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Long-term assessment of economic plug-in hybrid electric vehicle battery lifetime degradation management through near optimal fuel cell load sharing

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Highlights

â€¢ A near-optimal PHEV multi-component degradation management process is proposed.

â€¢ A 6 year-long economy-focused PHEV degradation management scenario is solved.

â€¢ Battery degradation management is found to be a strong cost reduction mechanism.

reduction mechanism.

â€¢ Significant battery lifetime gains between 18 and 41% are achieved.

â€¢ Overall long-term PHEV operating costs are improved by a slight 3â€“6% margin.

Abstract

This work evaluates the performance of a plug-in hybrid electric vehicle (PHEV) energy management process that relies on the active management of the degradation of its energy carriers â€“ in this scenario, a lithium-ion battery pack and a polymer electrolyte membrane fuel cell (PEMFC) â€“ to produce a near economically-optimal vehicle operating profile over its entire useful lifetime. This solution is obtained through experimentally-supported PHEV models exploited by an optimal discrete dynamic programming (DDP) algorithm designed to efficiently process vehicle usage cycles over an extended timescale. Our results demonstrate the economic and component lifetime gains afforded by our strategy when compared with alternative rule-based PHEV energy management benchmarks.

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Keywords

Batteries; Degradation; Electric vehicles; Optimal control; Dynamic programming; Energy management; Vehicle dynamics; Power system economics

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