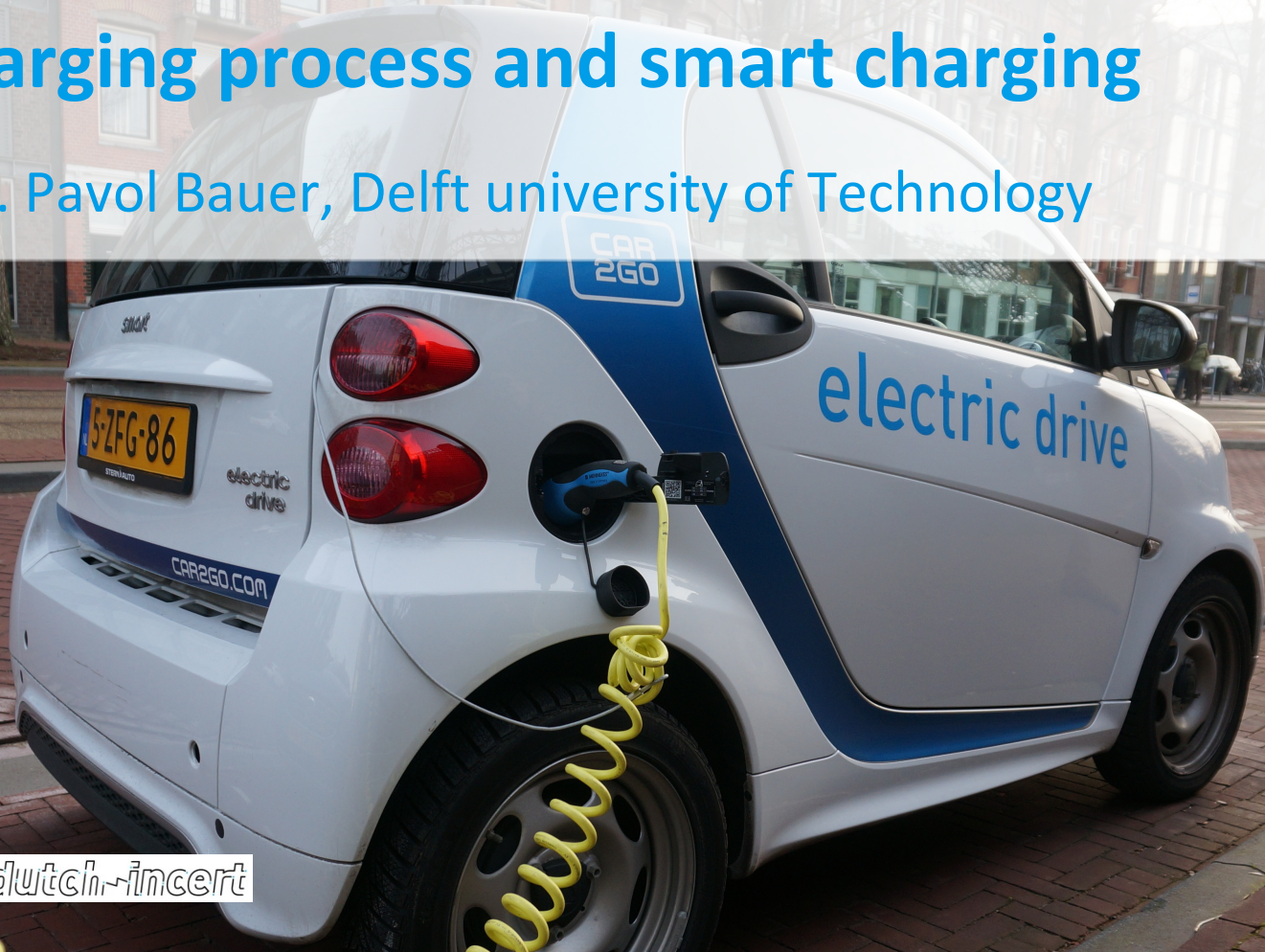
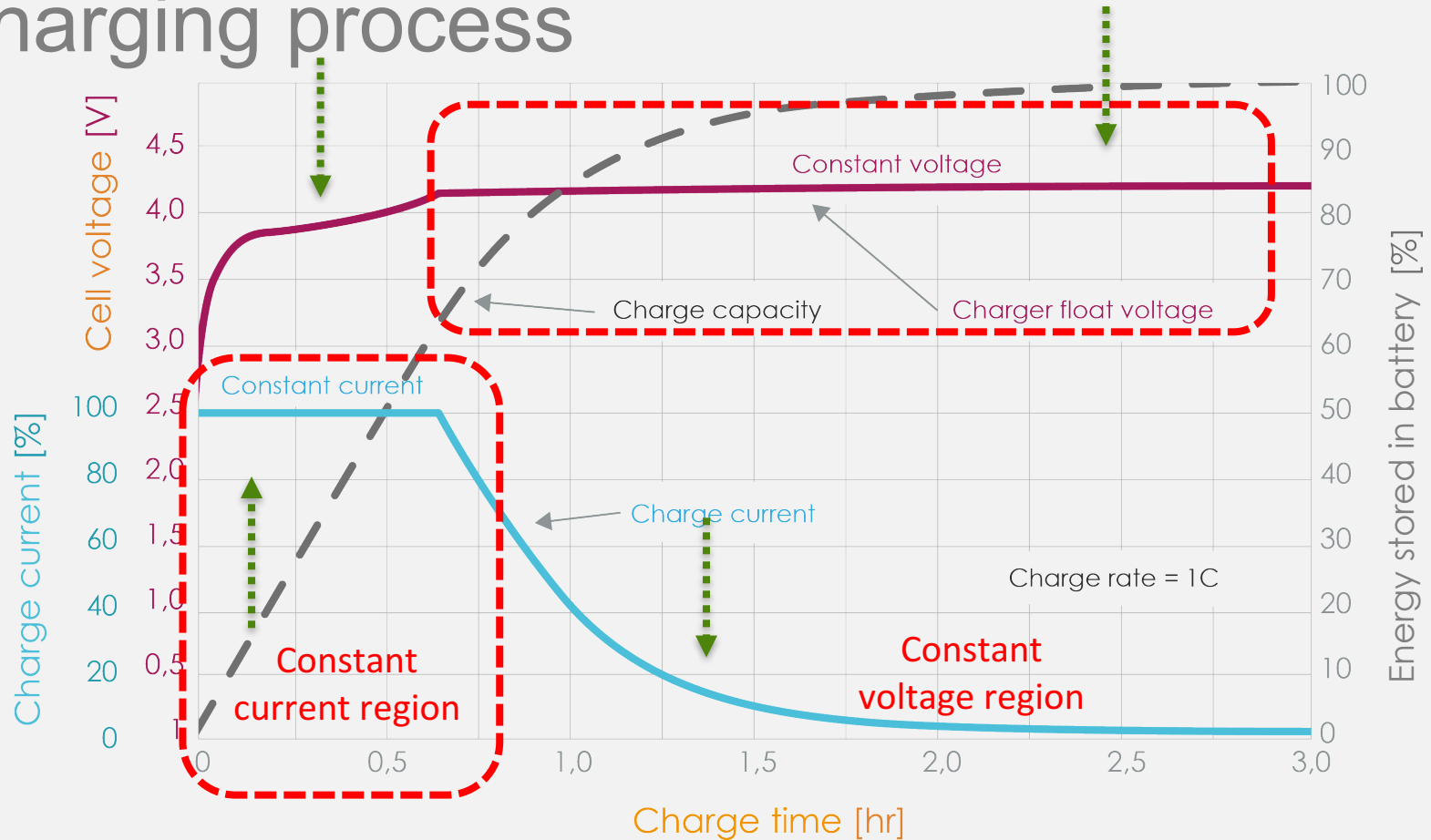


EV charging process and smart charging

Prof. Dr. Pavol Bauer, Delft university of Technology



Charging process



Charging calculation

Charging power and current:

$$P_{ch} = V_{batt} I_{ch}$$

where

P_{ch} is the charging power, in W

V_{batt} is voltage of the EV battery, in V

I_{ch} is the charging current, in A

Charging calculation

Charging power and energy:

$$E_{ch} = \int P_{ch} dt$$

where

P_{ch} is the charging power, in kW

E_{ch} is the energy delivered during charging, in kWh

t is the time period, in hours

Charging calculation

$$20 \text{ kWh} = 10 \text{ kW} (2 \text{ h})$$

Charging power and energy:

$$E_{ch} = P_{ch} t_{ch}$$

where

P_{ch} is the charging power, in kW

E_{ch} is the energy delivered during charging, in kWh

t_{ch} is the charging time, in hours

Charging calculation

C-rate

$$C\text{-rate} = \frac{P_{ch}}{E_{nom}}$$

where

P_{ch} is the charging power, in kW

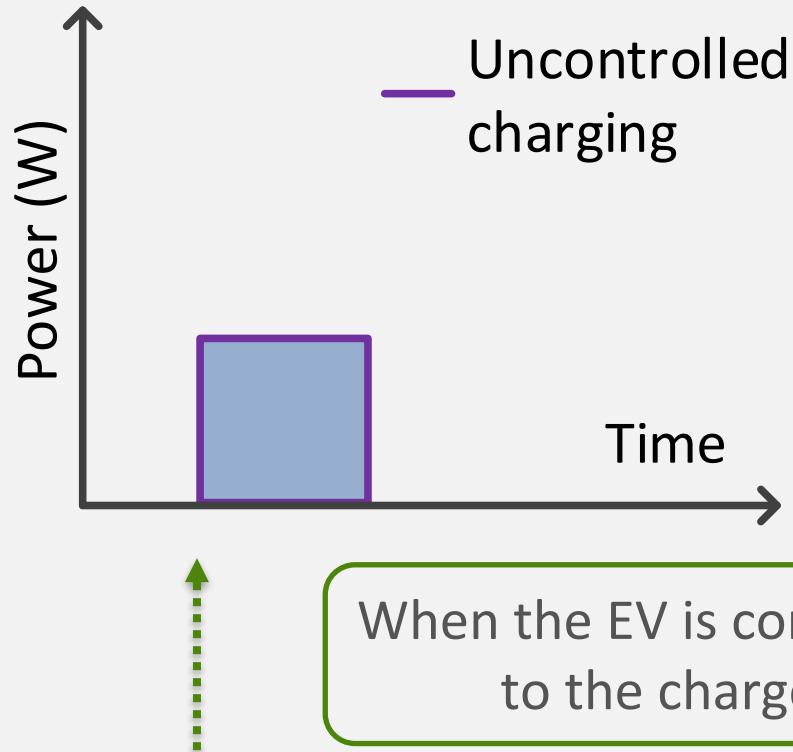
E_{nom} is the nominal energy capacity of the battery, in kWh

Higher C-rate \leftrightarrow Higher battery losses \leftrightarrow Lower lifetime

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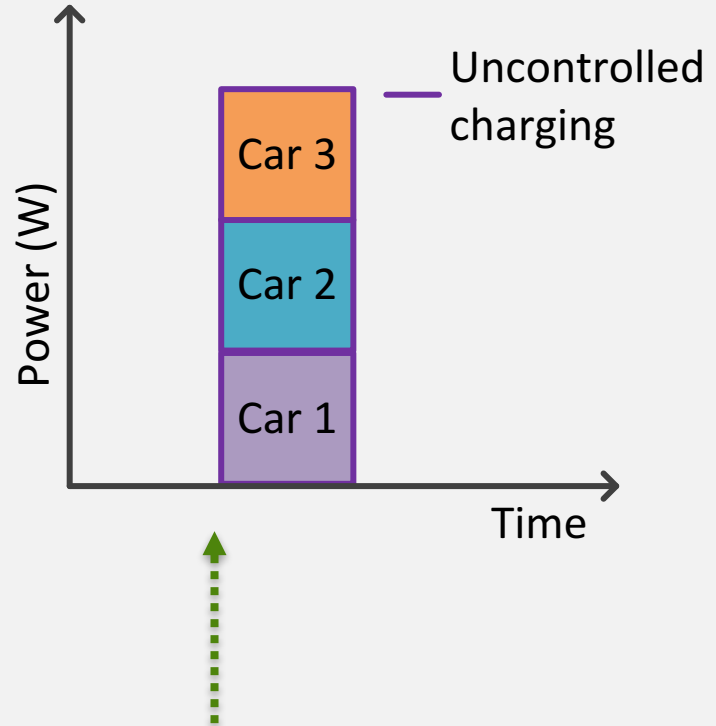
Smart charging

Uncontrolled charging

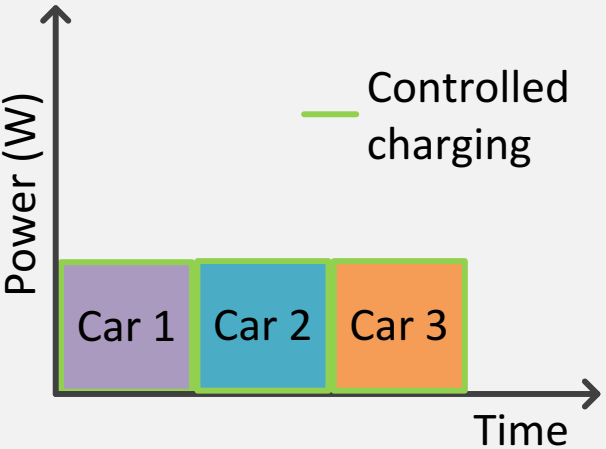


Uncontrolled charging: Effects

- Peak loading on grid
- Upgrade electricity network
- No correlation to renewable generation like solar
- No correlation to energy prices
- Many more.....



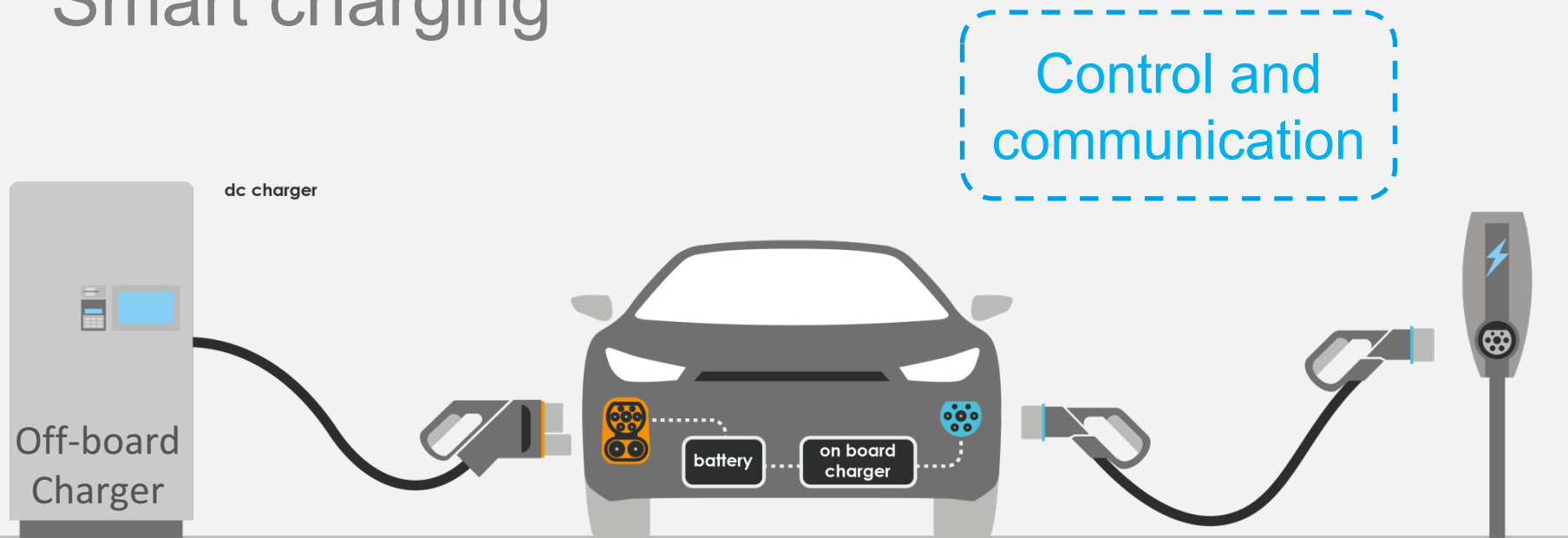
Smart charging



Smart charging



Smart charging



Control and
communication

IEC 61851
ISO 15118

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