UITP TROLLEYBUS

MOTAS

UITP TROLLEYBUS WORKSHOP

E-Bus 2020 – emission-free public transport

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E-BUS 2020 - SOLİNGEN

STADTWERKE SOLINGEN

- Lenght of route network 200 km
- 24 lines
- Total fleet of 98 buses
- Fleet of 50 articulated trolleybuses (TB) = 51%
- Total rd. 4,7 million km / year
- With TB rd. 3,1 million km / year = 65,2%
- 24,2 million passengers / year
- With more than 100 km catenary largest TB carrier in Germany
- 22 sub-stations

E-BUS 2020 – THE PRİMARY İDEA

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What would be, if…

…city plannung would have less limits due to a high flexibility?

City planning

Charging stations

Solar energy

Free of combustion engines

Modern mobility

Energy storage

…is an idea for a better future!

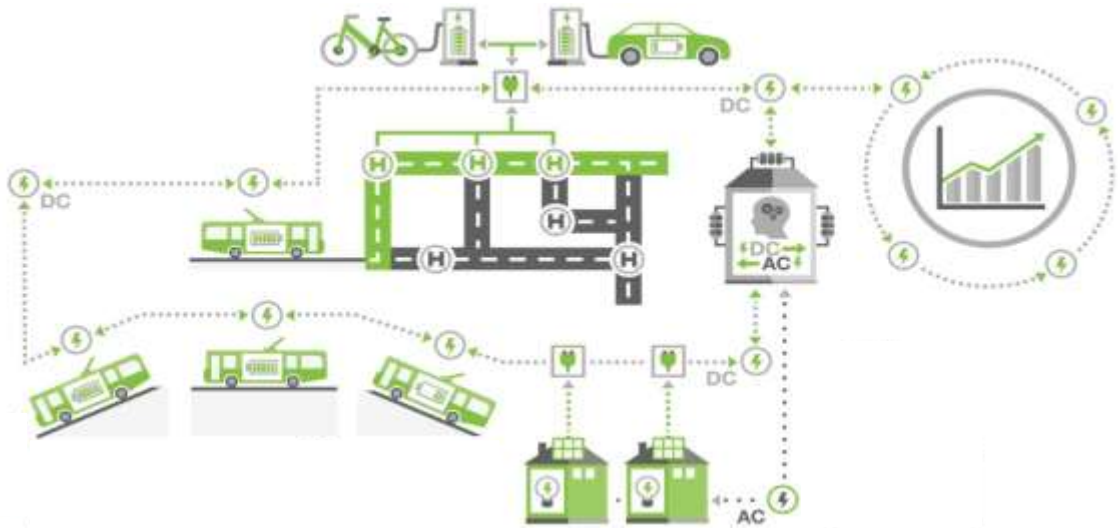
E-BUS 2020 – THE PRİMARY İDEA

Conversion of the catenary to a „smart grid“

Use of the catenary for energy storage and intelligent power supply (load management)

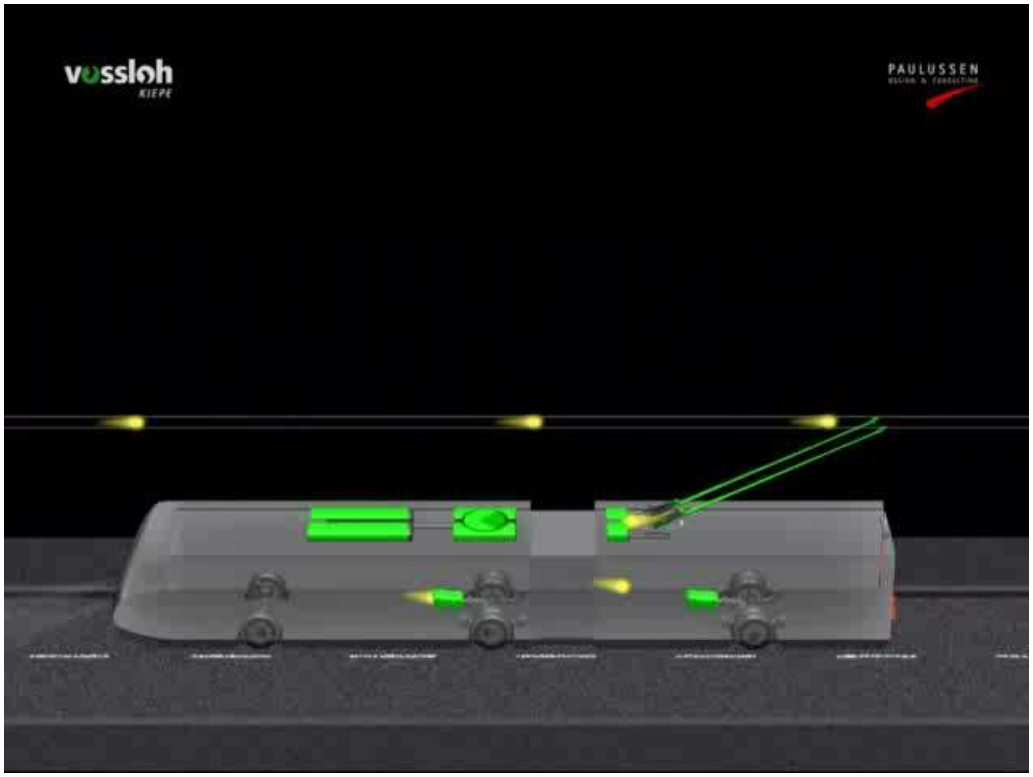
An efficient integration of the catenary into the power grid of the city,

by this way a better integration of regenerative energy



E-BUS 2020 – THE KEYSTONES

Aquisition of 4 articulated BATTERY TROLLEYBUSES for regular service on an existing bus line with particular catenary



E-BUS 2020 – PHOTOVOLTAİC

Commissioning of the first converter module in 2015

Test run for identification of ideal energy storage in real service with vehicle recuperation

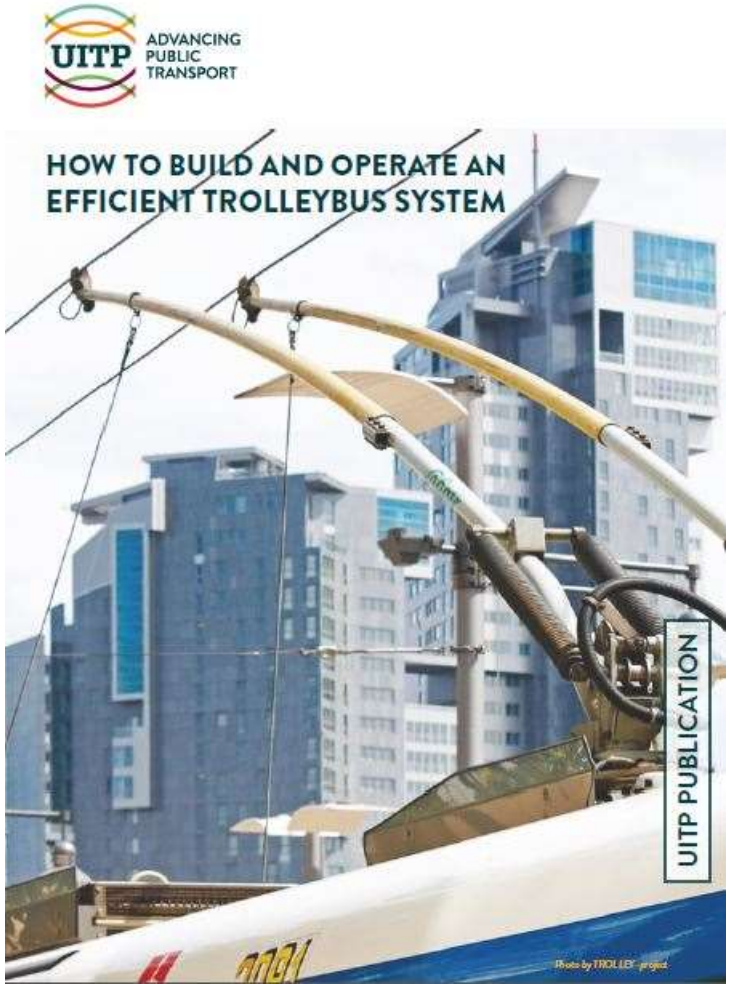
Later connection of more significant PV installations. Today there are 29 PV-installations with between 50 and 350 kW in Solingen.

output = 50,62 kWp
modules = 160
strings = 10
Uvo = 795 V
U_{MPP} = 608 V

Second life scenario for the traction batteries: expansion of the existing energy storages with replaced LTO-batteries of the vehicles with a remaining capacity of 70%

E-BUS 2020 – THE BUS

„The development of off-line electric buses is closely linked to the R&D efforts to develop less energy consuming on-board auxiliary systems such as AC and heating systems.“



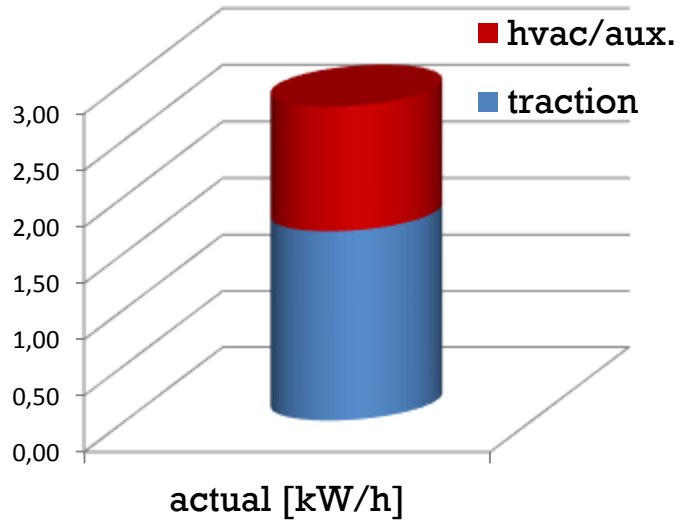
E-BUS 2020 – THE BUS

Necessary improvement of energy consumption of the trolleybus

Actual fleet:

Recuperation: 15%
HVAC consumption: 30%

Effective consumption:
2,78 kWh / km



Peak consumption in cold period: 3,5 kWh / km

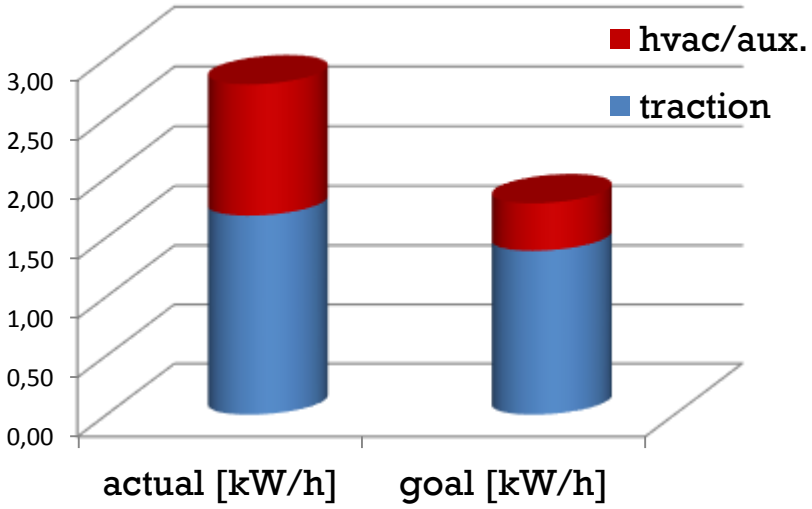
Important for battery dimension at the end of lifetime!!

E-BUS 2020 – THE BUS

Expected energy consumption:

Recuperation: 30+% (1)
HVAC consumption: 20% (2)

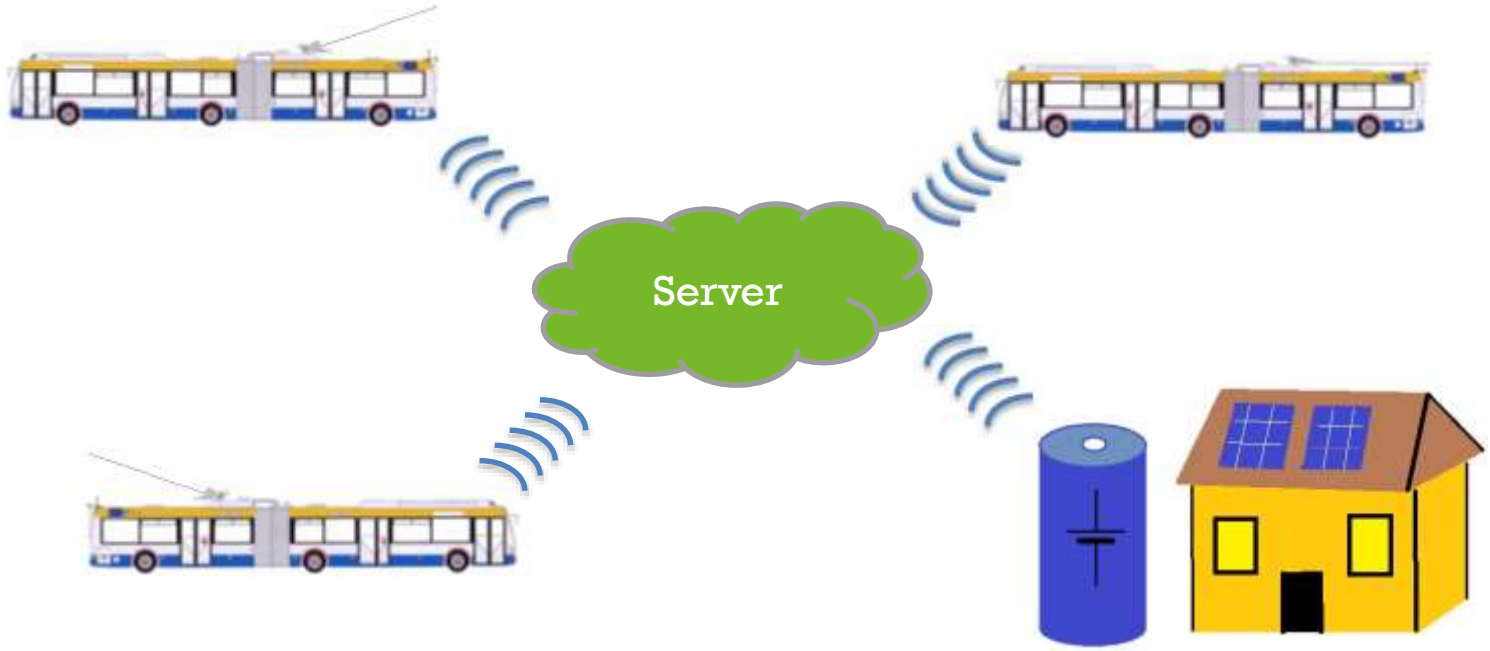
Effective consumption:
1,78 kWh / km



Peak consumption in cold period: 2,1 kWh / km

1 based on test period with bus with supercap storage
2 based on bus with optimized HVAC, 1 year in service

E-BUS 2020 – ENERGY MANAGEMENT



Reduction of peak demand by

- **Individual reduction with traction battery**
- **Energy balancing between vehicles**
- **Ideal integration of energy storages**

E-BUS 2020 - RISKS

Reliability of the bus fleet has top priority

- **trolleybus with mostly known and proven technology**
- **failure of photovoltaic has no influence**
- **energy management as additional function has no direct influence in bus service**

E-BUS 2020 - SAVİNGS

Increase of electromobility in Solingen of 4,4% to 69,6%

- **Savings of rd. 126.000 l diesel oil**
- **Rd. about 333 t CO_2 savings every year possible with the use of regenerative energy**
- **Raise of recuperation, load management and expansion to a „smart grid“ enable savings of approx. 50 thousands € a year**
- **Savings and additional costs for the battery technology in a period of 20 years are in a balanced condition**

E-BUS 2020 - SAVİNGS

Total savings of e-mobility in Solingen in a year

existing TB fleet and additional e-buses
= rd. about 70% of total traffic performance
(3,31 million km)

approx. 2 million litres diesel oil

approx. 5.300 t CO_2 with regenerative energy

E-BUS 2020 - PARTNER

Solingen

STADTWERKE SOLINGEN

NETZE SOLINGEN

BERGISCHE UNIVERSITÄT WUPPERTAL

neue effizienz

Bergische Gesellschaft für Ressourceneffizienz mbH

vossloh KIEPE