Bachelor Course Development on Electrical Energy Transition.

THUAS Delft, The Netherlands
P.J. van Duijsen(presenter), D.C. Zuidervliet

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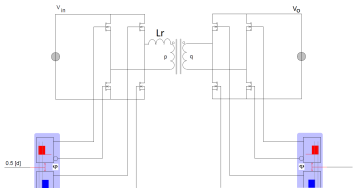
Introduction

Task:
Teaching the Electrical Energy Transition

- Generation
- Storage
- Transport&Distribution
- Appliances



Power Electronics is required

Applications

Typical applications include:

- Solar
- Battery storage
- Wind turbine
- Grid (AC & DC)
- Electric vehicles

Techniques

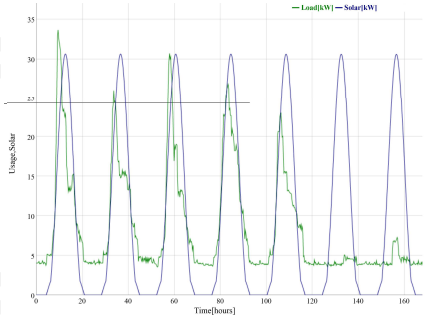
Typical techniques include:

- Power Electronics for DC-DC converters
- Power Electronics for inverters
- Electrical Machines and Control of Drives
- Field Oriented Control [FOC], for drives
- Voltage Oriented Control [VOC], for AC grid interfacing

Solar

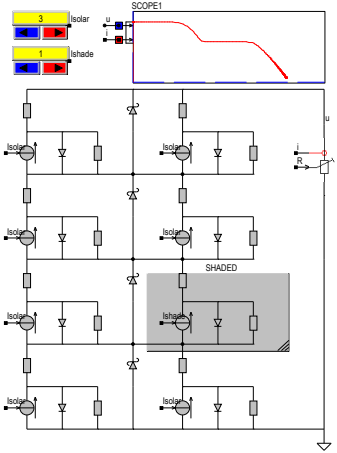
Solar Panel Irradiance (E_0=1360[W/m^2])

Tilt angle	gamma	40	[Deg]
Azimuth	alpha	0	[Deg]
Solar panel area (1kWh ~ 3*1.8m^2)	Area	1000	[m^2]
Efficiency, (Average quality)15% - (High quality)20%	Eff	16	[%]
Albedo Factor:water=0.05, Concrete=0.2, snow=0.9	albedo	0.05	[.]
Location			
Latitude(North/South)	latitude	52.373	[Deg]
Longitude(West/East)	longitude	4.8923	[Deg]



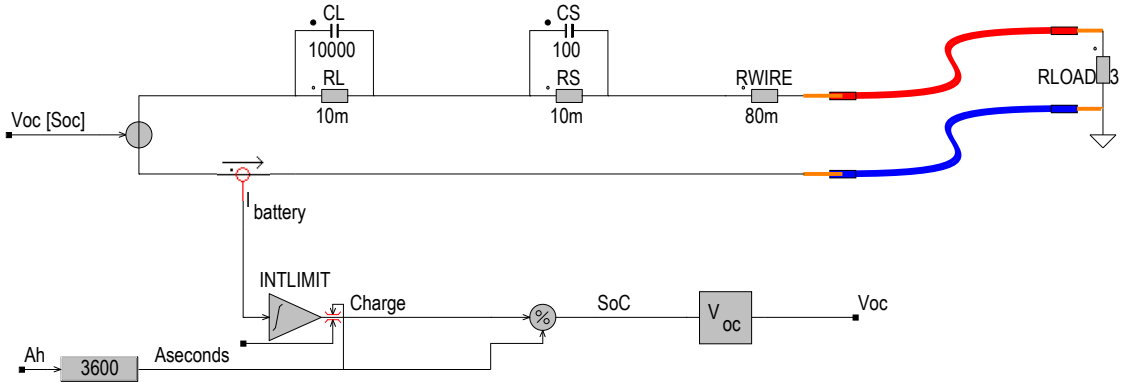
Solar and consumer profile in Caspoc-Online

Solar



Simulation of a solar panel with shadow

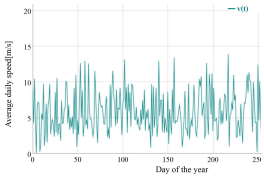
Storage



Internal simulation model of a battery, to better understand the transient response and the charging and discharging losses

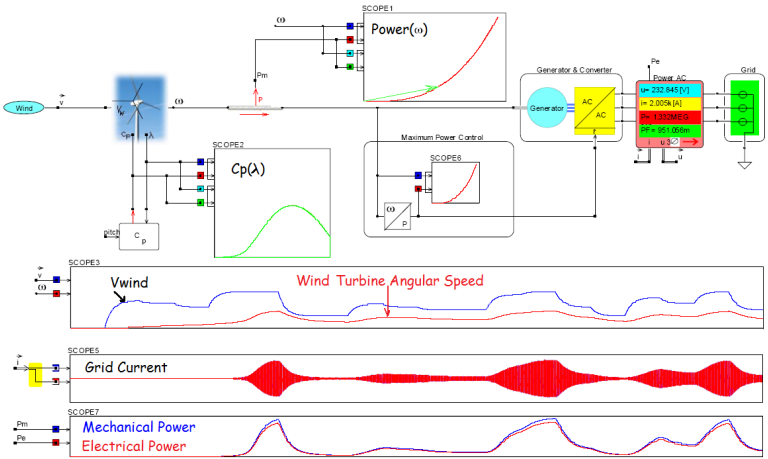
Wind

Wind speed			
Average wind speed at h=10m	v10	4	[m/s]
Air temperature	T	20	[˚C]
Turbine			
Rotor blade length	R	40	[m]
Rotor swept area(if set >0, overrules R)	A	0	[m^2]
hub hight	h	100	[m]
Wind hight factor	ha	0.16	[.]
Rotor Power Coefficient			
Power coefficient Cp	Cp	0.4	[.]
Cut-in wind speed	CutIn	3	[m/s]
Rated wind speed	Rated	12	[m/s]
Cut-out wind speed	CutOut	30	[m/s]



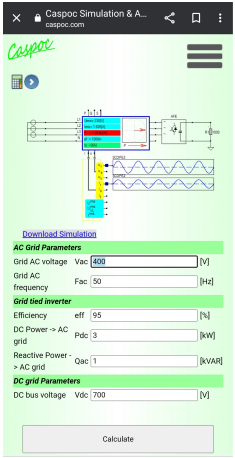
Creating a stochastic wind speed profile from typical wind speed parameters. The wind profile is then used in the simulation of the wind turbine in Caspoc-Online.

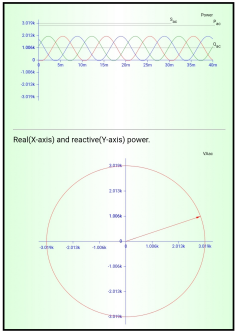
Wind



Simulation in Caspoc of controlling the torque generated by the generator, to optimize the turbine operation for various wind speeds

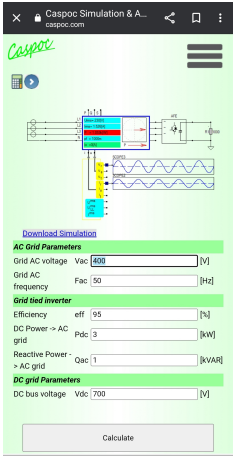
Distribution AC





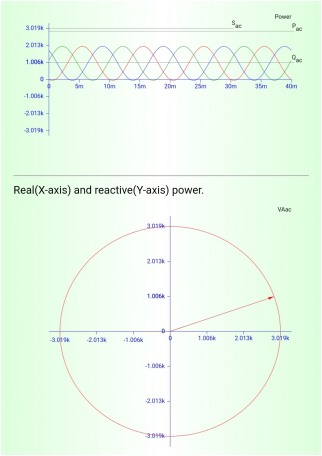
Calculation of real P and reactive power Q in a three phase Active Front End [AFE] and visualization using graphs and phasor(right) in Caspoc-Online

Distribution AC



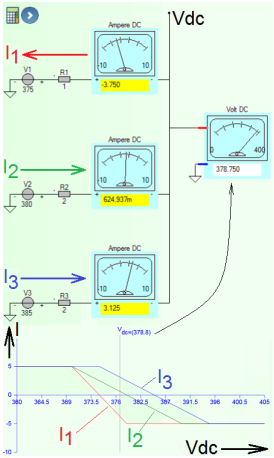
Calculation of real P and apparent power Q in a three phase Active Front End [AFE]

Distribution AC

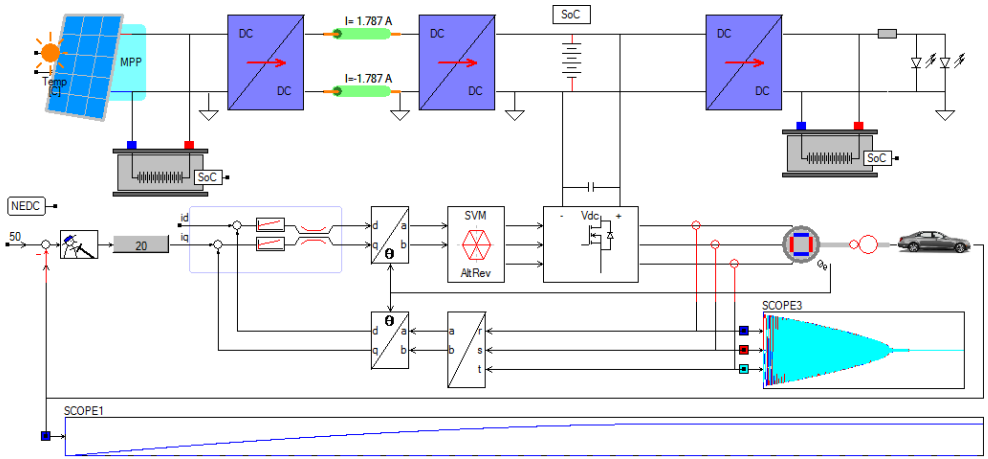


Visualization of real and apparent power in a three phase Active Front End [AFE]

Distribution DC

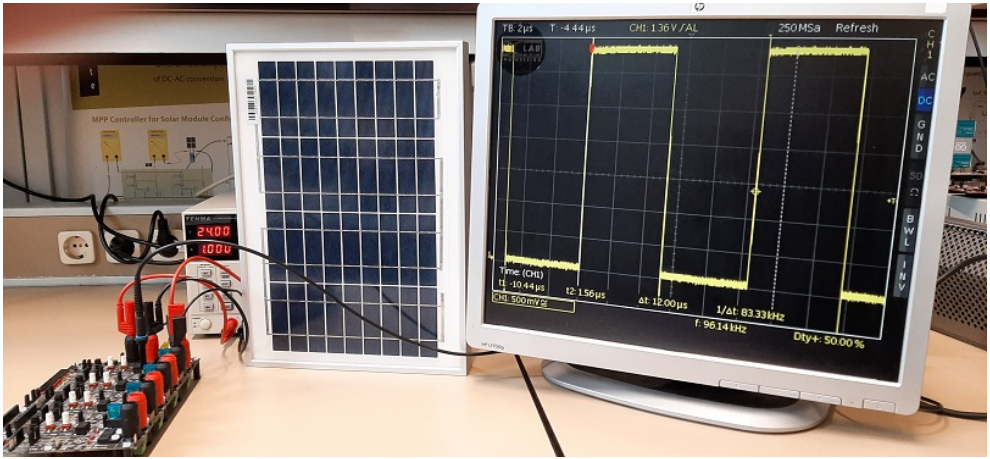


Simulation in Caspoc-Online, of droop control.



Simulation of an electric vehicle and battery usage. FOC in the motor drive is combined with solar power and battery charging in a single simulation in Caspoc

Hardware Trainer



MPP control of a solar panel using the U4L. The solar current is varied by the U4L to obtain the maximum power point in the solar panel characteristic.

Conclusion

- Power Electronics is key
- Techniques are used for various applications
- Design tools and Simulation
- Hardware Trainer

Thank you!
https://www.dc-lab.org
P.J.vanDuijsen@hhs.nl