



BATEMO

UNDERSTANDING BATTERIES

FAST-CHARGING OF LITHIUM-ION-BATTERIES IN PRACTICE

A way to get it done!

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OCTOBER 12TH, 2020

Motivation



Source: <https://ionity.eu>

DRIVING SCENARIOS

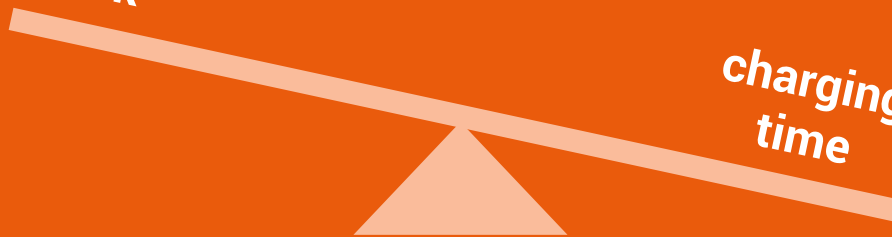
150 KW

15 MIN.

350 KW

aging
risk

charging
time

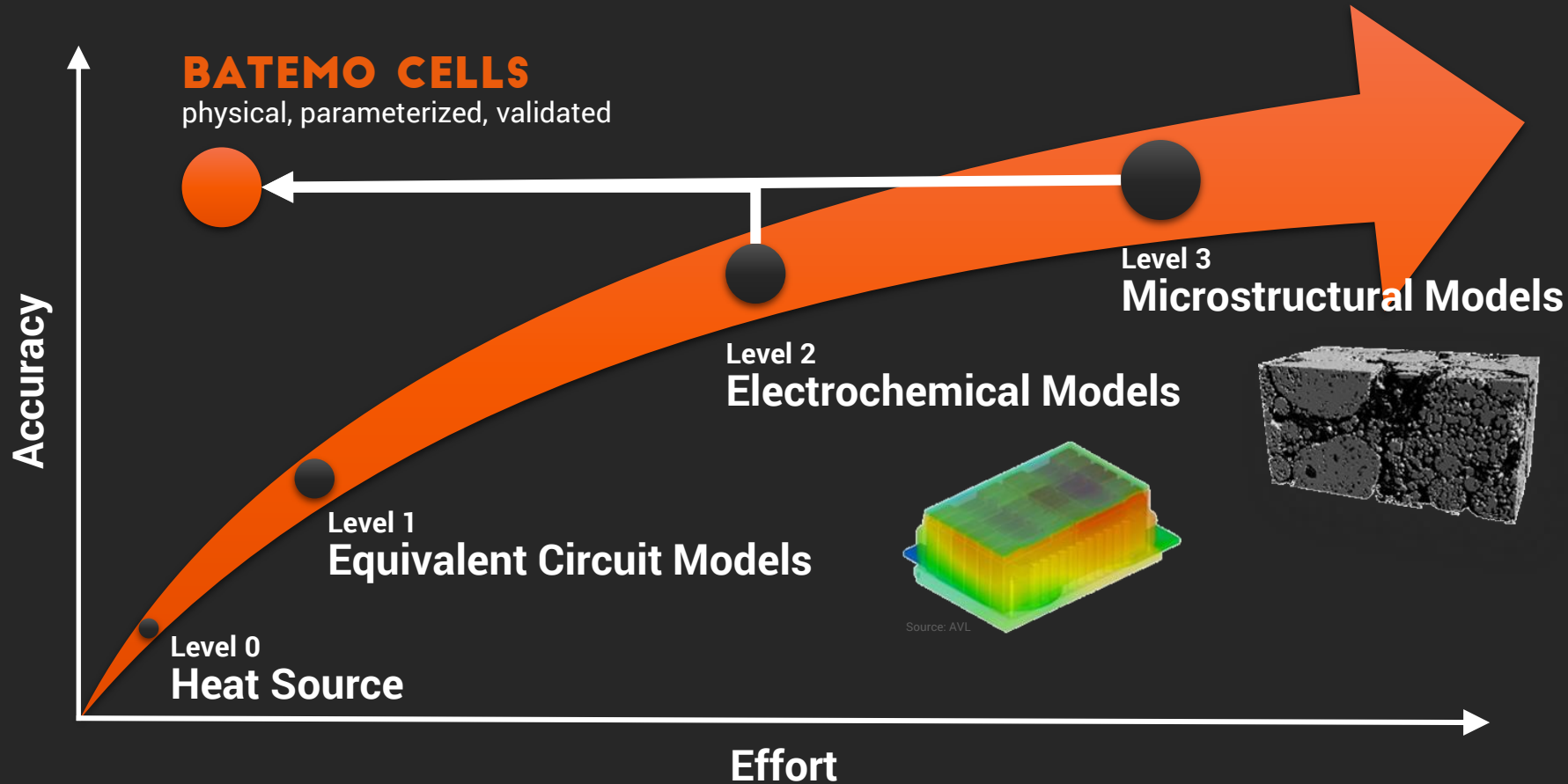


Agenda

- I Battery Modeling Fundamentals**
- II Fast-Charging of Lithium-Ion-Batteries**
- III CarMaker and Fast-Charging Scenarios**
- IV Summary**



Battery Modeling Fundamentals



BATEMO CELLS



physical
cell model



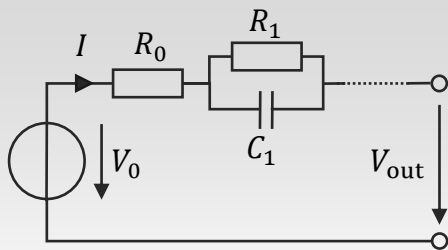
cell specific
parameterization



demonstrated
validity

PHYSICALITY

Level 1 Equivalent Circuit Models



- parameterization in several weeks
- simulation within seconds
- simple handling

development
unprecise and no aging

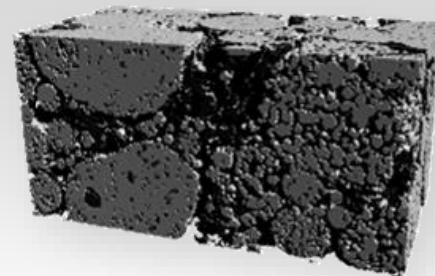
BATEMO CELL



- physical cell model
- parameterized for all cells
- global validity demonstrated

ideal solution
precise, fast and operable

Level 3 Microstructural Models



- parameterization of several months
- simulation time of several hours
- battery expert required

research
complex and slow

physicality & precision

speed & handling

PARAMETERIZATION



BATEMO CELL LIBRARY

license grants access to the **total** Batemo Cells Library
updates with new cell at least twice annually

Examples of available **automotive cells**

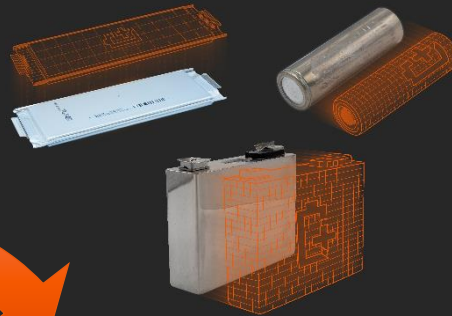
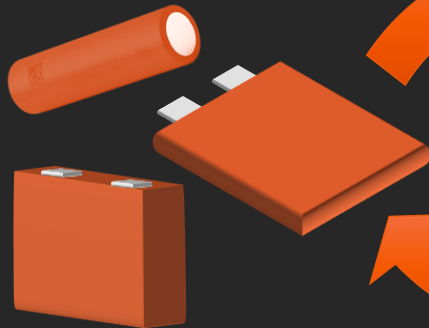
- LG Chem pouch (Porsche Taycan) *
- LG Chem pouch (Audi e-tron) *
- Panasonic zylindrisch (Tesla Model 3)
- Samsung prismatisch (BMW i3)
- Samsung prismatisch (BMW 530e)
- LG Chem pouch (Hyundai Kona) *
- Toyota Camry

* supplied by AVL

BATEMO CELL CUSTOM

parameterization of any cell **as a service**
takes only **several weeks**

CUSTOMERS



VALIDITY

TRANSPARENT

calculation of the **voltage, energy, power** and **temperature accuracies**
all data supplied as **Excel** document

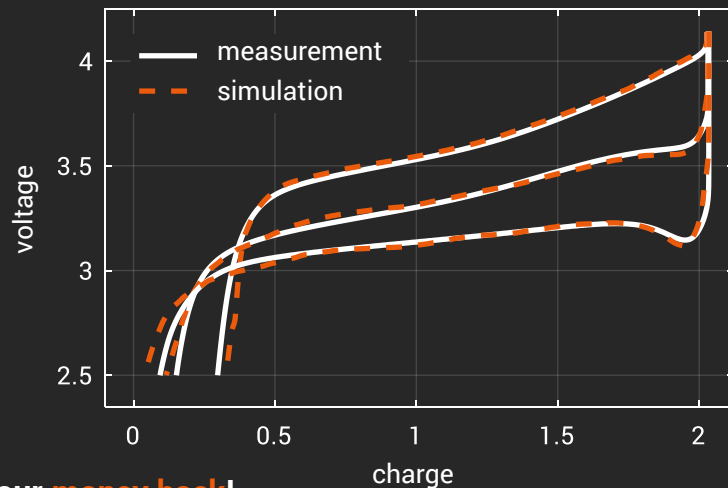


EXTENSIVE

measurements in the total **current, temperature** and **SOC** regime

GUARANTEED

We promise: If you can show us a more precise cell model, you will get your **money back!**



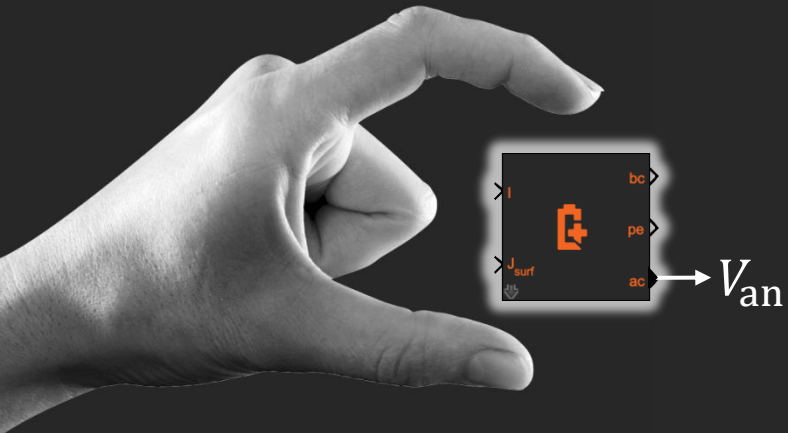
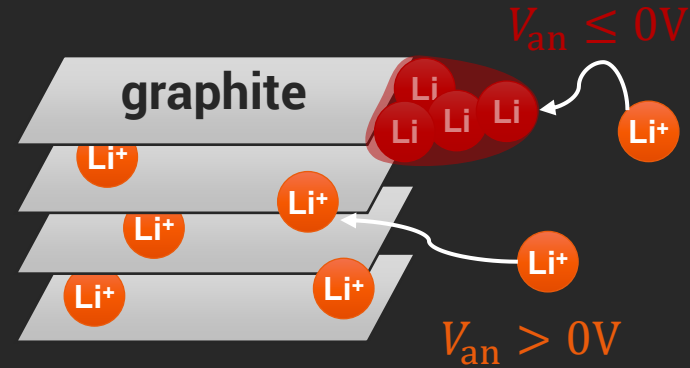
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Fast-Charging of Lithium-Ion-Batteries

LITHIUM-PLATING is the problem ...

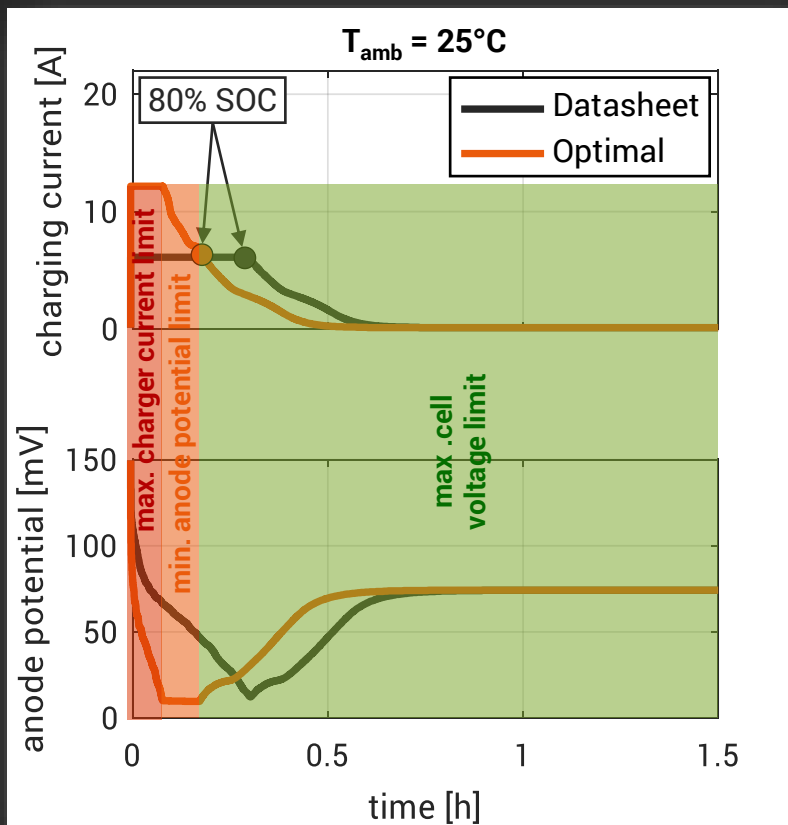
... and triggered by an **ANODE POTENTIAL** below zero.



If you have a **VALID MODEL** to simulate the anode potential ...

... you can calculate an optimal **CHARGING STRATEGY!**

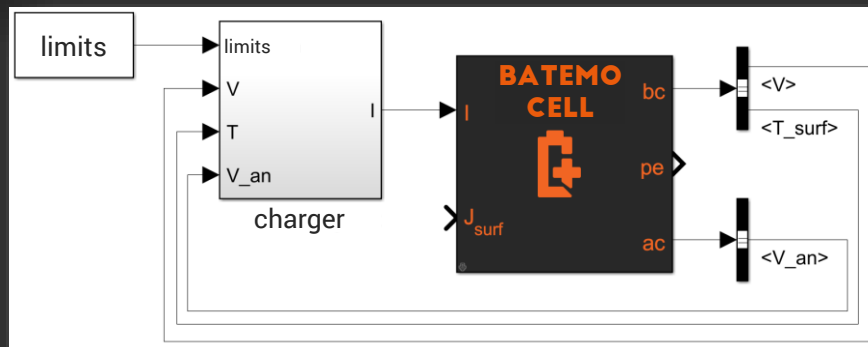
Fast-Charging Strategy



Physical Limits

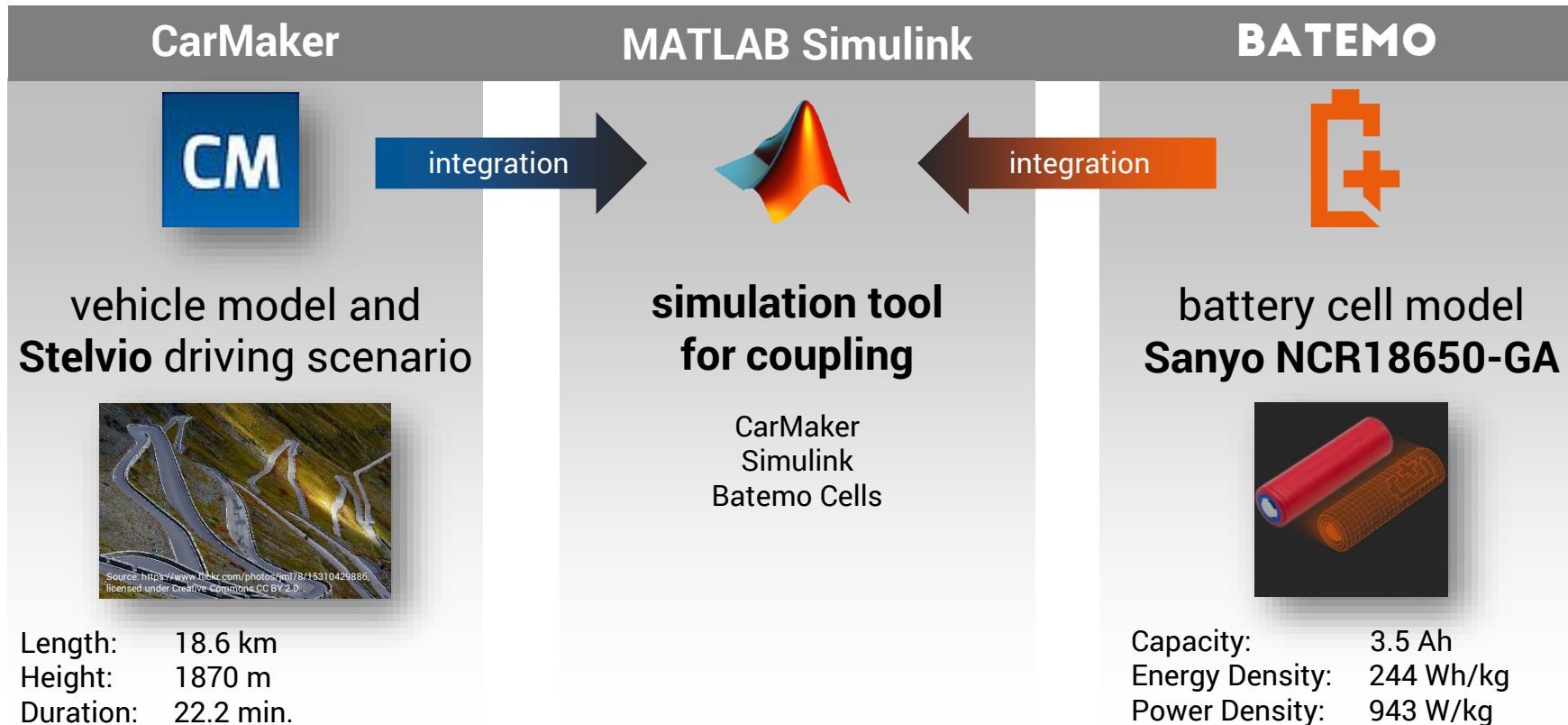
- max. charger current
- max. cell voltage
- max. cell temperature
- min. anode potential

Idea: Control current to all limits!








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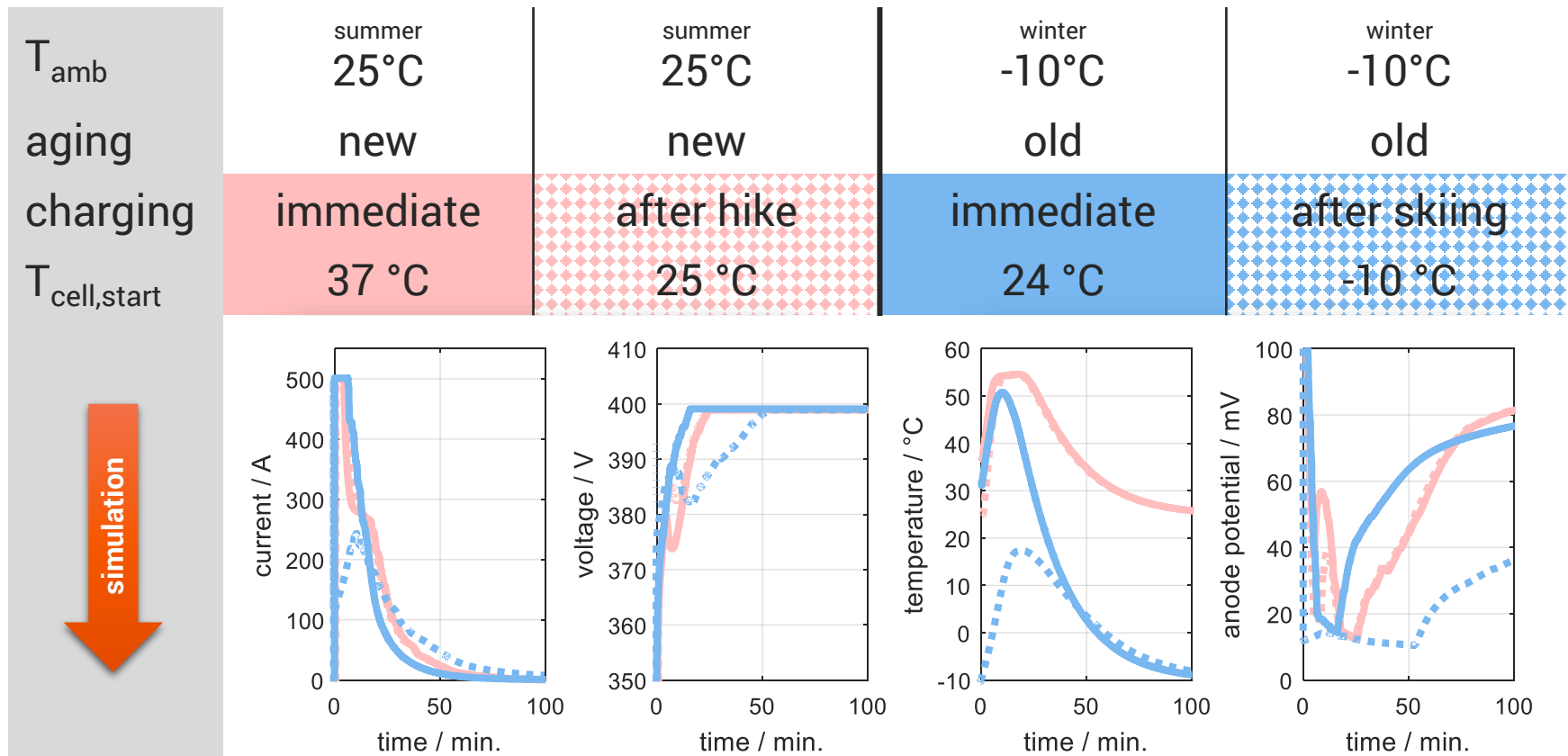




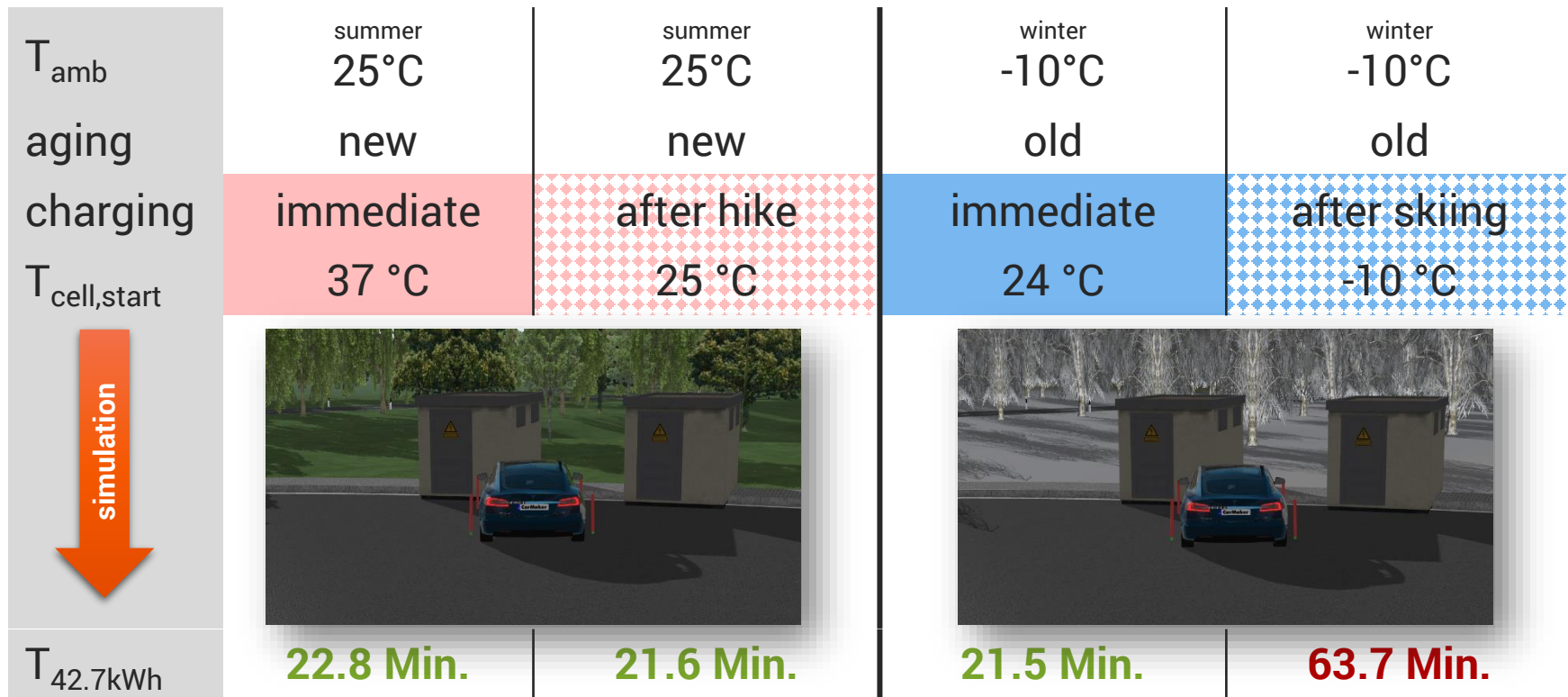
CarMaker – Driving Stelvio-Pass Uphill

T_{amb} aging 	summer 25 °C	summer 25 °C	winter -10 °C	winter -10 °C
	new	end of life	new	end of life
				
$T_{cell,end}$ SOC _{end} derating	37 °C 19 % no	40 °C 14 % no	24 °C 17 % no	32 °C 11 % yes

Batemo – Fast-Charging at the Top



Batemo – Fast-Charging at the Top



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BATTERY HEATER

DIFFERENT CELLS

CELL AGING

DRIVING SCENARIOS

AND

FAST-CHARGING

PACK COOLING

DRIVER BEHAVIOR

SOLUTION

TOTAL SYSTEM SIMULATIONS



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