

Non-Urban E-Bus Pilot Operations, Data Analysis & Inference

Exploring the Role of the Private Sector as a Catalyst for Accelerating the Transition to E-Buses in India

Why Leh? At about 3,500 m, with steep, undulating terrain and temperatures from 35 °C to −28 °C, Leh is a demanding test for battery-electric buses. In October 2022 SGArchitects ran pilot e-bus operations on seven non-urban routes radiating from Leh, using the Ladakh Administration's 8.5 m PMI Foton e-buses. The Civil Engineering Department, IIT Delhi analysed the data to understand how terrain, passenger load and temperature affect energy use and charging.

0.33 % SoC/km

Discharge on flat terrain, driver only

+0.165 %/km

Extra discharge per 1% of uphill gradient

≈ −2.5 % grade

Downhill gradient where regeneration offsets use

+0.02 %/km

Extra discharge per passenger of average weight

81–86 % SoC

Switch from constant-current to constant-voltage charging

36.6 min

Estimated time to charge from 20% to 80% SoC

Key findings

- **Terrain dominates energy use.** Gradient explains most of the variation in consumption ($R^2 \approx 0.7$). On undulating routes such as Leh-Alchi, average slopes mislead; consumption must be estimated segment by segment.
- **Regeneration is substantial.** On descents steeper than about −2.4% to −3%, energy recovered through regenerative braking equals or exceeds consumption, and the battery's state of charge can rise.
- **Passenger load matters less.** Within the observed 260–760 kg range, load did not materially change consumption estimates, and was not significant on downhill sections.
- **Charge to 80–90%, not 100%.** Charging runs at 1.64–1.77% SoC/min up to 81–86% SoC, then falls to as low as 0.2%/min. A 90% ceiling suits opportunity charging; 80% minimises layover time and protects battery health.
- **Next step: a winter pilot.** The pilot captured autumn conditions only (about 3–22 °C). Winter data, wider passenger-load ranges and access to battery-management-system data would sharpen predictions and policy.

PILOT AT A GLANCE

Routes

Alchi, Upshi, Stakna, Chuchot, Spituk, Phyang, Pathar Sahib

Operations

12 trip legs, close to 400 km, 7–20 October 2022, single charge per run

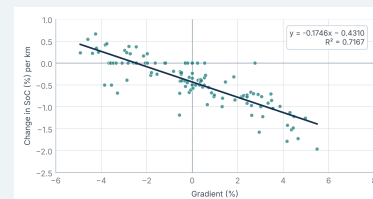
Vehicle

PMI Foton 8.5 m AC e-bus, 150 kWh battery; DC fast charging at Leh

Data

Dashboard and charger readings, altimeter, temperature, GPS and passenger weights

ENERGY USE VS GRADIENT



Change in SoC per km against segment gradient, all 118 segments (IIT Delhi analysis).