FTA
FEDERAL TRANSIT ADMINISTRATION

U.S. Department of Transportation
Federal Transit Administration

REPORT SUMMARY

Review and Evaluation of Wireless Power Transfer (WPT) for Electric Transit Applications

Background

This research report provides a status review of emerging and existing Wireless Power Transfer (WPT) technologies applicable to electric buses (EB) and/or light rail transit. WPT enables rapid in-station or dynamic opportunity (boost) recharging of electric bus batteries for range extension and promises improved energy efficiency, environmental compatibility, economic, convenience, and safety benefits.

Objectives

The purpose of this study was to review and evaluate the maturity of WPT technologies for transit applications. A literature review identified WPT for electric bus and light rail that were successfully demonstrated or deployed. WPT electric bus projects have recently been funded by the FTA Transit Investments in Greenhouse Gas and Energy Reduction (TIGGER) and Clean Fuels Grants to demonstrate and evaluate in service performance. The WPT technology providers, system specifications and attributes, and respective Technology Readiness Level (TRL) are summarized. Regulations and consensus standards for emissions and human exposure safety to electromagnetic radiation and fields (EMR/EMF) and protection from Electromagnetic Interference (EMI) were reviewed. Measured EMR/EMR levels for various WPT electric bus systems comply with applicable occupational and public safety, health, and environmental exposure standards. Information on the cost-benefit, reliability, durability, and safety of WPT infrastructure and vehicle systems is scant. Research gaps and challenges and opportunities for WPT commercial deployment are identified.

Findings and Conclusions

WPT technology offers the promise of economic benefits, greater convenience, and safety and environmental sustainability benefits.

Section 1 provides the rationale for considering transit applications of emerging and existing WPT technologies. Competing WPT technology options are discussed, especially the most widely-used subset of WPT known as Inductive Power Transfer (IPT), which enable rapid in-station or opportunity (boost) dynamic recharging of electric bus batteries for range extension. Section 2 identifies commercial WPT technology developers and providers of Electric Vehicle Supply Equipment (EVSE) infrastructure as well as vehicle modules for bus and rail systems. Ongoing research and development efforts at federal agencies to improve WPT vehicle technologies are described.

Section 3 discusses international and U.S. bus and rail projects using WPT, ranging from demonstration to in-service operation. FTA-funded WPT demonstrations currently underway or in planning stages are highlighted. Section 4 identifies Safety, Health, and Environmental (SHE) concerns, applicable regulations, and voluntary standards for WPT infrastructure, vehicles, and operations. Consensus standards limit electric and magnetic fields (EMF) and radiation (EMR) emissions to ensure human exposure safety and operational safety and environmental compatibility are discussed. Standards for the protection of electrical equipment and electronic devices from electromagnetic Interference (EMI) to ensure electromagnetic compatibility (EMC) are reviewed.

In Section 5, the Technology Readiness Level (TRL) is assessed for WPT transit systems that are deployed, demonstrated, or in planning and development. Knowledge gaps, research needs, and major challenges to deployment of WPT in transit are identified. Research needs, as well as WPT technology challenges and opportunities for public and commercial transit system deployment are summarized.

Benefits

Available WPT technologies promise to improve electric bus and light rail mobility, logistics, and user convenience through shorter station dwell times for recharging on vehicle batteries, or wayside energy storage systems. Potential advantages of WPT technologies in transit applications include interoperability, ease-of-use, and environmental sustainability, as well as lower lifecycle cost and higher energy efficiency than conventional wired alternatives. WPT could also reduce vehicle cost by allowing for smaller, lighter, and lower capacity batteries. WPT technologies could also improve system operational safety, since road-embedded infrastructure has no exposed high voltage cables or power outlets for plug-in hybrid and electric buses. Potential WPT benefits, such as lower cost of infrastructure construction, operation, and maintenance, as well as reliability and durability, are yet to be demonstrated and quantified for in-service operation for adoption by transit agencies.

Project Information

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