Joint Transportation Research Program

Principal Investigators: Konstantina Gkritza, Purdue University, nadia@purdue.edu, 765.494.4597
Dan Daehyun Koo, Purdue University, dankoo@iupui.edu, 317.278.1957
Kyubyung Kang, Purdue University, kyukang@purdue.edu, 765.496.0796
Samuel Labi, Purdue University, labi@purdue.edu, 765.494.5926
Program Office: jtrp@purdue.edu, 765.494.6508, www.purdue.edu/jtrp
Sponsor: Indiana Department of Transportation, 765.463.1521

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A Strategic Assessment of Needs and Opportunities for the Wider Adoption of Electric Vehicles in Indiana

Introduction

The diffusion of electric vehicles (EVs) can enhance energy security and reduce fuel consumption, emissions, and vehicle operating costs. As such, transportation agencies are encouraged to be strategic and adapt to the ongoing evolution in vehicle propulsion by identifying and pursuing a strategic assessment of needs and opportunities for wider adoption of EVs. In 2020, the Indiana Department of Transportation (INDOT) commissioned this study to address this issue. The study had the following objectives.

- Assess the current and emerging trends in EV operations, with a focus on EV charging infrastructure and EV demand forecasting.
- Examine opportunities for the strategic deployment of EV charging stations, including the identification of EV infrastructure deficit areas and the evaluation of strategic partnerships.
- Investigate the impact of EV adoption on highway revenue and the feasibility of new revenue structures.

Findings

The research team developed a framework to identify the EV infrastructure deficit areas and analyze potential EV charging station deployment. The simulation and GIS analysis also identified areas that could demand significant EV charging energy. Marion and Hendricks Counties were identified as the top two counties where many EV long-distance trips may be interrupted due to depleted energy. Other counties include Morgan, Johnson, Madison, Bartholomew, Hamilton, Marshall, Boone, Grant, LaPorte, Cass, White, Shelby, Huntington, Putnam, Decatur, and Owen as potentially charging deserts in the future. To minimize the impact of energy deficient areas for the EV charging station deployment, the future EV infrastructure investment plan shall consider those counties. The study outcomes also provide the geographical magnitude of the EV energy demand defined by the ISTDM regions. In addition, the study confirms that the Greater Indy area is potentially the most EV energy required region, followed by the SR-46 Corridor, SIDC, and NCIRPC among the 17 ISTDM regions.

The study also created a framework to estimate the impact of EV adoption on the fuel tax revenue and identify the optimal EV fee based on scenarios of EV market penetration levels. The fuel tax revenue loss for Indiana and INDOT were estimated for the following scenarios: most likely, optimistic, and pessimistic. In the most likely scenario (5% EV market penetration level for light duty vehicles in 2030, 30% for medium and heavy duty vehicles in 2030), the statewide fuel tax revenue will decrease by 21% and INDOT fuel tax revenue will decrease by 24% by 2035, relative to 2030. To maintain the same fuel tax revenue per vehicle, annual fees ranging from $241 (in 2021) to $342 (in 2035) for automobiles; $344 to $435 for light trucks; $1,246 to $1,488 for buses; $969 to $1,243 for single-unit trucks; $6,192 to $7,321 for combination trucks; and $26 to $35 for motorcycles would be needed over the analysis period (2021–2035).

The recovery EV fee was also converted to a vehicle miles traveled (VMT) ($/mile) and pay-as-you-charge ($/kwh) fee per vehicle class and per year. Potential barriers to the implementation of these options (e.g., sustainability, costs, privacy concerns) and policy aspects (e.g., implementation process, partnerships, and equity considerations) were examined.

Although EV users may pay additional charges that can hinder the adoption of EVs, this is only one aspect of the total cost of ownership since EVs have lower operating costs.

To gather knowledge on the main aspects related to the promotion of EVs and evaluate the strategic partnerships and business models, semi-structured interviews were conducted online with twenty-three stakeholders who represented the EV ecosystem. The content analysis showed that stakeholder partnerships and appropriate business models may depend on various factors, including the type of charging (private vs. public or level 2 vs. fast charging), the location (local, state, or regional level) and the vehicle type (commercial fleets vs. privately-owned vehicles). Most interviewees supported the idea that the provision of charging infrastructure involves mainly private entities, while public sector provides a critical role of providing direct or indirect incentives to users, as well as planning the charging infrastructure, raising awareness, and educating all stakeholders involved.

Furthermore, the interviewees identified transit buses as the vehicle type with the highest potential for electrification followed by school buses and small freight vehicles or delivery vans. Equity concerns were raised related to the availability of charging infrastructure in rural areas as well as the various fees/ taxes to be charged per EV to address the potential for decreased fuel tax revenue. A VMT fee was argued as a fair approach to generating highway revenue, but privacy concerns were viewed as a major barrier for its implementation. Lastly, the need for grid management and renewable energy integration was seen as a high priority as EV adoption and, especially, commercial electric vehicle adoption increases.

Implementation

The agent-based simulation model of the study is developed for future long distance EV trip scenarios in the State of Indiana and uses unique geographical information and model parameters for Indiana. This model enables INDOT to identify EV energy deficient areas for current and future energy charging demand scenarios and can support the state's strategic planning for the EV charging infrastructure development.

The results of the revenue impact analysis can inform INDOT's revenue model and assist decision makers establish more reliable plans regarding preparedness for prospective EV operations in the coming future. The estimations of the recovery EV fee, the VMT fee, and pay-as-you-charge fee can be used by INDOT in pilot programs to capture users' perspectives and estimate appropriate fee rates and structures. It is anticipated that the revenues from the EV recovery fee will be split between the state and the local governments. A state share of 75% or higher will ensure that INDOT's revenues move beyond break-even to a surplus. Additionally, to offset the gasoline revenue loss, a VMT or pay-as-you-charge fee may be more appropriate and equitable. Extensive public outreach and education should be undertaken to inform users about the overall long-term cost savings associated with EV use.

The insights obtained from the stakeholder interviews can be used to enhance preparedness for increasing EV adoption rates across vehicle classes and strengthen the engagement of different entities in the provision of charging infrastructure. Among others, collaboration between utilities and policy makers is needed to plan for increasing EV demand (especially regarding commercial vehicles that have increased power requirements). The planning process may consider upgrades of the transmission and distribution network, grid management technologies such as vehicle-to-grid, integrated plans for renewable energy projects, new tariff structures to reward charging behaviors, and investigation of the impacts of EV demand on transportation system operations.

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