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

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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
CHARGING INFRASTRUCTURE

➢ 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
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)
CHARGING INFRASTRUCTURE

➢ 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
➢ Theoretical example
➢ 118 potential locations
➢ 43 necessary
Development of charging infrastructure in Montenegro
Forecast of EV
Correlation with number of necessary charging stations (locations)
CHARGING INFRASTRUCTURE

➢ Practical example
➢ Montenegro case

➢ Minimum necessary locations for the existing road network

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CHARGING INFRASTRUCTURE

- Typical output result
- Montenegro case
CHARGING INFRASTRUCTURE

➢ Practical example
➢ Split case
➢ Minimum necessary locations for the existing road network
CHARGING INFRASTRUCTURE
Correlation between number of vehicles and number of public charging stations

CHARGING INFRASTRUCTURE

- Montenegro case
  - 1 charging location per 10 cars in the first phase (1:20 later)

Structure
- 30% of charging stations with 8 kW of installed power
- 60% of charging stations with 20 kW of installed power
- 10% of fast charging stations
➢ 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