The electrical vehicle photovoltaic grid

Chandra Mouli, Gautham Ram; Huijbrechts, Paul

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Electric Vehicle supported PV smart grid (EV-PV)

Gautham Ram, TU Delft
Paul Huijbrechts, PRE

WORLD OF ENERGY SOLUTIONS
12.–14. Oktober 2015
Messe Stuttgart
BATTERY+ STORAGE | f-cell | e-mobil conference

PRE – Power Research Electronics BV

- 30 years of experience in **Power Electronics**
- Development, Certification & Production
- 20 specialists (R&D)

PRE – Power Research Electronics BV

WAKA WAKA : Mini solar LED lamp + USB charger

PRE

PRE – Power Research Electronics BV

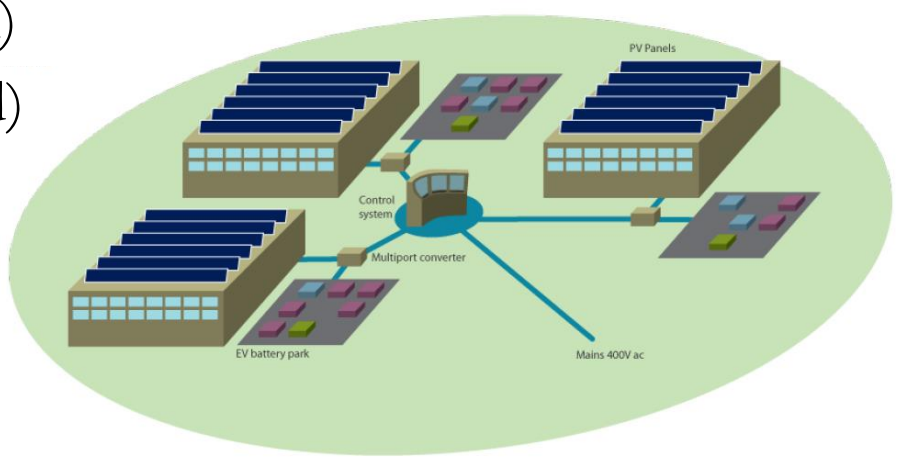
DC fast charger for EV

- 50kW fast charger (50..500V DC / 125A DC max)
- Setpoint generated by BMS
- Chademo / Combo certified

EV-PV Project

Electric vehicle supported PV smart grid

- Bi-directional converter for EV (V2X)
- Integration of PV and EV (Smartgrid)
- For Industrial areas



www.pr-electronics.nl/en/news/31/all-new-10kw-v2x-charger-module/

TU Delft PRE ABB

tki switch 2 smartgrids

DCE&S Group - TU Delft

- DC systems, Energy conversion & Storage
- Head of Group : Prof.Pavol Bauer
- >50 members in group

DCE&S

DC systems, Energy conversion & Storage

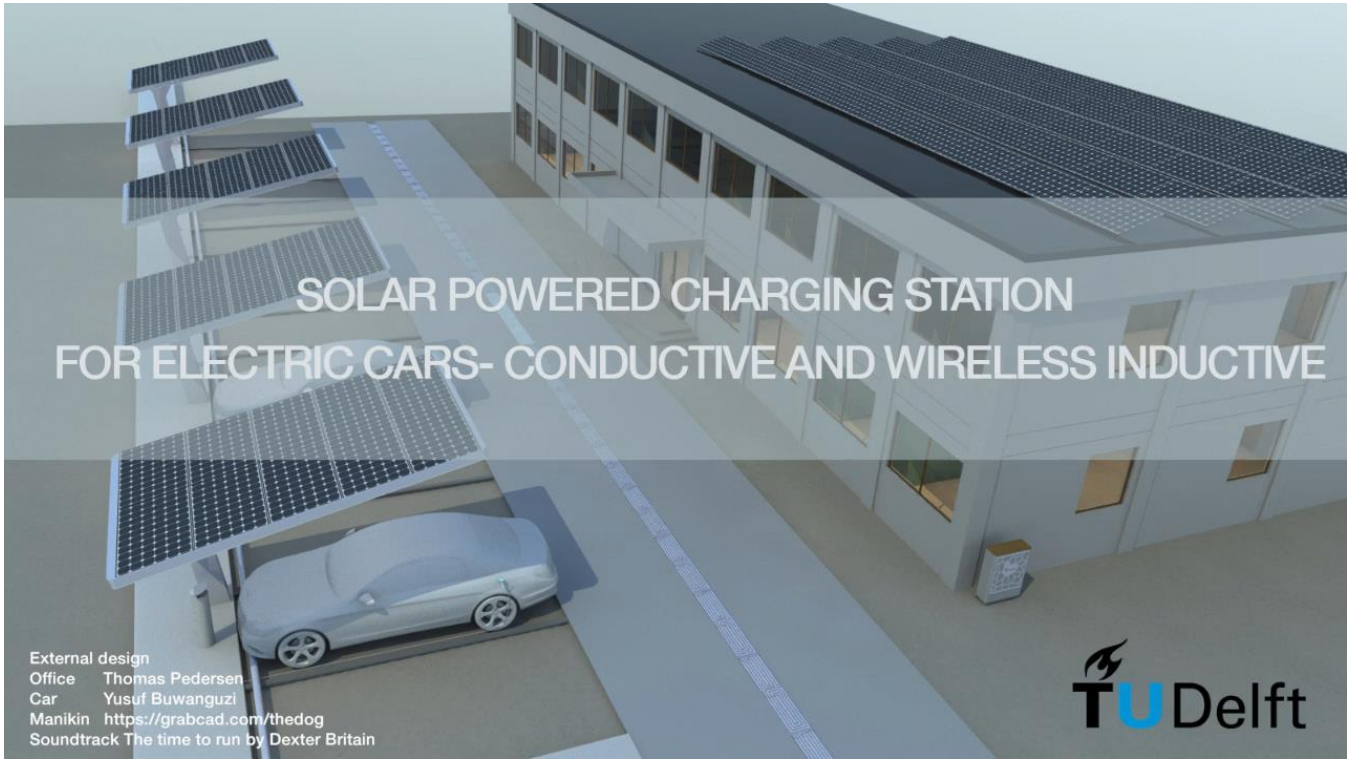
Key Research areas

- Electric vehicles – Wireless charging, EV-PV
- DC microgrids
- PV systems
- Electric machines
- HVDC and Wind system design & optimization

http://www.dcs.ewi.tudelft.nl/

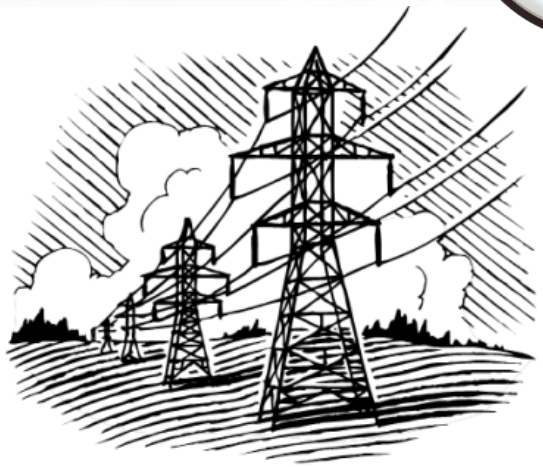
RESEARCH GOAL

- Develop a highly efficient, modular, V2G-enabled smart charging station for electric vehicles that is powered by solar energy.



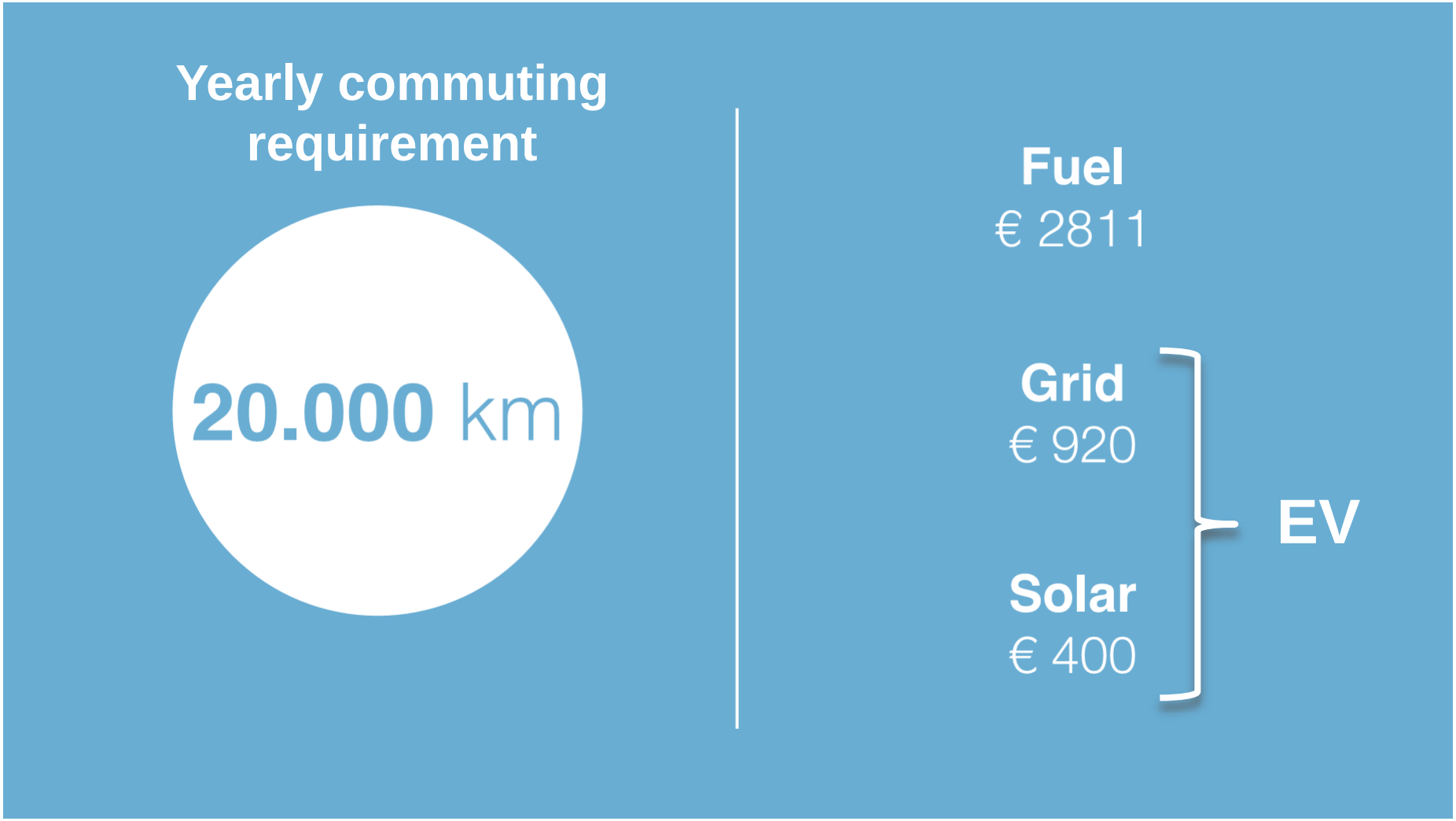
View video - www.youtube.com/watch?v=4Baz_QXowhU

Motivation



* Images taken from the internet

Motivation


Yearly commuting requirement
20.000 km
Fuel
€ 2811
Grid
€ 920
Solar
€ 400
EV

EV CHARGING USING PV

EV-PV charger - Charging level, mode and type

- Level 2, Mode 4, Type 4 - DC charging of upto 10kW
  - CHAdeMO [Maximum upto 50 kW]
  - Combined charging system (CCS) [Maximum upto 100 kW]

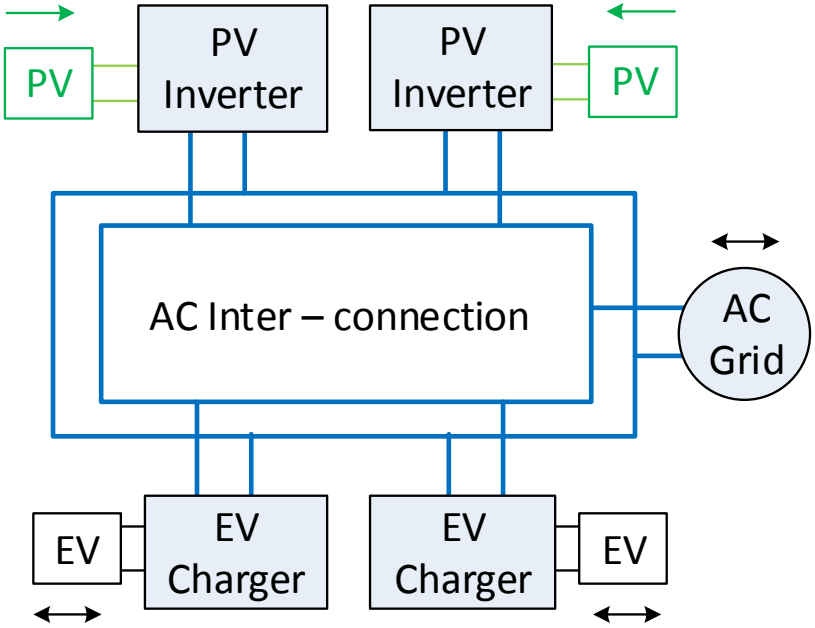
- 10kW*(8h) = 80kWh delivered to EV
- 10kW V2G possible as per CHAdeMO proposal

Type 4 CCS plug

Type 4 CHAdeMO plug

System architecture

AC interconnection of EV and PV



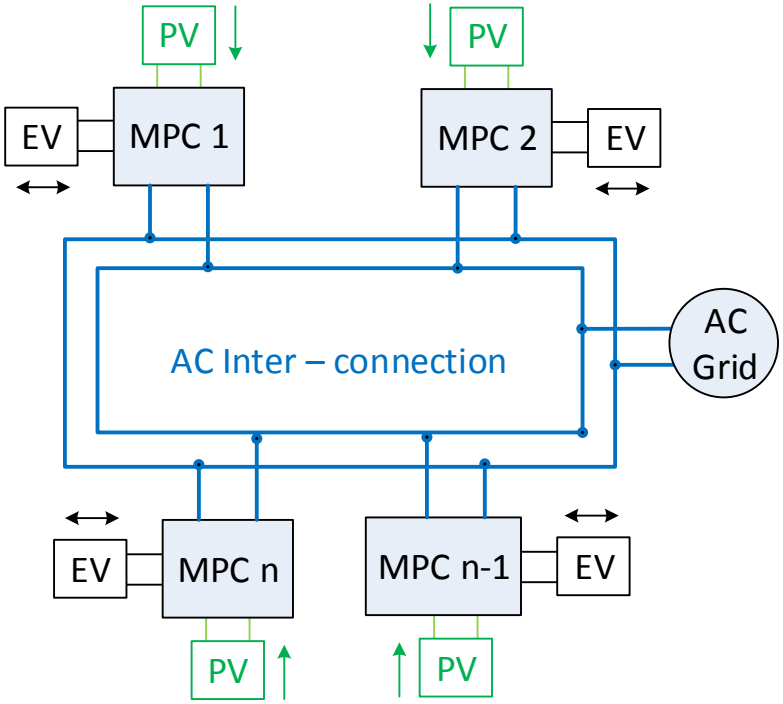
PV Inverter

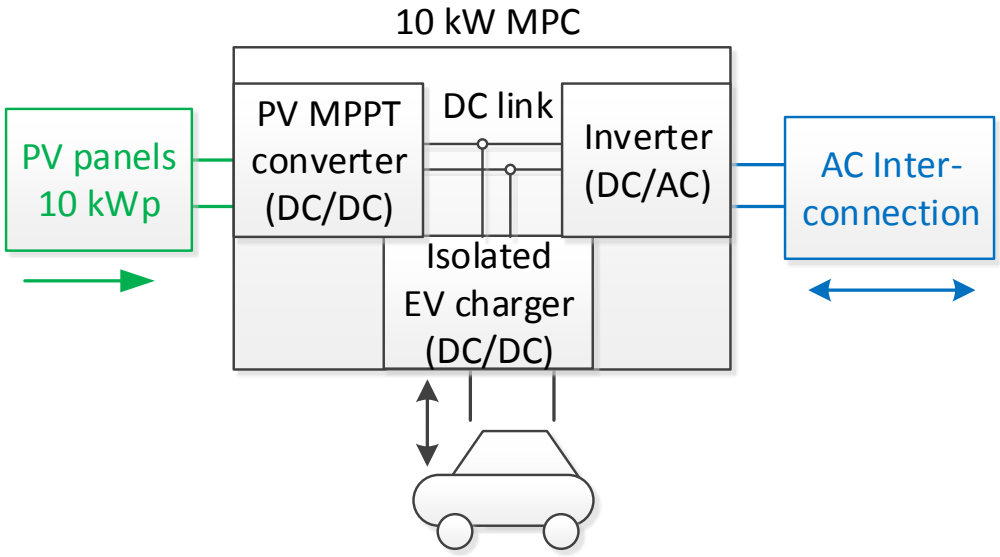
EV Charger

System architecture

DC interconnection of EV and PV

- Only one DC/AC converter → Lower cost of converter
- DC-DC connection of EV-PV → Improved efficiency





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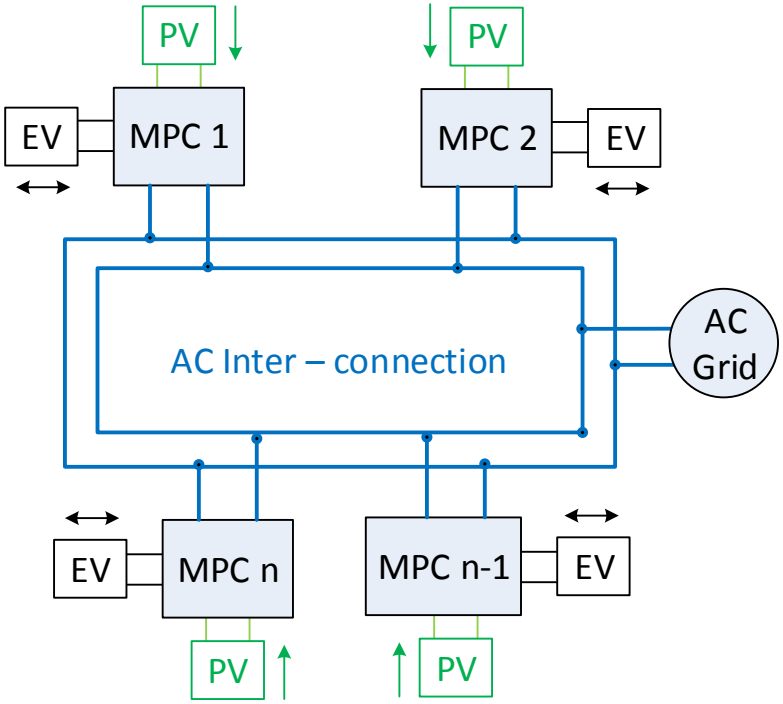
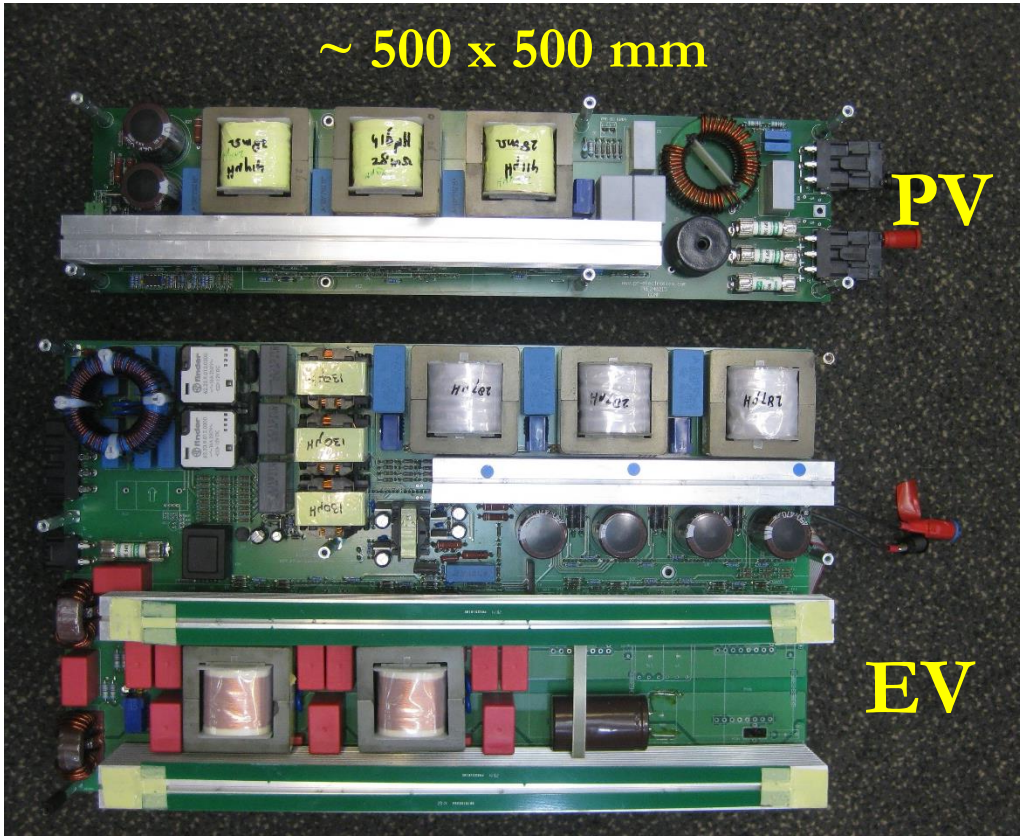
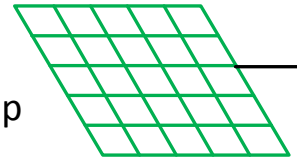




EV-PV POWER CONVERTER

EV charging
10kW
200-500V, 30A max.



DC/DC
Converter
(MPPT)

DC/AC
(High f)

AC/DC
(High f)

DC link

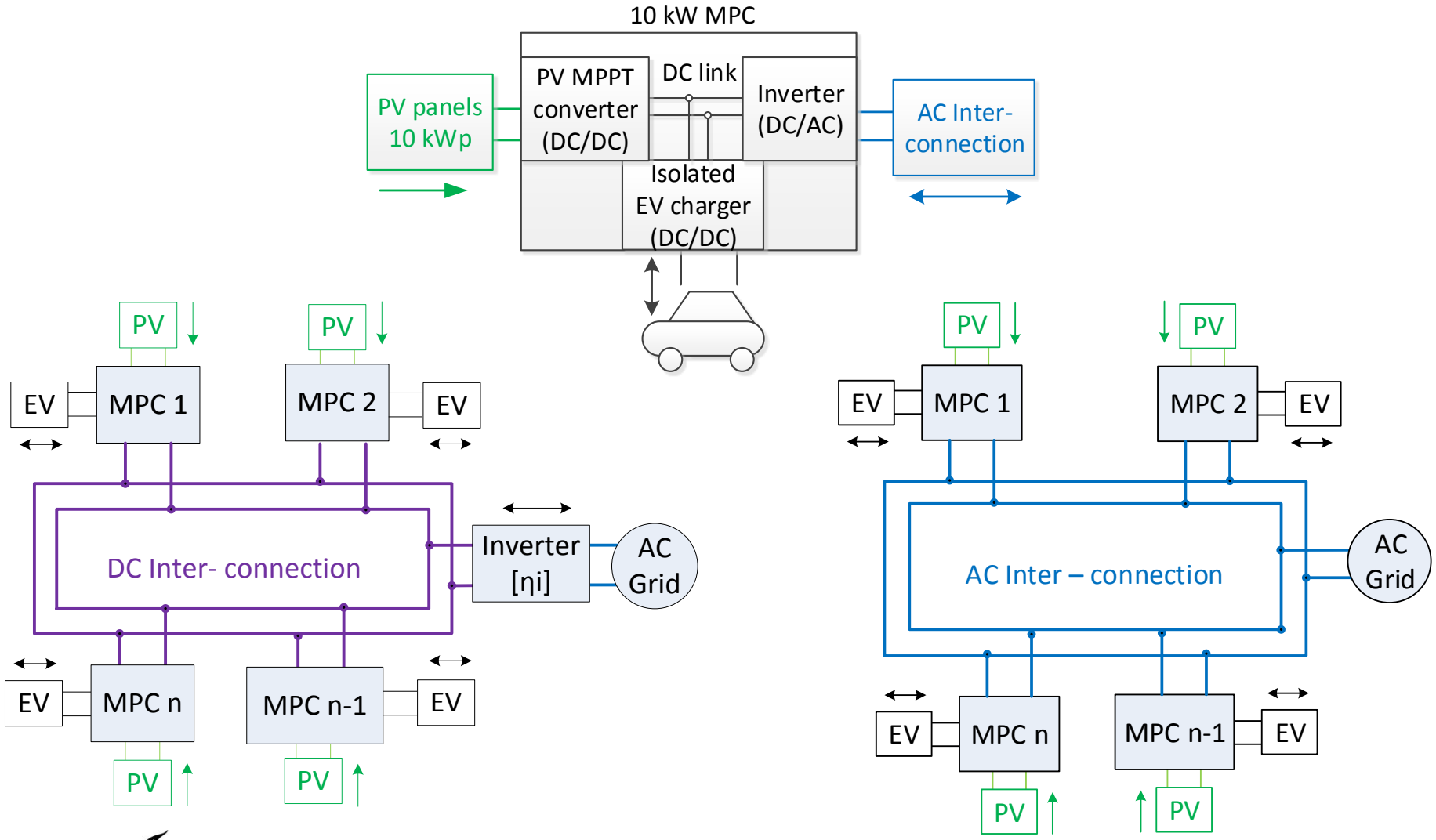
3 Phase
DC/AC
VSI

3 Phase AC
400V, 16A

Isolated DC/DC converter

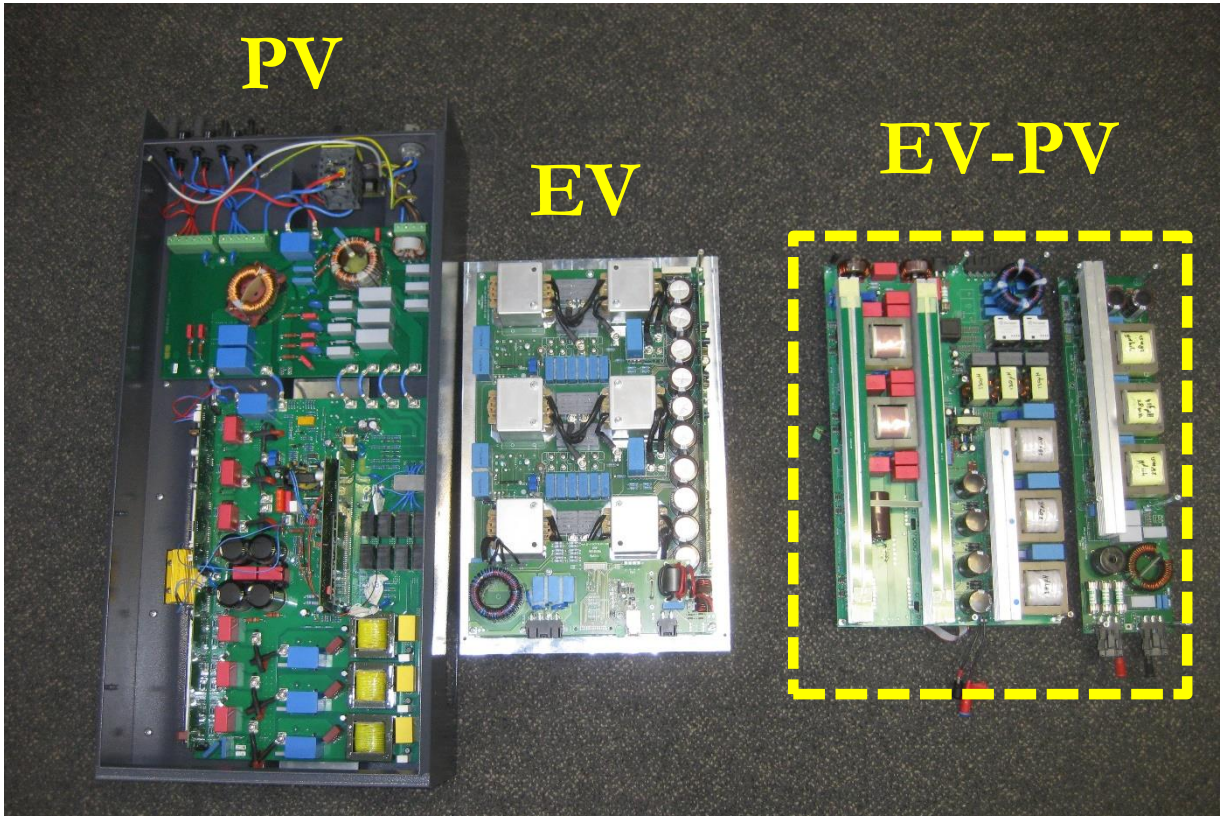
System architecture

Future ready for DC grids



EV-PV POWER CONVERTER

1. Higher power density
2. Higher efficiency
3. Bidirectional EV charging



EV-PV POWER CONVERTER

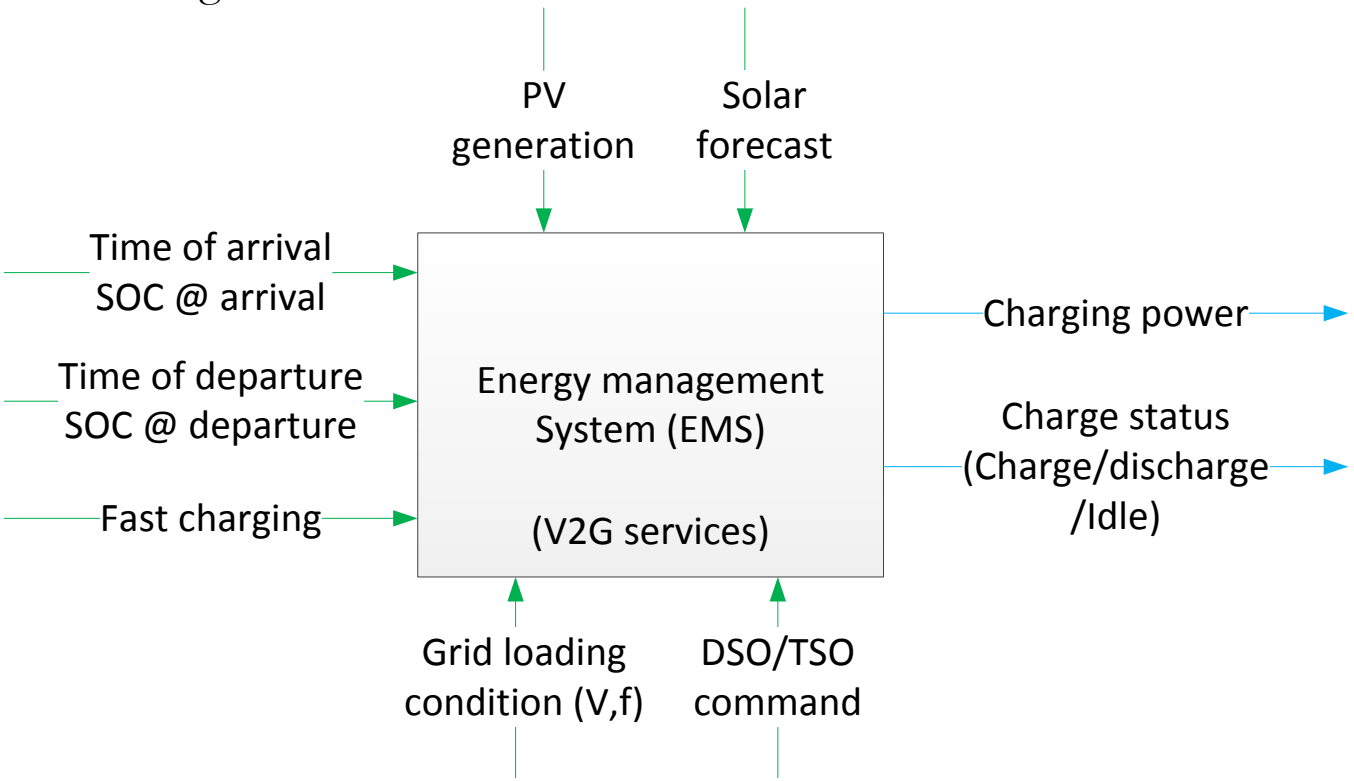
1. Higher power density
2. Higher efficiency
3. Bidirectional EV charging

1.	SiC switches	→ Possibility to use 1200V MOSFETs
2.	SiC schottky diodes	→ 1200V diodes with low losses → No reverse recovery
3.	KoolMu core	→ High saturation flux density → Low core losses → Gradual loss in inductance with mmf
4.	Packaging	→ Better thermal management

Energy Management System

Functions of EMS

1. Dynamic charging of EV based on PV
2. V2G – Primary, secondary frequency control
3. Dynamic grid price based V2G
4. Solar forecasting



THANK YOU

Further questions ?