A&M RECYCLING PRESENTATION

CLIENT A&M Recycling

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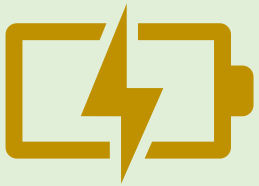
A&M Recycling's client, delivers used lithium batteries to A&M who bulk the batteries on-site and are now searching for a second-life solution.

PROBLEM 1

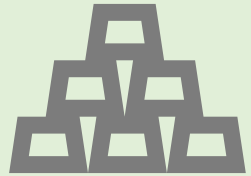
The cost of recycling lithium batteries is **€3,00 per kg**, a remarkably high cost for recycling.



PROBLEM 2

The functional capacity of the batteries differ immensely:

- (1) Batteries containing water – Recycle
- (2) Batteries with a charge capacity of 70% - **second-life options**



PROBLEM 3

Currently, the lithium batteries are being **bulked on-site**, taking up a significant amount of storage space for A&M recycling.

I. PROBLEM DEFINITION

MAIN RESEARCH OBJECTIVE

The research aims to **identify a strategic recommendation** for A&M recycling in repurposing second-hand lithium batteries in a circular manner taking into account the environmental, financial and ecological impact.

RESEARCH SUB-OBJECTIVES

1. A detailed outline of the material components of a lithium battery and how these contribute to the functionality of the products life cycle.
2. A literature review exploring the current development in the second-life options and markets of lithium batteries including a calculation of the financial and ecological impact per option suggested.
3. A realistic financial implication of implementing a circular strategy – both recycling and upcycling.
4. A detailed outline of social benefits resulting from implementing a circular strategy.
5. A complete Life cycle assessment (LCA) to identify the overall ecological impact of a lithium batteries life cycle.

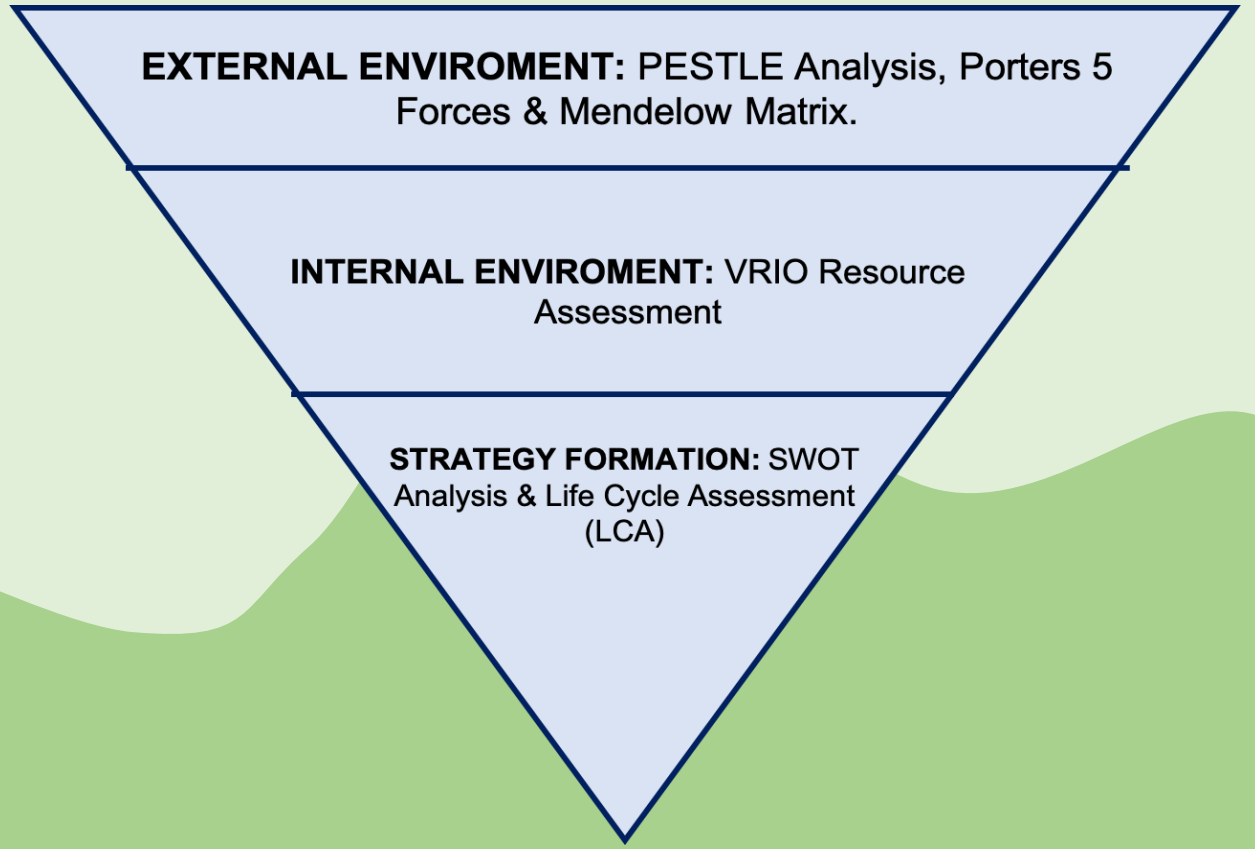
MAIN RESEARCH QUESTION

How can second-life options for A&M Recycling's lithium batteries contribute to the circular economy?

SUB-QUESTIONS

1. What are the material components of lithium batteries and how do these shape the nature of the battery's functionality across its life cycle?
2. Through conducting a literature review, what are the current developments in end-of-life options of lithium batteries?
3. What are the financial impacts of the possible second life options for used lithium batteries of EV?
4. What are the social impacts of second life options for used lithium batteries of EV?
5. What are the ecological impacts of lithium batteries and how can these be reduced by implementing circular strategies in its product life cycle?

2. RESEARCH FRAMEWORK



3. RESEARCH METHODS

DATA COLLECTION INSTRUMENTS

SEMI-STRUCTURED INTERVIEWS: Co-founder of scooter ridesharing company (CHECK) & Electric battery researcher of the University of Eindhoven

QUALITATIVE DESK RESEARCH: Company reports, Academic papers, and industry averages

Data structuring and Analysis

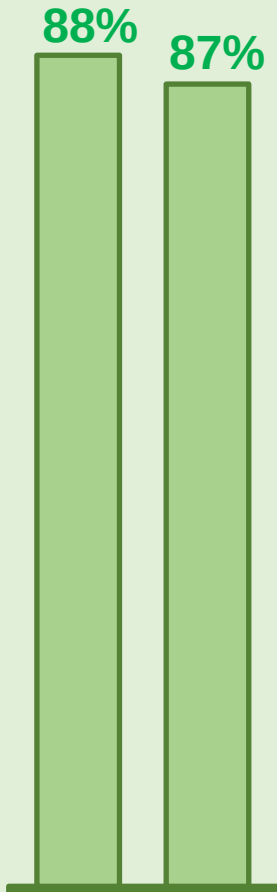
INTERVIEWS: Transcribed and coded per topic

QUALITATIVE DESK RESEARCH: Coded per topic

4. FINDINGS - Market Developments

European Lithium Battery Market

- **EU Green Deal** & EU Climate Laws.
- **Rapid technological innovations** – increased product lifetime & performance
- **Growing Lithium Battery Market** (115.98 Billion)
- **High barriers to entry** due to growing market – initial investments & costs increasing.



Change in Consumer purchasing behavior

- **87%** of consumers **will buy a product with a social or environmental benefit.**
- **88%** of consumers will be **more loyal to a company that will support social and environmental issues.**

European Lithium Battery Recycle Market players

- **Key European players dominating the European Lithium recycling market:**

(1) Umicore – Belgium

(2) Glencore - Switzerland

4. FINDINGS – A&M Internal Analysis

After conducting a VRIO Resource assessment together with A&M recycling we came to the following conclusions:

Internal Strengths A&M Recycling

- **Well-developed network of long-term clients in the Netherlands.**
- PostNL
- Bam
- Heijmans
- Engie
- Etc.

- **Diverse range of advanced machinery:**
- Trucks
- 5 cranes
- Hydraulic press
- Shredders
- Etc.

Internal Weaknesses A&M Recycling

- **Limited brand equity**
- Limited range of raw materials
- Few recycling plants
- Limited recycling equipment

4. FINDINGS – Strategy Formation

After conducting a SWOT Analysis, we generated the following four strategic recommendations considering both the external & Internal factors:

Internal Strength/External Opportunity (SO) Strategy

Use long-term client Engie to form a strategic partnership manufacturing solar powered streetlights using the lithium batteries.

Internal Weakness/External Opportunity (WO) Strategy

Overcome limited brand equity through effectively marketing the partnerships, such as A&M & Engie, and their production of solar-powered streetlights through mediums online social media channels, events and word-of-mouth.

Internal Strength/External Threats (ST) Strategy

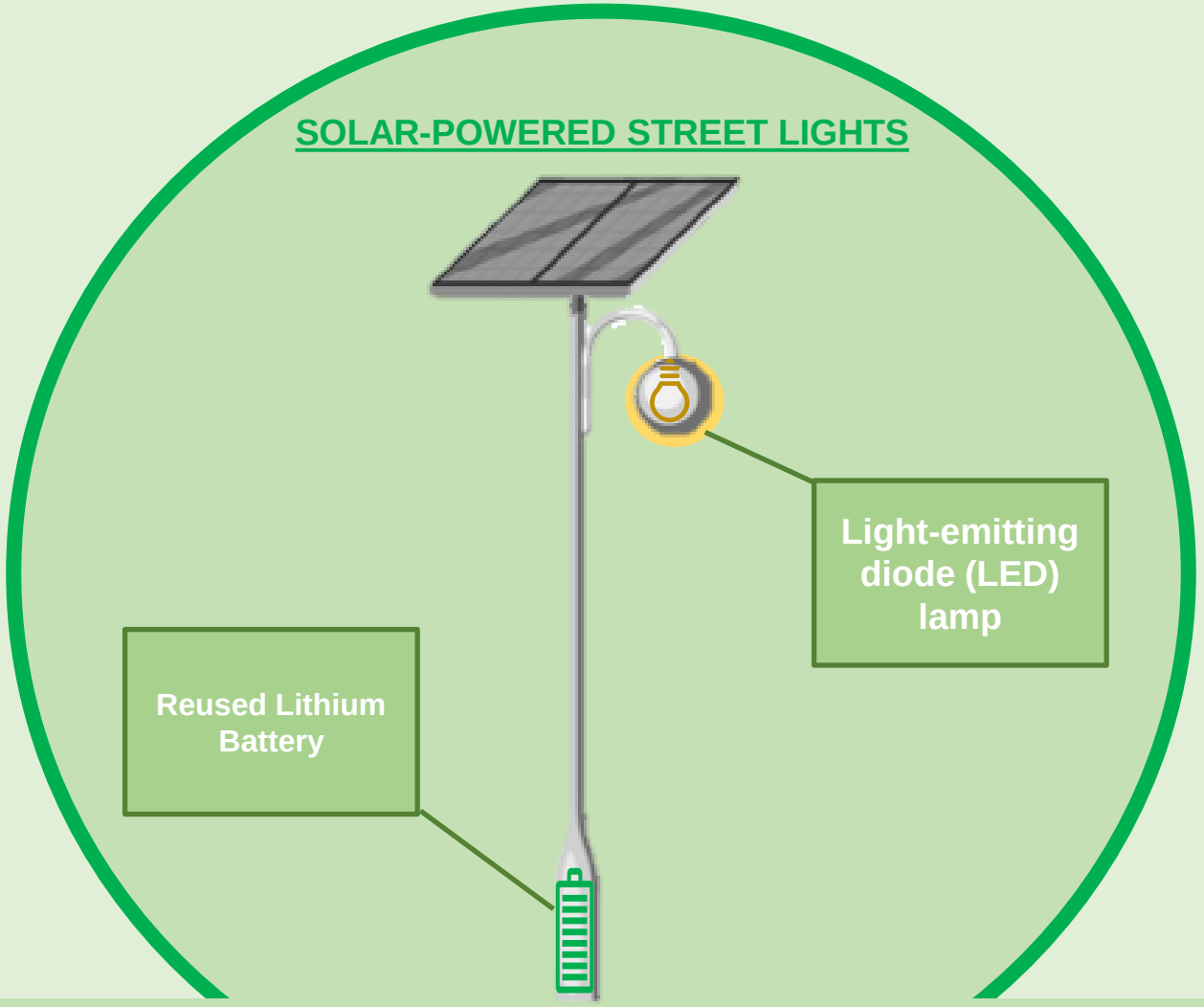
Form a strategic partnership with the Dutch government and use the diverse range of advanced machinery to aid the production, installment and distribution of the solar-powered streetlights, supporting the creation of cost-effective policies in the Netherlands.

Internal Weakness/External Threat (WT) Strategy

Overcome limited brand equity by avoiding highly competitive and costly lithium recycling industry and focusing on forming strategic partnerships with Engie and the Government, whilst executing effective marketing campaigns to improve overall brand equity.

4. FINDINGS – THE PROPOSED SECOND-LIFE SOLUTION

The proposed solution is to **reuse the used lithium batteries as the batteries of solar-powered streetlights** – as advised by the lithium battery expert Dr. Danilov.



PROPOSED PARTNERSHIPS:

- **(1) ENGIE -** Part of the *"Energy Cooperative"*
- **(2) Dutch Government –** Request Subsidies/Grants from "Rijksdienst voor ondernemend Nederland" & Legal Support
- **(3) Battery Experts** (TU Eindhoven) – Product Design

4. FINDINGS - Ecological impact

After conducting a LCA to examine the most efficient and sustainable lamp type for our proposed solar lamp:

OPTION 1: High pressure sodium lamp (HPS)

- **Total lifetime: 32,000 hours**
- **47% of streetlights**
- **Average 106.736 tone-kilometer (tkm) of transport**
- **Replace compensator & ignitor every 10 years.**
- **Operational for 32000 hours at 176 w = 5632 kWh**

OPTION 2: Light-emitting diode lamp (LED)

- **Total lifetime: 50,000 hours**
- **Ability to replace parts**
- **Lower energy consumption during usage phase**
- **5.96kg more aluminum used in production**
- **Average 142.189 tone-kilometer (tkm) of transport**
- **Operational for 50000 hours at 117 w = 5850 kWh**

4. FINDINGS - Social Impact

POSITIVE SOCIAL IMPACTS

- Solar-powered lamp generates own power – **zero emissions.**
- More solar streetlights installed in remote areas with no cabling will increase **Traffic Safety**
- Increase in **Social Safety**
- **Growing Dutch population** (0.59%+ annually) will require **new housing** which could be lit by solar powered streetlights.
- Increasing demand for green forms of transport– **larger quantities of used lithium batteries can be reused instead of bulked and stored in landfills.**
- Does not require new cabling to be installed – **funds saved could be reinvested** in other social projects by the local municipalities.

NEGATIVE SOCIAL IMPACTS

- May possibly **disrupt local ecosystems**
- May possibly disrupt the night-cycles of local animals
- **Light pollution**

4. FINDINGS - Financial Impact

(Standard) HPS Streetlight

1. Manufacturing cost € 1.800,-
2. Cable cost 35 meters € 1.120,-
3. Maintenance € 12,- per year
4. Electricity € 5,- per year
5. **Lifetime of 50 years costs:**

€ 3.770,-

Solar-powered Streetlight

1. Manufacturing costs € 3.000,-
2. No cables required € 0,-
3. Maintenance € 12,- per year
4. No electricity costs € 0,-
5. **Lifetime of 50 years costs:**

€ 3.600,-

Although the difference in one lifetime is **€ 170,-** on average a city has **35,000 lamp posts**, which would save **€ 175.000,-**

5. CONCLUSIONS

THE SOLUTION: Re-Use Lithium-ion Batteries in solar-powered streetlights.

PARTNERSHIPS:

- **Design:** TU Eindhoven Battery Experts
- **Production:** Engie and other energy companies
- **Distribution & Ownership:** A&M Recycling
- **Project management/Funding/Legal:** Dutch Government & Local municipalities.

LOGISTICS:

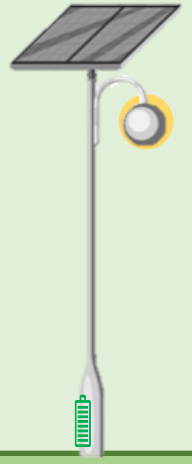
- **Provide A&M recycling with a list of Lithium-Ion Battery Experts at TU Eindhoven:**
- These experts have assured us that it is technologically possible to alter the batteries function to a power source for long-term light emission.

COSTS SAVED DUTCH GOVERNMENT & MUNICIPALITIES:

- **Cabling costs:** € 32,- per meter of cable.
- **Energy costs:** € 5,- annually per unit
- **Energy costs:** LED Light more energy efficient.

- All these costs saved can be reinvested in other social projects by the government and/or local municipalities.

6. RECOMMENDATIONS



The Large-scale operation & application of the proposed solar lights requires a sufficient battery supply and government collaboration.

RECOMMENDATION:

(1) **Contact long-term clients** about possible partnership
(2) **Contact external partners** for possible partnership
(3) **After establishing a partner, contact TU Eindhoven Experts to design a prototype & get accurate financial implications concerning the cost of production, installment, etc.**
(4) **After designing a functioning prototype,** contact the Dutch Government to discuss possible subsidies and/or investments for the project.
(5) **After receiving funds,** continue working with the Dutch Government and local municipalities to secure a project where the lamps can be installed.
(6) **Begin with regional projects, and if successful, expand the projects to a national level.**
(7) Throughout this process A&M recycling is to **invest time into marketing their new product and services to boost their brand image & equity.**

However, if A&M recycling lacks the supply of Lithium-Ion batteries, financial support or partnership collaborations they may explore the possibility of renting out the batteries as – A&M would maintain ownership and apply the solution on a smaller scale:

- **(1)** Lighting of company sites
- **(2)** Lighting at events – e.g., festivals

Q & A

THANK YOU FOR LISTENING