

Coaches as part of the eHighway system: State of research and development



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Indo-German Workshop on Innovative Charging Technologies for Heavy Duty Vehicles
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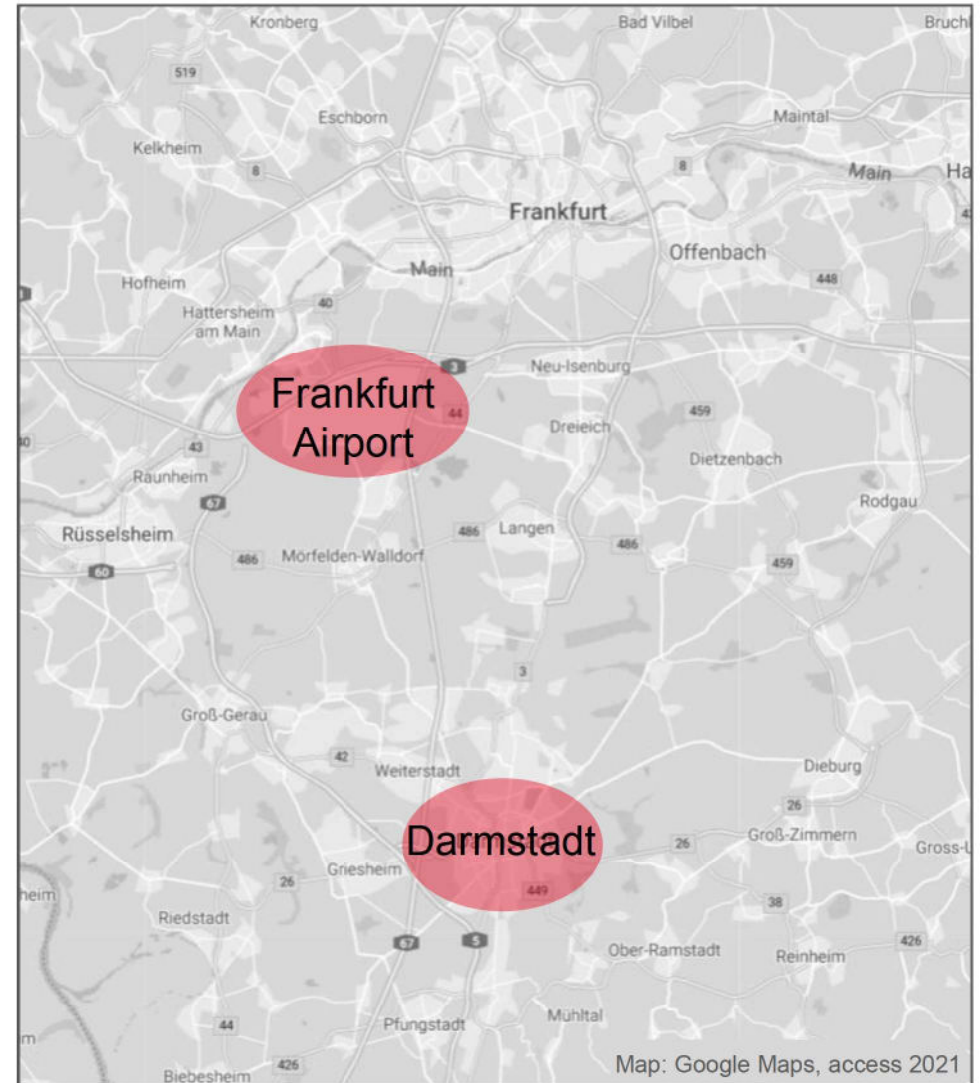


Picture: IVV 2020

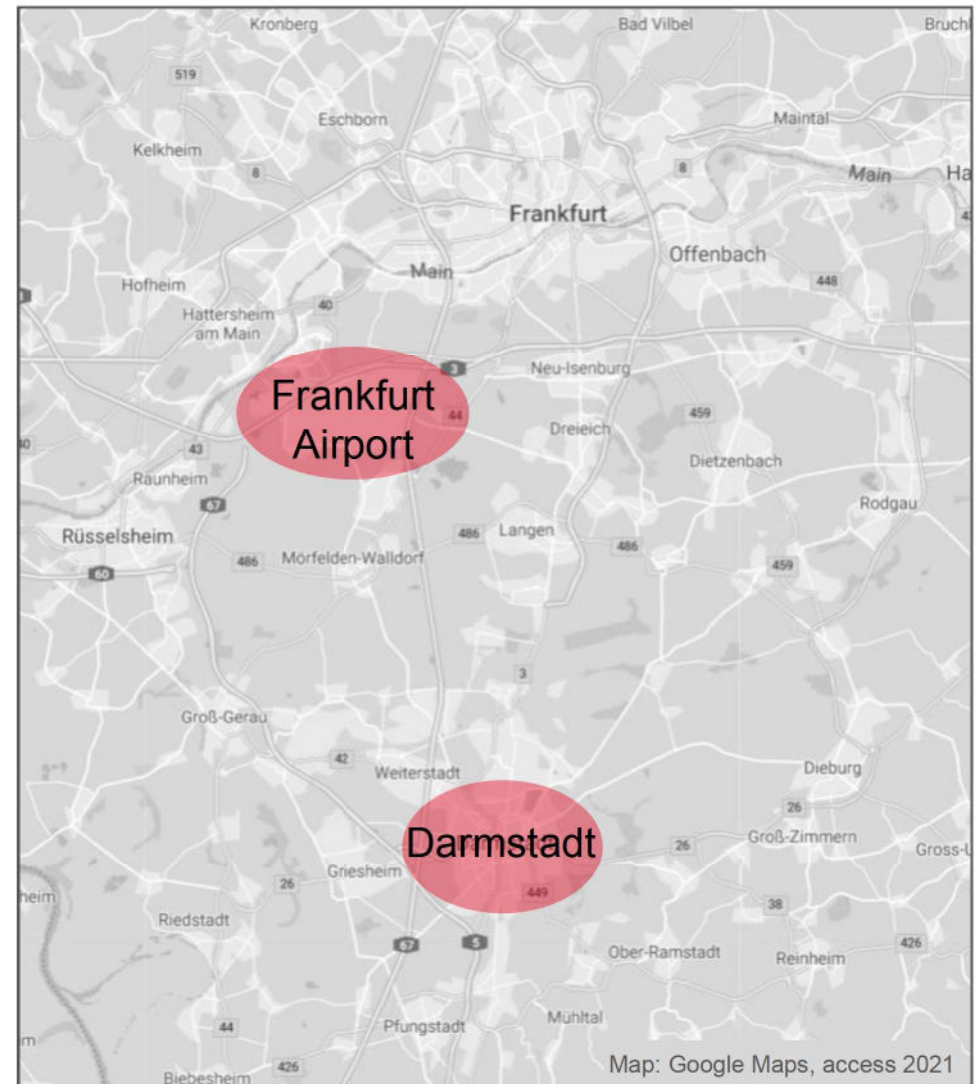
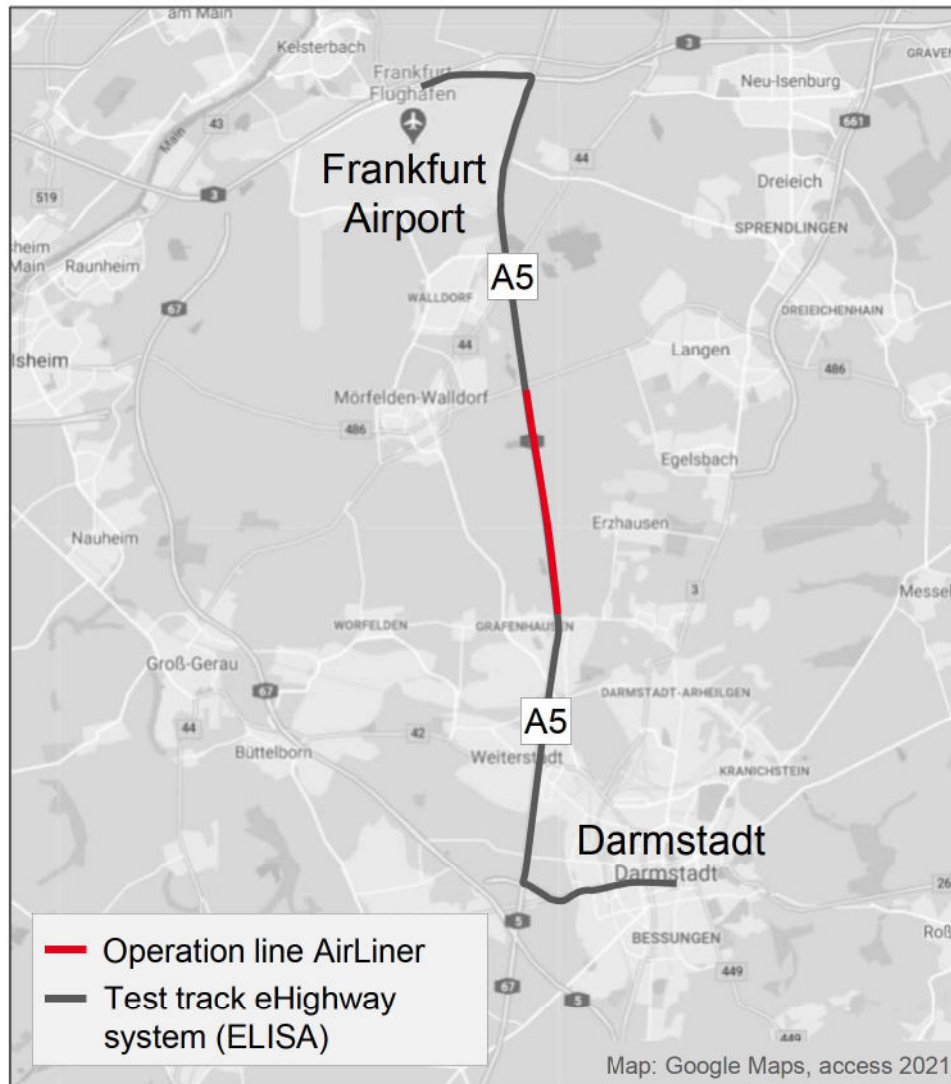
Research area: Frankfurt – Darmstadt



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Motivation and Research Scope



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Motivation

- Improving the quality of life by electrifying vehicles in inner city areas
- Identifying further user groups of the eHighway system
- Equipping the first bus for long-distance travel with a pantograph system



Research Scope

- Feasibility of equipping a coach with required components
- Feasibility from a legal point of view to operate a coach on the eHighway system
- Simulation of an existing bus line schedule, the *AirLiner*



Methodology and Research Questions



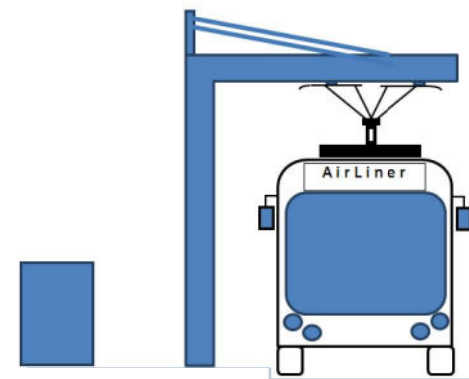
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Methodology

- Identifying a reference bus based on operational and technical requirements
- Identifying an additional charging location
- Simulation of an existing bus line schedule from the *Airliner* to derive the necessary technical requirements
- Derivation of simulation scenarios

Basic assumptions

- Vehicle switches to an electric operation mode when entering the city center of Darmstadt or the airport area (Entry → electric, Exit → diesel)
- Speed while using the catenary system: 80 km/h
- Vehicles operating per day: 3 busses



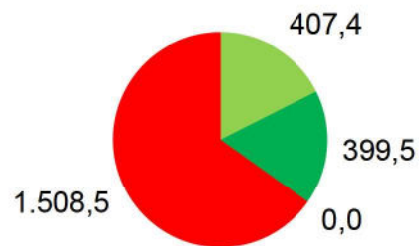
Pictures: Abschlussbericht AMPEAir, 2019

Results

Scenario 1: Base Case

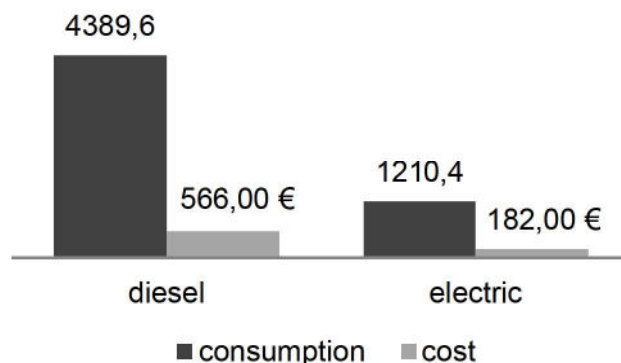
Mileage (km/d)

Total: 2.315,4 km/d



■ electric (inner city area) ■ electric (outside city area)
■ diesel (inner city area) ■ diesel (outside city area)

Consumption (kWh) und Costs (€)



Parameters

- Charging power surplus loading station 120 kW/h
- Charging power surplus test track 120 kW/h
- City borders fixed
- Time under catenary 3,8 min
- Battery capacity (gross/ net) 50/30 kWh
- Consumption rate
 - Air-conditioning/ heating 0,75 kWh/km
 - Traction 0,75 kWh/km

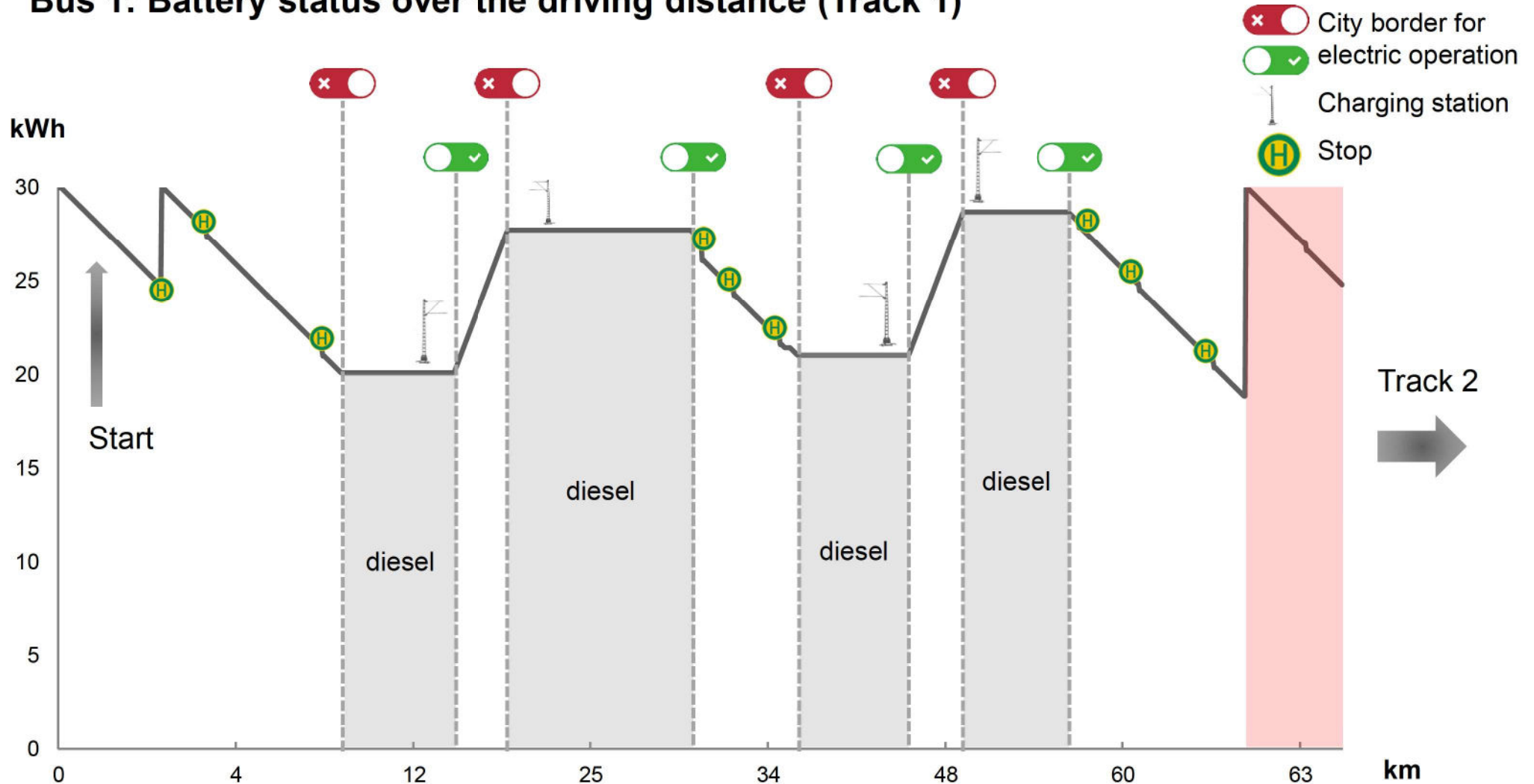
Results

- For the base case scenario an electric operation of the coach in the city center of Darmstadt and at the airport in both directions is possible
- No diesel operation within the city centre of Darmstadt
- The battery capacity and the charging power are sufficient to operate the busses fully electric within the necessary areas
- The unexploited capacity seems to be adequate
- Existing potential to reduce fuel costs

Results

Scenario 1: Base Case

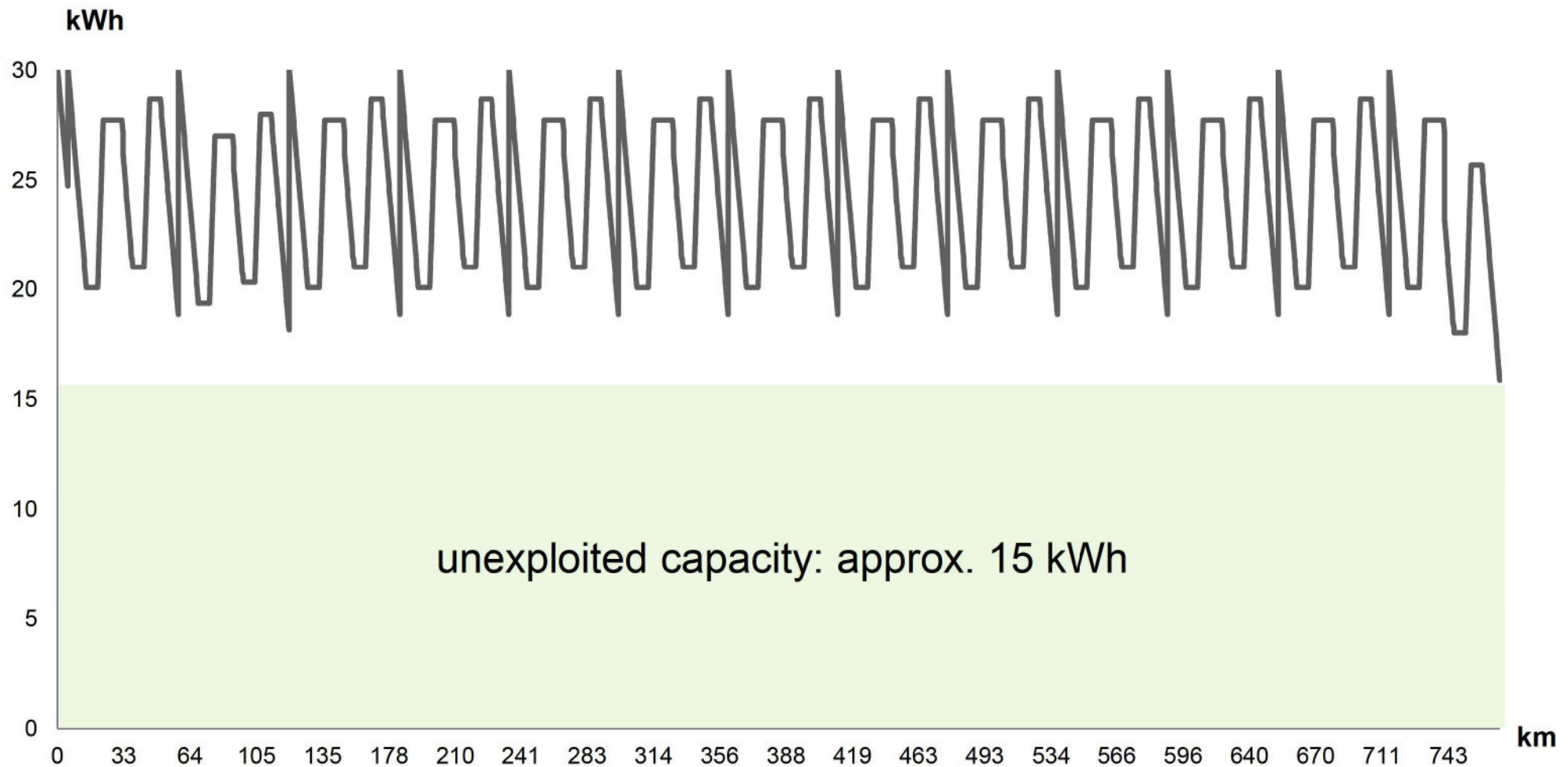
Bus 1: Battery status over the driving distance (Track 1)



Results

Scenario 1: Base Case

Bus 1: Battery status over the driving distance (Total)



Results

Comparison of fixed and variable city borders



Base Case (km/d)

fixed



1

variable



1a

■ electric ■ diesel

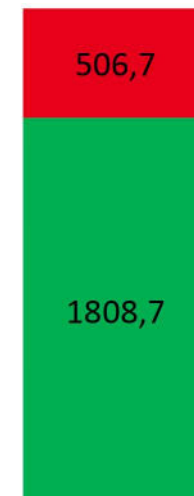
Best Case (km/d)

fixed



2

variable



2a

■ electric ■ diesel

Consumption rate (air-conditioning/ heating and traction)

0,75 kWh/km

0,5 kWh/km

Final Remarks



Conclusion

- For the base case scenario a partially electric operation of the Airliner within the city center and at the airport is possible with an adequate battery buffer.
- For the best case scenario an operation of the Airliner with a relatively small battery is possible in the inner city area.

Further analysis

- Simulation results only apply within limits of the made assumptions and the parameter value intervals.
- Delays should be analyzed and considered as a stochastic element in the simulation.
- Pilot study for testing the Airliner operation under realistic conditions.



Picture: www.oepnv-info.de 2019

Final Remarks



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Picture: IVV 2020