Zonder DC geen Energietransitie

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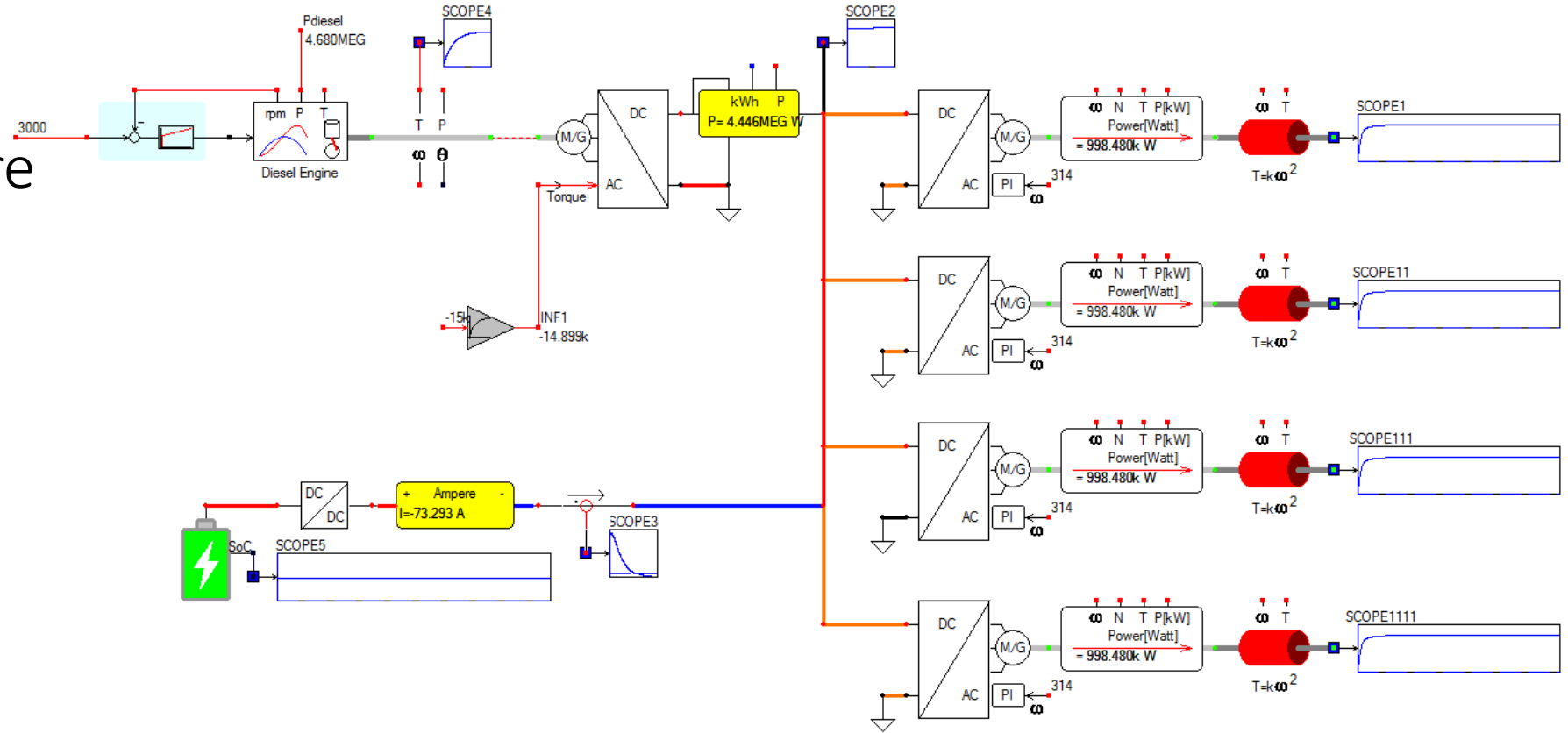
Zondâh gelijkstraum gein einegietransisie

Contents

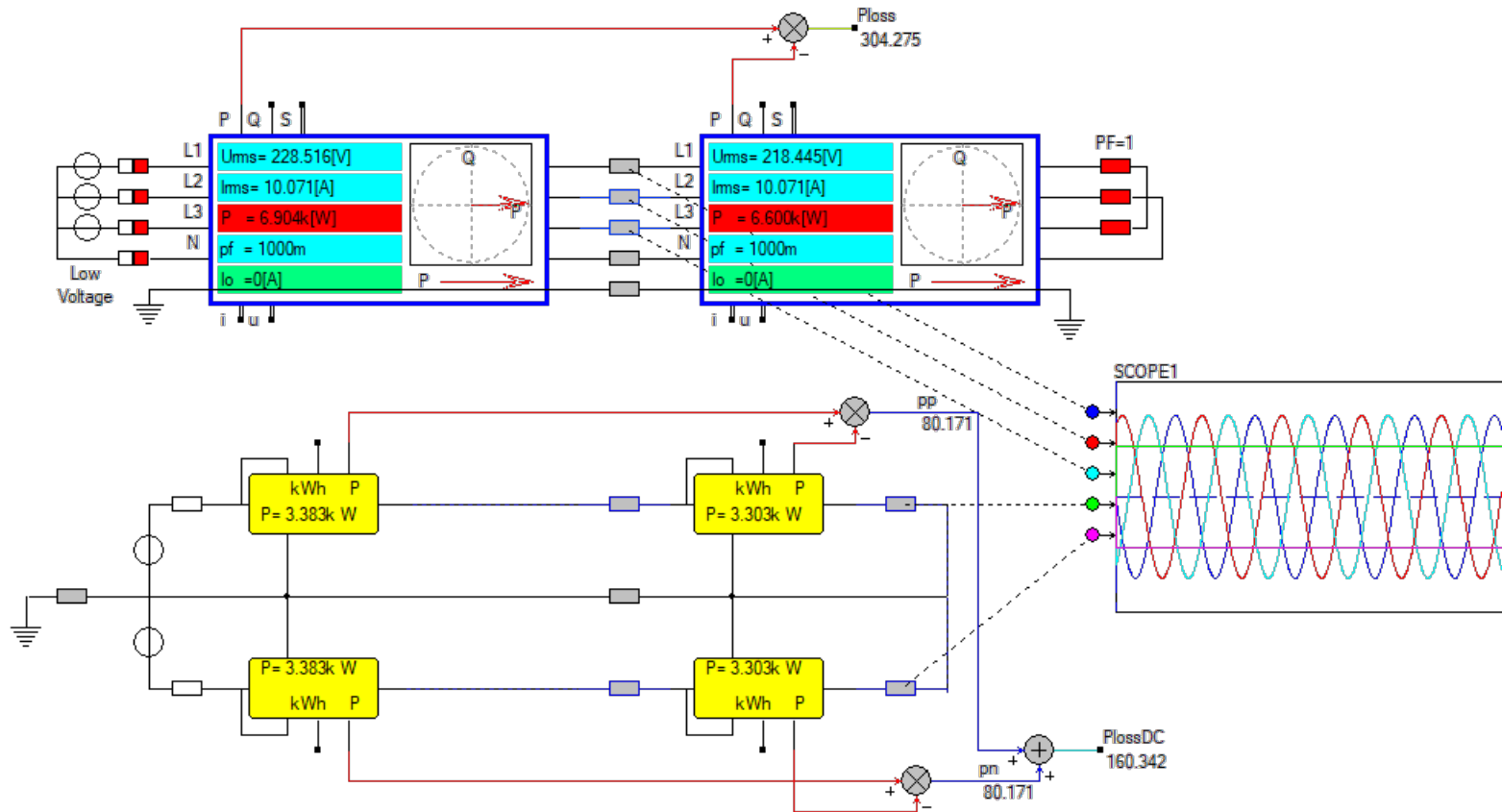- DC grid structure
- Control
- Switching
- Protection
- Stability

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DC grid structure and voltage levels?

EN50155 (2017) STANDARD			
Nominal Input	**Permanent Input Range (0.7 - 1.25 Vin)**	**Brownout 100ms (0.6 x Vin)**	**Transient 1s (1.4 x Vin)**
24V	16.8V – 30V	14.4V	33.6V
28v	19.6V – 35V	16.8v	39.2V
36v	25.2v - 45v	21.6v	50.4v
48V	33.6V – 60V	28.8V	67.2V
72V	50.4V – 90V	43.2V	100.8V
96V	67.2V – 120V	57.6V	134.4V
110V	77V – 137.5V	66V	154V

CONNECTR energy innovation

STICHTING GELEIKSPANNING NEDERLAND

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TUDelft

HAN_UNIVERSITY OF APPLIED SCIENCES | Sustainable Electrical Energy Centre of Expertise

DC LAB

Why do we need a DC Grid?
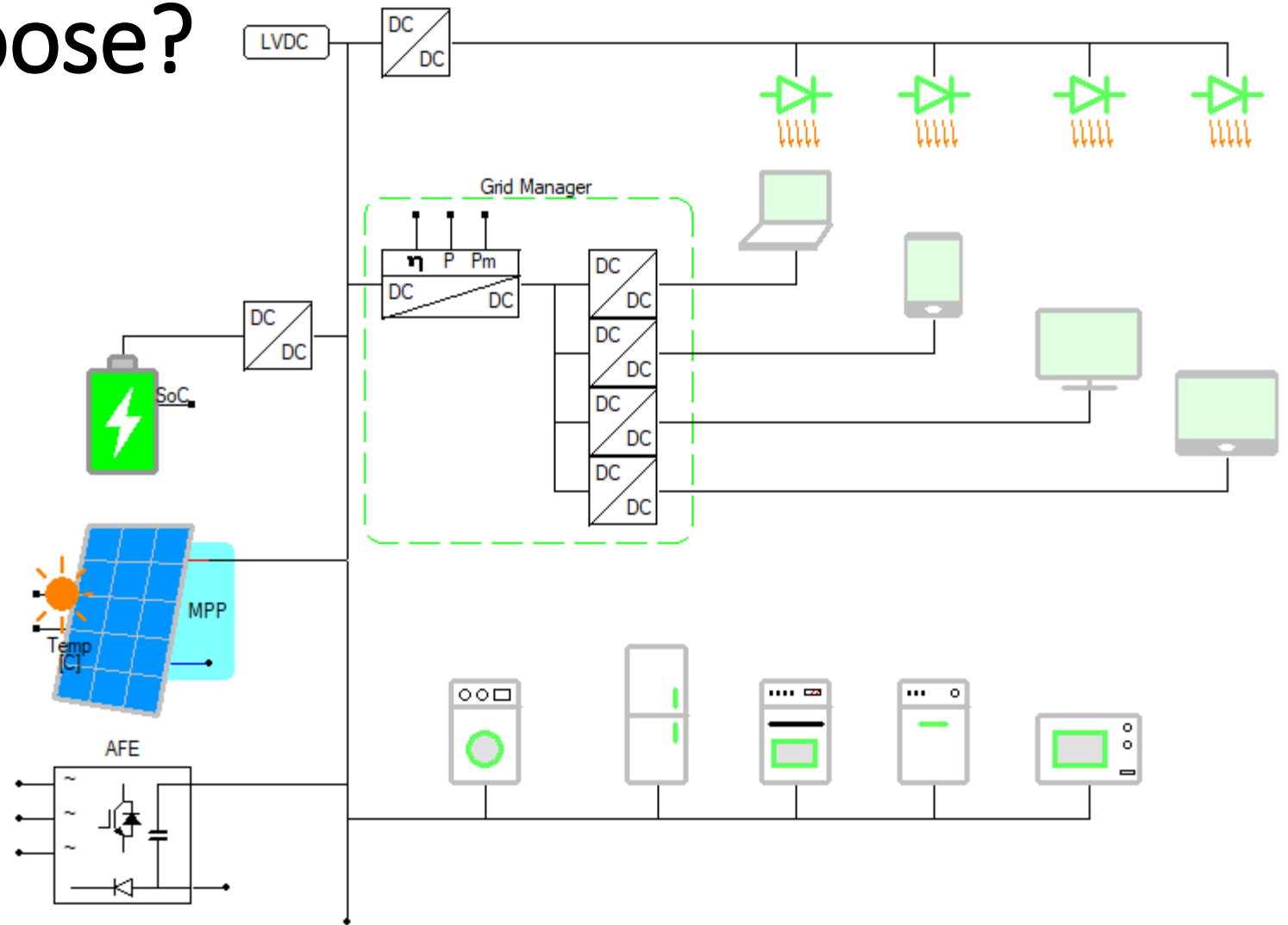# Lower losses is not the reason why we choose DC!

It is not about optimizing components
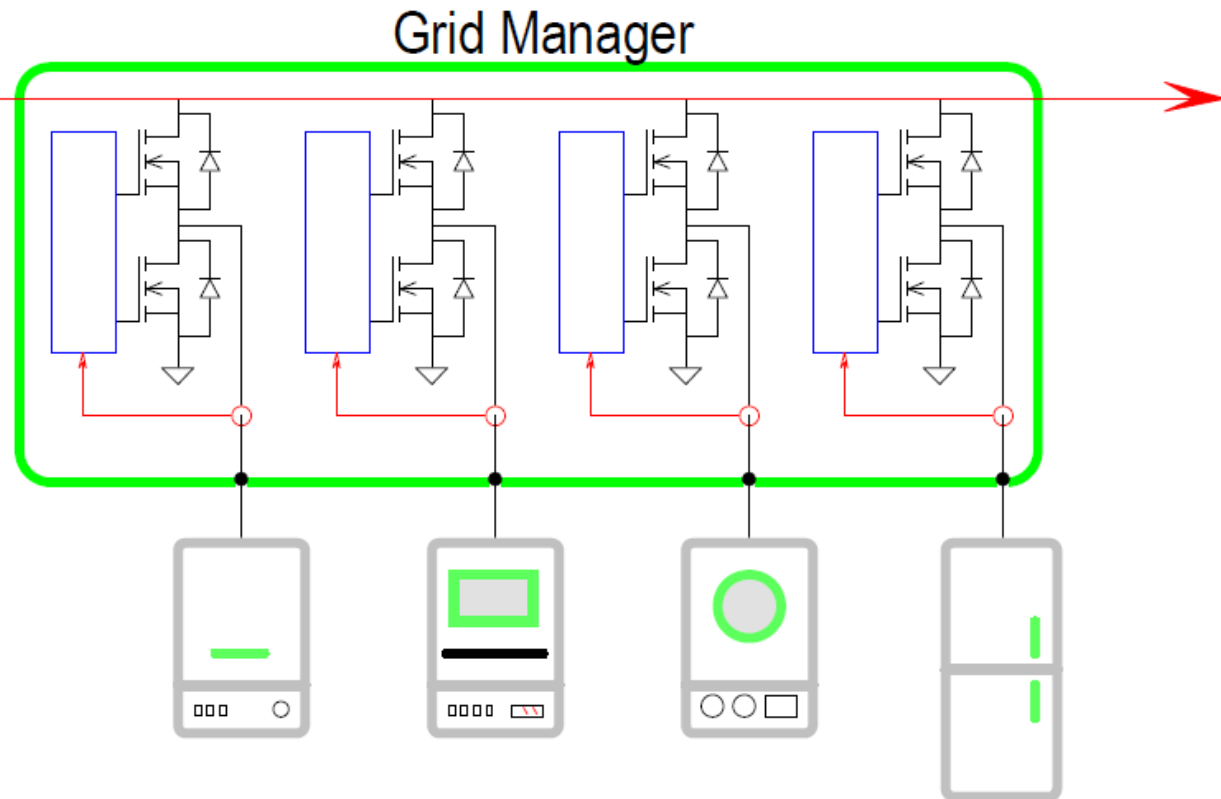# It is optimizing the system!
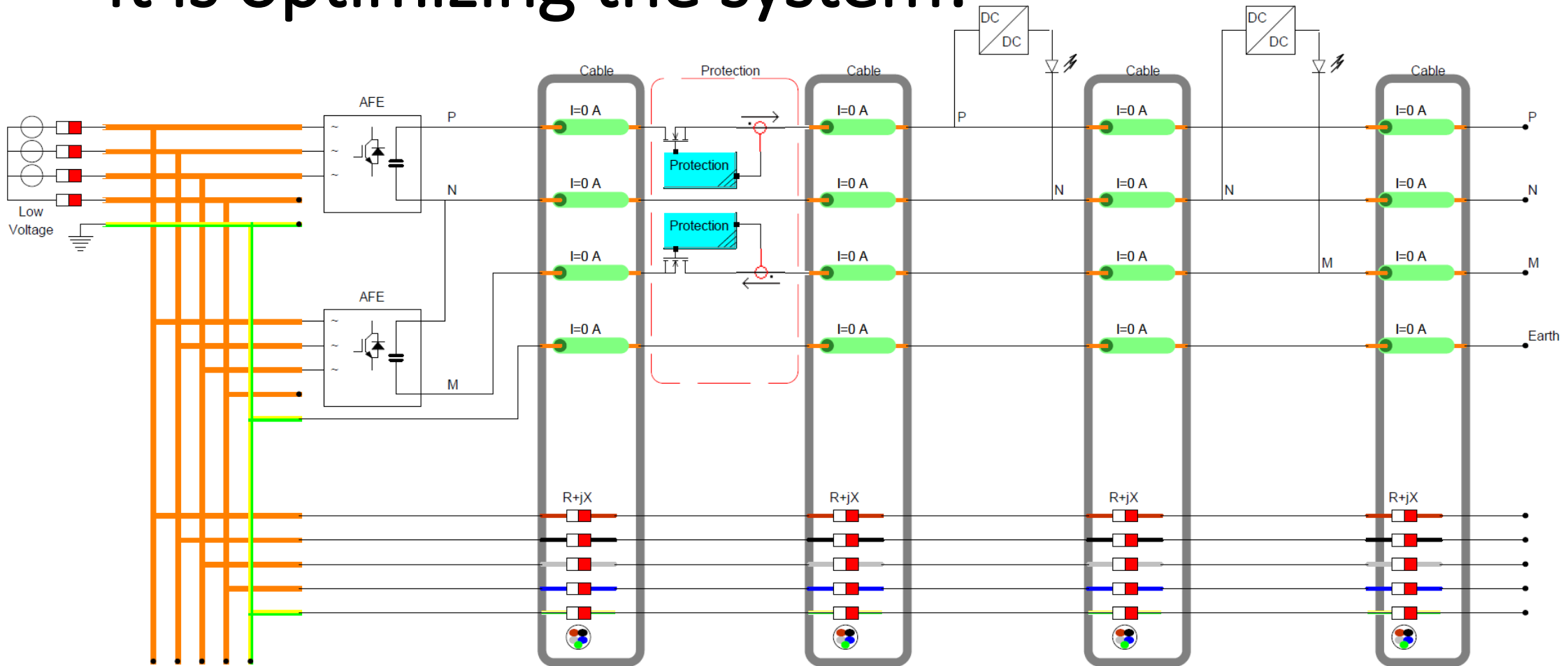
Which grid to choose?

- Centralized
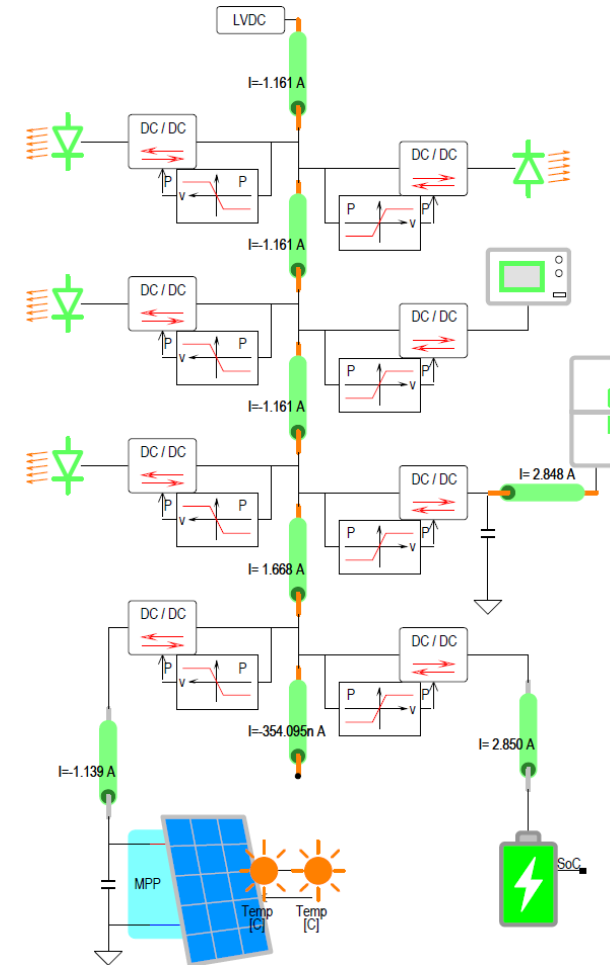- Decentralized

Centralized DC Grid with Grid Manager

- All control in one device
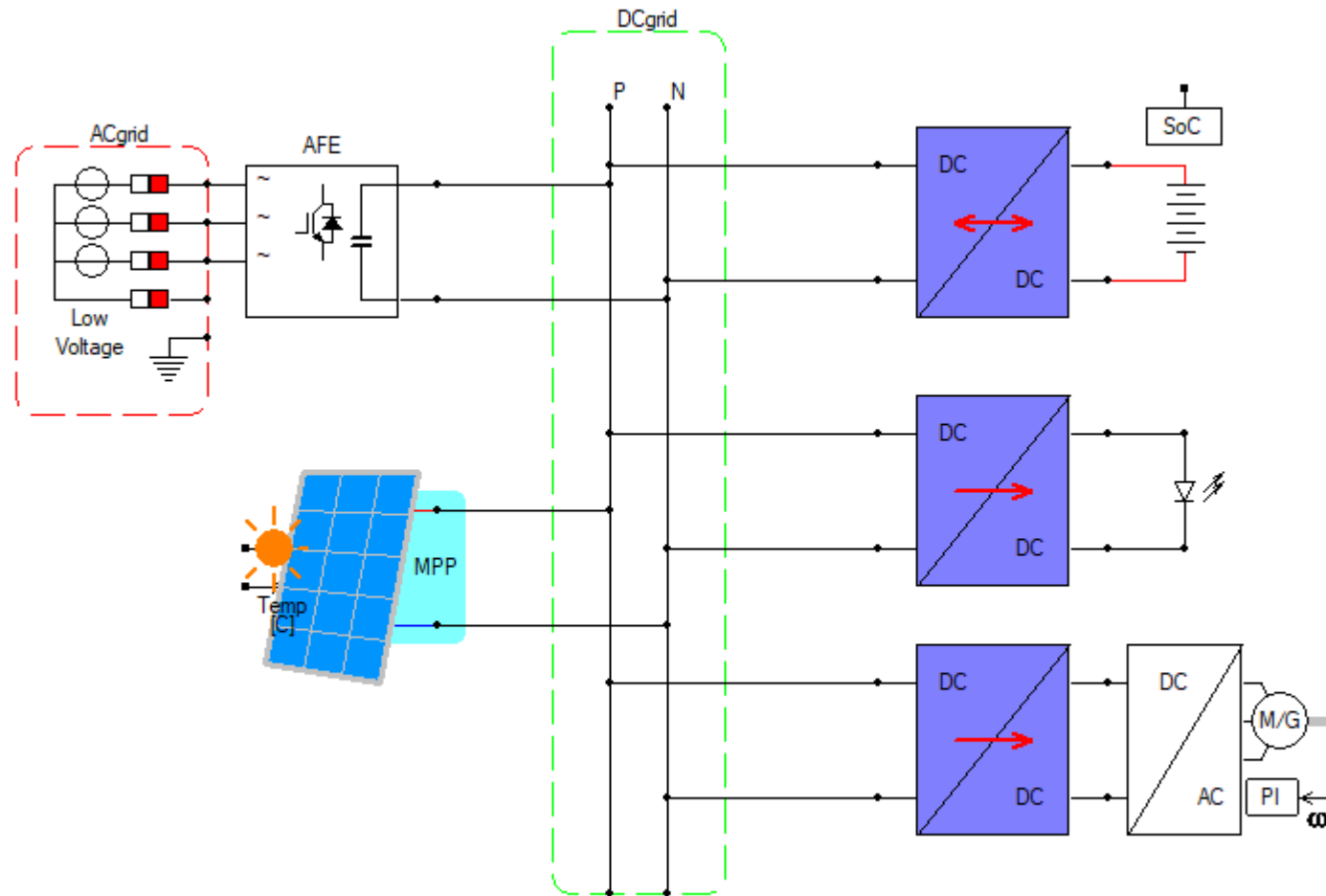- Control of Power
- Breaker
- Inrush limiter

Decentralized DC Grid with Droop Control

- Droop control per appliance
- DCDC converter per appliance
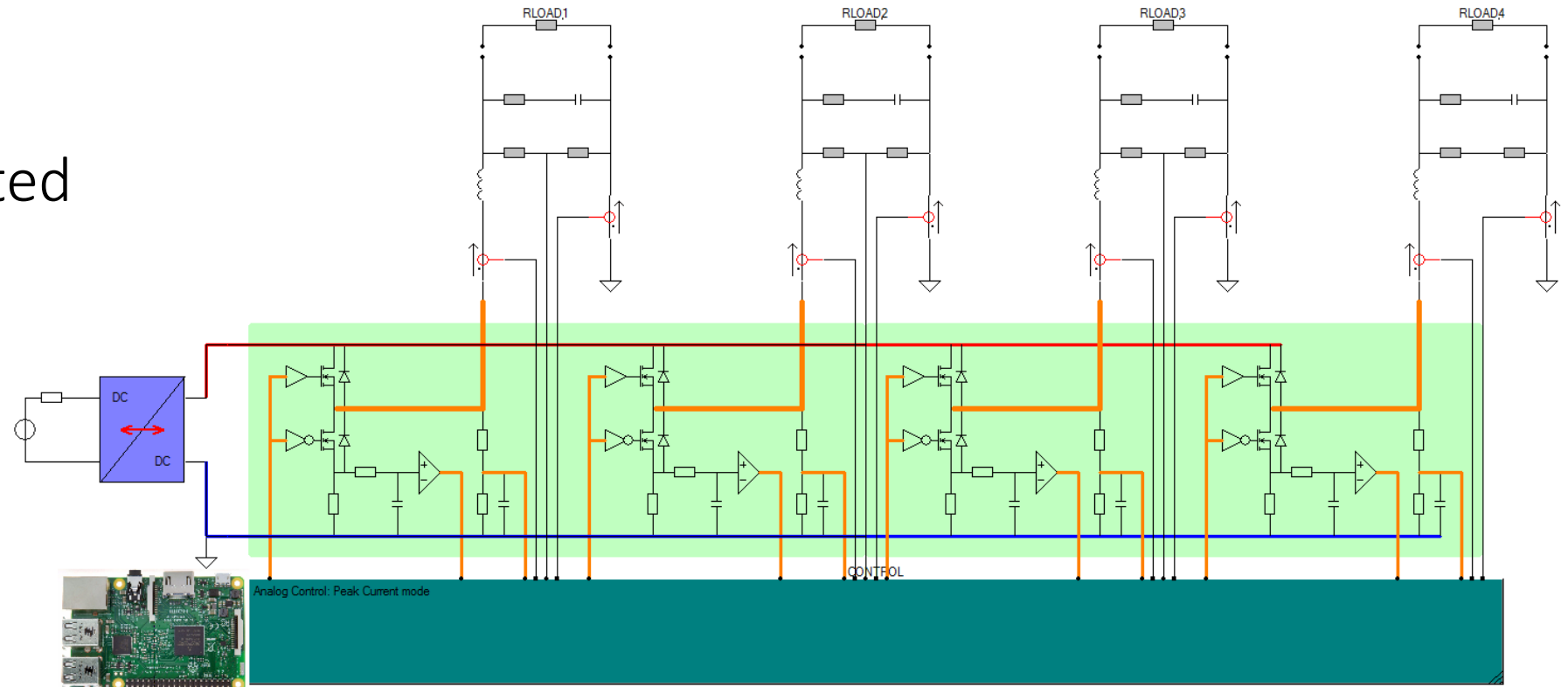
Producers and Consumers are directly coupled

Switching in the DC grid?

What type of switches do exist,
if they do exist at all?

Grid Manager contains multiple Synchronous Buck Converters
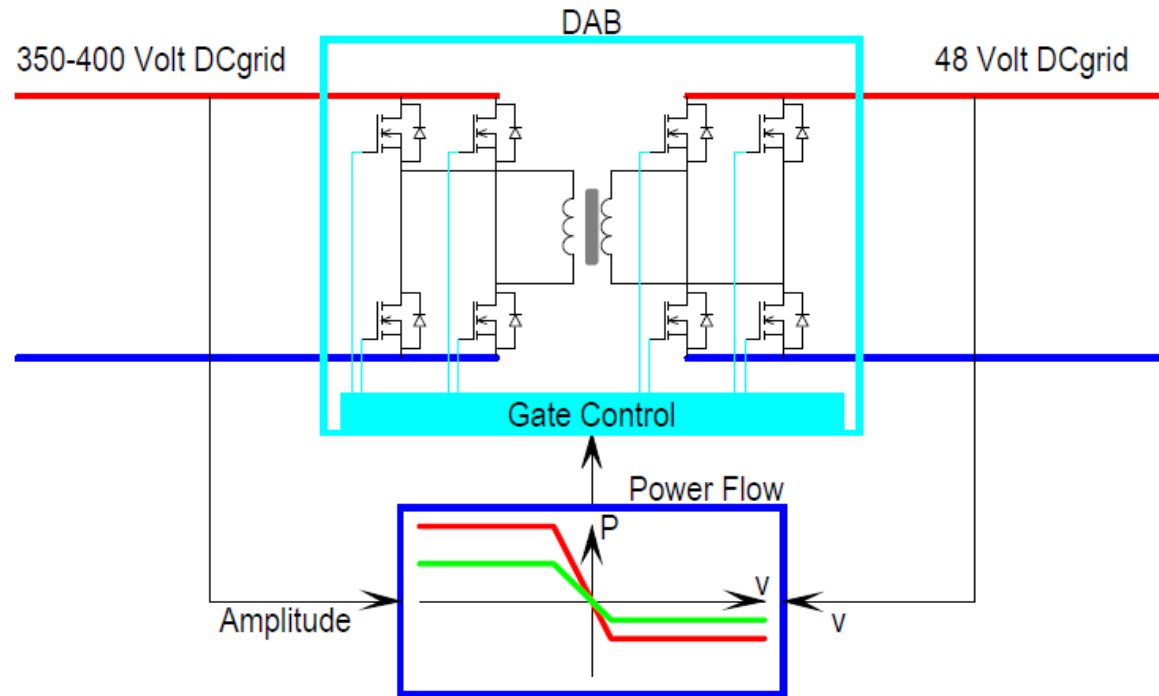
- Power flow
- Current Limited
- Breaker
- Non-Isolated

Dual Active Bridge is Isolated

- Bidirectional power flow
- Current Limited
- Breaker
- Isolated
- DC transformer
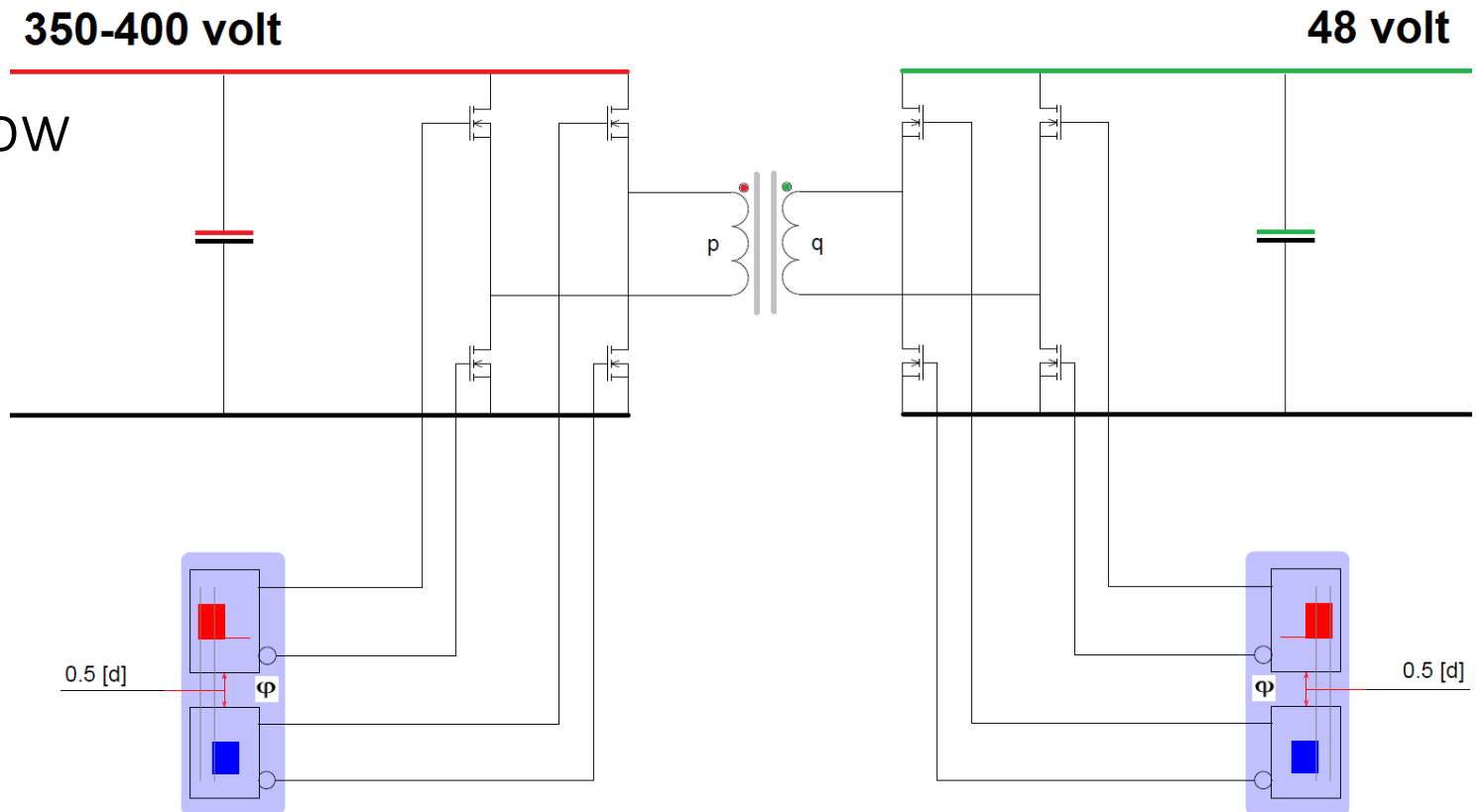
Connecting two DC grids with different voltage levels
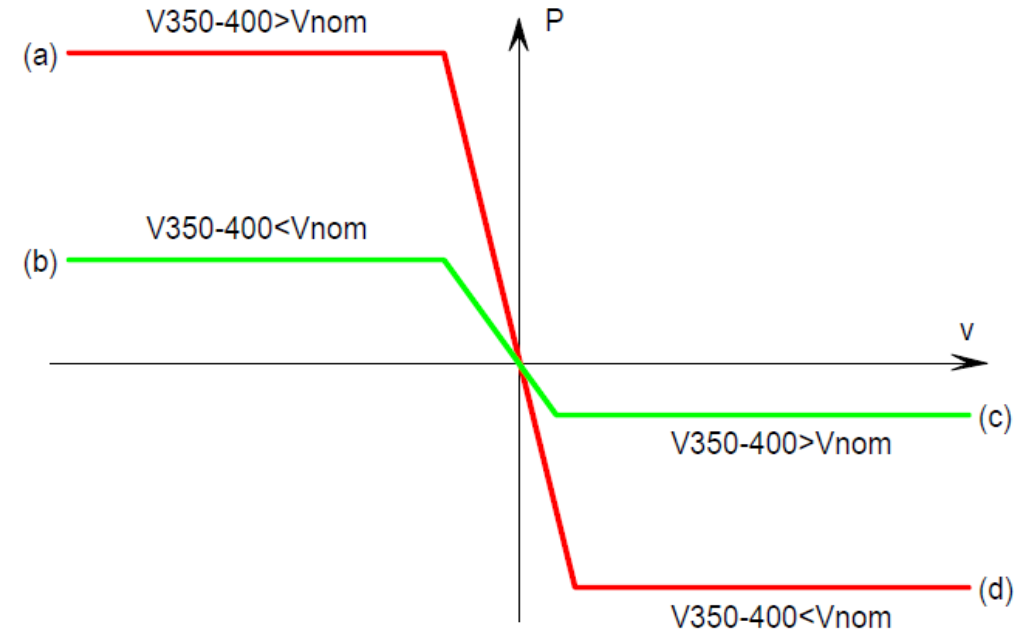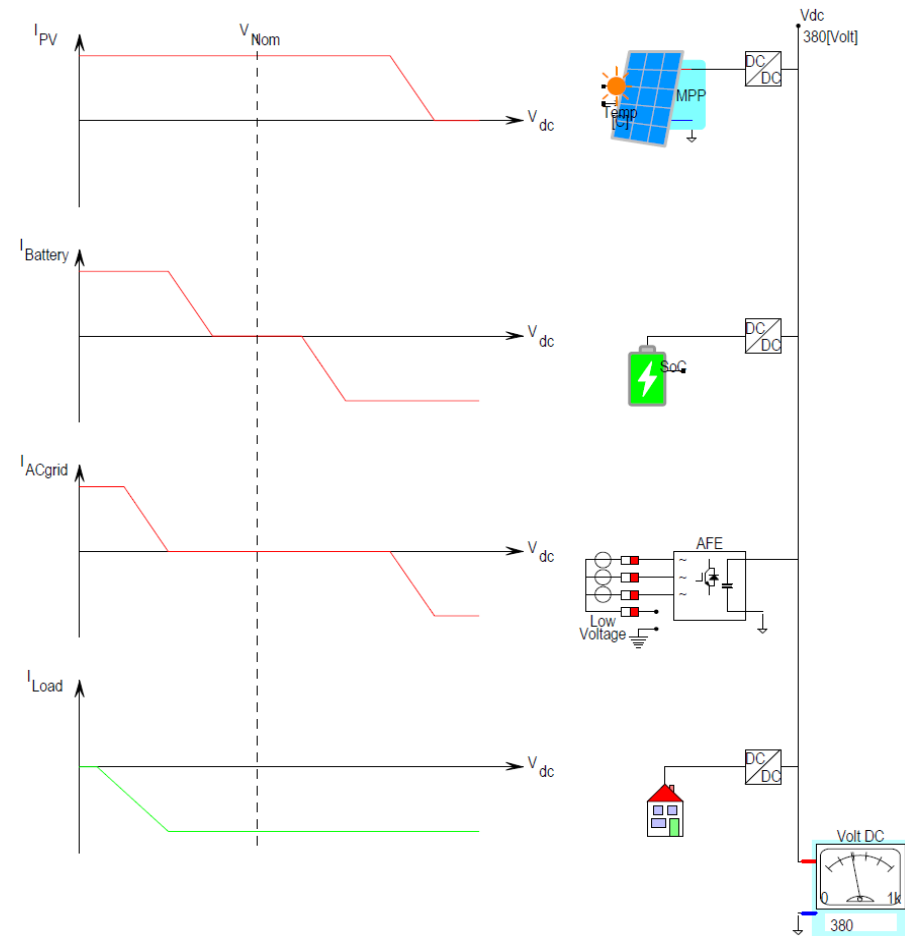
DC grid control?

Control and Power Congestion Management in the DC Grid

Control the current in a Meshed grid

- Nodal voltage defines current flow
- DCDC converters have losses
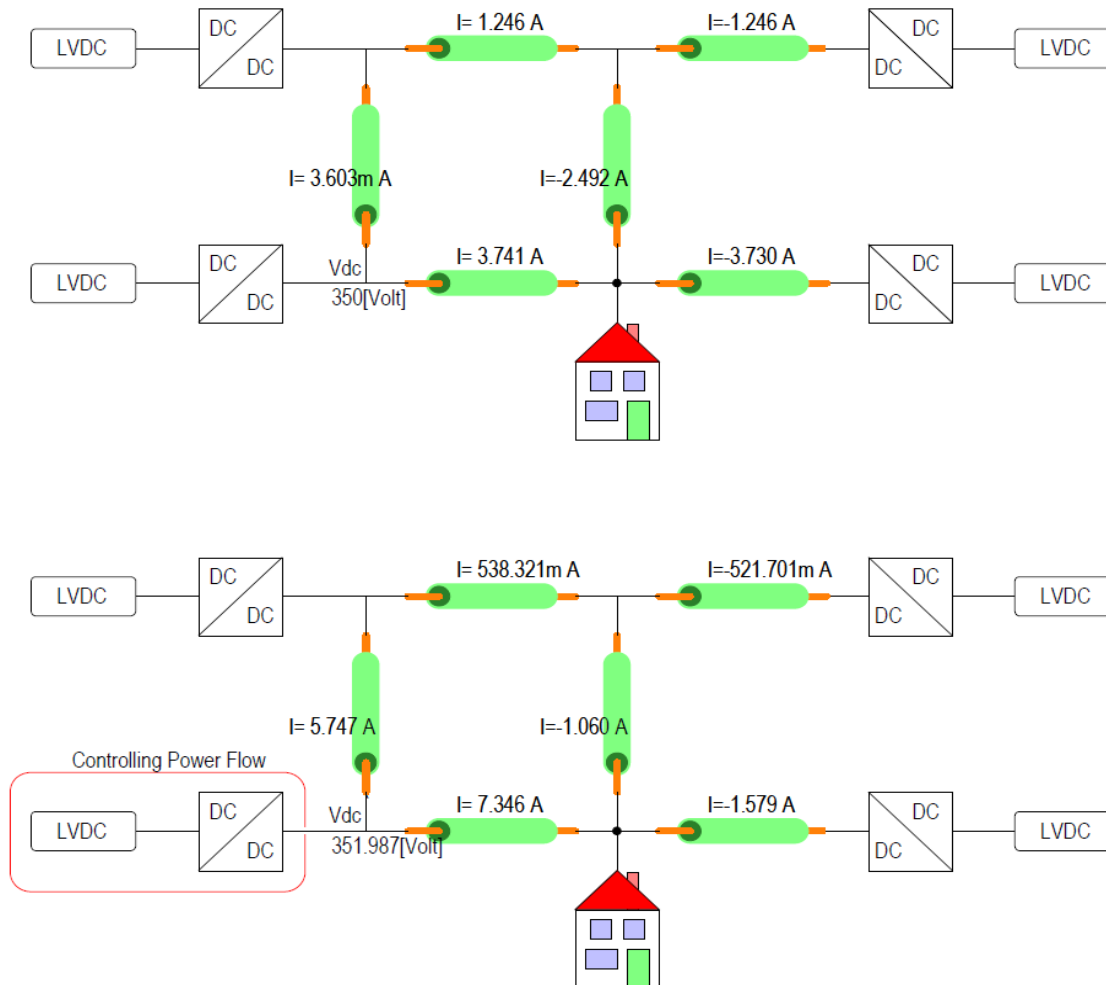
Droop Control regulates in a decentralized grid

- Controlled current flow per appliance
- Islanding operation
- No communication required

DC grid Selectivity and Protection?

Protection and/or selectivity in the DC Grid?

When grounding, the DC grid has to be isolated from the AC grid
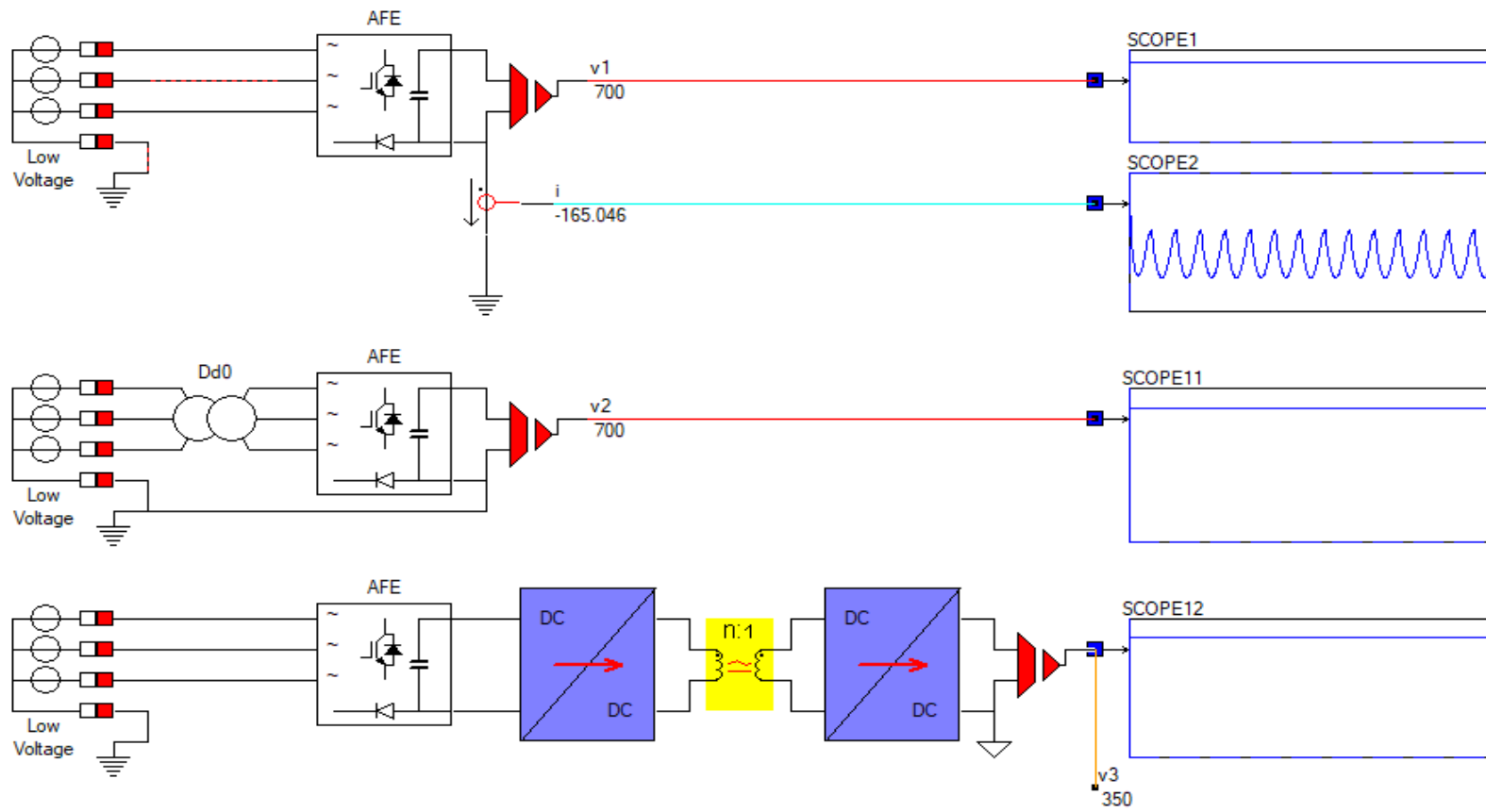
Grid system?

- You can choose an isolated Grid IT to implement earth leakage detection,
- but your grid is floating!
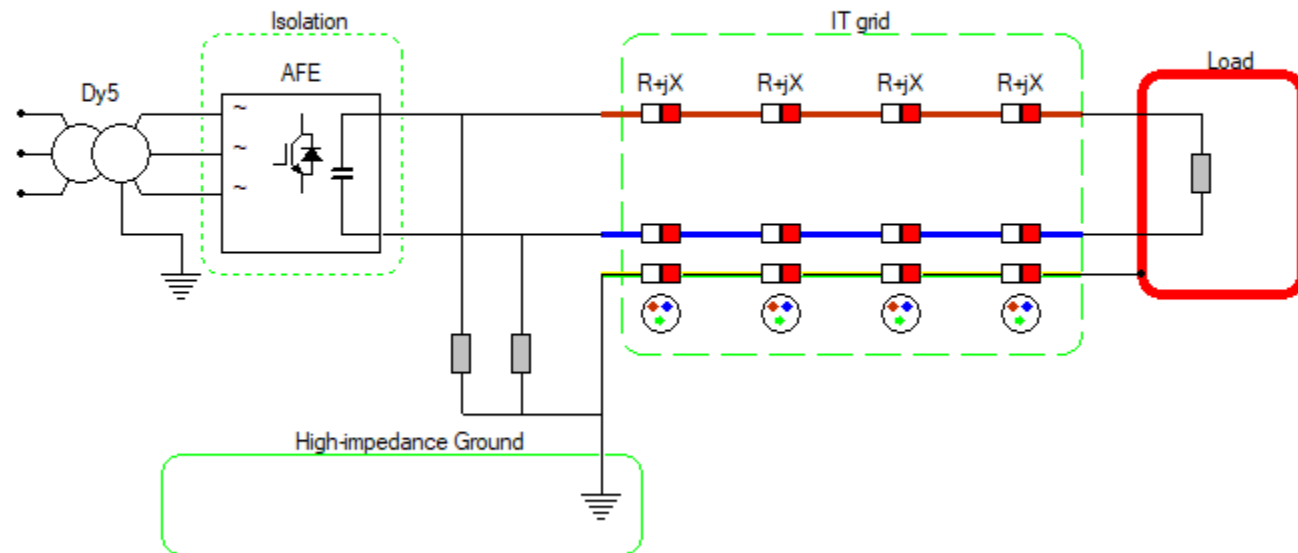
RoCoC Rate of Change of Current
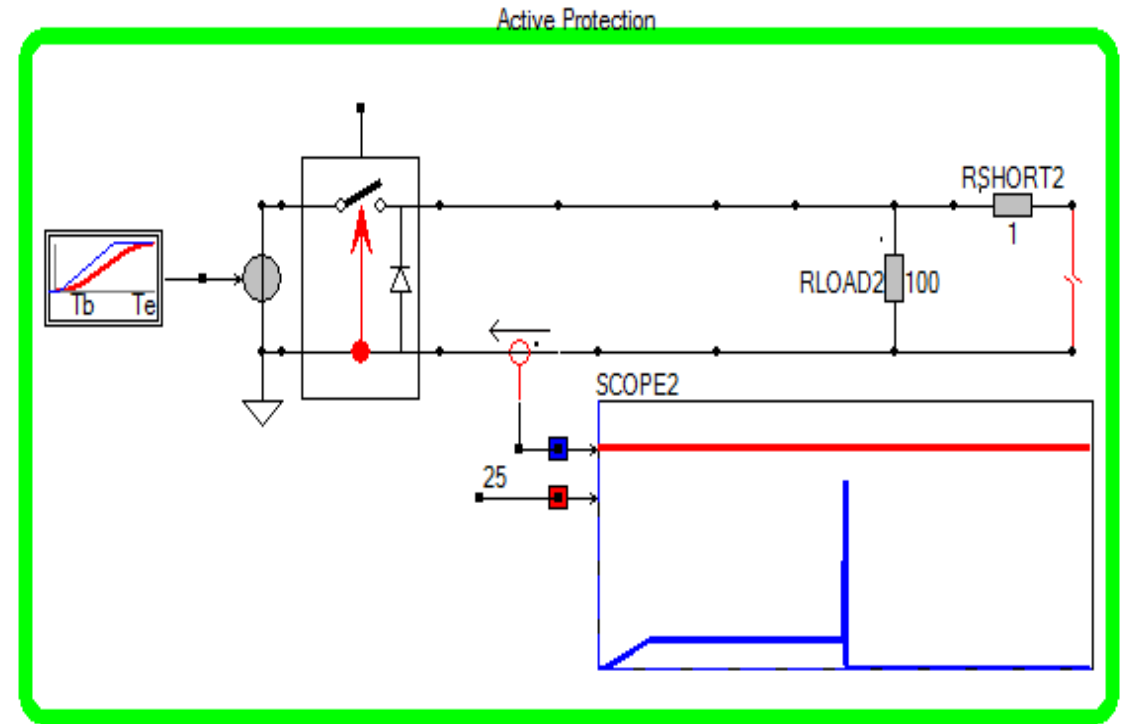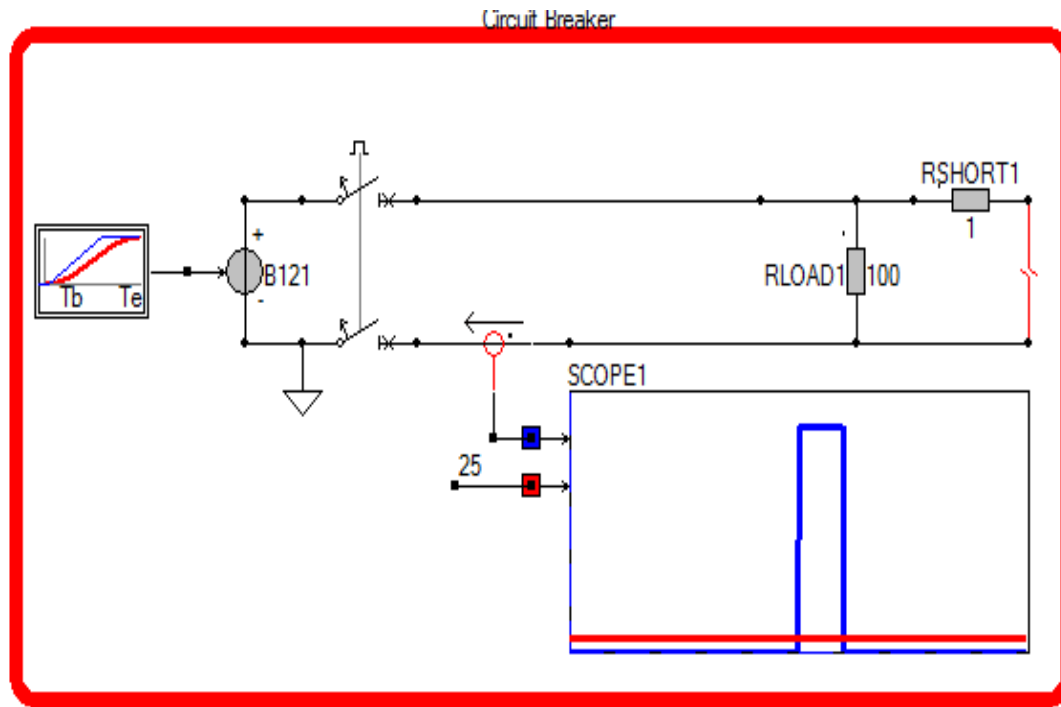
DC grid stability?

How to predict and ensure stability in the DC Grid

Static stability depends in Droop Control Characteristics

- Droop characteristic
- Per appliance
- Low Bandwidth
- Stand alone operation
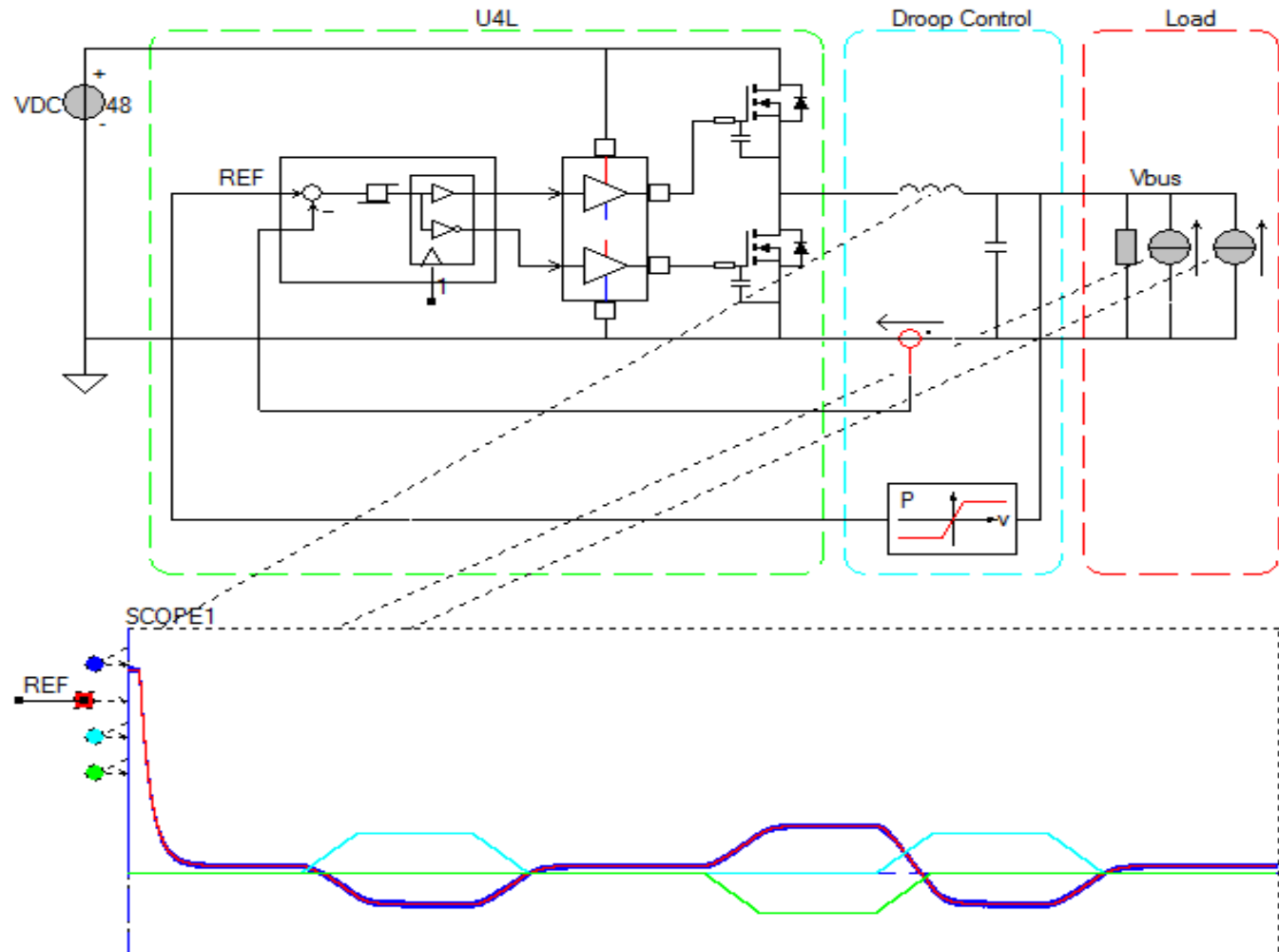
Dynamic stability depends on input and output impedance

- Zout < Zin
- Middlebrooks Stability Criterion
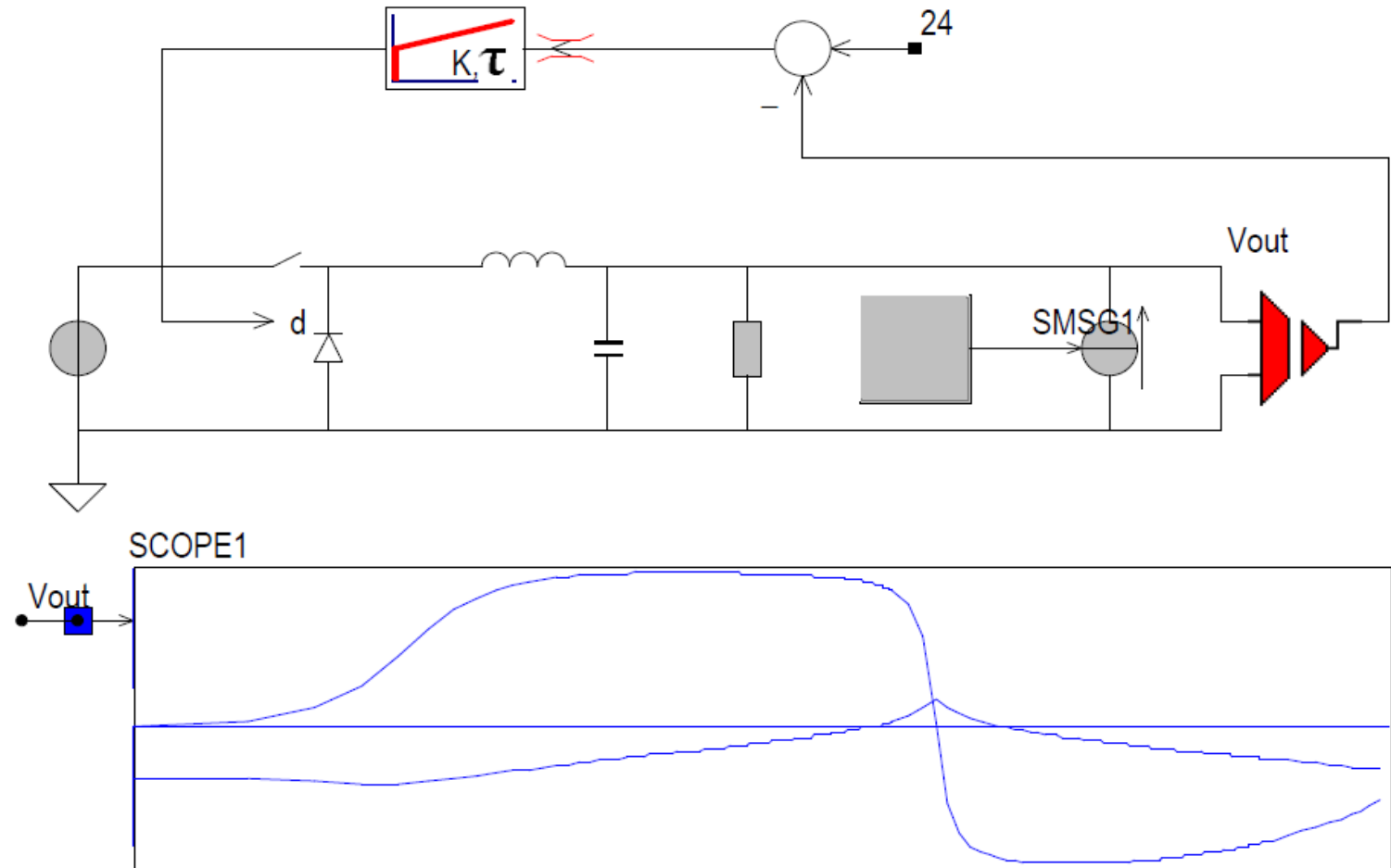
Available?

- What is available?
- Price?
- Vendor lock?

HVDC – MVDC - LVDC

© Siemens

- HVDC
  - Standard, there is nearly no HVAC
- MVDC
  - Connection between MVAC grids
    - Siemens[DE], SP Energy Networks[UK]
- LVDC
  - Industry / Railway
  - Marine / Offshore
  - USB-C
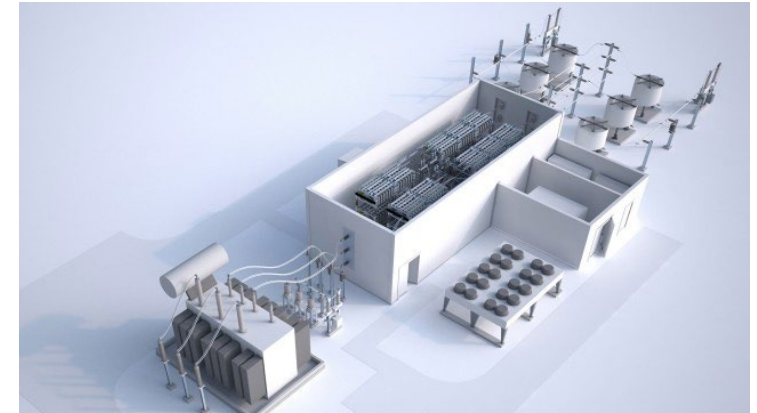
Traction: Standard (Hundred years!)
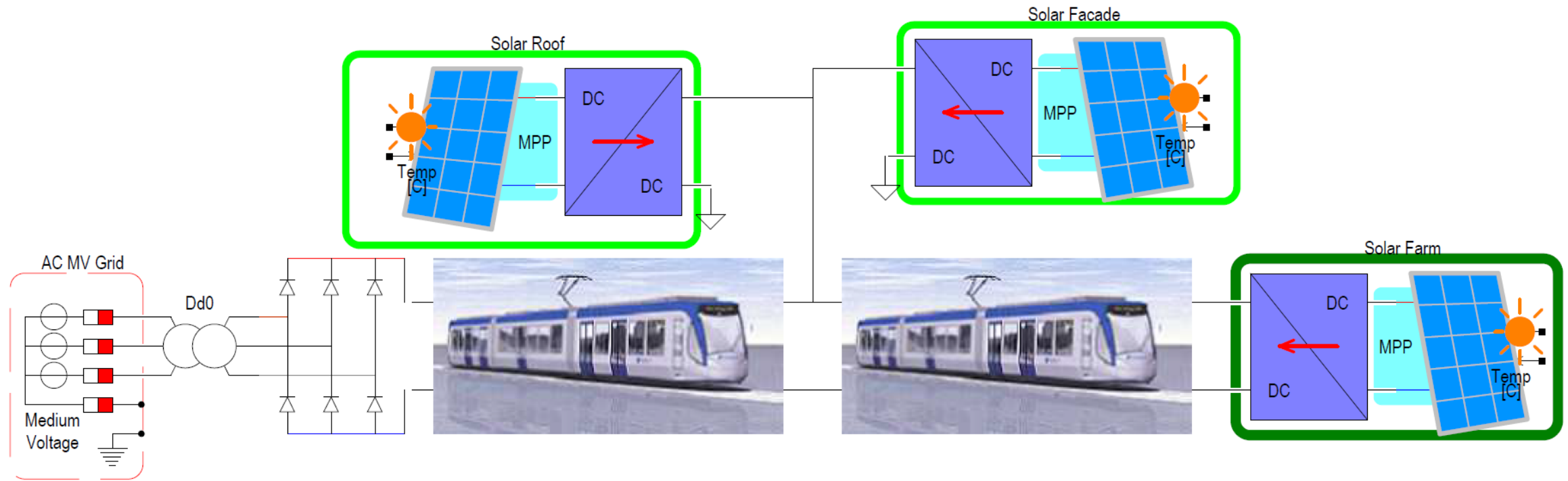
Data-center: Standard 380/400 volt

Street Lighting: Emerging
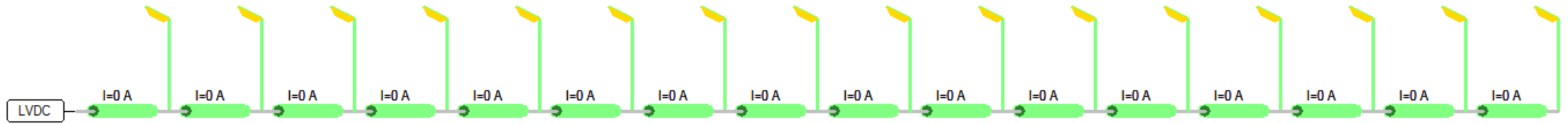
Hoge Rijndijk © Wilfred
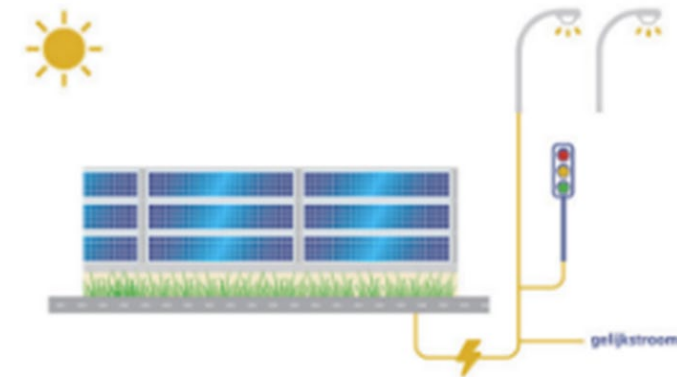
N470 © Sven & Harry

Exchange of Drive and Brake Energy
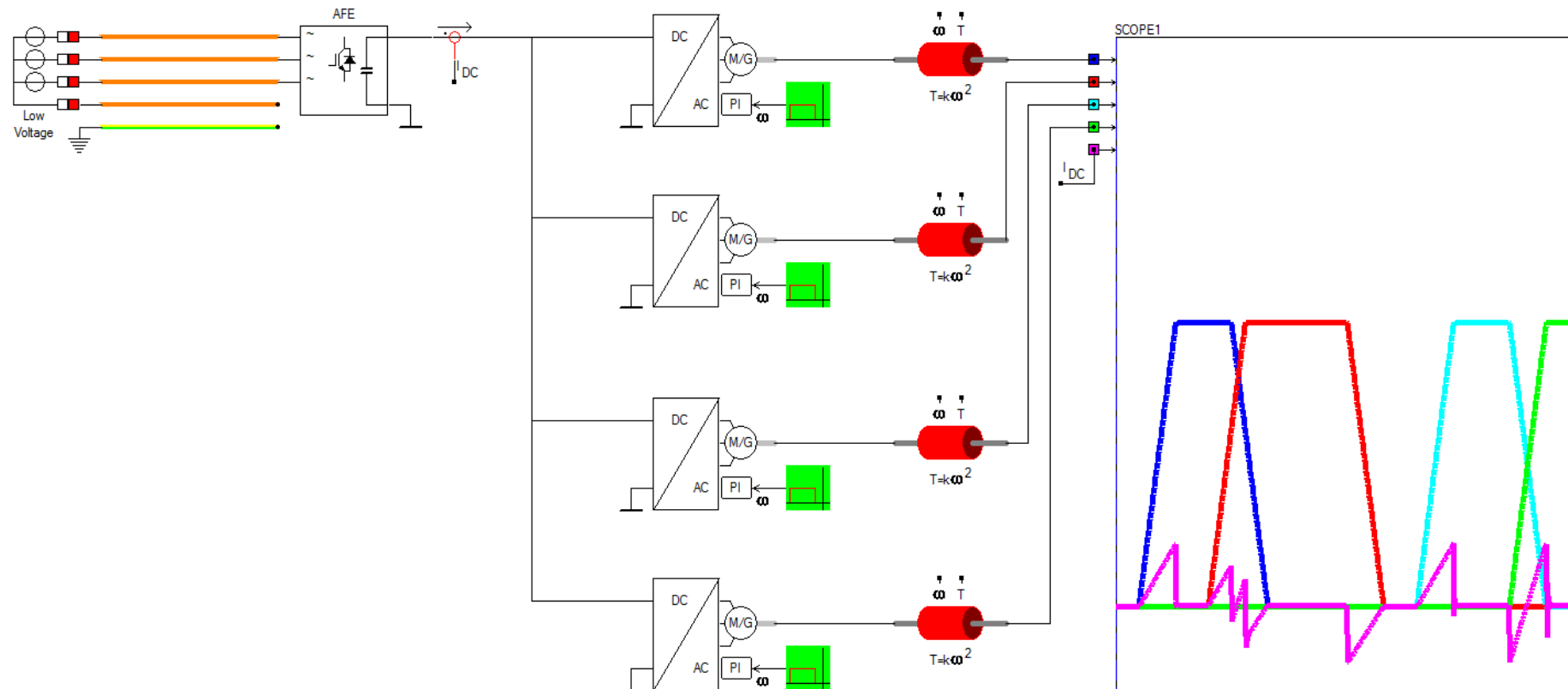
Maritime: Standard in new designs
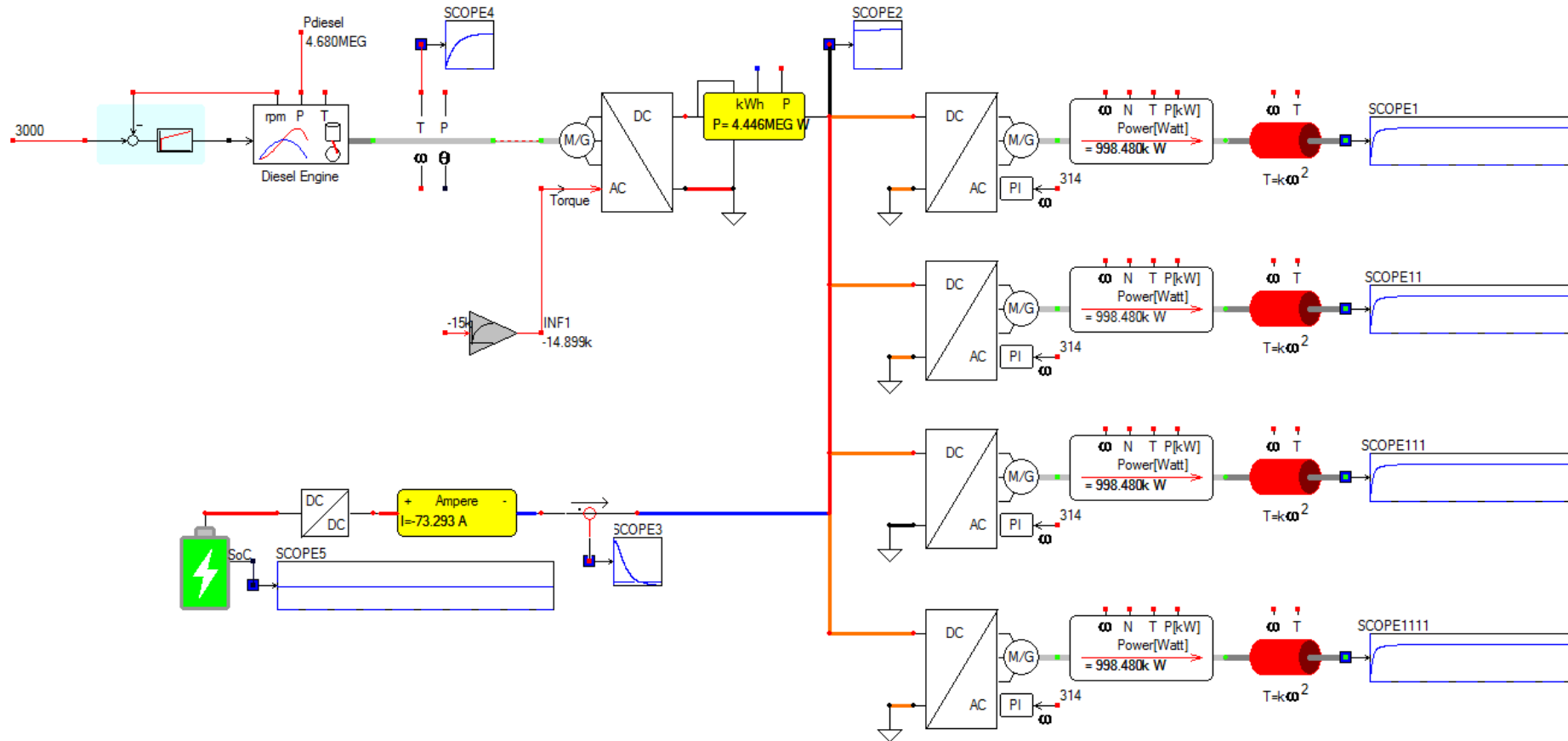
Vehicle2Grid?

- Technology
  - Ready

- Price
  - Same as the charger

- Acceptable?
  - What are you doing with my car?
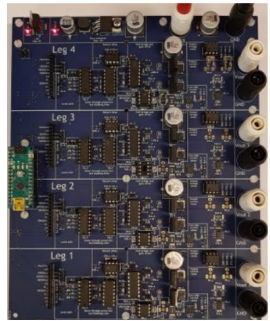 - Lifetime battery gets shortened

© Harry

Research & Education?

- Research
- Prototyping

- Education:MBO/HBO/WO
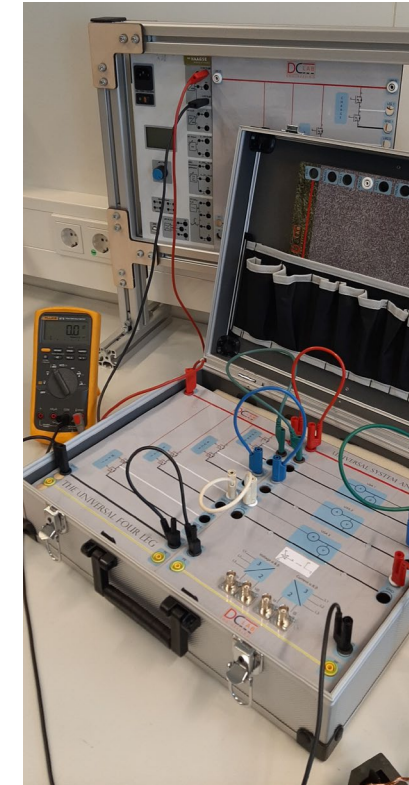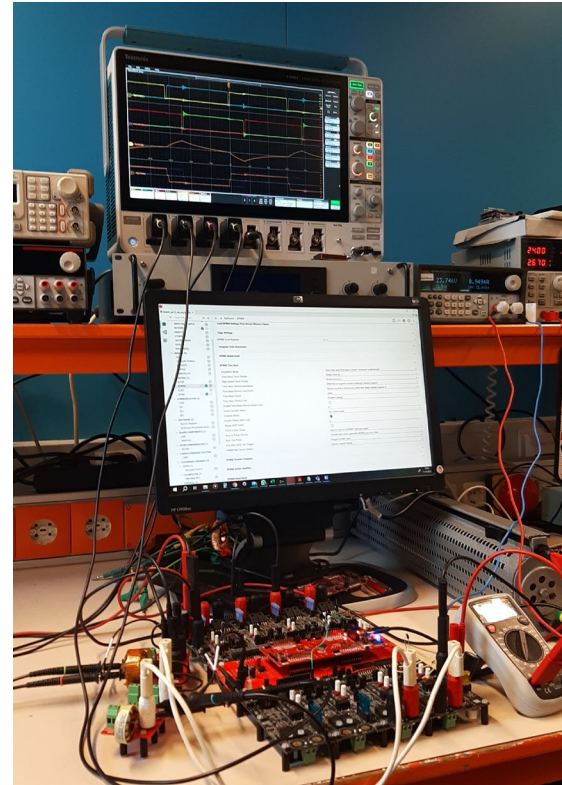
DC-Lab: Induction Hob

DC-Lab: Universal-Four-Leg U4L

U4L v.4
2019
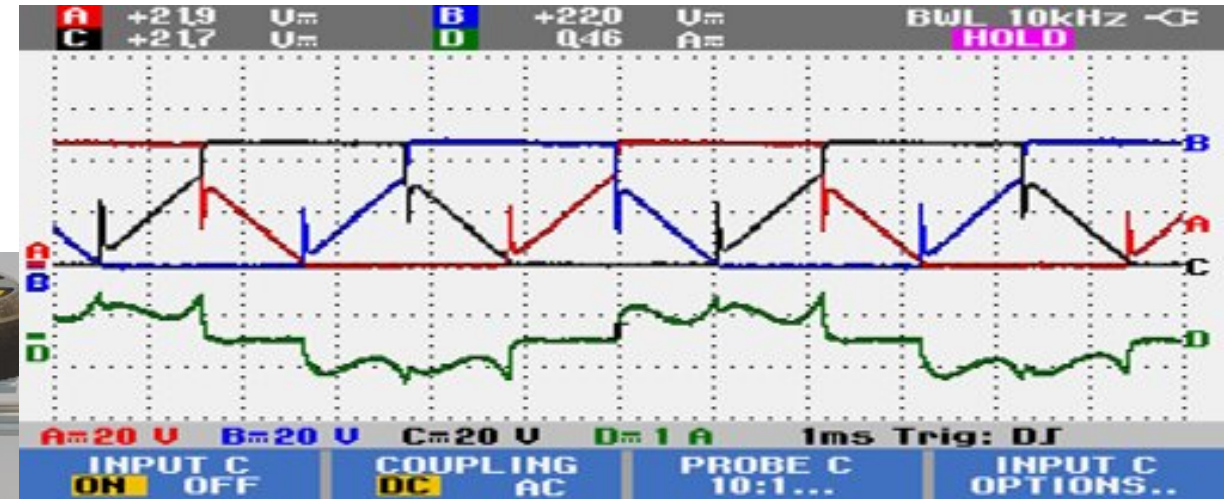
480W

U4L v.5
2020

600W

U1L
2021

600W
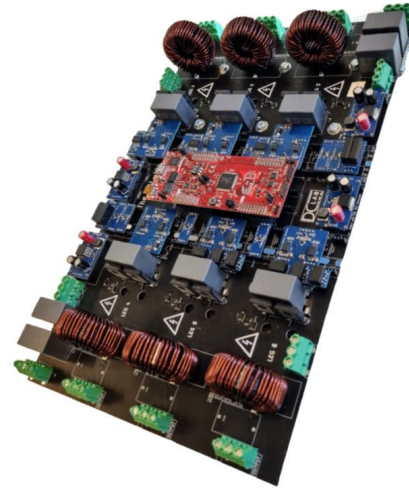
U6L
2022

15kW

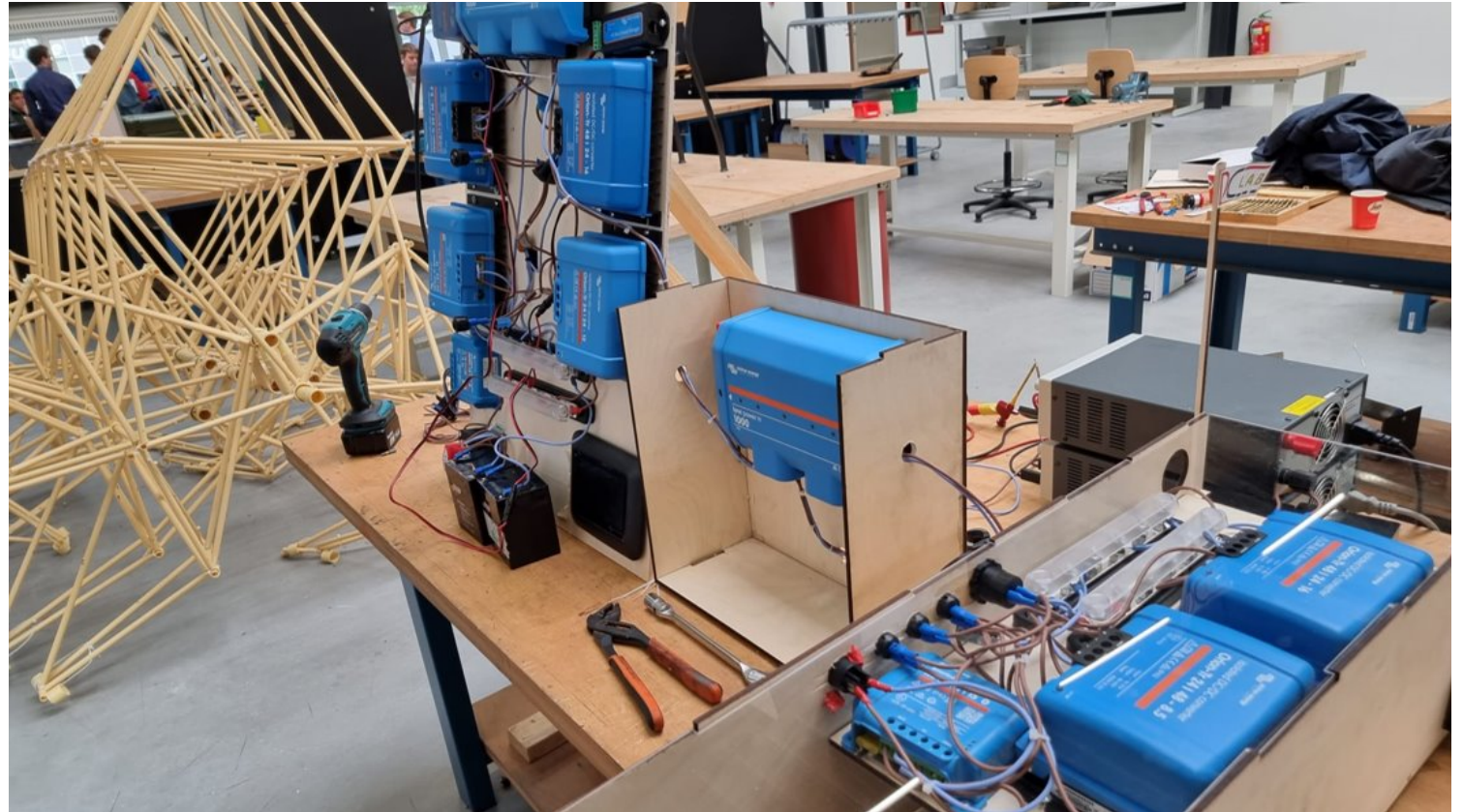**U4L over de tijd**

U4L 2023 1kW IoT
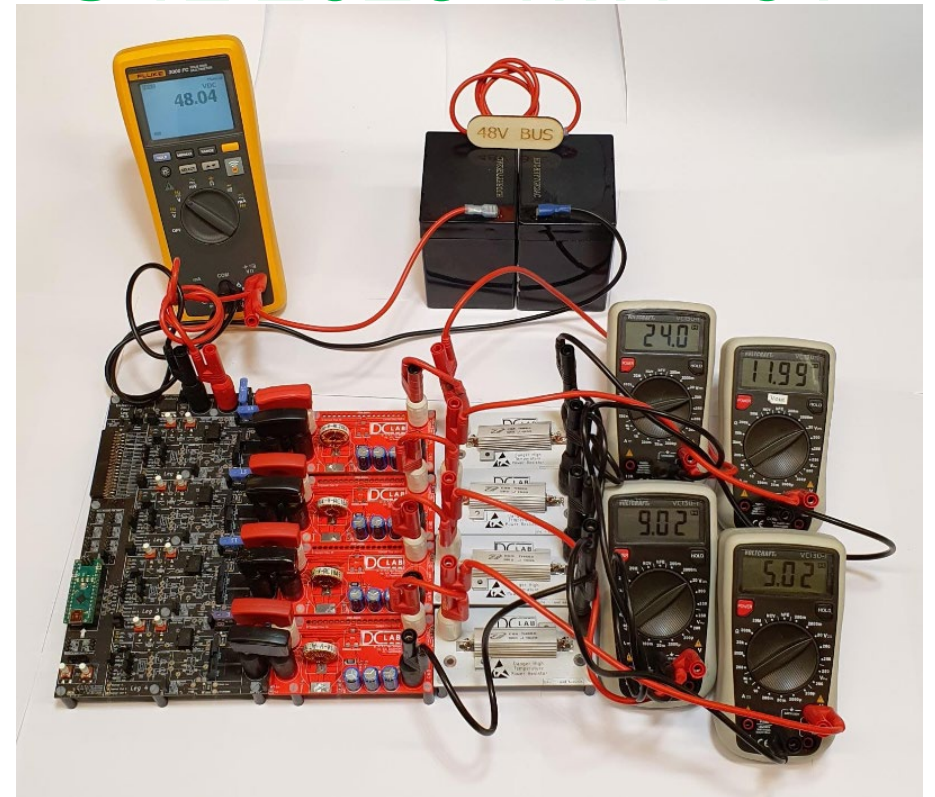
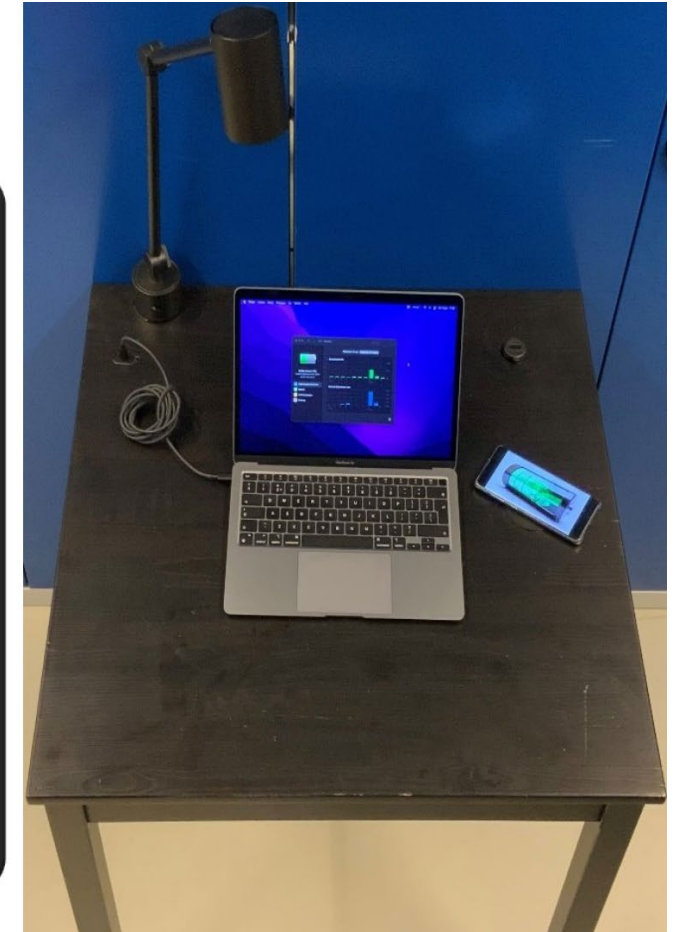# DC-Lab: Motor control
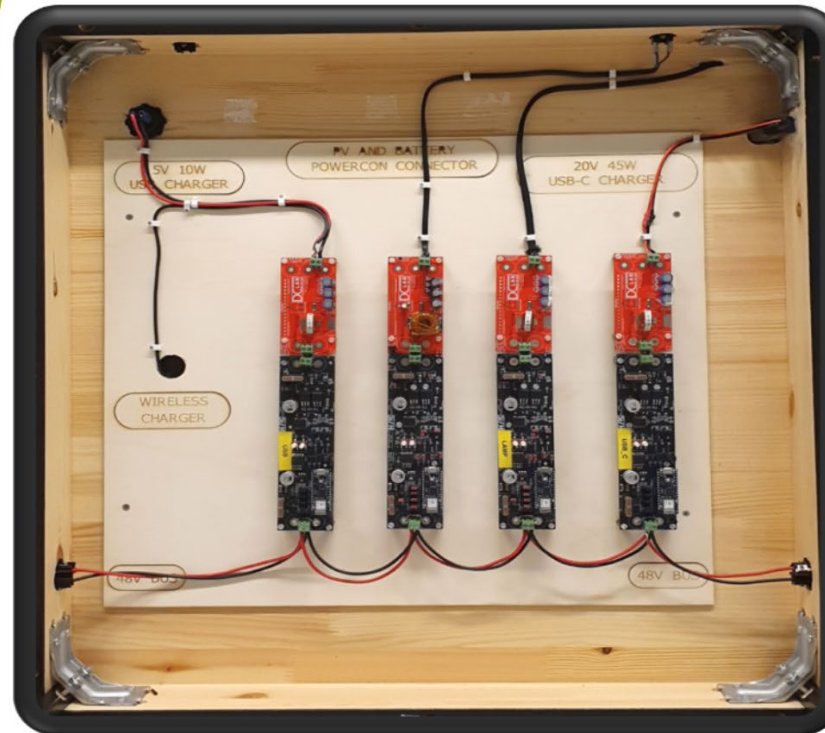
DC-Lab: Electric Kart
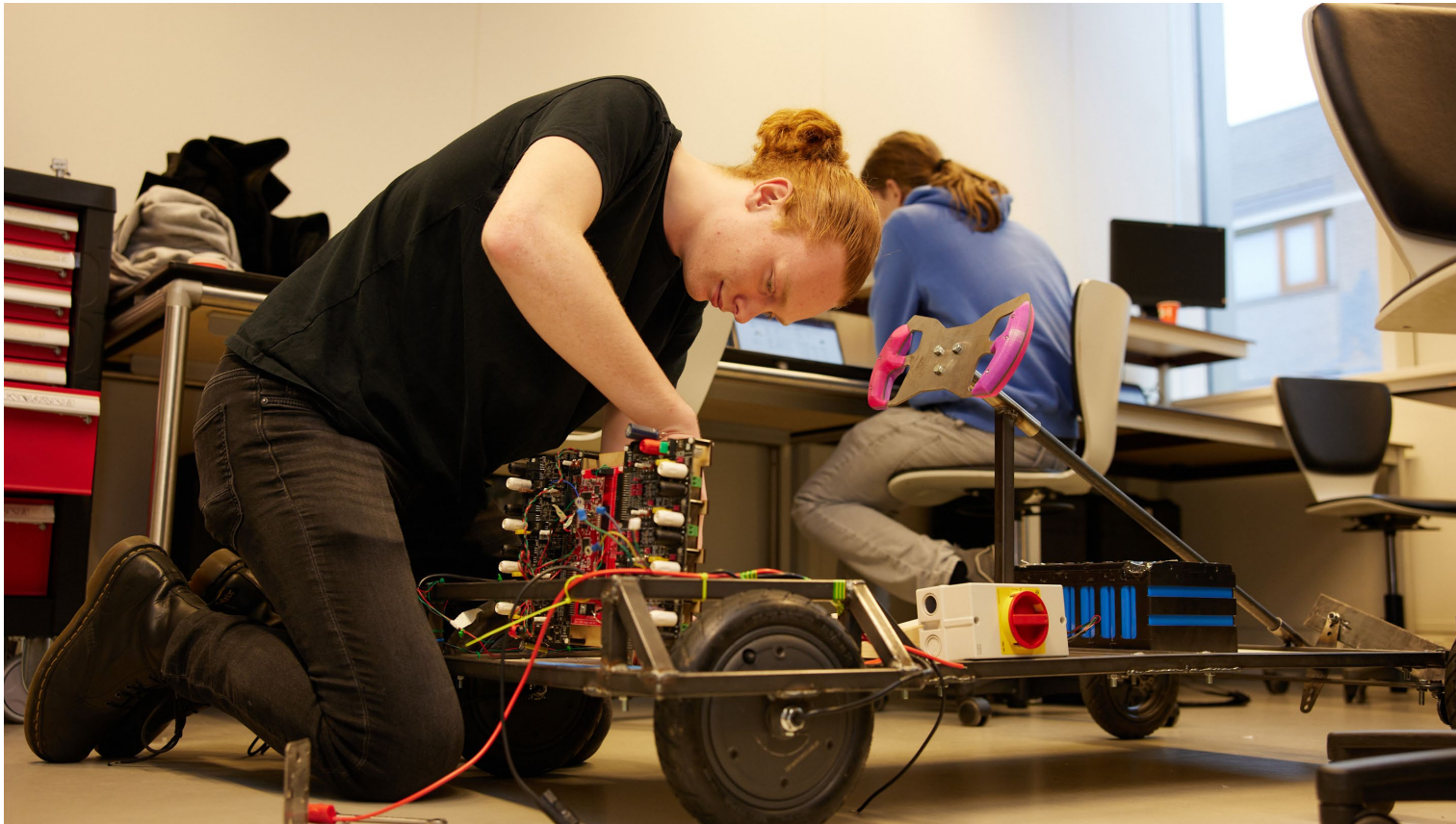
DC-Lab: DC Harbor

DC-Lab: Foodtruck with DC nano-grid

DC-Lab: DC-office table

DC Grid for Offices
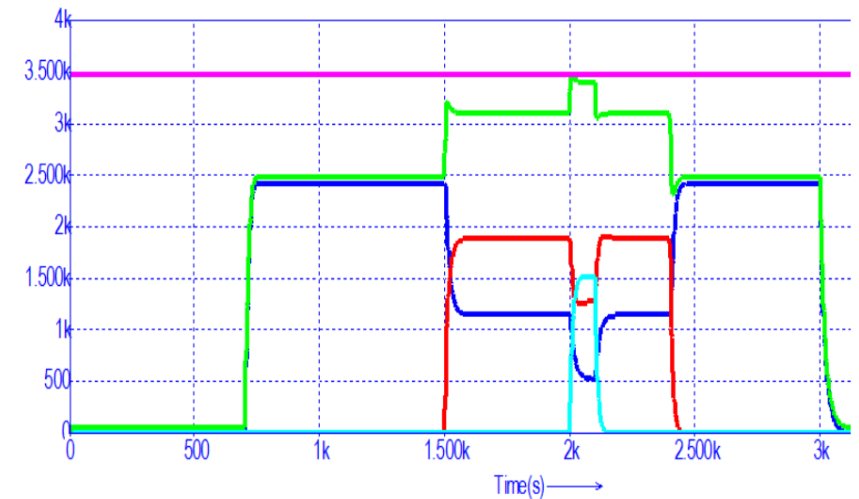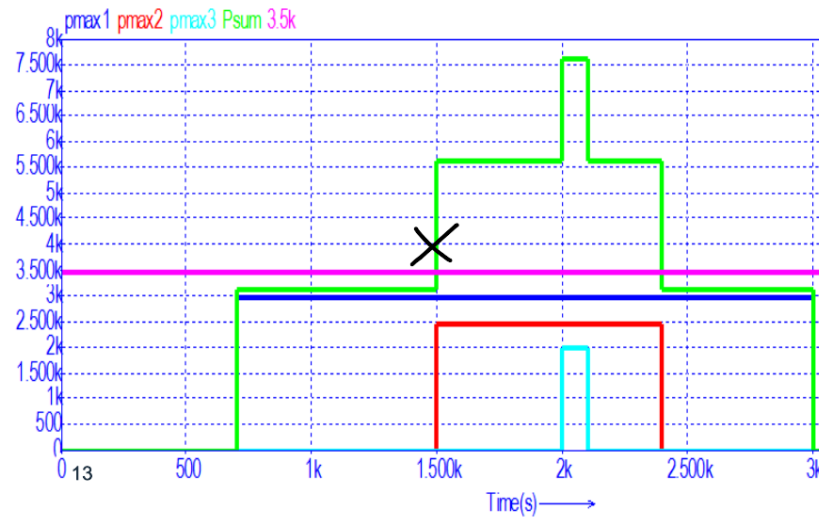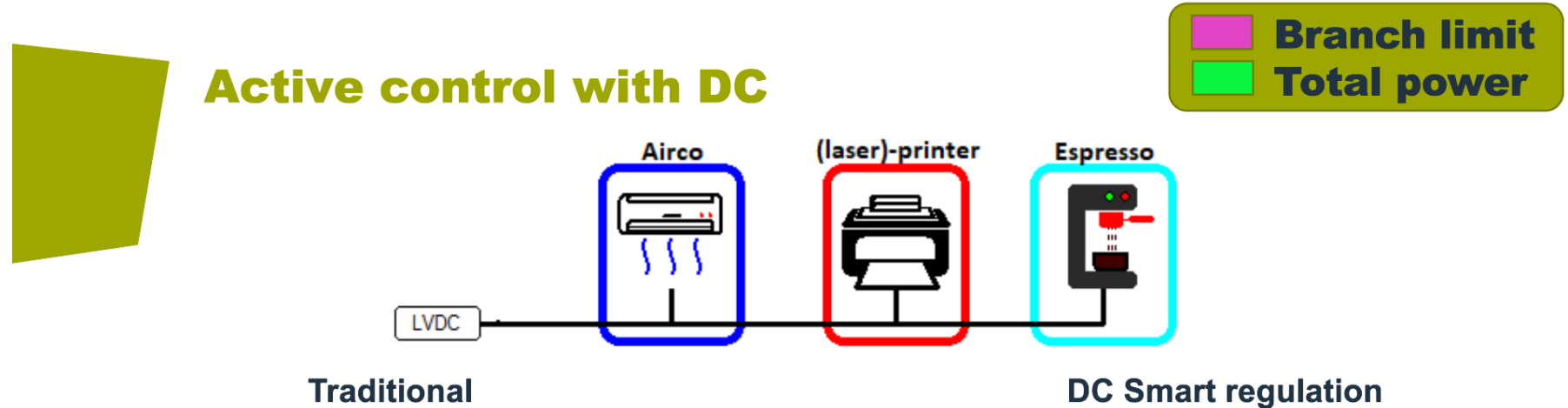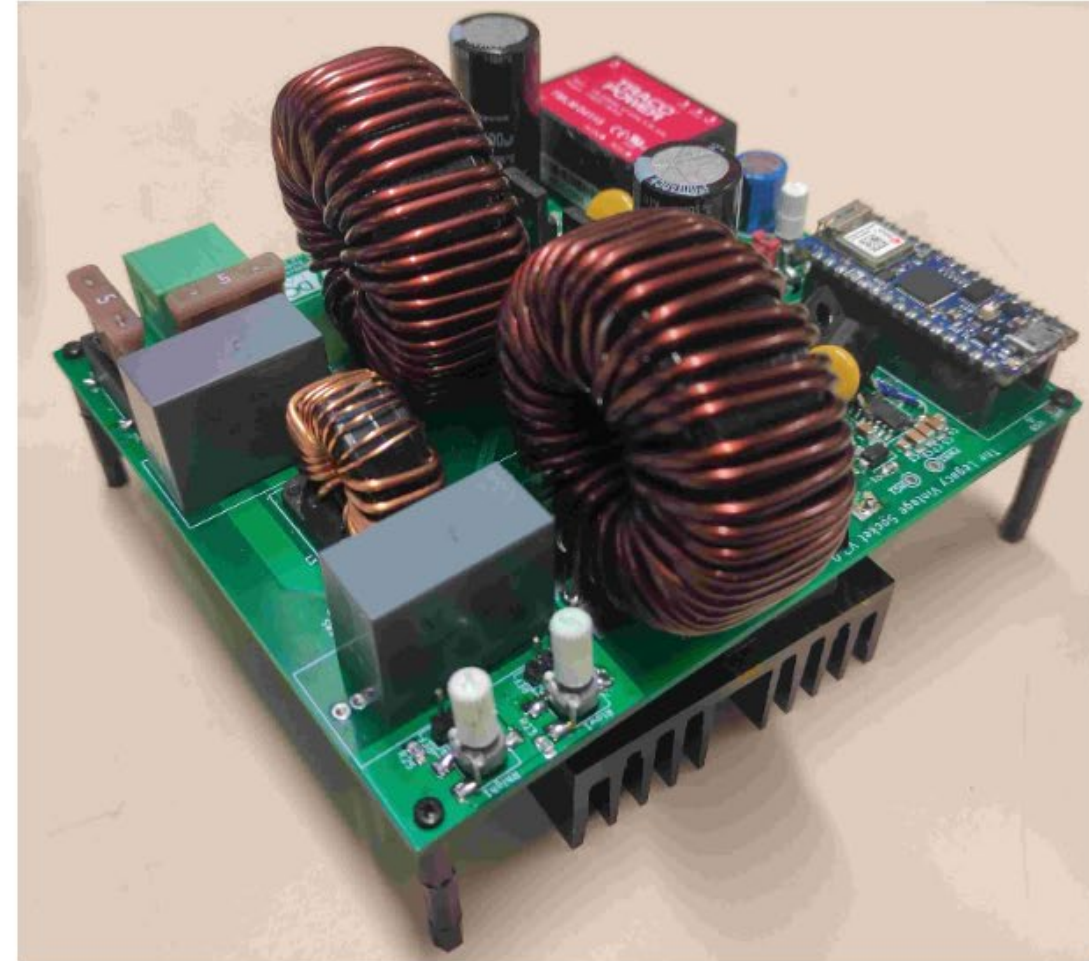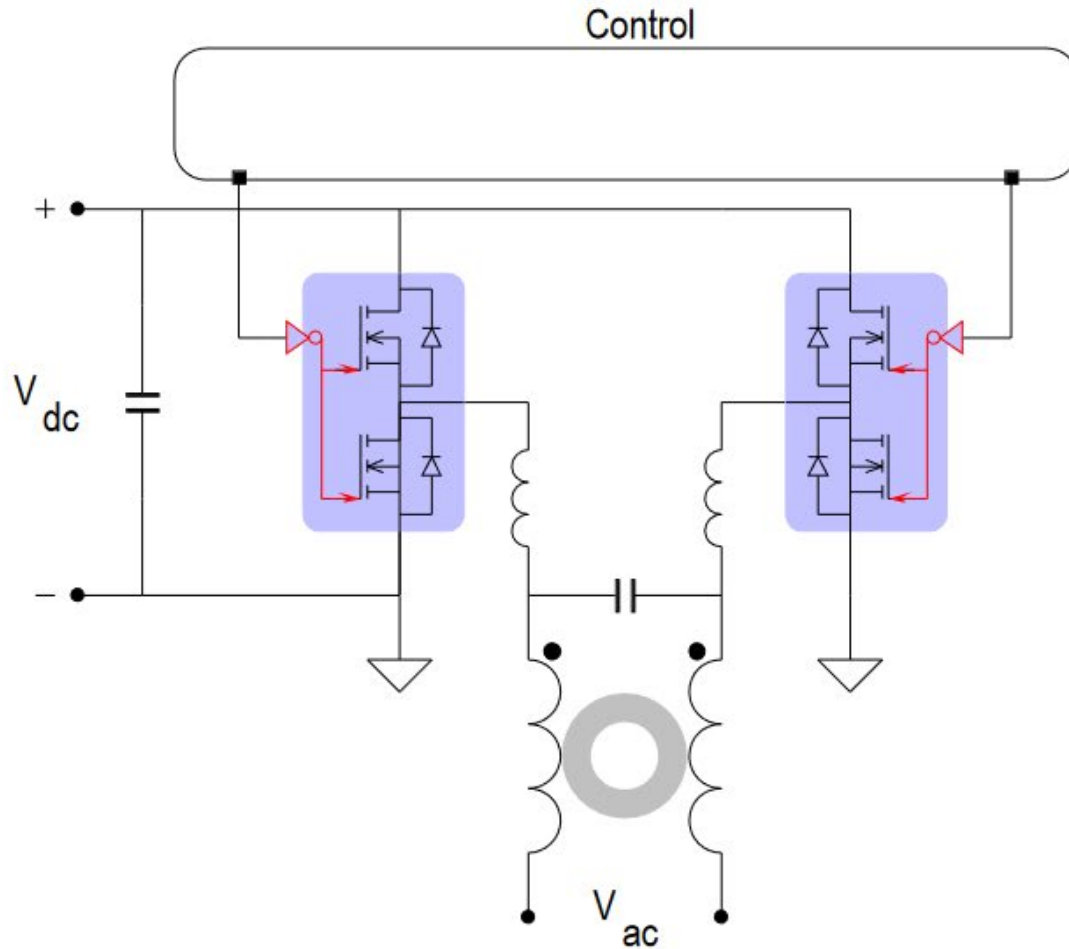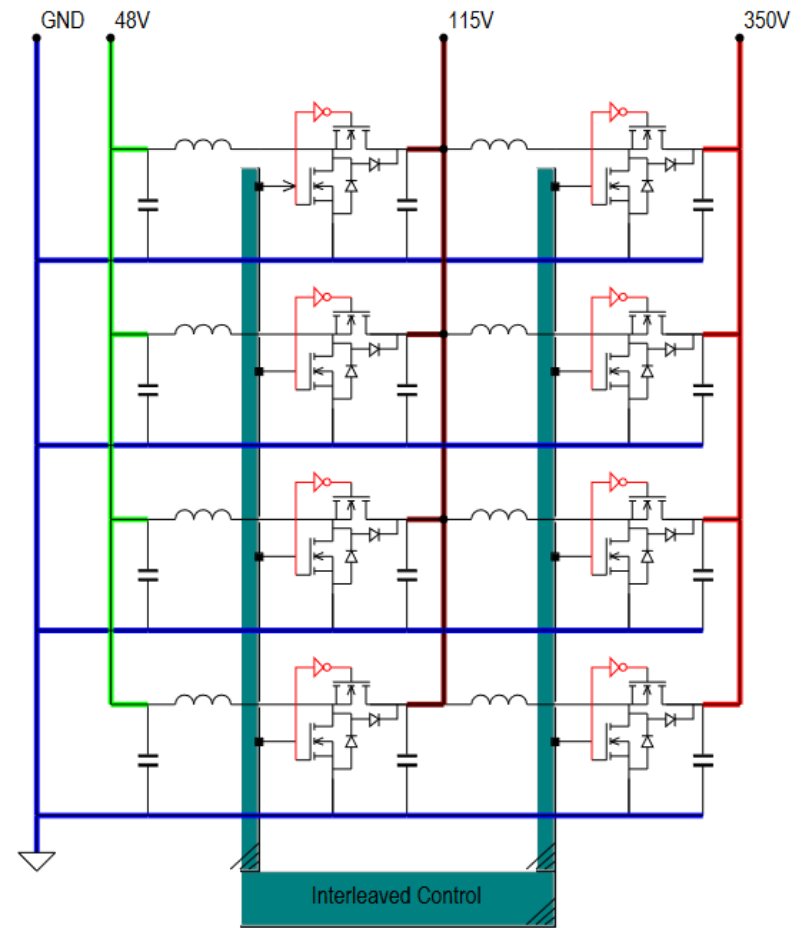
DC-Lab: Power Congestion Management
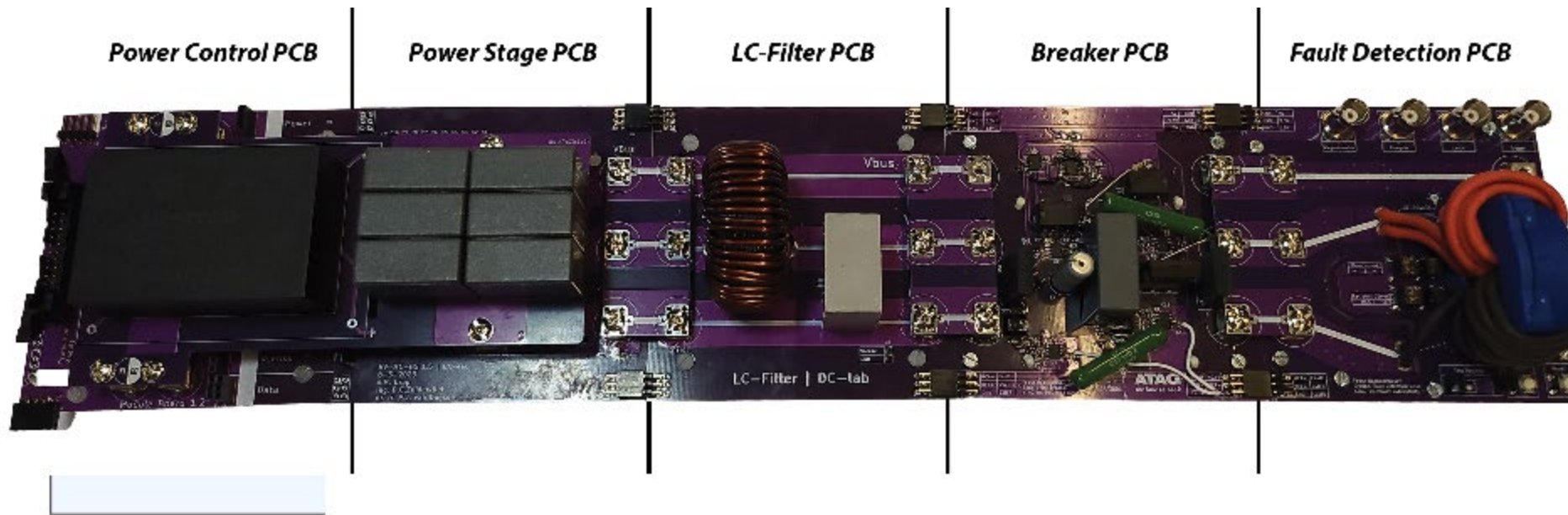
DC-Lab: Power Congestion Management

DC-Lab: AC Socket

DC-Lab: Interleaved Stackable Boost

DC-Lab: Fault detection

Power Control PCB | Power Stage PCB | LC-Filter PCB | Breaker PCB | Fault Detection PCB
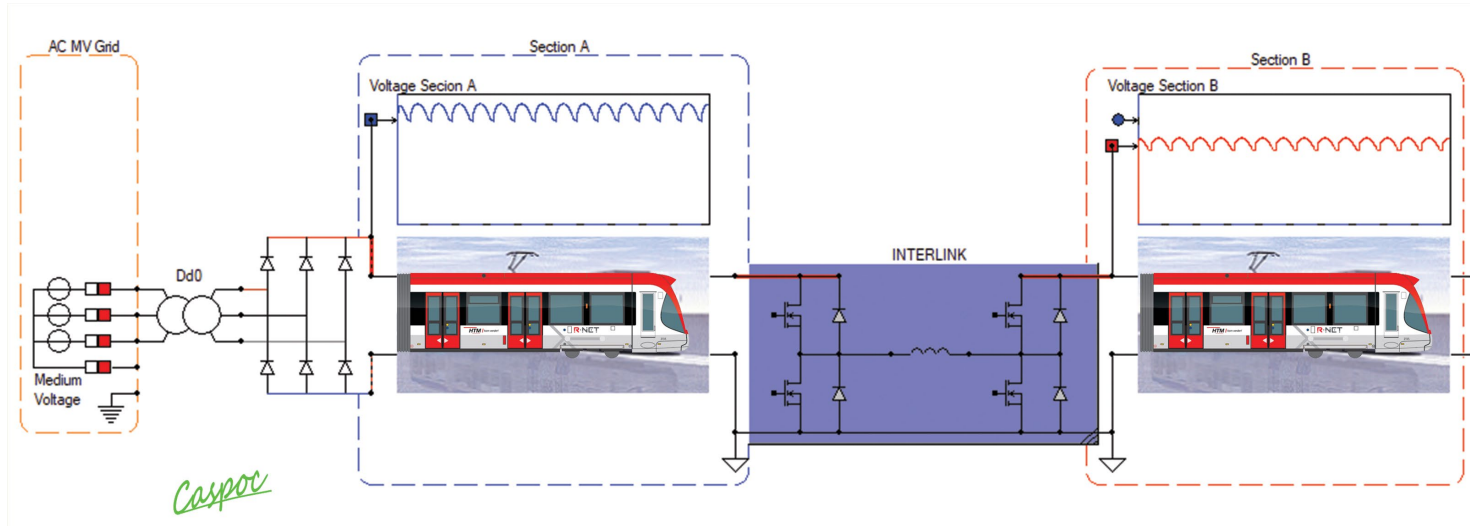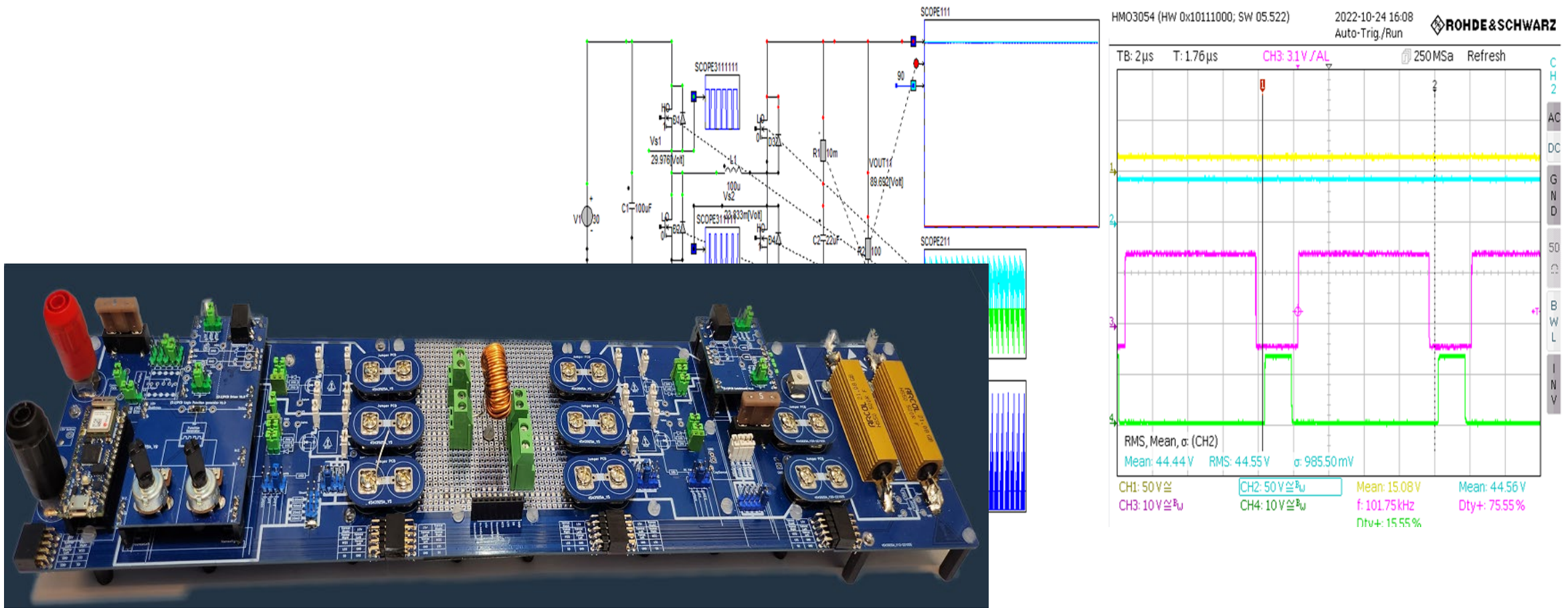
DC-Lab: Interlink to connect overhead lines
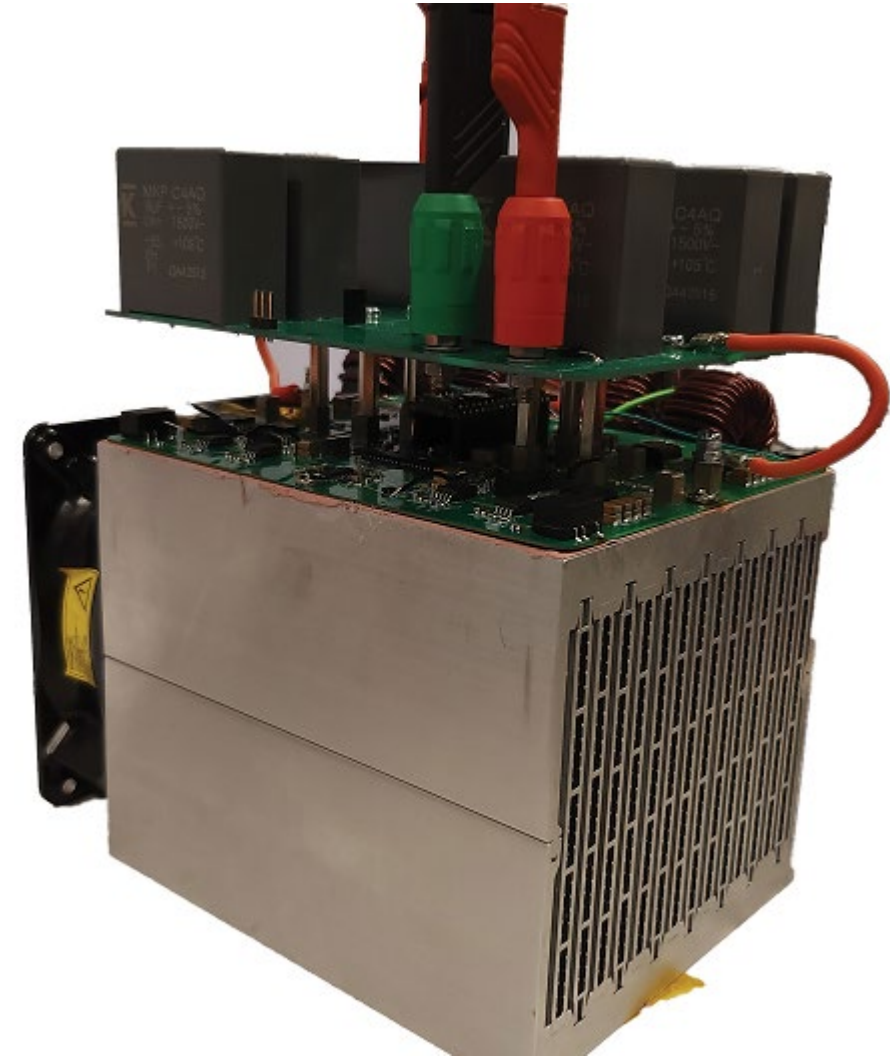
DC-Lab: Power Electronics Education

Conclusion:
Electric Energy Transition & DC Grid?

✓ Control

✓ Safety

Thanks for your attention!

www.dc-lab.org

www.caspoc.com