Electrification of School Bus Routes: A Summary on Risk, Resilience, and Sustainability

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1. Summary

The shift to electric school buses is an important step toward sustainable and clean transportation. This transition can significantly reduce greenhouse gas emissions and improve public health, but it also presents risks and challenges. This summary outlines the key risks, resilience benefits, and sustainability impacts of electrifying school bus routes.

2. Risk, Resilience, and Sustainability

2.1. Risks in School Bus Electrification

School buses may be well-suited for electrification due to their low daily use levels and long overnight dwell periods, but this process faces significant challenges. Firstly, electric school buses (ESBs) require a much higher initial investment, costing around $400,000 per bus compared to diesel buses at about $100,000, with added costs for charging infrastructure and software [1]. While ESBs have lower operational costs due to reduced fuel and maintenance needs, offsetting the high upfront expense remains a challenge. Secondly, under time-of-use (TOU) rate structures, the difference in electricity prices between peak and off-peak hours highlights the need for careful management of charging schedules to control costs [2]. Lastly, adding a large number of ESBs to the power grid may stress the distribution system, requiring studies to understand and mitigate these impacts [2]. As the fleet grows, it's increasingly urgent to address costs, operational needs, and power grid effects. Also any major disruption in the power grid may lead to significant consequences on the operation of electric school buses.

2.2. Resilience Benefits

A handful of studies have evaluated the economic feasibility of transitioning school buses from diesel to electric. Noel and McCormack, for example, assessed the cost-effectiveness of vehicle-to-grid (V2G)-capable ESBs compared to traditional diesel buses [3]. Their analysis considered factors such as fuel and electricity costs, battery expenses, health impacts, and

market prices for frequency regulation. They concluded that purchasing V2G-capable ESBs consistently offers a net present benefit across all scenarios tested. Transitioning to electric school buses also provides community resilience against fossil fuel price volatility.

2.3. Sustainability Impact

Adopting ESBs offers health benefits by reducing exposure to ambient air pollution and greenhouse gas emissions [4]. Replacing old diesel buses with electric ones in large metropolitan areas provides substantial health benefits, especially for local populations. Policies that support fleet turnover in densely populated areas can be highly cost-effective. However, health benefits vary by region, so evaluating the most cost-effective strategy requires location-specific cost analysis. Additional research is needed to understand the health impacts on children riding electric school buses, particularly in rural areas where older diesel buses may significantly affect in-bus air quality for children.

3. Conclusion

The shift to electric school buses presents a promising path toward sustainable and resilient transportation, with substantial benefits for public health and reduced greenhouse gas emissions. However, the transition involves challenges, such as high upfront costs, operational complexities, and potential impacts on the power grid. By strategically managing these challenges and promoting policies that support fleet turnover, especially in densely populated areas, communities can maximize both the health and economic benefits of ESBs, advancing toward cleaner, more resilient transportation systems.

References

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