DRISI
Caltrans Division of Research, Innovation and System Information

Research Results

Planning, Policy & Programming

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Potential Greenhouse Gas Emissions Reductions from Optimizing Urban Transit Networks,

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Potential Greenhouse Gas Emissions Reductions from Optimizing Urban Transit Networks

The researchers evaluated the benefit of design and operational approaches for reducing the greenhouse gas emissions of urban transit systems.

WHAT WAS THE NEED?

The public transportation sector in the United States annually emits approximately 13 million metric tons of the greenhouse gas carbon dioxide. Recent investments in the transit sector to address greenhouse gas emissions have concentrated on purchasing lower emission replacement vehicles. There has been little focus on the potential for operational improvements to reduce greenhouse gas reductions. Transit system design modifications such as reducing the frequency of service or increasing the distance between transit lines have not been evaluated. Previous research by the Principal and Co-Principal Investigators has shown that a greenhouse gas emission reduction can occur by reducing the level of service to transit customers. However, elastic demand was not considered in this research. Elastic transit demand may lead to a city-wide increase in greenhouse gas emissions because travelers switch from relatively clean transit to polluting vehicles such as single-occupancy automobiles. There is a need to develop policies more likely to achieve the greenhouse gas emissions reduction set by Assembly Bill (AB) 32.

WHAT WAS OUR GOAL?

The goal of the research was to investigate two different policy scenarios that are consistent with greenhouse gas emissions reduction called for in AB 32. In the first scenario, transit operators are required to reduce their greenhouse gas emissions, while in the second scenario cities are required to reduce their greenhouse gas emissions from the transportation network, as a whole. The research will identify which of these two policies is more likely to lead to the desired results and move cities closer to achieving the greenhouse gas emissions reduction set by AB 32, while avoiding the unintended results of lowering greenhouse gas emissions from transit only to accrue an overall increase in greenhouse gas emissions.

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WHAT DID WE DO?

Literature Review: First, we developed a concise literature review on the state of the art in emissions from public transportation and transit network design. A previous literature review which focused on emissions from public transportation and public transportation network design was expanded and updated to insure completeness, up-to-date models, and data. Additionally literature on transit travel time elasticities were included to obtain realistic values for a U.S. city context.

Model Extensions: We extended our models by incorporating elastic demand, to allow for the possibility of transit users shifting to the auto mode in the face of level-of-service reductions. Curves showing the relationships between greenhouse gas emissions and user travel time were developed for a range of hypothetical cities, of varying sizes, demand densities, and elasticities, and for four different trunk technologies (bus, bus rapid transit, light rail transit, and heavy rail transit). This was done for both versions of the problem formulation: transit agency emissions constraint and city-wide emissions constraint.

Case Study: We applied our methodology to the MUNI bus network in San Francisco as a case study. The objective was to demonstrate the applicability of our proposed approach to a realistic setting.

The case study quantified the following:

1. The agency and user costs and greenhouse gas emissions for the current Muni system, and where it falls relative to the Pareto frontier
2. The potential for system cost reductions for San Francisco if the system were designed optimally to minimize costs
3. How the answer to #2 might change if greenhouse gas emissions constraints are introduced, for both the idealistic and elastic demand cases.

WHAT WAS THE OUTCOME?

The main findings of this research are:

1. In large cities, hierarchical transit systems with mass transit modes (metro, for example) tend to be more cost- and emission-efficient. However, in small cities, trunk-only bus systems may be more favorable with regards to both costs and emissions savings.
2. Transit demand elasticity offsets transit emissions reduction efforts by causing additional automobile emissions due to demand shifting away from transit. Transit agencies should evaluate the demand elasticity in areas of interest before trying to reduce emissions through lowering transit levels of service.
3. The process of transit cost minimization may also reduce greenhouse gas emissions.

WHAT IS THE BENEFIT?

Quantifying the potential tradeoffs between level of service and emissions can help transit agencies select the trunk transit technology and optimal network attributes for hierarchical transit grid systems.

LEARN MORE

The final report may be accessed at the following website:
http://escholarship.org/uc/item/25x1b693