



Cost Benefit Analysis: the trolleybus cluster within ELIPTIC project

ELIPTIC Final Conference, 26.04.2018, Bremen

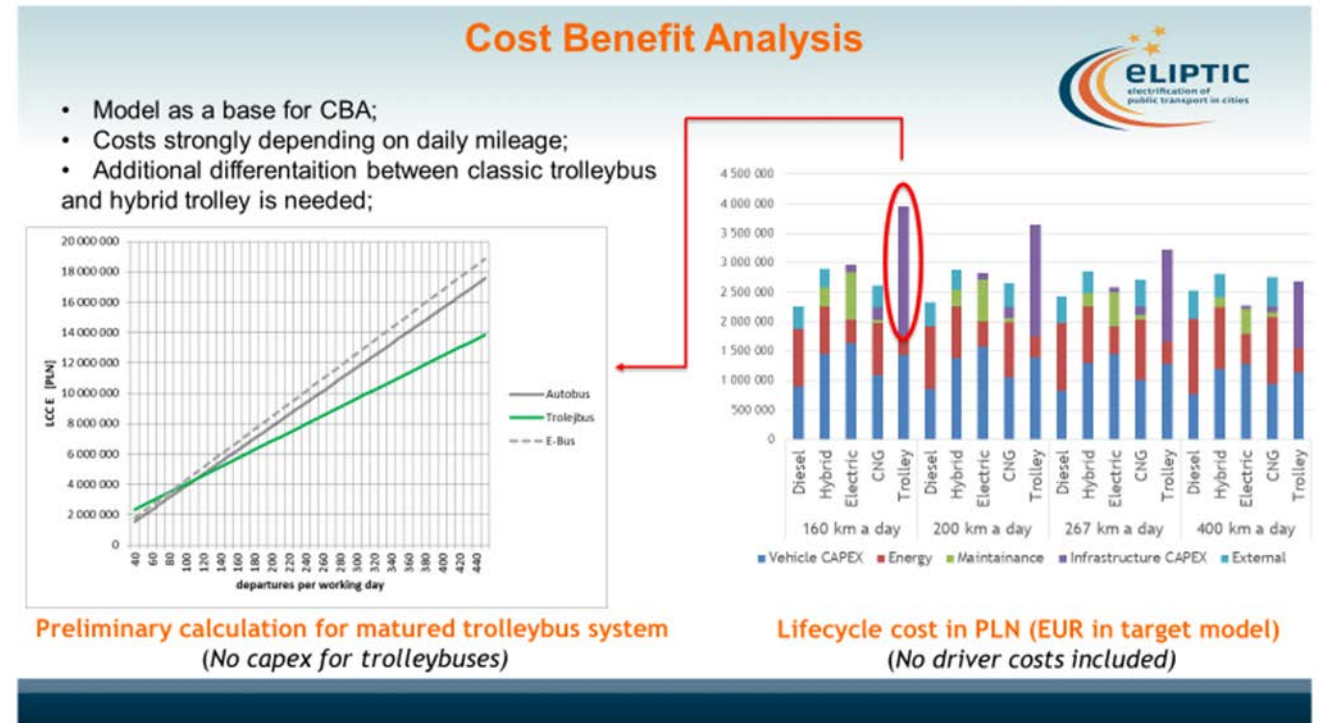
Michał Wolański, Marcin Wołek, Aleksander Jagiełło
University of Gdansk



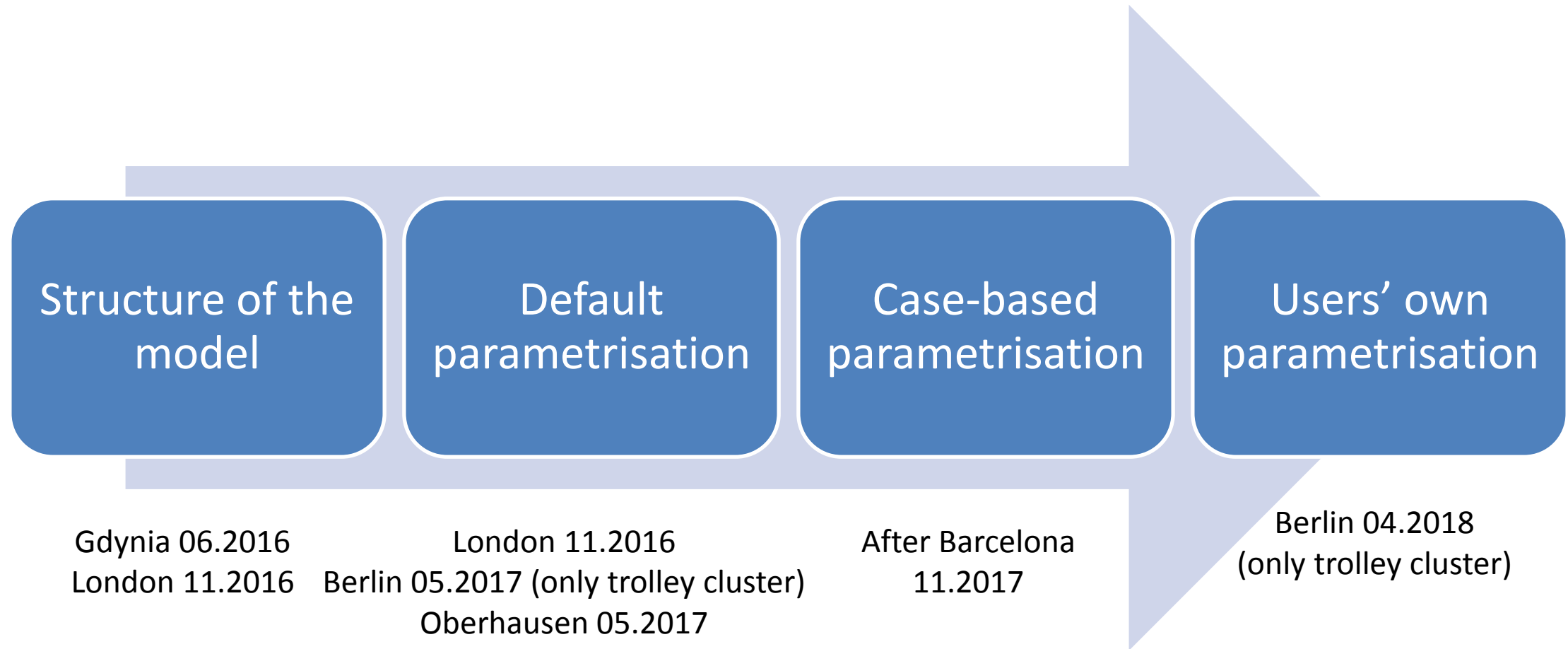
Horizon 2020
Programme

Why model?

- A variety of different use cases within ELIPTIC project;
- Different valuation of external costs in particular countries;
- Different share of non-emission energy sources in the ELIPTIC countries;
- Different cost evidence and calculation among operators;
- Possibility to modify and to develop within the Project;
- Best solution in case of „battery lifetime uncertainty” issue;
- Possibility to bridge former (TROLLEY) and future activities (TROLLEY 2.0);



Model process development

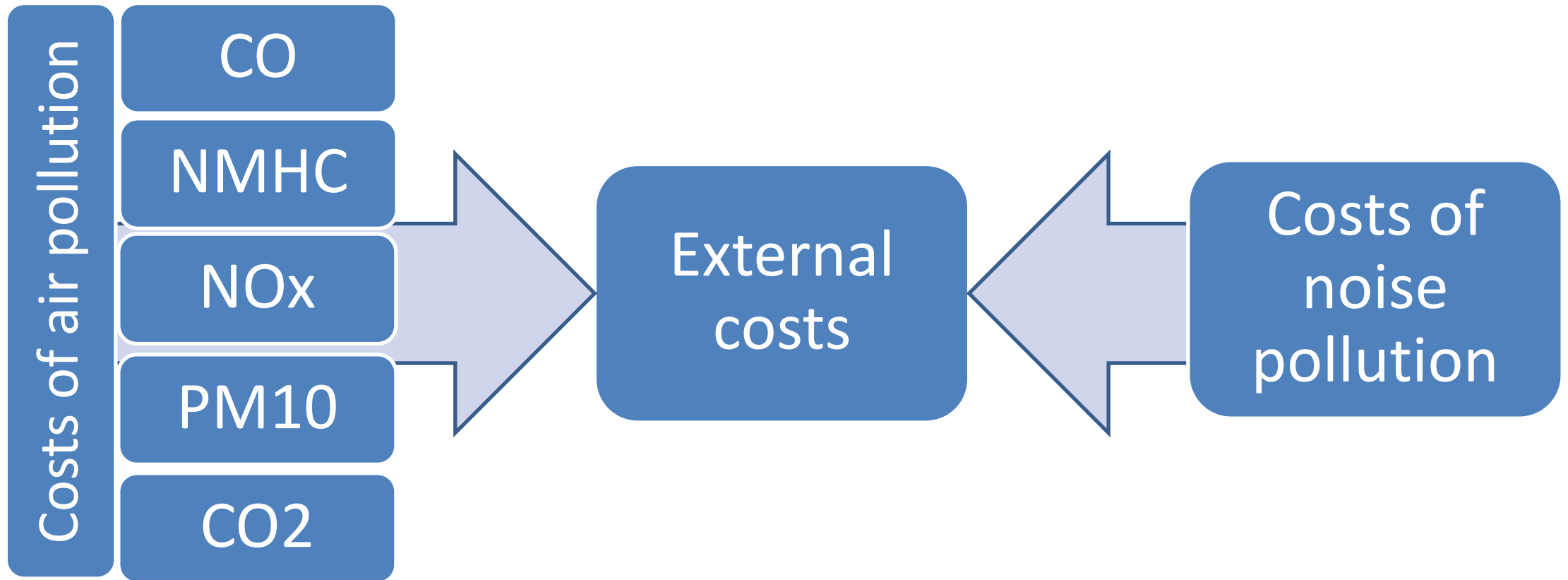


Generic model features

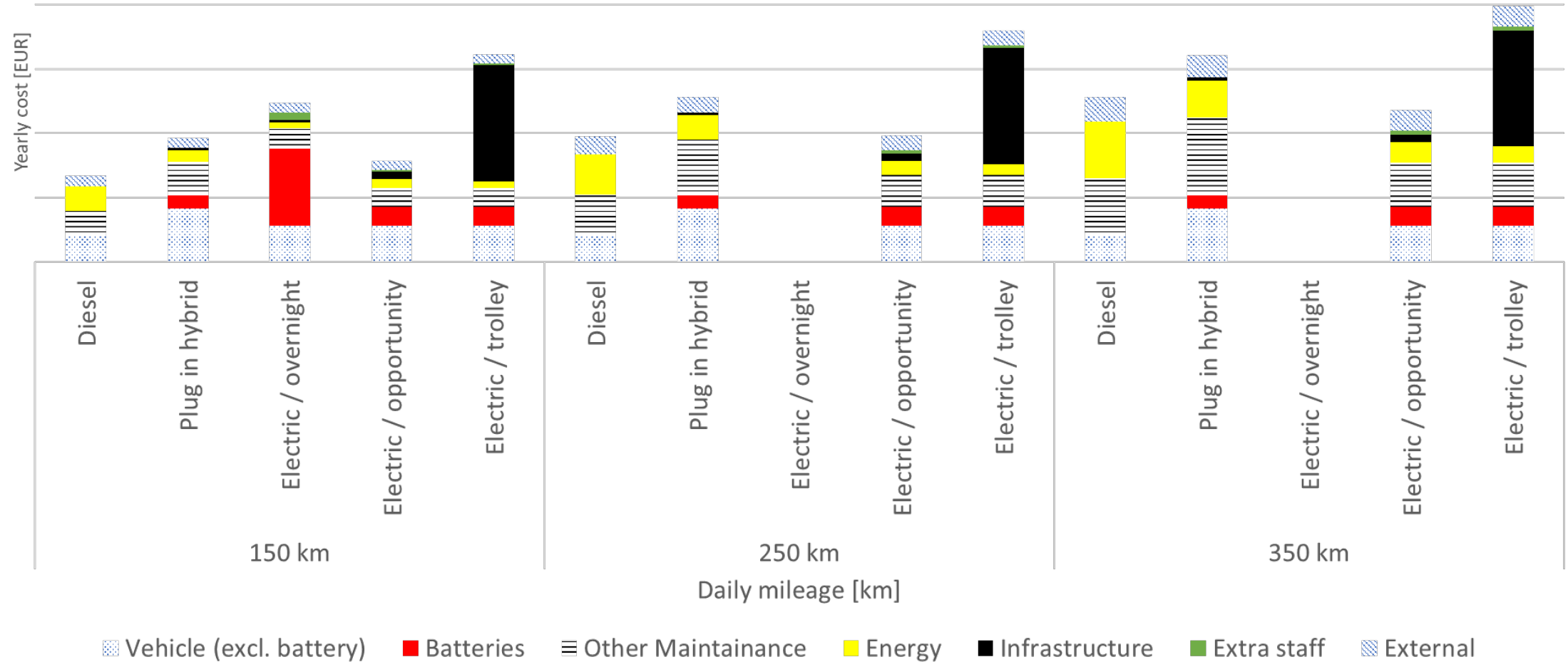


- A brand new model has been constructed after last years' discussion
- It includes *i.a.*:
 - Up to five scenarios:
 - Diesel;
 - Plug in hybrid;
 - Electric / overnight;
 - Electric / opportunity;
 - Electric / trolleybus.
 - Easy assumption of battery and vehicle lifecycle;
 - Possible higher number of EV needed compared to diesel (in the 1st period of operation);
 - Possible multipliers of noise / PM emissions for dense urban areas.

External costs taken into account in the model

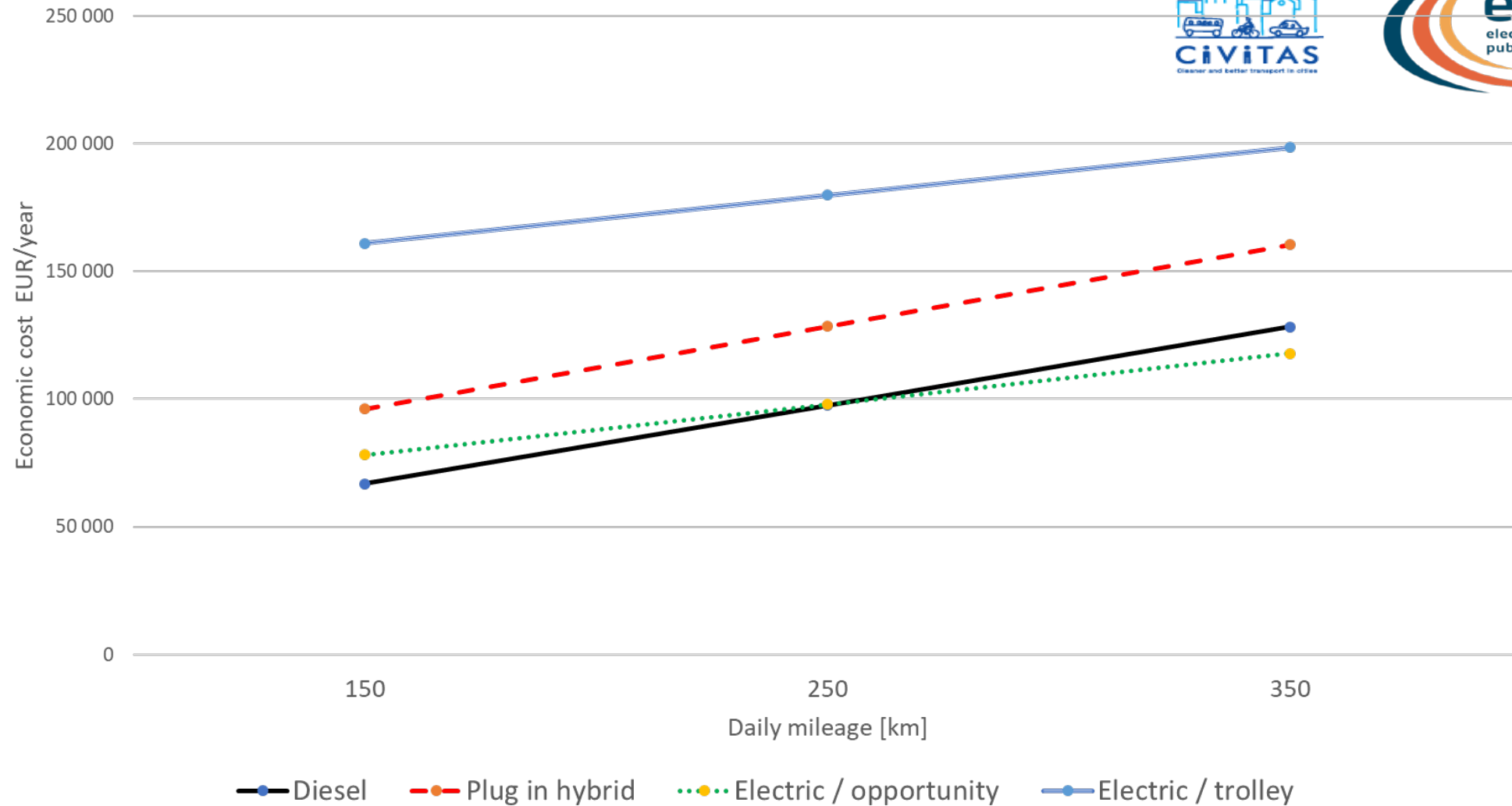


Generic model output (1)



Remark: for trolleybuses, 100% of the network coverage was assumed

Generic model output (2)



Remark: for trolleybuses, 100% of the network coverage was assumed

Generic model features



- The longer the daily mileage, the higher efficiency of electric vehicles;
- Especially opportunity charging constitutes good alternative to Diesel buses, especially at high mileages;
- Much depends on battery lifecycle (is there anyone who exchanged batteries after their lifecycle is completed?), future battery costs and externalities level.
- Model shows sensitivity to fixed costs and energy-mix,
- Nevertheless, this outcomes cannot be treated as „general truth” and may significantly change upon local conditions (level of public transport system or even particular line);
- Gdynia test-case proves that.

Summary of use case descriptions: trolleybus cluster

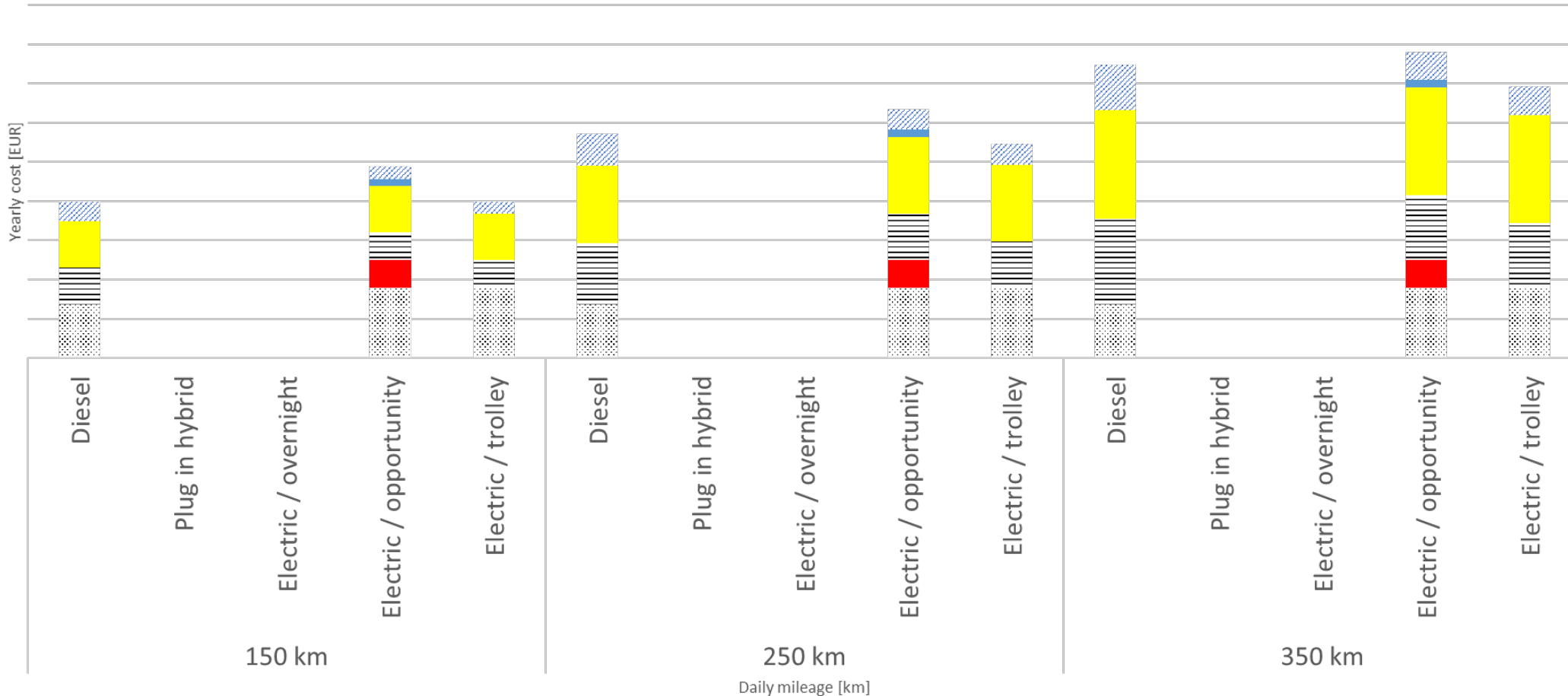


	Eberswalde (Germany)	Gdynia (Poland)	Szeged (Hungary)
Trolleybus network	Y	Y	Y
Vehicle	18 m	12 m	18 m
Hybrid trolleybuses	Y	Y	Y
Running out of catenary	Y	Y	Y
Congestion during peak hours	N	Y	Y
Energy mix [share of non-emission energy]	100%	42%*	62%**

*Contracted from regional energy provider, ** National level energy-mix

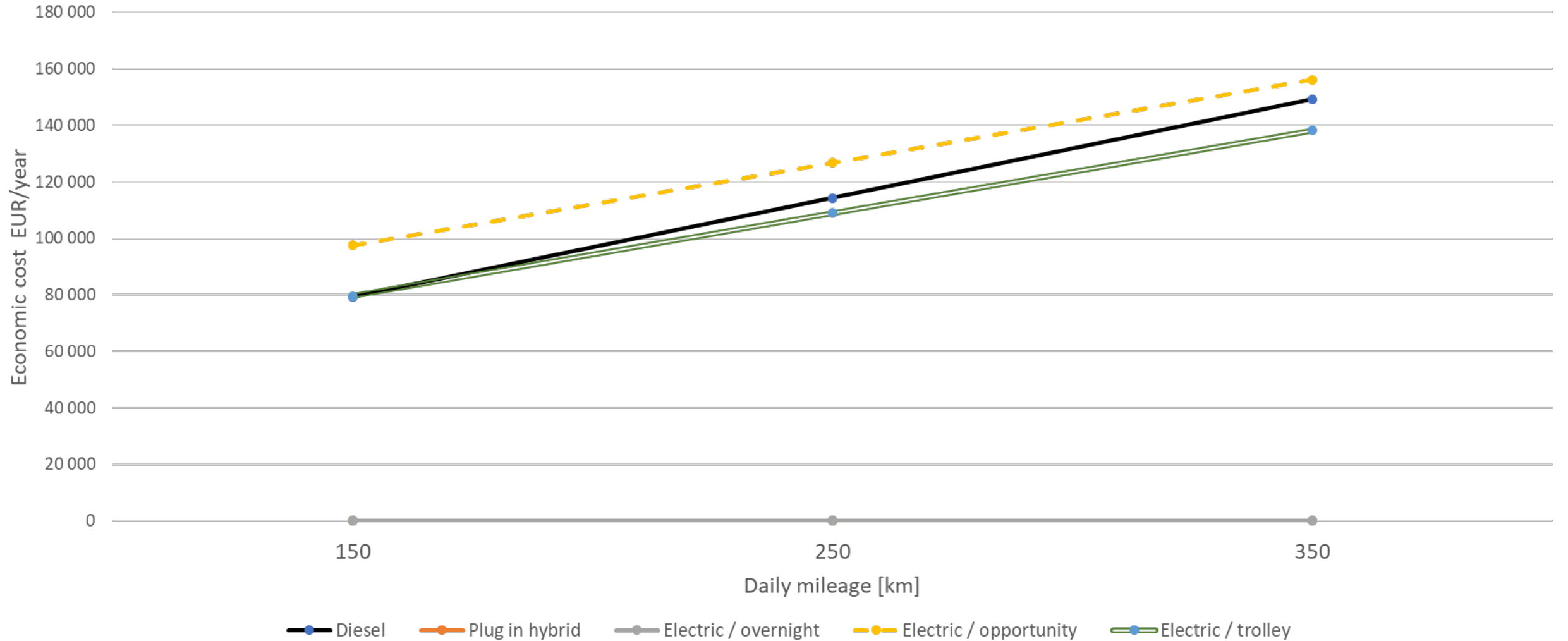


Eberswalde output 1 [no capex trolleybus infrastructure costs as it already exists]



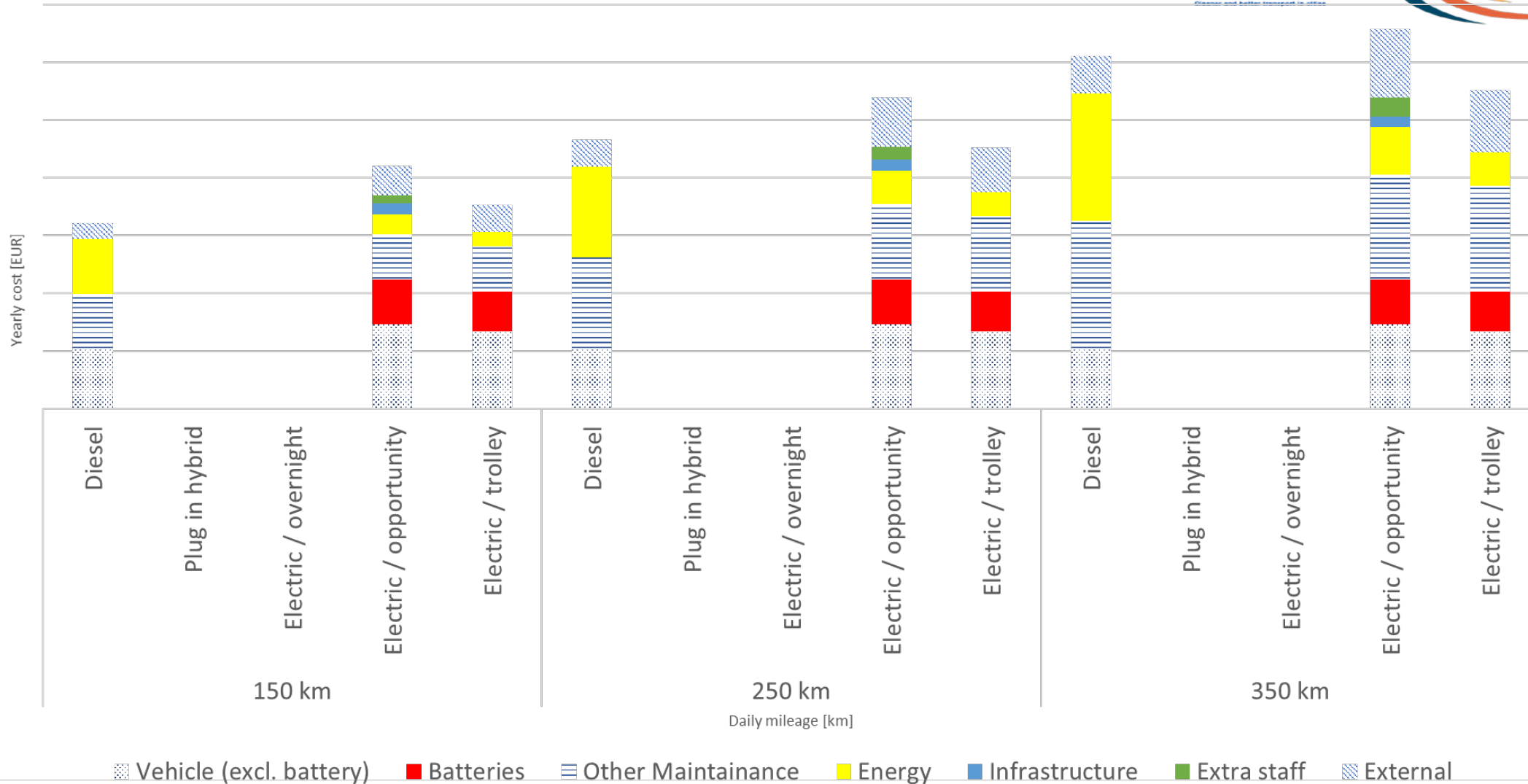
▨ Vehicle (excl. battery)
 ■ Batteries
 ≡ Other Maintenance
 ■ Energy
 ■ Infrastructure
 ■ Extra staff
 ▨ External

Eberswalde output 2 [no capex trolleybus infrastructure costs as it already exists]

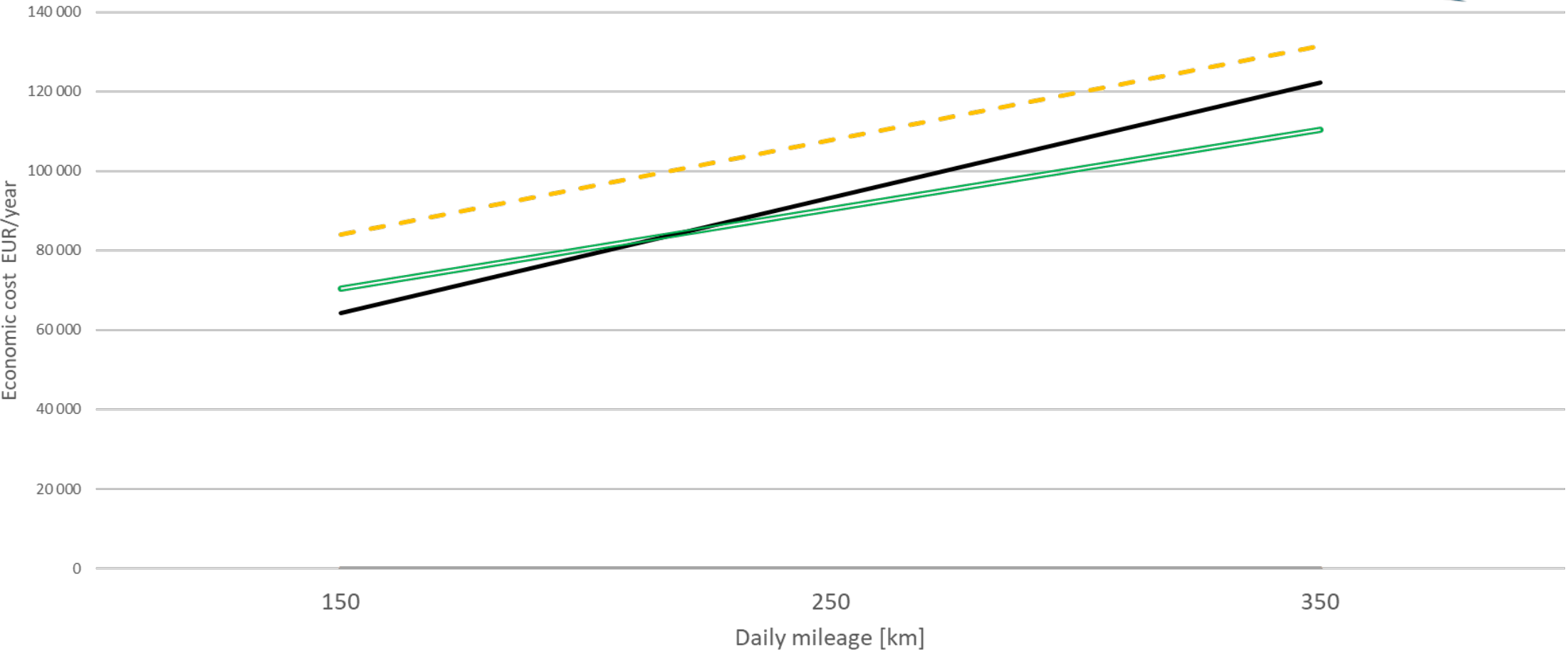


—●— Diesel —●— Plug in hybrid —●— Electric / overnight —●— Electric / opportunity —●— Electric / trolley

Gdynia output 1 [no capex trolleybus infrastructure costs as it already exists]



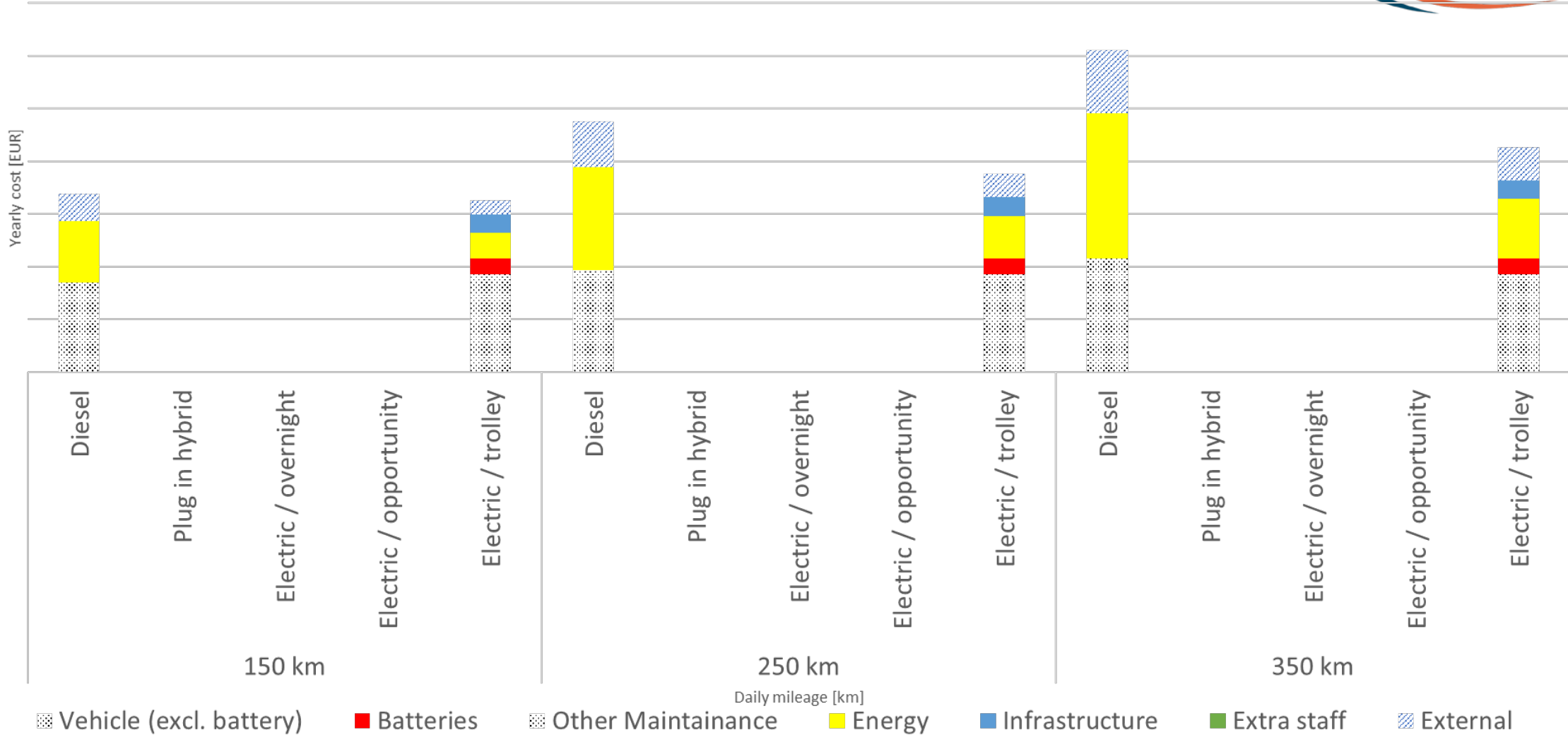
Gdynia output 2 [no capex trolleybus infrastructure costs as it already exists]



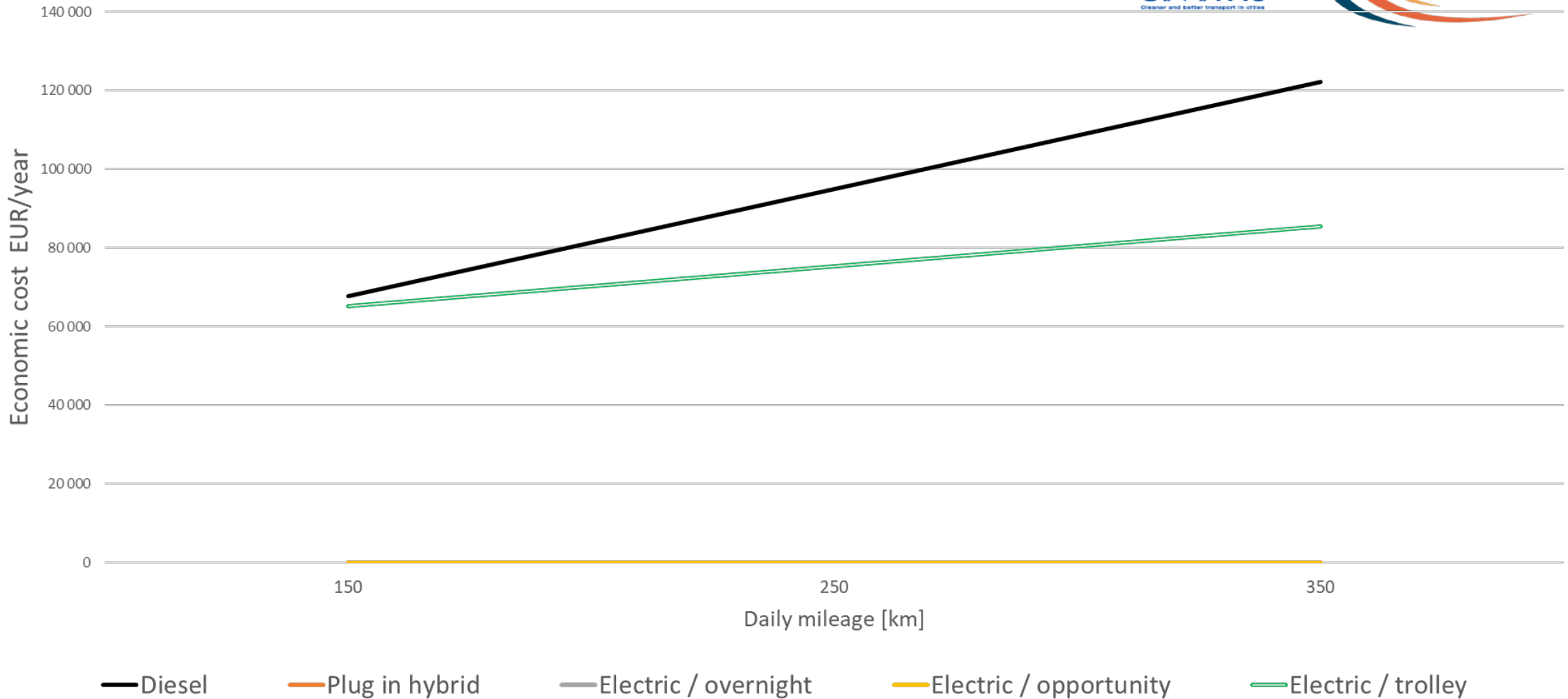
— Diesel — Plug in hybrid — Electric / overnight - - - Electric / opportunity — Electric / trolley



Szeged output 1 [no capex trolleybus infrastructure costs as it already exists]



Szeged output 2 [no capex trolleybus infrastructure costs as it already exists]



Conclusions based on Eberswalde, Gdynia and Szeged hybrid trolleybus cluster



- battery hybrid trolleybuses seem to be the most promising solution for cities that operate trolleybus network, as long as no marginal overhead network costs have to be covered (only existing network is used);
- Nevertheless, for short mileage services diesel buses could still be an efficient option - diesel buses should still be used for peak services,
- Electric / trolley vehicles should be used if there is a possibility to charge from the existing trolley network and the mileage of a service is medium or high,
- Positive results are strengthened by the high share of non-emission energy,
- Electric / opportunity vehicles should be used if there is no access to overhead wires and the mileage of a service is medium or high (opportunity charger is cheaper than the extension of the network),
- Hybrid trolleybuses seem to be technologically „safe” solution in case of mass electrification of public transport supply (heating/air conditioning, adaptability to specific conditions, i.e. topography, temperature, etc...).

thank you for your attention



mwol@wp.pl