Low Voltage Regulation System LVRSys™

- Power range: 7,5 kVA up to 630 kVA
- Regulation ranges: ± 6 % … ± 20 %
- Number of steps: up to 9
- Overall efficiency: 99,4 % bis 99,8 %
- maintenance like outdoor LV-cabinets
- Phase independent regulation
- No grid interferences

Changes in the distribution grids create new challenges

Smart Grids and the resulting changes in the distribution grids face many distribution grid operators with different challenges. These include:

- Voltage range deviations becoming more frequent and more critical.
- Photovoltaic systems in the low-voltage grid raise the voltage level.
- Photovoltaic systems dominate the daytime voltage level.
- The increase of heat pumps and electric vehicles lower the voltage level, and both dominate the voltage level in the evening as well as at night.
- The majority of electric vehicles are charged at home in single-phase.
- Voltage increases and voltage decreases are usually time-shifted.
- Asymmetries of the 3-phase voltages occur more frequently.

This economic analysis is intended to help power utilities in the planning process of the distribution grid to make the right decision for their investment and to pitch if a line expansion is worthwhile or not.

Low investment- and operating costs make the LVRSys™ attractive in comparison to line expansion

Economic analysis

Our analysis examines in which scenario an LVRSys™ pays off compared to conventional line expansion. A distinction is made as to whether the line expansion is carried out with low (scenario "country") or high capital investment (scenarion "village"). The costs for one kilometre of "village" line expansion are taken as the basis here. An LVSys™ system with 110 kVA is used for the cost comparison. A service life of 40 years is assumed in all scenarios.

LVRSys™ investment costs

The investment costs of the individual resources were summarised on the basis of the BMWi distribution grid study (Büchner, J.; Katzfey, J.; Flörcken, O. (2014): "Moderne Verteilernetze für Deutschland", BMWi). The investment costs are assessed at 1 km ≙ 100% relative to "village" line expansion.

	Investment
Line per km “country” / “village”	**60% / 100%**
LVRSys™ 110 kVA	**15%**

Table 1: Investment costs line per km vs. LVRSys™

LVRSys™ operating costs

The operating costs are made up of the maintenance costs, the electricity heat losses and the planned replacement of the electronics after 20 years until the end of the total service life. No maintenance costs are expected for the lines. A comparison of the operating costs is shown in Table 2, also in relation to basis 1, which corresponds to the costs for one kilometre of "village" line extension.

	Costs	Useful life/ interval [in years]
Line “country” / “village”	**0%**	**40**
LVRSys™ Electronics	**1%**	**20**
LVRSys™ Maintenance	**0,4%**	**5**

Table 2: Operating costs line vs. LVRSys™

Maintenance is limited to cleaning the switch cabinet and checking the screw connections. For the costs of electricity heat losses, it is assumed that the LVRSys™ is in operation throughout the year with an average load factor of 50 % and an efficiency of 99.5 %. The results of the analysis are visualised in Figure 1.

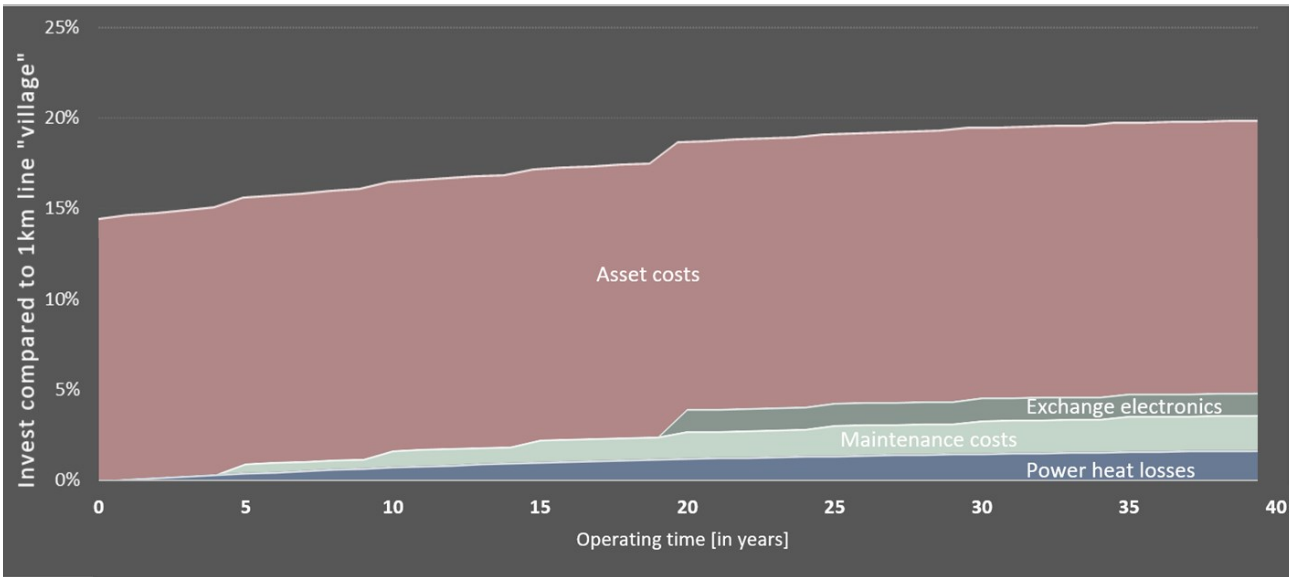

Figure 1: Investment requirement LVRSys™ 110 kVA with a useful life of 40 years and discounting of 5%.

Cost parity already exists from a few hundred meters of line

Investment calculation

The investments are calculated over the entire lifetime and discounted to the current year according to the capital value method.

Table 3 shows the cost parity with the LVRSys™ over the entire operating period of 40 years, starting from the length of the line extension.

Cost parity Line extension	Costs „country“	Costs „village“
LVRSys™ 110 kVA	33 % ≙ 330 m	20 % ≙ 200 m

Table 3: Cost parity of the LVRSys™ compared to the line extension

Current heat losses in voltage regulation systems

Rising costs of energy losses are a concern for grid operators and require efficient grid management. LVRSys™ is optimised for this with an efficiency of **99.8 - 99.4%.** Alternative technologies for voltage regulation have efficiencies of < 99%. A comparison of long time energy losses is shown in table 4.

Energy loss during operating time	LVRSys™ 99,5 %	Alternative 99,0%“
1 year	5 MWh	10 MWh
40 years	200 MWh	400 MWh

Table 4: Current heat losses LVRSys™ compared to alternatives

Alternative to line extension

LVRSys™ represents a real alternative to line extension due to tension. As shown in our calculation, line expansion is associated with high investments. These investments tie up the capital employed for decades. The use of LVRSys™ is different. With the use of our system, comparatively low investments are required, which are also flexible and independent of location. If the conditions in the distribution network change fundamentally, the system can simply be relocated and work elsewhere.

Additional benefits of using LVRSys™

Compared to line expansion, the following additional benefits must be taken into consideration:

- Flexible use: assembly/disassembly as required.
- Guarantee of VDE-AR-N 4105 with regard to voltage swing (3%) through decentralized generation systems.
- Optional with EN 50160 monitoring.
- Recording of useful data in the grid.
- Increase in the transmission power of the lines used by 20%.
- Reduction of network losses.

Conclusion: Not just an alternative, but a useful tool for the future

LVRSys™ low voltage regulation system is not only a cost-effective alternative to line expansion, but a tool for the grids of the future. Its use makes sense not only from an economic point of view. The system is developed with Future viability in mind and is designed to meet future challenges. It also offers a range of useful functions that useful functions that will provide our customers with significant added value in the low-voltage grid for years to come.