NT RECYCLING

UNFC Classification Report

For NT Battery Manufacturing Scraps Recycling Project

Contents

1. Introduction

This report outlines the classification of the Lithium Battery Manufacturing Scraps Recycling Project in Hungary according to the United Nations Framework Classification for Resources (UNFC). The UNFC is a universally applicable system for classifying and managing resources, providing a standardized approach to assess the social, economic, and technical feasibility of projects. By applying this classification, the project can be evaluated in a structured manner, ensuring that all relevant aspects are thoroughly considered.

The UNFC framework allows for a comprehensive assessment of resource projects, covering a broad range of factors, including economic viability, environmental impact, social responsibility, and technical feasibility. The framework is designed to be adaptable to various types of resources and projects, making it particularly useful for complex initiatives such as the recycling of lithium battery manufacturing scraps.

In this report, we will apply the UNFC framework to classify the Lithium Battery Manufacturing Scraps Recycling Project in Hungary. The classification process will involve an in-depth analysis of the project's economic, social, and technical aspects, supported by appropriate evidence and data. This analysis will help to determine the project's status within the UNFC system, providing a clear understanding of its readiness for development and its potential contributions to sustainable resource management.

The subsequent sections of this report will detail the criteria used for classification, the evidence supporting the classification, and the final assessment of the project according to the UNFC categories. This structured approach ensures that the project is aligned with international best practices and meets the necessary standards for sustainability and feasibility.

2. Project Overview

2.1 Project Background

The Lithium Battery Manufacturing Scraps Recycling Project in Hungary represents a significant step forward in the sustainable management of battery waste. As the demand for lithium-ion batteries continues to grow, driven by the rapid expansion of electric vehicles, consumer electronics, and renewable energy storage, so too does the challenge of managing the byproducts and waste generated during their production.

This project is specifically focused on the recycling of manufacturing scraps from lithium battery production. These scraps, which include materials such as aluminum, copper, black mass, and various polymers, are typically discarded during the battery manufacturing process. However, these materials contain valuable metals and other components that can be recovered and reused, reducing the demand for virgin resources and minimizing environmental impact.

Hungary has been chosen as the location for this project due to its strategic position within the European Union, its growing focus on green technologies, and its commitment to meeting the EU's stringent environmental standards. The project is aligned with Hungary's national objectives of promoting a circular economy, reducing waste, and enhancing resource efficiency. Additionally, the project supports the European Union's broader goals of achieving sustainability in the battery supply chain and reducing dependency on raw material imports.

The project's scope includes the establishment of a state-of-the-art recycling facility equipped with advanced technologies to efficiently process lithium battery manufacturing scraps. The facility will employ a combination of mechanical and chemical processes to recover valuable metals and materials, which will then be reintroduced into the production cycle. This closed-loop approach not only conserves resources but also reduces the environmental footprint associated with battery production.

Overall, the Lithium Battery Manufacturing Scraps Recycling Project in Hungary is poised to play a crucial role in the sustainable management of battery waste, contributing to the circular economy and supporting the global transition to cleaner energy solutions. Through this project, NT aims to set a new standard in resource recovery and demonstrate the economic viability of large-scale battery recycling initiatives.

2.2 Objectives

The Lithium Battery Manufacturing Scraps Recycling Project in Hungary has been developed with the following key objectives in mind:

1. **Resource Recovery and Waste Reduction**: The primary objective of the project is to recover valuable materials from lithium battery manufacturing scraps that would otherwise be discarded as waste. By extracting metals such as lithium, cobalt, copper, and aluminum, the project aims to significantly reduce the demand for virgin resources, thus contributing to the conservation of natural resources and minimizing environmental degradation.
2. **Support for a Circular Economy**: This project is designed to align with the principles of a circular economy by ensuring that materials extracted from battery manufacturing waste are reintegrated into the production cycle. By doing so, the project will help reduce the environmental impact of battery production and promote sustainability within the supply chain.
3. **Enhancement of Hungary's Green Technology Sector**: The project seeks to position Hungary as a leader in green technology and sustainable resource management within the European Union. By establishing a cutting-edge recycling facility, the project will contribute to the development of a robust recycling infrastructure in the region, fostering innovation and creating new economic opportunities.

4. **Compliance with EU Environmental Standards**: A critical objective of the project is to ensure full compliance with the European Union's stringent environmental regulations, including the newly introduced EU Battery Regulation 2023/1542. The project aims to set a benchmark in environmental responsibility by adhering to best practices in waste management, emissions control, and resource efficiency.
5. **Economic Viability and Profitability**: While the project is driven by environmental and social goals, it is also designed to be economically viable. The recovery and sale of valuable materials extracted from the scraps will generate revenue, ensuring that the project is financially sustainable in the long term. Additionally, the project aims to create job opportunities and contribute to the local economy.
6. **Promotion of Innovation and Technological Advancement**: The project intends to leverage the latest advancements in recycling technology, particularly in the field of lithium battery recycling. By investing in research and development, the project will continually improve its processes, increase efficiency, and reduce costs, thereby setting a new standard in the industry.
7. **Reduction of Carbon Footprint**: By recycling battery manufacturing scraps instead of relying on the extraction and processing of new raw materials, the project aims to significantly reduce the carbon footprint associated with battery production. This aligns with global efforts to combat climate change and reduce greenhouse gas emissions.
8. **Education and Awareness**: The project also seeks to raise awareness about the importance of recycling and sustainable resource management. Through partnerships with local communities, educational institutions, and industry stakeholders, the project will promote best practices and encourage broader adoption of recycling initiatives.

By achieving these objectives, the Lithium Battery Manufacturing Scraps Recycling Project in Hungary aims to contribute meaningfully to environmental sustainability, economic development, and technological innovation, while setting an example for similar initiatives globally.

3. Economic and Social Viability (E-Axis)

3.1 Market Analysis

The market analysis for the NT Lithium Battery Manufacturing Scraps Recycling Project reveals a strong economic and social viability, driven by the growing demand for sustainable battery materials and the increasing emphasis on environmental responsibility within the European Union.

Global Market Trends

The global market for lithium batteries has experienced exponential growth in recent years, primarily driven by the rapid adoption of electric vehicles (EVs) and the expansion of renewable energy storage systems. This surge in demand has led to a corresponding increase in the need for raw materials such as lithium, cobalt, nickel, and copper—critical components in battery production. However, the finite availability of these materials, coupled with the environmental impact of traditional mining practices, has created a significant market opportunity for recycling.

The European Union, through its Green Deal and the 2023/1542 EU Battery Regulation, has positioned itself at the forefront of the global shift towards a circular economy. These regulations emphasize the importance of recycling and material recovery to reduce the environmental footprint of battery production and promote resource efficiency. As a result, the market for recycled battery materials is expected to grow substantially, offering a lucrative opportunity for the NT recycling facility.

European Battery Market Dynamics

Europe's battery market is characterized by a strong push towards sustainability and self-sufficiency. The region is home to several leading battery manufacturers and is a key market for electric vehicles. The European Battery Alliance, a strategic initiative by the European Commission, aims to make Europe a global leader in sustainable battery production. This initiative, coupled with significant investments in battery production facilities across the continent, has created a favorable environment for battery recycling.

Hungary, in particular, has emerged as a strategic location within the European battery value chain. The country has attracted substantial investments in battery production, positioning itself as a key player in the European market. The NT recycling facility's location in Hungary provides strategic advantages, including proximity to major battery manufacturing hubs, access to key markets, and alignment with EU sustainability goals.

Demand for Recycled Materials

The demand for recycled materials, particularly lithium, cobalt, and nickel, is expected to grow in tandem with the expansion of the EV market and energy storage systems. Recycled materials offer several advantages, including lower environmental impact, reduced dependence on mining, and potential cost savings. As battery manufacturers seek to meet regulatory requirements and consumer demand for sustainable products, the market for recycled materials will continue to expand.

The NT recycling facility is well-positioned to capitalize on this demand. With a processing capacity of 1,876 tonnes of lithium battery manufacturing scraps per year, the facility will produce significant quantities

of valuable materials, including black mass (containing lithium, cobalt, and nickel), copper, and aluminum granules. These materials are in high demand and will contribute to the facility's profitability and long-term viability.

Competitive Landscape

The battery recycling market in Europe is competitive, with several established players and new entrants seeking to capture market share. However, the NT recycling facility's focus on advanced recycling technology, environmental sustainability, and strategic location provides a competitive edge. The facility's ability to meet or exceed recovery targets for critical materials will enhance its market position and attract additional business opportunities.

In conclusion, the market analysis confirms the economic and social viability of the NT Lithium Battery Manufacturing Scraps Recycling Project. The facility's strategic location in Hungary, alignment with European sustainability goals, and focus on high-demand recycled materials position it for success in the rapidly evolving battery market. The project is poised to contribute significantly to the circular economy, reduce environmental impact, and support Europe's leadership in sustainable battery production.

3.2 Legal and Regulatory Compliance

Legal and regulatory compliance is a critical component of the NT Lithium Battery Manufacturing Scraps Recycling Project, ensuring that the facility operates within the frameworks established by both Hungarian and European Union laws. The project’s alignment with stringent environmental, safety, and operational regulations not only facilitates smooth approval processes but also enhances the project's credibility and long-term sustainability.

European Union Regulatory Framework

The European Union has established a comprehensive regulatory framework to govern the production, use, and disposal of batteries, with a strong emphasis on environmental protection and sustainability. The 2023/1542 EU Battery Regulation is central to this framework, introducing new requirements for the entire lifecycle of batteries, including manufacturing, use, recycling, and disposal. This regulation mandates that all battery-related activities in the EU adhere to strict environmental standards, promote material recovery, and minimize waste.

The NT recycling facility is designed to comply fully with the 2023/1542 EU Battery Regulation. The regulation requires facilities to implement advanced recycling technologies that maximize the recovery of critical materials such as lithium, cobalt, and nickel. Additionally, the regulation imposes stringent controls on waste management, emissions, and the overall environmental impact of battery recycling operations. NT

has incorporated these requirements into the design and operation of the recycling facility, ensuring full compliance with EU standards.

Hungarian Environmental and Safety Regulations

Hungary, as a member state of the European Union, enforces the EU's regulatory framework alongside its national environmental and safety laws. The Hungarian Government Decree Nr. 314/2005 (XII. 25.) on environmental assessment and the integrated environmental permitting procedure is particularly relevant to the NT project. This decree outlines the requirements for environmental impact assessments (EIA) and the integrated permitting process for industrial projects.

NT has conducted a thorough EIA as part of the project's feasibility study, assessing the potential environmental impacts of the recycling facility, including emissions, waste generation, and resource use. The EIA identified key areas of concern and proposed mitigation strategies to ensure that the facility operates within the regulatory limits. The results of the EIA have been submitted to the relevant Hungarian authorities as part of the integrated environmental permitting process.

In addition to environmental regulations, NT is committed to adhering to Hungary's labor, safety, and waste management laws. This includes compliance with regulations on hazardous waste handling, worker safety, and emissions control. The facility will implement robust safety protocols and environmental management systems to meet these regulatory requirements and protect both employees and the surrounding community.

Permit and Licensing Requirements

The successful operation of the NT recycling facility requires obtaining several permits and licenses, including environmental permits, construction permits, and operational licenses. NT has initiated the permit application process, which involves submitting detailed documentation on the facility's design, environmental impact, and safety measures to the relevant Hungarian authorities.

The facility's design includes integrated pollution prevention and control (IPPC) measures, ensuring that all emissions, waste, and environmental impacts are minimized and managed in compliance with EU and Hungarian regulations. NT is also committed to continuous monitoring and reporting, ensuring that the facility remains compliant with all legal and regulatory obligations throughout its operational life.

Risk Management and Compliance Monitoring

Legal and regulatory compliance is not a one-time activity but requires ongoing monitoring and management. NT has developed a comprehensive risk management strategy that includes regular audits, compliance checks, and updates to operational practices in response to any changes in the legal landscape.

This proactive approach to compliance ensures that the facility can adapt to new regulations and maintain its commitment to environmental and social responsibility.

In summary, the NT Lithium Battery Manufacturing Scraps Recycling Project is fully aligned with both European Union and Hungarian legal and regulatory frameworks. The project's design and operational plans have been developed to meet or exceed all relevant standards, ensuring legal compliance, environmental protection, and long-term sustainability. This commitment to regulatory compliance is a cornerstone of the project's strategy, enhancing its credibility and reducing the risks associated with legal and environmental challenges.

3.3 Environmental and Social Impact

The NT Lithium Battery Manufacturing Scraps Recycling Project is designed to align with environmental sustainability and social responsibility goals. This section evaluates the potential environmental and social impacts of the project, focusing on its contribution to reducing environmental harm and enhancing community welfare.

Environmental Impact

Reduction in Raw Material Extraction The recycling facility plays a critical role in reducing the need for raw material extraction by recovering valuable materials such as lithium, cobalt, nickel, and copper from manufacturing scraps. This not only conserves natural resources but also minimizes the environmental degradation associated with mining activities, such as habitat destruction, water pollution, and carbon emissions.

Emission Control and Air Quality A significant concern in any industrial operation is its impact on air quality. The NT facility is equipped with advanced dust control and filtration systems, including HEPA filters, which are designed to capture fine particulate matter and prevent harmful emissions. These measures ensure that the facility operates within stringent EU and Hungarian emission standards, thus protecting local air quality and reducing the risk of respiratory problems in nearby communities.

Waste Management and Resource Efficiency The project is committed to minimizing waste generation and enhancing resource efficiency. During the recycling process, the facility will generate some waste materials, including non-recyclable residues and dust. However, NT has implemented comprehensive waste management strategies to handle these materials responsibly. Recyclable waste will be processed further, while non-recyclable waste will be treated and disposed of in accordance with environmental regulations. This approach aligns with the principles of a circular economy, where waste is minimized and resources are used efficiently.

Water and Soil Protection Although the NT facility does not require significant water use in its operations, it is still committed to protecting local water and soil resources. The facility's design includes measures to prevent contamination of soil and water bodies, such as secure storage for hazardous materials and effective drainage systems to manage any accidental spills. Regular monitoring will ensure that any potential risks to water and soil quality are identified and mitigated promptly.

Energy Use and Carbon Footprint The facility's operations are energy-intensive, but NT is committed to optimizing energy use and reducing its carbon footprint. The project's energy efficiency measures include the use of energy-efficient machinery and renewable energy sources where possible. NT is also exploring opportunities to further reduce its carbon emissions through participation in carbon offset programs and by continuously improving the energy efficiency of its operations.

Social Impact

Job Creation and Economic Development The NT recycling facility is expected to have a positive social impact by creating jobs and contributing to local economic development. The project will generate employment opportunities in various fields, including engineering, operations, administration, and environmental management. This will not only provide livelihoods for local residents but also contribute to the development of skills and expertise in the growing field of battery recycling.

Community Engagement and Support NT recognizes the importance of building strong relationships with the local community. The facility has been strategically located away from residential areas and environmentally sensitive zones to minimize its impact on the local population. NT is committed to maintaining open communication with the community, addressing any concerns, and involving local stakeholders in decision-making processes. Regular public consultations and information sessions will be held to ensure that the community is informed and engaged throughout the project's lifecycle.

Health and Safety The health and safety of employees and the local community are paramount. NT has implemented rigorous safety protocols to prevent accidents and protect workers from occupational hazards. These protocols include regular safety training, the use of personal protective equipment (PPE), and strict adherence to safety regulations. Additionally, the facility's environmental controls, such as dust suppression and emissions management, help protect the health of nearby residents by ensuring that the facility's operations do not negatively impact local air quality.

Support for Local Initiatives NT is also committed to supporting local initiatives that align with its values of sustainability and social responsibility. This includes participating in or sponsoring community projects related to environmental protection, education, and health. By actively contributing to the community, NT aims to foster goodwill and demonstrate its commitment to being a responsible corporate citizen.

Conclusion

The NT Lithium Battery Manufacturing Scraps Recycling Project is designed to minimize its environmental footprint while maximizing its positive social impact. Through careful planning, advanced technology, and a commitment to sustainability, the project aims to contribute to the circular economy, support local communities, and protect the environment. By addressing potential environmental and social impacts proactively, NT is setting a standard for responsible industrial development in the battery recycling industry.

3.4 Economic Viability

The economic viability of the NT Lithium Battery Manufacturing Scraps Recycling Project in Hungary has been comprehensively analyzed, demonstrating the project's potential for substantial profitability and long-term sustainability. This section details the key financial metrics, revenue streams, cost structures, and sensitivity analyses that underpin the project's economic outlook.

Revenue vs. Cost of Goods Sold (COGS)

The project is projected to generate consistent monthly revenue of €400,452 starting from December 2024, primarily driven by the sales of recycled materials such as black mass, copper, and aluminum granules. The stable Cost of Goods Sold (COGS), estimated at €126,200 per month, reflects efficient production processes and a well-managed supply chain. The balance between revenue and COGS is crucial for maintaining profitability, ensuring that the project can generate a healthy gross profit margin.

Gross Profit vs. Operating Expenses

The project is expected to achieve a gross profit of €274,252 per month, indicating strong operational efficiency. Operating expenses, including administrative costs, salaries, and utilities, are estimated at €51,291 per month. This results in a robust EBITDA (Earnings Before Interest, Taxes, Depreciation, and Amortization) of €222,961 per month, highlighting the project's ability to generate substantial earnings from core operations before accounting for non-operational expenses.

Cash Flow Analysis

During the initial phase, the project will incur significant capital expenditures. However, it is expected to start generating positive net cash flow from December 2024, with monthly inflows of approximately €140,877. The healthy cash flow will allow the project to cover ongoing operational costs and accumulate a strong cash reserve, projected to reach €616,462 by May 2025. This financial cushion will provide stability and support future growth initiatives.

Profitability

The profitability of the project is evident through its strong EBITDA of €222,961 per month and net income of €182,961 per month after taxes and other non-operational costs. The project's ability to maintain a high gross profit margin and manage operating expenses efficiently contributes to its overall profitability and financial health.

Sensitivity Analysis

A sensitivity analysis was conducted to assess the impact of key variables on the project's financial performance:

- **Machine Price Impact**: A moderate increase in machine price slightly raises the break-even point, but the project remains profitable.
- **Production Efficiency**: Enhancing production efficiency significantly improves revenue and reduces the break-even point, making it a critical factor for maximizing profitability.
- **Lithium Price Sensitivity**: Fluctuations in lithium prices directly affect revenue. Higher lithium prices substantially boost profitability, while lower prices have a negative impact.
- **Input Cost Management**: Effective management of input costs is essential for maintaining profitability. An increase in input costs can reduce net income and delay the break-even point.

Taxation

The project is expected to incur annual taxes of approximately €174,572, including Corporate Income Tax (CIT) and Local Business Tax (LBT). Effective tax planning will be essential for optimizing net income while ensuring compliance with Hungarian tax regulations.

Break-even Analysis

The project's break-even point is achievable within the first year of full operations, supported by consistent revenue generation and efficient cost management. The well-balanced structure between fixed and variable costs ensures that the project can remain profitable even amid market fluctuations. The strategic planning and financial management in place provide confidence in the project's ability to achieve and surpass its break-even point, leading to sustained profitability and growth.

In conclusion, the NT Lithium Battery Manufacturing Scraps Recycling Project demonstrates strong economic viability, with substantial profitability, positive cash flow, and robust financial management practices. The project's success will contribute significantly to the circular economy, aligning with global sustainability goals while delivering solid financial returns for stakeholders.

4. Project Feasibility (F-Axis)

4.1 Project Lifecycle Stage

The NT Lithium Battery Manufacturing Scraps Recycling Project in Hungary is currently in the advanced planning stage, with key milestones outlined for each phase of the project lifecycle. This section provides an overview of the project's lifecycle stages, from initial planning and feasibility studies through to full operational capacity.

1. Initial Planning and Feasibility Studies (Q1 2024 - Q2 2024):

- **Feasibility Study Completion:** By April 2024, a comprehensive feasibility study will be completed, covering technical, environmental, and economic assessments. This study is critical for validating the project's viability and ensuring alignment with strategic objectives.
- **Site Selection and Initial Designs:** Following the feasibility study, the project will move into the site selection phase in May 2024, with preliminary designs for the recycling facility being developed concurrently. The selected site will be chosen based on its strategic location, accessibility, and potential for minimal environmental impact.

2. Design and Engineering (Q2 2024 - Q3 2024):

- **Final Design and Engineering Plans:** From May to August 2024, detailed engineering plans and designs will be finalized. This includes the selection of specific recycling technologies, layout of the facility, and integration of environmental controls such as HEPA filtration systems to meet regulatory requirements.
- **Permitting and Regulatory Compliance:** The permitting process will commence in August 2024, with all necessary environmental and operational licenses being secured to ensure compliance with Hungarian and EU regulations.

3. Construction and Installation (Q3 2024 - Q4 2024):

- **Site Preparation and Infrastructure Upgrades:** In September 2024, construction activities will begin, focusing on site preparation, infrastructure upgrades, and the installation of essential utilities such as power, water, and waste management systems.
- **Machinery Fabrication and Installation:** By November 2024, the fabrication of specialized recycling machinery will be completed, with transportation and installation at the selected site following immediately. This stage includes trial testing to ensure that all equipment functions correctly and meets performance standards.

4. Commissioning and Start-up (Q4 2024 - Q1 2025):

- **Commissioning and Initial Operations:** The final quarter of 2024 will see the commissioning of the facility, with initial operations starting by December 2024. This phase includes the testing of all systems, calibration of machinery, and training of operational staff.
- **Full Operational Capacity:** The project is expected to reach full operational capacity by Q1 2025, with the facility processing up to 1,876 tonnes of lithium battery manufacturing scraps per year.

5. Operational and Continuous Improvement (Q1 2025 and Beyond):

- **Ongoing Operations and Monitoring:** Once fully operational, the facility will enter a steady state of operation, with continuous monitoring of environmental impact, production efficiency, and compliance with regulatory standards.
- **Continuous Improvement and Expansion:** NT plans to continuously optimize the facility's operations, explore opportunities for capacity expansion, and incorporate new technologies to enhance recycling efficiency and reduce environmental impact further.

The project lifecycle is designed to ensure that each phase is completed on schedule, with careful attention to detail and adherence to best practices in project management and environmental stewardship. This structured approach minimizes risks and maximizes the project's chances of success, positioning NT as a leader in lithium battery recycling in Europe.

4.2 Technical Feasibility

The technical feasibility of the NT Lithium Battery Manufacturing Scraps Recycling Project in Hungary has been thoroughly assessed through a comprehensive feasibility study. This section outlines the key technical aspects that demonstrate the project's viability, focusing on the chosen recycling technology, environmental controls, overall operational strategy, and pre-transportation testing.

1. Recycling Technology

- **Mechanical Recycling Process:** The project will employ a state-of-the-art mechanical recycling process specifically designed to handle the dry scraps from lithium battery manufacturing. This technology is recognized for its high efficiency in material recovery, including valuable components such as lithium, cobalt, nickel, and copper. The selected process ensures that the maximum amount of recyclable material is extracted, minimizing waste and optimizing the facility's output.
- **Technological Advancements:** NT has integrated advanced technological solutions to enhance the recycling process. These include automated sorting and shredding systems that improve the accuracy and speed of material separation. Additionally, the facility will incorporate real-time monitoring systems that allow for precise control of the recycling process, ensuring consistent quality and compliance with regulatory standards.

2. Pre-Transportation Testing

- **Real Test of Machinery:** Before the transportation of the machinery to Hungary, NT will conduct a full-scale real test of the recycling equipment at the manufacturing site. This testing phase is crucial to validate the performance, reliability, and safety of the machinery under real operational conditions. The results of these tests will be compiled in a comprehensive Test Report, which will confirm that the machinery meets all technical specifications and is ready for full-scale operation.

- **Test Report Documentation:** The Test Report will serve as an essential document to ensure that all equipment is fully functional and adheres to the expected standards before it is shipped to Hungary. This proactive approach minimizes the risk of operational delays and ensures a smooth installation process upon arrival at the project site.

3. Environmental Controls

- **Dust Control and Air Filtration:** To address the environmental impact of dust emissions, the facility will be equipped with high-efficiency particulate air (HEPA) filtration systems. These filters are capable of capturing up to 99.97% of airborne particles, including fine dust generated during the recycling process. This ensures that the facility operates well within the stringent environmental regulations set by the European Union and the Hungarian government.
- **Waste Management and Emissions Control:** The project includes comprehensive waste management strategies to handle by-products and non-recyclable materials generated during the recycling process. The facility will utilize advanced emission control technologies to minimize the release of harmful substances into the environment. These controls are in line with Best Available Techniques (BAT) as recommended by the EU's Industrial Emissions Directive.

4. Operational Strategy

- **Capacity and Scalability:** The recycling facility is designed with a processing capacity of 1,876 tonnes of lithium battery manufacturing scraps per year. This capacity meets the current demand while allowing for potential scalability in response to market growth. The modular design of the facility also enables NT to expand operations without significant disruptions or additional capital expenditures.
- **Efficiency and Reliability:** The facility's operational strategy emphasizes efficiency and reliability, with a focus on minimizing downtime and maximizing throughput. Preventive maintenance schedules, coupled with continuous monitoring and predictive analytics, will help maintain optimal operational conditions and extend the lifespan of critical machinery.
- **Staff Training and Safety Protocols:** NT is committed to ensuring that all personnel involved in the recycling process are highly trained and equipped with the necessary skills to operate the machinery safely and efficiently. Comprehensive safety protocols have been established to prevent accidents and protect workers from potential hazards associated with the recycling process.

5. Risk Mitigation

- **Contingency Planning:** To address potential technical risks, NT has developed detailed contingency plans. These plans include backup systems for critical processes, emergency response protocols, and partnerships with local suppliers to ensure a continuous supply of essential materials and services.
- **Technology Partnerships:** NT is collaborating with leading technology providers and research institutions to stay at the forefront of recycling innovation. These partnerships ensure access to the latest advancements in recycling technology and provide a platform for continuous improvement.

In conclusion, the technical feasibility of the NT Lithium Battery Manufacturing Scraps Recycling Project is well-supported by advanced technology, robust environmental controls, comprehensive operational strategy, and thorough pre-transportation testing. These elements work together to ensure that the facility operates efficiently, safely, and in full compliance with all regulatory requirements, positioning the project for long-term success and sustainability.

4.3 Project Implementation and Risk Management

The implementation of the NT Lithium Battery Manufacturing Scraps Recycling Project in Hungary is a critical phase that requires meticulous planning and execution. This section outlines the project's implementation strategy, including the timeline, key milestones, and the comprehensive risk management approach that will ensure the project's success.

1. Project Implementation Strategy

- **Phased Approach:** The project will be implemented in a phased manner, with each phase carefully planned to ensure smooth transitions and minimize risks. The key phases include site selection, machinery fabrication, pre-transportation testing, transportation and installation, and the commencement of operations.
- **Timeline and Key Milestones:**
    - **April 2024:** Completion of the feasibility study, including technical, environmental, and economic assessments.
    - **May 2024:** Commencement of machine fabrication, ensuring that all equipment meets the highest standards of quality and safety.
    - **July 2024:** Selection of the project site, based on rigorous criteria such as environmental impact, proximity to infrastructure, and community considerations.

- **August 2024:** Completion of pre-transportation testing, with results documented in the Test Report to confirm machinery readiness.
- **September 2024:** Transportation of machinery to the selected site in Hungary, followed by installation and setup.
- **December 2024:** Start of operations, marking the official launch of the recycling facility.

- **Resource Allocation:** Resources will be allocated efficiently across the project phases to ensure that each phase is completed on time and within budget. This includes the mobilization of skilled labor, the procurement of materials and services, and the coordination of logistics for machinery transportation and installation.

2. Risk Management Strategy

- **Risk Identification:** NT has identified potential risks associated with the project, including technical, operational, financial, and regulatory risks. These risks have been thoroughly analyzed to understand their potential impact on the project's timeline, cost, and overall success.
- **Technical Risks:**
  - **Machinery Performance:** The risk of machinery underperformance is mitigated through rigorous pre-transportation testing and the use of high-quality components. The Test Report will provide evidence of machinery reliability before it is shipped to Hungary.
  - **Installation Challenges:** Potential challenges during the installation phase, such as site-specific issues or unexpected technical difficulties, are addressed through contingency planning and the involvement of experienced engineers during the setup.
- **Operational Risks:**
  - **Supply Chain Disruptions:** To mitigate the risk of supply chain disruptions, NT has established strong relationships with key suppliers and identified alternative sources for critical components. Regular communication with suppliers ensures timely delivery of materials and services.
  - **Environmental Compliance:** The risk of non-compliance with environmental regulations is managed through the implementation of advanced emission control technologies and continuous monitoring. NT is committed to adhering to Best Available Techniques (BAT) and maintaining compliance with all relevant environmental standards.
- **Financial Risks:**

- **Cost Overruns:** To prevent cost overruns, NT has developed a detailed budget with built-in contingencies. Regular financial monitoring and reporting will ensure that any deviations from the budget are identified and addressed promptly.
- **Revenue Variability:** The project's revenue projections are based on conservative estimates to account for potential market fluctuations. NT has also diversified its revenue streams to reduce dependency on any single market factor, such as the price of lithium.

- **Regulatory Risks:**
  - **Permit Delays:** The risk of delays in obtaining necessary permits is mitigated through proactive engagement with regulatory authorities. NT has established a dedicated team to oversee the permit application process, ensuring that all required documentation is submitted accurately and on time.
  - **Policy Changes:** NT continuously monitors regulatory developments in Hungary and the European Union to anticipate and adapt to any changes in policy that may affect the project. This proactive approach ensures that NT remains compliant with all legal requirements.
- **Risk Mitigation Measures:**
  - **Contingency Planning:** NT has developed comprehensive contingency plans to address potential risks at every stage of the project. These plans include backup systems for critical operations, emergency response protocols, and alternative suppliers and contractors.
  - **Insurance Coverage:** The project is protected by extensive insurance coverage, including coverage for machinery, property, liability, and business interruption. This provides a financial safety net in the event of unforeseen incidents that could impact the project.
  - **Ongoing Risk Assessment:** Risk management is an ongoing process that will continue throughout the project's lifecycle. NT's risk management team will conduct regular risk assessments and update mitigation strategies as needed to address emerging risks.

In conclusion, the successful implementation of the NT Lithium Battery Manufacturing Scraps Recycling Project is supported by a well-structured project plan and a robust risk management framework. By addressing potential risks proactively and ensuring that all aspects of the project are carefully managed, NT is well-positioned to achieve its strategic goals and contribute to the sustainability of the European battery industry.

5. Geological Knowledge (G-Axis)

5.1 Resource Estimation

The NT lithium battery recycling project in Hungary is designed to process 1,876 tonnes of lithium battery manufacturing scraps annually. This estimate is based on detailed resource assessments and benchmarks established in similar recycling operations worldwide. The expected output from this process includes:

- **Aluminum Granules**: 150.08 tonnes/year
- **Copper Granules**: 225.12 tonnes/year
- **Black Mass**: 1,219.4 tonnes/year
- **Shell Materials**: 131.32 tonnes/year
- **Plastic Film**: 150.08 tonnes/year

These estimations are grounded in the typical composition of lithium battery scraps, which contain valuable metals, plastics, and other recoverable materials.

Hungary is witnessing a rapid expansion in its battery manufacturing industry, driven by significant investments from global leaders such as SK, LG, CATL and EVE. CATL's upcoming 100 GWh battery factory in Debrecen, set to begin operations in 2025, is one of several major developments in the country. Despite this growth, Hungary currently lacks adequate recycling facilities to manage the increasing volume of battery manufacturing scraps.

For reference, every megawatt-hour (MWh) of battery production generates approximately 50-100 kg of manufacturing scraps that require recycling. Given the scale of Hungary's battery manufacturing sector, this translates to over 20,000 tonnes of manufacturing scraps annually. Moreover, during the initial years of operation, the volume of scraps is expected to be even higher due to ramp-up phases in production. This underscores the strategic importance of NT's recycling facility, which will play a critical role in processing these scraps and supporting Hungary's efforts toward a sustainable and circular economy.

5.2 Data Quality and Reliability

In the context of battery recycling, data quality and reliability are paramount, but they differ significantly from those in traditional mining operations. For battery recycling, the quality and reliability of data are primarily based on the composition of the battery materials rather than on the geological consistency found in mining.

1. **Variability in Battery Composition**: Unlike natural mineral deposits, which can be relatively consistent in composition within a given area, the materials in lithium batteries can vary widely

depending on the manufacturer, the type of battery, and its usage history. This variability makes it crucial to have precise and accurate data on the composition of the battery scraps being processed.

2. **Material Content Analysis**: Reliable data collection in battery recycling involves detailed analysis of the material content in the batteries, including lithium, cobalt, nickel, and other critical elements. This analysis requires sophisticated testing and monitoring to ensure that the recycling process can effectively recover these valuable materials.
3. **Process Monitoring and Traceability**: The recycling process also demands continuous monitoring and traceability to ensure that the data on material recovery rates and environmental impact are accurate and dependable. This includes tracking the input materials, the efficiency of the recycling process, and the purity of the output materials.
4. **Regulatory Compliance**: Given the stringent environmental and safety regulations in place for battery recycling, the reliability of data is essential for ensuring compliance. Accurate data helps in meeting regulatory requirements and in obtaining necessary certifications for the recycled materials.
5. **Data Integration and Management**: The use of advanced data management systems is critical to integrating and validating data from different stages of the recycling process. This ensures that the data is not only accurate but also usable for optimizing operations and improving recovery rates.

Overall, in battery recycling, data quality and reliability are not just about the initial assessment of materials but involve ongoing analysis and verification throughout the recycling process. This approach ensures that the recycling operations are efficient, compliant, and environmentally responsible.

5.3 Exploration and Resource Development

While the NT lithium battery recycling project is centered on the recycling of manufacturing scraps rather than traditional resource extraction, exploration and resource development remain critical components of the project's ongoing success. Continuous research and development (R&D) efforts are vital to optimizing the recycling process and improving resource recovery rates, which in turn enhances the project's economic viability and environmental impact.

1. **Technological Advancements**: As the battery industry evolves, so too must the recycling technologies used to recover valuable materials from lithium battery waste. Ongoing R&D will focus on developing and integrating new technologies that can increase the efficiency of the recycling process. This may include advancements in mechanical processing, hydrometallurgical techniques, or innovative separation methods that improve the purity and yield of recovered materials such as lithium, cobalt, nickel, and copper.

2. **Process Optimization**: Beyond adopting new technologies, the project will also emphasize optimizing existing processes to ensure maximum material recovery with minimal environmental impact. This includes fine-tuning operational parameters, such as temperature control in thermal processes or chemical concentration in leaching processes, to maximize the extraction of valuable elements from the waste stream.
3. **Resource Recovery Rate Enhancement**: Improving the recovery rates of critical materials is a key objective. By investing in R&D, NT aims to develop methods that can achieve higher recovery rates for lithium and other strategic materials. This not only increases the economic value of the recycling process but also contributes to the sustainability goals of reducing the demand for virgin raw materials.
4. **Exploring Alternative Recycling Methods**: The project will also explore alternative recycling methods that may offer advantages over current practices. For example, exploring cryogenic or electrochemical recycling techniques could potentially reduce energy consumption or increase the recovery of specific materials. Continuous exploration of these methods will ensure that NT remains at the forefront of recycling technology.
5. **Sustainability and Circular Economy Initiatives**: The exploration efforts will not be limited to technical aspects alone. NT will also explore ways to integrate the recycling process more deeply into the circular economy. This might involve developing partnerships with battery manufacturers to create closed-loop systems where recycled materials are fed directly back into new battery production, thereby reducing the overall environmental footprint.
6. **Collaboration with Research Institutions**: To drive innovation, NT will collaborate with universities, research institutions, and industry partners. These collaborations will provide access to cutting-edge research and development capabilities, ensuring that the project remains innovative and competitive in the global market.
7. **Pilot Projects and Scale-Up**: New technologies and processes developed through R&D will be initially tested through pilot projects to assess their feasibility and scalability. Successful pilot projects will then be scaled up for full implementation in the recycling facility, ensuring a smooth transition from research to real-world application.

By focusing on exploration and resource development, NT is committed to not only maintaining but also enhancing its position as a leader in the lithium battery recycling industry. The continuous improvement of recycling processes will contribute to the overall success of the project, ensuring long-term sustainability and profitability while supporting global environmental objectives.

6. UNFC Classification

The United Nations Framework Classification for Resources (UNFC) provides a comprehensive and standardized framework for classifying, managing, and reporting on resources, including energy, mineral, and anthropogenic resources like recycled materials. The classification is designed to integrate social, environmental, and economic aspects, providing a holistic approach to resource management. This section outlines the classification of the NT lithium battery recycling project in Hungary according to the UNFC framework.

Economic and Social Viability (E-Axis)

The E-Axis of the UNFC focuses on the socio-economic viability of the project. The NT lithium battery recycling facility is strategically important due to the increasing demand for battery recycling driven by the European Union's sustainability goals and regulatory frameworks, such as the 2023/1542 EU Battery Regulation. The project is expected to contribute significantly to the circular economy by recovering valuable materials like lithium, cobalt, and nickel. The market analysis shows strong demand for these materials, ensuring the project's long-term economic viability.

Project Feasibility (F-Axis)

The F-Axis addresses the feasibility of the project in terms of technical, operational, and financial factors. NT has conducted a comprehensive feasibility study, which confirms the technical viability of the recycling processes and the project's overall feasibility. The project lifecycle is well-planned, with milestones for machine fabrication, site preparation, and full-scale operations clearly outlined. Risk management strategies have been integrated into the project, ensuring that potential risks are mitigated effectively.

Geological Knowledge (G-Axis)

While the NT project focuses on recycling rather than traditional resource extraction, the G-Axis is still relevant as it relates to the resource base and data reliability. The project is based on a detailed assessment of the availability and quality of lithium battery manufacturing scraps. With Hungary's growing battery manufacturing industry, the project has a reliable and sustainable resource base. Data on resource availability, including the amount of manufacturing scraps generated by battery factories, is robust and has been corroborated by industry standards and research.

UNFC Classification Outcome

Based on the analysis of the E, F, and G axes, the NT lithium battery recycling project can be classified under the UNFC as follows:

- **E-Axis: E1.1** - The project is economically viable, with strong market demand, regulatory support, and social acceptance. It is fully aligned with current EU sustainability goals and regulations, ensuring both immediate and long-term socio-economic benefits.
- **F-Axis: F1.3 -** The project is justified for development. It is at an advanced stage of planning and feasibility, with a clear pathway toward obtaining necessary approvals and permits. The project is not yet approved for development or in production but is well-positioned to move forward upon securing the required authorizations.
- **G-Axis: G1** - The resource base is well understood, with high data reliability and a secure supply of raw materials. The project has a clearly defined resource potential, supported by comprehensive assessments and a strong foundation of geological knowledge.

This classification indicates that the NT recycling project is not only viable but also aligns with global standards for sustainable resource management. It reflects the project's potential to contribute meaningfully to the circular economy and supports Hungary's strategic role in the European battery industry.

7. Conclusion

The NT lithium battery recycling project in Hungary stands as a significant initiative that aligns with global sustainability goals and the European Union's ambitious targets for resource recovery and environmental protection. Through the comprehensive feasibility study, this project has demonstrated its potential to be a major contributor to the circular economy by efficiently recycling lithium battery manufacturing scraps into valuable materials such as lithium, cobalt, nickel, aluminum, and copper.

Strategic Importance and Market Potential

The project is well-positioned to capitalize on the rapidly growing demand for electric vehicles (EVs) and renewable energy storage solutions, both of which heavily rely on lithium-ion batteries. Hungary's strategic location within the European Union, coupled with substantial investments in battery manufacturing, makes it an ideal site for this recycling facility. The market analysis confirms that there is strong demand for recycled materials, which will only increase as the transition to electric mobility and renewable energy accelerates. This demand ensures the long-term economic viability of the project.

Technological and Environmental Feasibility

The project has chosen advanced mechanical recycling technologies, which are proven to be effective in processing lithium battery scraps with minimal environmental impact. These technologies, including dust control measures like HEPA filtration systems, are designed to meet stringent EU environmental standards.

The environmental impact assessment has thoroughly addressed potential concerns, and the project has incorporated best practices in pollution prevention and control.

The real test of the machinery will be conducted before transportation to Hungary, ensuring that all equipment meets the required performance and safety standards. This proactive approach minimizes the risk of operational delays and ensures that the facility will be fully operational as planned.

Economic Viability

The financial projections for the project are robust, with strong revenue streams expected from the sale of recovered materials. The economic analysis indicates a high gross profit margin, with the project achieving a positive cash flow shortly after operations commence. The cost management strategies, including efficient use of resources and strategic location advantages, further enhance the project's profitability.

Regulatory Compliance and Risk Management

NT has carefully aligned the project with the regulatory requirements in Hungary and the European Union. The comprehensive risk management framework addresses potential risks related to raw material price fluctuations, environmental compliance, and operational challenges. By ensuring full regulatory compliance and adopting a proactive approach to risk management, NT is well-prepared to navigate the complexities of the battery recycling industry.

Social and Community Impact

The project is expected to have a positive impact on the local community by creating jobs, fostering skill development, and contributing to environmental sustainability. NT's commitment to social responsibility, including community engagement and adherence to high environmental standards, strengthens the project's acceptance and support within the local population.

Final Thoughts

In conclusion, the NT lithium battery recycling project in Hungary is not only technically and economically feasible but also strategically important for both NT and the broader European battery industry. By aligning with global sustainability goals, adopting best-in-class recycling technologies, and ensuring robust financial management, the project is poised to become a leader in the battery recycling sector. The successful implementation of this project will set a benchmark for future initiatives, contributing to a more sustainable and resource-efficient future.