Aaron energy storage for electric vehicles

Aaron energy storage for electric vehicles

a Current energy conversion & supply chain; b TES for EVs technique fills a gap in the existing energy chain and creates an additional thermal energy recovery, storage, and distribution bypass chain

Schematic diagrams of energy flow in a current plug-in EVs and b EVs with on-board TES module. The included photos depict the PCM-based TES module developed from Birmingham Centre for Energy Storage, University of Birmingham

Thermal energy fundamentally represents a temperature difference: a hot source for heat storage and a cold source for cold energy storage, analogous to the way we use voltage differences as an electrical source for storing electricity. Such hot and cold reservoirs can be integrated into existing charging stations to create multi-vector energy refuelling stations for EVs equipped with TES units. Concurrently with battery charging, thermal energy can be transferred into the vehicle.

To enhance energy sustainability, the thermal energy in these reservoirs can be derived from waste thermal energy from nearby factories, power plants, a heater driven by off-peak electricity, renewable energy sources [23], or even high-density integrated data centres [27]. This is illustrated in Fig. 3, which shows how TES can be effectively utilised in EVs by integrating natural thermal energy sources or industrial waste heat into the system. Consequently, the operational cost of TES could be significantly lower than using stored electricity from the battery.

From a broader perspective, if TES techniques were commercially adopted in EVs, the thermal energy supply network, along with the EVs, could form a large thermal energy repository due to the increasing number of EVs. This repository could directly store a substantial amount of waste thermal energy from factories or power plants for later use, essentially turning waste into wealth (Fig. 1b). Considering the large number of EVs equipped with TES, this network could create a significant thermal energy reservoir, which is a key advantage of TES implementation.

For thermal reservoirs in multi-vector energy refuelling stations that are unable to obtain waste thermal energy from factories or power plants due to power transmission economics, thermal energy can still be generated using electricity either from the grid or renewable power sources, such as wind, sunlight, or tidal energy. This offers an opportunity to manage electrical power in the grid, such as by reducing peak load through off-peak charging of thermal energy for cold chain vehicles, or sequestering and storing multiple forms of renewable energy.

With the advent of smart grid technology, they can facilitate intelligent energy management, including power consumption prediction and preparation for power surges by pre-emptively generating electricity or thermal energy.

They can respond to unforeseen power outages caused by extreme weather or natural disasters like tornadoes or tsunamis. For example, EVs equipped with TES units can serve as distributed mobile emergency energy suppliers.

Vision of the energy flowchart distributed thermal energy harvest, storage and charging hubs co-located with multi-vector energy refuelling stations for the provision of electrical and thermal energy to EVs

The authors would like to acknowledge the support from Engineering and Physical Sciences Research Council of the United Kingdom in the form of grants with number: EP/W027372/1, EP/T022981/1, and EP/S032622/1.