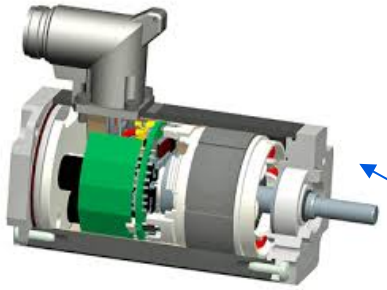
V.-M. Leppänen ABB Corporate Research, Dättwil April 16, 2014

Power Trains
Future High MW Drives

Power Train Integration
Combining two or more adjacent functions



CO

Electrical energy

Mechanical energy

EM PE EM MEC

Various applications in heavy and light industries, marine, traction, wind, wet renewables, robotics, electric vehicles, white goods,… employ power trains. Integration and optimized system control are some of the trends.

Disciplines: Control, Power Electronics, Electromagnetics, Mechanics

Power Trains
Traditional and emerging applications

Installed wind capacity in the world will reach 350 GW in 2014. Installation run rate was ca. 40 GW per year in 2009 – 2013.

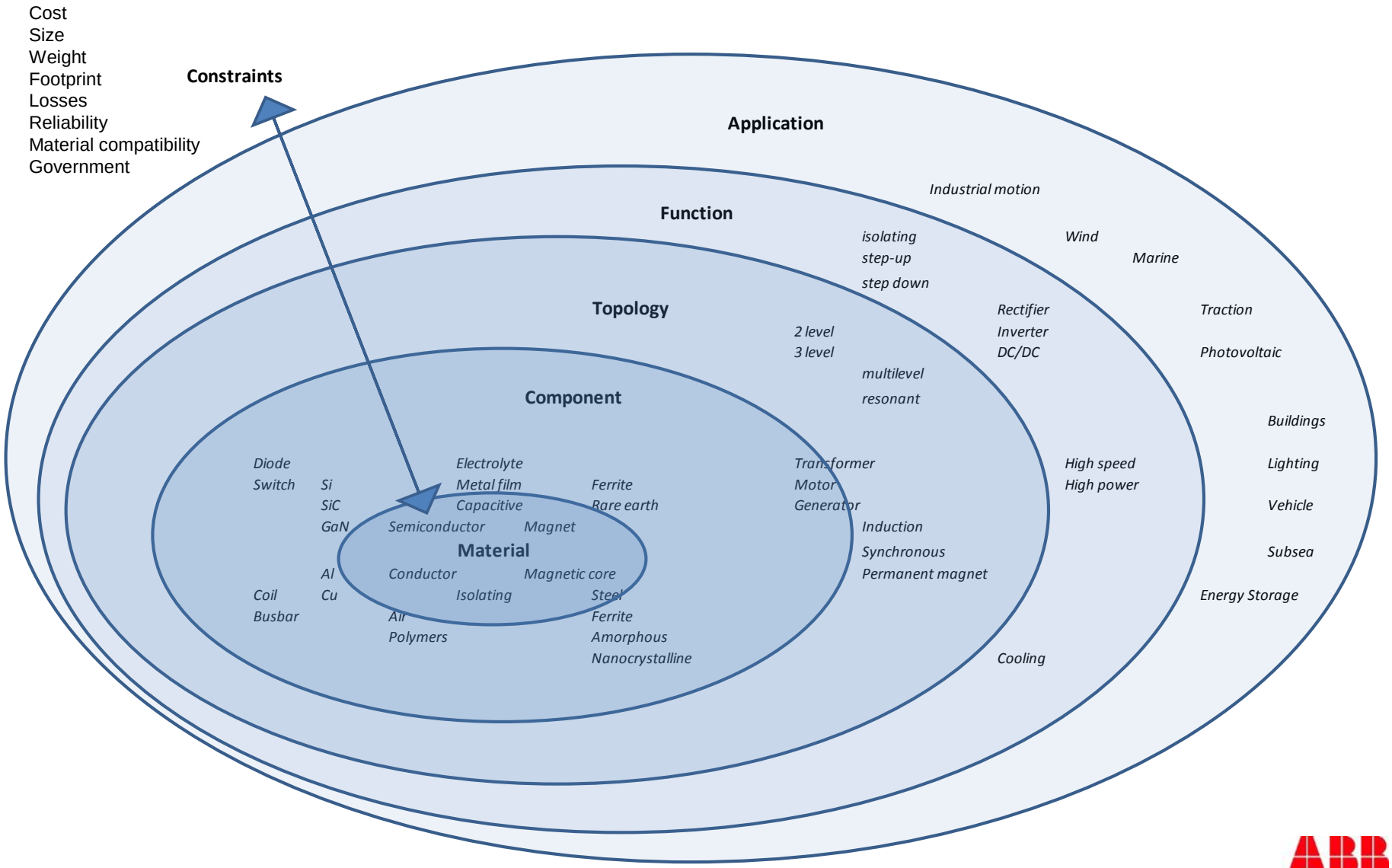
Pumps, fans, compressors make the biggest market for industrial drives.

Traction and HHEV are growing sectors, as well as small industrial systems.

DC grids for wind farm collection as well as on board distribution in marine call for > 10 kV converter technologies.

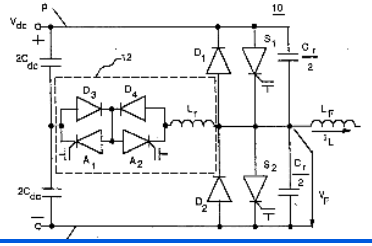
Power Electronics Spheres

from materials to components, from functions to applications



Power Trains

Revolution Enablers In the Past



Fast thyristors (1970's)

voltage source inverters

but: commutation and snubber circuits

Darlington transistors (1980's)

gate turn-off

but: snubber circuits

GTO thyristors (1980's) and IGCTs (1990's)

gate turn-off

VSI for MV drives

but: turn-off energy recovery circuits

IGBTs (1985): the last revolution!

MOS gate

short-circuit capability

faster switching

no snubber circuits

easy parallelling

Digital control

from early 1980's microprocessors to today's DSPs, ASICs and FPGAs

Digital communication

fieldbuses, internet based, real-time

Vector control

of induction machines

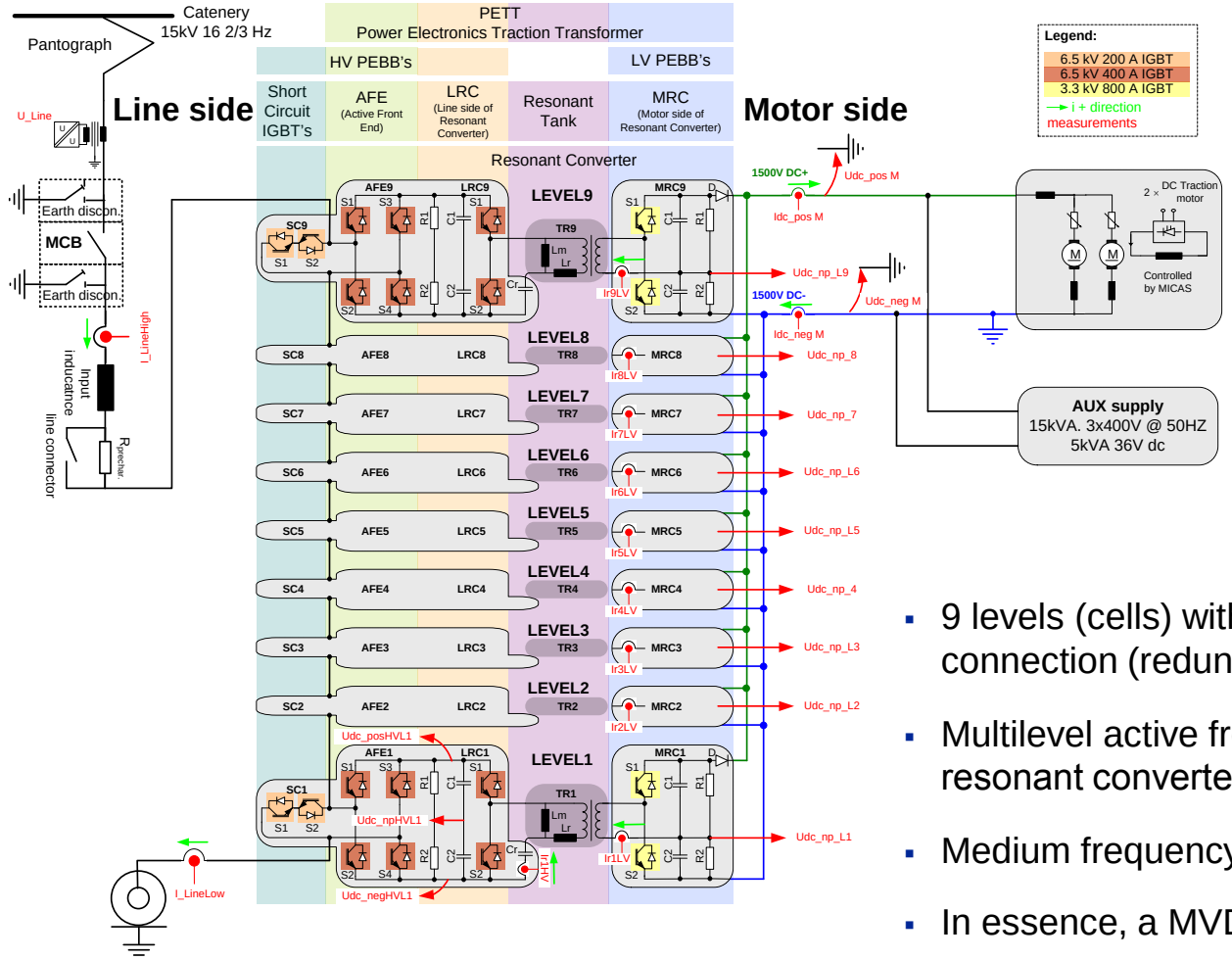
Analyzis and design SW like 3D Maxwell, 3D CFD, computer-optimization tools

Power semiconductors have been the main industry driver

Microelectronics development from outside the industry

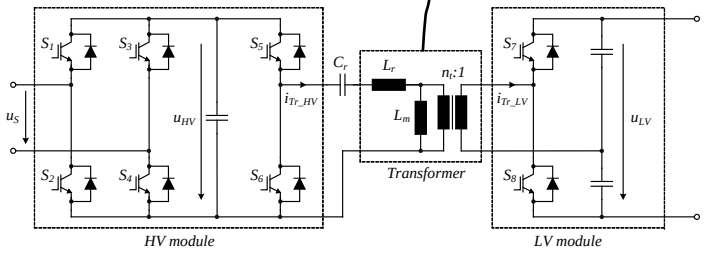
Today, revolution replaced by evolution?

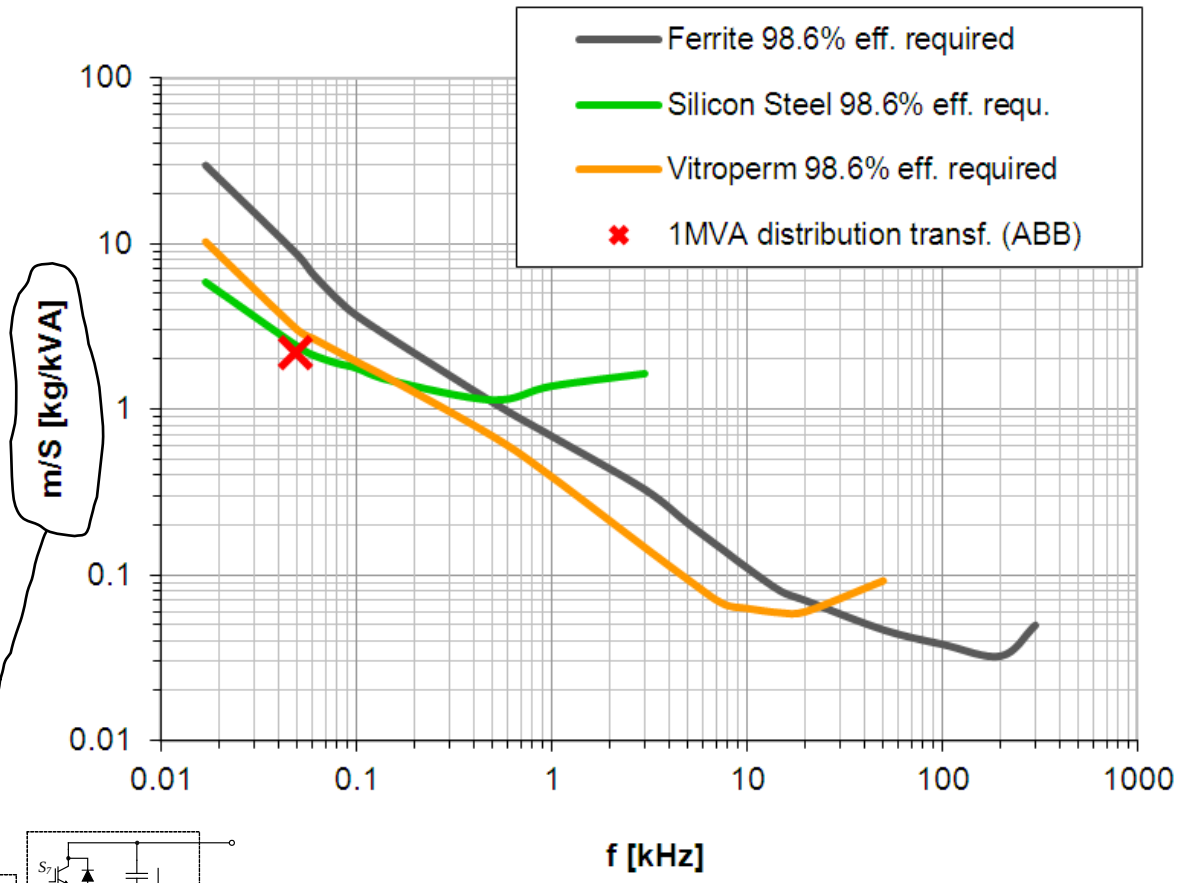
Power Electronic Transformer.. A New Enabler?



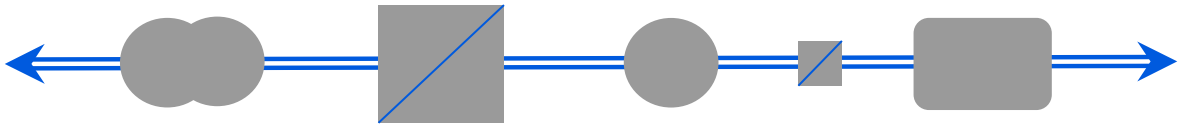
- 9 levels (cells) with series input-parallel output connection (redundancy (n+1))
- Multilevel active front end with DC-DC LLC resonant converters (3.6kV ↔ 1.5kV)
- Medium frequency transformers
- In essence, a MVDC/LVDC converter

Power Electronic Transformer.. A New Enabler?





Power Trains
Game changers?



SiC

Promise for high voltage (>10 kV)

Promise for higher switching frequency

Is this enough for a new revolution?

Long distances force to MV

Motor insulation limiting factor?

Emerging Drivers

- EV
- Solar
- Wind
- Tidal
- Pumped hydro
- Subsea
- => RELIABILITY

Future DC distribution and collection lead to need for dc grid compatible drives.

How to best combine MV supply and LV drive and motor? Future role of transformers?

Do nor forget the gearbox! Optimum balance between speed and torque.