

Promoting clean public transport

Innovations in trolleybus infrastructure



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- Energy management
- Simulations
- Freezing protection
- Components for overhead contact line
- Agglomeration – Network expansion



Continuously increasing demand of energy

- Increasing passenger transport
- New requirements on customer comfort
- Higher engine outputs
- Rising impairment caused by individual traffic (traffic jams!)

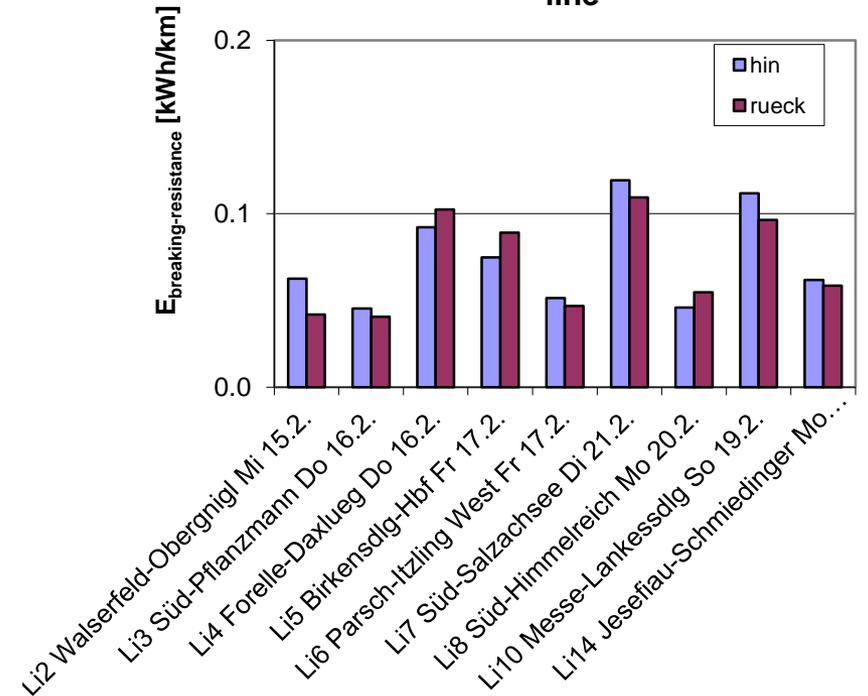
Different demand for power output per season

Total consumption of 12,2 GWh in 2011

appr. 2,55 kWh / km

0,07 kWh/km unused breaking energy
= 350.000 kWh / year (2,86%)

Average breaking-resistance-energy on a line



Heating power

Air conditioning

Engine output

Efficiency factor of engine

Roll resistance

Driving style from driver

powerbalance :

$$P_{\text{mech}} = \frac{d}{dt} E_{\text{kin}} + P_{\text{fric}} \quad \text{mit} \quad \begin{array}{l} P_{\text{mech}} - \text{mechanical power,} \\ P_{\text{fric}} - \text{friction power,} \\ E_{\text{kin}} - \text{kinetic power} \end{array}$$

$$P_{\text{mech}} = m * v * (a + R * g) \quad \text{mit} \quad P_{\text{reib}} = F_{\text{fric}} * v = R * g * v$$

mechanical power :

$$E_{\text{mech}} = \int m * v(t) * (a(t) + R(v) * g) dt$$

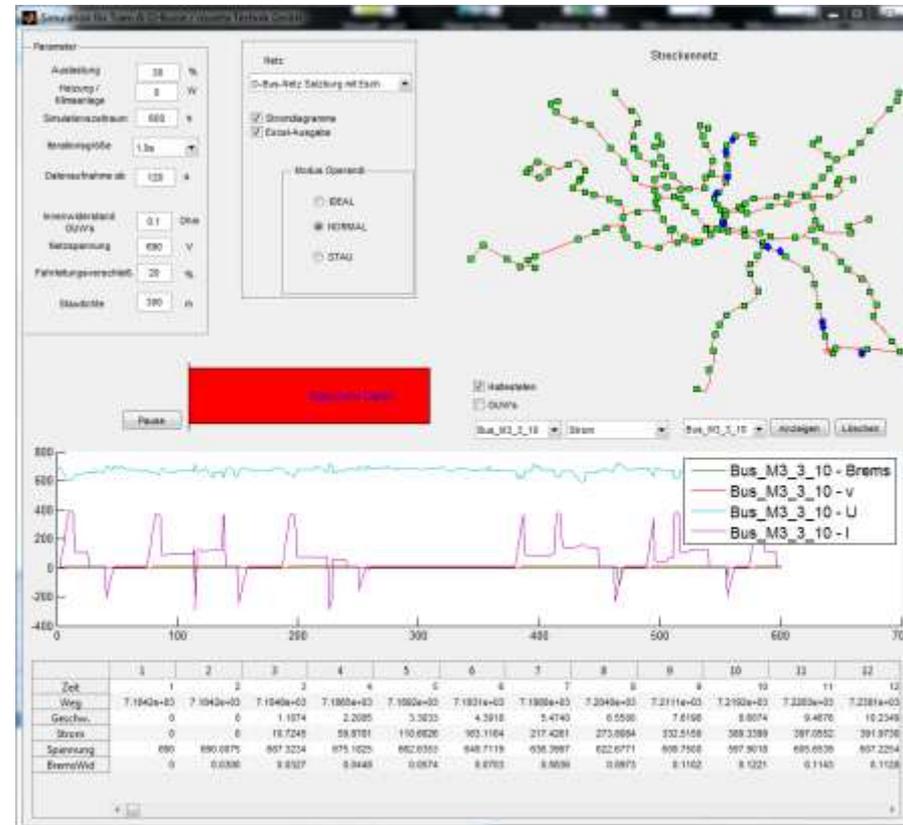
and efficiency factor on feeding :

$$\eta_{\text{ein}} = \frac{E_{\text{mech}}}{E_{\text{elektr}}} \quad \text{mit} \quad E_{\text{elektr}} = \int U_F * Idt$$

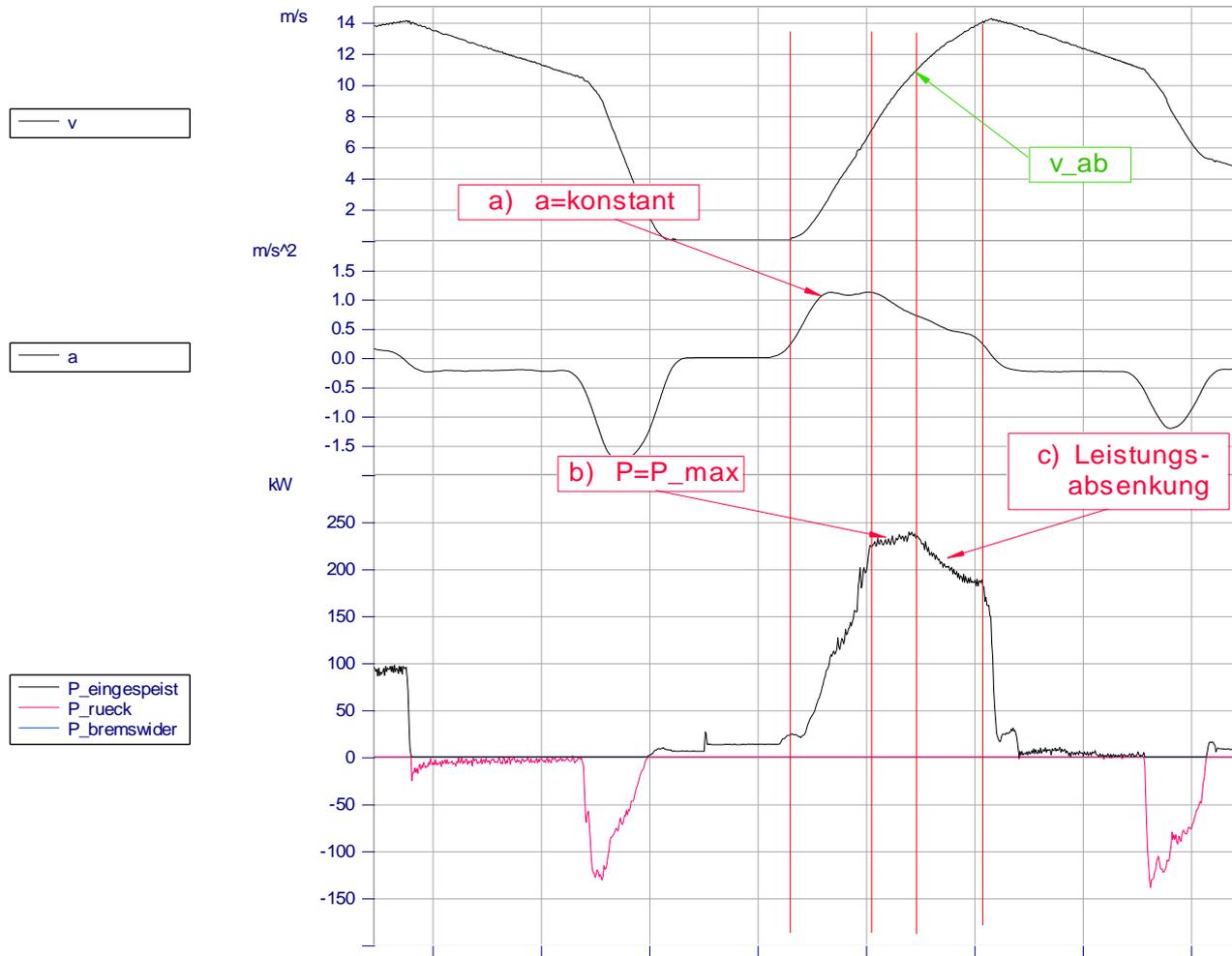
Supplying the energy on the right time in demanded amount

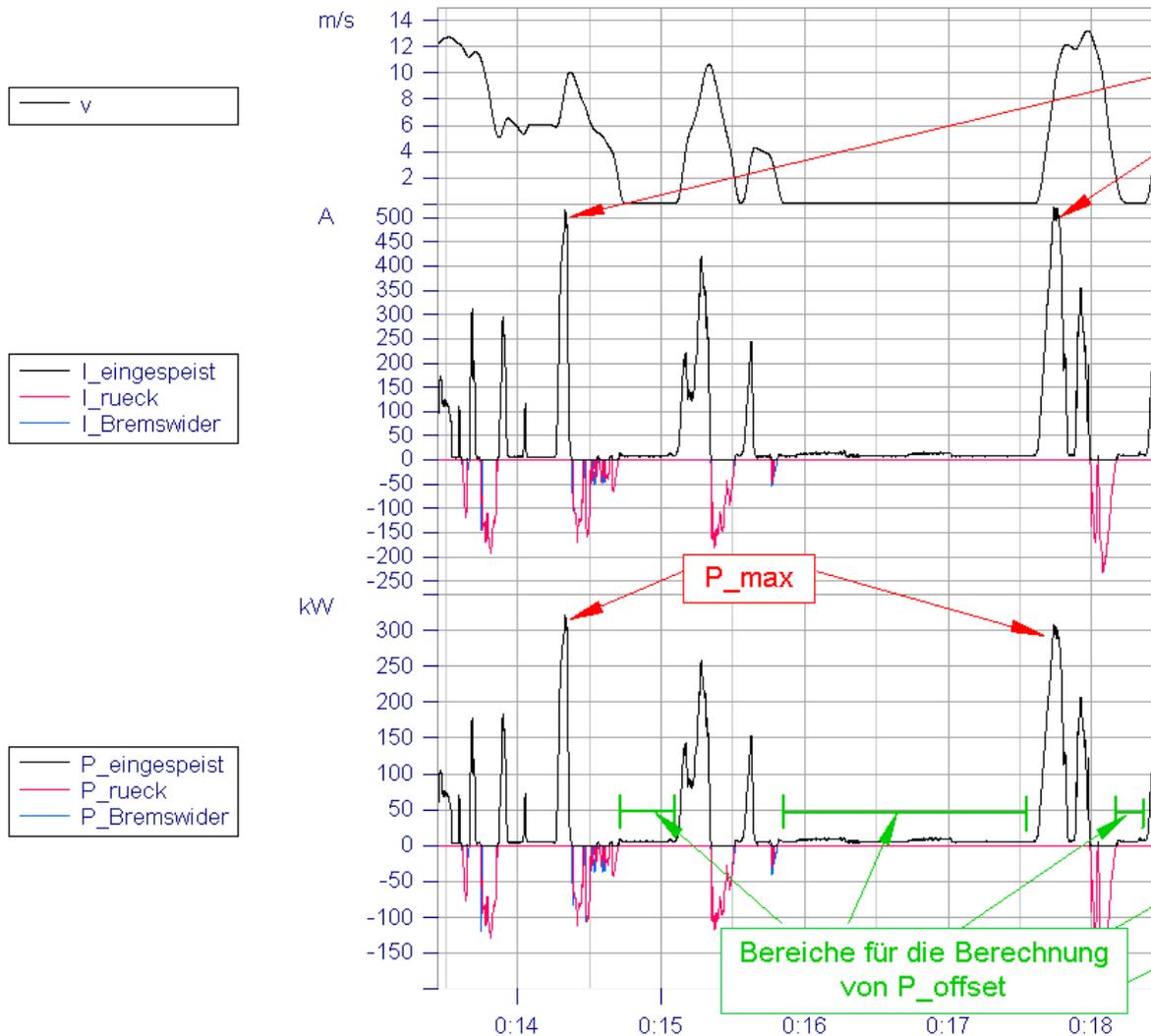
Challenge -> Efficiency and profitability:

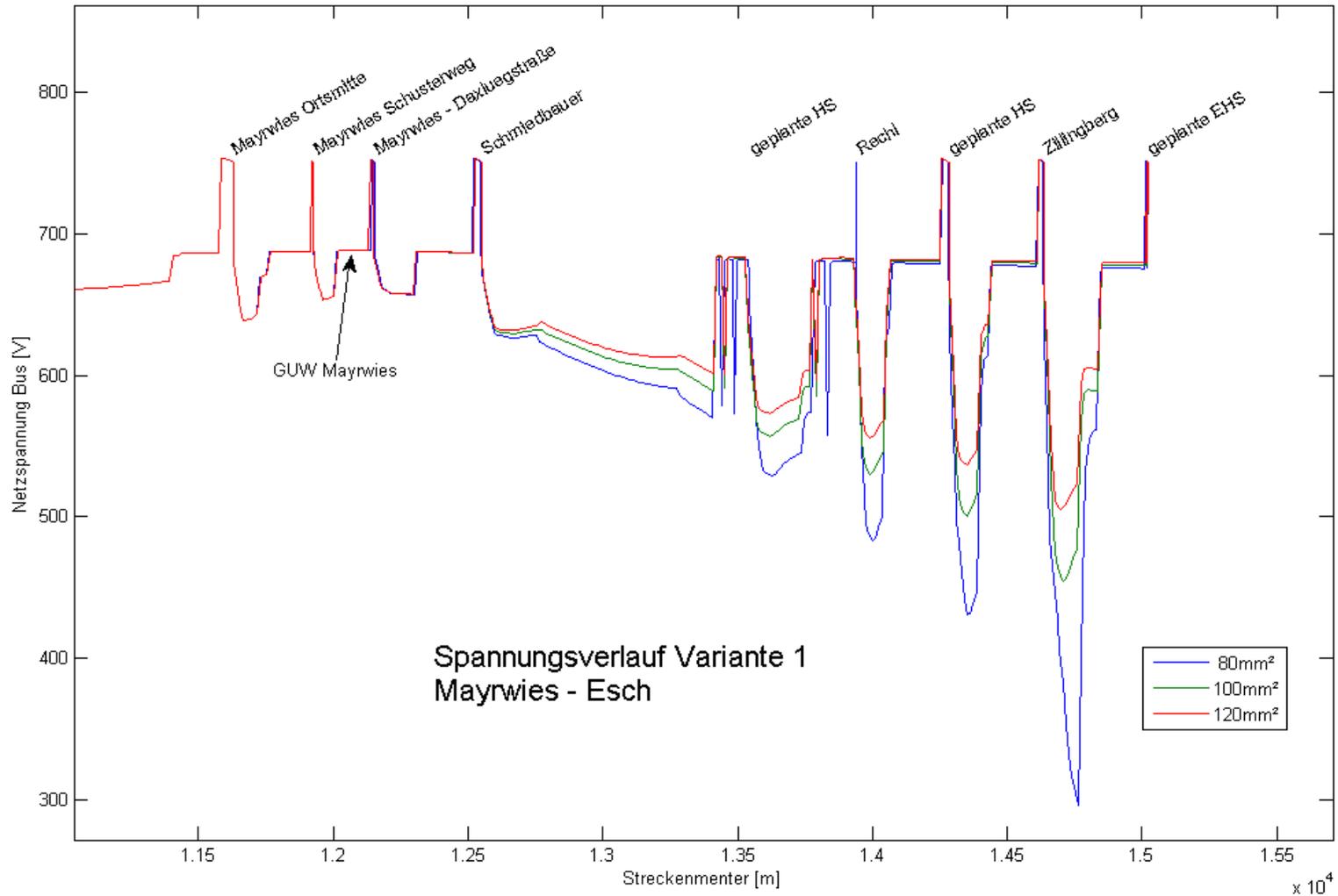
- very high power-fluctuations
- complex networks / calculations
- Safety / short circuits
- complex feeding situations in existing network
- high pressure on costs
- very dynamic environment
- interaction with rolling stock
- handling of new technologies and traffic systems



Beschleunigungsbereiche







Freezing protection

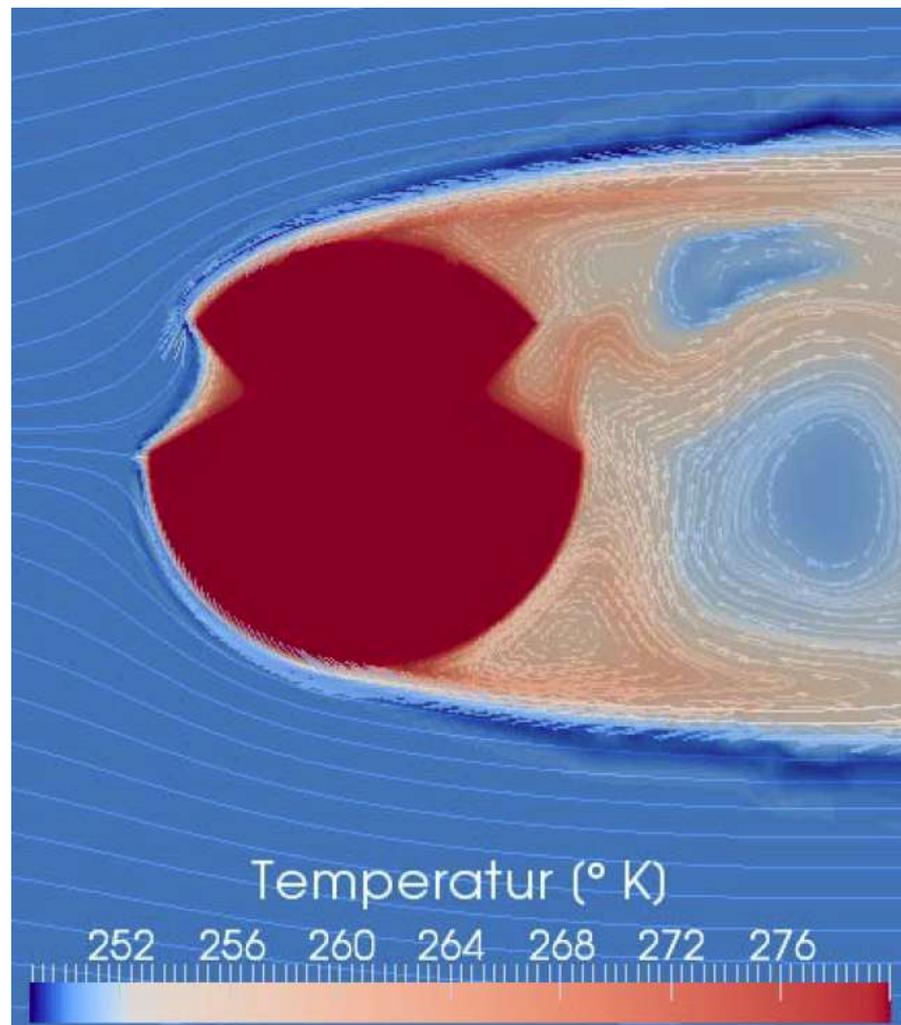
task:
guarantee the uninterrupted operation also
on bad weather conditions

basis:
electric energy

aim:
centralised automation

status:

- | | |
|---|-------|
| development of the control system | OK |
| preparation of the energy supply | OK |
| preparation of the control software | OK |
| formulate the weather parameters | i. P. |
| preparation of the switching technology | i. P. |
| preparation of the interfaces | i. P. |



Components for overhead contact line

task:

- reducing costs of components
- opening up new suppliers
- standardisation of the components
- reducing the maintenance costs

status:

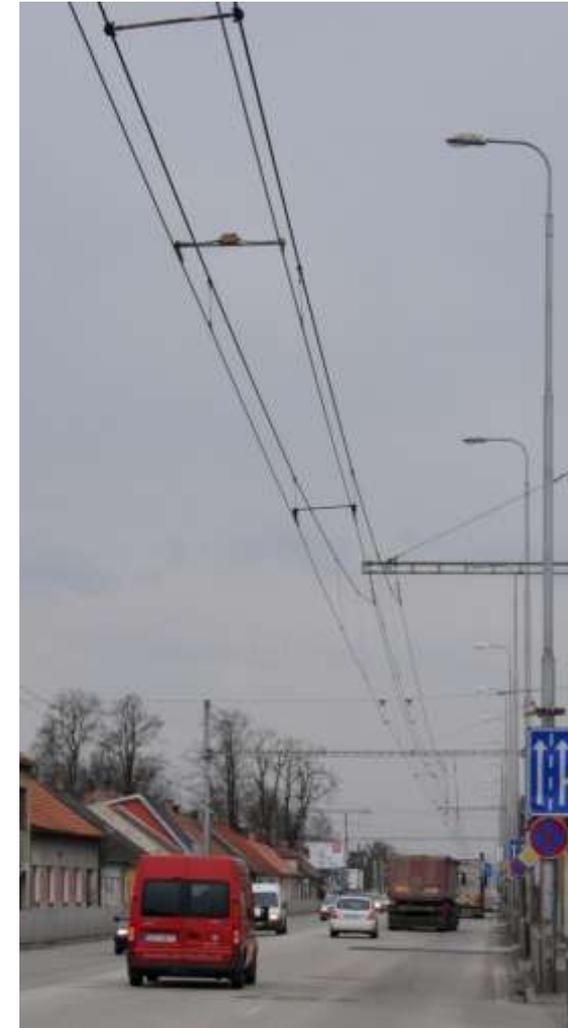
- capture of the life cycle from existing components
- development of new crossings
- development of new switches (mech. + electr.)
- implementation of Condition monitoring
- installation optimizing of crossings and switches
- development of new components for anchoring

- i. P.
- i. P.
- i. P.
- i. P.
- OK
- OK



Agglomeration – Network expansion

- Connecting Esch
 - 3km interurban
- Connecting Grödig
 - 4km interurban
- Cross connection of existing lines
- Redesign and extension of the Depot
 - adaption of the routes to new requirements
 - connecting existing garages
 - Provision of new parking- and maintenance areas and –garages
- Provision of new costumers with existing infrastructure
 - concepts for increasing degree of utilization of the infrastructure
 - opening up new markets for taking extra profits



Connecting Esch

- 3km interurban
- Design optimising
- Increasing speed
- Energy supply
- Optimising overhead line components





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You got it? – You got it!