

Fraunhofer Institute for Transportation and
Infrastructure Systems IVI

GUW+ Energy Supply for Trams and e-Buses



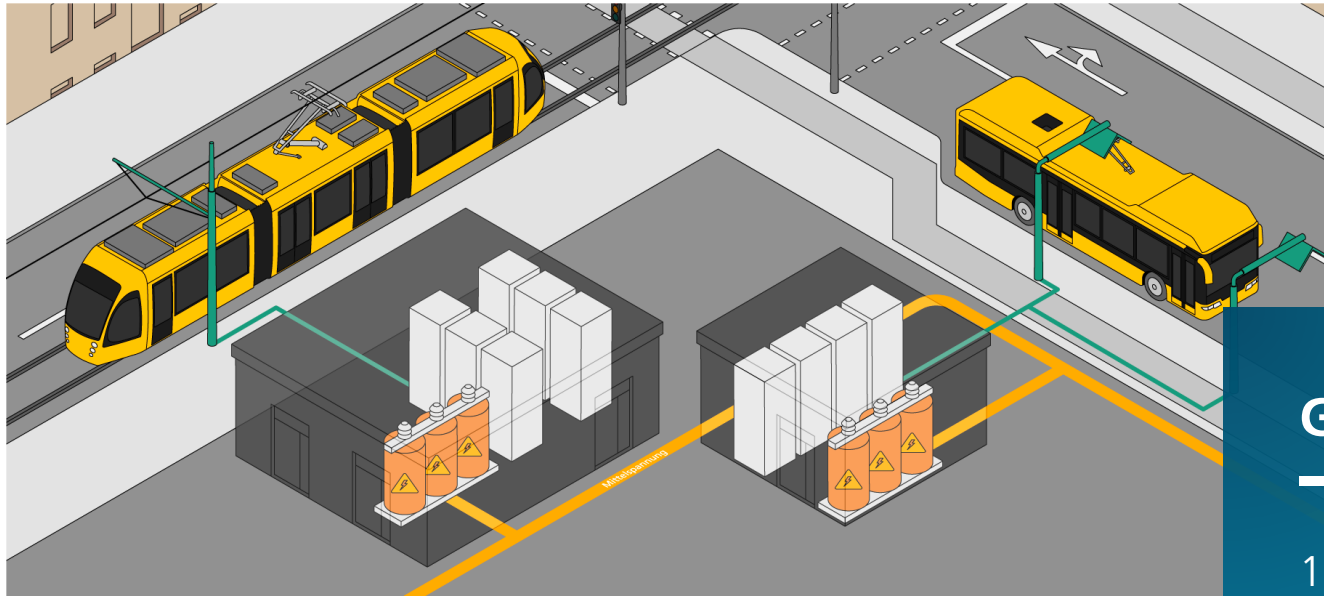


The GUW+ energy supply concept addresses transport providers that operate electric tram systems and are additionally planning to substitute Diesel buses with battery buses that rely on opportunity charging at their end stops.«

Dr. Sven Klausner
Group Manager »Charging Infrastructure«

GUW+ Shared energy supply for trams and e-buses

Overview



Status Quo

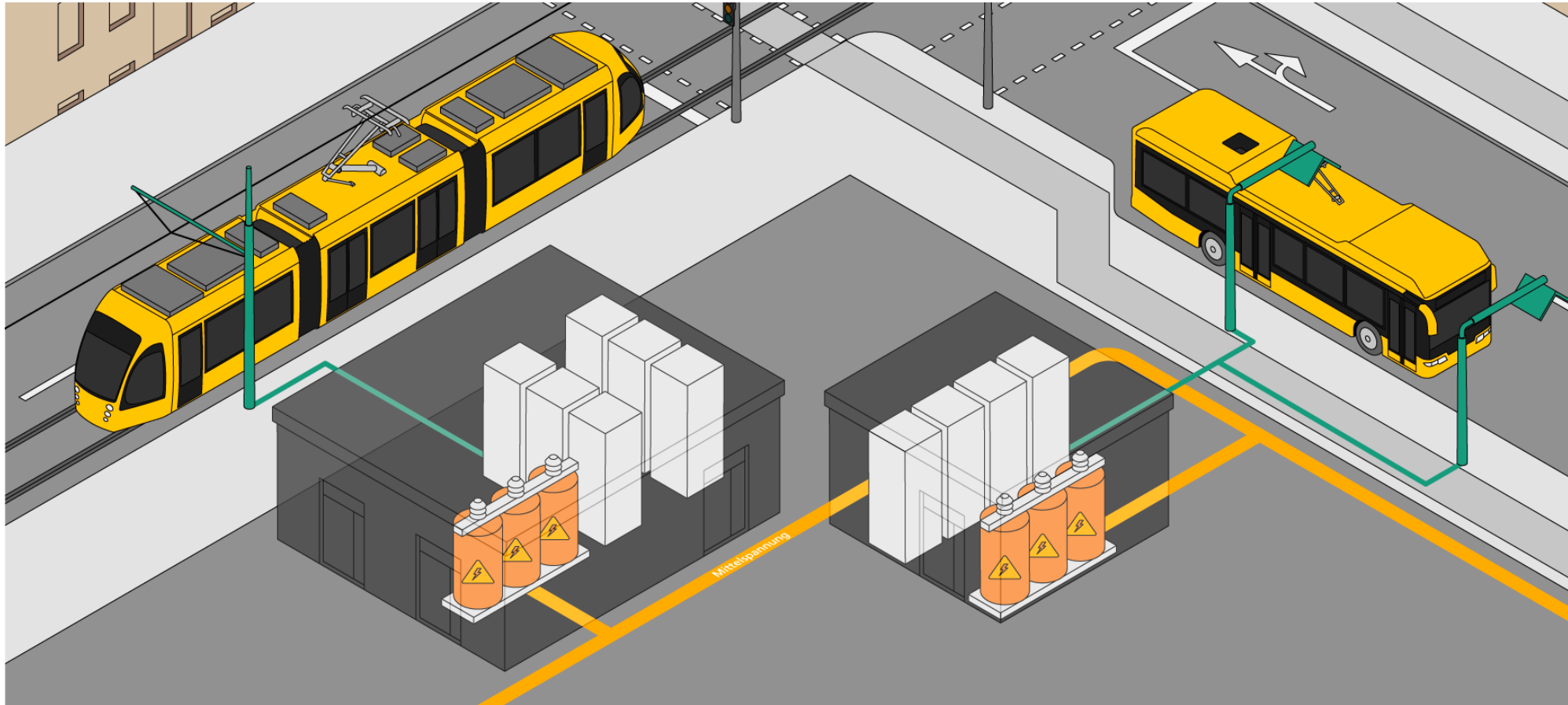
Separate energy supply for trams and electric buses

GUW+ Configuration levels

- 1 Use of existing infrastructure for charging e-buses
- 2 Energy storage
- 3 Grid interaction
- 4 Partly autonomous operation

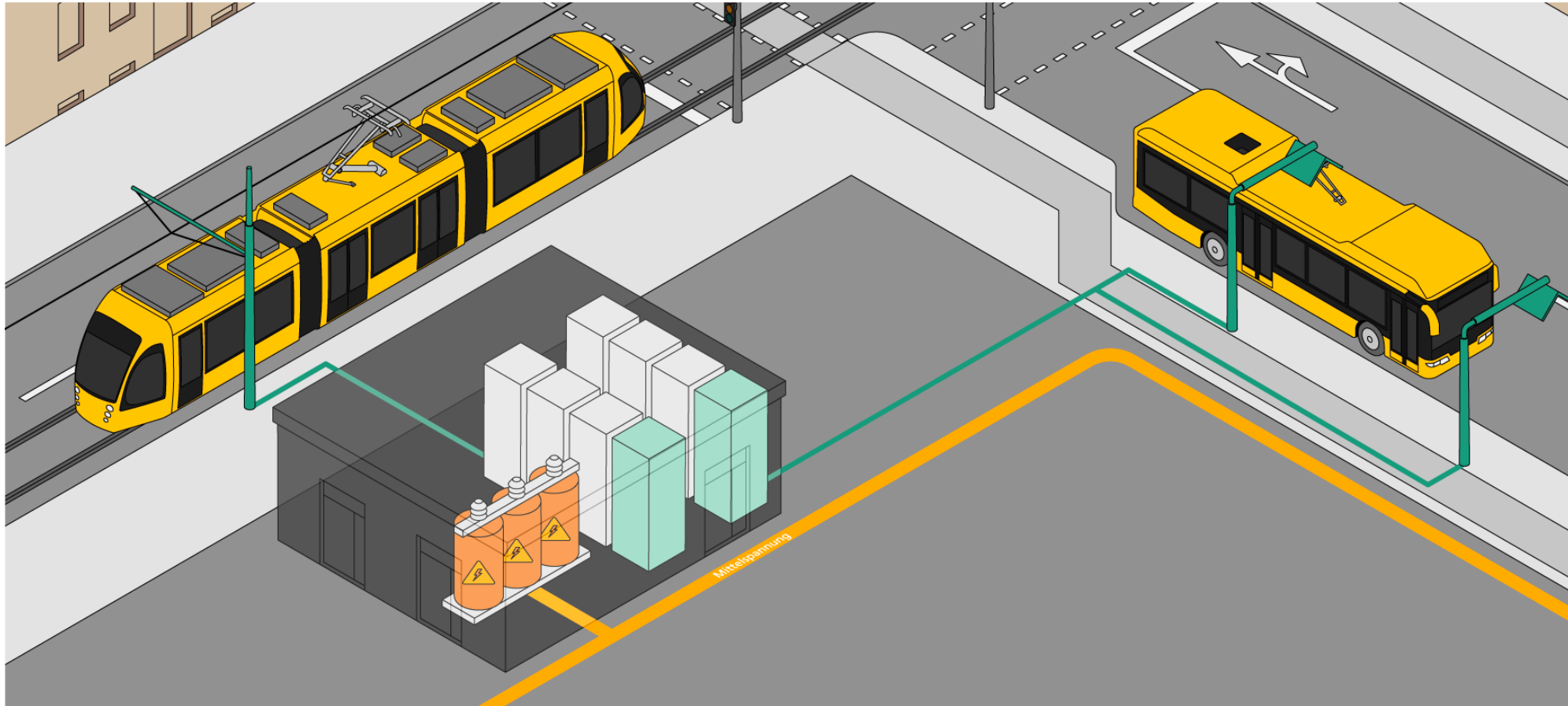
Separate energy supply for trams and electric buses

Status Quo



GUW+ Shared energy supply for trams and e-buses

Level 1: Use of existing infrastructure for charging e-buses



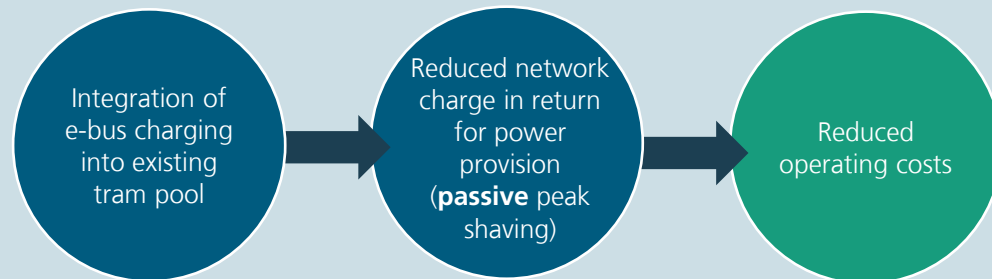
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Level 1: Use of existing infrastructure for charging e-buses

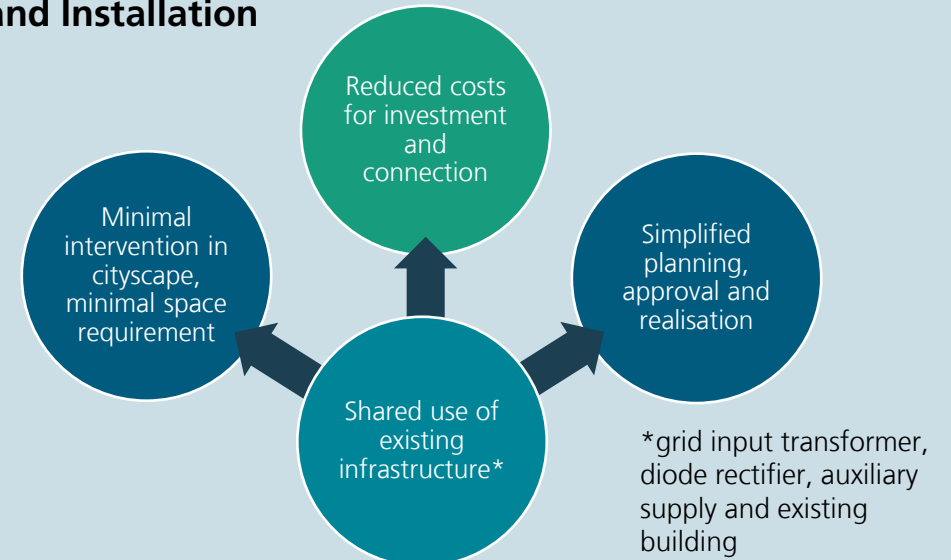
- Integration of e-bus charging equipment into a tram operator's existing substation in close proximity to the buses' charging location
 - No new building required for the the e-bus charging equipment (shared use of the existing substation building), merely new charging pole(s) need to be erected
 - No separate grid connection needed at the medium-voltage level (shared use of the substation's connection point)

Positive Effects

Operation



Planning and Installation



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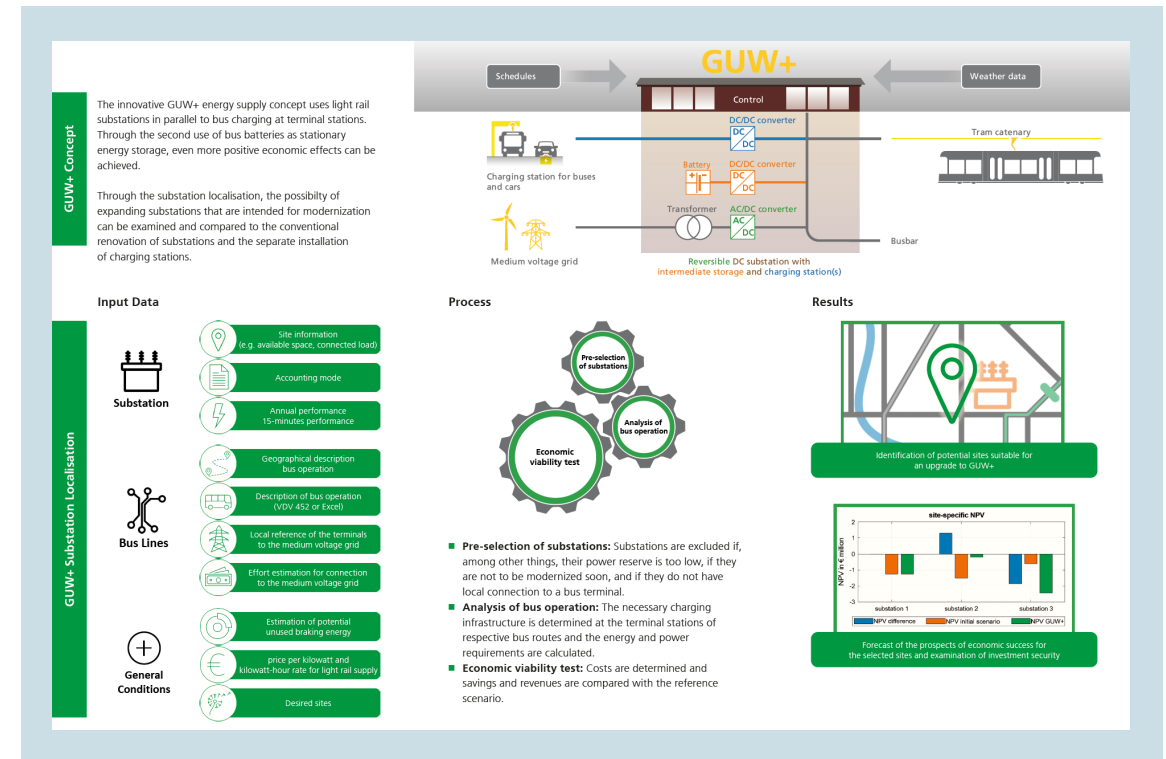
Level 1: Use of existing infrastructure for charging e-buses

Support for transport providers in site planning

- (Identification of required e-bus charging points and performance profiles)
- (Ageing prognoses for the traction energy storage units)
- Assessment of the technical and geographical suitability of substation locations regarding e-bus charging point locations
- Analysis of the substation pool's historical load profiles
- Compilation of annual load profiles for the combined operation of e-buses and trams
- Dimensioning of the bus charging equipment within the substation
- Determination of the potential for reducing network charges through passive and active peak shaving
- Economic assessment of the investments according to DIN 17463

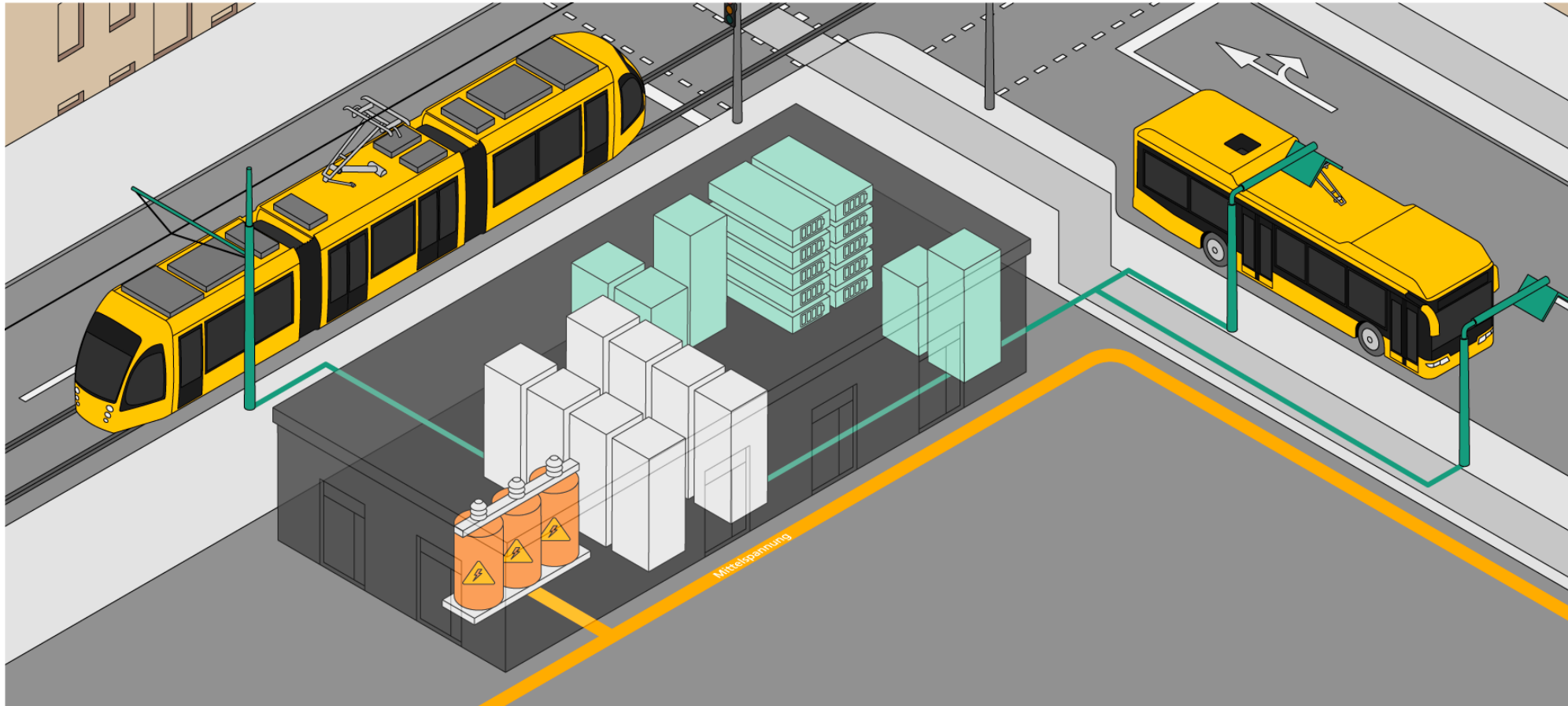
References

- DVB AG, ÜSTRA AG, MVG (SWM GmbH)



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Level 2: Energy storage

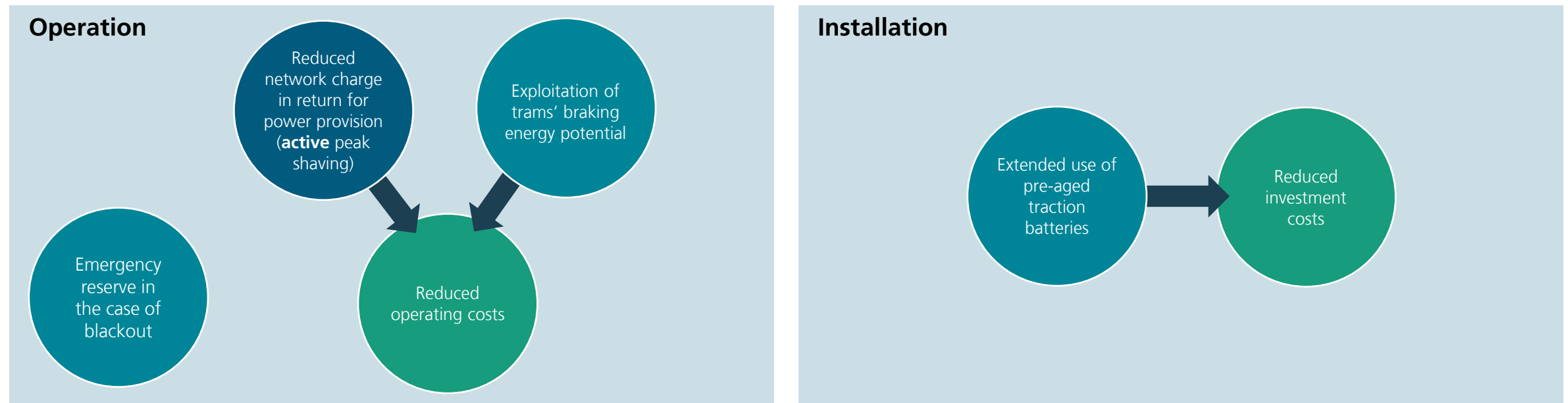


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Level 2: Intermediate energy storage

- Integration of a stationary storage system that helps to implement extended operating targets
 - Cost-efficient way to implement a 2nd-use application for pre-aged e-bus traction batteries
 - Technical feasibility proven (battery modules by Daimler Buses GmbH)

Positive effects

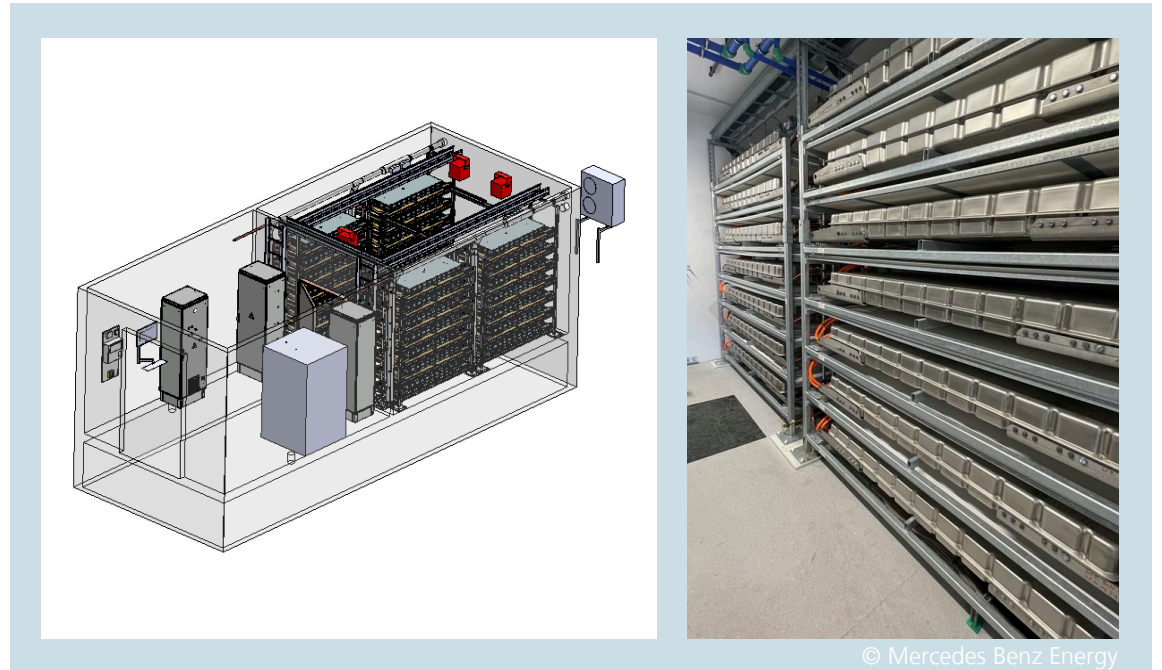


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Level 2: Intermediate energy storage

Support for transport providers in integrating a stationary storage system

- Location-specific determination of braking energy potential in trams (outfitting of measurement vehicle(s) and application of proprietary analysis routines)
- Determination of the potential for reducing network charges
- Dimensioning of the stationary storage technology within the substation
- Economic assessment of the investments according to DIN 17463
- Support in the tendering process for integrating the stationary storage technology into the substation(s)

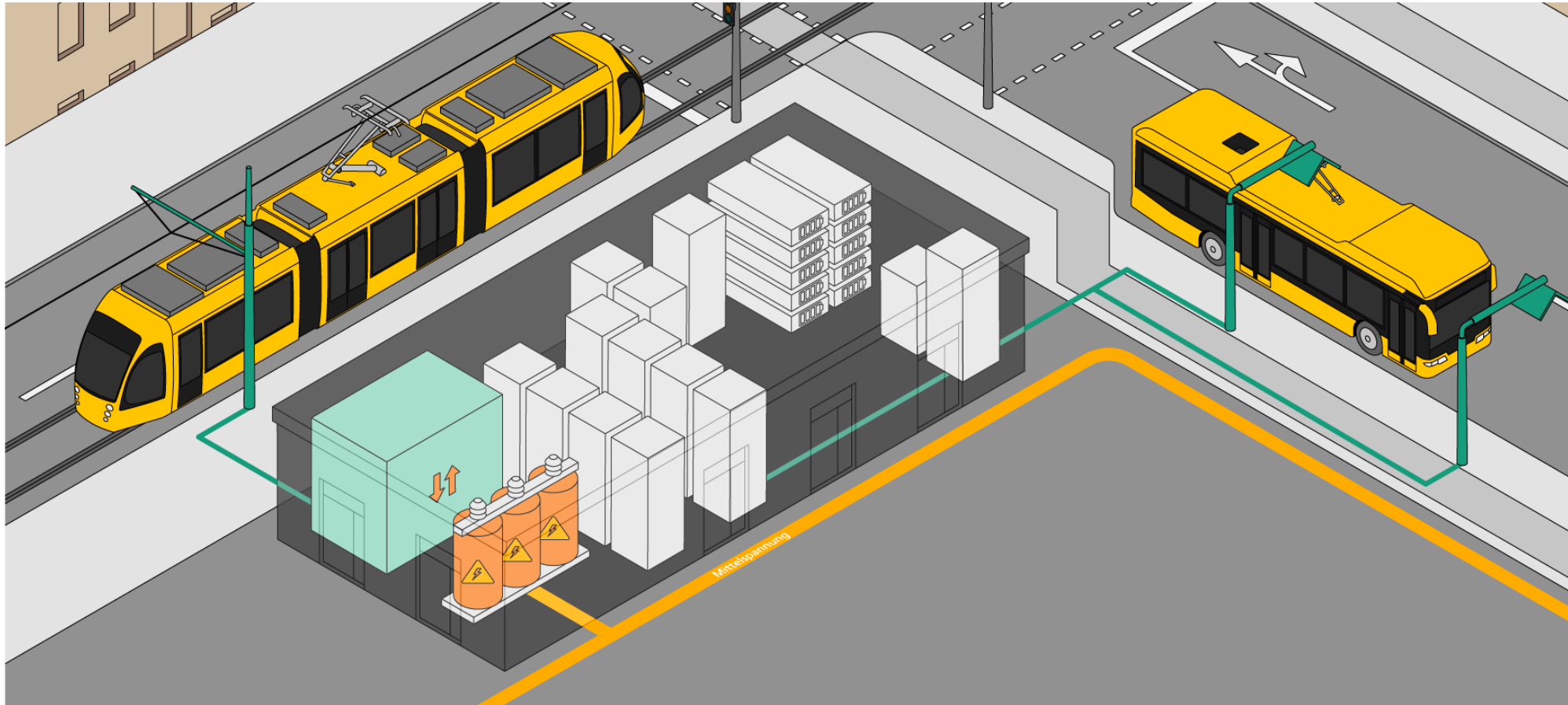


References

- DVB AG, ÜSTRA AG

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Level 3: Grid interaction



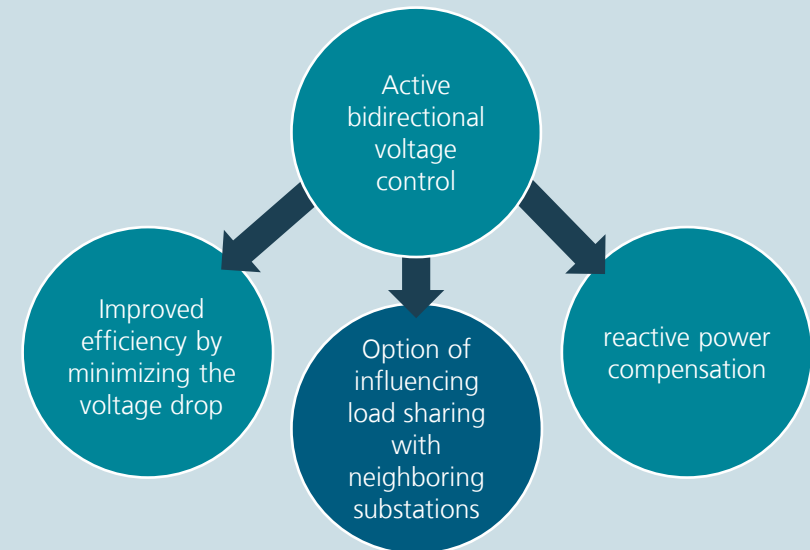
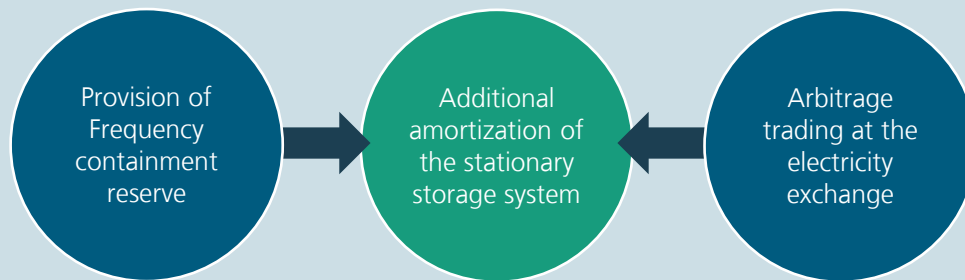
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Level 3: Grid interaction

- Integration of a bi-directional grid rectifier
 - Additional use of the storage system in terms of trading at the electricity exchange (external services)
 - Increased degree of utilization of the braking energy through very high-capacity feedback to the medium voltage grid
 - Additional adjustment options for the tram supply network

Positive effects

Operation

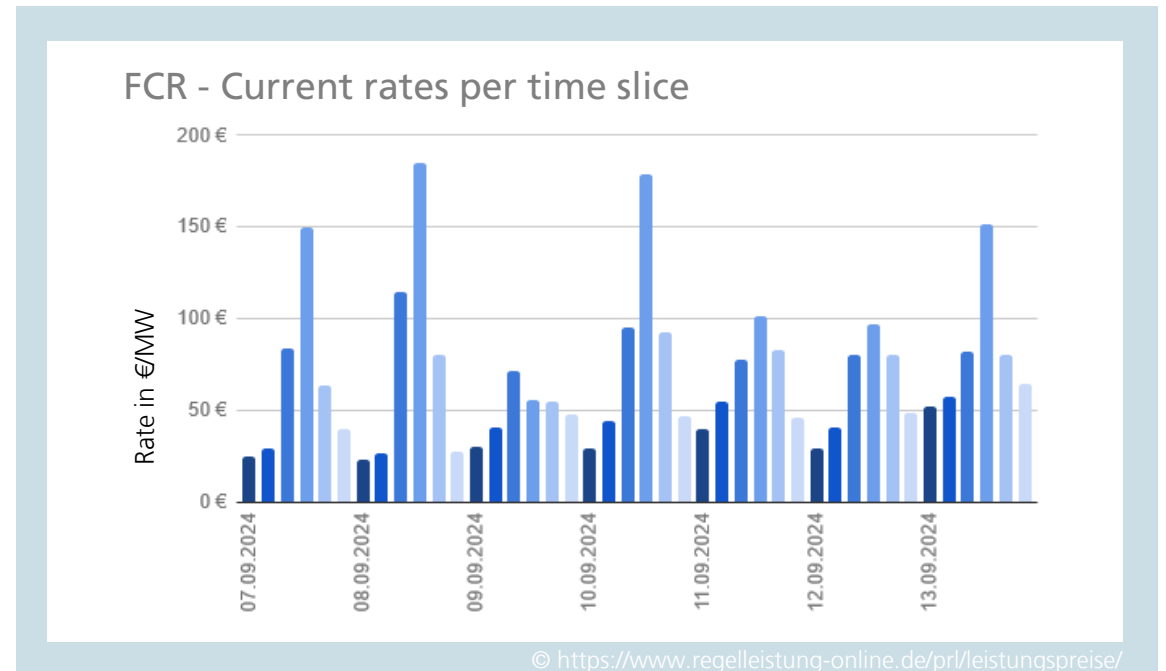


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Level 3: Grid interaction

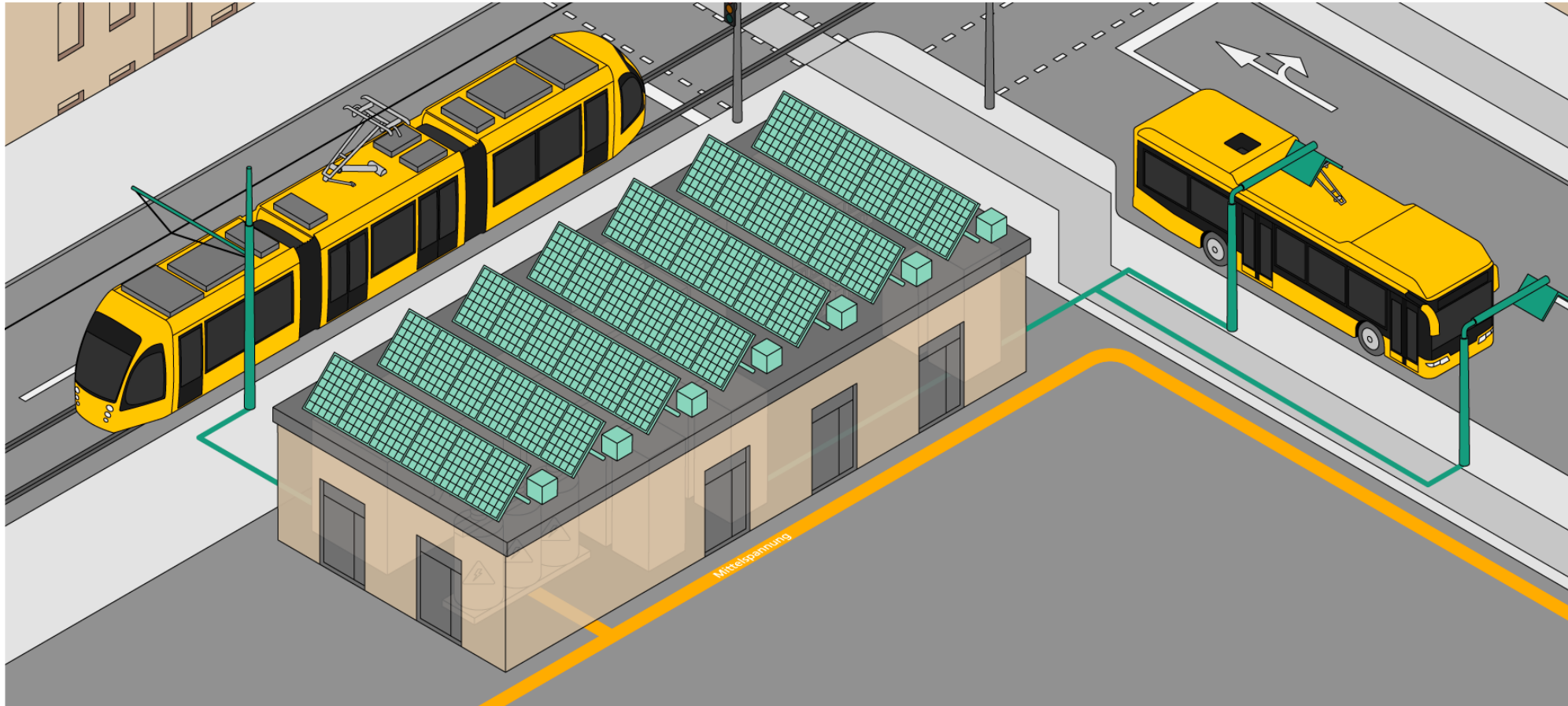
Support for transport providers in utilizing the storage system for grid stability

- Planning for the extension by a bi-directional grid rectifier
 - Evaluation of technical feasibility
 - Assessment of investments according to DIN 17463
- Provision of frequency containment reserve (FCR)
 - Predictive determination of possible time slots within the operational schedule
 - Storage system management → reliable supply for trams / buses
- Arbitrage trading at the electricity exchange
 - Predictive determination of possible time slots for trading energy units (DayAhead / Intraday) within the operational schedule
 - Storage system management → reliable supply for trams / buses



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Level 4: Partly autonomous operation

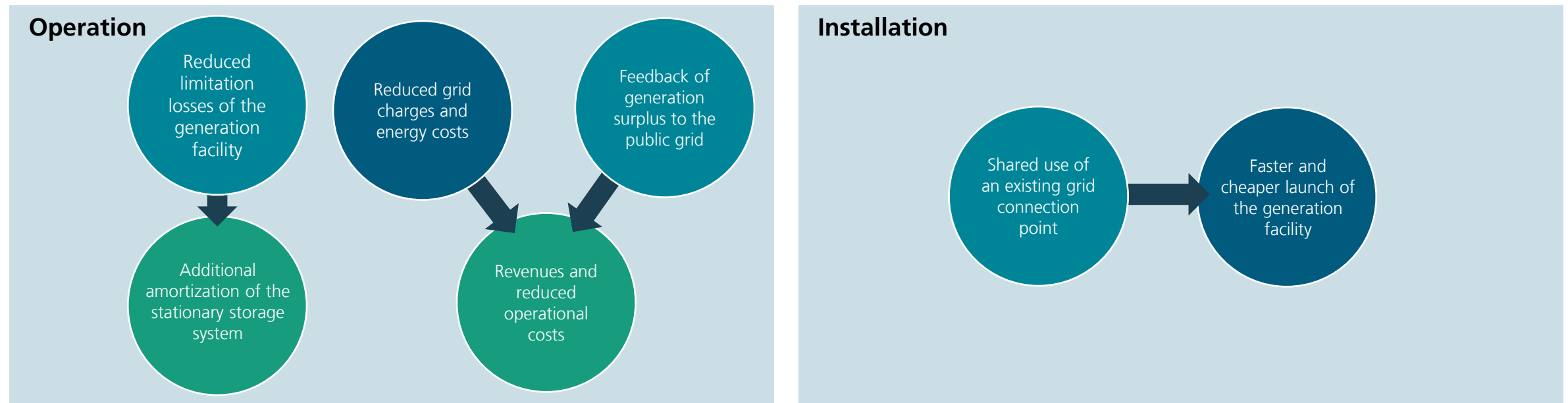


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Level 4: Partly autonomous operation

- Integration of a facility for the generation of regenerative energy (e. g. solar panels on the roof of the vehicle depot)
 - Use of climate-neutral electricity generated by own facilities for operational purposes
 - Possible increase of self-consumption quota through combination with a battery storage system

Positive effects



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Level 4: Partly autonomous operation

Support for transport providers in implementing a partly autonomous energy supply system

- Location-specific determination of potentials
 - Local integration of regenerative energy generation facilities (e. g., photovoltaics)
 - Reduction of grid charges and energy costs
- Generation facility and stationary storage system
 - Dimensioning
 - Participation in the tendering process
- Assessment of the investments according to DIN 17463



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Thank you very much for your
attention!
