Abstract:

The emergence of EV battery rescue systems and recycling industries has been significant in addressing the pressing issue of disposing of millions of end-of-life electric vehicle (EV) batteries. Our sustainable project aims to bridge the demand and supply gap between second-life battery users and EV car manufacturers. We propose a supply chain model that involves the company and recyclers. Quality checks, packaging, and transportation of used EV batteries are all part of our comprehensive services, as is the collection and transportation of fully used batteries to battery manufacturers for recycling. Our goal with this approach is to increase the lifespan of EV batteries, reducing the environmental impact of new battery production and lowering both financial and environmental costs.

Problem Statement:

To establish an effective and dependable system to acquire used electric vehicle (EV) batteries for second-life purposes nowadays becomes an important challenge. The significant challenge involves creating a system that maximises the value and potential of these batteries while promoting sustainable energy storage solutions.

STABL Energy, an organisation dedicated to promoting sustainable energy consumption through innovative power conversion technology, is leading the way in advancing energy storage for renewable sources. Their primary objective is to establish a groundbreaking benchmark in battery storage, thereby improving the efficiency and effectiveness of renewable energy systems.

The challenge at hand is to establish an efficient and reliable system for acquiring used electric vehicle (EV) batteries specifically for second-life purposes, aiming to increase their potential value and contribute to sustainable energy storage solutions.

Methodology

This section explains the methods used for our project. We did research on a lot about different usage and kinds of batteries and came to a conclusion, we will focus on the Li-ion batteries used in Electric Vehicles. After that we conducted a qualitative interaction with our challenge partner STABL energy from there we came to clarify the problem of our challenge. With the advice of our mentor Martin Weiß we try to focus on supplying Used EV batteries to STABL which they modify and use for energy storage.

Then we collaboratively did research about different options available. We studied about the current recycling technologies such as mechanical separation, hydro-metallurgical processes, pyrometallurgical process, these methods do not focus on the state of health of EV batteries. In addition, research and innovation project grants from governments are promoting recycling technology advancement, such as the EU's European Battery Alliance and the United States' National Science Foundation Phase II Small Business Innovation Research grants. Furthermore, sourcing from recyclers domestically avoids creating primary demand for raw materials sourced from conflict regions or extracted using child labour, or both.

Explanation of final project Concept

After brainstorming for 1-2 weeks we came to a finding that we can use the existing state of health of batteries that is not utilised by the recyclers. We plan to act as a mediator between the battery recyclers and STABL. The proposed plan is to facilitate a battery pool with STABL and battery recyclers, in which we exchange the batteries from recyclers for the exhausted ones used by the Stabl in the energy storage. The process is that we analyse the battery onsite from the Recyclers using the technology from our planned collaborators. The one which satisfies our criteria will be supplied to the battery pool. Failed ones will be sent back to the recyclers itself. Transportation of batteries to and fro between the recyclers and the STABL is done with the help of our battery logistic collaborator. By using our proposed plan we have various advantages such as

- Material security:

By lowering the demand for new raw material extraction, second-hand EV batteries aid in resource conservation. The need for vital components like lithium, cobalt, nickel, and other priceless components is reduced by recycling old batteries. This reduces the environmental impact of extracting and processing these limited resources and helps to conserve them.

- Efficient resource utilisation:
  With the second life usage of EV batteries their useful life is extended beyond their primary use. This maximises the energy storage capacity of the batteries and reduces the need for new battery production and premature disposal of the used batteries.

The acquired advantages inherent to STABL's Technology include:

- Low Voltage architecture:
  The inverter switching method utilised by STABL results in a disconnected system of individual modules which are at relatively very low voltage states, this enables the battery swaps and other minor maintenance work to be more accessible and safe.
- Inherent failsafe capability:
  The modular system combined with the computer controlled switching ensures that even if a battery module fails, the system can engage other modules to continue being operational.
- Cloud backed analytics:
  The data from the system is continuously being recorded and analysed, to further be used to train AI models to predict failure and estimate optimal operational lifecycle for the batteries. This is especially useful in the case of second life batteries.
- Continuous monitoring:
  The battery packs are continuously monitored for abnormalities, The system can decouple battery modules exhibiting non optimal behaviour, this helps avert catastrophic failure.

Overview

The purpose of this report is to propose the establishment of UPCELL. Upcell creates a battery pool as a solution to the challenges faced by our client. These act as a platform for trading second life batteries for the client from different recyclers across the country. These platforms collect some details of the second life batteries. Using the diagnostic tool, the following parameters are measured.

1. State of health
2. State of charge
3. Thermal Performance
4. Physical state

The technical information helps to analyse whether the battery is suitable for the pool or not. The key abstract being to optimally deploy the battery to a site where the qualities of the battery pack matches maximally the requirements of the pack that needs replacement, this way the battery gets to be utilised to the maximum extent, enabling the battery to be used for energy storage the longest, After initial screening ,the battery with a state of health of minimum 60 percent will be absorbed into the pool and others will be returned to the recycling partners. After a suitability check, once again the tool runs a diagnostics and discharges and prepares the pack for shipment to site, The system then designates an exhausted battery pack for relief from the system The recyclers will receive the same amount of battery as taken by the pool. It will be packed and shipped by our logistics partner. When the battery enters the Upcell network it will be transported to the suitable client. Collaboration with our clients, will allow for the utilisation of these batteries for second life energy storage systems. After the batteries have optimally exhausted their state of health during the second-life storage , they will be shipped back to the recyclers for recycling. Throughout this process, we will only engage with sustainable recyclers and prioritise material security. Furthermore, we will ensure maximum energy utilisation and offer continuous monitoring services to our customers, enabling them to track the performance of their batteries. This report highlights the methodology , results and benefits of implementing the battery pool platform, Which aims to promote responsible recycling practices and meet the increasing demand for the electric vehicle batteries.

Outlook for the Future

There are several procedures and contingencies that need to be completed concurrently in order to start the Upcell Project. Developing our network is essential so that we may comprehend our concrete needs of our battery recyclers and STABL together, Logistics proves as a hurdle to the operation due to the flammable and hazardous nature of the battery packs, We expect to outsource the logistics to specialised battery logistic services in the primary phase and further develop logistic solution in house to further streamline the network operation. With the data collected from the many deployed battery packs, a very accurate AI model can be trained to further accurately manage the deployment of the battery packs, with increased fitting and failure prediction capability, The evaluation of battery pack also needs to be further simplified with less data points to expedite the intake, this is also planned with collaborations with specialty diagnostic firms and later integrated with an in house diagnostic solution further into operation. The system also allows into the possibility of utilising the battery pool as an active storage solution for the second life batteries which could further enable the establishment of large scale energy storage facilities using second life batteries, Leveraging the technology from STABL, the operational voltages are always low and the constant monitoring would allow the safe active storage than unsupervised bulk battery storage. Our solution would potentially offer the best value per cost of battery storage, together with the constant cycling would offer an overall reduced risk of failure. The project hence would greatly make the energy storage more accessible and further affordable to maintain.

The nature of the project is such that all upfront investments are towards establishing the system, the batteries are technically never purchased and are leased for their period of deployment in the system, General market surveys could hint at the demand and their current cost of maintenance, this can be used as a foundation to approach the customers with the alternative, Funding for the initial phases can be crowdsourced or supported by Government initiatives. The project actively supports the partner company STABL to help stock the sites with second life batteries continuously and keep the batteries serving as energy storage devices for the longest before being recycled for material extraction.

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