# The Charging-While-Driving Approach to Push the Highway Mobility towards Full Electrification

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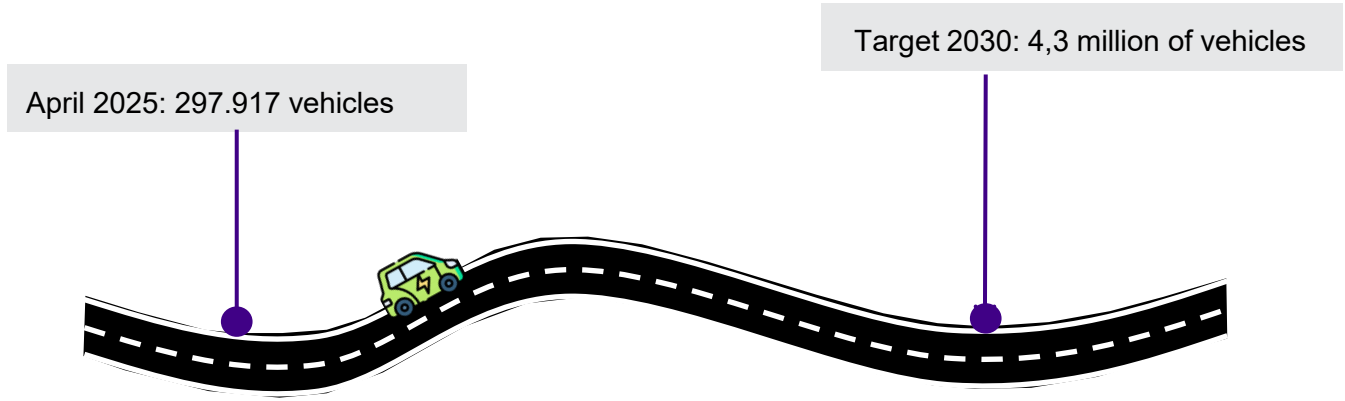
# AGENDA

1. Introduction
2. Objectives
3. Sizing methodology for dynamic wireless power charging
4. Case study
5. Results
6. Conclusions

# INTRODUCTION

## Charging-while-driving: a possible driver for the adoption of electric mobility

Battery Electric Vehicles situation in Italy




There is still a long way to go because BEVs are not as accessible and usable as traditional internal combustion engine vehicles.

**Charge-while-driving approach** with Inductive Dynamic Wireless Power Transfer (DWPT) could be a possible solution, but:

- High investment costs
- High maintenance costs
- Difficut integration with existing infrastructure

- **It is not clear how extensive a potential dynamic wireless power charging infrastructure needs to be to make a real advantage for electric vehicles drivers.**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# OBJECTIVES

Sizing methodology and impact of a charging-while-driving infrastructure


Development of a **Design Support System** for road operators, to optimally size a dynamic wireless power transfer infrastructure.

The tool provides answers to the following key questions:

- **How many charging sections (plants) are needed?**
- **What should be the optimal length of each section?**
- **How many electric vehicles can complete their journey without stopping for recharging at service areas?**

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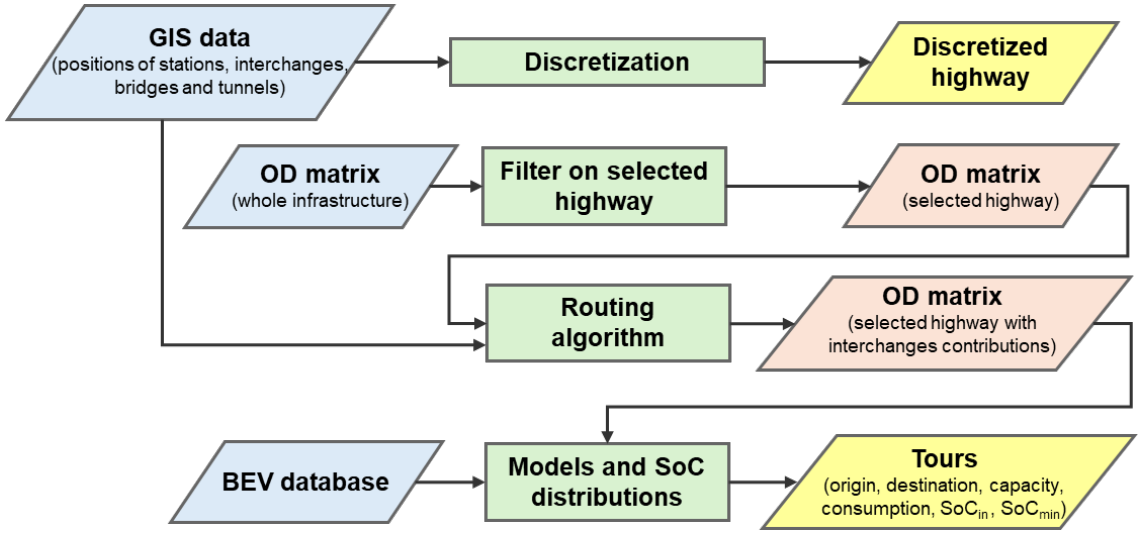
# PROPOSED SIZING METHODOLOGY

General procedure

The methodology can be divided in two main parts.

## FIRST PART: HIGHWAY SEGMENTATION AND TOURS CREATION




## SECOND PART: SIMULATION AND KPI EVALUATION

# PROPOSED SIZING METHODOLOGY

Control function evaluation and simulation procedure

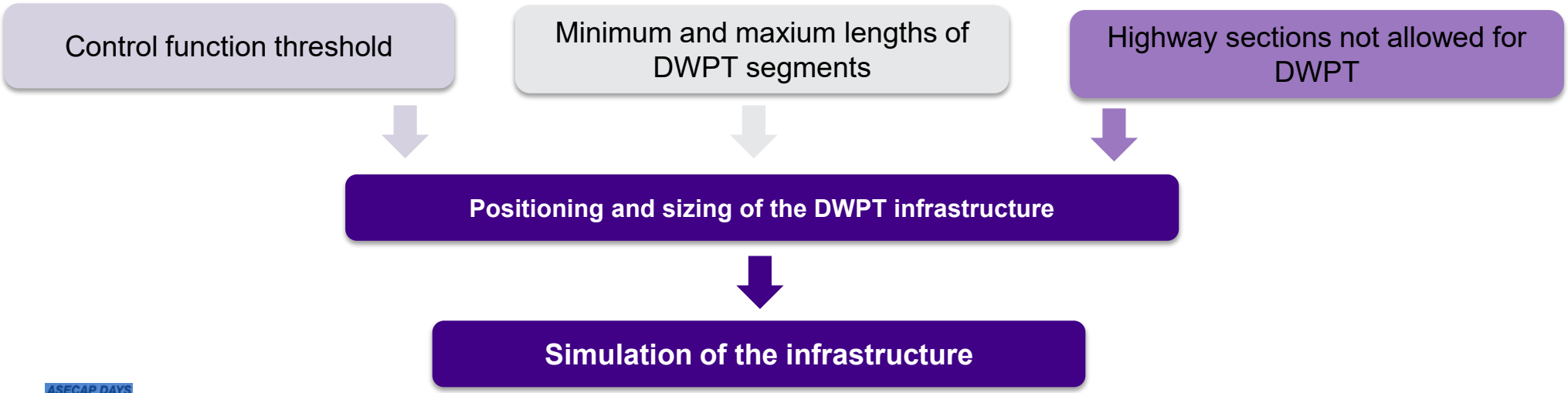
## CONTROL FUNCTION EVALUATION

A **Control function** is used to decide where to place the DWPT.

Decision logic:

- DWPT must be placed at points with high number of daily tours;
- DWPT must be placed at points with high number of vehicles with $\mathrm{SoC} < SoC_{min}$;
- DWPT must be placed where the variance of the SoC distribution is low.

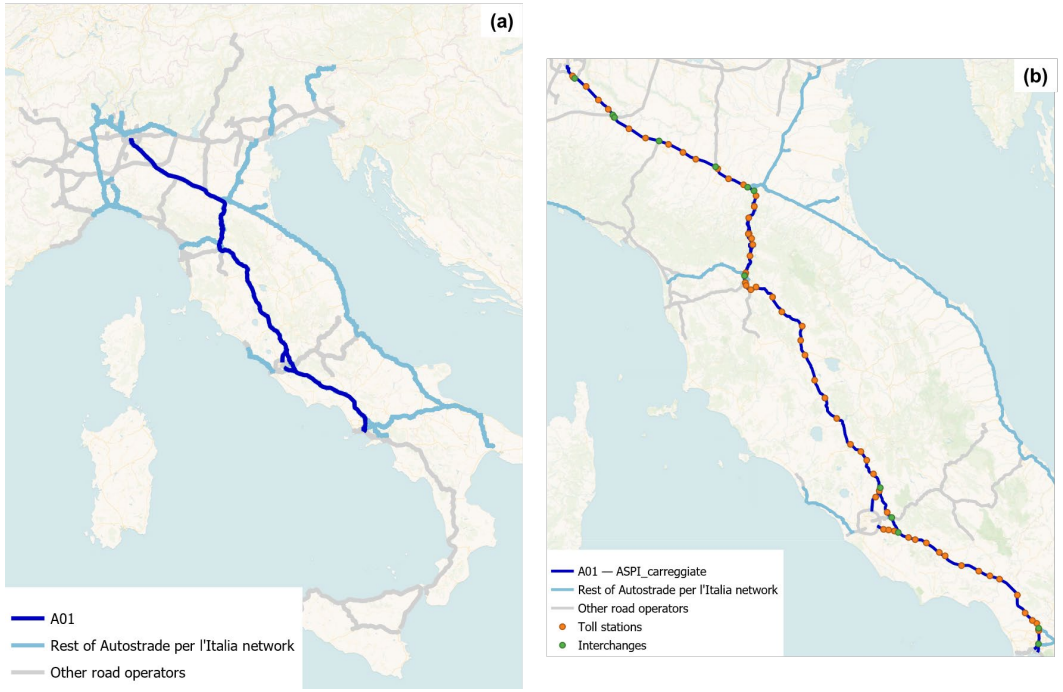
**Simulation procedure**



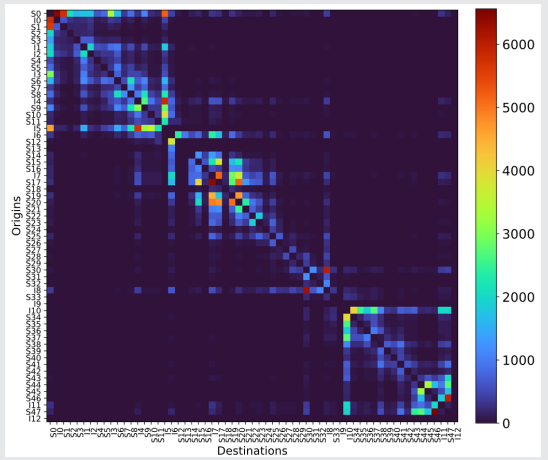
# CASE STUDY

Considered highway on Autostrade per l'Italia network

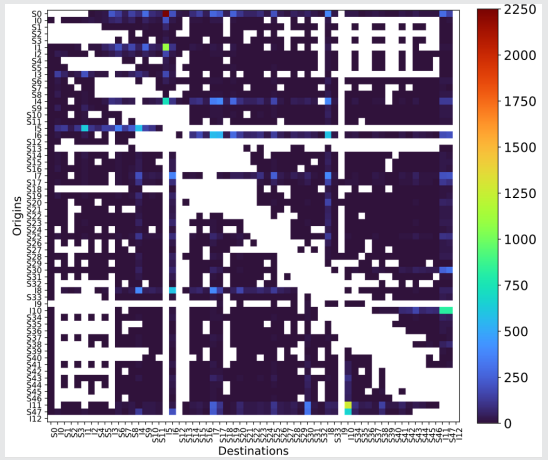
2050 penetration scenario → 100% battery electric vehicles




Highlight of highway A1 managed by Autostrade per l'Italia (**a**). Zoom of A1 highway with stations and interchanges in orange and green dots, respectively (**b**).



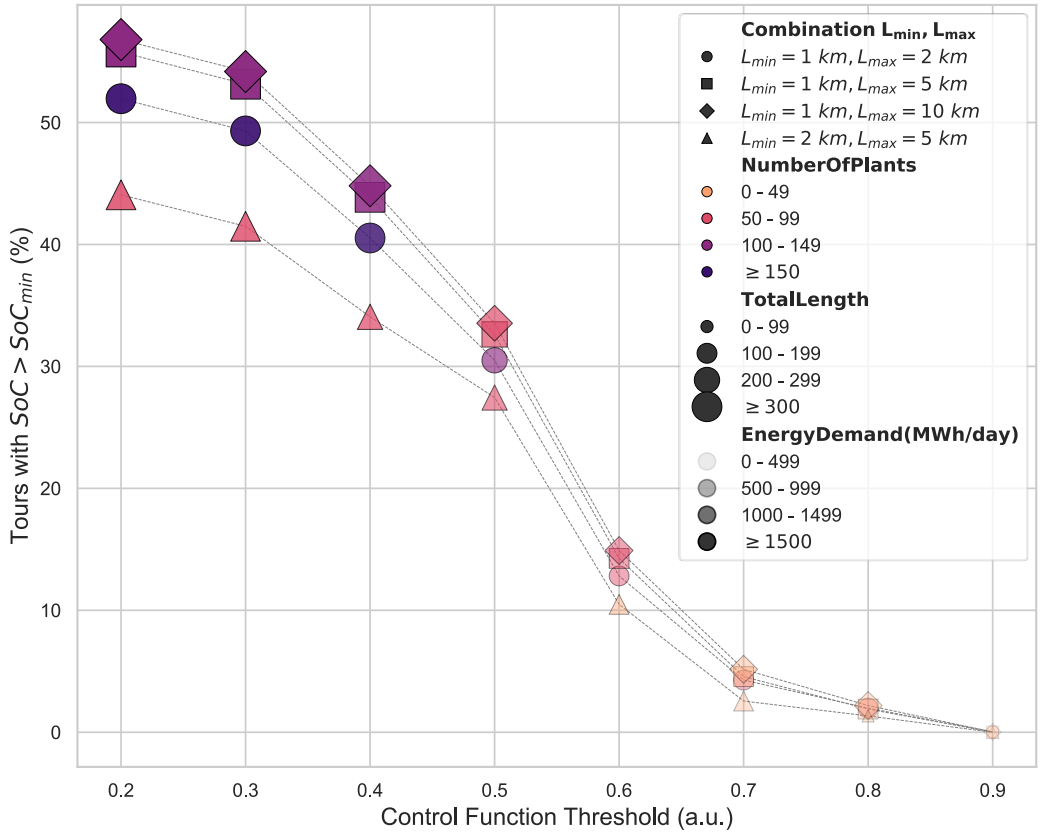

OD Matrix from average daily traffic on the highway A01.




Reduced OD Matrix considering only the tours that require to charge during the journey.

# RESULTS

Simulation results with different sizing strategies




- No combinations with 100% of satisfaction.
- Maximum satisfaction is 56.8% (DWPT coverage equal to 58% of highway A01).

- **Satisfaction ≥25% → 1 GWh per day.**
- **Satisfaction ≥30% → coverage 35%, 1.2 GWh per day.**
- **Maximum satisfaction → 1.9 GWh per day.**

# CONCLUSIONS

- A novel methodology for sizing a **Dynamic Wireless Power Transfer** (DWPT) infrastructure on highways has been presented.
- A case study was conducted to apply the sizing methodology to the main Italian highway, the A01.
- Maximum percentage of satisfied tours around 57% (138 plants, total length of 437 km per carriageway, total energy demand 1.9 GWh per day).

The dynamic charging infrastructure can not replace the static infrastructures, that must be consequently further empowered in next years.

The expansion of the charging infrastructure must be supported by an appropriate modernization and strengthening of the energy infrastructure.

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# Thank You

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