

Study trolleybus- tram network use in Leipzig



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EU-Project Trolley: excerpt of the main activities in Leipzig

WP 3: Draw up of a compendium for the setup of new electrical bus systems or for conversion into electrical bus systems within an existing urban or tram network

WP 4: Feasibility study for the conversion into electrical operation on the example of the city bus line 70

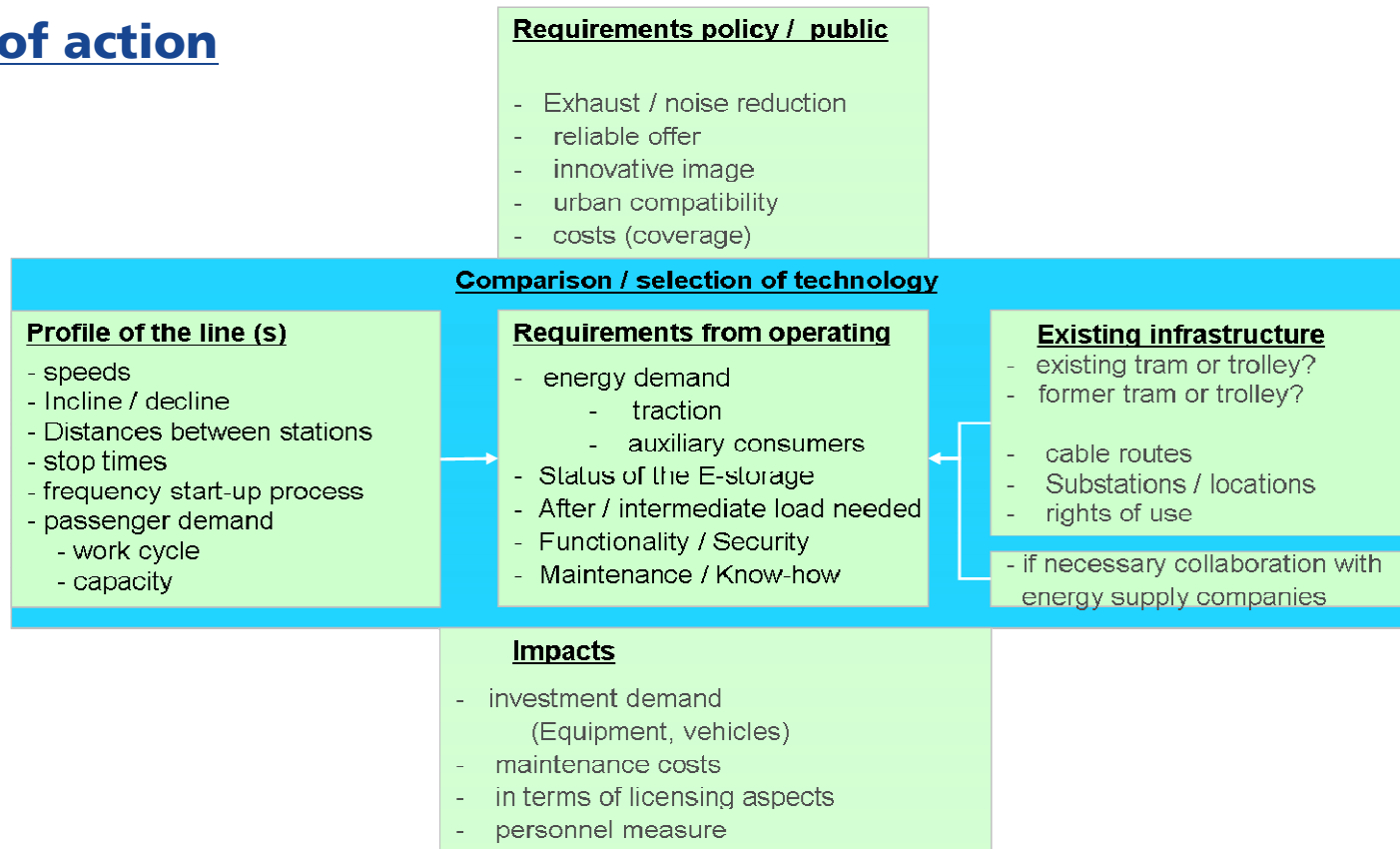


An existing **infrastructure** and

know-how from the **operation and maintenance** of electric railways

provide important **synergies** for the conversion of bus lines into electrical operation

Course of action



Criteria for the selection of a suitable bus line

Proximity to existing facilities of the power supply

- Catenary for tram
- Substations
- Cable routes

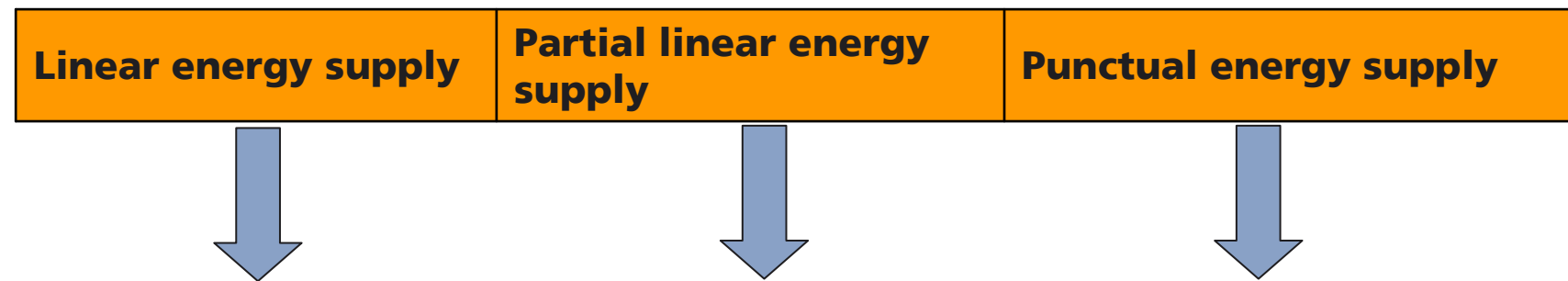
Operational concept

- Schedule (work cycle,)
- Ridership
- Total number of vehicles in use (capacity, ...)
- Operating performance (vehicle- km per circulation)

Urbanistic environment

- Historical or otherwise sensitive environment
- Compatibility with the townscape
- Structural requirements for infrastructure

On which way goes the energy into the vehicle?



- ▶ all energy supply systems require powerful DC networks
- ▶ where tram or trolley bus networks operate, it's already available
- ▶ Using existing systems can significantly reduce the infrastructure costs for a conversion

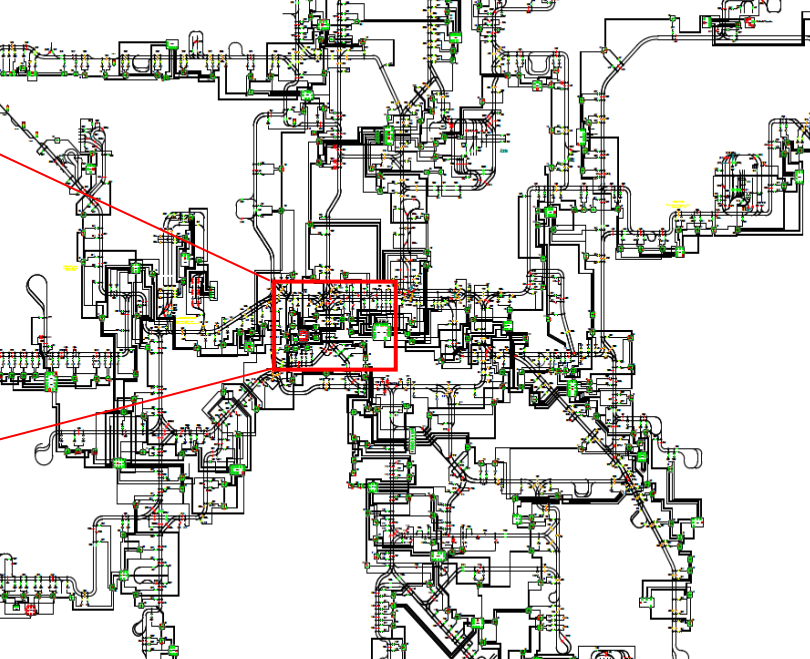
Bus stop with catenary line



Diagram illustrating the power supply and control infrastructure for a tram system. The tram is shown above the track. The track segments are labeled "Segment enable" and "Power pickup". The primary winding is labeled "Primärwindung". The vehicle's power generation is labeled "Fahrzeuergenerierung". The supply voltage is labeled "Versorgungsspannung 400 V_{AC} / 750 V_{DC}". The transformer is labeled "Netzanbindung". The inverter is labeled "Umrichter".

Dipl.- Verk. Wirtsch. Christiane Wagner, LVB GmbH, 23.01.2013

network "to these



cables

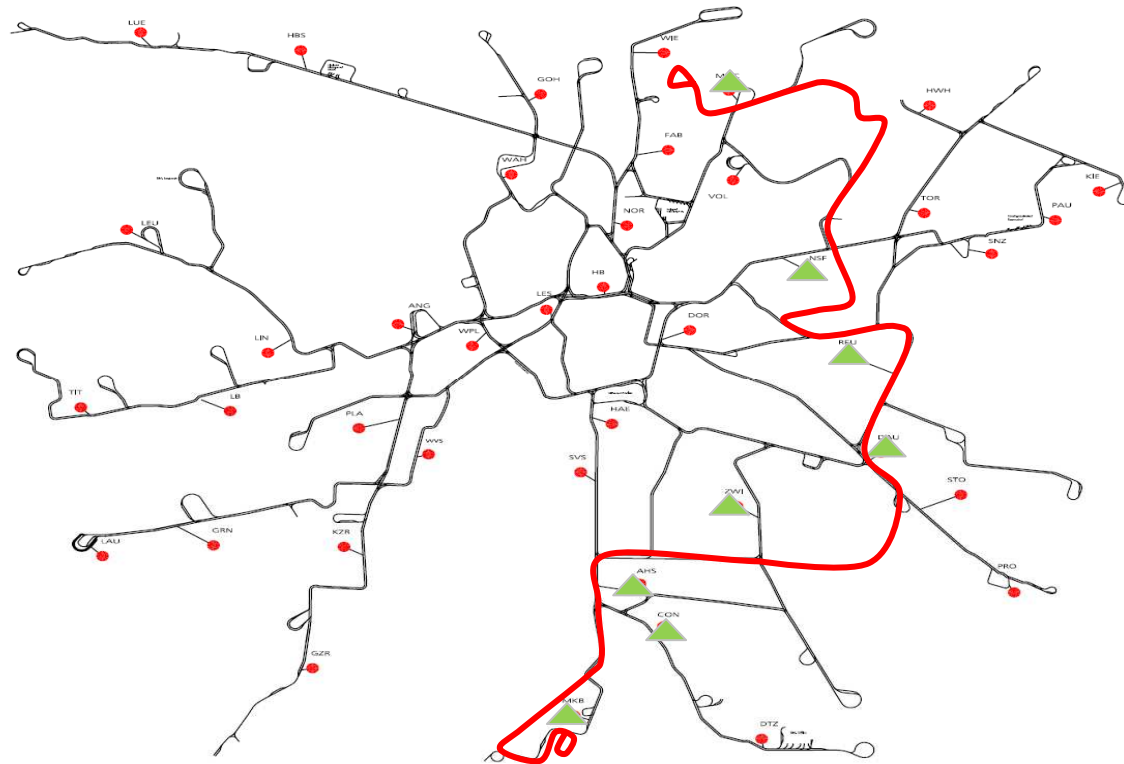
Specific requirements for the use of the tram infrastructure for electric buses in Leipzig

Rectifier substations	DC cable networks	Overhead lines
<p>Yes</p> <ul style="list-style-type: none"> ▶ because the energy balance is usually designed for a maximum load ▶ unrestricted useable also for punctual energy supply 	<p>Yes</p> <ul style="list-style-type: none"> ▶ if separate feeding will be enabled ▶ Joint use for punctual recharging possible 	<p>No</p> <ul style="list-style-type: none"> ▶ different construction of both pantograph system (not compatible) ▶ Shared suspensions are possible on parallel tracks

Location of substations for tram and the course of line 70

Analysis of the
availability of already
existing tram power
supply along the course

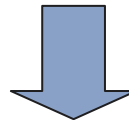
8 rectifier substations
along the route course
available



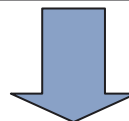
Configuration of energy storage and charging infrastructure

The question of feasibility and selection of the optimal operating mode is determined by the following three steps

1. Energy storage: what kind of energy storage (capacity, size, weight) can be placed instead of the diesel engine in the 18m bus?



2. Determination of demand: Based on the system parameters (topography, distances between stops, speed), the energy demand needs to be determined!



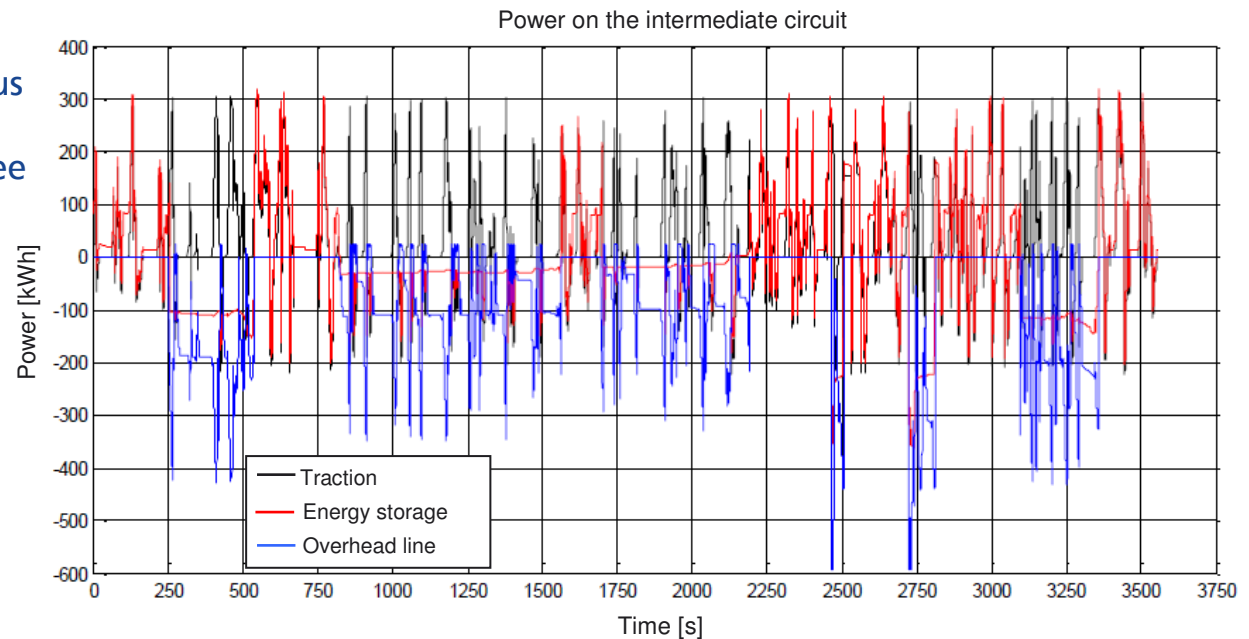
3. Charging system: In accordance with point 1 +2, the location and length of the required catenary sections and charging stations needs to be determined!

Important is a qualified determination of the energy demand!

Test runs with an 18-meter hybrid bus and simulation for the use case "trolleybus with partial catenary-free operation" conducted

The diagram shows:

- no power consumption > 300 kW but
- Peaks in the recuperation up to 600kW

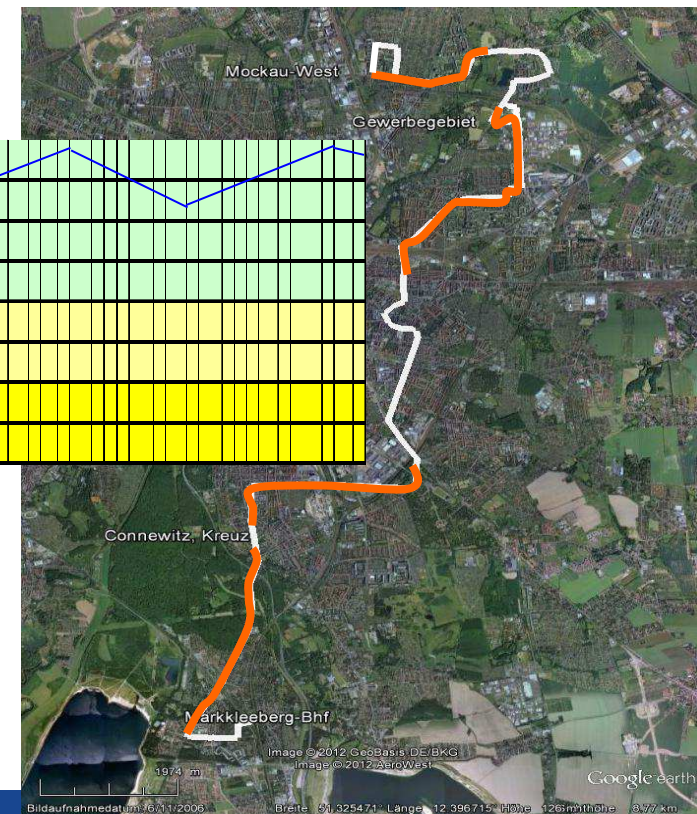


Simulated operating conditions of the reference line

Energy storage status for the direction of
travel from Markkleeberg- Bhf to Mockau-West



Trolleybus operation with energy storage
4 sections with overhead lines



Maintenance and repair services

Trolley- and Diesel buses can be maintained in the same repair shop

= because of the joint use of facilities, duplication of necessary investments for further properties can be eliminated

No new work equipment is required compared to the already existing Hybridbus fleet in Leipzig

2 Depots for electric buses: Technical Centre Heiterblick and Bus depot Lindenau
At both depots charging stations will be established

Lindenau is and will be the maintenance centre for the Leipziger buses

Economic aspects for bus line N° 70

Position	Trolleybus line with continous overhead line		Trolleybus line with partial overhead line (traction power useable)	
	technology	costs in € (exclusive of VAT)	technology	costs in € (exclusive of VAT)
Track length in meter (in both directions)	43.874		43.874	
Thereof overhead line in meter (in both directions)	43.874	18.865.820	26.319	11.317.170
Thereof overhead line in %	100		60	
Substation new construction	0	0	0	0
Substation expansion	7 units	840.000	7 units	420.000
Charging station (only at depot)	2	400.000	2	400.000
Total costs		20.105.820		12.137.170
in %		100		60

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Rolling stock for 16 courses (+ 2 for reserve)	18 units à 750.000 €	13.500.000	18 units à 850.000 €	15.300.000
Total costs		33.605.820		27.437.170
in %		100		82

What are the open issues of our approach?

1. **There is no vehicle (18m bus) of the described configuration on the market available.**
Available Information encourages our assumption that this will change within the next 3 years.
2. **The specific location of the as basis taken traction energy storage with the parameters:**
 - Capacity of 85 kWh
 - Maximum power 400 kW
 - Mass 950 kg**is yet not clearly resolved.**
3. **Given the height of the installed capacity of electric auxiliary consumers on the 18m bus in the order of 180 kW, the function of the entire system especially at extreme temperatures, can only be ensured with an intelligent energy management system, which sets the priorities of the individual energy consumers independently.**

Summary / Generality: Supply of the E-buses using the tram power supply network

Comprehensive analysis of a specific bus line provides useful results in the following form:

Operation of an electric city bus line (supplied by the existing tram power supply network) is technically and economically feasible

with a conversion, a continuous contact line from the classic trolley bus can be partially dispensed without an operational risk

required vehicle and infrastructure components are available in the required form

the selected example of line N° 70 in Leipzig is in all likelihood transferable to many problems other cities and transport operators

Thank you for your attention!

