

Promoting **clean** public transport

# Trolley

## 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!)

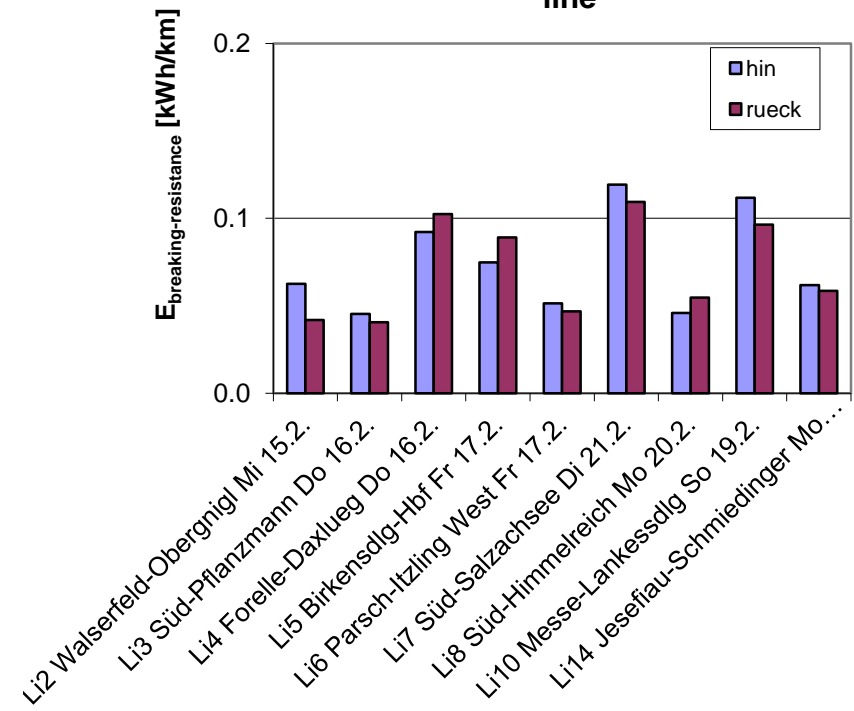
## Different demand for power output per season

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 :

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

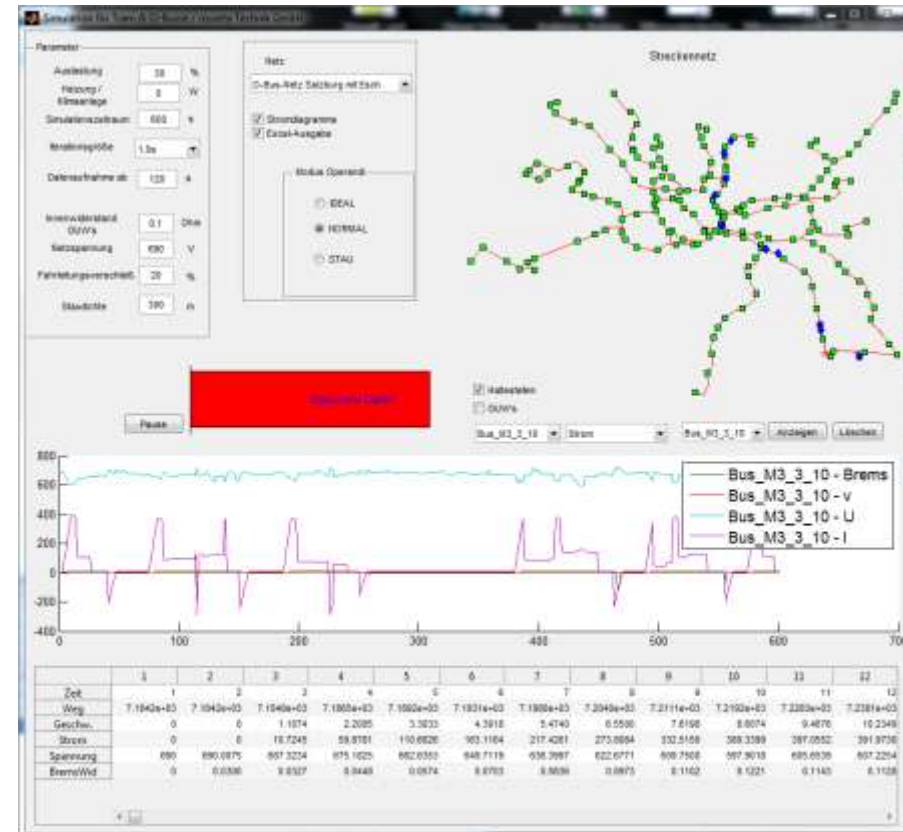
and efficiency factor on feeding :

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

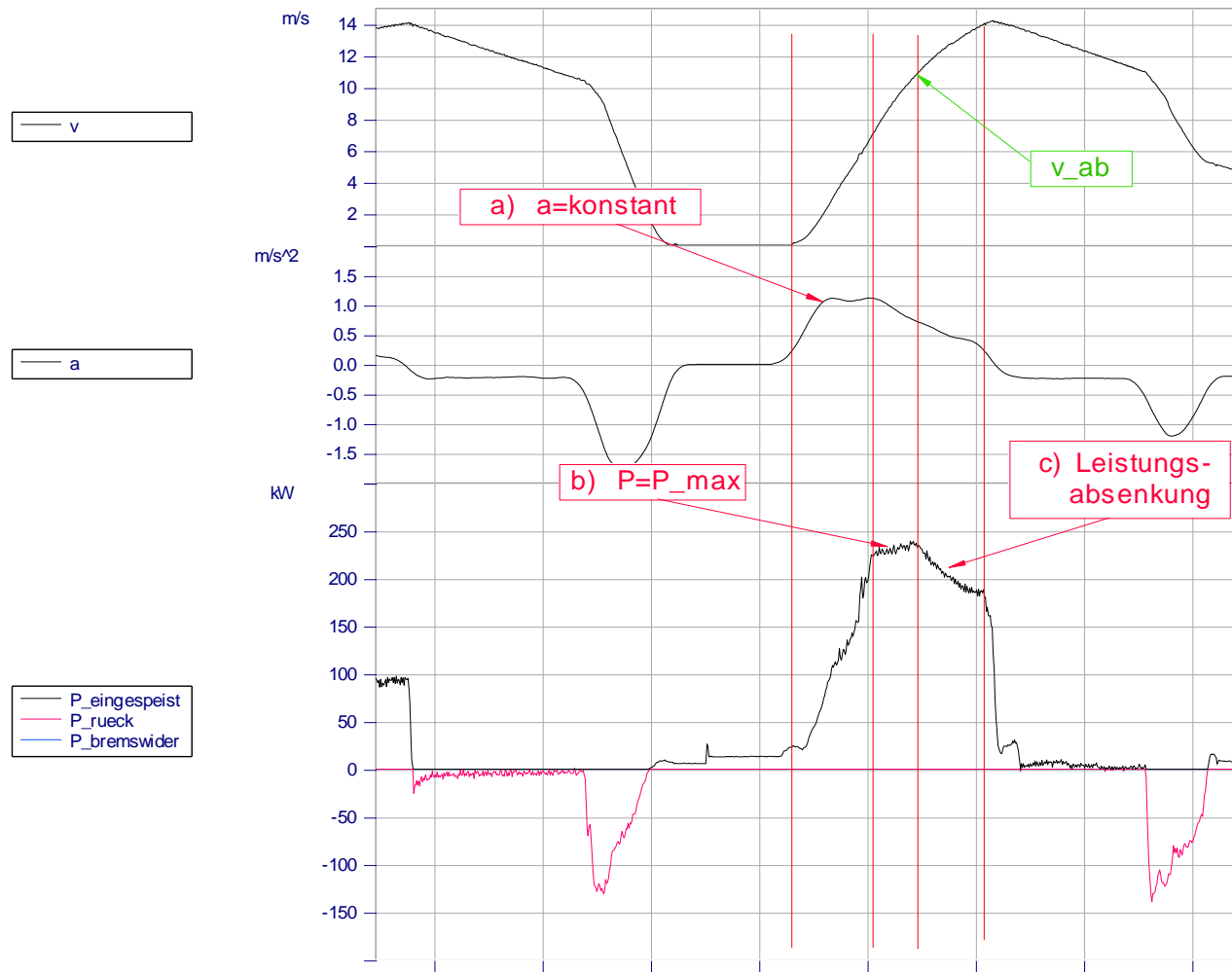
Supplying the energy on the right time in demanded amount

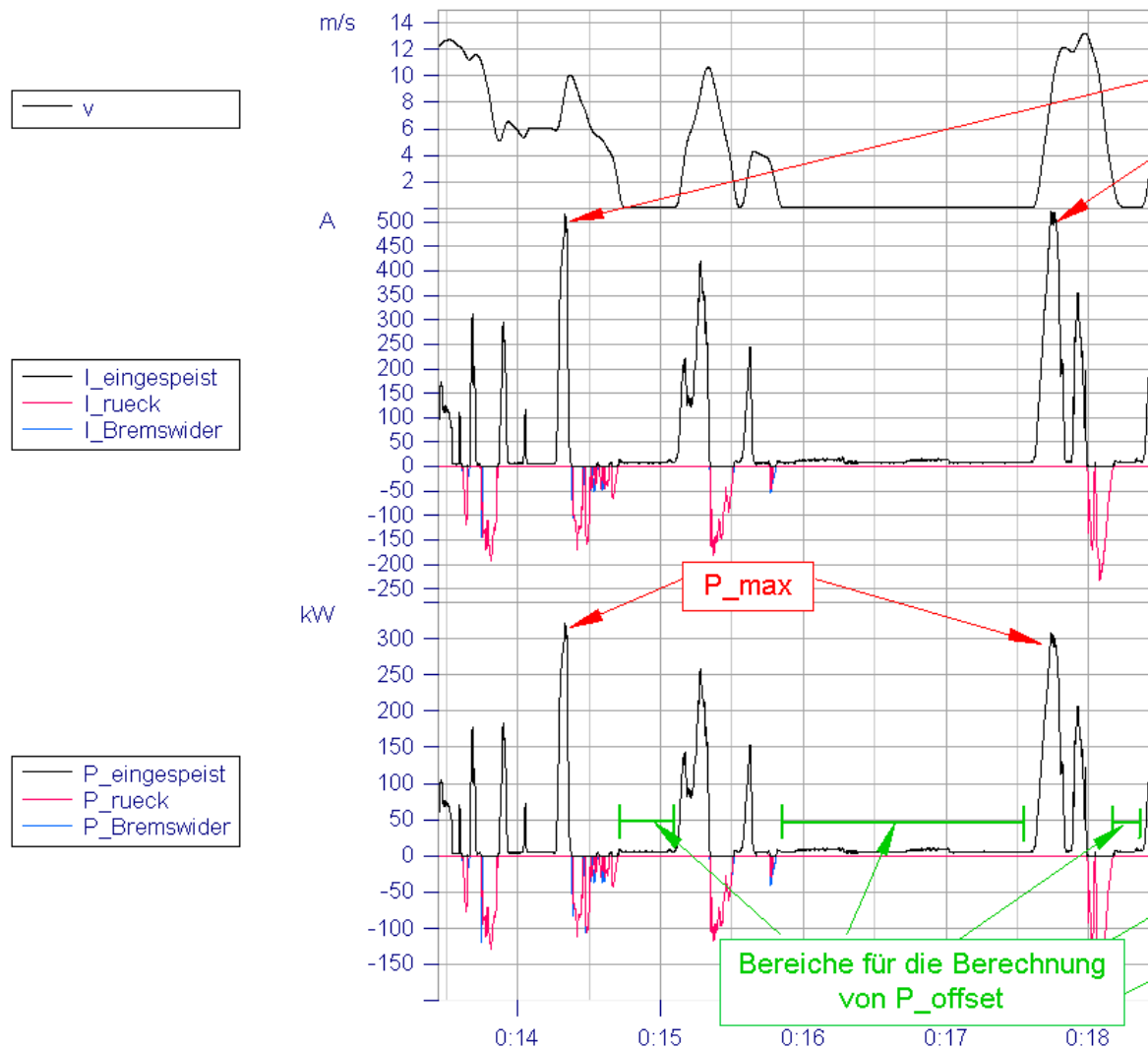
Challenge -> Efficiency and profitability:

- 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

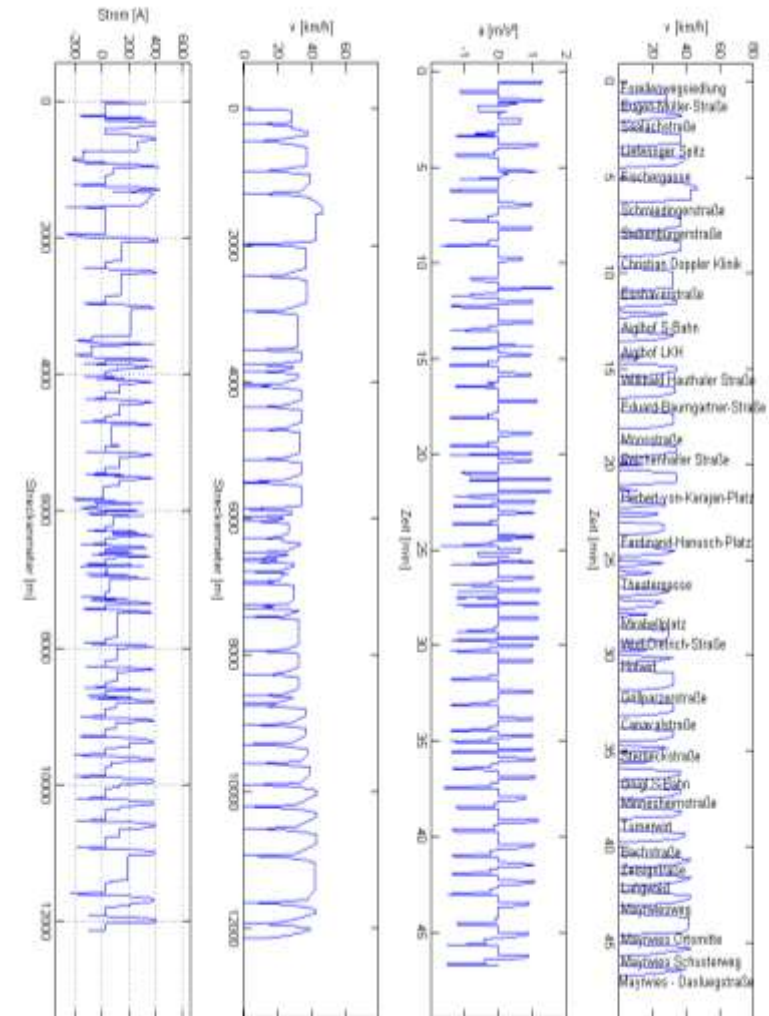




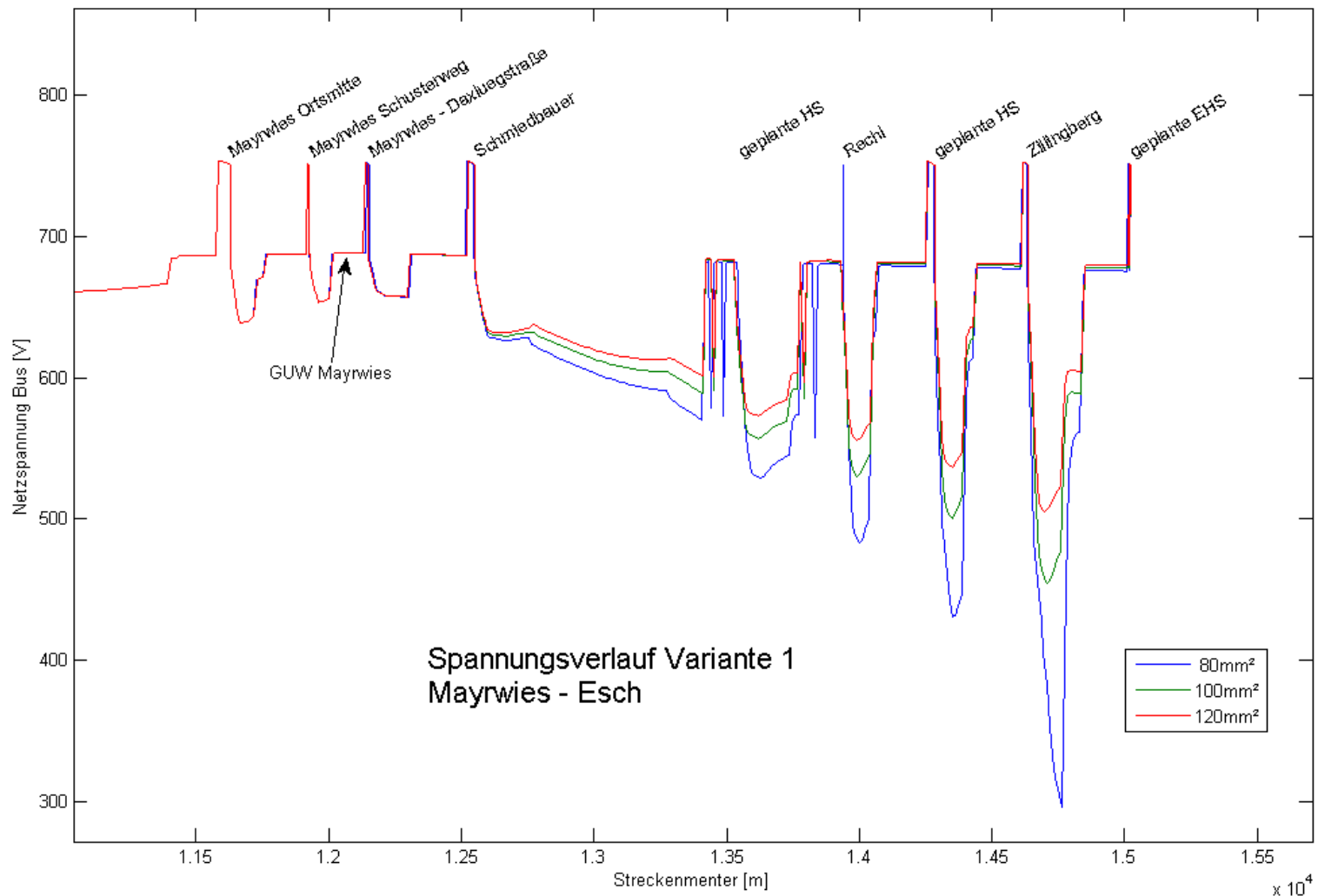


## Simulation programs

- knowledge of the parameters
- future requirements (crystal ball???)
- integration of new traffic systems?







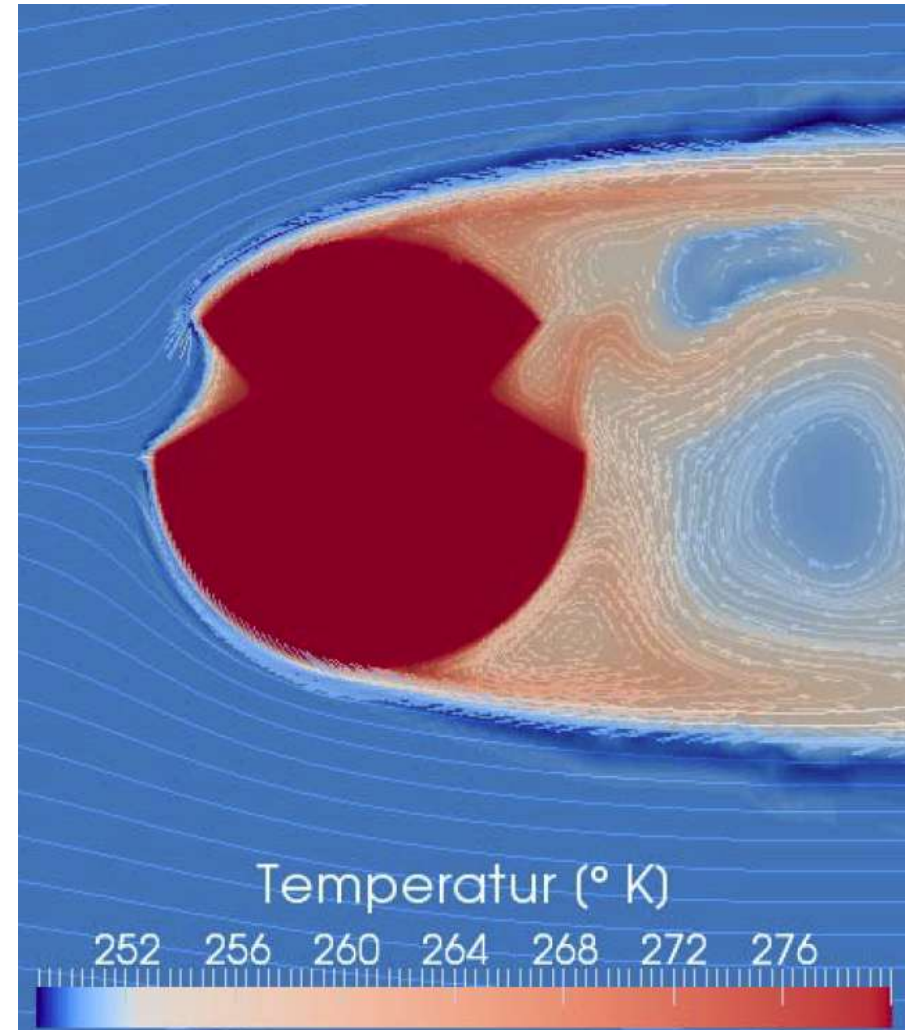
task:  
guarantee the uninterrupted operation also  
on bad weather conditions

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







**ObusSLB**  
Ein Service der Salzburg AG

**Ing. Andreas Randacher, BSc.**

Salzburg AG, Bereich Verkehr

Centerleiter Infrastruktur

+43 676 86826161

[andreas.randacher@salzburg-ag.at](mailto:andreas.randacher@salzburg-ag.at)



**You got it? – You got it!**