

Life Cycle Environmental Impact of Houston METRO System – Evaluation of Electric Alternatives

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19PPPVOU01

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Funds Requested to UTC:
\$45,500

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Tran-SET

Total Project Cost:
\$46,500

Providing a comprehensive cradle-to-grave environmental impact of the Houston METRO system

The proposed project would address the critical gap in comprehensive cradle-to-grave environmental impact of the Houston METRO system, and develop environmental life cycle assessments for the bus and light-rail routes operated by METRO. This project also will provide quantitative estimates for GHG and CAP emissions, when considering future route expansions, and fleet modification to electrical vehicles. A novel component of the proposed project would be the development of a decision making tool that would provide CO2 and energy payback times as a function of ridership and mode shifts from automobile to METRO bus/light-rail. Results from this project would serve as a guidance framework in order to evaluate the effects of the decision to expand METRO system, and estimate the contribution of METRO system in realizing the environmental objectives of the Greater Houston Area.

Problem Statement

Urban mass transit systems alleviate road traffic congestion and reduce the total greenhouse gas emissions (GHG) from the transportation sector. Houston METRO operates buses along 86 routes in the Greater Houston area, and three light rail lines, red, purple and green lines that have an average daily ridership of 61,000 passengers as of June, 2018. Public transportation systems reduce the total emissions of criteria air pollutants (CAPs) from urban centers, and form an integral part of environmental strategies to combat climate change. A comprehensive energy and environmental life cycle assessment (LCA) study is vital to quantify the improvements, and identify any potential systemic modifications that could further lower environmental impact. As per EPA's 2014 National Emission Inventory, mobile sources (on- and off-road vehicles) contributed the highest share (67%) of nitrogen oxide (NOx) emissions, and second-highest share (23%) of volatile organic (VOC) emissions in the Greater Houston Area. The METRO system is a key element in Houston's infrastructure that can be expanded to lower emissions of CAPs and GHGs, and improve regional air quality. However, any expansion of

the METRO system includes upfront infrastructure, and supply chain processes, that need to be considered when evaluating environmental impact. Currently, there is a lack of quality data on the comprehensive energy and environmental impacts from the METRO system. In addition, comparative studies for relative emissions and environmental impacts between passenger automobiles and METRO routes in Houston are non-existent. The proposed project would address this critical gap and develop environmental life cycle assessments for the bus and three light-rail routes operated by METRO, and provide quantitative estimates for GHG and CAP emissions, when considering future route expansions, and fleet modification to electrical vehicles.

Objectives

The overall objective of this study is to provide an estimate of the energy and environmental impacts from the total life cycle of the Houston metr system and provide cost-benefit analysis for an electrification alternative. Following are the major objectives that constitute in realizing the overall goal: (a) Estimate the total GHG and CAP emissions from the current operational routes of the bus and light-rail fleet of the Houston metro system; (b) Quantify the total energy and environmental impact resulting from Houston metro, across 15 mid-point and four end-point/damage categories for the Greater Houston region; (c) Evaluate the net change in energy and environmental impact due to transitioning of metro fleet to electric vehicle; (d) Determine the impact of electrification and expansion of Houston metro system on regional air quality and global warming potential; (e) Compare the improvement in sustainability resulting from varying degrees of traffic migration/passenger adoption from automobiles; and (f) Provide guidance to stakeholders, community leaders within Houston to adoption of electric vehicles and expansion of metro ridership.



Intended Implementation of Research

Education: The PIs will incorporate new information on SimaPro software and LCA research into existing training modules and course content. This training modules will be integrated into the course curriculum of Civil & Environmental Engineering at PVAMU. The PIs will deliver presentations and lectures in undergraduate engineering classes on the importance of LCA as a powerful tool for assessing the environmental/energy impact all construction and engineering projects. Comprehensively, the research team proposes to upgrade the three LCA traing modules for use in educationg students.

- Module 1: Introduction to LCA
- Module 2: LCA METHodoology
- Module 3: LCA applications in Civil & Environmental Engineering

Outreach activities and Education: The research team will work with PVAMU's research and outreach programs to coordinate educational offerings on transportation infrastructure for minority and underrepresented students in PVAMU. Through this current project we anticipate to partially fill the requirement of improving participation of underrepresented groups in critical STEM areas, thereby increasing diversity in STEM professions and encouraging future enrollment by increasing visibility and national recognition of PVAMU. The PIs will also leverage existing collaborations with CEES netwroks to establish seminal/workshop to disseminate research findings to community leaders and stakeholders in the city of Houston and Harris County. In order to increase public awareness to electrification and expansion of metro system, we propose to organize information sessions to present information on the potential environmental/social benefits to Houston and the South-Central region of U.S.

Anticipated Impacts/Benefits of Implementation

Anticipated impacts of the project output have not been determined at this time. They will be reassessed at the end of the technical phase.

Web Links

- [TranSET's website](https://transet.lsu.edu/research-in-progress/)
(<https://transet.lsu.edu/research-in-progress/>)
- [TRB's Research in Progress \(RIP\) database](https://rip.trb.org/View/1644236)
(<https://rip.trb.org/View/1644236>)

Tran-SET

Tran-SET is Region 6's University Transportation Center. It is a collaborative partnership between 11 institutions (see below) across 5 states (AR, LA, NM, OK, and TX). Tran-SET is led by Louisiana State University. It was established in late November 2016 "to address the accelerated deterioration of transportation infrastructure through the development, evaluation, and implementation of cutting-edge technologies, novel materials, and innovative construction management processes".

Learn More

For more information about Tran-SET, please visit our [our website](#), LinkedIn, Twitter, Facebook, and YouTube pages. Also, please feel free to contact Mr. Christopher Melson (Tran-SET Program Manager) directly at transet@lsu.edu.

