

Promoting **clean** public transport

Trolley

TROLLEY Roadmap – Industry perspective on ebus future



trolley:motion

An international action group
to promote modern e-bus systems
with zero emission



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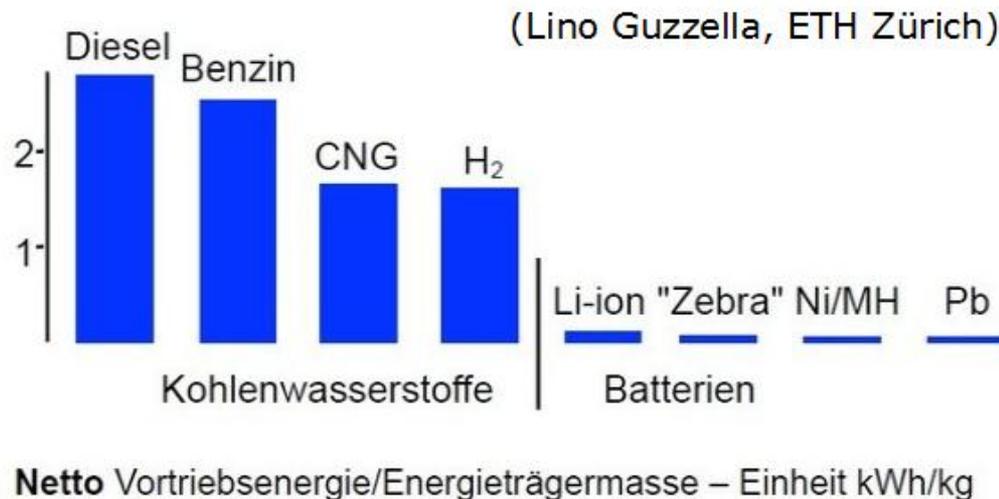
TROLLEY Roadmap – Industry perspective

▶ **Involved stakeholders:**

- ▶ Kummler+Matter AG, CH
- ▶ Carrosserie HESS AG, CH
- ▶ Solaris Bus & Coach, PL
- ▶ Vossloh-Kiepe, DE
- ▶ Cegelec a.s., CZ
- ▶ POWERLINES Group, AT
- ▶ Kirsch GmbH Trier, DE

► Greatest potential for further development of propulsion modes for public transport vehicles by 2020/2050?

Energy Densities of on-board energy carriers:



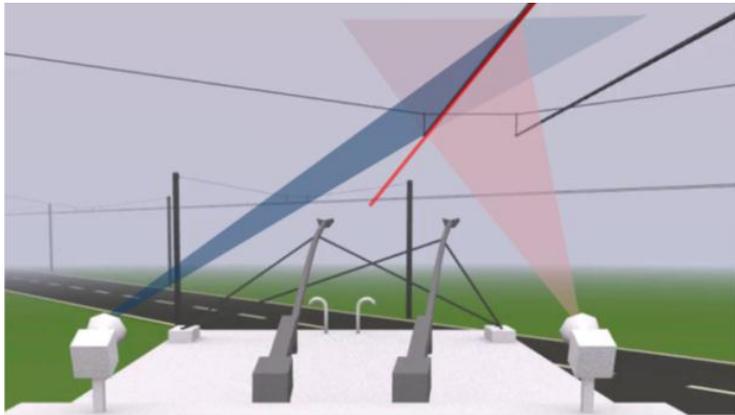
► Direct Current (DC) from overhead lines (tram/trolley-bus) for charging of electric on-board energy carriers

- ▶ **Greatest potential for further development of propulsion modes for public transport vehicles by 2020/2050?**
- ▶ Today, from a technological and energy-efficiency perspective the **pure trolleybus with catenary** is “**best-of-class!**”
- ▶ Current solutions are **far from stable economic full electric daily** with 18 m vehicles
- ▶ Investments in battery-electric **buses remain a risk market** for industries (e.g. Dreamliner experience)
- ▶ **Trolleybus and tram systems with DC infrastructure as a “bridge”** towards more flexible ebus systems in 2030 and a full-electric PT in 2050!
- ▶ Including **optimisation of necessary batteries** and **recharging interfaces**

- ▶ **Trends and biggest impact on the electrification of urban mobility in EU cities / what political action would be required?**
- ▶ Oil dependency of public transport in EU is huge; **only 5% of European bus fleet is running on alternative fuels** (incl. electricity as clean power)!
- ▶ Replacing oil with alternative fuels will **save several billions of EUROS** per year on EU's oil import bill! ("€ 4.2 billion per year already in 2020, increasing to € 9.3 billion per year in 2030"; Prof. Müller-Hellmann, VDV Förderkreis)
- ▶ **Lack of catenary and (re)charging infrastructure in EU** for wider take up of electric PT
- ▶ Need for **comprehensive business models** for PT systems and **funding schemes** (e.g. Public-Private Partnership; start-up incentives)

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- ▶ **Game-changing technologies and scientific challenges for electric public transport in European cities of the next two decades?**
- ▶ Besides long-term research & development on batteries and (wireless) (fast) charging systems; **automatic wiring and de-wiring technology** need to exploit trolleybus systems as a “bridge” towards more flexible ebus systems



Left: DiaLOGIKa / KM:
GPS-based software and
pole drive system for
automatic wiring and
de-wiring

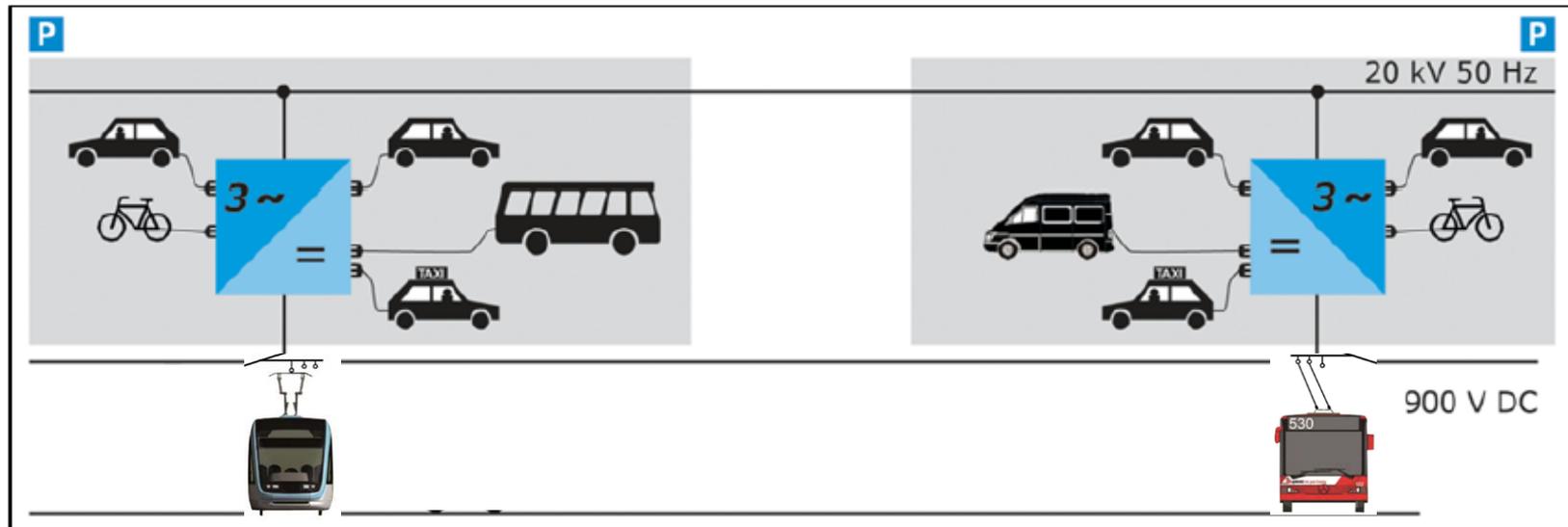
Right: Europe's first
Trolley-Battery-Hybrid-
Bus operating in
Eberswalde



- ▶ **Promising strategies and business models to boost the introduction of electric public transport in future European smart cities?**
- ▶ Development of **new financing models** for costly initial investment into infrastructure (catenary and (re)charging stations) and on-board energy storage systems (e.g. leasing concepts)
- ▶ **Using ICT for smart** and more efficient **energy management** in tram and trolleybus networks (smart grids, smart meter, real time information)
- ▶ Including **energy management at bus stops and/or substations** in combination with plug-in/docking stations for fast charging of electric buses

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- ▶ **Promising strategies and business models to boost the introduction of electric public transport in future European smart cities?**
- ▶ **Double use of power supply infrastructure of existing tram and trolleybus systems as loading stations for other e-vehicles (e-cars, e-bikes etc.)**



Source:
Prof. Müller-
Hellmann,
VDV-Förder-
kreis;
adapted)

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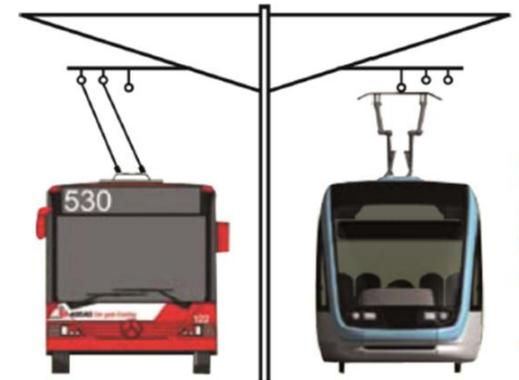
- ▶ **Need for flexible, modular, and efficient charging infrastructure for different business models and double use of existing power supply of PT** (e.g. COMBO 2 plug-in system combines both AC charging and fast DC charging)

Normal charging time: 5.5 hours (AC charging) | With 40 kW DC: 30 minutes (DC charging)



Source: PHOENIX CONTACT GmbH & Co. KG; Prof. Müller-Hellmann, VDV-Förder-kreis)

- ▶ **Future catenary network for trolleybus systems and auxiliary engines in trolleybuses by 2020/2050?**
- ▶ **Trolleybuses** operating 100% under catenary are the **only pure e buses today!**
- ▶ Catenary network will become **architecturally more appealing** (less invasive)
- ▶ If partially catenary-free, **trolleybuses will need battery and/or supercaps (2020) or fuel cell (2050) technologies as additional energy source(s)**
- ▶ **Smart infrastructure concepts;** exploiting synergies between tram and trolleybus electrical infrastructure (including joint use of overhead wires)



Source: Prof. Müller-Hellmann

- ▶ **Main factors that increase attractiveness of trolleybus systems and groundbreaking technologies needed for further development?**
- ▶ **Partial catenary networks** supported by **automatic wiring and de-wiring** (while driving); combined overhead and induction power supply
- ▶ Trolleybuses need different **branding/marketing; system approach** with integrated e-mobility concept (design of vehicles, stops, catenary network)
- ▶ Trolleybus systems as the **backbone for smart city solutions** (reliable and proven electromobility that is capable of recharging energy on a big scale into the network to be used by other e-modes; e.g. braking recuperation of up to 25 % into the network)

Thank you for your attention!

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