

# **INTEGRATION OF RENEWABLE ENERGY SOURCES IN POWER SYSTEMS**

Razvan Magureanu  
University POLITEHNICA Bucharest

---



Fig.1. Zeus in action



Fig.2. Otto von Guericke producing and transporting static energy



Fig.3. The kissing machine

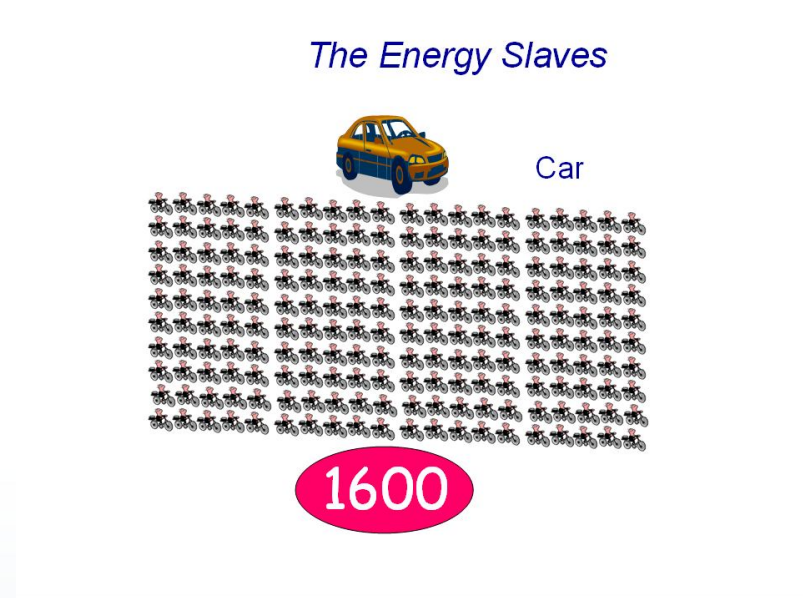
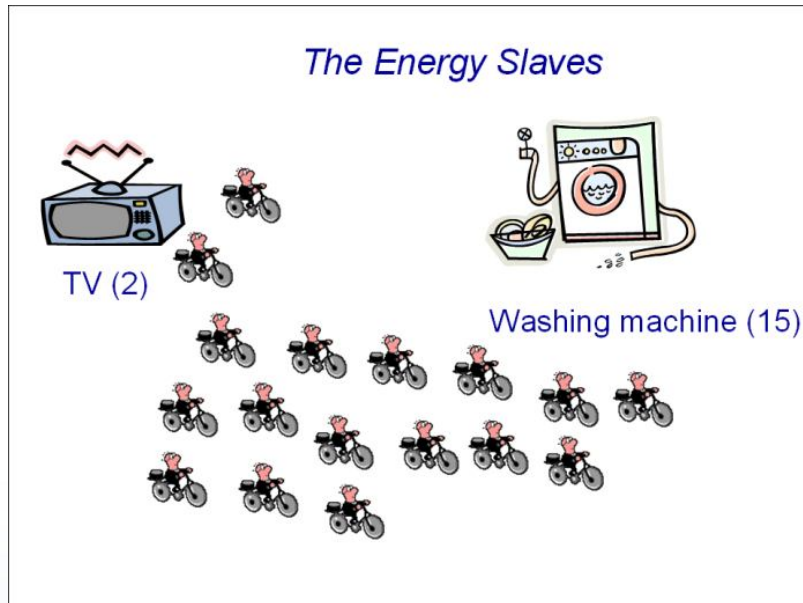


Fig.4. Equivalent power

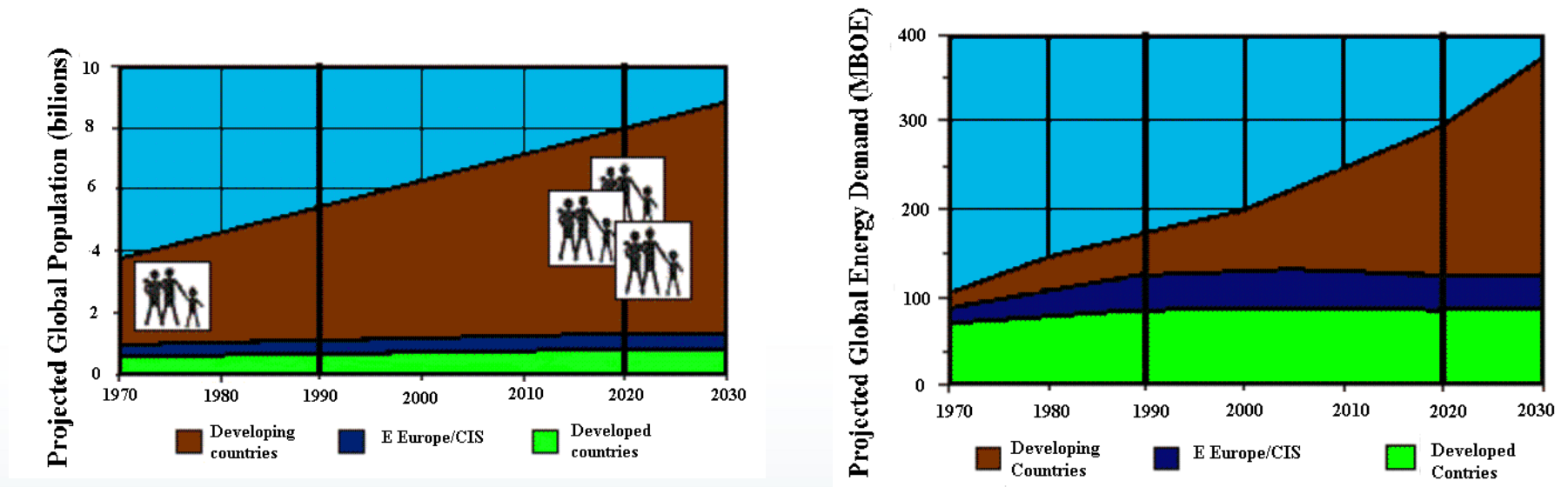


Fig.5. Projected global population (left) and energy demand (right)

*Renewables growth: Electricity projections by 2020*

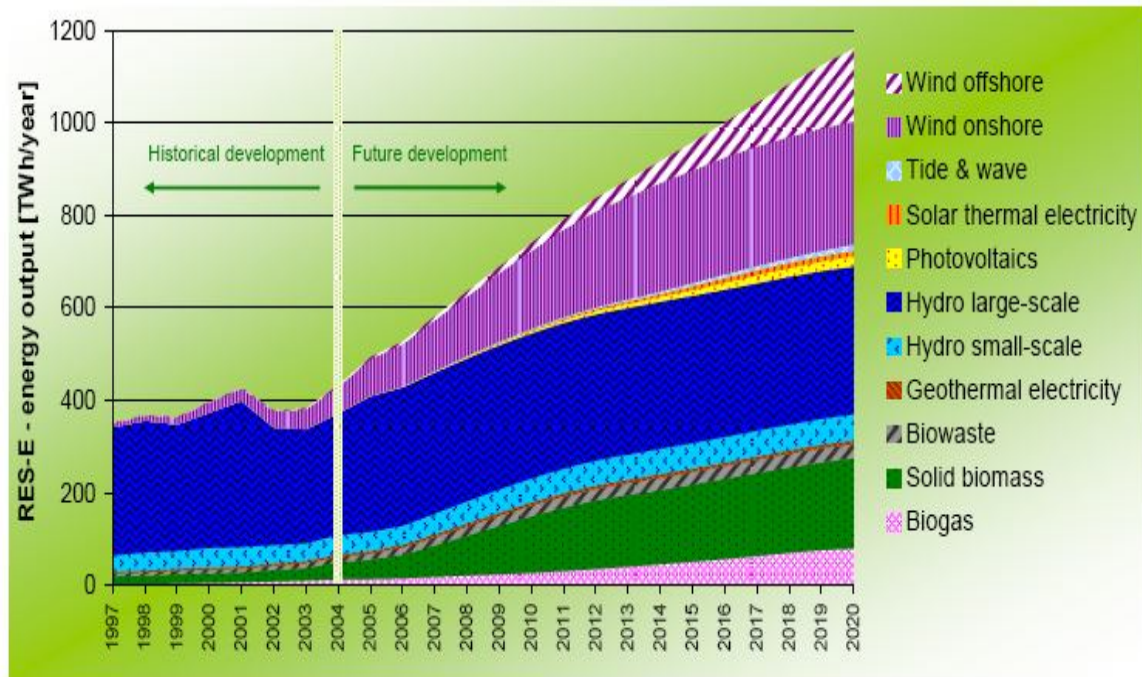


Fig.6. Primary resources

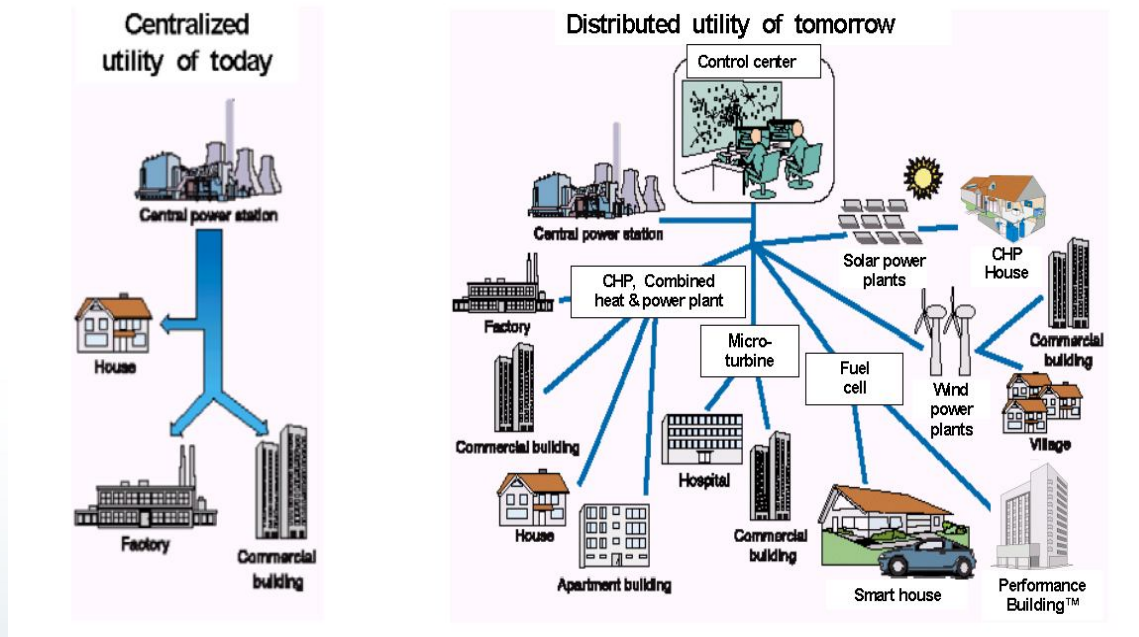


Fig.7. Centralized and distributed solutions

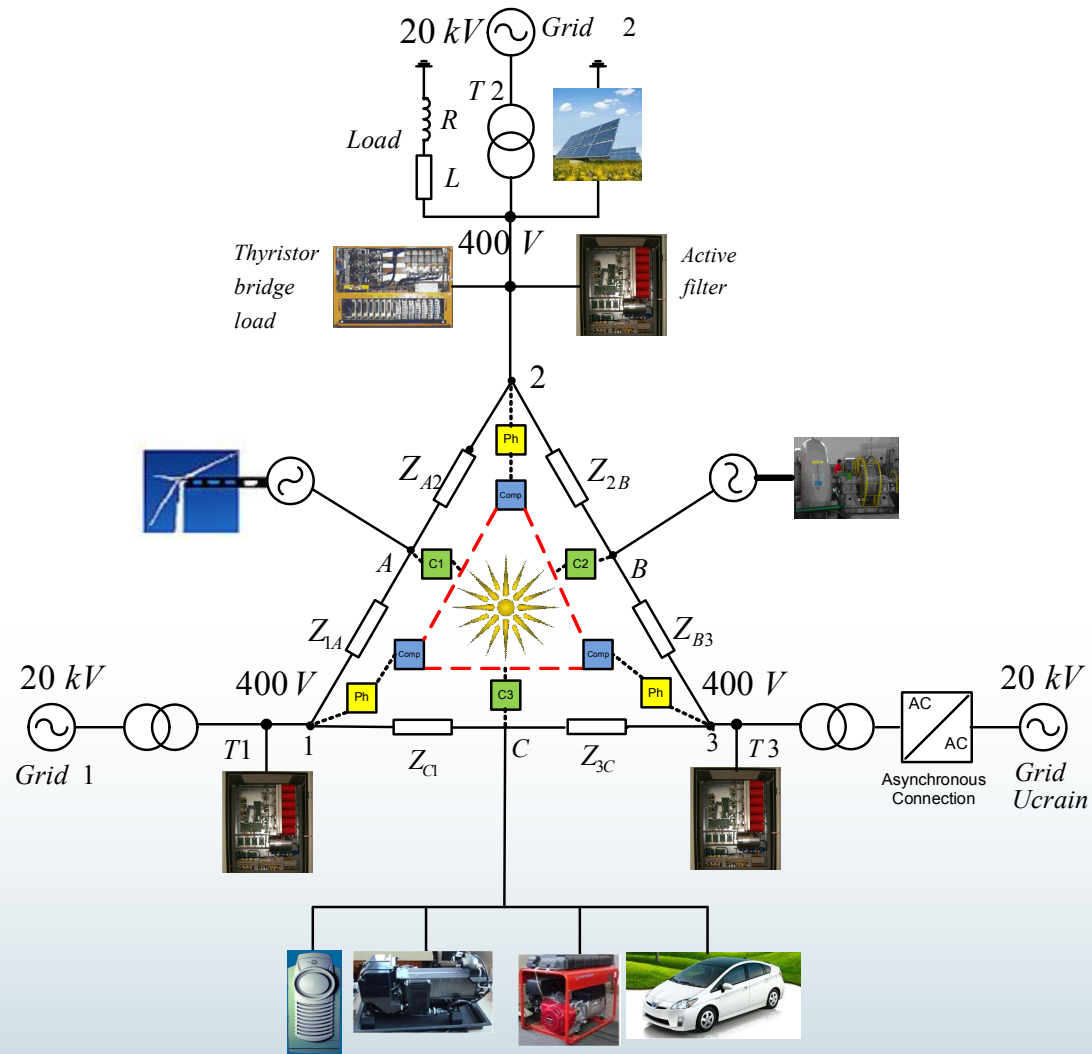


Fig. 8 Smart Grid with renewable sources and different types of loads and storage facilities



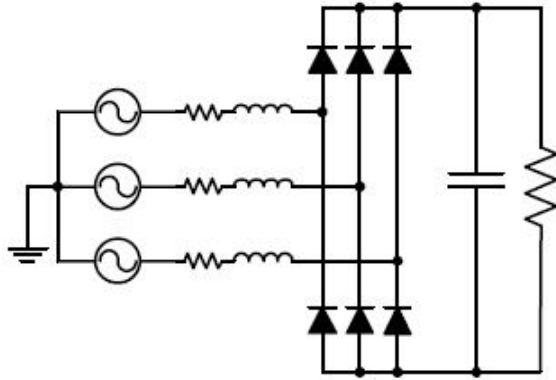


Fig.9. The diode bridge rectification of AC input

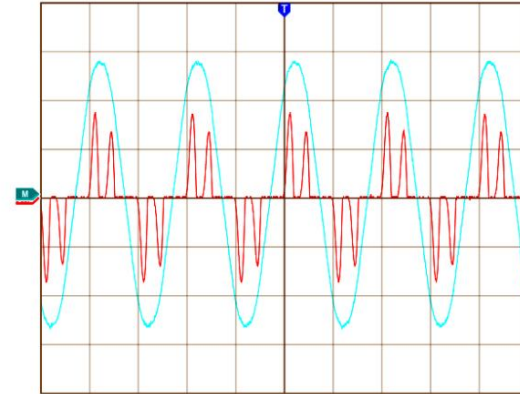


Fig.10. Measured AC stator voltage (blue) and instantaneous currents (red).

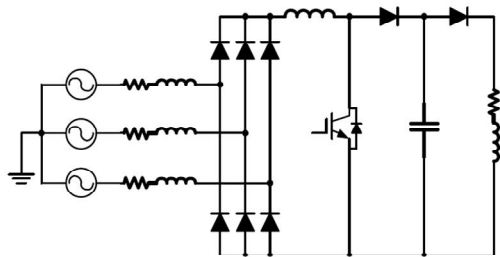


Fig.11. Rectification with booster circuit.

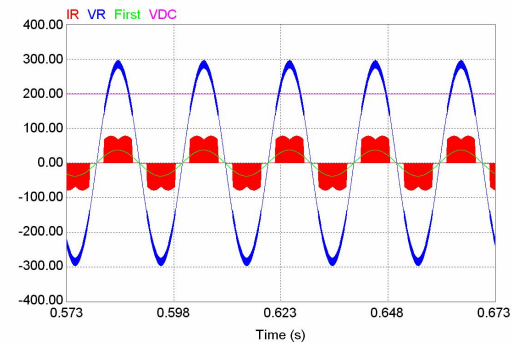


Fig.12. AC stator current (red) and fundamental (green).  
The AC voltage (blue) and DC output voltage (magenta).

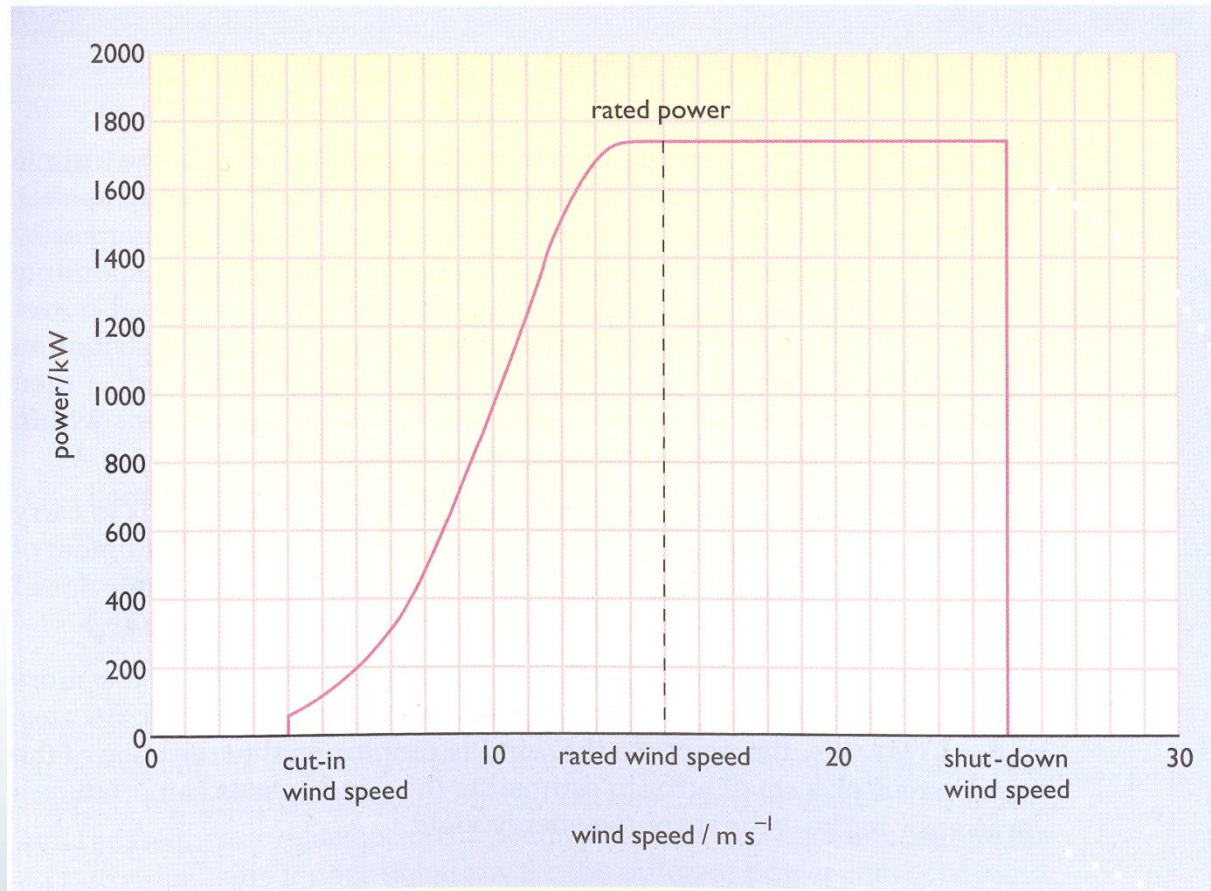


Fig. 13. Typical wind turbine wind speed-power characteristic

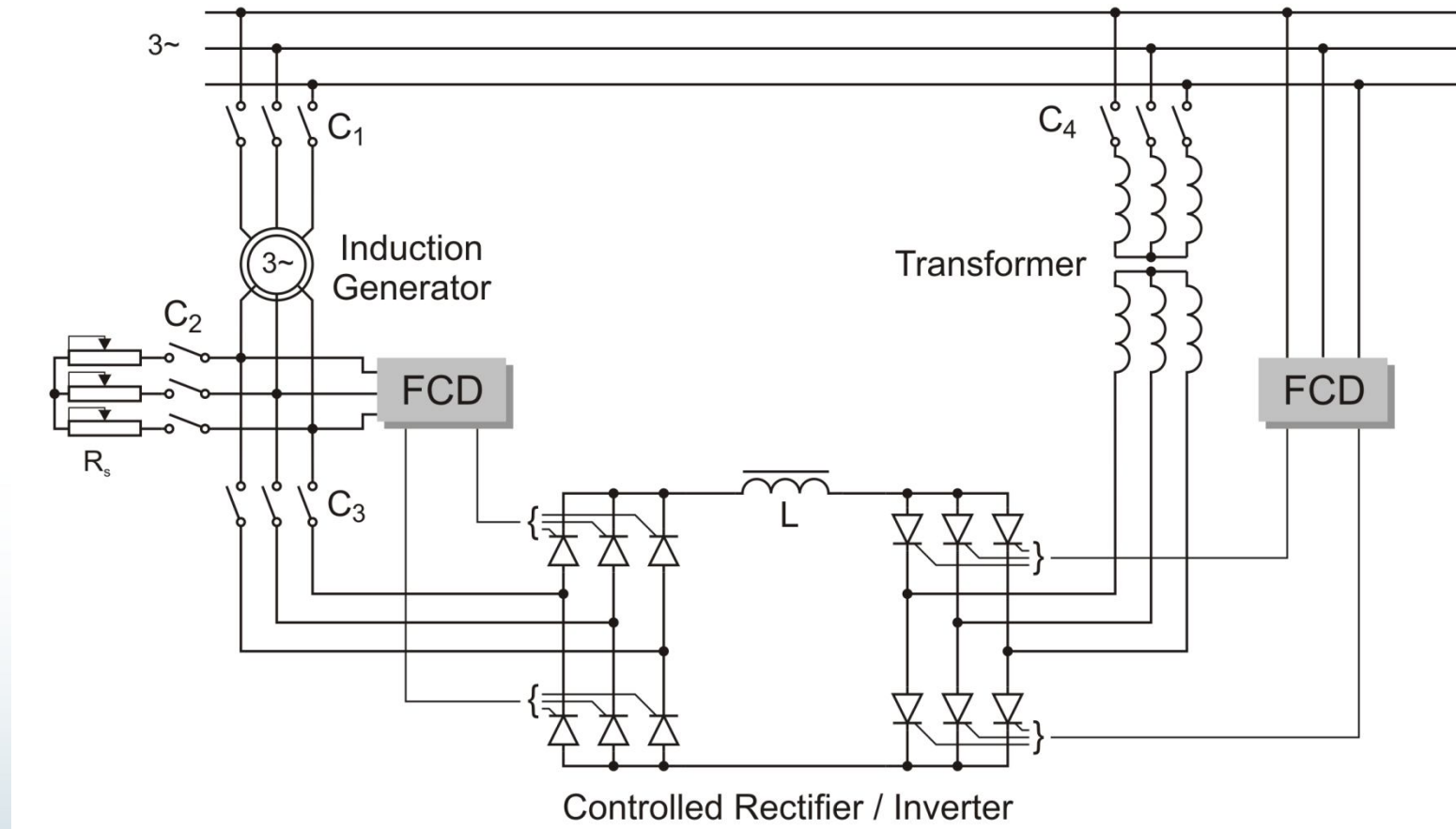


Fig. 14. Double fed induction generator for variable speed applications

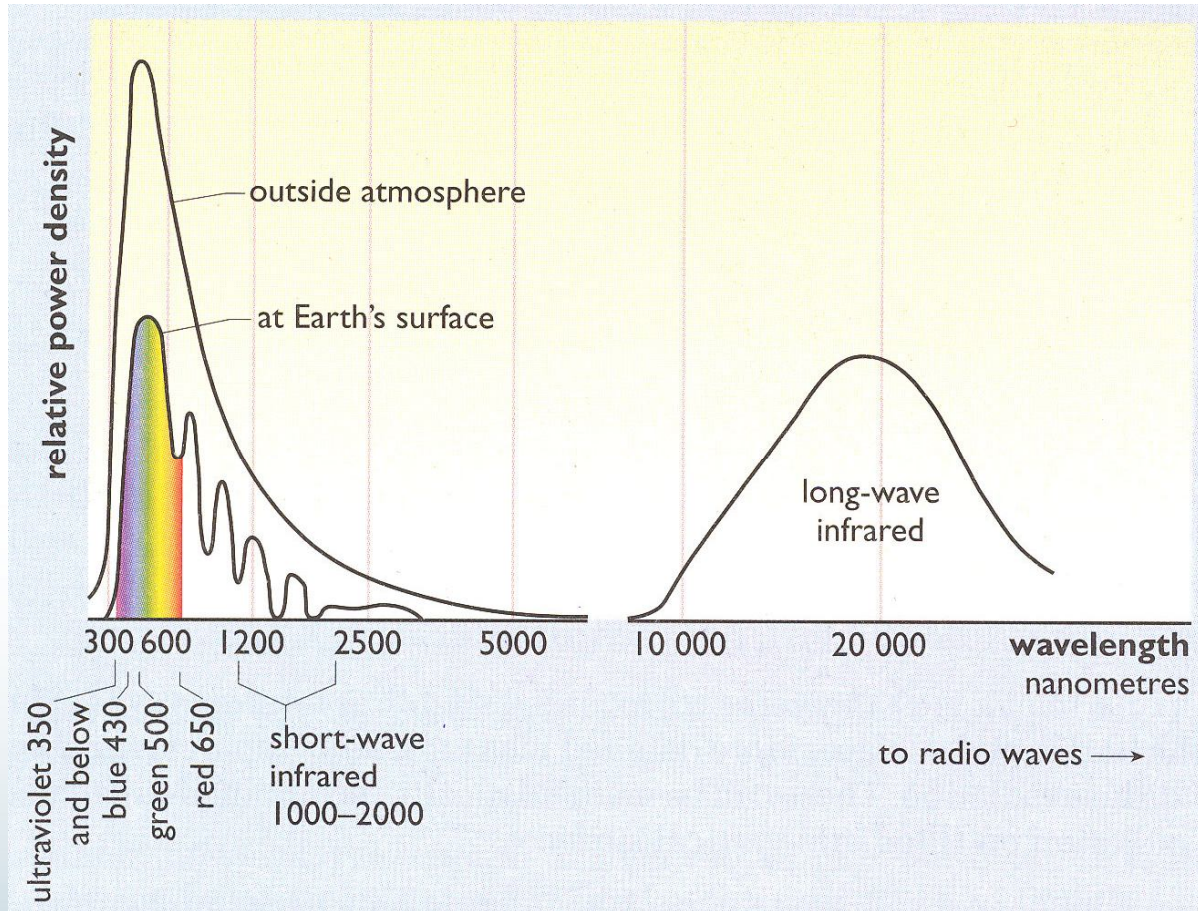


Fig. 15. Solar radiation spectrum



Fig. 16. Barstow central receiver system – heliostat field

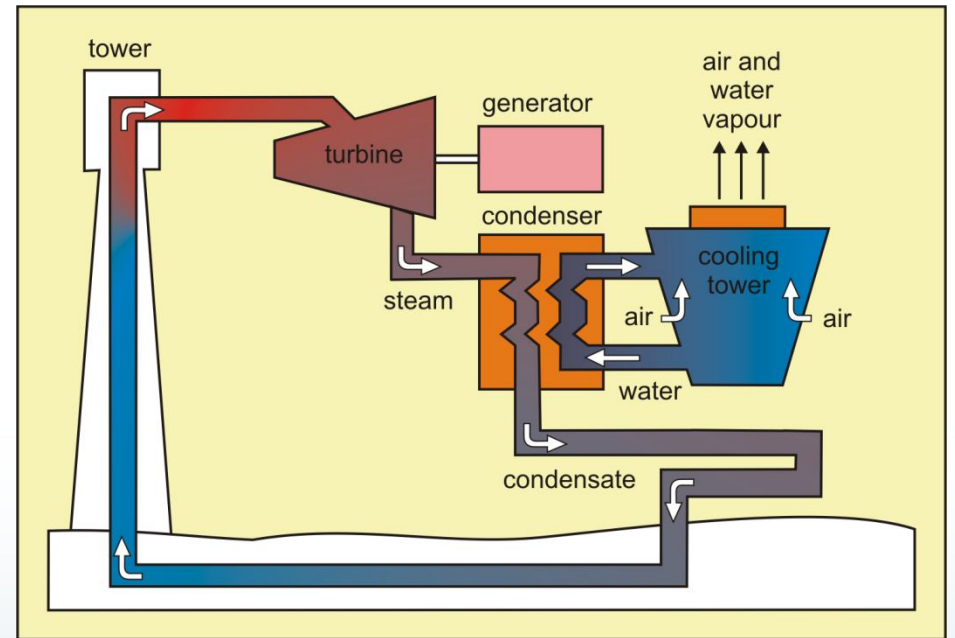


Fig. 17. Conversion of thermo energy into electricity

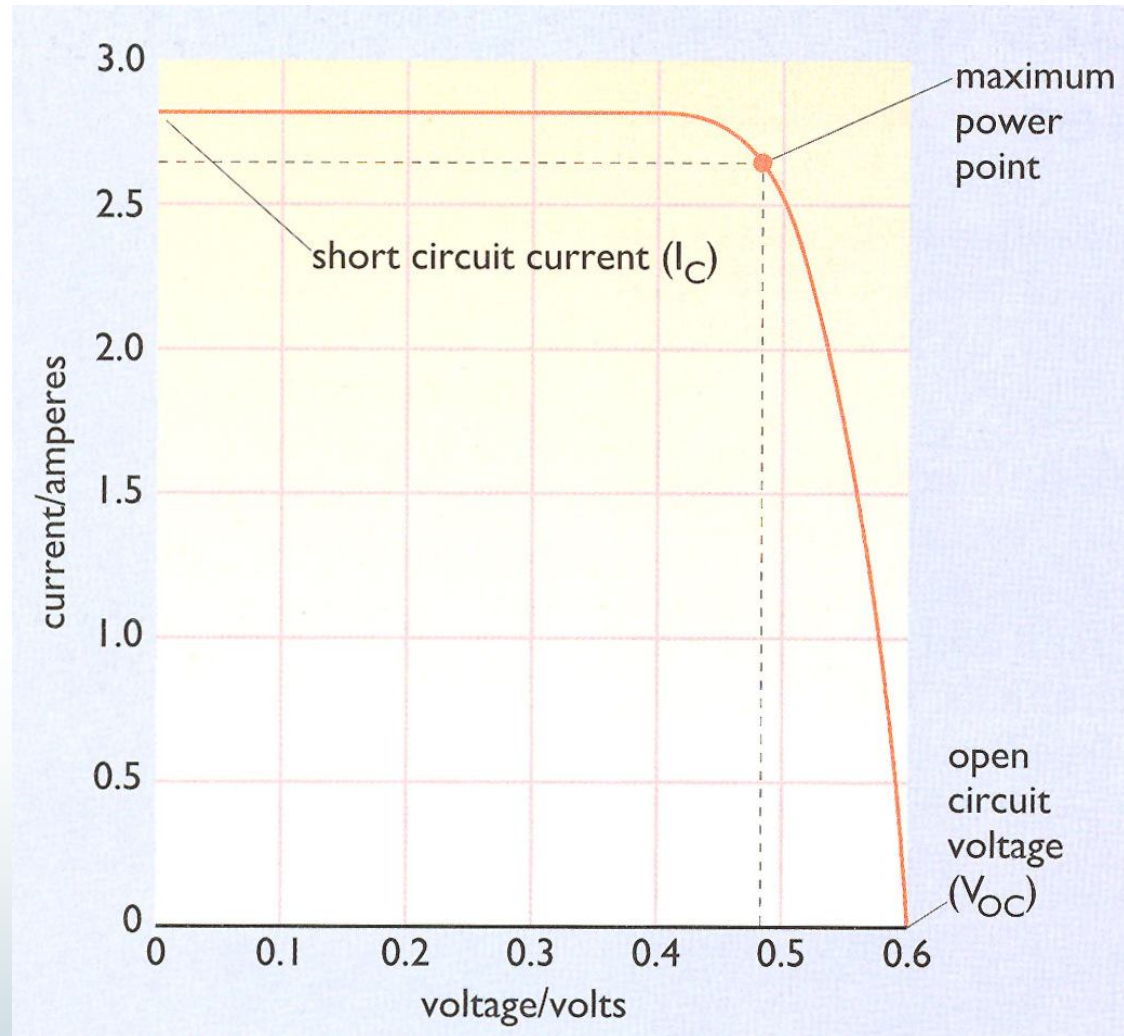


Fig 18. Current-voltage characteristic of a typical silicon PV cell

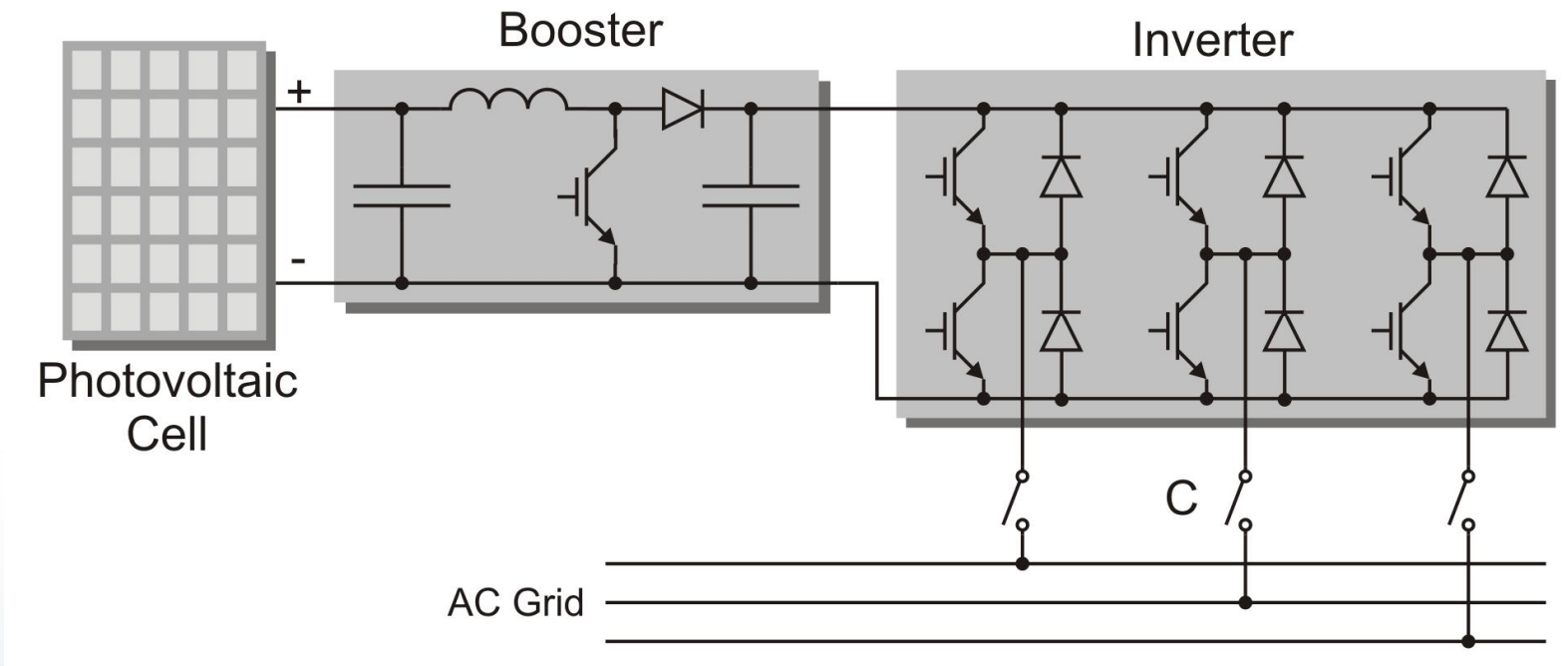


Fig 15. Connection of a photovoltaic panel to the grid

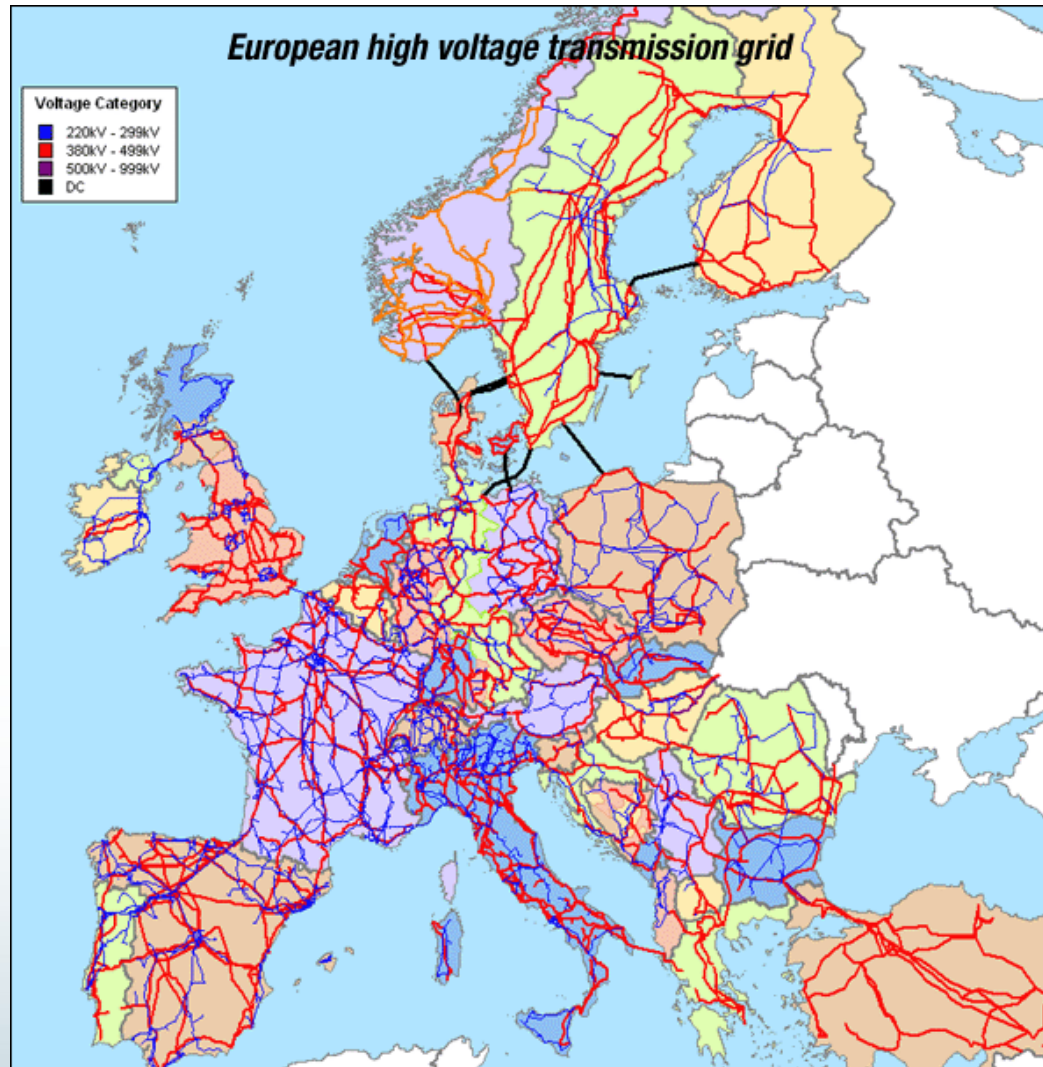


Fig .19.



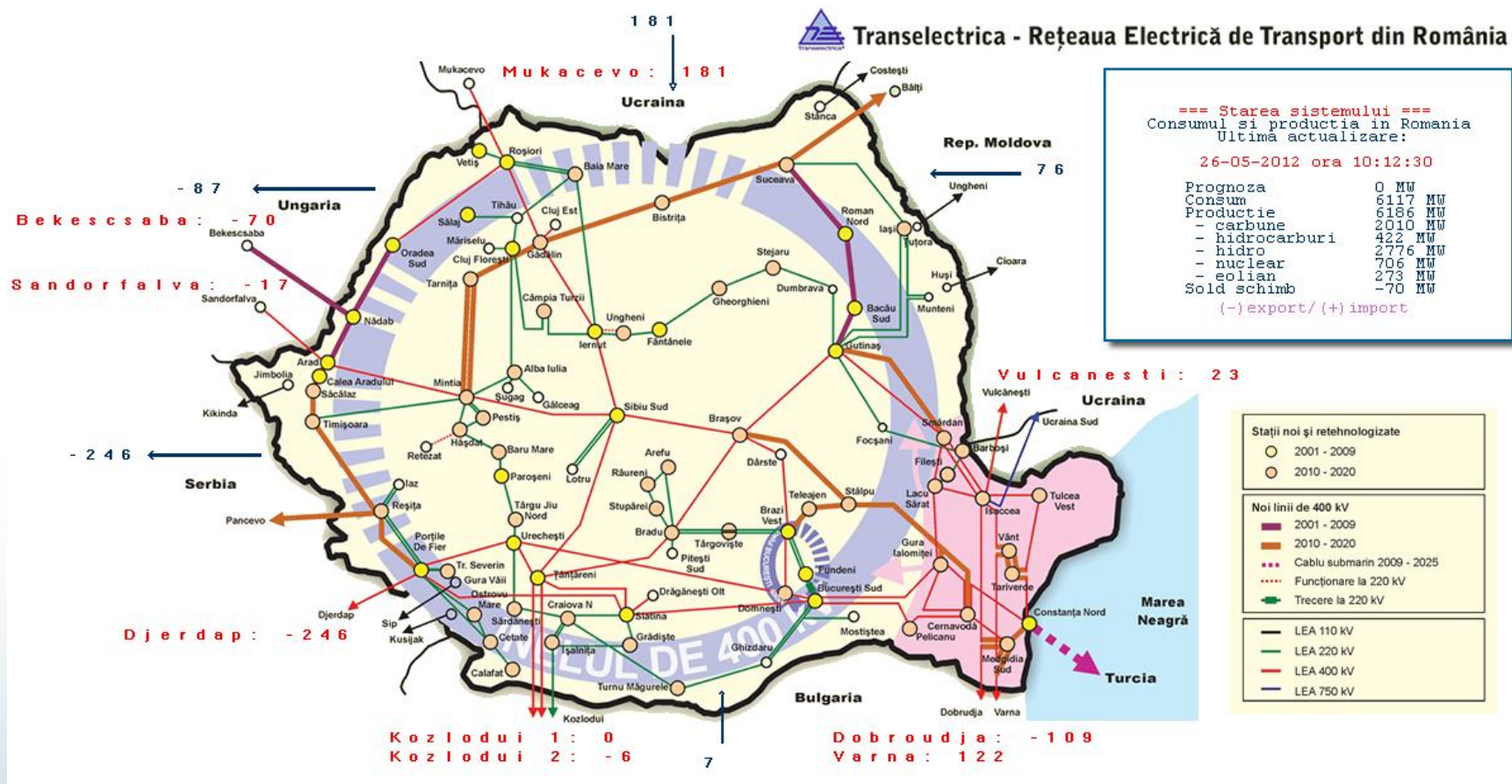
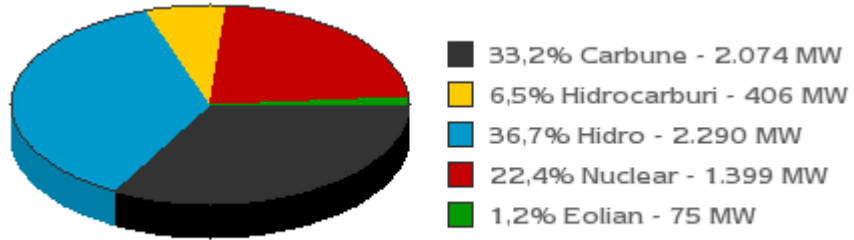


Fig. 20.



Total 6244 MW - Productia in 16-06-2012 ora 10:26:01

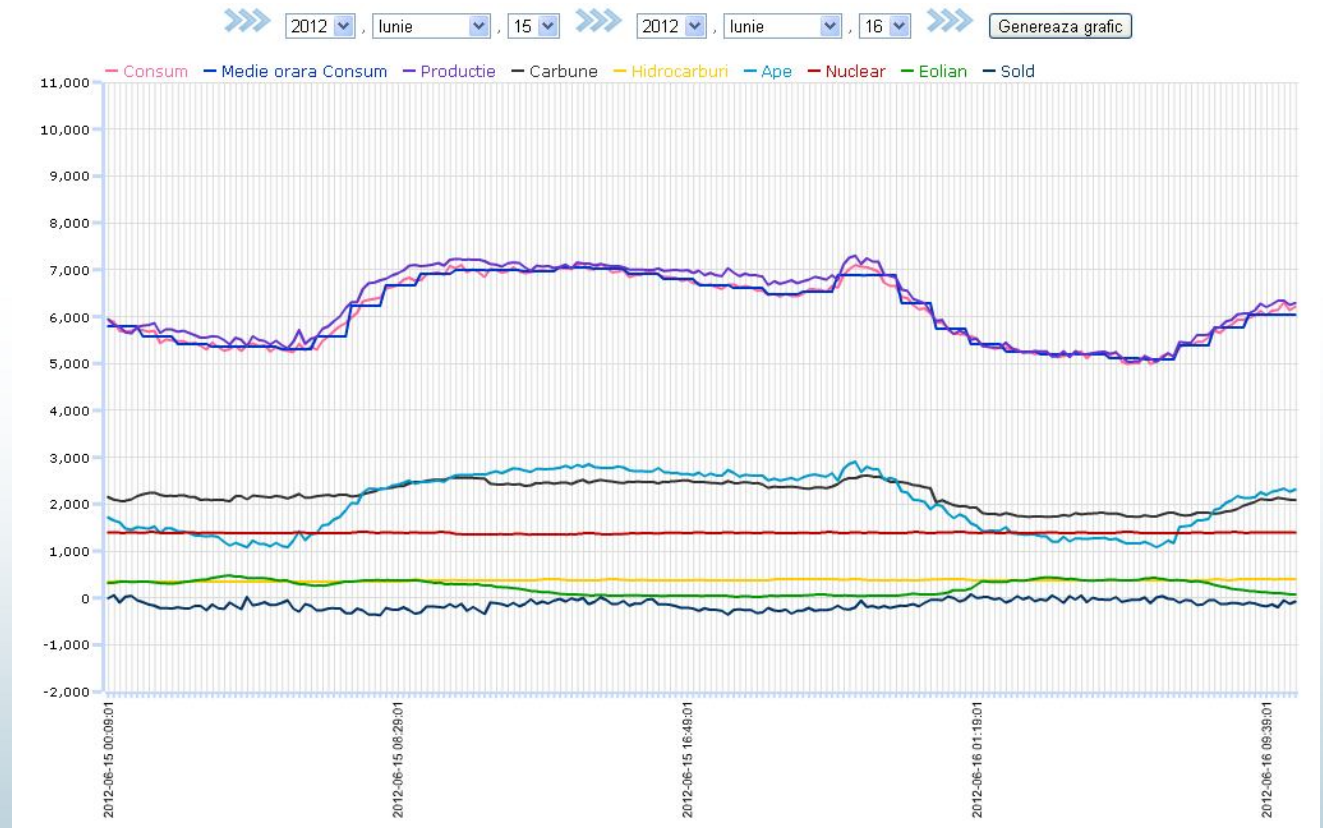


Fig. 21.

*Patras*  
9 July 2012

---

*Patras*  
9 July 2012

---

*Patras*  
9 July 2012

---

# **Power Quality in AC Grids**

Razvan Magureanu  
University POLITEHNICA Bucharest

---

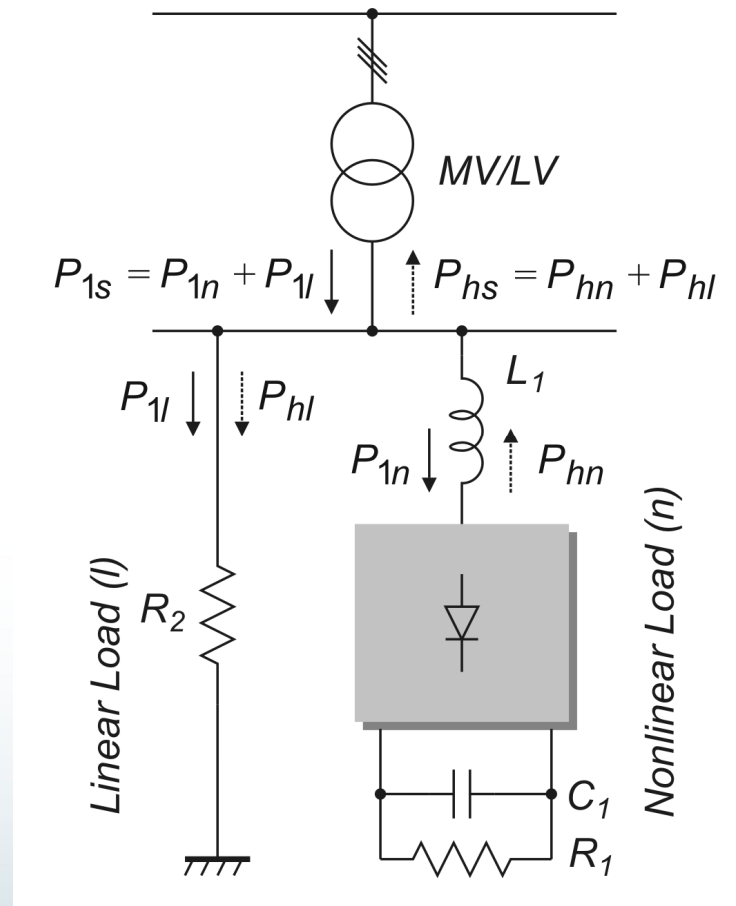


Fig. 1 Simplified low voltage power circuit model with a linear and a nonlinear load

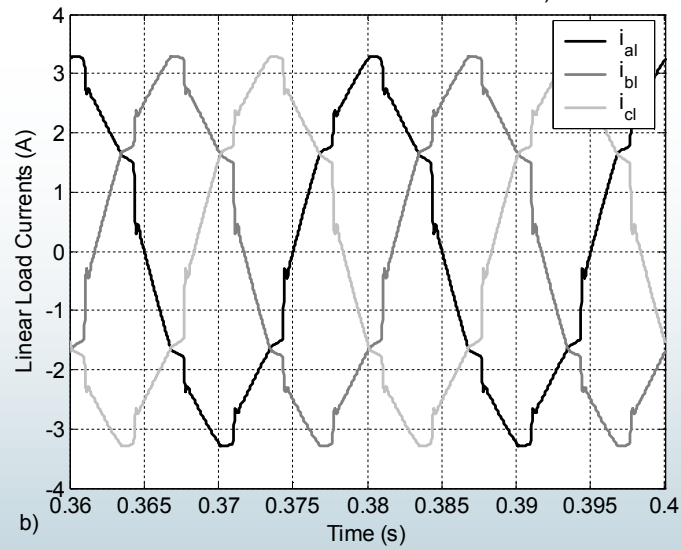
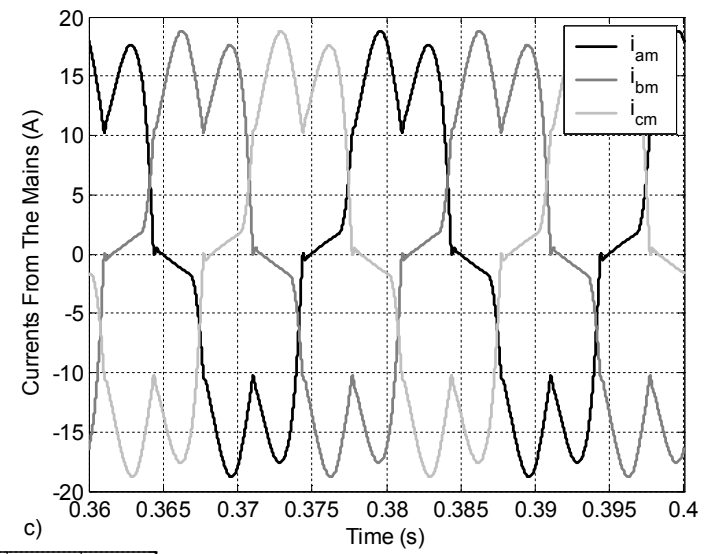
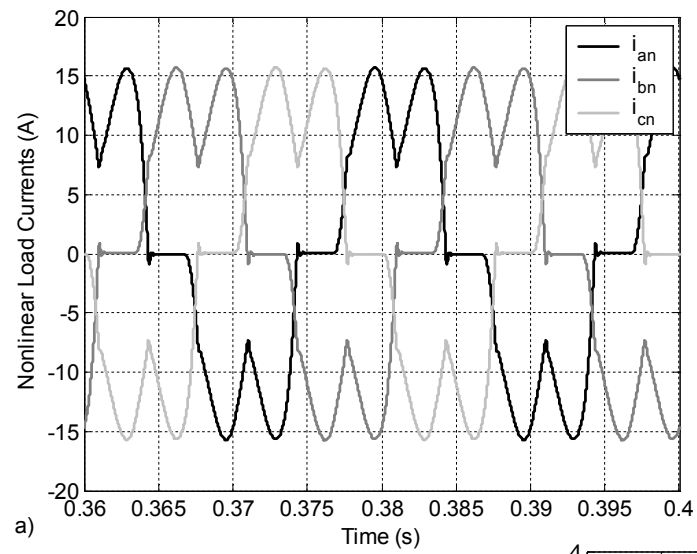


Fig. 2 Current waveforms: a) for the nonlinear load; b) for the linear load; c) for the mains



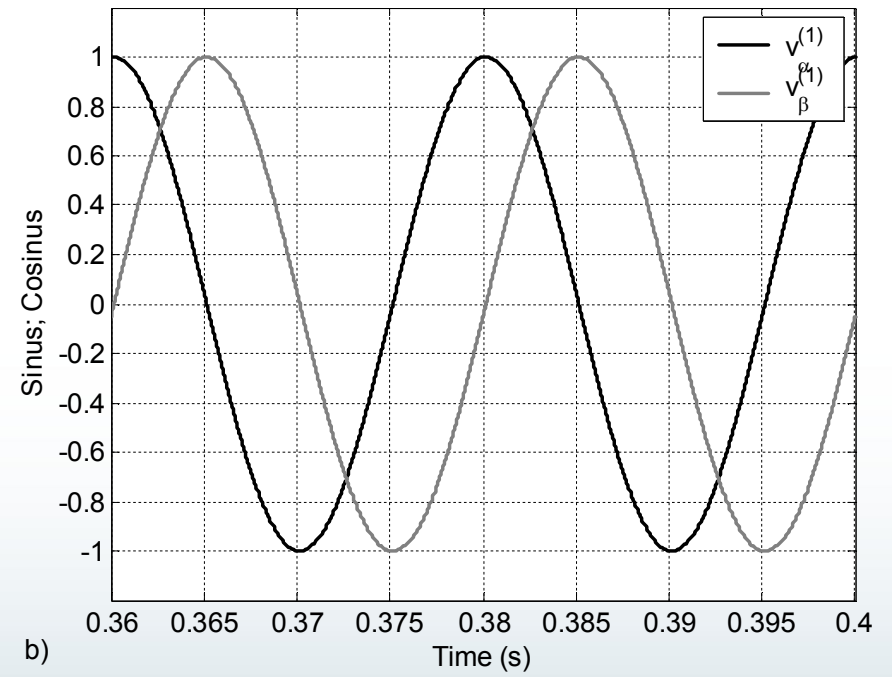
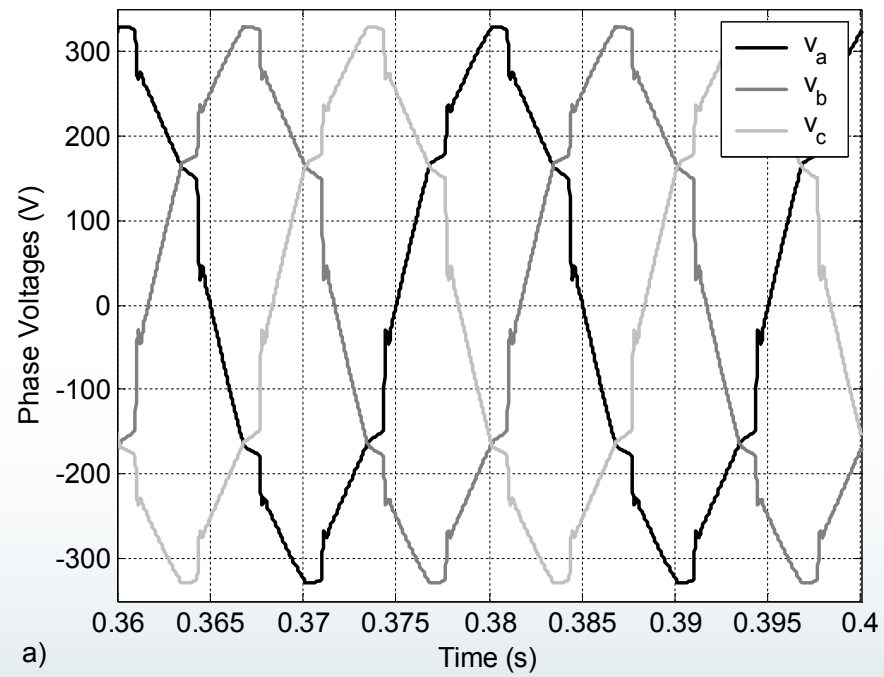


Fig. 3 Voltage waveforms: a) the mains; b)  
DPLL output

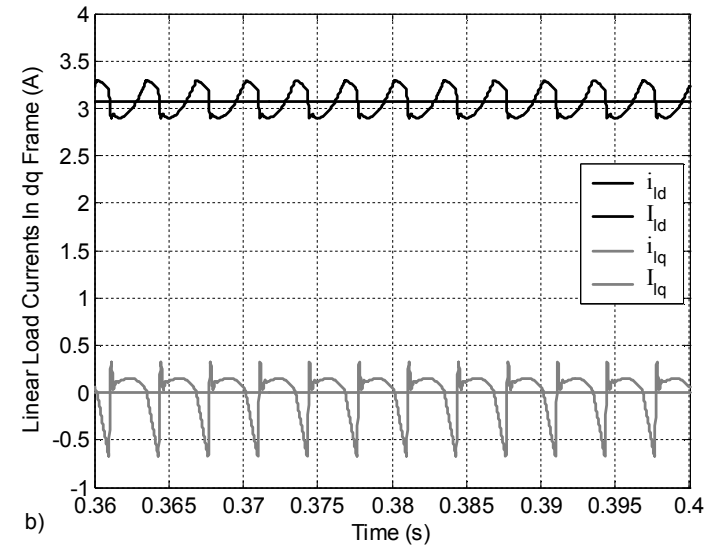
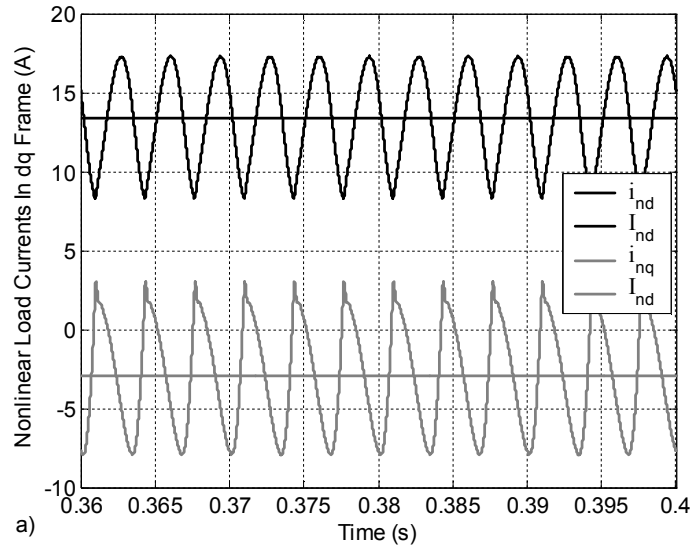


Fig. 4 The dq synchronous frame instantaneous and average value currents: a) for the nonlinear load; b) for the linear load

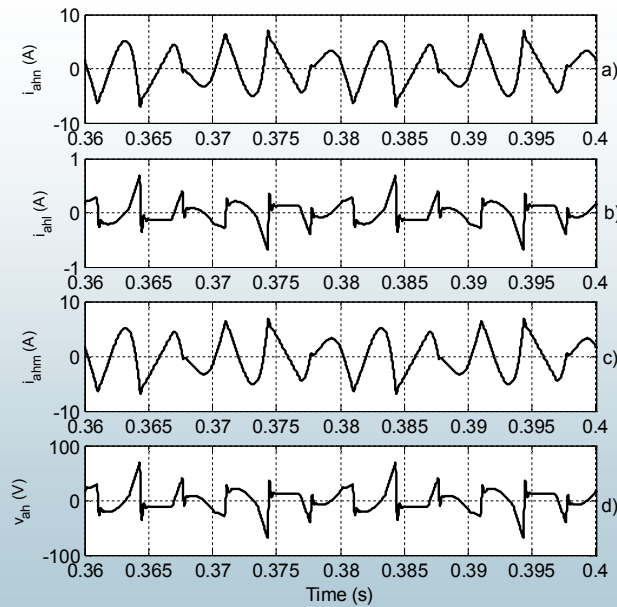


Fig. 5 Harmonic waveforms for the “a” phase: a) the current for the nonlinear load; b) the current for the linear load; c) the current for the mains; d) the voltage for the mains

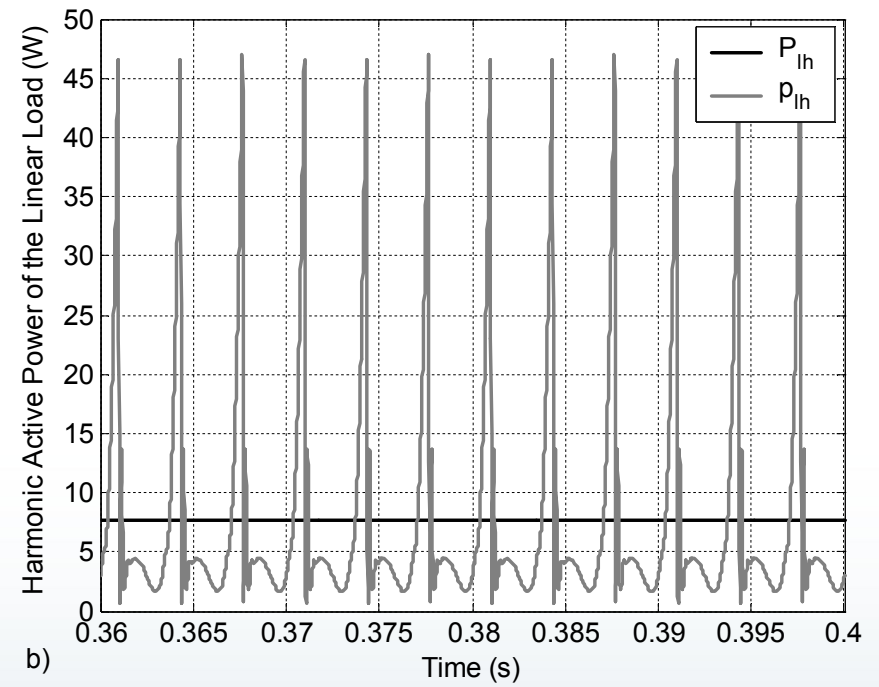
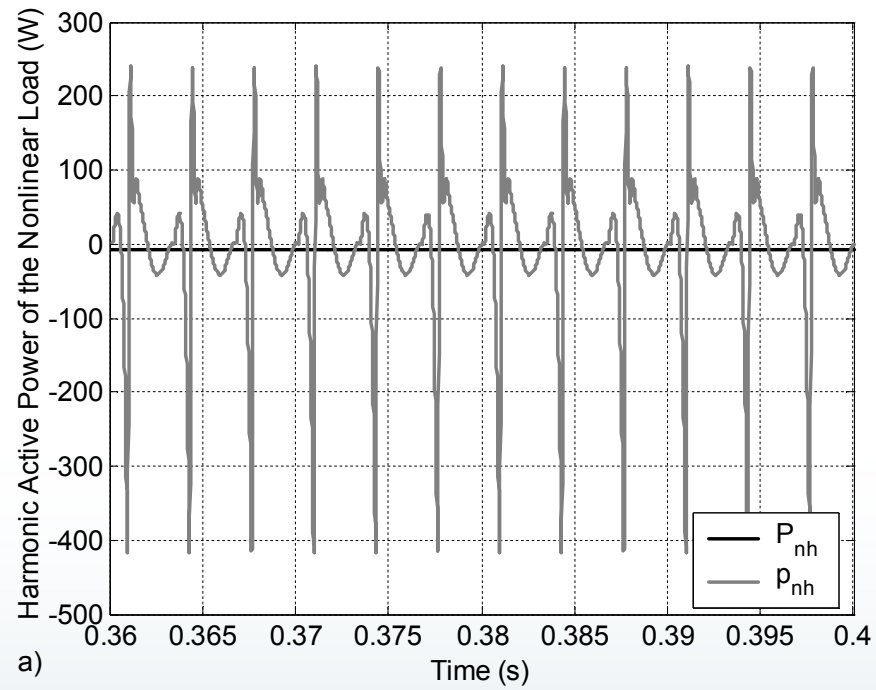


Fig. 6 The instantaneous and average value active power

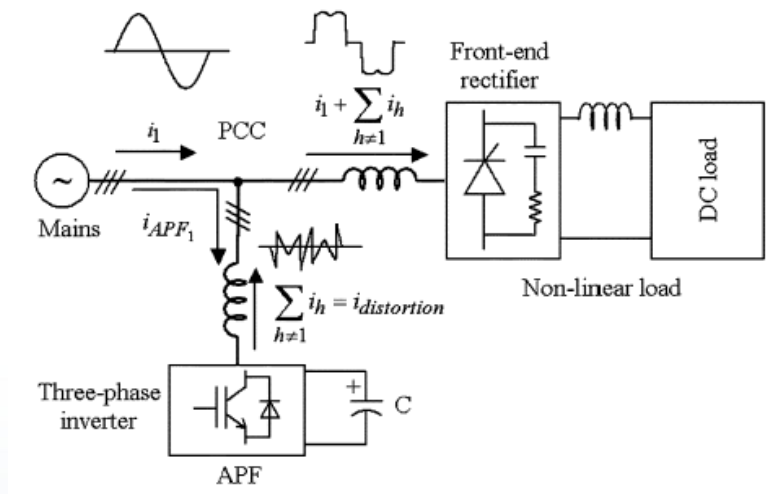


Fig. 7 Diagram of a basic active filter configuration

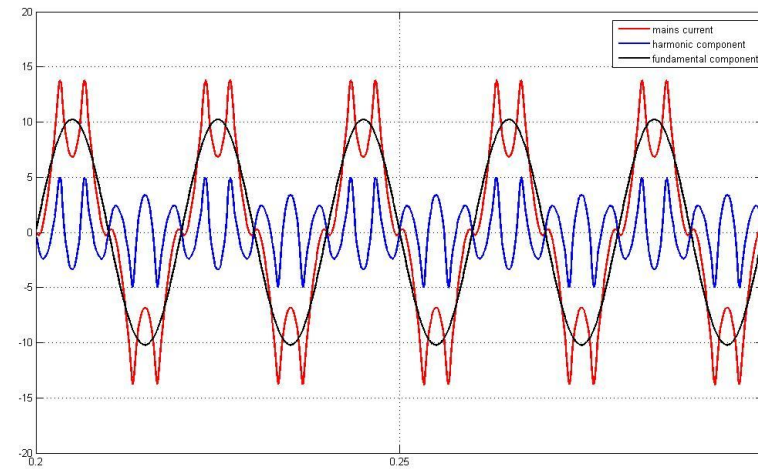


Fig. 8 Per phase results

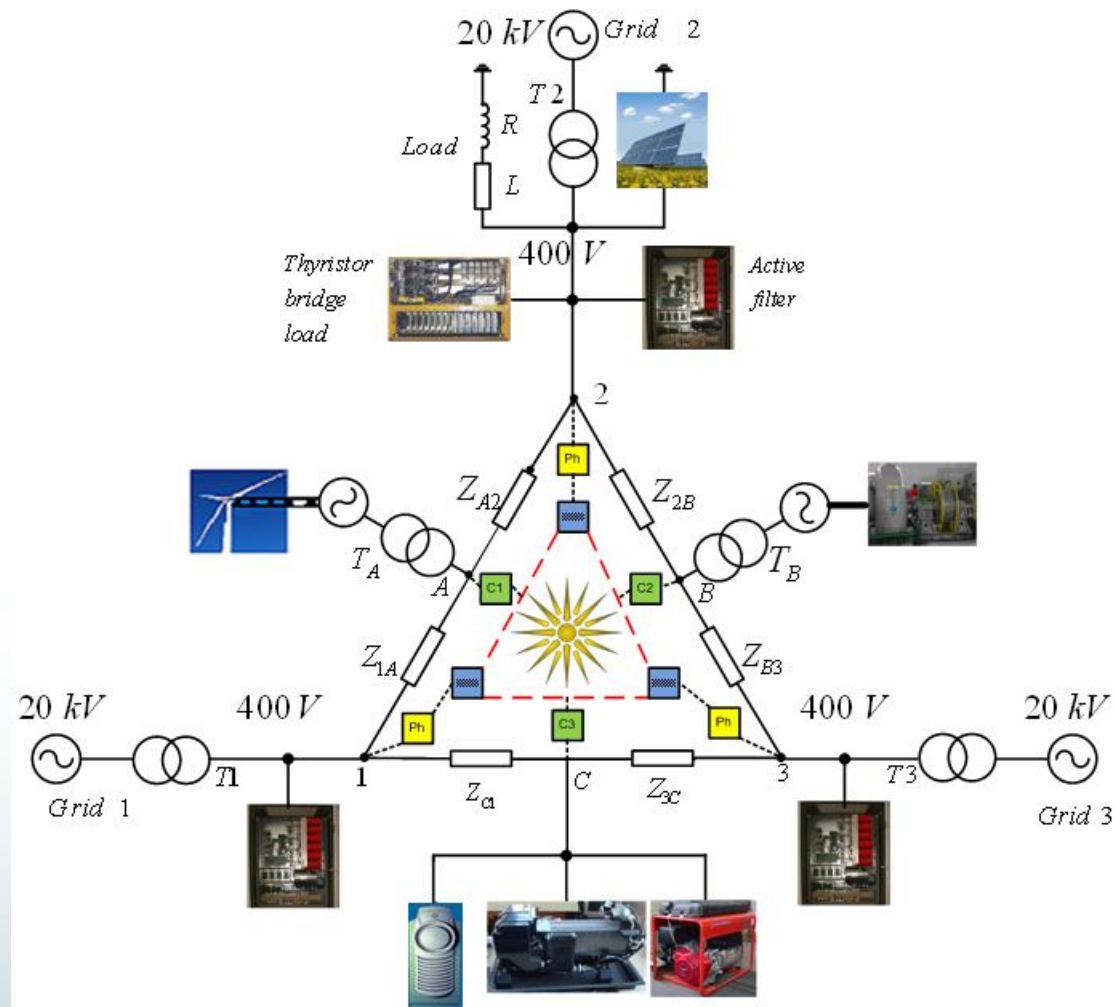


Fig. 9 Smart grid example

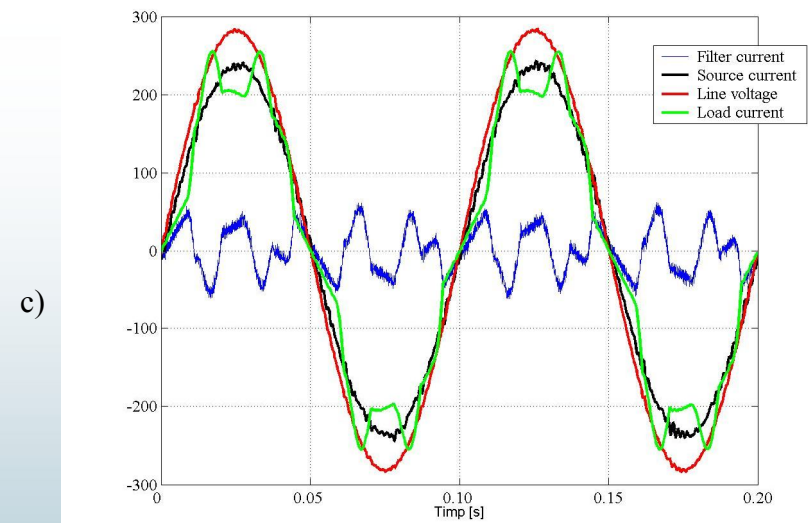
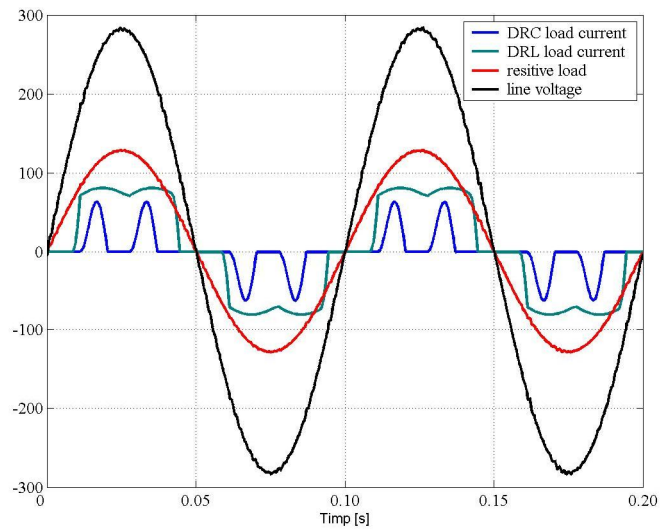
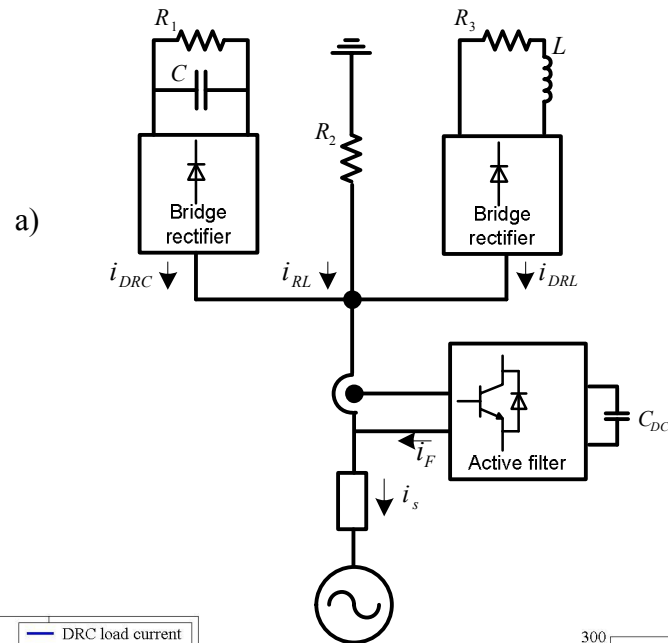


Fig. 10 Compensation at the PCC  
a) electric connections; b) uncompensated currents; c)  
harmonics compensated currents

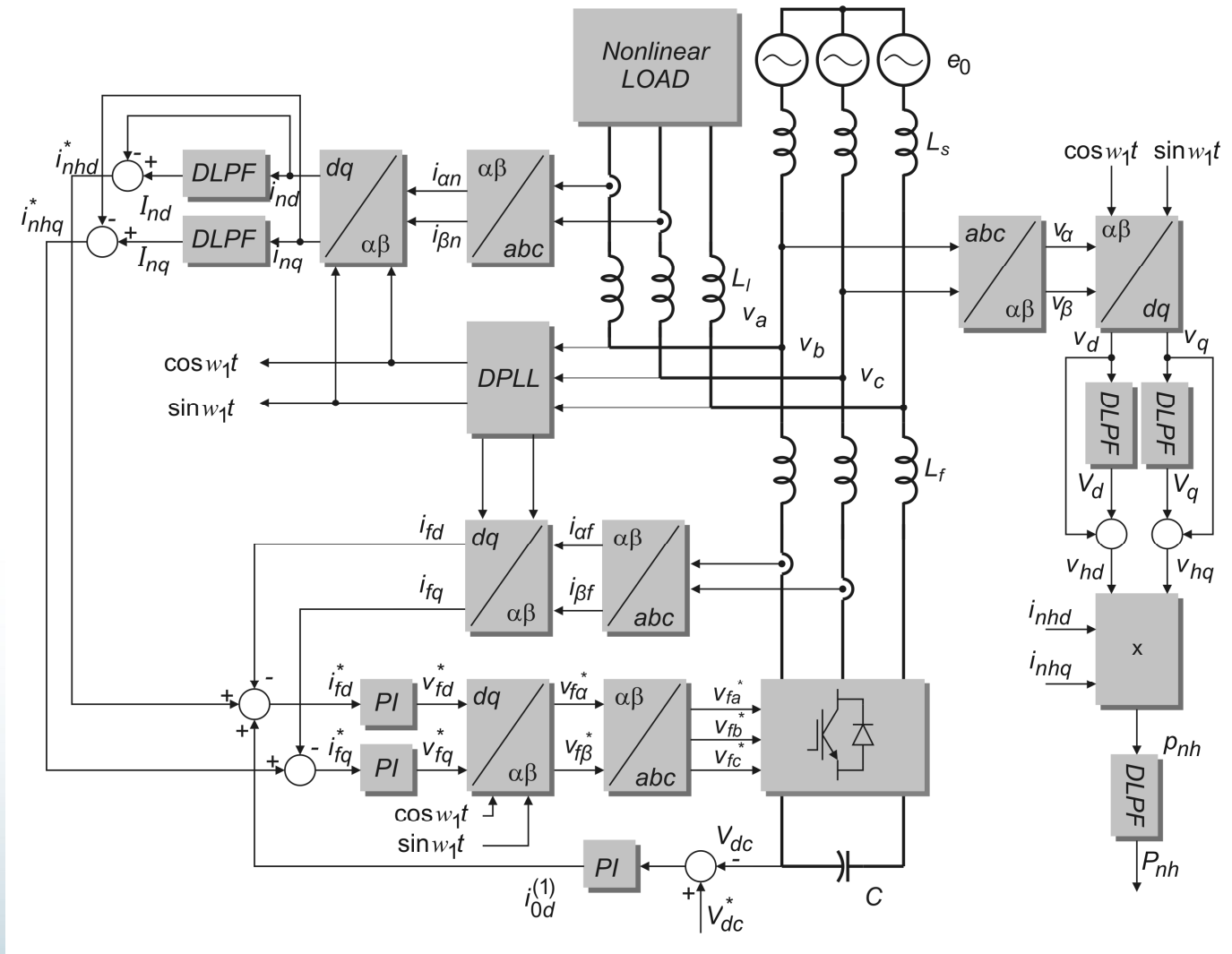


Fig. 11. The block diagram for active filter control

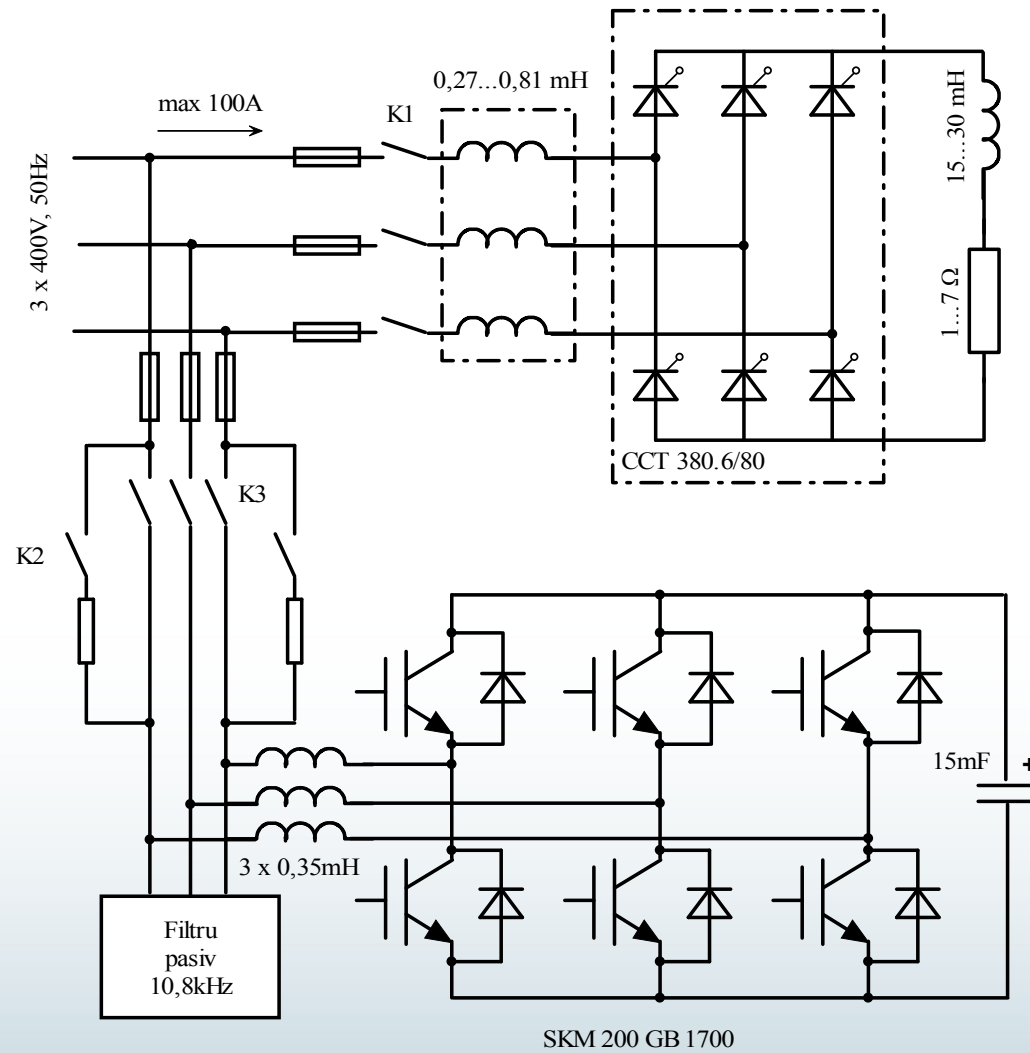


Fig.12 The experimental set-up



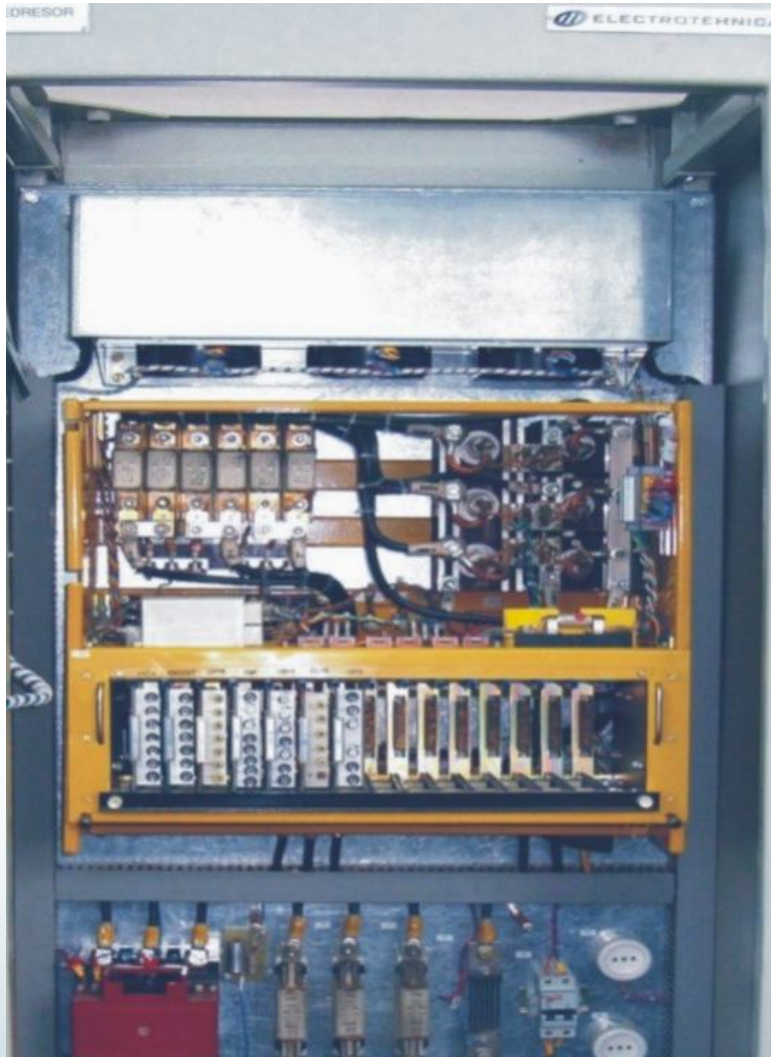


Fig. 13 The controlled rectifier as nonlinear load



Fig. 14 The inverter component of the active filter

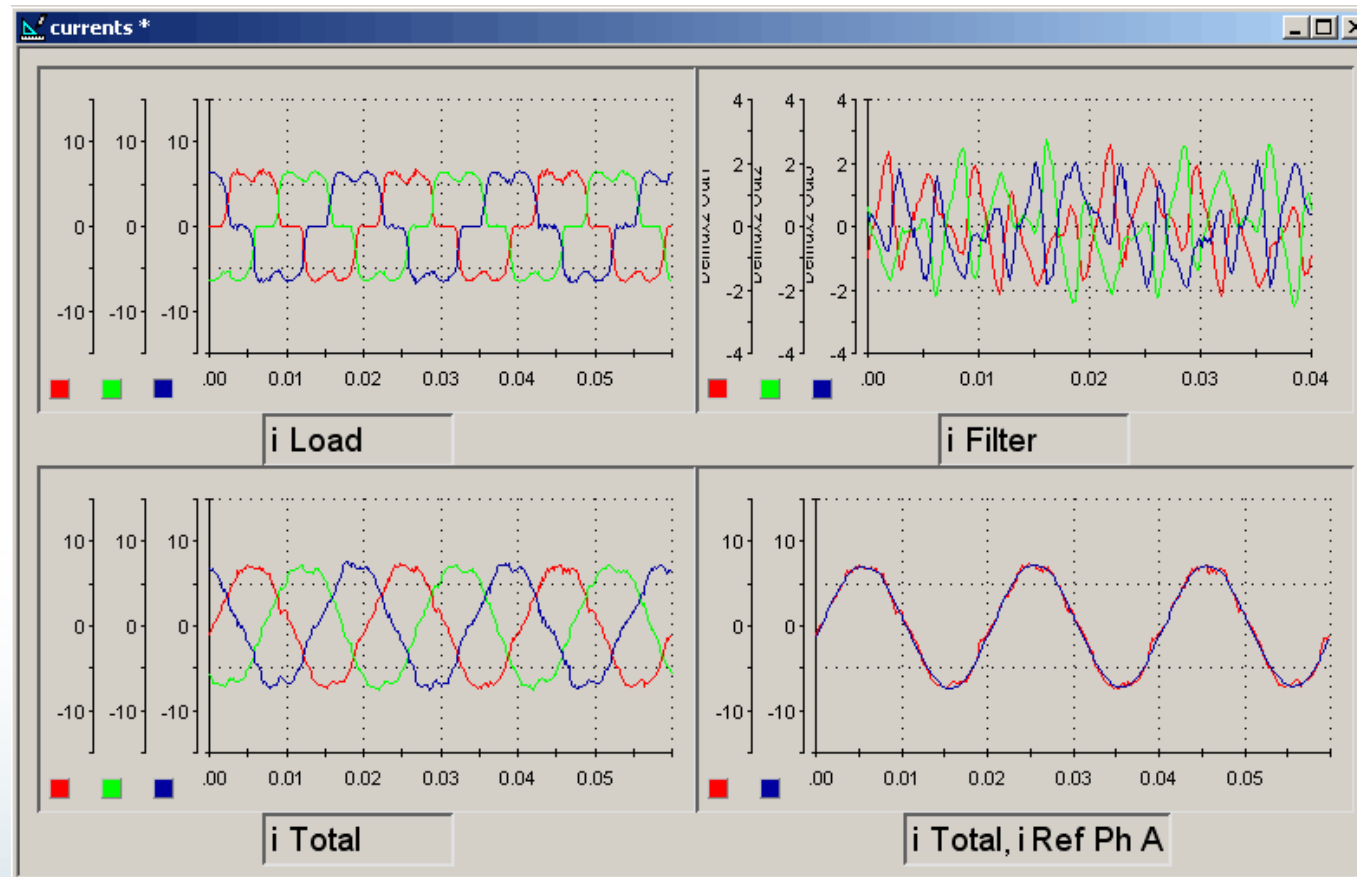


Fig. 15 Experimental results for power and control parameters