Format for uploading details of completed projects

1. **Project details**
   - **a.** *Title*: *Development of an on-board hybrid charging system for hilly-station performance light electric vehicle*
   - **b.** *Institute*: Tezpur University

2. **Aim / Objectives:**

   Design and development a vehicle on-board hybrid charging system for 48 V, 30 Ah energy storage system.

   Development of a microcontroller based algorithm for vehicle on-board power flow and charging management system to be operated from PV/grid/regenerative braking for hilly-station performance light electric vehicle.

3. **Executive Summary (*One page*):**

EVs adoption in hilly stations encounters the major challenges from the requirement of high acceleration power for up-hill driving and the inappropriate charging facility (charging station). First one causes frequent deep discharge of the battery pack degrading the battery life. Second one suggests for developing a self-sufficient fixable vehicle on-board charging system to reduce dependency on external road-side or parking charging systems.

An efficient vehicle on-board battery charging can play a significant role on the success of viable EVs adoption in hilly and remote stations. An on-board charging system with hybrid energy storage for light electric vehicles is developed. On-board charging system integrates devices that convert AC power from a grid or shore supply into DC power to charge batteries directly without removing them, And, through designing an on-board energy charging system compatible with a hybrid energy storage system, the driving range of EVs can be prolonged without requiring larger batteries or explicit road-side/parking charging infrastructure.

Integrating the on-board charging system with a hybrid energy storage system—typically consisting of a combination of batteries and auxiliary energy storage elements such as supercapacitors—can significantly improve vehicle performance and energy efficiency. In such a configuration, the supercapacitor can supply high transient power during acceleration or uphill driving, while the battery provides sustained energy for longer

durations. This coordinated energy sharing reduces the stress on the battery, minimizes deep discharge events, and enhances the overall lifespan of the battery pack.

4. Scope for further work

Extension of the system for bidirectional charging (V2G/V2V) applications.

Implementation of AI/ML-based energy management to enhance efficiency and battery life.

Advancing for adaptive charging algorithms optimized for hilly terrain and variable load conditions.

5. Benefits visualized

Hybrid energy operation using solar PV and battery for uninterrupted propulsion and charging.

A hybrid energy storage system (Battery + Supercapacitor), where the supercapacitor supports the battery during acceleration and uphill driving, reducing battery stress.

SOC-based battery management, preventing overcharging and deep discharge to increase battery life