



Ee 6/6-2



Am 843



Am 842



Am 841



Tm 234 1.+2. Serie



Tm 234 3. Serie



Tm 232



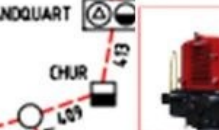
Hubwagen Windhoff



Kranwagen Windhoff



Kranwagen Plasser & Theurer



18m Hocharbeitsbühne



Windhoff Combilocomotive



7m Hocharbeitsbühne



dries Kranwagen zu Ariane



Ariane



Tm Hocharbeitsbühne



dries Kranwagen zu Ariane



dries Kranwagen zu Ariane

Übertragung



SBB CFF FFS

# BIENE Battery Manger - A Railway Sector Approach.

Markus Halder, SBB Energy  
Sep 2023



Tmf 232



Tm II



Krow KRC 250m



dries Kranwagen zu Ariane



Dandini 30m



Krow KRC 1000m



Krow KRC 800m



Krow KRC 1000m



LRZ 96



Trennungswagen



LRZ 14



LRZ 08



LRZ 04



Am 6/6



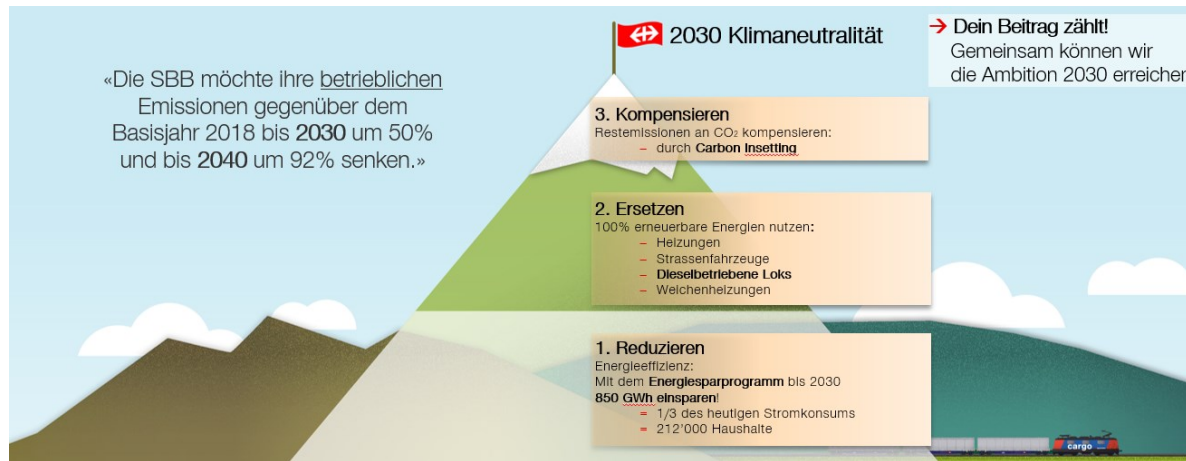
Bm 4/4



Em 3/3

# Climate neutral SBB

More than 40% of SBB's CO2 emissions come from diesel traction and construction site power supply. (12 Mio. l diesel / year)



Phase OUT: fossile energy carriers  
Phase IN: energy storage / batteries

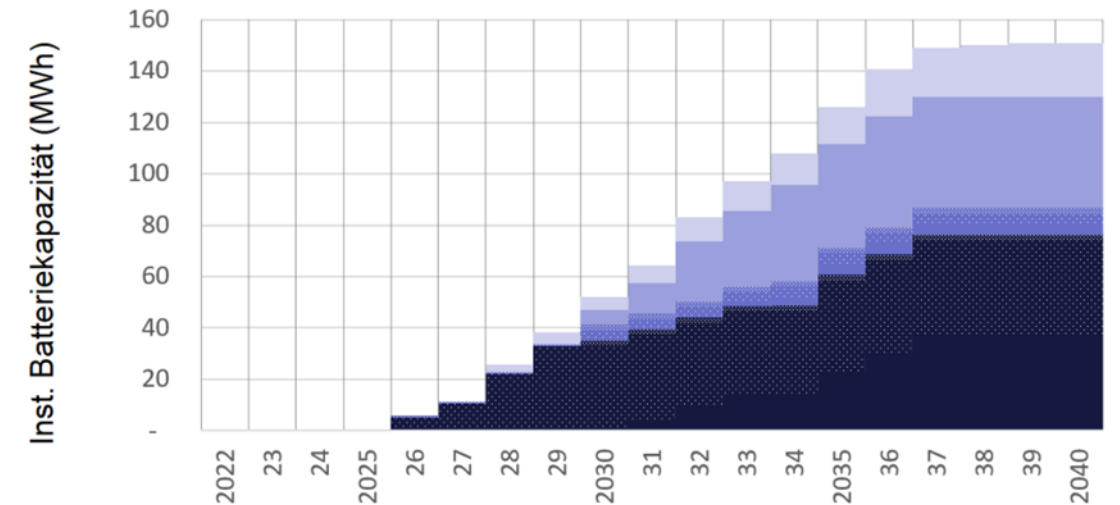
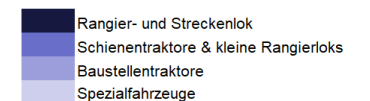
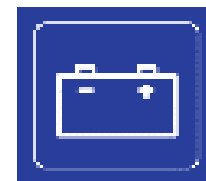
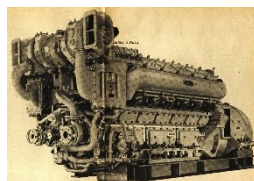
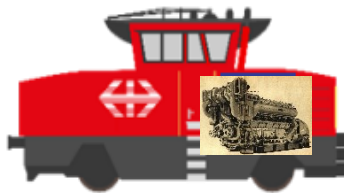


Abbildung 6: Prognostizierte Zunahme der installierten Batteriespeicherkapazität durch die Elektrifizierung der Diesel-  
flotte SBB-weit bis 2040. Legende siehe Abbildung 3.



Keine Punkte: Infra  
Leicht gepunktet: Cargo  
Stark gepunktet: Personenverkehr

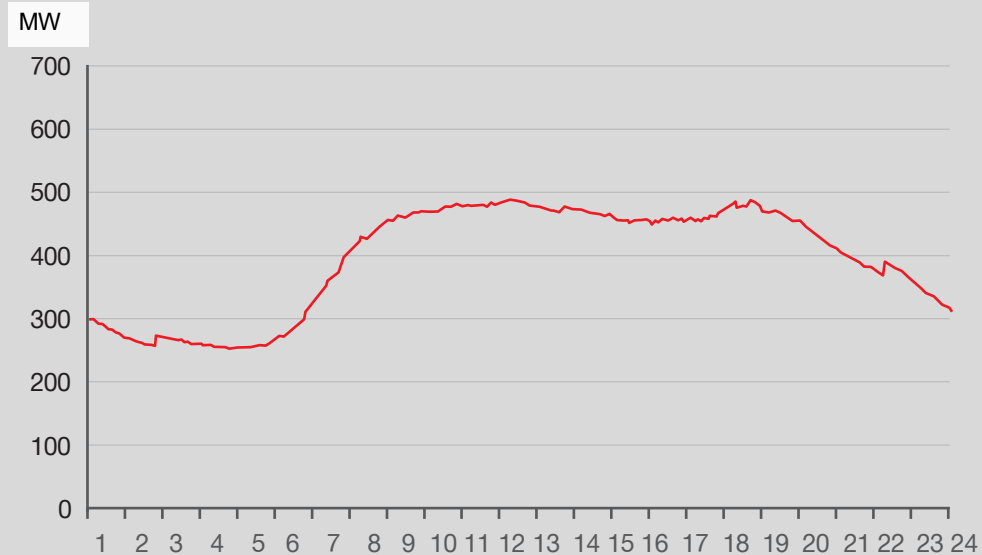




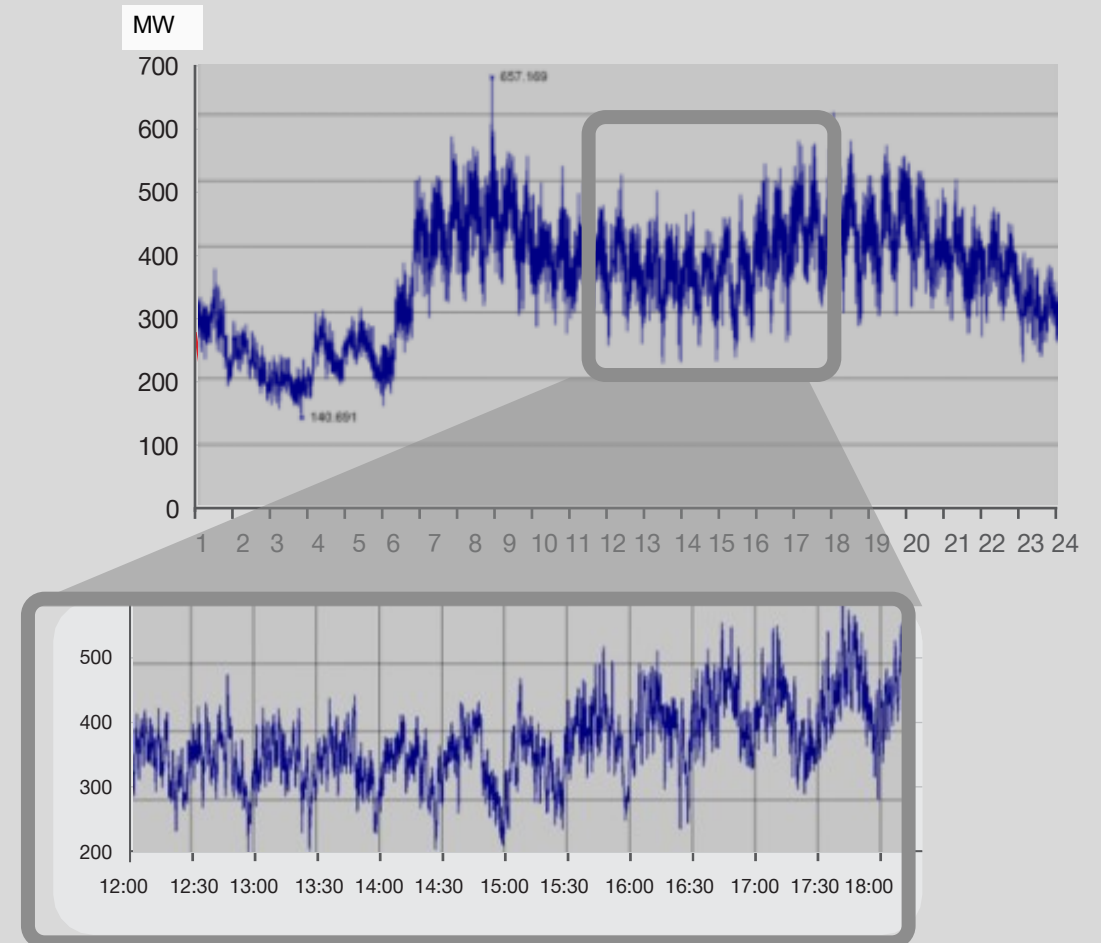
# Rail power (16.7 Hz).

Dynamic power profile is challenging. Reserves are expensive.

1 day in Zurich (50 Hz)



1 day at SBB (16.7 Hz)



# On what we can build on:

## BAV/FOT Study BIENE (= BatterIeschwarm im BahnstromNetz)

(Battery swarm in railway power grid)



### Electrification of diesel fleet.

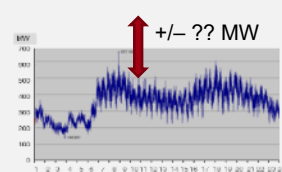


Swarm of batteries in railway power grid to be expected ...

Shunting locomotives, construction site vehicles, fire-fighting and rescue trains, special vehicles.



### Growing Power Demand



Impact on grid?

### Project Scope BIENE



Risks and Chances  
- Overload Risks  
- Value Cases with central battery management.



Concept of Solution  
- Battery management platform  
- Cost/benefit  
- General conditions



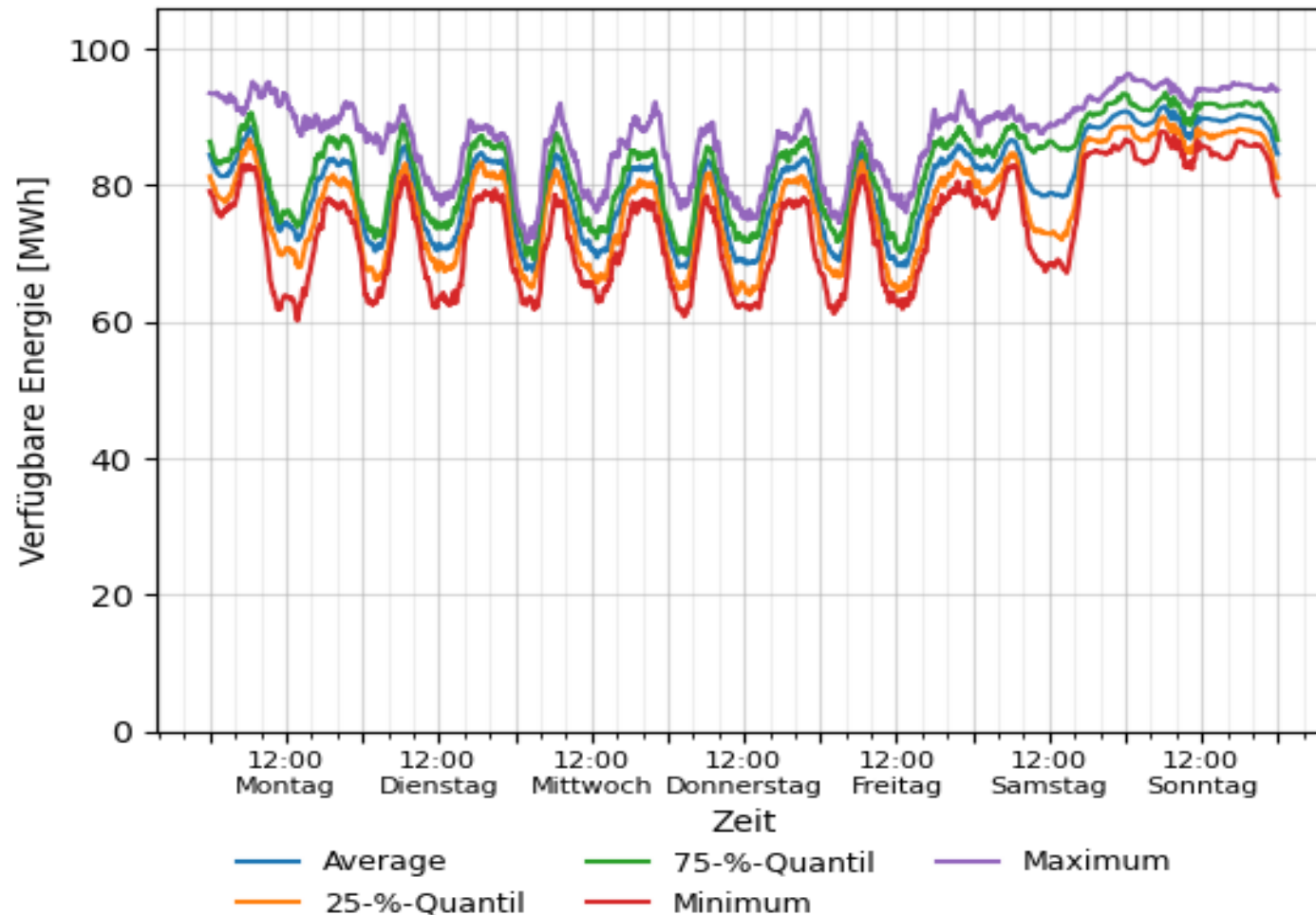
PoC  
- Proof of Concept of battery management: simulation tool.



Requirements for Pilot  
- Next steps for realisation

Funded by Federal Office of Transport (FOT), Energiestrategie im öffentlichen Verkehr (ESöV)  
Final report March 2022

# Results of BIENE study: 60 MWh battery capacity always available in the grid.



Weekly profile of available energy (under catenary) of 252 vehicles.

To compare:

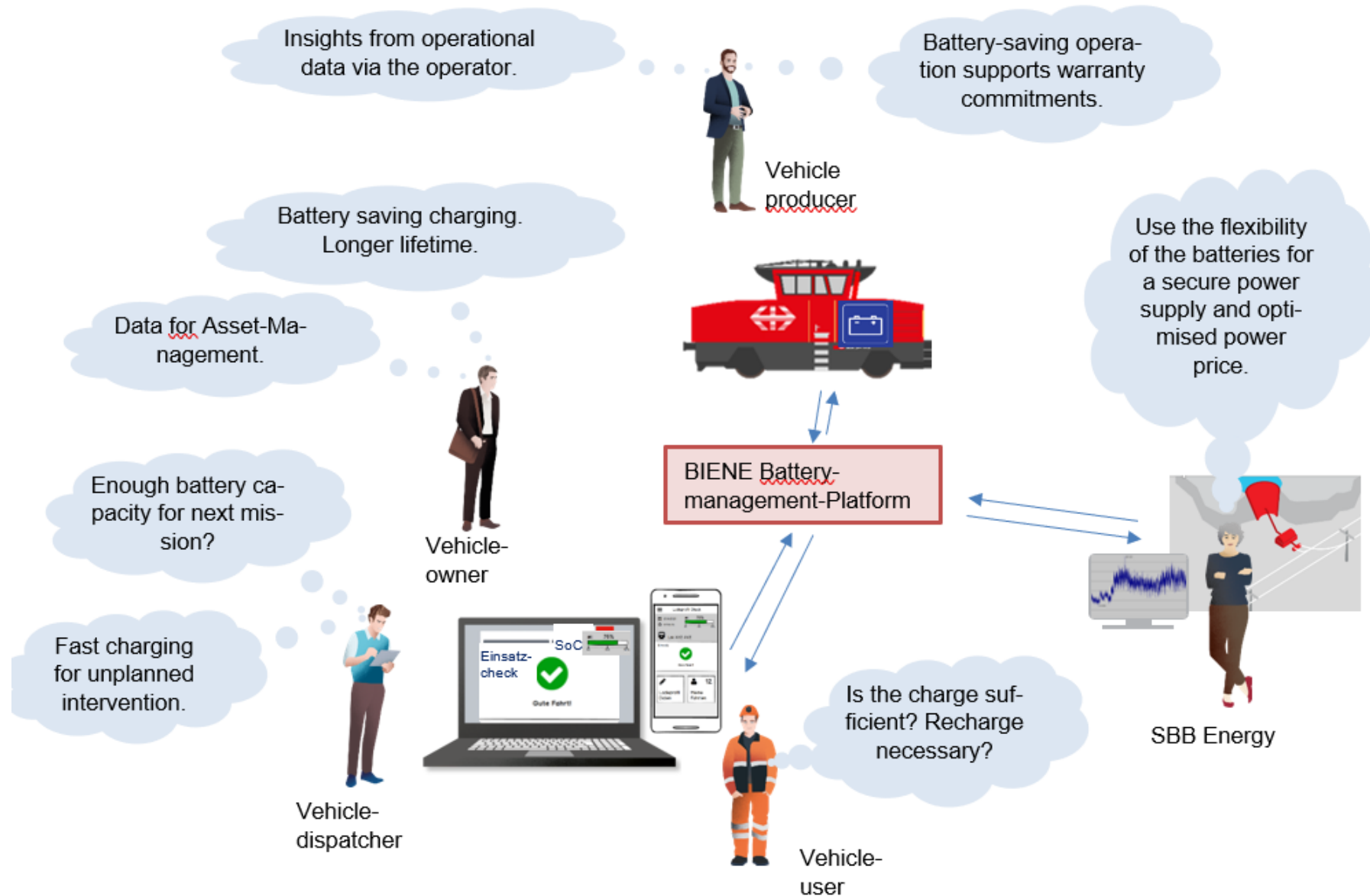


60 MW,  
>1 h  
(neue 16.7Hz Turbine & Generator)

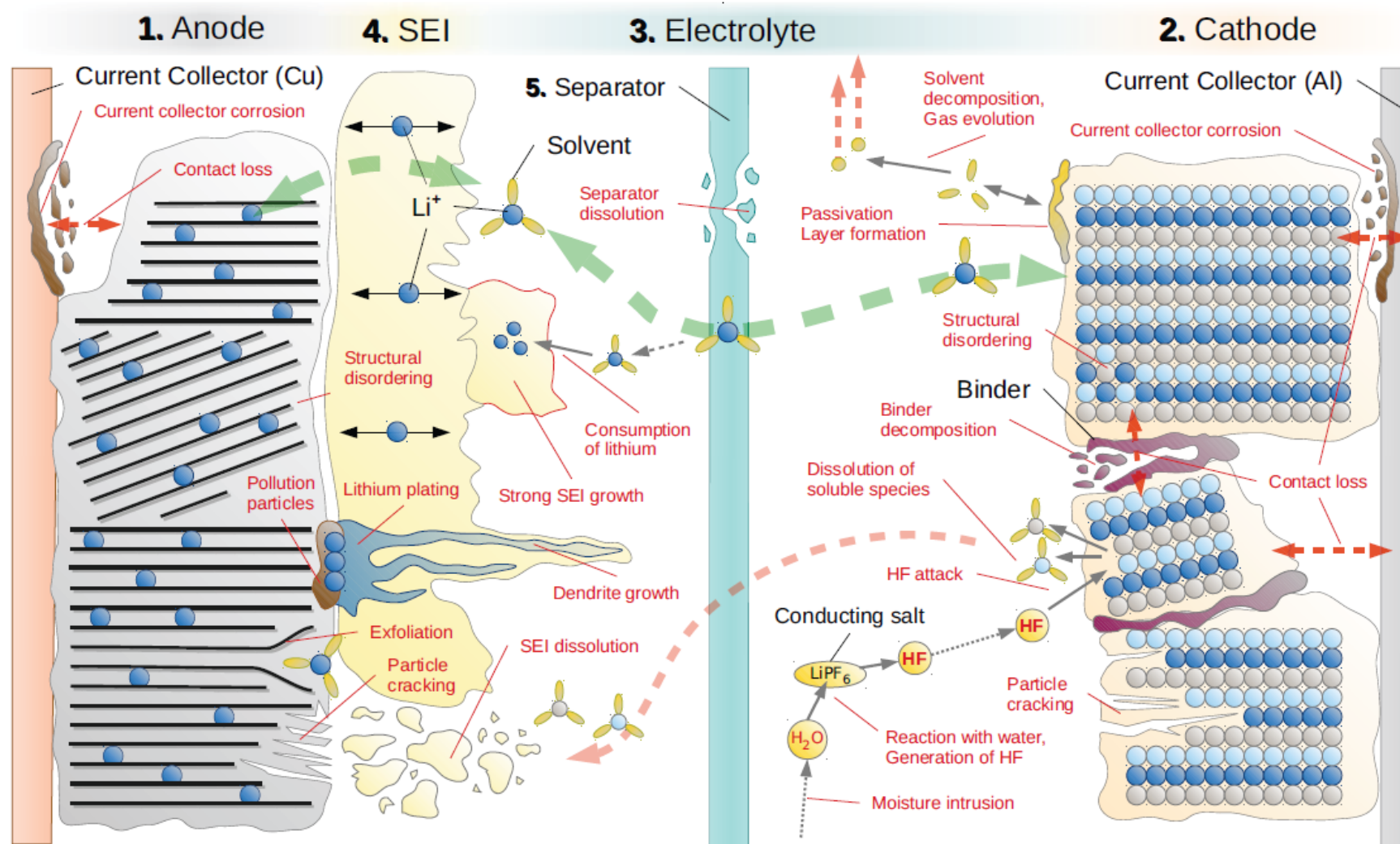


42 MW,  
>1.4 h

# User expectations of a central battery management system.

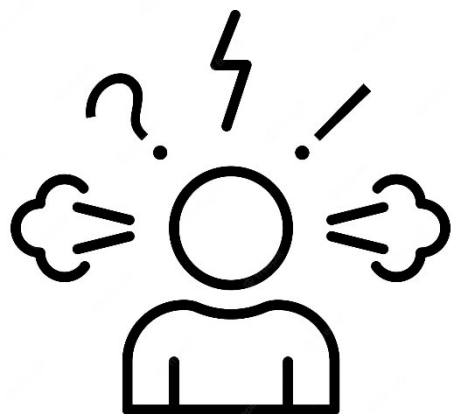
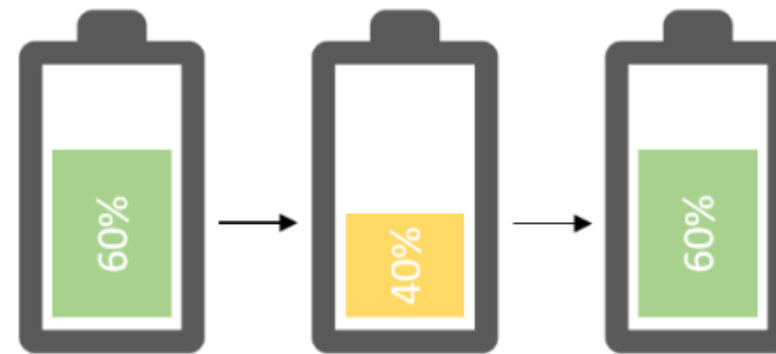
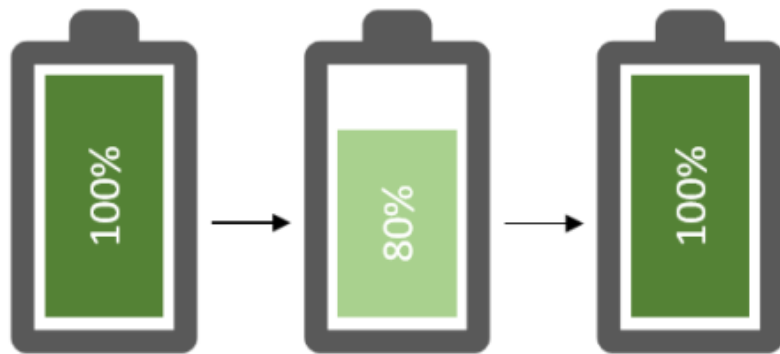


# Ageing mechanisms of a lithium-ion battery cell.

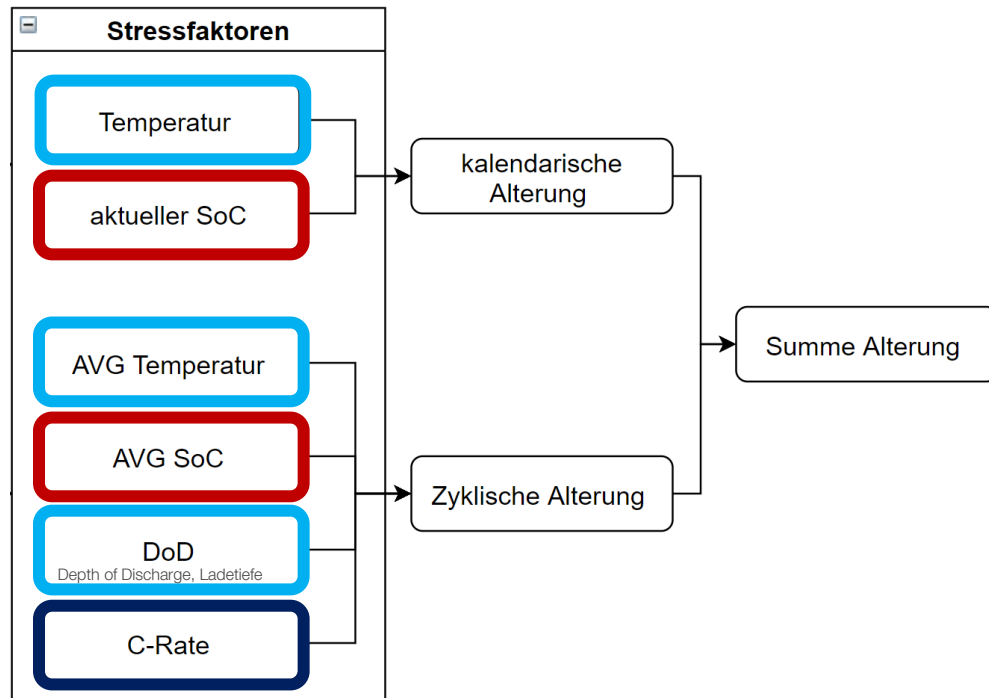




Example: Depth of discharge of 20 % of capacity stresses the battery more at high storage level (SoC).



# Operational influences on battery ageing – Approaches for central battery management.



BIENE Batterie-  
management-Plattform

Lower State of Charge (SoC)

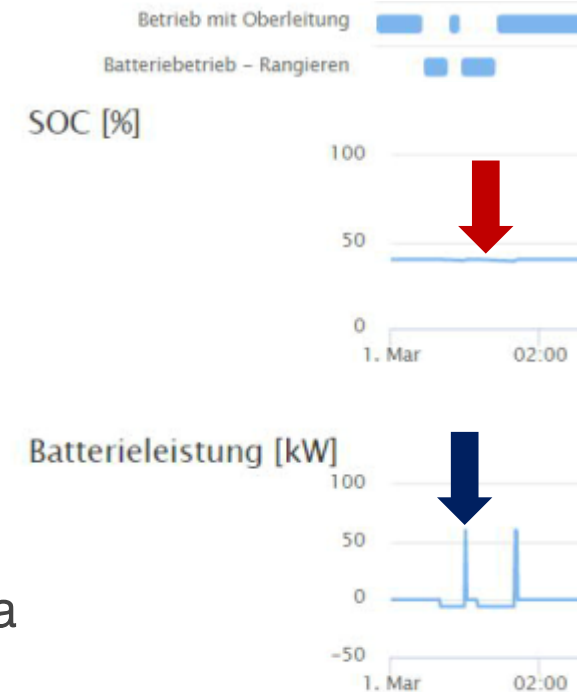
Reduced Charging Power (C-Rate)

Monitor temperatures, charge  
depth,... with battery monitoring



BIENE study: Potential > 1 Mio. CHF/a  
through age-optimised charging.

Plus > 1 Mio. CHF/a for railway power supply  
due to reduced control reserves.

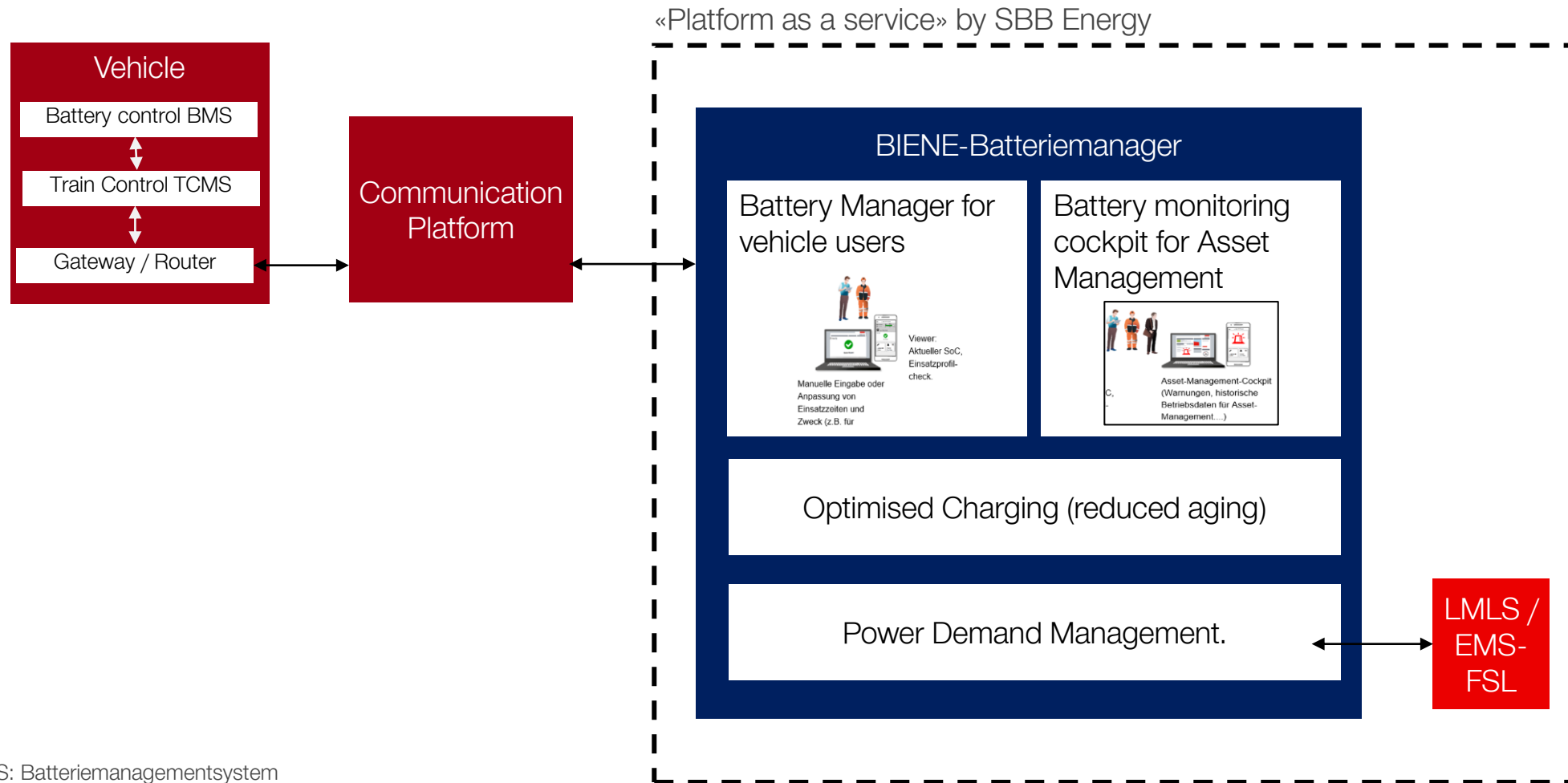


# SFOE Pilot Project «BIENE Battery Manager».

- Project from 2023-2026, funded by Swiss Federal Office of Energy SFOE.
- Project partner:
  - SBB: Software, Pilot vehicle Tafag Hocharbeitsbühne
  - BFH Center Energy storage: scientific support, battery models, ...
  - RhB: Pilot vehicle shunting locomotive Geaf 2/2
- Work Packages:
  - WP 1. Model-based support for battery assessment
  - WP 2: 2nd life readiness
  - **WP 3: BIENE battery management platform**
  - WP 4: Fleet-wide implementation



# Features BIENE-Battery Manager.



BMS: Batteriemanagementsystem

TCMS: Train Control Management System, Fahrzeugleitgerät

LMLS: Lastmanagement-Laststeuerung, existing power demand management platform from SBB Energy

EMS-FSL: Energiemanagement- und Fahrstromleitsystem, existing system for control of power supply



# BIENE-Batteriemanager as railway sector approach

- Using synergies: one solution for all.
- Developing, testing and using a joint standard.
- Pragmatic solution with win-win-win effect (benefits for vehicle owners/users, vehicle producers and energy provider).  
Use the opportunities of integrated railways in Switzerland for system optimisation.
- SBB Energy as system leader for traction current wants to support the energy transition:
  - Efficient electrification of the diesel fleet
  - Reduce the need for expansion of the traction current infrastructure
  - Economic, secure and sustainable traction current supply.

Recommendation BIENE-Study: SBB Energy provides battery manager free of charge (in return: use of swarm batteries for the traction current network under defined conditions).
- Support from BAV (funding of BIENE preliminary study) and BFE (funding of pilot BIENE battery manager).

# Diesel



# Electricity/Battery

