Sample Case for Case Presentation at the International Final

Electric Vehicle (EV) Battery Recycling Challenges and Opportunities

Background

The global transition towards carbon reduction and carbon neutrality has spurred the swift development of new energy vehicles, particularly electric vehicles (EVs). According to the International Energy Agency (IEA), the global electric car stock reached 11.2 million units in 2019, with Norway leading the way at 56% of new car sales being EVs. This trend is expected to continue, with the number of EVs projected to reach 145 million by 2030.

However, the widespread adoption of EVs brings forth a significant challenge: the recycling and disposal of their batteries. Currently, the lithium-ion battery is the predominant choice for EVs, with an average lifespan of about 8 to 10 years. As the first generation of EVs approaches the end of their service life, a surge in waste battery production is anticipated, growing at an annual rate of approximately 10-15%. The improper handling of these batteries could lead to environmental hazards, including the contamination of soil and water with heavy metals and toxic chemicals. Moreover, these batteries still retain a significant portion of their storage capacity (around 70-80%), which could be harnessed for secondary applications.

Against the backdrop of the burgeoning new energy vehicle market and the critical role of lithium-ion batteries in powering these EVs, students are tasked with developing innovative and sustainable solutions to address the pressing issue of battery recycling, ensuring that the environmental benefits of EVs are not undermined by the challenges posed by end-of-life battery management.

Additional Information

Lithium-Ion Battery Technology in New Energy Vehicles

Lithium-ion batteries have become the cornerstone of new energy vehicles (NEVs) due to their high energy density, lightweight nature, and slow loss of charge when not in use. These characteristics make them ideal for powering electric vehicles (EVs), which require a compact, efficient, and reliable energy source for propulsion.

Working Principle

Lithium-ion batteries operate based on the movement of lithium ions between the positive and negative electrodes during the processes of charging and discharging. The positive electrode, typically made of a lithium metal oxide, and the negative electrode, usually graphite, are separated

by an electrolyte. During charging, lithium ions move from the positive to the negative electrode, where they are stored. When the battery is used to power an EV, the lithium ions move back to the positive electrode, releasing energy in the process.

Advantages

- **High Energy Density**: Lithium-ion batteries offer a much higher energy density compared to other battery types, which translates to longer driving ranges for EVs without the need for frequent recharging.
- **Rechargeability**: These batteries can be recharged hundreds of times, making them suitable for daily use in EVs.
- **Low Self-Discharge Rate**: Lithium-ion batteries have a low self-discharge rate, meaning they can be stored for longer periods without significant loss of energy.
- **Environmental Friendliness**: Compared to traditional internal combustion engine vehicles, EVs powered by lithium-ion batteries produce zero tailpipe emissions, contributing to reduced air pollution.

Challenges

Despite their advantages, lithium-ion batteries used in NEVs also face several challenges:

- **Cost**: The production of lithium-ion batteries is currently more expensive than traditional car batteries, although costs have been decreasing over time.
- **Degradation Over Time**: The capacity of lithium-ion batteries degrades over time, affecting the performance and range of EVs.
- **Safety Concerns**: There have been instances of lithium-ion batteries overheating or catching fire, leading to strict safety requirements and ongoing research into improving battery safety.
- **Recycling and Disposal**: The end-of-life management of lithium-ion batteries poses environmental and logistical challenges that require effective recycling solutions.

Innovations and Future Developments

The field of lithium-ion battery technology is continuously evolving, with research focusing on improving battery life, increasing energy density, and reducing costs. Innovations such as solid-state batteries, which replace the liquid electrolyte with a solid material, promise even higher energy densities and improved safety. Additionally, advancements in battery recycling technologies aim to recover valuable materials like lithium, cobalt, and nickel, reducing the environmental impact and making the battery lifecycle more sustainable.

Things to Consider

1. **Stakeholders Involved**: Who are the stakeholders involved? Vehicle manufacturers, battery producers, recycling companies, consumers, and government regulatory bodies, etc.?
2. **Primary Responsibility**: Who may bear the primary responsibility in the recycling?
3. **Regulatory Measures**: For the potential measures that could be implemented, would incentive-

based or punitive measures be more effective?
4. **Long-Term Sustainability**: As the number of discarded EV batteries continues to rise, what solutions could be more sustainable in the long-term?

You Must Address the Following in Your Presentation

1. **Potential Impacts**: Analyze the societal, economic, and environmental consequences of improperly managed EV battery waste.
2. **Recycling Methods**: Discuss current recycling practices, and their respective advantages and disadvantages in terms of efficiency, cost, and environmental impact.
3. **Solutions and Stakeholder Roles**: Present a comprehensive recycling strategy that outlines the roles and responsibilities of each stakeholder group.
4. **Challenges and Contingency Measures**: Evaluate potential obstacles to the proposed recycling solutions, and propose strategies to mitigate these risks.

Submission Instructions

1. Teams must submit a video of their case analysis presentation via the specified method by the deadline.
2. All team members are expected to participate in the presentation, which can be conducted online or in-person.
3. Use of PowerPoint (PPT) is permitted; however, no additional off-screen prompts or materials are allowed.
4. Keep the presentation video to a maximum of 7 minutes to concisely convey your analysis and solutions.
5. The video must be a single, uninterrupted recording without any post-editing.
6. Upload the video to a video platform or cloud storage service and share it via an unlisted link (only viewable with a link).

Additional Notes

- Ensure that the video quality is clear and the audio is audible to facilitate evaluation.
- Teams are responsible for checking the video's accessibility and ensuring that the link works correctly before submission.
- Late submissions will not be accepted, so plan accordingly to meet the deadline.