



Aging simulation of lithium- ion cells

In any user profile and application

February 2016



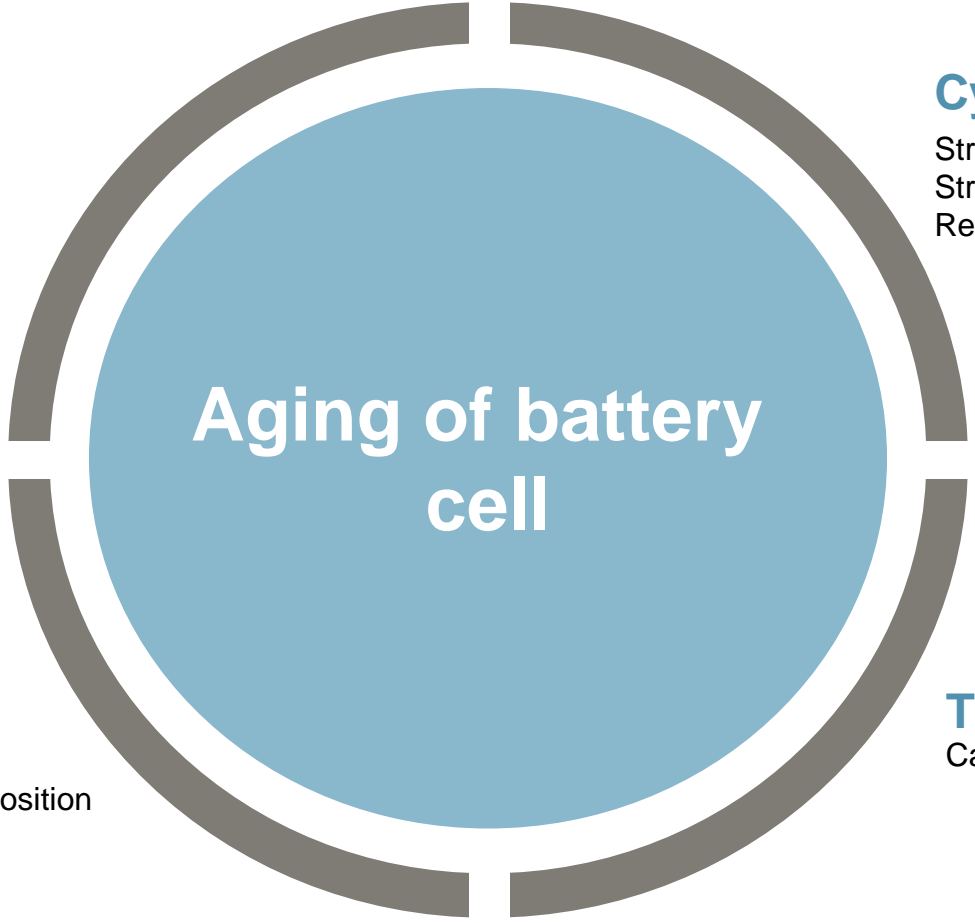
Thermal impact

Influence of ambient temperature
Cell temperature development
Changing thermal stress

Cyclic impact

Strength of discharge current
Strength of charge current
Recuperation

**Aging of battery
cell**

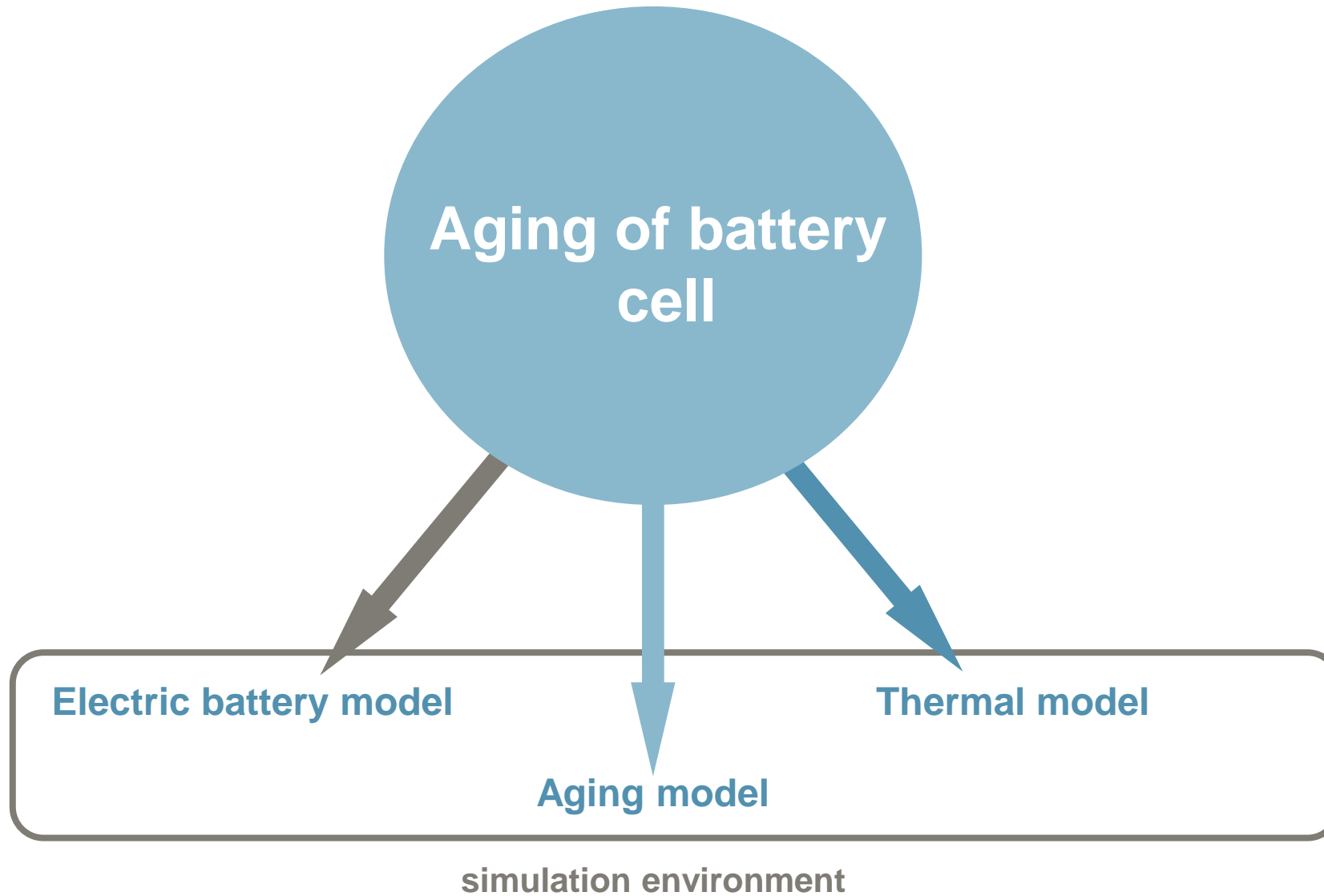


Boundaries

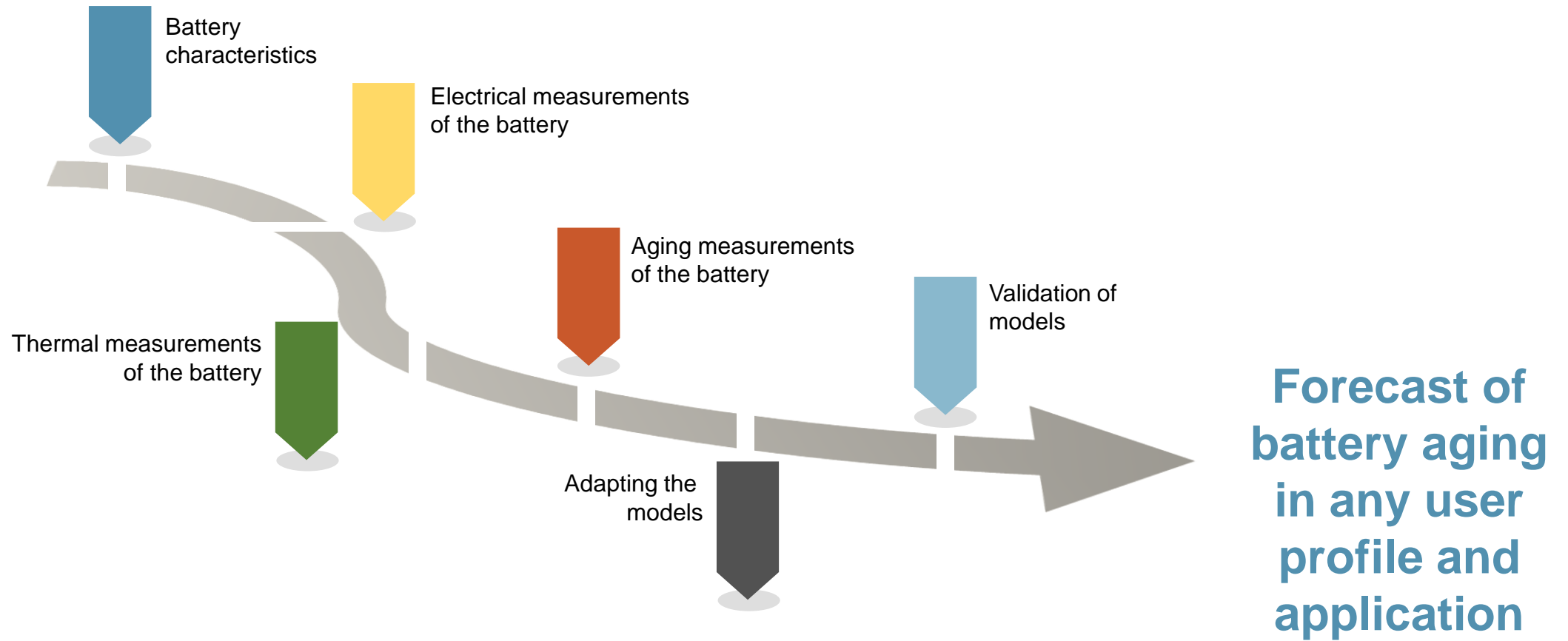
State of Charge limits
State of Charge window position
Total amount of charge

Time

Calendrical aging



Aging simulation Development



Aging simulation Graphical user interface

Xcellvision
Version: 17
Alterungsmodell für Lithium Ionen Zellen

Batteriemodell

Elektrische Parameter:

- Panasonic 28 Ah Stand 1
- Panasonic 25 Ah Stand 1
- Panasonic 25 Ah Stand 2
- Sanyo 25Ah Stand 1
- Sanyo 25Ah Stand 2
- Samsung 28Ah Stand 1
- Samsung 28Ah Stand 2
- Samsung 28Ah Stand 3
- Samsung 37Ah Stand 1

Alterungsparameter:

- Sanyo 25Ah kV0 Stand 1
- Sanyo 25Ah kV1 Stand 1
- Sanyo 25Ah kV1 Stand 2
- Sanyo 25Ah kV1 Stand 3
- Samsung 28Ah kV2 Stand 1
- Samsung 28Ah kV2 Stand 2

Thermisches Modell

Temperaturprofil:

- Gemäßigtes Jahresprofil
- Heissland Jahresprofil
- Konstanttemperatur Jahresprofil
- Deutschland 2015 Jahresprofil

Zusatzeneinstellungen:

- Konstanttemperatur [°C]: 23
- Kühlung im Fahrmodus:
- Kühlung im Lademodus:
- Kühlleistungstabelle: Öffnen

Fahrprofilmanager

Zyklus:

- PKF VW370/9; 96s1p
- PKF VW376/9; 104s1p
- PKF VW481/7; 96s1p
- PKFNAR VW370/9; 96s1p
- PKFNAR AU373/9; 96s1p
- EPH VW370/9; 96s1p
- EPH (2x pro Tag) VW370/9; 96s1p
- EEF VW120/7; 102s2p
- Vielfahrer VW370/7; 88s3p
- Konstantstrom; 1s1p
- Kalendarische Alterung; 1s1p
- NEFZ; VW120/7; 102s2p
- Artemis; VW120/7; 102s2p
- SWFZ; VW120/7; 102s2p
- WLTP Class 1; VW370/7; 88s3p
- WLTP Class 2; VW370/7; 88s3p
- WLTP Class 3.1; VW370/7; 88s3p
- WLTP Class 3.2; VW370/7; 88s3p
- ADAC Highway; VW370/7; 88s3p
- Auto Motor Sport Zyklus; VW370/7; 88s3p

Zusatzeneinstellungen:

- Start SOC [%]: 95
- End SOC [%]: 5
- Lade SOC [%]: 95
- Zellen pro Strang [1]: 96
- Parallele Stränge [1]: 1
- Nebenverbraucher [W]: 0
- Entladestrom [C]: 1
- Ladestrom [C]: 1
- Ladungsdurchsatz [Ah]: 99999
- Pausentag [Tag]: 14
- Pausendauer [h]: 24

Simulationseinstellungen

- Simulationszeit [Jahre]: 1
- Min. Stepsize [s]: 0.1
- Max. Stepsize [s]: 60
- Relative Toleranz [%]: 0.001
- Ergebnisreduktion: 50
- Solver: ode23s
- Simulation starten: Start
- Simulation stoppen: Stopp
- Simulationsmodell öffnen: Öffnen
- Simulationsstatus: Beendet
- Simulationsfortschritt [%]: 0
- Restkapazität [%]: 100

Ergebnisdarstellung

1. Subplot, 2. Subplot, 3. Subplot

Plot, Addplot, Linkaxes, Close, Reset

Titel, y-Label, x-Label, y-Bereich, x-Bereich

Parameterization of aging model and electric battery model

Parameterization of thermal model

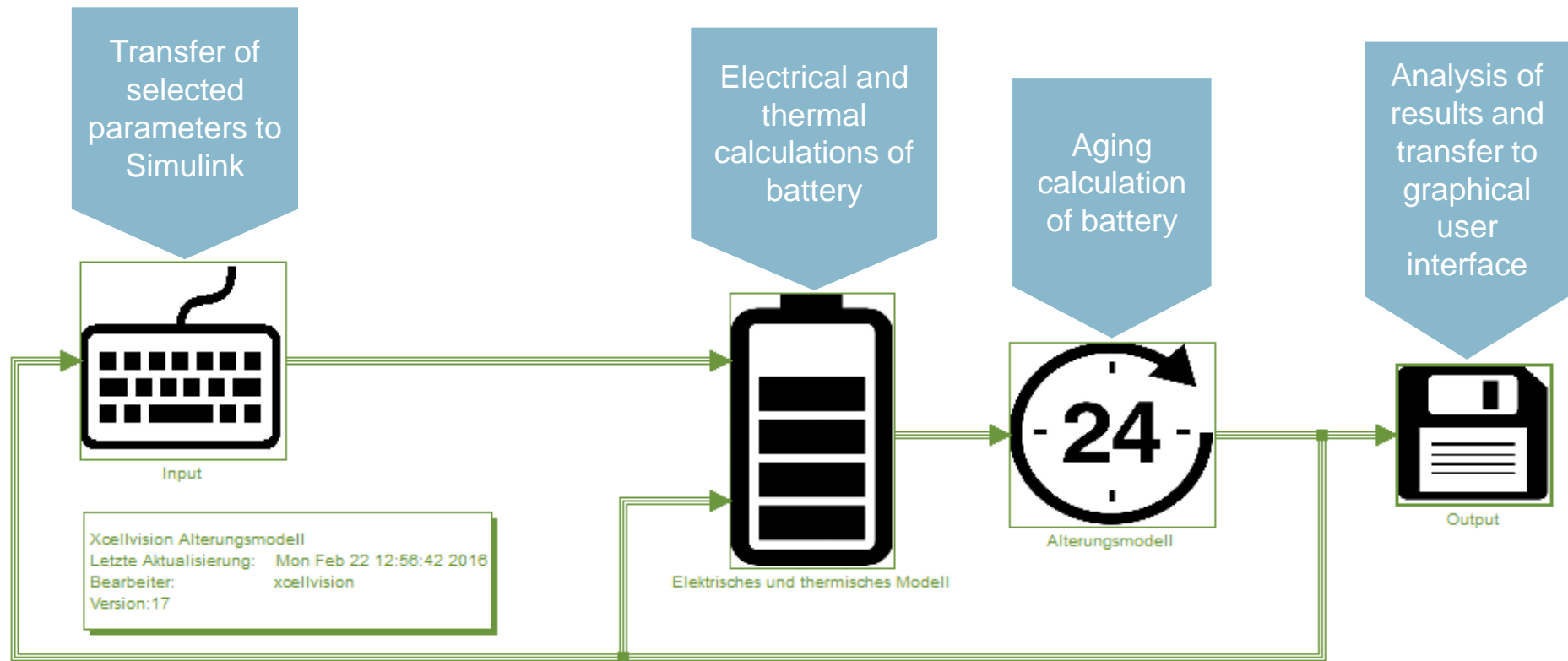
Simulink settings

Selection of stress (week profiles of driving cycles)

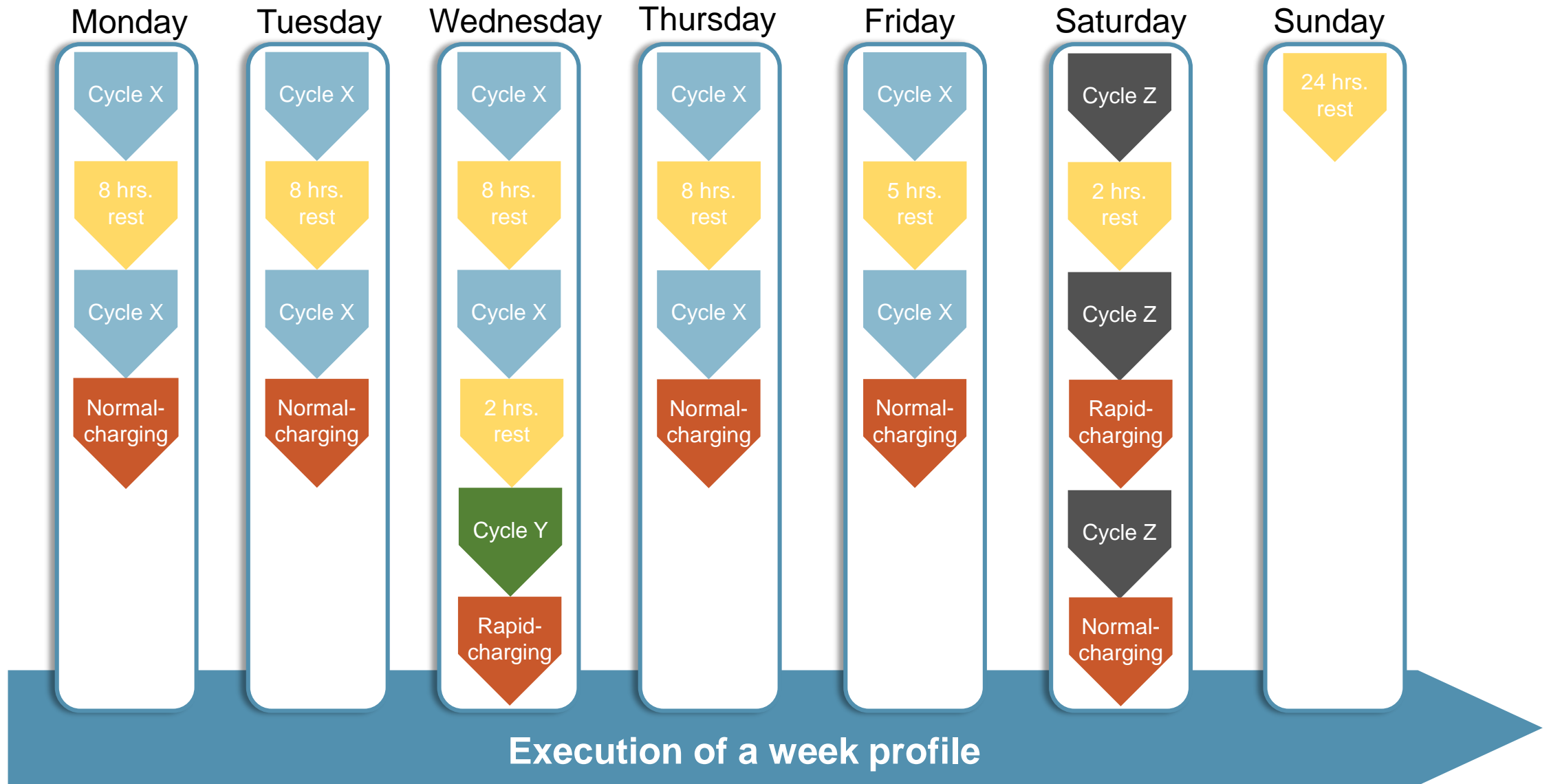
Status update of the simulation progress

Graphical representation of the results

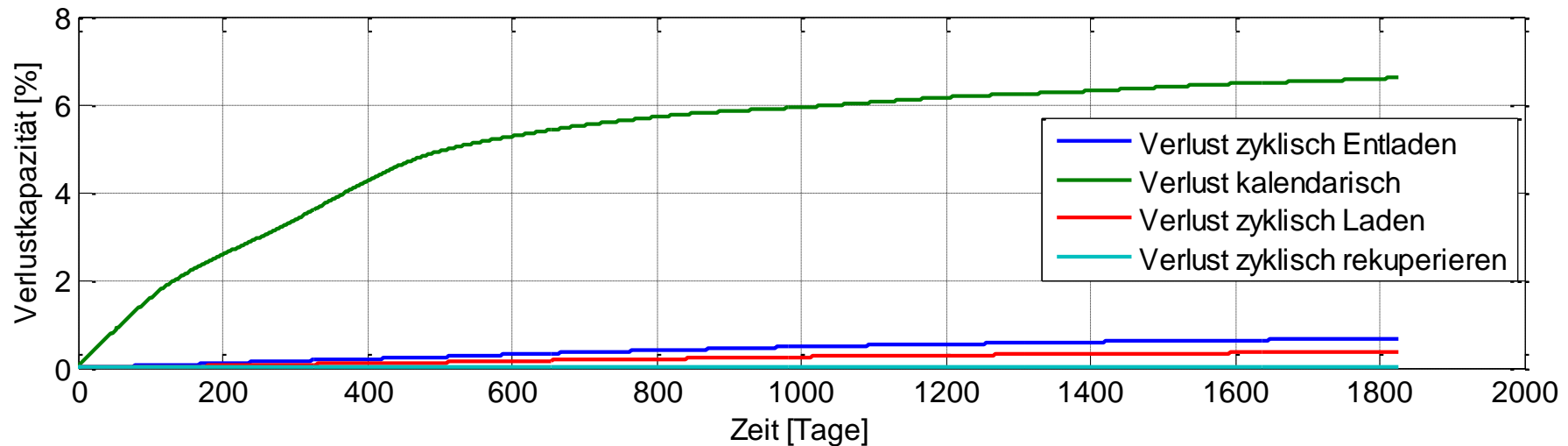
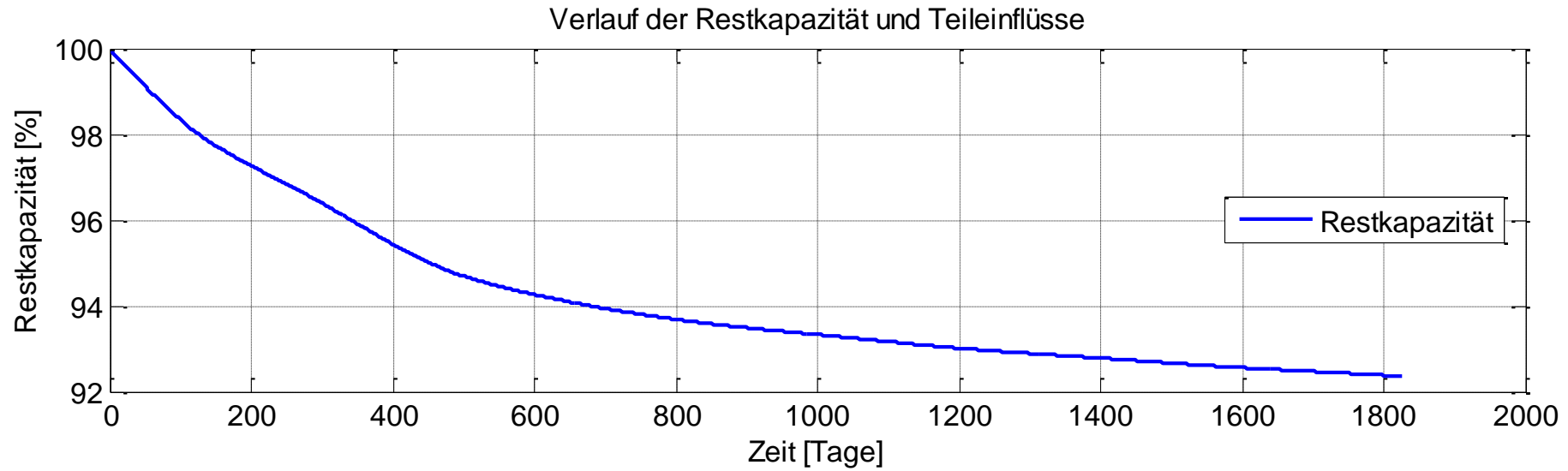
Aging simulation Simulation model



Aging simulation Week profile

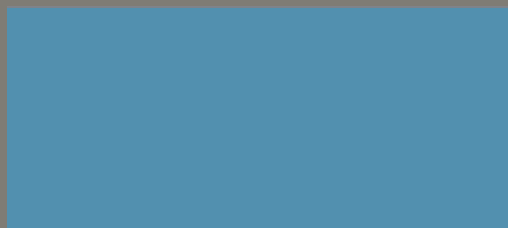


Aging simulation Result analysis



Aging simulation Summary

- ✓ Easy handling due to graphical user interface
- ✓ No additional programming is required
- ✓ Specific temperature profiles and load profiles possible
- ✓ Simple analysis due to graphical user interface
- ✓ Transparent overall process
- ✓ Transferable to different applications (vehicles, solar ...)



Contact

Dr.-Ing. Karl-Heinz Hauer
Major-Hirst-Strasse 11 (Innovationscampus)
D-38442 Wolfsburg

Tel. +49 (5361) 897- 7300
Email: kh.hauer@xcellvision.com

