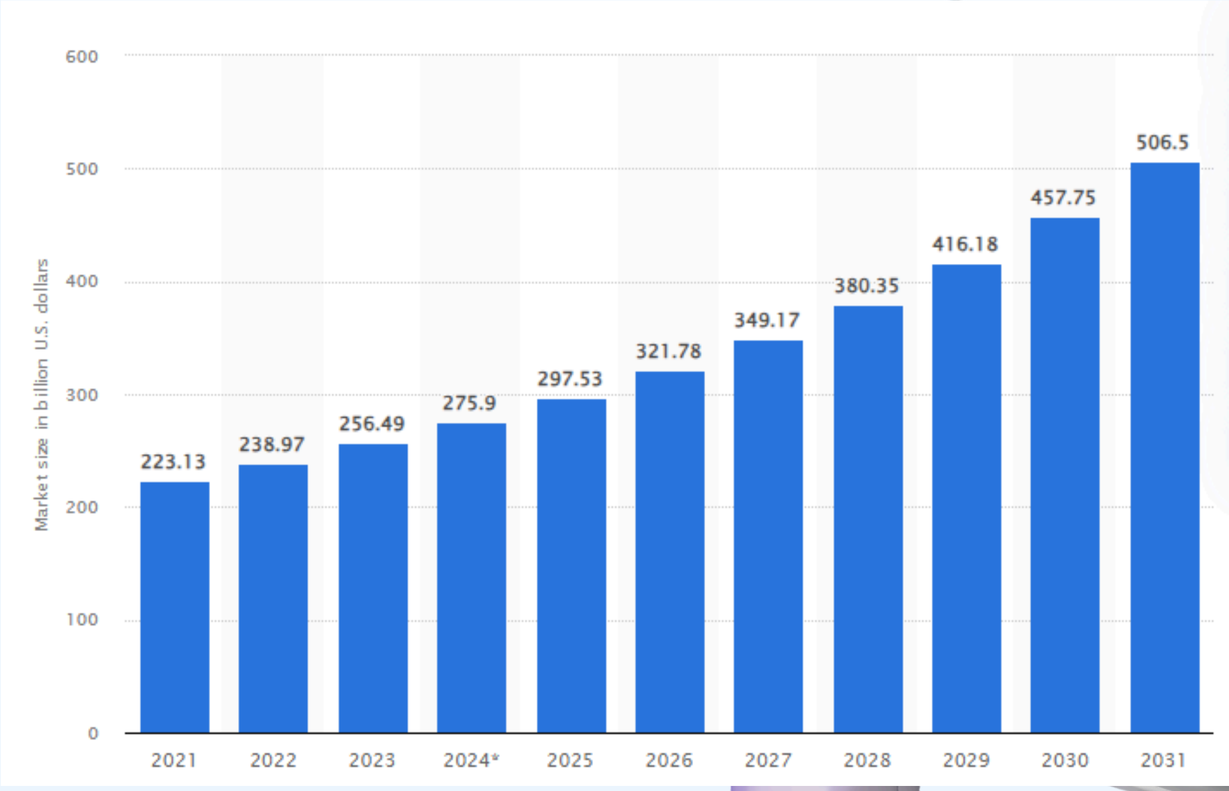
1. Sustainability: Reduce environmental impact by offering eco-friendly alternatives to lithium-based batteries, minimizing harmful mining and resource depletion.
2. Innovation: Develop and market efficient, high-performance batteries that meet growing energy demands.
3. Transformation: Lead the shift towards a more sustainable energy industry by ending full dependence on lithium and promoting responsible, circular energy solutions.

Market Analysis

- In 2023, the global energy storage market size was estimated at USD **221.5** billion.
- By 2030, the market is expected to exceed USD **400 billion**, with a compound annual growth rate (CAGR) of around 25-30%.

Some of the Major Growth Drivers:

1. Increase of **Electric Vehicles**
2. **Grid modernization**/necessity of large-scale storage systems to maintain grid stability.
3. **Decentralized Energy** Systems: Growth in off-grid solutions and microgrids demands a large amount of storage.



Global Market Growth Forecasting for Energy Storage [1]

THE WORLD IS MOVING TOWARDS A SUSTAINABLE FUTURE

Regulatory and Policy Shifts Towards Sustainable Energy Storage Technologies

Global Climate Commitments: Countries around the world are committing to net-zero emissions, encouraging the development of sustainable technologies. Notable Policies and Initiatives include:

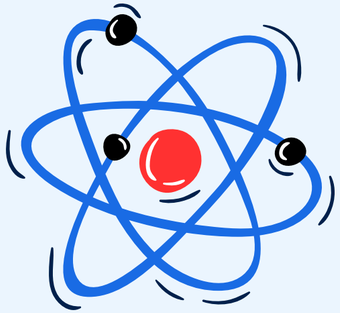
USA announced Bipartisan Infrastructure Law which allocates billions toward modernizing the electrical grid and increasing storage capacities.

The EU is focusing on the Next Generation EU initiative, with significant funds for sustainable energy projects, including storage.

Chinese government is investing in large-scale energy storage to integrate its vast renewable energy capacity. The China Energy Storage Alliance (CNESA) is actively promoting industry growth.

What is our gain from these shifts?

These policies along with several others regularly created and updated by many countries will play a huge role in the energy storage industry. They are creating a favorable environment for energy storage technologies, with incentives such as tax credits, subsidies, and research grants. The rising market size is a clear indicator that this industry will be huge in the upcoming years. Companies able to offer efficient and scalable storage solutions will benefit from these shifts.



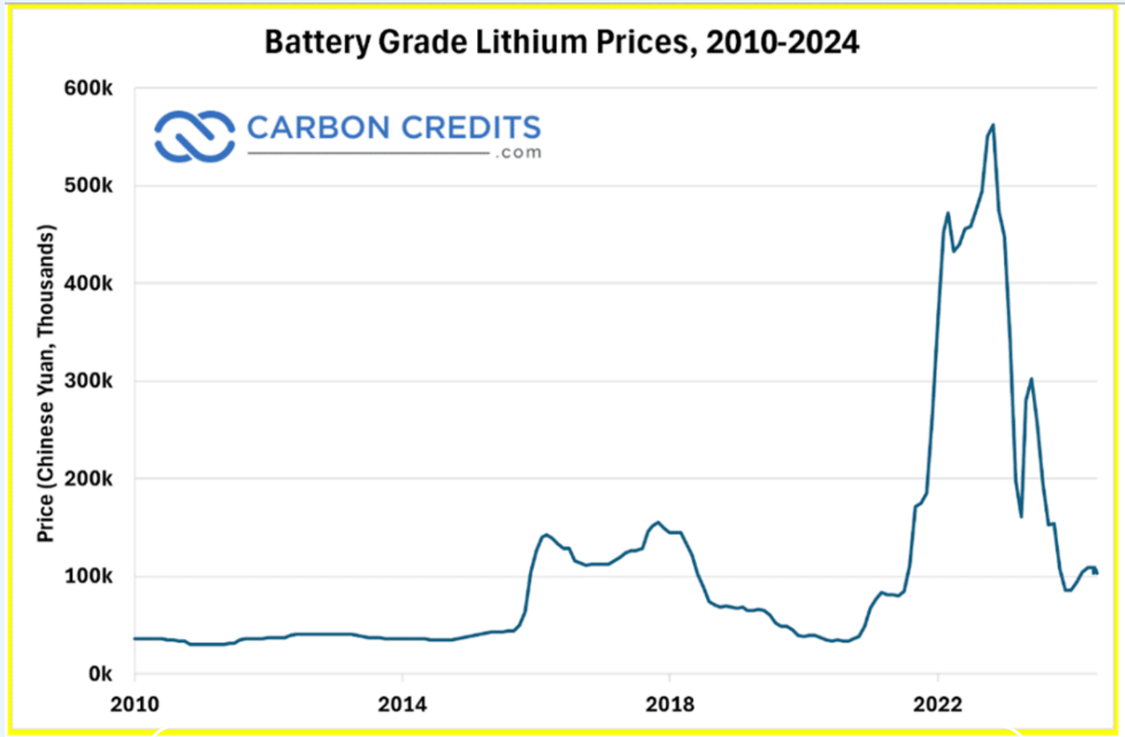
Why shift the focus from lithium-ion batteries?

COST

- The price of lithium has increased drastically through these years.

However, a fall has been seen recently due to the recent surge in supply and weaker-than-expected demand for electric vehicle (EV) batteries.

- This doesn’t mean that the demand is gone. In the upcoming years, a heavy rise in demand will be seen, according to the forecast.
- The cost of lithium refining and recycling is very high.

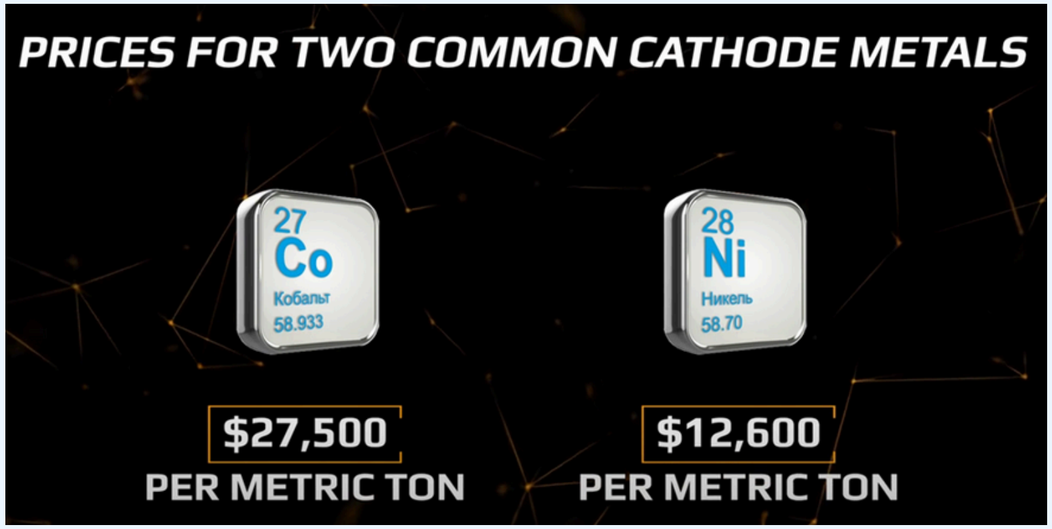


Price hike in battery grade lithium throughout the years [2]

CONTINUED

COST & SCARCITY

- The price of cathode materials for lithium-ion batteries is also increasing very fast.
- Lithium and cobalt, key components of lithium-ion batteries, are scarce and concentrated in a few regions, leading to supply chain vulnerabilities.



Price hike in Li-ion batteries cathode materials Cobalt and Nickel

RECYCLABILITY

- Lithium-ion batteries have poor recyclability, leading to waste and a growing e-waste problem with a large portion of used batteries ending up in landfills.
- Lithium-ion batteries degrade over time, losing capacity after a few years of use, which shortens their overall lifespan and necessitates frequent replacements.
- Recycling lithium costs more than making new batteries.
- Working in the recycling plants can be dangerous.

CONTINUED

ENVIRONMENTAL CONCERNS

- Lithium and cobalt mining cause significant environmental degradation, including deforestation, water pollution, and high carbon emissions.
- The process of production leaves a high carbon footprint.
- The production and disposal of lithium-ion batteries contribute significantly to greenhouse gas emissions, hindering global sustainability efforts.

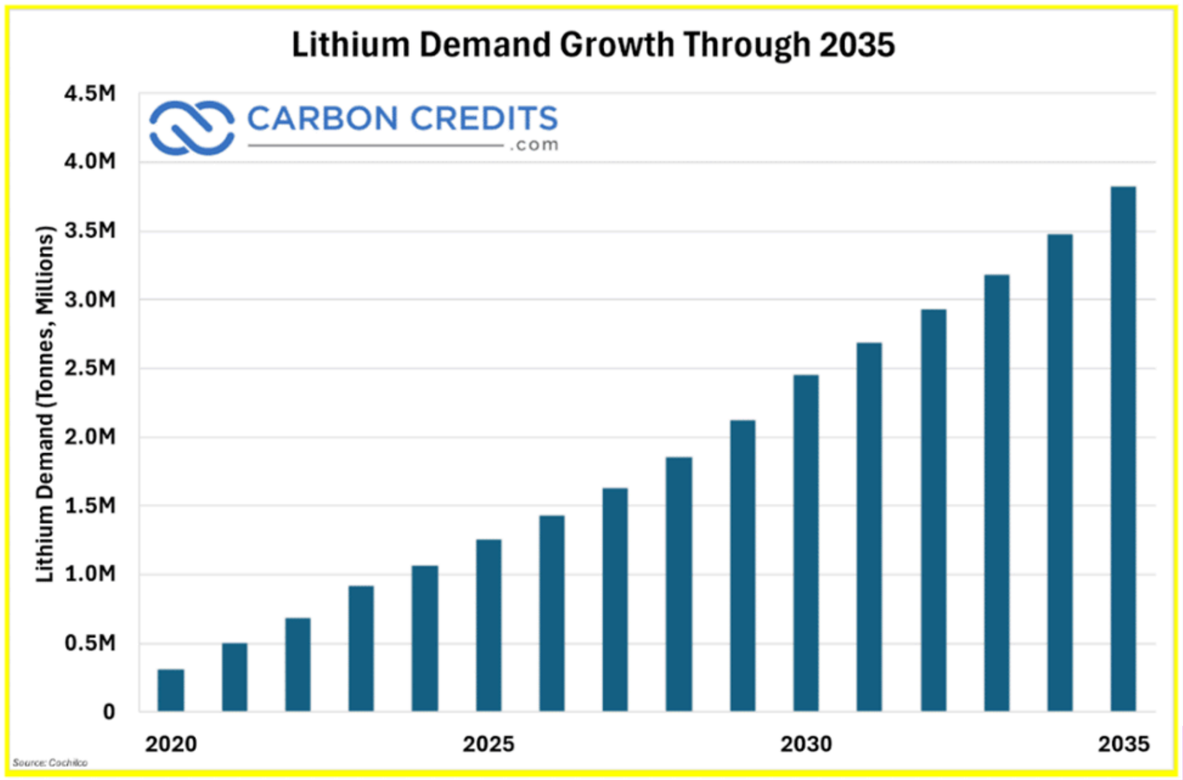
SAFETY AND ETHICAL CONCERNS

- Mining for these materials, particularly cobalt, is often linked to unsafe labor practices and human rights violations in countries like the Democratic Republic of Congo. Example: Artisanal.
- Lithium-ion batteries are prone to overheating, fires, and even explosions due to their chemical instability, making them hazardous.

CONTINUED

UPCOMING HUGE DEMAND

- Currently, Li-ion batteries are leading the market single-handedly. According to forecasts, there will be a huge surge in lithium-ion battery demand in the coming future.
- The other battery types are mostly in research and development phase. Very few of them are marketed and not as popular as lithium batteries.
- This makes a full dependency on the market for lithium-ion batteries.



Demand forecast for the upcoming years [2]

OUR GOAL IS TO DIVERSIFY THE MARKET.

PROJECT HENKA

Calcium Ion Batteries

We will initially launch this business with calcium ion batteries.
Calcium ion batteries are an emerging technology that uses calcium ions (Ca^{2+}) as the charge carrier. They offer several potential advantages over traditional lithium-ion batteries:

01

Abundance and Cost: Calcium is more abundant and cheaper than lithium, making it a more sustainable option

02

Energy Density: Calcium-based batteries promise high energy density at low manufacturing costs. It is also safer than Li-ion batteries.

03

Research and Development: Although still in the research phase, recent breakthroughs have rekindled interest in calcium-based batteries. Challenges include developing stable and efficient electrodes and electrolytes

Sodium Ion Batteries

Sodium ion batteries are another alternative to lithium-ion batteries, using sodium ions (Na^+) as the charge carrier. They also have several advantages:

01

Abundance and Cost: Sodium is more abundant and cheaper than lithium, making it a cost-effective option

02

Long-Duration Storage: Sodium ion batteries are being explored for long-duration energy storage applications.

03

Research and Development: The U.S. Department of Energy (DOE) is actively working on developing sodium batteries for long-duration storage. The goal is to achieve significant cost reductions and improve energy storage capabilities.

FUTURE EXTENSIONS

We are committed to creating and offering products that are environmentally friendly and promote sustainability. Our business model is designed to adapt and evolve with emerging technologies, staying aligned with the latest research and innovations. However, some of the future extension projects include:

1. **SOLID-STATE BATTERIES**
2. **MAGNESIUM ION BATTERIES**
3. **GRAPHENE BATTERIES (FAST CHARGING)**
4. **NUCLEAR BATTERIES**
5. **ZINC AIR BATTERIES**
6. **HYDROGEN FUEL CELLS FOR MASS PRODUCTION**

Potential Target Markets:

- Electric Vehicles (EVs)
- Grid Storage
- Industrial Energy Storage
- Renewable Energy Integration
- Automotive Applications Beyond EVs
- Consumer Electronics
- Aerospace and Defense

And many more.....

Competitive Analysis

Our first product launch will be calcium-ion batteries. There are a few reasons why we chose to start our work with it.

COMPARISON OF PRODUCTS

Here's a comparison of calcium and sodium ion batteries with lithium-ion batteries in terms of cost, sustainability, and performance:

- **Cost**

Calcium Ion Batteries: Calcium is more abundant and cheaper than lithium, which could lead to lower manufacturing costs1.
Sodium Ion Batteries: Sodium is also more abundant and cheaper than lithium, making sodium ion batteries a cost-effective alternative2. CATL said sodium ion batteries will cost 30% less than li ion batteries.
Lithium-Ion Batteries: Lithium is relatively scarce and expensive, contributing to higher costs for lithium-ion batteries.

- **Sustainability**

Calcium Ion Batteries: Calcium is more abundant and environmentally friendly, offering a more sustainable option.
Sodium Ion Batteries: Sodium is highly abundant and poses fewer environmental risks compared to lithium.
Lithium-Ion Batteries: Lithium mining and extraction have significant environmental impacts, including water usage and ecological disruption.

- **Performance**

Calcium Ion Batteries: Calcium ion batteries are still in the research phase, and their performance metrics are not yet fully established.
Sodium Ion Batteries: Sodium ion batteries have shown promise with decent energy density and cycle life, but they still lag behind lithium-ion in terms of energy density and longevity.
Lithium-Ion Batteries: Lithium-ion batteries are currently the industry standard, offering high energy density, long cycle life, and excellent performance.

WHY CALCIUM BATTERIES WILL WIN

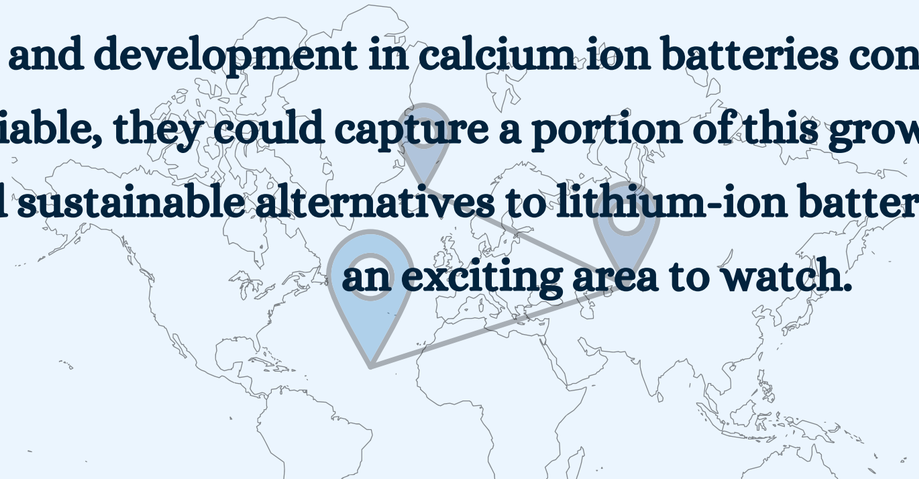
Element	Abundance	Redox Potential	Charge	Safety	Practicality	Stability
Calcium	High	Similar to Li	2+	High	High	High
Lithium	Low	High	1+	Low	Moderate	Low
Sodium	Moderate	Lower than Li	1+	Moderate	Moderate	Moderate
Magnesium	Moderate	Moderate	2+	High	Low	Low
Aluminum	Moderate	High	3+	Moderate	Low	Low
Potassium	Low	Low	1+	Moderate	Moderate	Low
Zinc	Very Low	Very Low	2+	High	Very Low	Low

This table highlights the superior attributes of calcium batteries compared to other types, particularly in terms of mineral abundance, charge capabilities, and safety.

Market Size

The market for calcium ion batteries is still in its early stages, and specific projections for its future size are not yet available. However, the overall battery market is expected to grow significantly due to the increasing demand for sustainable energy storage solutions1. The global battery market was estimated at USD 118.20 billion in 2023 and is projected to grow at a CAGR of 16.1% from 2024 to 2030.

As research and development in calcium ion batteries continue, and if they become commercially viable, they could capture a portion of this growing market. The potential for cost-effective and sustainable alternatives to lithium-ion batteries makes calcium ion batteries an exciting area to watch.



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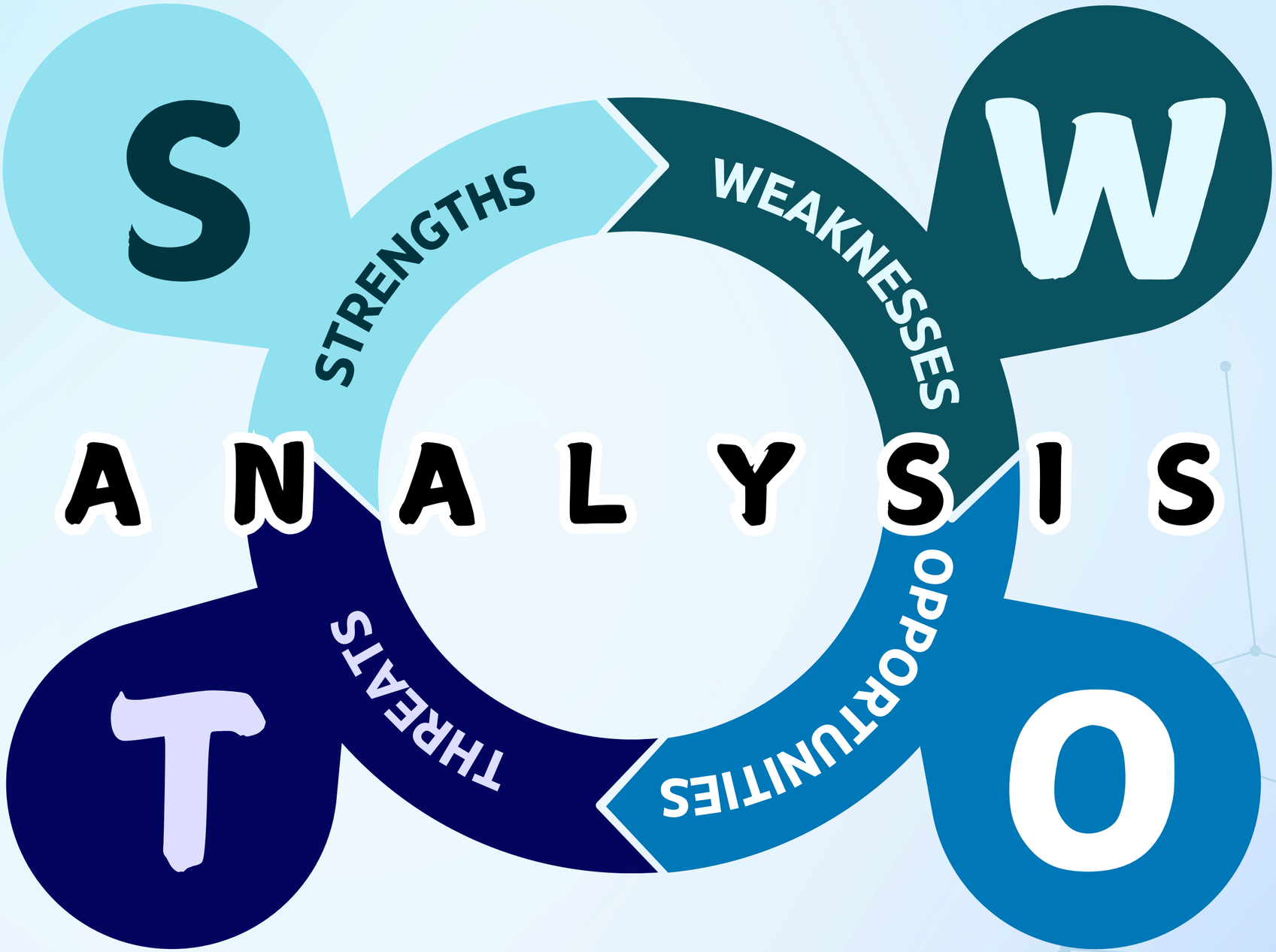
Main Leaders in the Lithium-Ion Battery Market

1. **Contemporary Amperex Technology Co. Limited (CATL)**: Leading the market with a significant share.
2. **BYD Company Limited**: A major player from China.
3. **LG Energy Solution**: South Korean company with a strong presence.
4. **Samsung SDI**: Another South Korean giant in the battery market.
5. **Panasonic Corporation**: The Japanese company is known for its partnership with Tesla.
6. **Tesla Inc.**: Not just a car manufacturer, but also a key player in battery production.
7. **SK Innovation**: South Korean company expanding its battery production capabilities.

Main Leaders in the Calcium Ion Battery Market

The calcium ion battery market is still emerging, and specific leaders are not as well-defined as in the lithium-ion market. However, research institutions and universities are leading the development efforts in this area. Companies like **Tesla Inc.** and **Panasonic Corporation** are also exploring alternative battery technologies, including calcium ion batteries.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Strengths

- **Sustainability:** Pioneering eco-friendly battery solutions, reducing reliance on lithium, and addressing environmental concerns.
- **Innovation:** Developing cutting-edge technologies in calcium and sodium ion batteries.
- **Cost-Effectiveness:** Utilizing more abundant and cheaper raw materials, potentially lowering production costs.
- **Market Differentiation:** Standing out in the market with a unique value proposition focused on sustainability and innovation.

W

Weaknesses

- **Development Stage:** Calcium and sodium ion batteries are still in the research phase. Further development is needed to match the performance of lithium-ion batteries. However, continuous R&D will make it possible.
- **Limited Awareness:** Potential lack of market awareness and consumer trust in non-lithium-based solutions.
- **Initial Costs:** High initial R&D and production setup costs.

O

Opportunities

- **Growing Demand:** Increasing demand for sustainable energy storage solutions globally.
- **Government Incentives:** Potential for government policies, subsidies, and incentives for green technologies.
- **Partnerships:** Opportunities for collaborations with renewable energy companies and organizations focused on sustainability.
- **Market Expansion:** Expansion into emerging markets with a high need for cost-effective and sustainable energy storage.

T

Threats

- **Competition:** Intense competition from established lithium-ion battery manufacturers.
- **Technological Challenges:** Unforeseen technological hurdles in scaling and commercializing new battery technologies.
- **Regulatory Hurdles**: Potential regulatory challenges and the need for industry standards compliance.
- **Economic Fluctuations:** Economic instability affecting investment and development in new technologies.

Business Plan and Roadmap

This roadmap outlines the stages and key milestones for developing, testing, launching, and supporting calcium-ion battery technology. It includes product development, testing, and post-launch phases to ensure successful commercialization.

Phase 1: Research and Development (12-18 months)

Material Research and Feasibility Study (Months 1-6)
Objective: Conduct in-depth research on calcium-ion battery chemistry, materials, and components.
Key Milestones:

- Identify suitable materials for electrodes, electrolytes, and separators.
- Complete feasibility analysis and proof of concept for lab-scale calcium-ion batteries.
- Develop initial prototypes for lab testing.

Deliverable: Feasibility report and prototype design specifications.

Prototype Development and Testing (Months 7-12)
Objective: Develop prototypes and test their performance on key parameters like energy density, charge/discharge cycles, and safety.
Key Milestones:

- Produce first-generation prototype cells for testing.
- Test battery efficiency, longevity, and safety under various conditions.
- Identify any technical bottlenecks and refine materials and processes.

Deliverable: Optimized prototype ready for pre-pilot production.

Business Plan and Roadmap

Partnerships and IP Development (Months 7-18)

Objective: Establish partnerships with academic institutions, suppliers, and technology providers, and secure intellectual property (IP).
Key Milestones:

- File patents for novel materials or processes.
- Finalize agreements with material suppliers and research partners.

Deliverable: Patents filed and partnerships formalized.

Phase 2: Pilot Production and Testing (12-18 months)

Pilot Production Setup (Months 13-18)

Objective: Scale up from lab to pilot production to validate manufacturing processes and product performance.
Key Milestones:

- Set up pilot production line with appropriate machinery and process flows.
- Train technical staff on the production process.
- Produce pilot-scale batches for further testing.

Deliverable: Operational pilot production facility.

Business Plan and Roadmap

Pilot Testing and Iteration (Months 18-24)

Objective: Test pilot batches in real-world applications and iterate based on performance data.
Key Milestones:

- Distribute batteries for field testing with strategic partners and early adopters.
- Collect data on performance, safety, and customer feedback.
- Refine manufacturing processes and materials based on test results.

Deliverable: Pilot product refined and ready for commercial-scale production.

Phase 3: Commercialization and Market Launch (12-18 months)

Commercial Production Setup (Months 25-30)

Objective: Establish a full-scale production facility to meet initial demand.
Key Milestones:

- Design and build commercial production line.
- Implement quality control systems to ensure consistent product performance.
- Finalize supply chain for raw materials and components.

Deliverable: Full-scale production facility operational.

Business Plan and Roadmap

Regulatory Approvals and Certifications (Months 26-30)

Objective: Obtain necessary certifications and regulatory approvals to bring the product to market.
Key Milestones:

- Complete regulatory testing and secure compliance certificates (e.g., safety, environmental, and manufacturing standards).
- Obtain certifications for key markets (e.g., CE mark, UL certification).

Deliverable: Regulatory approvals and product certifications secured.

Product Launch and Marketing (Months 31-36)

Objective: Launch the product to the market and build brand awareness.
Key Milestones:

- Develop marketing and branding strategy, focusing on product advantages (safety, sustainability, performance).
- Organize product launch event and secure media coverage.
- Begin sales and distribution to early adopters and strategic partners.

Deliverable: Product launched to the market with initial sales and distribution network in place.

Business Plan and Roadmap

Phase 4: Post-Launch Support and Scaling (Ongoing)

Post-Launch Customer Support (Months 37-42)

Objective: Ensure customer satisfaction and support for product adoption.
Key Milestones:

- Set up customer support infrastructure (help desk, technical support, online resources).
- Collect customer feedback and resolve issues or complaints.
- Offer training and resources to distributors and end-users.

Deliverable: Operational customer support and feedback mechanisms.

Product Improvements and New Versions (Months 43-54)

Objective: Continuously improve the product based on feedback and emerging technology trends.
Key Milestones:

- Release product updates and introduce second-generation calcium-ion batteries with enhanced features.
- Expand into additional markets and applications (e.g., electric vehicles, grid storage).

Deliverable: Improved products and expanded market penetration.

Business Plan and Roadmap

Scaling and Global Expansion (Ongoing)

Objective: Expand production capacity and enter new geographic markets.
Key Milestones:

- Set up additional production facilities or license technology for third-party manufacturers.
- Expand the distribution network to new countries and regions.
- Adapt products to local market needs (e.g., energy storage for developing countries).

Deliverable: Global presence and scalable production to meet market demand.

High-Level Timeline Overview

Months 1-12: Research and Development (Material research, prototype development).

Months 13-24: Pilot Production and Testing.

Months 25-36: Commercial Production, Regulatory Approvals, and Market Launch.

Months 37+: Post-launch support, continuous product improvements, and scaling.

FINANCIAL ASPECTS

Both short-term capital for development and long-term investment is necessary for growth and expansion. We will get funds from various sources including:

1. **Venture Capitals**
2. **Angel Investors**
3. **Battle of Minds Prize Money**
4. **Crowdfunding**
5. **Corporate Partnership**
6. **Strategic Partnerships**
7. **Research Grants**

Risk Analysis & Mitigation

The risk, threats and weakness mitigation is the first priority for us right now. This will ensure a proper headstart for the business.
We have divided the risks into 3 sections: technical, market, and financial. In the mitigation section, the measurement to be taken is noted.

Technical Risks

01

Material Sourcing and Processing: High-purity calcium metal and appropriate electrolyte materials may not be readily available or could be expensive to process.

02

Scalability of Production: Scaling from lab-scale production to commercial-scale manufacturing may introduce unforeseen technical challenges, such as poor battery performance or low energy density.

03

Production Process Complexity: Calcium-ion batteries are less mature than lithium-ion technologies, and there may be technical hurdles in mass-producing them at competitive yields. The large size of calcium ions makes it hard to insert calcium ions inside a battery electrode.

Mitigation

01

Establish long-term supply contracts with reliable suppliers, invest in R&D to improve material extraction and processing efficiency.

02

Conduct phased pilot-scale production runs, collaborate with academic and industrial research institutions to refine the technology, and implement modular production systems that can be scaled incrementally.

03

Focus on continuous process optimization, invest in automation, and explore partnerships with experienced battery manufacturers for knowledge transfer. The size problem can be overcome by using molybdenum vanadium oxides. This can move calcium ions rapidly into the electrode.

Market Risks

01

Competition from Established Technologies: Lithium-ion batteries dominate the market, and new entrants like calcium-ion batteries face stiff competition, especially if performance improvements are incremental rather than revolutionary.

02

Customer Acceptance: Customers may be hesitant to adopt a less-proven battery technology due to concerns about reliability and long-term performance.

03

Global Supply Chain Issues: Disruptions in global supply chains could affect the availability of critical components or raw materials.

Mitigation

01

Position the product in niche markets where calcium-ion technology offers specific advantages, such as safety, cost, or resource availability, and invest in marketing to differentiate it from established alternatives.

02

Offer extended warranties, emphasize the environmental benefits (such as reduced reliance on rare or conflict minerals), and build partnerships with early adopters for field testing.

03

Diversify the supplier base, create local supply chains where possible, and maintain buffer stocks of critical materials.

Financial Risks

01

High Initial Capital Expenditure: The high capital costs associated with building battery production facilities and developing new technology could lead to financial strain.

02

Long Payback Period: As calcium-ion battery technology is still in development, there could be a long payback period before the company becomes profitable.

03

Fluctuating Raw Material Prices: The cost of calcium or other raw materials used in battery production may fluctuate, impacting profitability.

Mitigation

01

Secure a mix of equity investment, government grants, and strategic partnerships to share financial burdens. Also, explore joint ventures with companies that have complementary technologies or market access.

02

Focus on developing a robust financial model that includes multiple revenue streams (e.g., licensing technology, providing consulting services) and begin with small-scale, high-margin products to generate cash flow in the short term.

03

Hedge against raw material price volatility using financial instruments, and invest in R&D to explore alternative materials or more efficient uses of calcium.

TEAM NEUTRINO

Summary

The rise of electric vehicles is undoubtedly rapid, and the demand for energy storage is increasing with it. Countries are also shifting towards sustainable policies for this technology. However, current energy storage technologies, like lithium-ion batteries, face sustainability challenges. They are difficult to extract, recycle, and pose safety, scarcity, and environmental risks. With the growing need for storage solutions, the market must be **diversified**, and alternatives should be developed and marketed. That's why we, Team Neutrino, are launching "**Project Henka**". Our aim is to replace harmful storage technologies by introducing new, sustainable options, starting with **calcium-ion batteries**. We aim to expand our business by integrating emerging technologies into our current model. Through ongoing research and development, coupled with strategic marketing, we will promote our brand and position it as the industry standard.

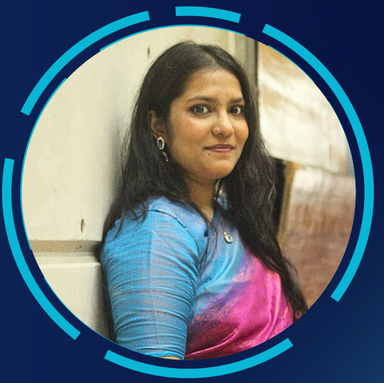
TEAM NEUTRINO

Our Team

Team Neutrino is a group of Engineers driven by a mission to transform the energy storage industry. We are focused on developing and marketing innovative storage technologies that offers a sustainable alternative to lithium-ion solutions. With a passion for solving energy challenges, we aim to lead the way in creating a cleaner, more efficient future for energy storage.

Larry Andrew Penheiro
Industrial and Production Engineering
Military Institute of Science and Technology

Chaity Fariha
Industrial and Production Engineering
Military Institute of Science and Technology



Sumiaya Akter Barsha
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Military Institute of Science and Technology

TEAM NEUTRINO

THANK YOU!

Get in Touch With Us

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