E-Bike city Munich: Gains in accessibility, capacity and energy savings

Master Thesis of Rahmi Puspita Sari

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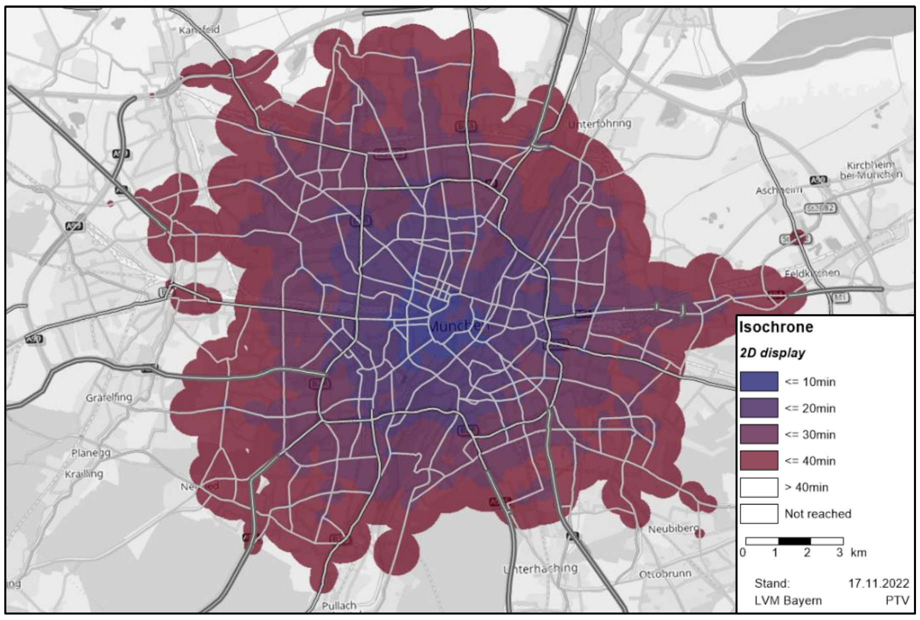
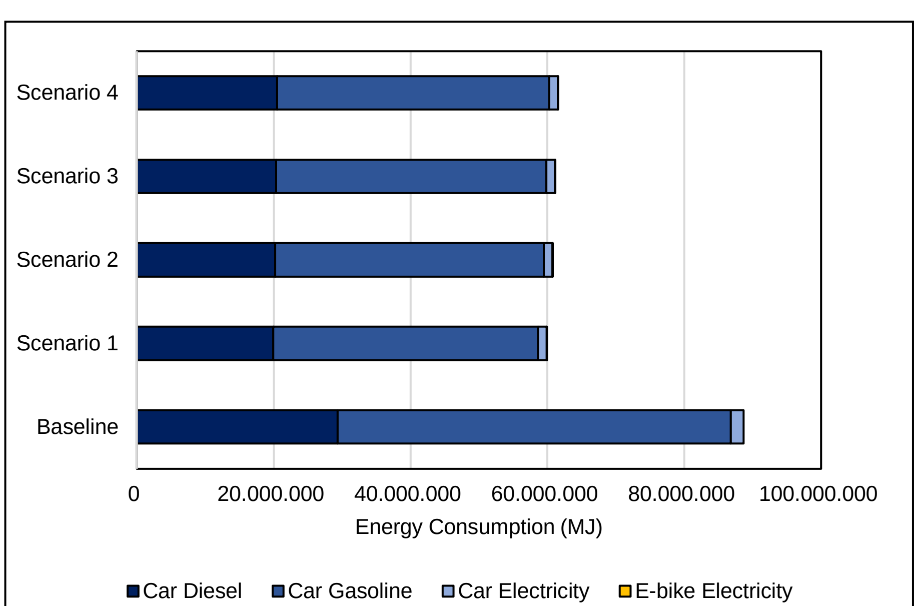


Figure 1. Bicycle Isochrones Assignment Result (Scenario 1)

Result

The overall results show that e-bikes perform well in terms of traffic performance. Speed profiles and trip distribution between trip length is shown in ***Figure 2***. The demand split distribute the trips into cars and e-bikes. For e-bike, the demand split occurred for direct OD distance under 10 km, therefore the generated results are not exactly 50-50 due to the nature of rerouting in each mode. The cars baseline does not outperform both cars and e-bikes in the scenario. e-bikes speed hover at 20 km/h and outperform cars for trips under 10 km. Meanwhile passenger cars outperform e-bikes when the trip length is exceeded 10-15 km

The result suggests that the e-bike city would have more suitable in an area that is dominated by short-distance trips such as the city centre area. The overall result shows a net environmental gain after E-bike City adoptions. The highest reduction is shown in Scenario 1, which only involves 25% of repurposing in Munich City with a total reduction of 750 tons CO_2e per day.



Introduction

Electric bikes (e-bikes) have the potential to displace conventional motorized (internal combustion) modes as it is inexpensive, flexible and faster than cars. Previous research shows that e-bikes have a substitution effect on cars to a certain degree (Kroesen 2017; Söderberg f.k.a. Andersson et al. 2021; Haas et al. 2022).

Ballo et al. (2022) is the one of the earliest studies to use the term of "e-bike City". In this study, the core principle involved is a radical reallocation of transport capacity to be more sustainable modes. approximately 50% of existing road space will be consistently dedicated to cycling, making it safe and attractive while at the same time reducing the attractiveness of driving.

Research Objective

- To develop a comprehensible methodological approach to transforming a city into an E-bike City
- To evaluate the benefits in terms of accessibility, network capacity, energy savings, pollution, and carbon emission using Munich city as a pilot study area

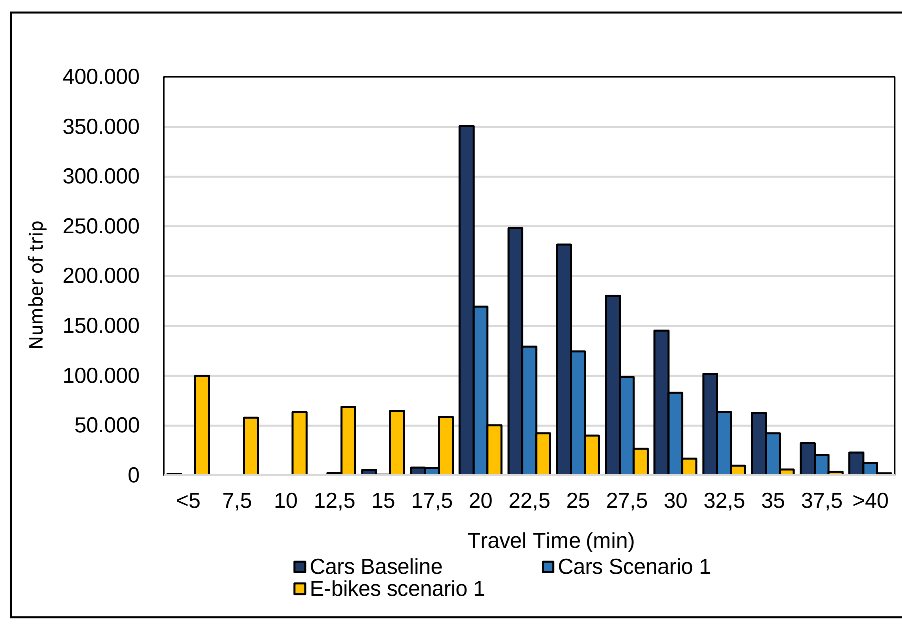


Figure 2. Trips distribution between travel time (Scenario 1)

Analysis

Despite having the difference in the network characteristic, the reduction of CO_2 is mostly contributed by cars shifting. The city-wide application will involve a 12% reduction of the car in the total network while resulting in 29-30% energy savings, 30% CO_2 emission reduction, and under 2% isochrones accessibility reduction.

E-bikes have the lowest cost per kilometer travelled than many other modes (0,89 EUR/km). The cost for passenger cars differs according to fuel type, with a car powered by gasoline having the highest internal cost per kilometer travelled at 1,58 EUR/km, diesel at 1.31 EUR/km, and electricity at 1,13 EUR/km. Meanwhile external cost for e-bikes and cars respectively are 0.000167 EUR/km and 0,6184 EUR/km (3684 times higher).

Overall performance shows that e-bikes contribute to a massive reduction in internal cost, external cost, air pollution, and energy consumption, which can be achieved with minimum network modification and slight congestion.