Capstone checklist for standards, sustainability, health & safety and legal.

Absence, or insufficient completion, of this checklist will result in the rejection of the proposal or report.
Please use this checklist as a guide to help you express these topics in your reports, and to summarize them.

This checklist must be completed in full by each capstone team member and submitted with the final project proposal (Capstone I) and final project report (Capstone II). Where appropriate, responses should relate to your sub-system and area of responsibility. Write full sentences; simply answering "yes" or "no" will not be accepted.

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Project Title: Developing Battery Management System for Laboratory Scale Set-up	Project code: 1010885	Date: 14/12/2024

Provide a brief overview of your project

The increasing depletion of fossil fuels is expected to drive the growth of electric vehicle (EV) usage in the present and future. Consequently, research is being conducted on the development of charging stations and battery management systems (BMS). This project aims to enhance battery management systems and their features, while also planning the integration of charging stations with solar panels.

Part A - Overview

1. What are the main functional and performance requirements of your product or sub-system?

The system should continuously monitor cell voltages, module temperatures, and current flow to maintain battery health and prevent faults. It also must estimate the State of Charge (SoC) and State of Health (SoH) accurately.

2. What are the dominant design constraints for your product or sub-system?

Economic: High costs for sensors, microcontrollers, and other components.
Environmental: The manufacture and disposal of lithium-ion batteries present challenges.
Technical: The system must handle dynamic solar inputs and ensure scalability.
Operational: The system must minimize energy loss and integrate easily with new modules.

3. Who will be the users of your product?

The product will be used by electric vehicle charging station operators and electric vehicle owners.

4. What realistic operating conditions have you assumed your product will be exposed to?

High energy demand periods requiring robust energy storage. Variable solar energy inputs due to weather and time of day. Extreme temperature ranges impacting battery performance.

5. Other.

The system should be modular, fault-tolerant, and capable of real-time communication and monitoring.

Part B - Standards

1. What safety standards apply to your product or sub-system? For example, ISO.

IEC 61851-1: EV charging equipment safety.
IEC 62196 and IEC 62196-2: Standards for EV plugs, sockets, and connectors.

2. Are there any basic standards (legal metrology) that apply to your product or sub-system?

ISO 26262: Functional safety for road vehicles.

3. Are there any performance standards that apply to your product or sub-system?

Standards for battery SoC/SoH estimation and thermal management systems.

4. Are there any codes (government laws) that apply to your product or sub-system

Renewable energy policies and local grid regulations.

5. Other.

The system must adhere to data security protocols for communication.

Part C - Economic impacts

1. Explain how you minimized the cost of your prototype, and how production costs could be reduced if the prototype were to be mass produced?

Use of modular design to reduce initial implementation costs.
Selection of scalable components to allow future expansions without redesign.

2. Compared to other similar products that are on the market, how does your design lead to cost savings for the user?

Efficient energy management minimizes electricity costs.
Modular architecture reduces maintenance and upgrade costs.

3. Would there be any *tax incentives* to be considered towards final product cost. For example, renewable energy and energy-efficient products tax incentives, carbon footprint reduction, etc.

Renewable energy and energy-efficient product tax incentives may apply.

4. Are there any environmental aspects, such as availability of resources that may affect the product cost and therefore price and market vulnerability?

The availability of rare earth elements like lithium and cobalt impacts costs.

5. Other.

Recycling strategies for lithium-ion batteries may reduce long-term costs.

Part D - Environmental impact

1. Are there any greenhouse gas emissions related to the production or use of your product, what aspects of your design attempts to reduce those emissions?

Emissions during lithium-ion battery production; design focuses on extending battery lifespan to reduce waste.

2. Does your product require usage of environmentally sensitive resources such as water, energy, wood, etc. and how does your design encourage efficient use of such resources?

The system uses lithium-ion batteries but aims to optimize their lifespan and efficiency.

3. Does your product rely on materials or resources that scarce (such as rare elements)? Has your design been adapted to make use of materials that are more abundant?

Yes, the system relies on lithium and cobalt; alternative chemistries like LiFePO4 are being considered.

4. Does your product introduce or encourage different usage or behaviors that are more environmentally friendly?

Promotes the use of renewable energy and reduces reliance on fossil fuels.

5. Other

Recycling and safe disposal measures are part of the product lifecycle design.

Part E - Social impact

1. In what way can your product impact people's lives (positively and negatively)? What design decisions have you made to maximize positive impact and minimize negative impact.

Positively: Provides reliable EV charging infrastructure and reduces emissions.
Negatively: Potential job displacement in traditional energy sectors.

2. Does your product address any social needs?

Yes, it supports the transition to sustainable transportation.

3. Who will benefit from this product?

Electric vehicle (EV) owners, renewable energy advocates, and society at large through reduced emissions.

4. If your product were to be mass-produced, would it create new jobs, or destroy jobs?

It would create jobs in renewable energy and manufacturing sectors.

5. Other

Public education on renewable energy benefits may be necessary.

Part F - Health and safety

1. What relevant health and safety laws or standards does your product or sub-system comply with?

ISO 26262 and IEC 61851-1.

2. What practices did you adopt during the development of your prototype to protect your own health and safety and the health and safety of those around you?

Use of safe testing environments and compliance with electrical safety protocols.

3. What design decisions did you make to increase the safety of your product or sub-system?

Incorporation of fault detection, overvoltage protection, and thermal management.

4. Can your product be used in any way that can impact the health and safety of the user or others?

Yes, improper use or faulty batteries could cause safety risks; the design minimizes these risks through monitoring.

5. Other

Training modules for safe product operation will be included.

Part G - Legal

1. What laws or regulations apply to your product?

Renewable energy and battery recycling laws.

2. The manufacturer of a product is liable for any damage or harm that results because of a defect. What harmful defects could occur during mass production of your product, and how could they be minimized?

Defects in battery modules or sensors; minimized through quality assurance and testing.

3. Have you violated any licenses or patents in the development of your prototype? Would there be any such violations if the product were mass produced? How have you mitigated such issues?

No known violations; the design adheres to open-source and standard practices.

4. What security and privacy laws are relevant to your product or sub-system, and what aspects of your design ensure that these laws are adhered to?

Data privacy laws related to telemetry and communication.

5. Other

Intellectual property will be registered to protect the design.

Part H - Others

Do you have any other relevant information to share related to your design experience regarding *standards*, *sustainability*, *health & safety* and *legal* aspects of your capstone project?

The project emphasizes modularity, scalability, and sustainability to address future challenges in EV infrastructure and renewable energy integration.