Project Report: Container Grid

Abuhuraira Azhar, Dominik Childs, Vanessa Günther,
Lucia Nückel, Daniel Wiesenfeld, Vaibhav Raichura,
Kilian Rehnert

Contributing authors: go56mas@mytum.de; dominik.childs@hm.edu;
vguenthe@hm.edu; ge92zoz@mytum.de; daniel.wiesenfeld@hm.edu;
vaibhav.raichura@tum.de; kilian.rehnert@hm.edu;

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1 Introduction

This report is part of the class "SustAInability" in the summer semester of 2024, supervised by Helene v. Schwichow (TUM) and Charlotte Böhm (HM). It explains the challenge and procedure for the duration of the course and the challenge week. The challenge was given by "Container Grid", a Munich, germany-based company specializing in the optimization of material flows.

1.1 Problem Statement

The rapid increase in the adoption of electric vehicles has led to a corresponding surge in the production and subsequent disposal of lithium-ion automotive batteries. While these batteries are instrumental in reducing greenhouse gas emissions and reliance on fossil fuels, their disposal presents significant environmental and economic challenges. Current recycling practices for lithium-ion batteries are inadequate, with a considerable portion ending up in landfills, posing severe risks of soil and water contamination due to the leaching of hazardous materials such as lithium, cobalt, and nickel. Furthermore, the inefficient recovery and reuse of these critical materials exacerbate the depletion of finite natural resources and elevate the carbon footprint associated with the mining and processing of new raw materials. There is an urgent need to develop and implement more efficient, cost-effective, and environmentally friendly recycling technologies to address the growing volume of discarded lithium-ion batteries. This research aims to explore innovative recycling processes that can enhance material recovery rates, reduce environmental impact, and contribute to the sustainable management of resources in the electric vehicle industry.

1.2 Challenge

The "Container Grid" challenge aims to connect the Waste Management Corporation of Munich (AWM) and BMW to create efficient logistics paths for electrical vehicle battery recycling. BMW is activly trying to increase their use of second hand materials for various areas of application, with high standards for quality and ever increasing quantity. In cooperation with AWM, both stakeholders promote the reuse, repair, refurbishing and recycling of materials, not just in private homes but also across industries.

The demand for electric vehicles continues to surge, with projections indicating that by 2030, half of all cars sold will be electric. These vehicles require highly efficient lithium-ion batteries, which currently account for approximately 90% of the battery demand. Compared to producing new batteries, recycling lithium-ion batteries can save up to 51% in electricity, 50% in water, and reduce costs by a third.[1]

2 Project week

2.1 Challenge giver

During the project week, we had the opportunity to engage with Aron Handreke, the CEO and Co-founder of ContainerGrid. After graduating from esteemed European institutions such as Rotterdam and HEC, Aron acquired extensive experience in supply chain management, logistics, and waste disposal across four continents, with noteworthy at Miele and Roland Berger.

ContainerGrid, founded in 2021 following its triumph at the 2019 HEC Paris startup competition, has since revolutionized the industry. ContainerGrid vertically integrates companies within the waste management sector. Utilizing cloud-based software solutions, it specifically supports waste disposal and recycling companies in gaining control over their facility and transport capacities, with the aim of sustainably increasing recycling rates. By optimizing material flows between a company's facilities and coordinating with partner businesses, the reintegration of products and materials into the economic cycle is intended to be enhanced.

In the long term, the B2B startup aims to accelerate the transition to a circular economy by simplifying the procurement of secondary raw materials, thereby contributing to sustainability.

2.2 Support

Throughout the week, we received invaluable feedback and suggestions from our supervisors, Helene v. Schwichow and Charlotte Böhm. Additionally, we benefited from comments on our interim presentation by Prof. Stefan Wurster, Prof. Gudrun Socher, and Maximilian Dauner. We had one half-hour meeting with our challenge giver, Aron Handreke, who shared his vision for the challenge outcome. Unfortunately, he was unable to attend our final pitch.

2.3 Goal

The goal is to enhance the efficiency and sustainability of electric vehicle battery recycling logistics through improved collaboration and coordination among all stackholders involved.

2.4 Social Impact

BMW's commitment to reducing its carbon footprint by 60% is significantly supported by our innovative approach to managing recycled materials. Our idea centers on predicting waste amounts of specific materials, collecting them efficiently, and bundling them for sale to BMW. This streamlines the use of recycled materials in the production of electric vehicle batteries, making sustainability more practical and achievable.

By accurately forecasting waste material quantities and facilitating their collection, we ensure a steady supply of high-quality recycled materials. This process significantly reduces carbon emissions, with each kilogram of recycled cathode material saving up to 6 kilograms of CO2 compared to newly mined materials. Additionally, recycling

requires up to 51% less energy, further lowering the environmental impact and reducing production costs. Given that newly mined materials are up to 45% more expensive, our approach also provides substantial economic benefits.

Our initiative promotes a circular economy by enabling the reuse and recycling of materials, creating a closed-loop system that minimizes waste, conserves natural resources, and reduces the need for virgin material extraction. This not only lowers BMW's environmental footprint but also encourages sustainable consumption patterns within the automotive industry.

Socially, our strategy helps mitigate the ecological disruption and conflicts associated with mining activities, such as habitat destruction and water pollution. By decreasing reliance on newly mined materials, we support sustainable community development and reduce social tensions in mining regions. Additionally, our approach fosters job creation in the recycling and renewable energy sectors, contributing to global economic growth and social well-being.

In essence, our idea not only facilitates BMW's sustainability goals but also acts as an enabler for broader industry change. By making it easier for BMW to use recycled materials in EV battery production, we inspire other companies to adopt similar practices, driving collective action towards a greener future. Our initiative positions BMW as a leader in sustainable innovation, demonstrating how strategic management of recycled materials can lead to significant environmental, economic, and social benefits.

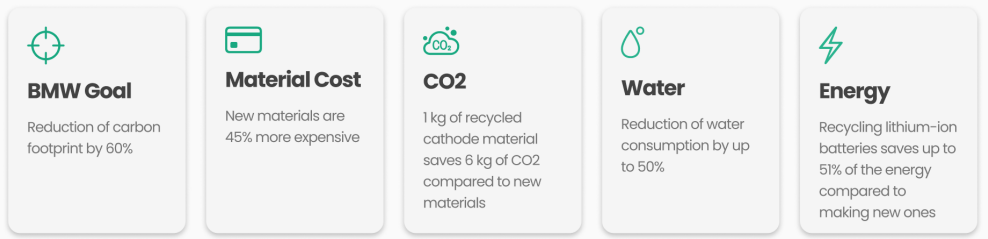

Fig. 1 The most important opportunities regarding the project's outcome.

2.5 Ideation process

We began with researching which ideas would make sense and where we could identify a niche and specific demand for materials for a circular economy. During this phase, several ideas emerged:

1. **AI-Supported Automated Sorting of Trash:** This concept involved enhanced human-machine collaboration while sorting trash, with real-time learning to adapt to specialized kinds of waste, making the system more robust and flexible.
2. **Object Recognition for Consumer Waste:** This idea focused on using object recognition technology to provide recommendations on proper waste disposal. It could potentially collaborate with AWM to suggest specific locations for disposal

and offer compensation if the recycled material is in high demand, aiding in achieving a more sustainable future and providing necessary materials for the circular economy.

3. **Predictive Analysis for Future Waste Management:** This idea aimed to predict future amounts of trash, their price, and quality collected by different waste management sites of AWM. It included strategies for efficient collection and bulk selling to BMW, leveraging BMW's efforts to include more second-hand materials, using a time series model.

We opted for Idea 3 as it was most aligned with the challenge givers' expectations of how our project should look. We then defined our stakeholders: AWM for material collection, recyclers for material recycling, and BMW to whom we would sell our recycled goods and decided on our mission statement.

Our mission is to enhance the efficiency and sustainability of EV battery recycling logistics through improved collaboration and coordination among all stakeholders involved.

We reached out to AWM for necessary data via email and telephone. Sadly, they were unable to provide the needed time series data for our model development.

Nonetheless, we decided to initially focus on Munich as our starting point, with plans to expand to other cities if our business model proves successful and efficient.

3 Business Model

Our software solution business model for BMW incorporates a hybrid payment structure tailored to meet the client's needs. Initially, we will offer the software through a one-time payment plan, providing BMW with full ownership and immediate access to the complete suite of functionalities. This approach allows for a substantial initial investment, laying a robust foundation for deployment.

Furthermore, we propose a subscription plan available on a monthly or yearly basis to ensure continuous improvement, seamless operation, and up-to-date features. This recurring plan includes maintenance, updates, and technical support, guaranteeing that the software remains cutting-edge and reliable. Additionally, the subscription model features a commission-based component for AWM, incentivizing consistent performance and alignment with BMW's evolving requirements. This comprehensive approach ensures a stable revenue stream while fostering a long-term, collaborative relationship with BMW.

3.1 Market Analysis: TAM, SAM and SOM

Total Addressable Market (TAM): The global market for lithium-ion battery recycling is projected to experience significant growth, with an estimated value reaching approximately USD 23.6 billion by 2030. This represents a compound annual growth rate (CAGR) of around 21.4 percent from 2022 to 2030. The primary drivers for this expansion include the increasing adoption of electric vehicles (EVs), stringent

environmental regulations, and the pressing need for sustainable waste management solutions

Serviceable Available Market (SAM): In Europe, the SAM for lithium-ion battery recycling is anticipated to constitute a significant portion of the global market. By 2030, it is expected to reach around USD 6.2 billion. This growth is underpinned by Europe's strong regulatory framework, high adoption rates of EVs, and aggressive promotion of circular economy practices aimed at reducing carbon footprints

Serviceable Obtainable Market (SOM): Within Germany, the SOM is estimated to be approximately USD 1.25 billion by 2030. Germany's prominent role in the European market is supported by its robust automotive industry and commitment to sustainability. This figure reflects the country's capacity to capitalize on existing recycling infrastructure and advancements in battery management technologies, positioning it as a leader in the lithium-ion battery recycling industry[2]

These projections highlight the substantial opportunities in the lithium-ion battery recycling sector, driven by regulatory support, technological advancements, and the growing emphasis on sustainable practices. This market analysis underscores the potential for significant economic, environmental, and social benefits within Germany and beyond.

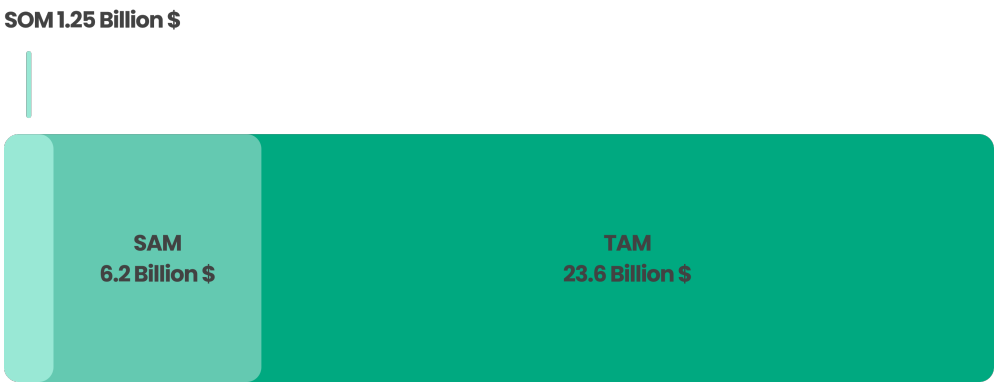

Fig. 2 TAM, SAM and SOM visualisation.

4 Growth Strategy

The current implementation plan includes research, planning, development, and deployment phases, after which the software solution will be up and running. We also devised a three-phase growth strategy to expand our pilot project.

In the first phase, the idea is to diversify our recyclables portfolio to include all the recycled materials that can be used by BMW. In the next phase, we aim to expand our client base to other car manufacturers all over Germany, streamline their supply chain, and include a stable supply of recycled materials like Lithium, Cobalt, and Plastic for their own manufacturing. The final phase includes expanding our customer base

to include all manufacturers of various industries that are interested in using recycled materials as raw materials for their manufactured products.

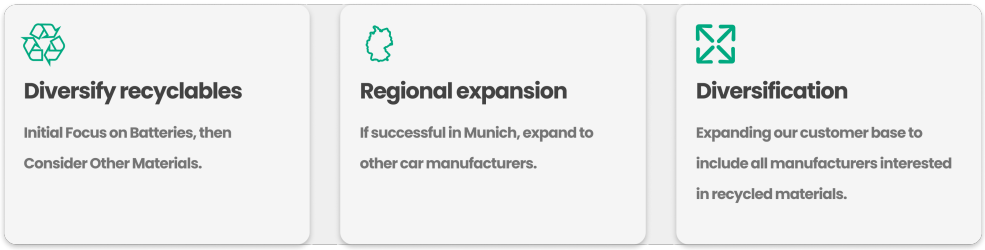

Fig. 3 The 3 Scaling Steps.

5 Limitations

This project faces several limitations that affect its development and implementation. Firstly, our ability to predict future amounts of waste of a specific kind is contingent on the availability of previous timeseries data. This data needs to be granular, with a minimum granularity of one day, to ensure the accuracy of our predictions.

Additionally, the model's predictions are constrained by the predicted maximum supply of waste generated by the customers of AWM, e.g., people transporting their waste to one of AWM's many waste management sites. A critical challenge is that AWM currently does not want to provide us with their data, which restricts our ability to move beyond the conceptual phase and prevents us from training an initial model.

Moreover, our project is highly dependent on the cooperation of local suppliers who are willing to collaborate with us. Their participation is essential for obtaining the necessary data and ensuring the project's success.

6 Conclusion

In conclusion, our project under the "SustAInability" class has effectively highlighted the urgent need for improved recycling processes for lithium-ion batteries, driven by the rapid increase in electric vehicle adoption. The partnership challenge presented by ContainerGrid aimed to enhance the logistics and collaboration between the Waste Management Corporation of Munich (AWM) and BMW, focusing on increasing the efficiency and sustainability of electric vehicle battery recycling.

Through our engagement with ContainerGrid and its CEO, Aron Handreke, and the support from our supervisors and academic feedback, we developed a robust strategy centered on predictive analysis for waste management. This approach promises significant environmental, economic, and social benefits by forecasting waste material quantities, optimizing collection, and facilitating the use of recycled materials in BMW's production processes.

Despite facing limitations, such as the lack of granular time series data from AWM and the dependency on local supplier cooperation, our project sets a solid foundation for future development. Our initiative not only supports BMW's sustainability goals but also paves the way for broader industry changes, encouraging the adoption of sustainable practices across the automotive sector.

Overall, our work underscores the critical role of efficient recycling logistics in promoting a circular economy, reducing environmental impact, and fostering sustainable growth. This project demonstrates that with strategic collaboration and innovative thinking, significant advancements in sustainability can be achieved, contributing to a greener and more sustainable future.

References

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