a-eberle

LVRSys
the revolutionary low- voltage- regulation- system

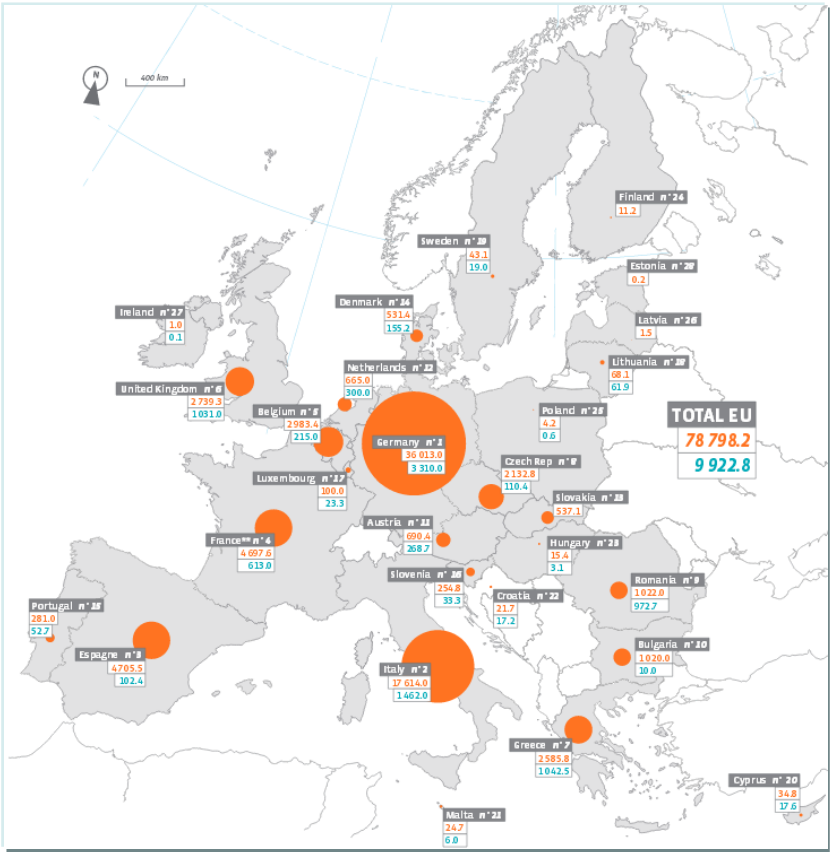
Agenda

- Photovoltaic in Netherland and worldwide
- Changes in the low voltage network
- Controling systems in the low voltage network
- LVRSys applications

Photovoltaic installations Netherland

	2012	2013
Germany	26 380.0	30 000.0
Italy	18 862.0	22 146.0
Spain	8 193.0	8 289.0
France	4446.0	4 900.0
Greece	1 232.0	3 648.0
Belgium	2 149.0	2 352.0
Czech Republic	2 149.0	2 070.0
United Kingdom	1 1879	1 800.0
Bulgaria	754.0	1348.5
Austria	337.5	686.0
Slovakia	561.0	600.0
Netherlands	253.8	582.0
Denmark	338.0	490.0
Portugal	393.0	446.0
Romania	7.5	397.8
Slovenia	162.8	240.0
Luxembourg	38.3	50.0
Lithuania	2.0	45.0
Cyprus	19.8	45.0
Sweden	21.4	38.8
Malta	13.6	30.1
Croatia	3.7	12.3
Hungary	79	9.3
Finland	5.4	5.4
Poland	3.4	4.0
Ireland	0.7	0.7
Estonia	0.6	0.6
European Union	**67523**	**80236**

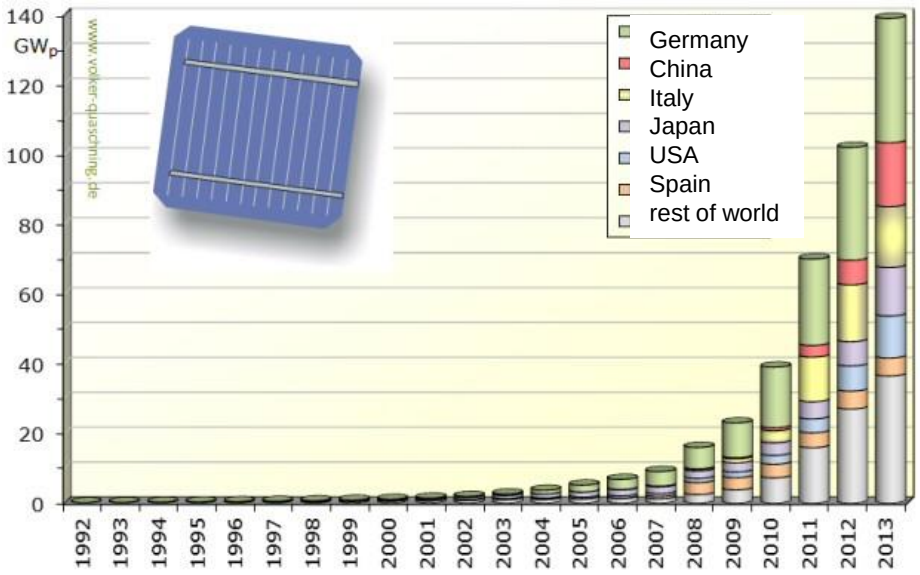
*E stimate. ** Overseas department included for France. Source: EurObserv'ER 2014.



20% reduction in EU greenhouse gas emissions below 1990 levels

Baro-jdp11_en.pdf

Photovoltaic installations worldwide



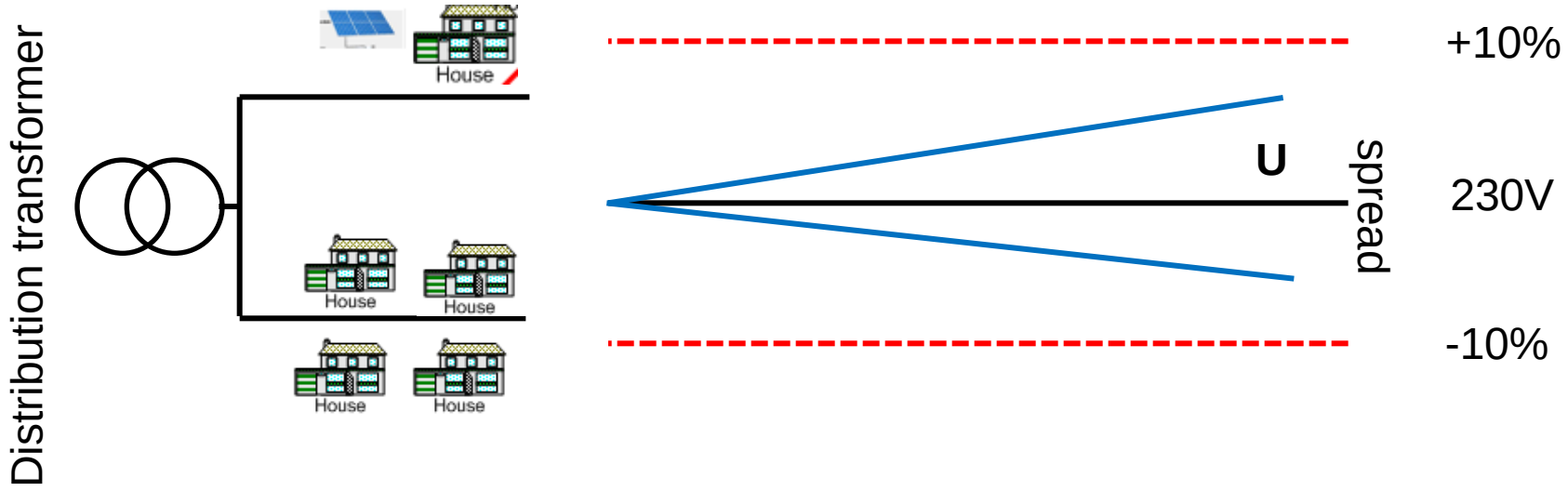
Total photovoltaic peak power capacity (MWp)[70][71]				
Country or Region	2010	2011[72]	2012[73][74][75]	2013 (est.)
World	39,778	69,684	102,024	140,000[76]
European Union	29,328	51,360	68,640	
Germany	17,320	24,875	32,411	36,600[77]
Italy	3,502	12,764	16,987	19,000[76]
China	893	3,093	8,043	20,000
United States	2,519	4,383	7,665	11,933[77]
Japan	3,617	4,914	6,704	15,700[78]
Spain	3,892	4,214	5,166	
France	1,025	2,831	3,843	4,330[79]
Belgium	803	2,018	2,650	
Australia	504	1,298	2,291	
Czech Republic	1,953	1,960	2,072	
United Kingdom	72	1,014	1,831	3,300[76]
India	189	461	1,839	2,180[80]
Greece	206	631	1,536	
Romania				1,155[81]
Bulgaria	18	133	1,066	
South Korea	662	754	1,006	
Canada	200	563	831	
Slovakia	145	488	523	
Austria	103	176	418	
Switzerland	111	216	416	

http://www.erneuerbare-energien-und-klimaschutz.de/datserv/pv-welt/index.php
http://en.wikipedia.org/wiki/Solar_power_by_country

Changes in the low voltage network

Voltage bands in unregulated networks

- **Voltage rise on lines with a decentralized supply**
- **Voltage drop in cables without a decentralized supply**



Choices for solving voltage problems

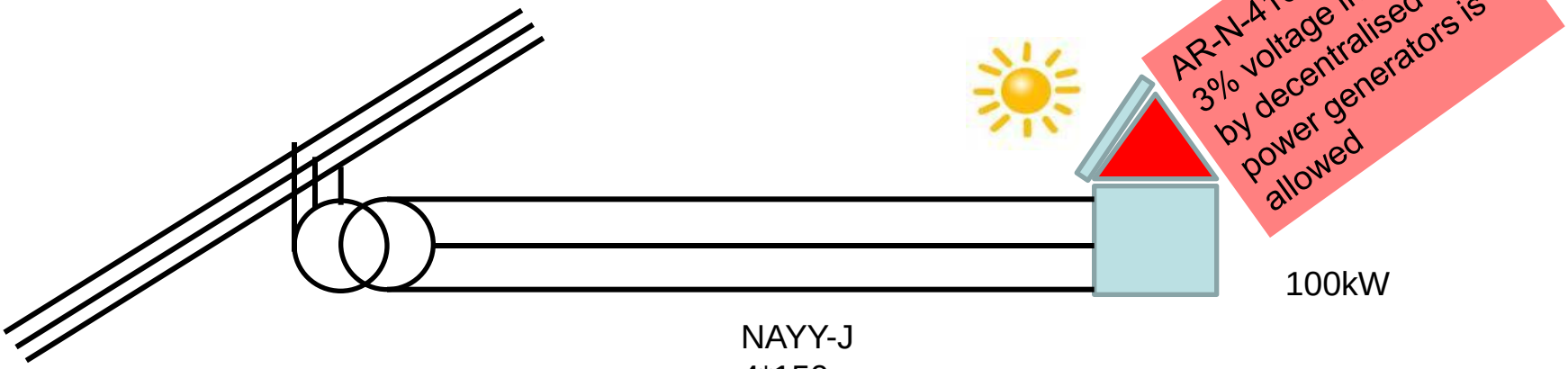
The problems of increasing voltage can be solved via:

- **Upgrading Lines**
  - + increases the short circuit power
  - - upgrading with a larger conductor size is very expensive
  - - changing from overhead lines to cable is very expensive
  - - does not solve over-voltages

- **Reactive power control**
  - + cheapest control method
  - - does not really work in the low voltage urban network

- **Active voltage control**
  - + increases the utilization of the lines
  - + solves over-voltages
  - - additional electrical losses

Line expansion



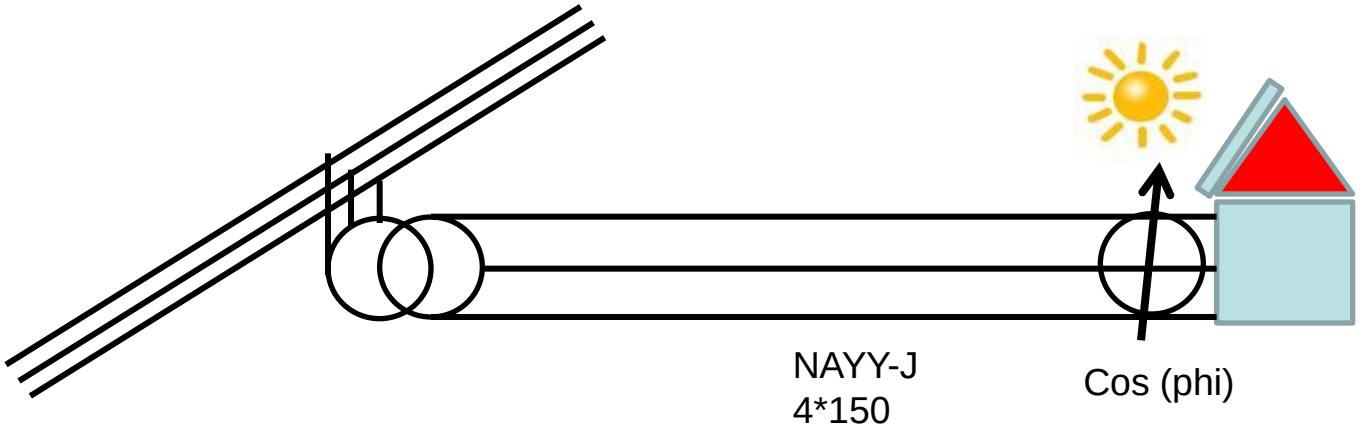
Voltage drop across LV cable

Type	NA2X2Y 4*150
Length l	500 m
Resistance R	0.5 km * 0.206 Ω/km = 0.1 Ω
Reactance X	0.5 km * 0.08 Ω/km = 0.04 Ω
Current	290A
Capacity	200kW

$$\boldsymbol{\Delta U_K} = \frac{S_A * (R_K * \cos(\varphi) - X_K * \sin(\varphi))}{U^2} = \frac{100kVA * (0{,}1\Omega * 1 - 0{,}04\Omega * 0)}{400V^2} = 6{,}2\% \triangleq 25V$$

$$S_E = \frac{\Delta u * U^2}{R * \cos(\varphi) \pm X * \sin(\varphi)} = \frac{0{,}03 * 400^2}{0{,}105 * 1 - 0{,}053 * 0} = 45{,}7KW!!$$

Reactive power control

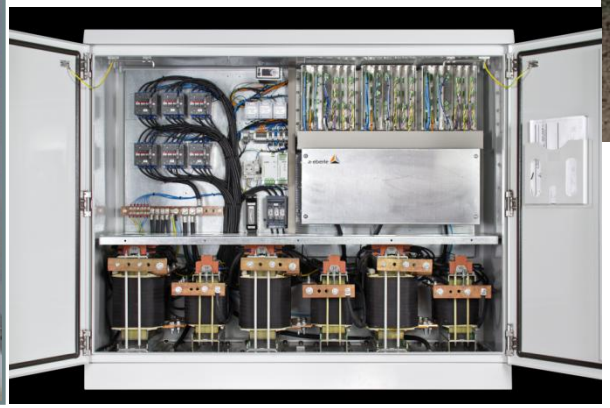


$$\boldsymbol{\Delta U_K} = \frac{S_A * (R_K * \cos(\varphi) - X_K * \sin(\varphi))}{U^2} = \frac{100kVA * (0{,}1\Omega * 0{,}9 - 0{,}04\Omega * 0{,}44)}{400V^2} = 4{,}4\%$$
$$\triangleq 17{,}6V$$

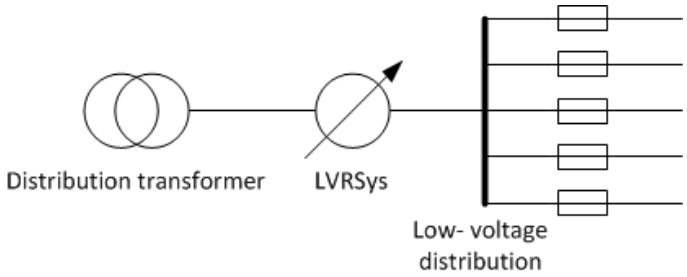
VDE AR-N 4105

3,68kW - 13,8kW	:	Cos (phi) von 0,95
> 13,8kW	:	Cos (phi) von 0,90

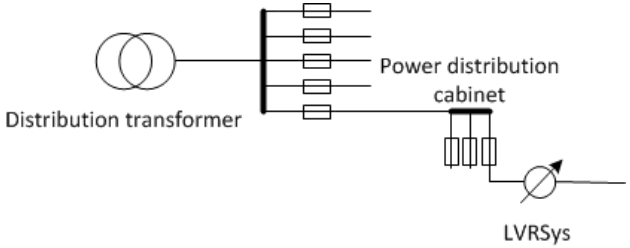
LVRSys active voltage control



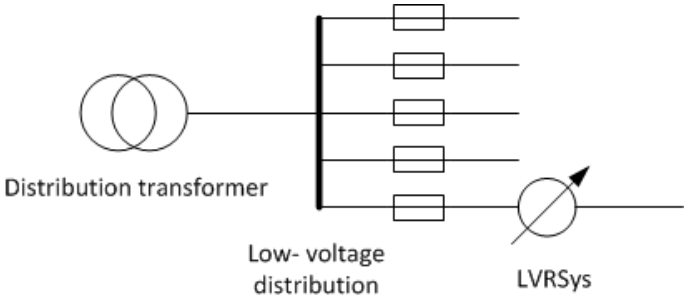
Applications of LVRSys in the low voltage network

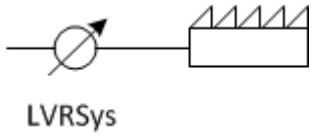


250kVA - 630kVA



50kVA - 250kVA

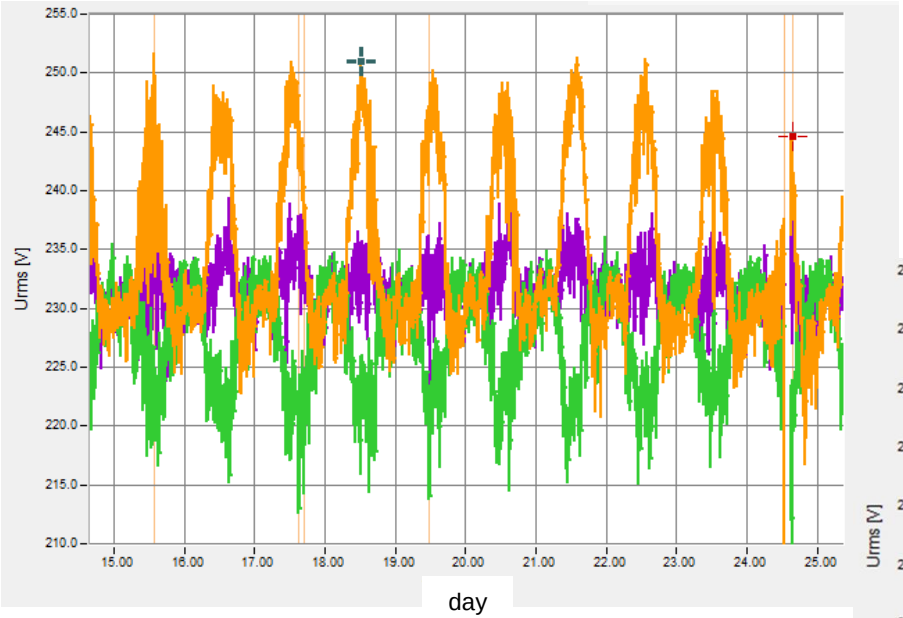




50kVA - 630kVA

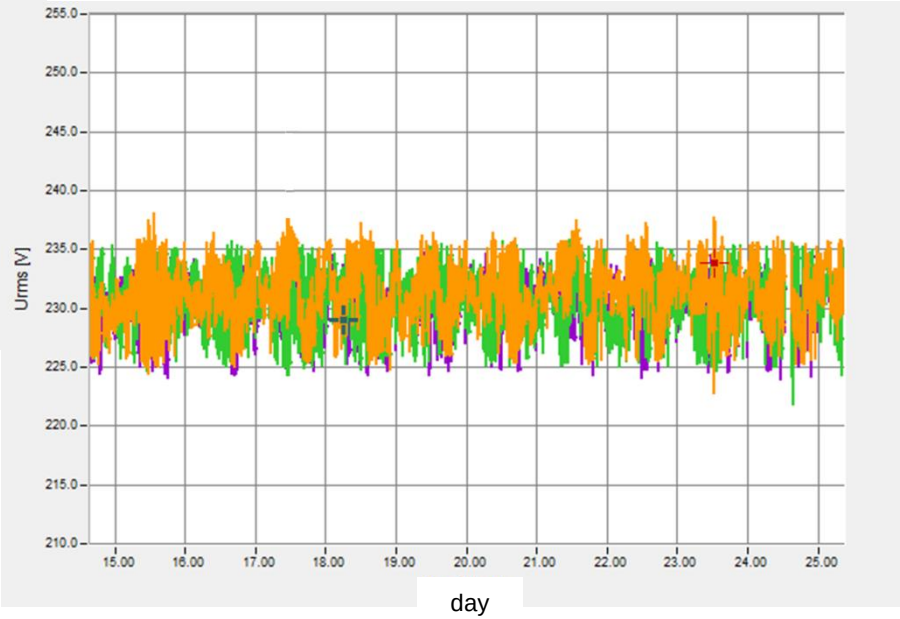
Non regulated input voltage

Regulated output voltage

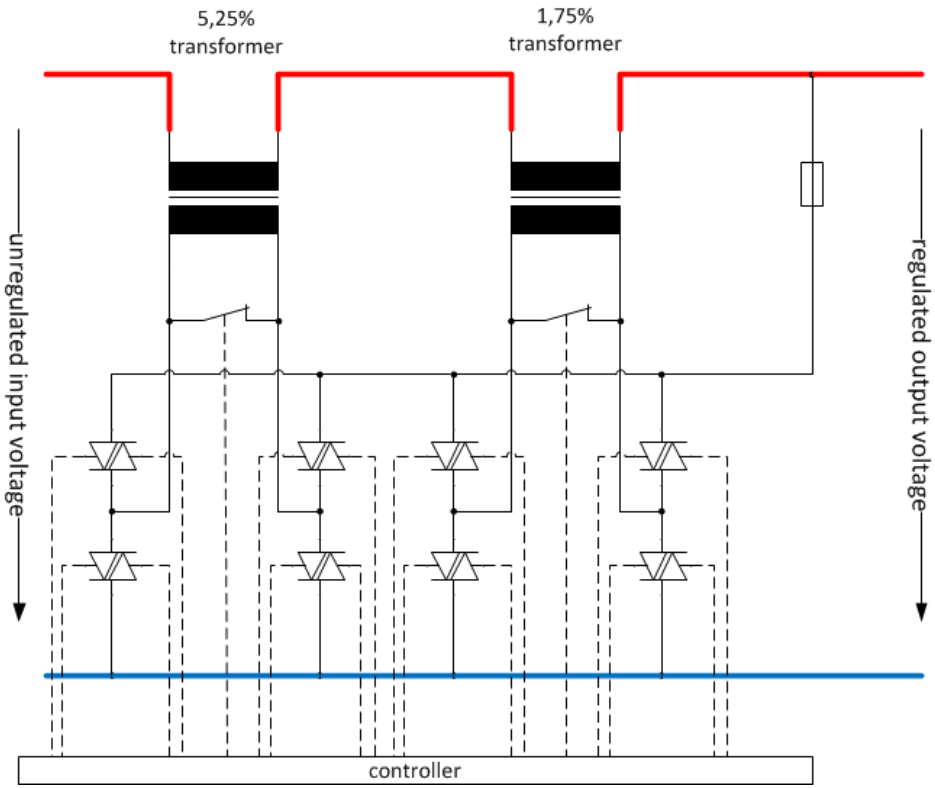


without LVRSys

with LVRSys



Technical overview LVRSys
1 phase



LVRSys applications

- Voltage instability caused caused by renewable energy
- Voltage instability caused by changed loads (heat pump/electro mobility)
- Unbalance caused of one phase loads/feeders
- Energy saving in the industrial sector

Guiding principle
„wherever a voltage stability problem exists, however the current carrying capacity of cables and transformers is not fully utilized, the LVRSys™ is a convenient and affordable alternative to solve this problem“