Speed and Energy Consumption for Electrical Vehicles

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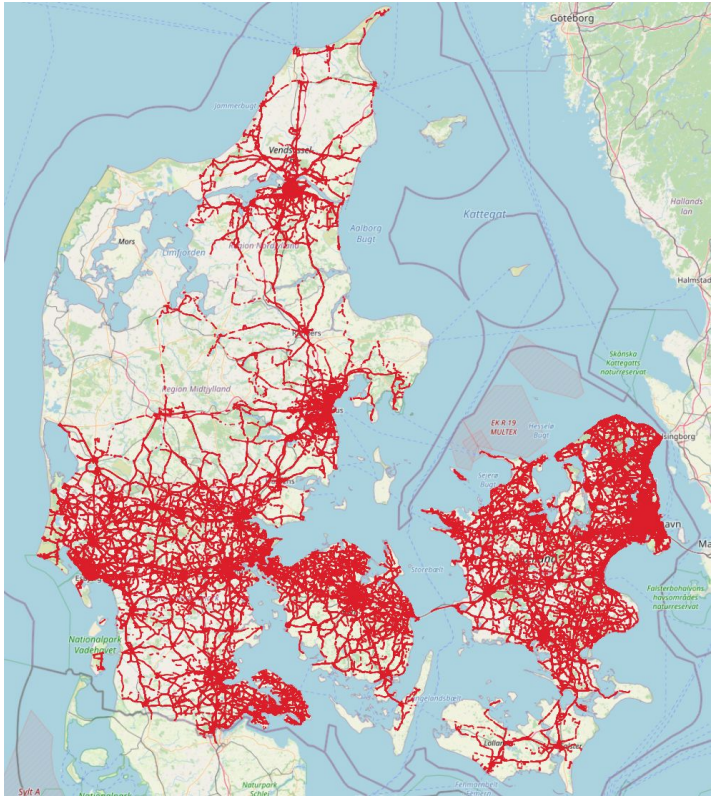
Introduction

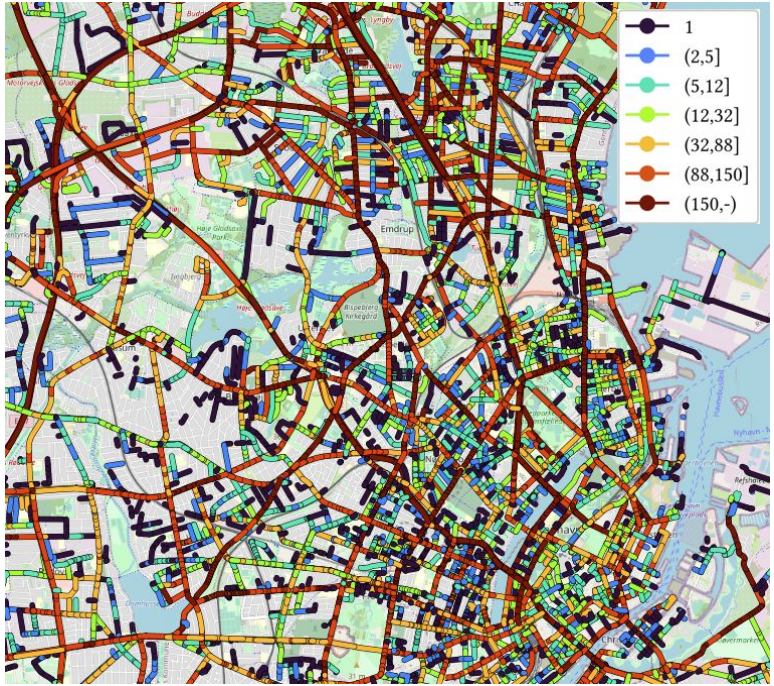
- Transportation sector:
  - 23-36% of all GHG in developed countries;
  - Passenger vehicles account for almost half of it.
- Electrical vehicles do not emit GHG, but...
  - 393g of CO2 per kWh of electricity produced in the US;
  - 306g in EU-28 and 560g for China.
- Eco-driving:
  - Collection of advice to reduce energy consumption (and GHG);
  - Great amount of interest in the last decade, but almost only for ICEVs.

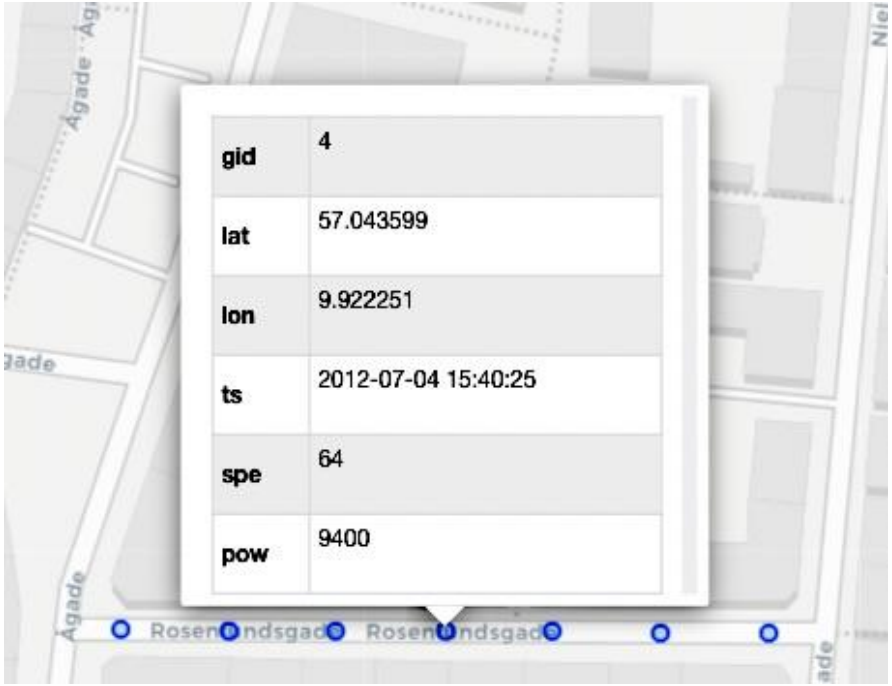
Data Statistics

- Dataset:
  - 75.178.775 GPS+ points;
  - 272.289 trajectories;
  - 7.579.386 subtrajectories;
  - 174.182 road segments.
- GPS device:
  - Latitude, longitude, and timestamp.
- OBD device:
  - Speed and power.
- 29 months of collection.

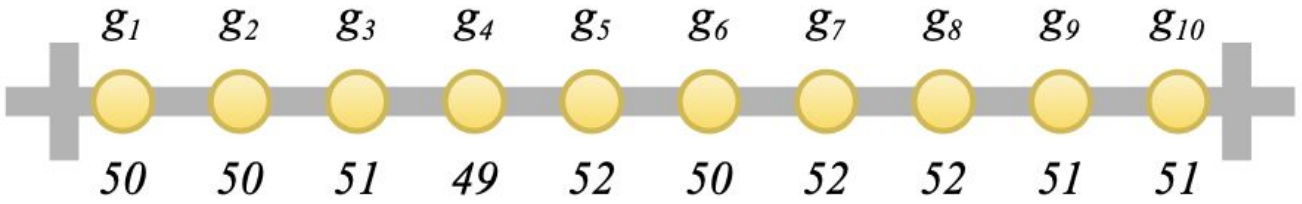


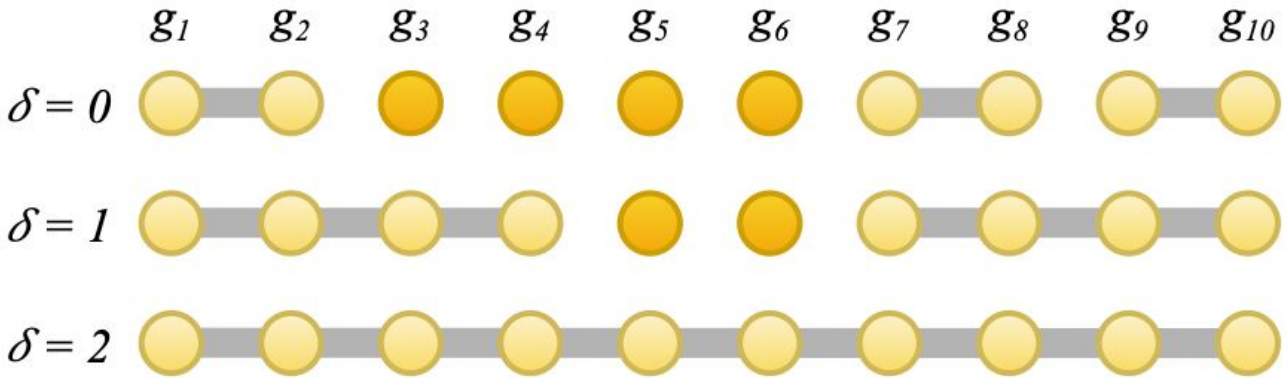
Data Statistics





Steady Speed Period

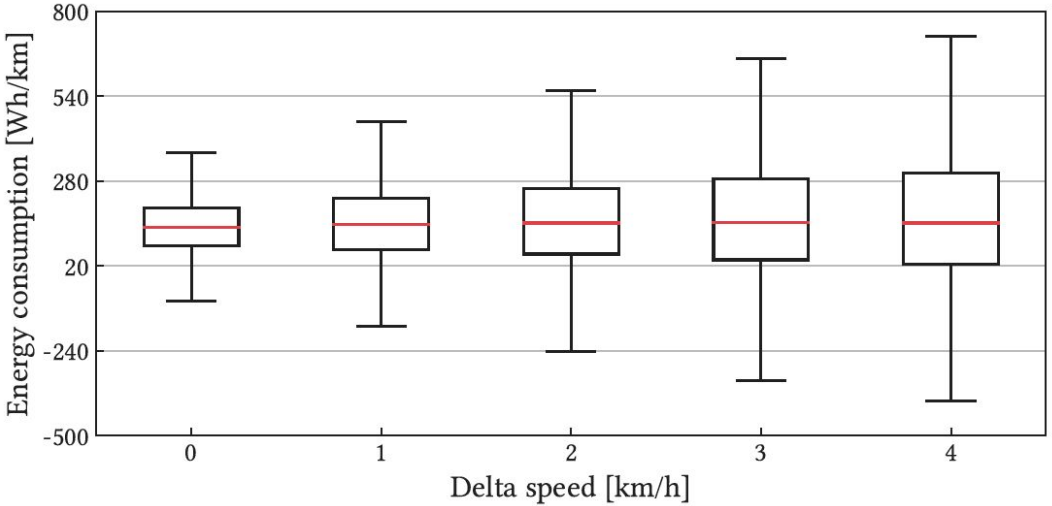




Motivation and Contribution

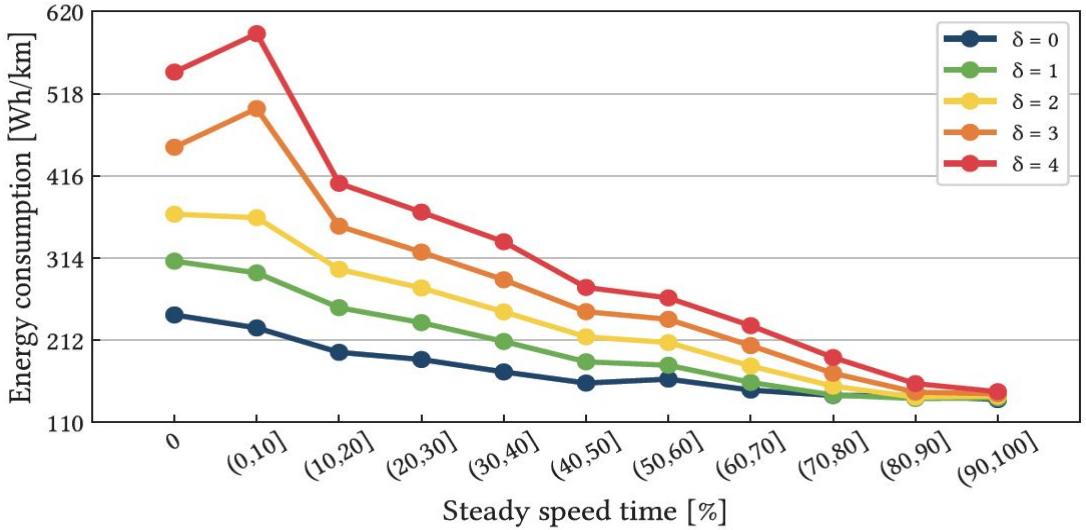
- Strong points:
  - Segment-level study;
  - Large dataset;
  - High-frequency data;
  - Long period of data collection;
  - No controlled or artificial conditions.
- Novel quantified information:
  - Degree of speed fluctuations;
  - Average driving speed;
  - Road category;
  - Time of day, week, month, and year.

Delta Speed



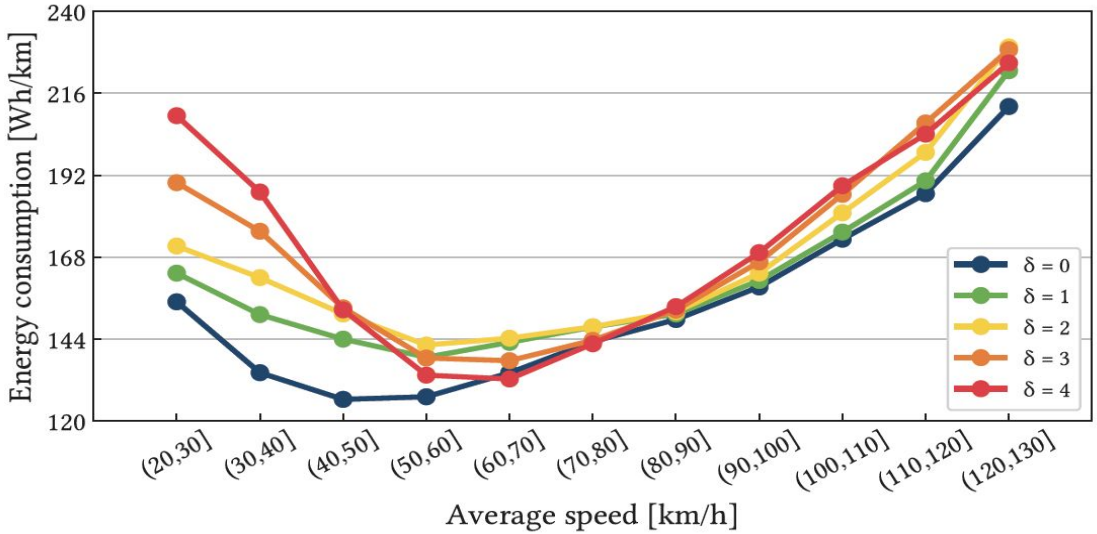
- Slight increase in the median value, from 138 to 151 Wh/km.
- Great increase in variance, from 366 to 724 Wh/km.

Speed Speed Time



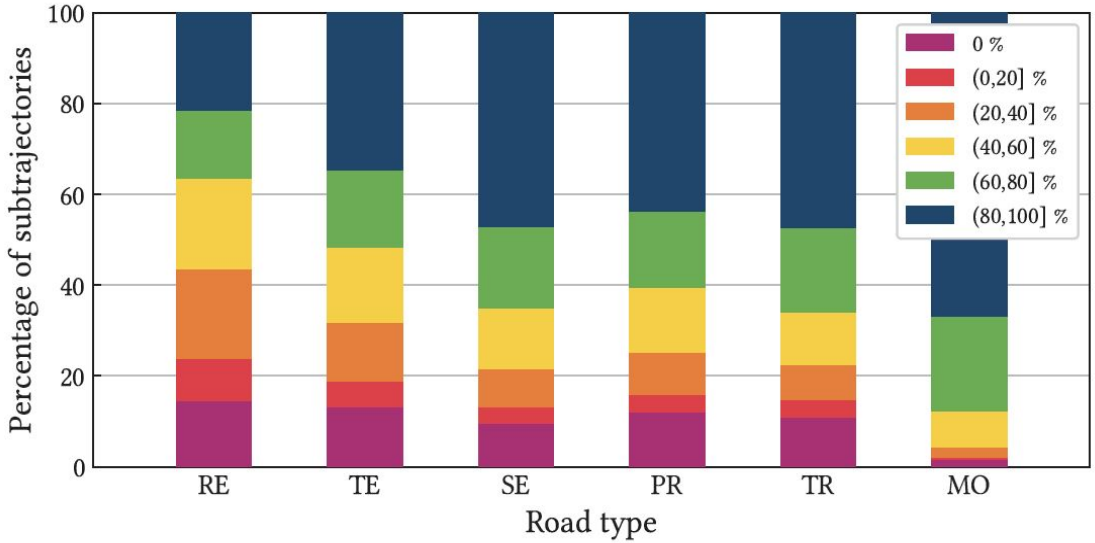
- Same trend for all delta speeds.
- Energy consumption decreases as the steady speed time increase in a linear fashion.

Average Speed



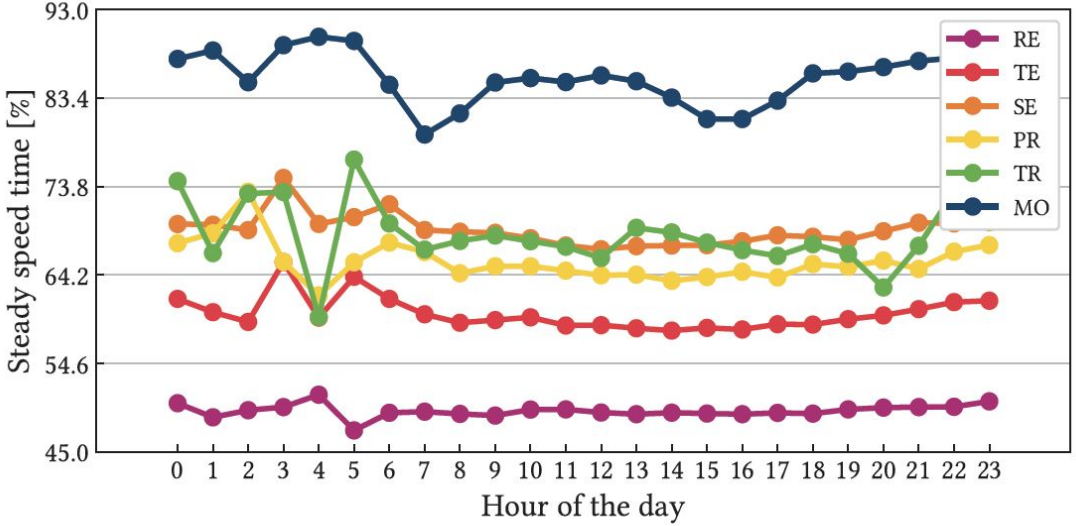
- Clear separation from 20 to 50 and 90 to 130 km/h.
- Overlap from 50 to 90 km/h is likely due to regenerative braking.

Road Segment Type



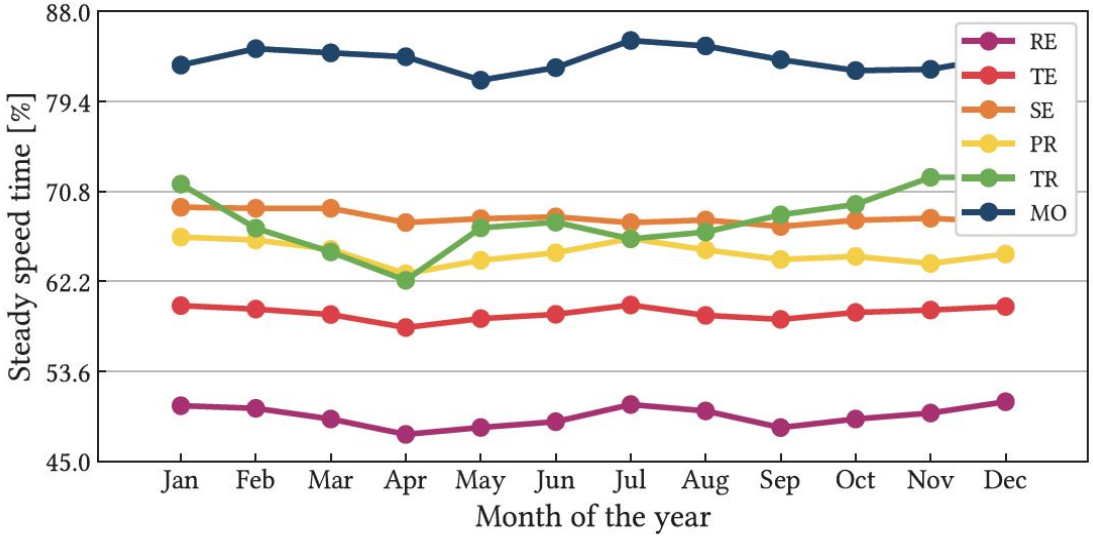
- Clear increase in steady speed time as we move from residential roads to motorways.
- Strong correlation between SST and road length, speed limit, and traffic elements.

Hour of the day



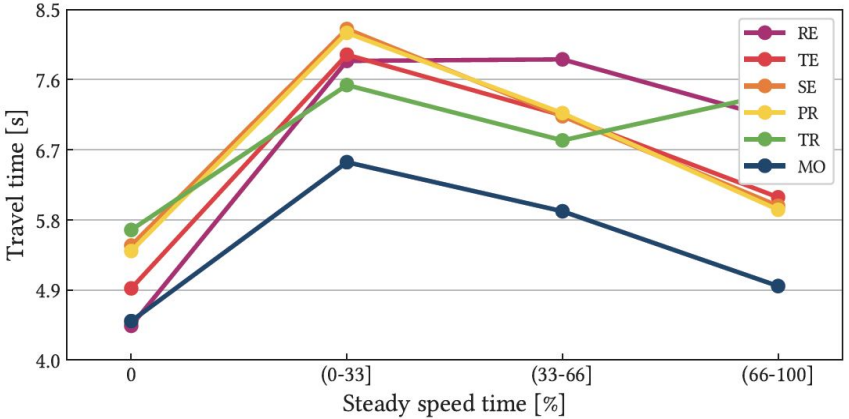
- Difference of around 1% in all road types, except motorways.
- Indication of a high sensibility to traffic volume.

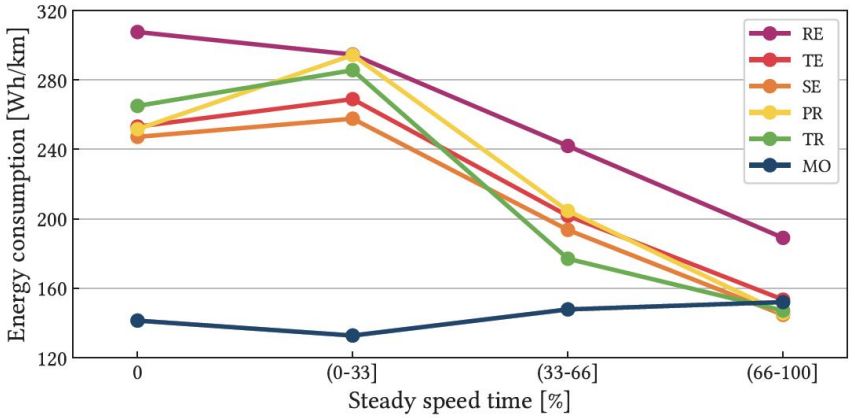
Month of the year



- Around 2% more steady speed from January to March and July to August.
- Low influence of seasonality, more responsibility on the driver.

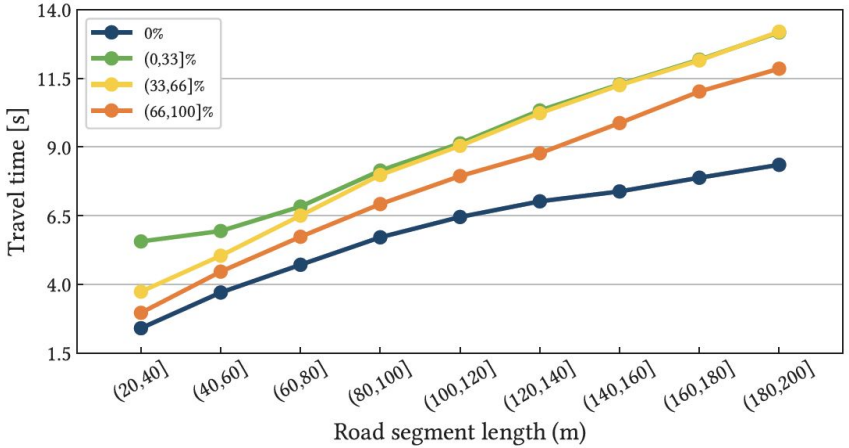
Steady speed and travel time

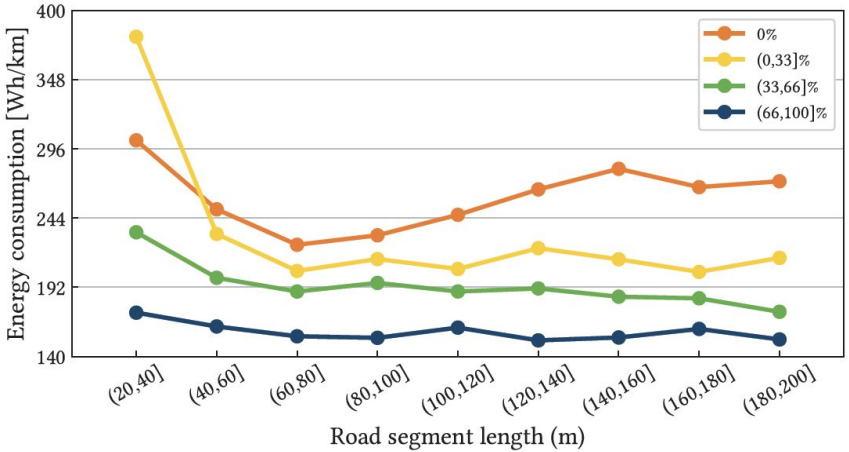




- No steady speed has the shortest time and highest consumption.
- For the travel time, it increases at 33% of SST, but then it decreases.
- For the consumption, it goes down at all SST.

Steady speed and travel time





- From no steady speed to 66-100% increases travel time by 22%.
- From no steady speed to 66-100% decreases consumption by 37%.
- 62% of road segments have 200 m or less.

Summary

- Strong correlation between steady speed and low energy consumption;
- Novel and quantified information:
  - Delta speed;
  - Average speed;
  - Road segment type;
  - Seasonality.
- Identification of window of opportunity:
  - Save up to 42% of energy by increasing travel time by just 10%.
- Most of all, it is possible to save energy now.

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