Impact of Energy-Efficient Route Selection on Charging Infrastructure

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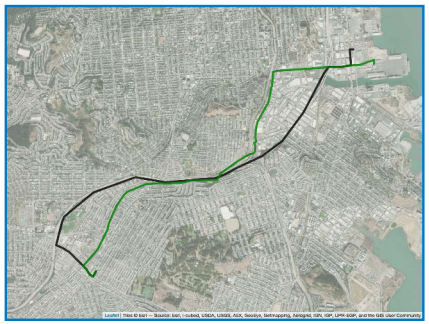
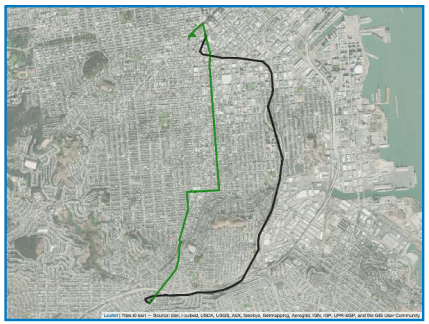
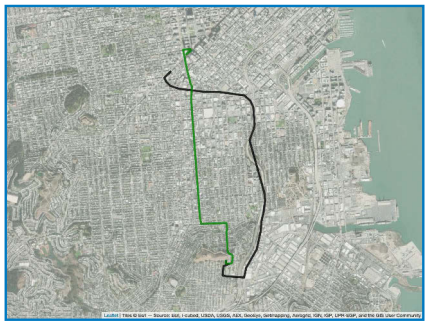
AUTOMATED VEHICLES SYMPOSIUM 2019
USERS. VEHICLES. INFRASTRUCTURE.



RouteE calculates that this non-highway alternative (green) shows an energy cost improvement of 412.36 Wh.



By travelling 1,370.79 fewer meters for an added 1.5 minutes, this eco-alternative (green) saved 534.27 Wh.



Some route alternatives (green) include walking access/egress segments, which were not included.

BEAM

RouteE

The Modeling Framework for Behavior, Energy, Autonomy, and Mobility (BEAM) is an open-source transportation simulator designed to explore the dynamic interaction of resource markets, including EVs, transportation network companies (TNCs), and connected and automated vehicles (CAVs).

RouteE is a data-informed model that predicts energy use for a proposed vehicle route. The methodology leverages real-world driving data and either simulated or vehicle-reported energy consumption to train the model.

Motivation

Vehicle automation and electrification have major implications for the transportation network and will create a critical interdependency between transportation and power distribution networks.

Wide electric vehicle (EV) adoption would necessitate a charging experience equivalent to that of fueling a conventional vehicle at a gas station to minimize driver wait times at charging stations.

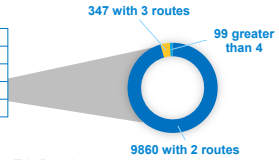
This work employs a co-simulation of BEAM (LBNL) and RouteE (NREL) to attempt to understand the intersection of mobility and energy supply in two modal scenarios, namely energy-efficient and time-efficient routing.

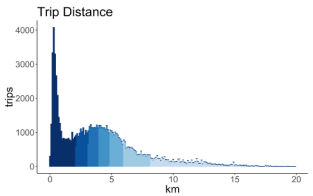
Objective: To explore the scope for energy savings, and corresponding impacts on charging infrastructure from energy-efficient route selection compared to time-efficient route selection by EVs.

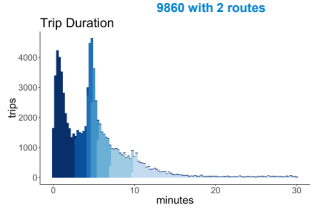
Data

Route requests were extracted from BEAM where multiple trip alternatives existed for the car travel mode.

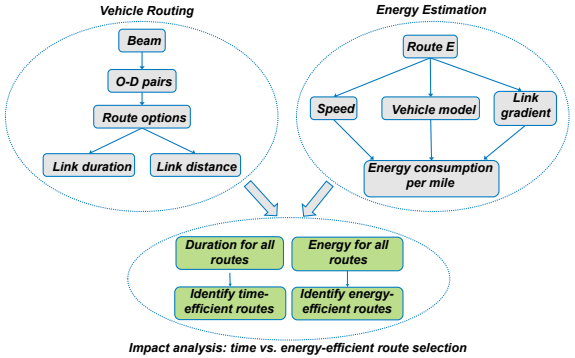
Total Trips	53,607
Trips with Single Routes	43,301
Trips with Multiple Routes	10,306
Time Efficient Route = Energy Efficiency Route	9,172
Time Efficient Route ≠ Energy Efficiency Route	1,134







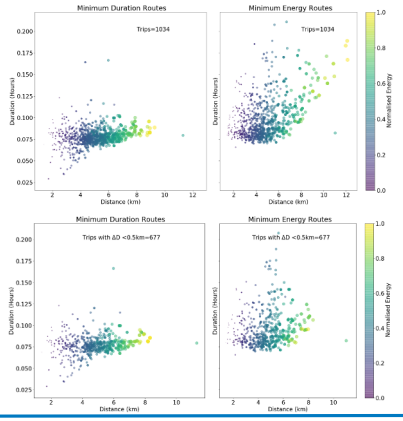
Methodology



Impact analysis: time vs. energy-efficient route selection

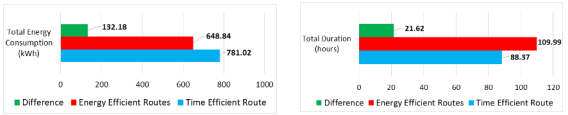
Results

An energy-optimal route plan has a clear trade-off in travel duration

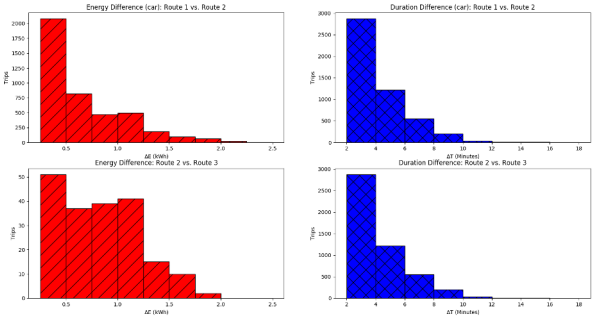


Results (cont..)

Global energy and time observations



Identifying marginal duration and energy across route alternatives



Conclusions & Future Work

Preliminary results indicate energy savings of up to an average of 116.56 Wh per trip, albeit with an average travel time increase of 1.144 minutes per trip.

Although counterintuitive at first glance, this result is of consequence in a future EV scenario where travelers are making a trade-off between reaching a destination in the fastest possible way versus the most energy-efficient way (more so for fleets that operate on demand).

Future efforts will extend the analysis to explore impacts of energy-efficient route choices on charging demand and charging infrastructure in San Francisco.

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