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AaCTA set of tools for the increase in EV charging stations in local self-government units

Prof. Zoran Miljanić

Final conference of the EUKI project Alpe-Adria clean transport alliance – AaCTA June 27th 2022

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- Selecting optimal locations – PROBLEM
  - Purpose of locations – fast or slow charging
    - Fast charging – main traffic routes with high traffic frequency
    - Slow charging – strategic locations in city center (public parking lots, city malls, intermodal nodes, etc)
  - Constraints
    - Spatial planning preconditions – important challenge in Montenegro caused by limitations in valid regulation in the area of spatial planning and construction
    - Availability of power grid infrastructure
      - Connection point, available power (direct impact on number of stations)
      - Control possibility – a challenge in the middle phase of charging infrastructure development
  - Number of charging stations – impacted by expected number of electric vehicles

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- Tools for charging infrastructure planning
  - Basic input data
    - Fast charging
      - Geographic disposition of main roads and motorways – GIS information with nodes (road crossings), lengths and traffic frequency
      - Petrol stations locations – as main strategic locations for charging EVs
      - Power grid limitations – available substations, installed power, peak demand
    - Slow charging
      - GIS data of local municipality with coordinates of strategic locations (public parking lots, city malls, other public buildings)
  - Optimization criteria
    - Basic – minimum number of necessary charging stations in order to enable full autonomy of EVs for observed road network

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- Tools for charging infrastructure planning
  - Constraints – tools are flexible for including desired level of constraints
    - Assumed autonomy of fully charged EVs
    - Typical charging time (slow or fast charging)
    - Number of charging places per charging station – impacted by power grid limitation
  - Optimization engine (technique)
    - Flexible and modular – optimization goal and criteria can be easily changed
    - MILP – mixed integer linear programming (reliable and fast execution)
    - Metaheuristic techniques – using the same constraints and optimization goal
- Realization
  - Input
    - excel spreadsheet with strategic locations and their additional data (grid limitation, traffic frequency)

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- Realization
  - Input
    - GIS disposition of road infrastructure or picture with numerical information
    - Forecast of number of EVs
  - Results
    - Minimum number of locations for charging stations
    - Geographic distribution of charging stations
    - New locations for charging stations if there are no already available strategic location (petrol station, parking lot etc.)
    - Necessary number of charging places at charging locations depending on the expected number of EVs
    - Defined locations are saved in excel sheet and kml format to be used with map software

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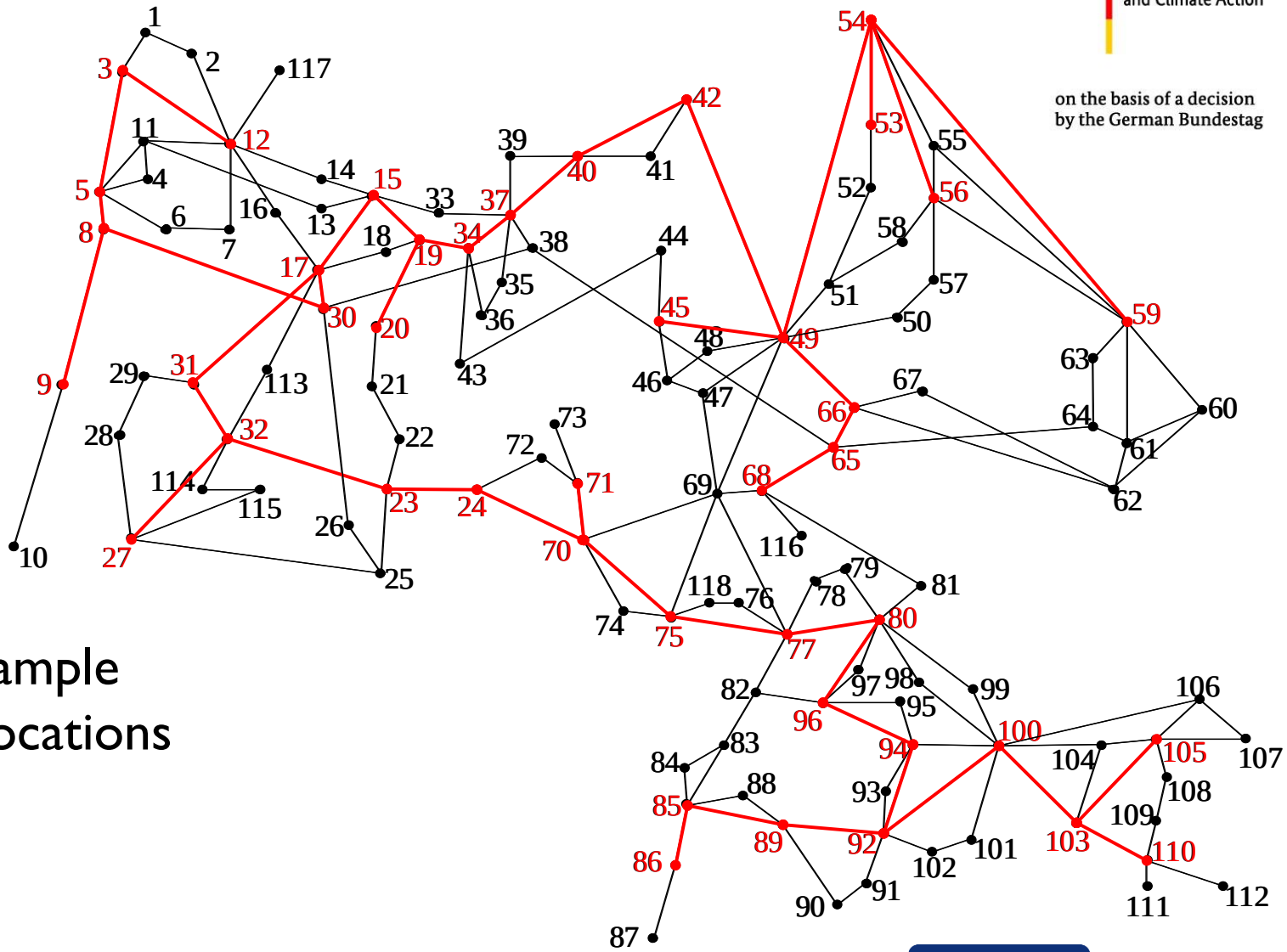

- Theoretical example
- 118 potential locations
- 43 necessary

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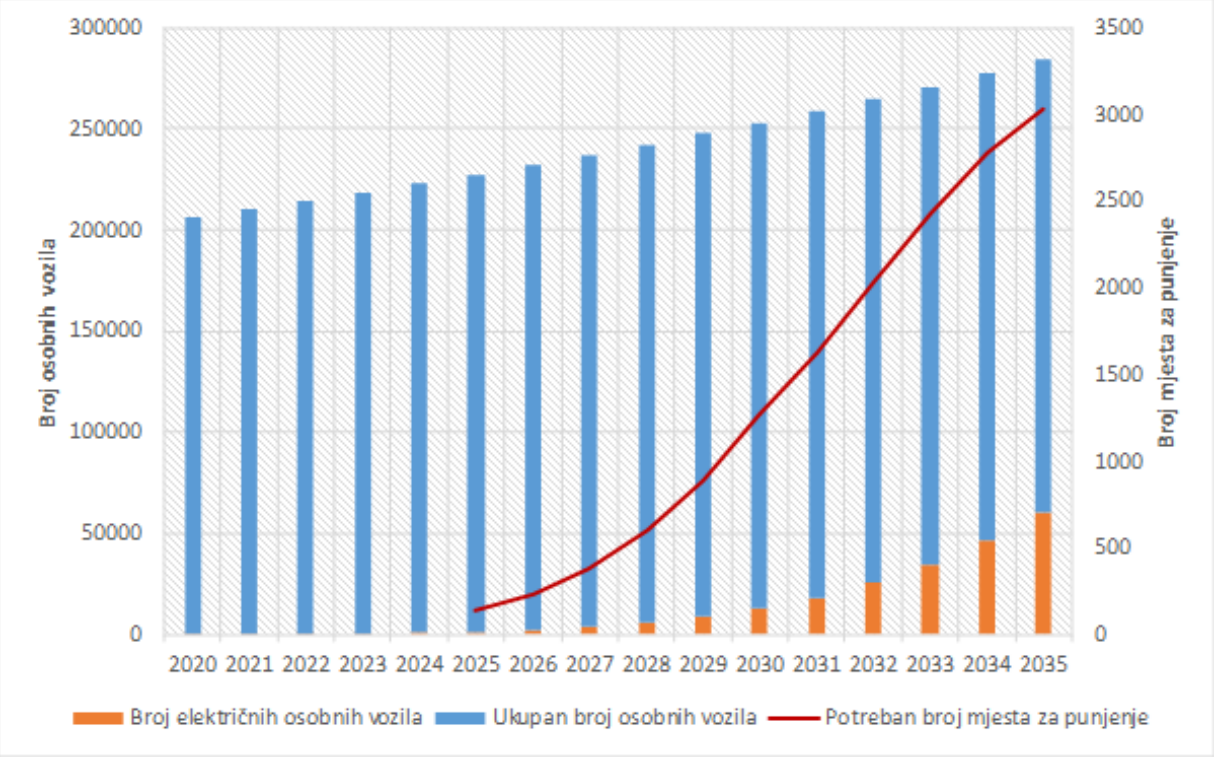
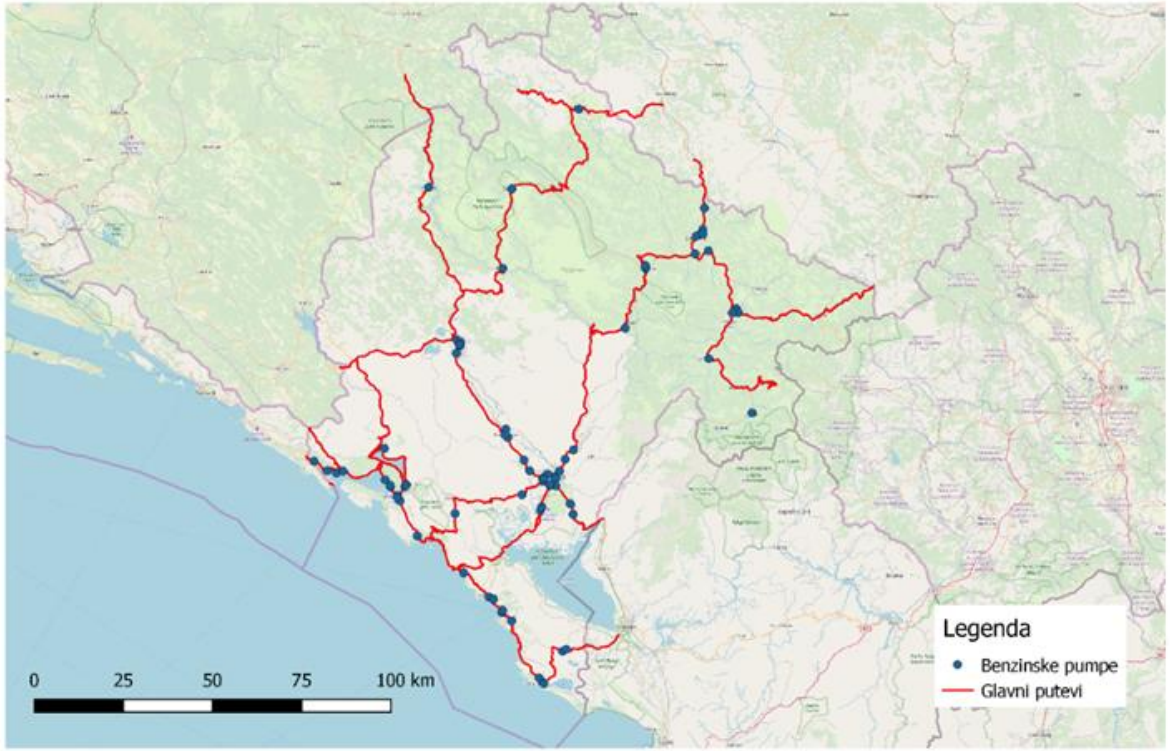
- Development of charging infrastructure in Montenegro
  - Forecast of EV
  - Correlation with number of necessary charging stations (locations)





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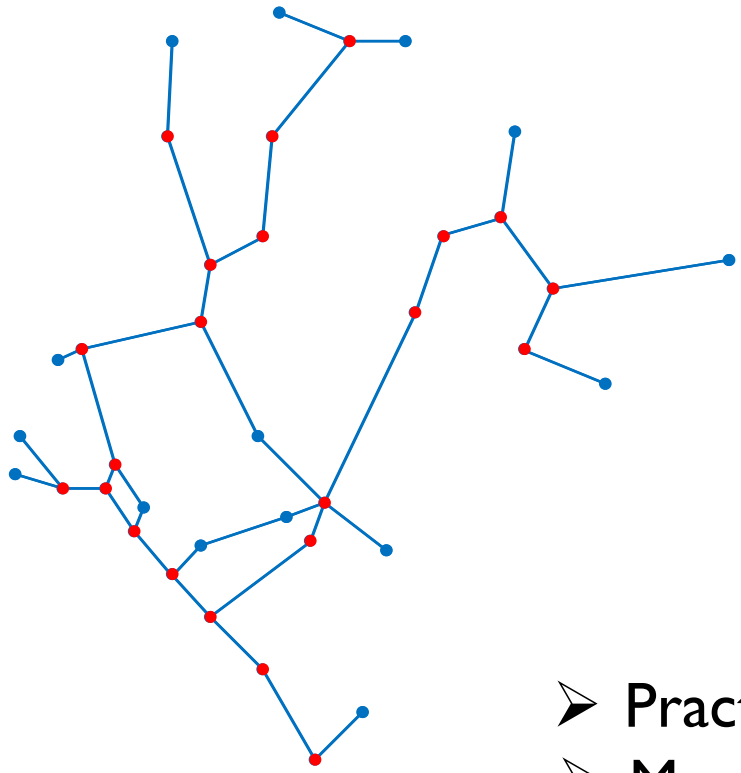

- Practical example
- Montenegro case

- Minimum necessary locations for the existing road network

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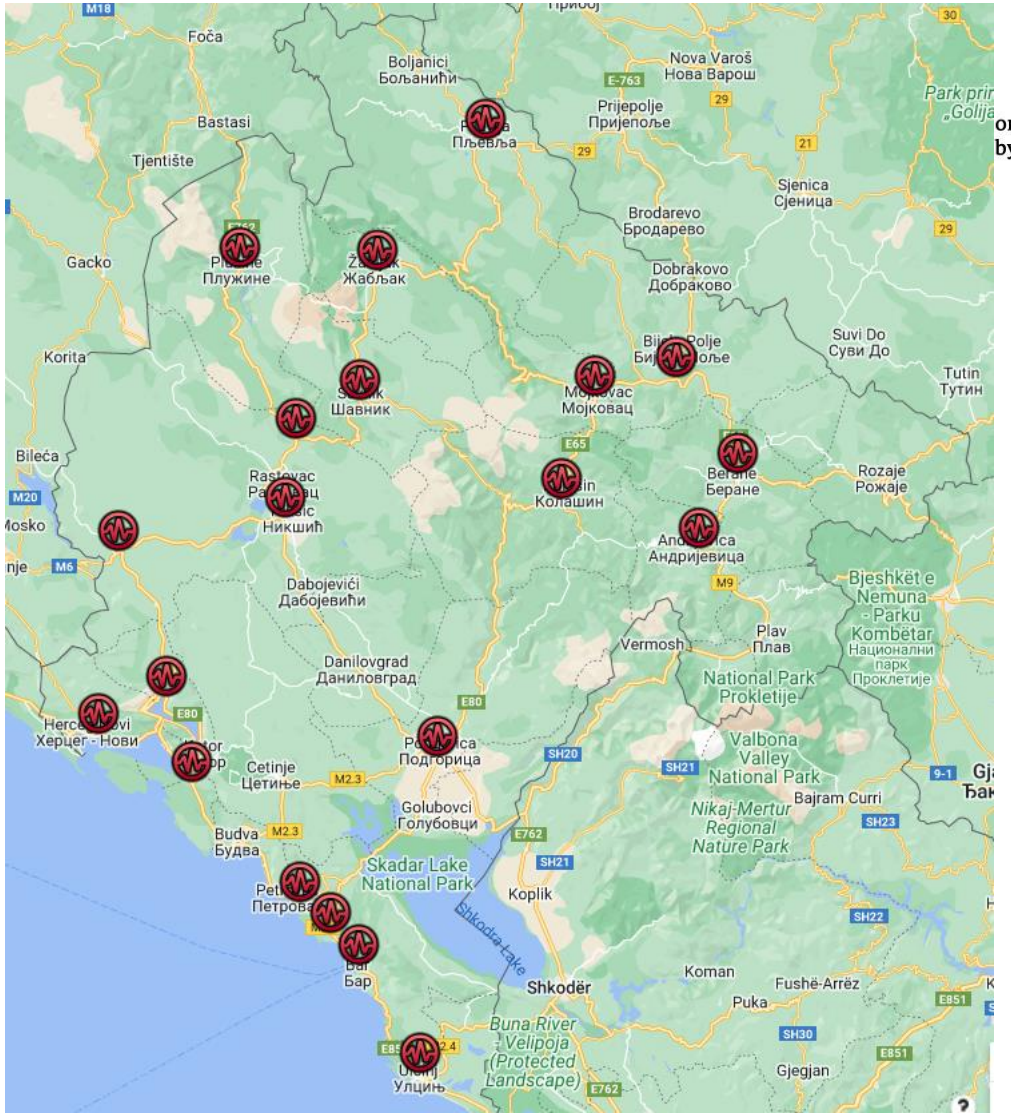
- Typical output result
- Montenegro case



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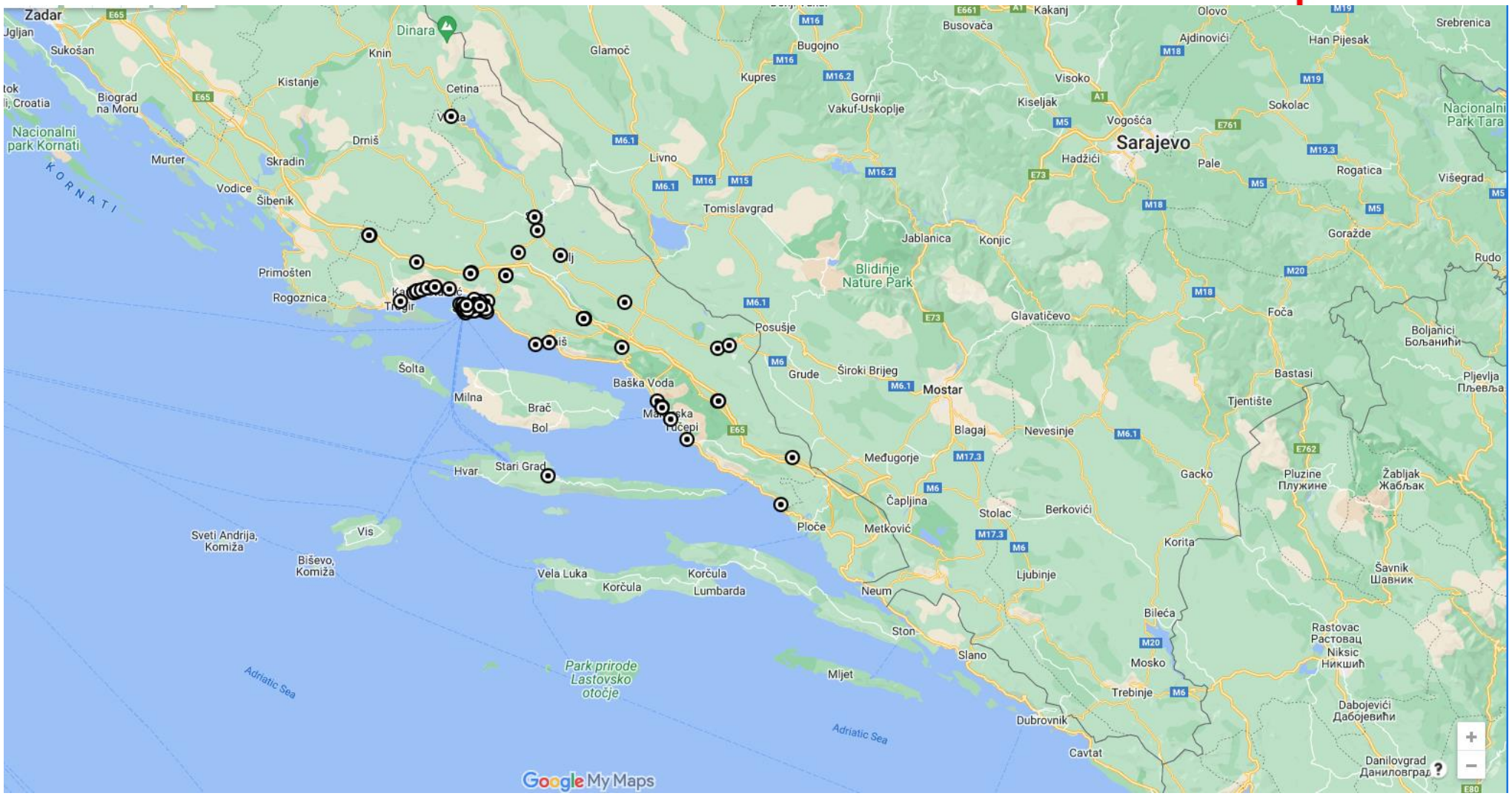

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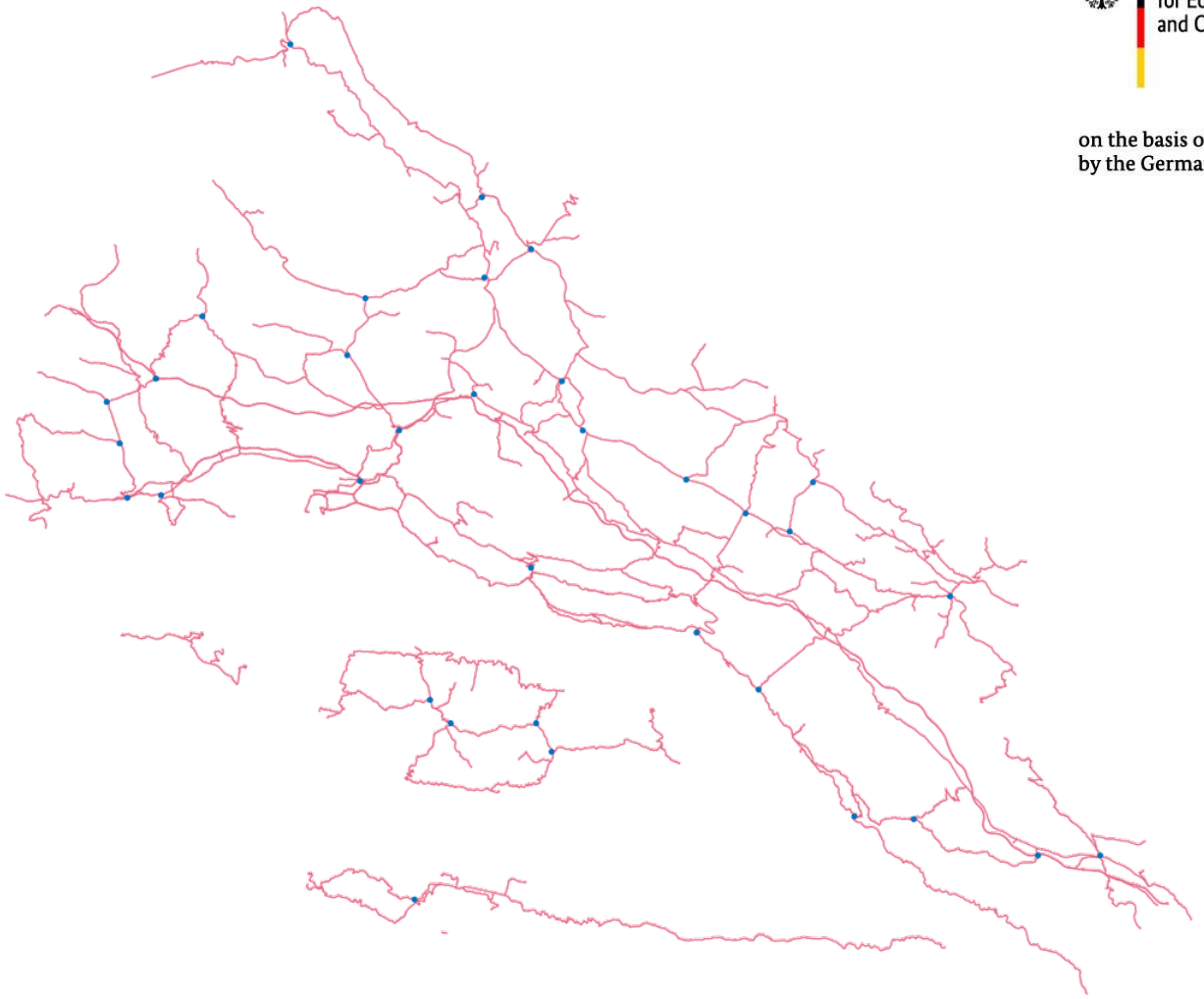

- Practical example
- Split case
- Minimum necessary locations for the existing road network

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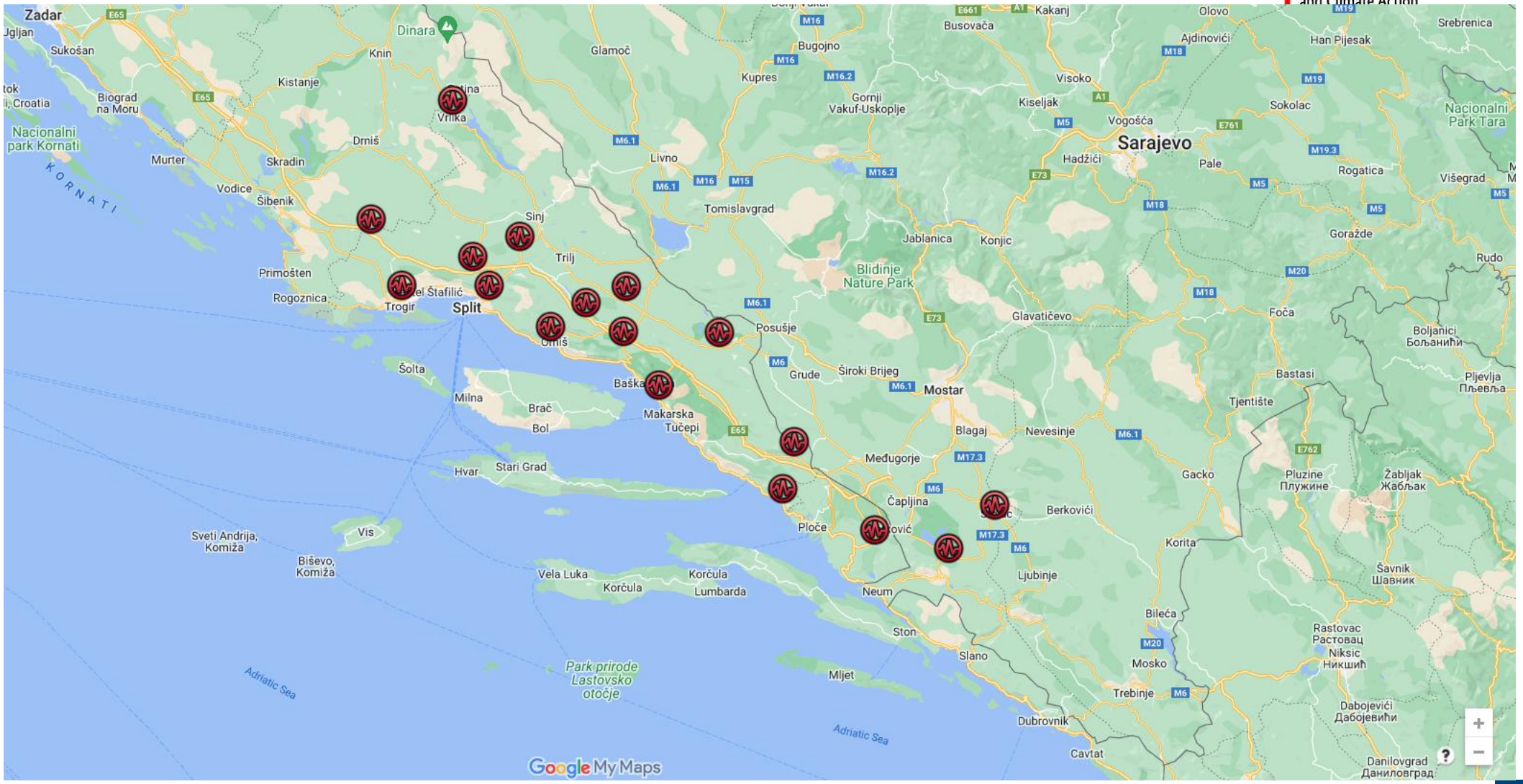

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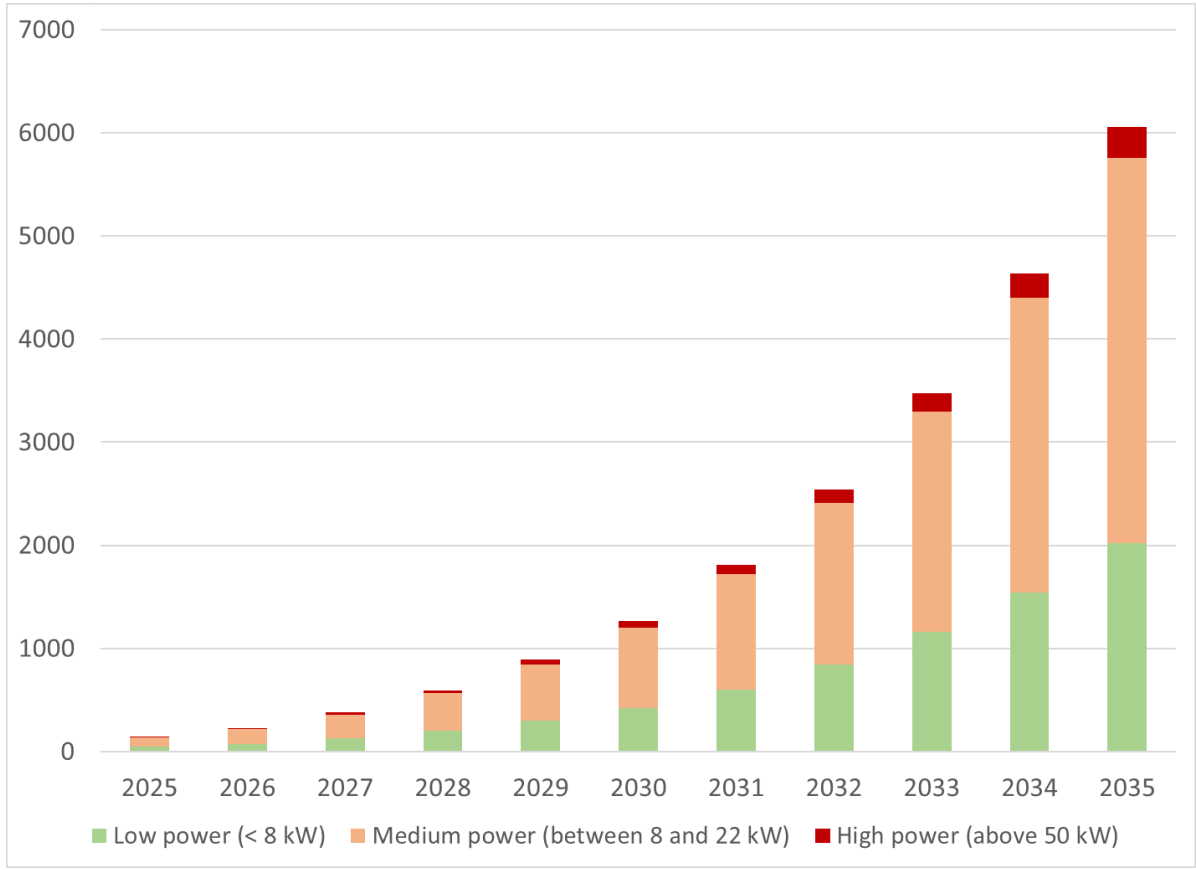
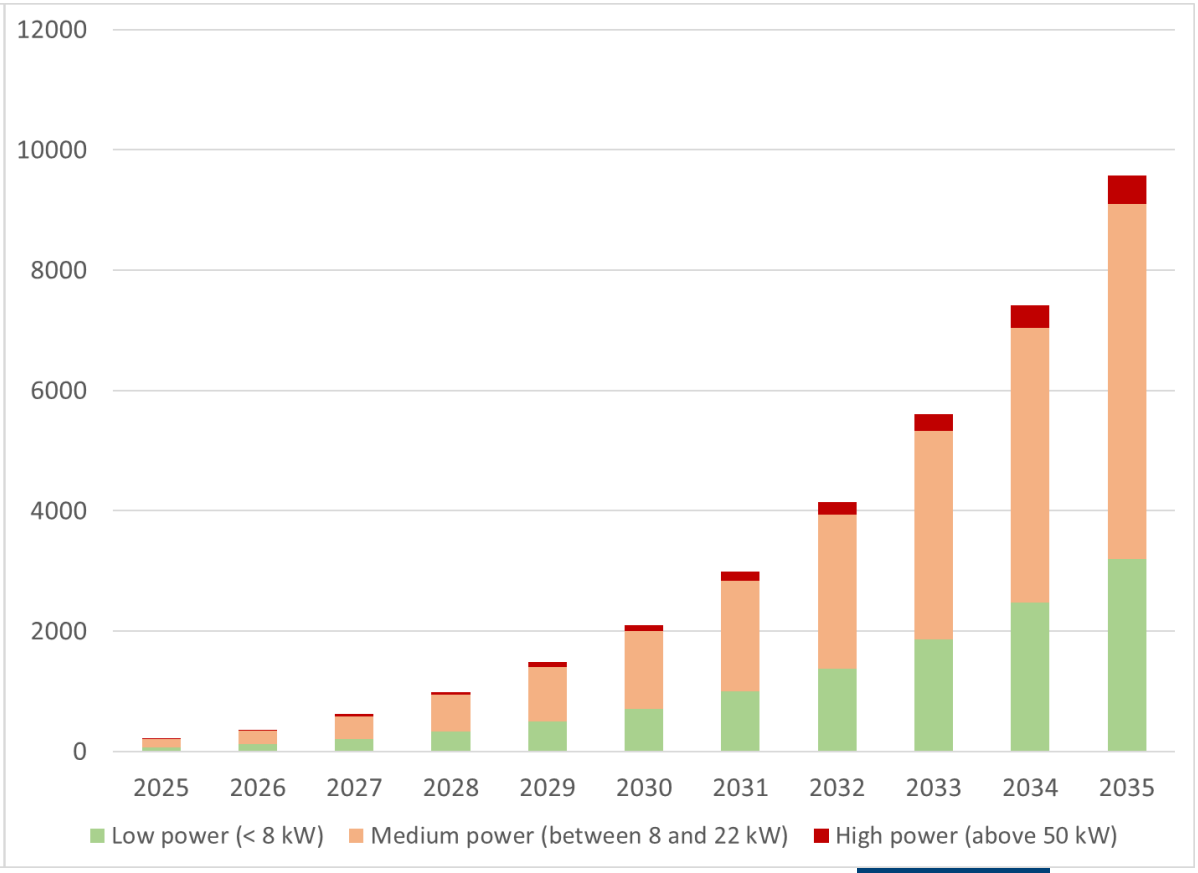
- Correlation between number of vehicles and number of public charging stations





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CONCLUSION

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- Optimization tool is based on easily accessible data (road infrastructure, traffic frequency, petrol station and parking lots locations)
- Excel is the basic tool for arranging input and output data
- Output is prepared in form of kml file or other types of files that can be used with GIS software
- Main engine of the optimization is developed in Matlab but it can migrate to other platforms, excel or web platform
- Future plans:
  - Preparation of easy to use web based interface
  - Using location specific power grid data
  - Enabling addition of other optimization constraints that are location specific
  - Testing on other practical problems

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