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University of Ljubljana
Faculty of Electrical Engineering
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Distribution Network Development Based on Stochastic Modelling Approach

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Abstract. The main objective of network planning is to determine a technical and economical optimal network development that will provide the required power quality and enable further integration of distributed generation (DG), despite their substantial impact on the network performance. Probabilistic approach of network planning is presented, which has many advantages compared to traditional approaches using estimated peak load/generation values and empirically defined simultaneity factors. The stochastic method enables the evaluation of voltage conditions and thus, by analysing different possible solutions to minimize the necessary investments, can form the basis for planning decisions.

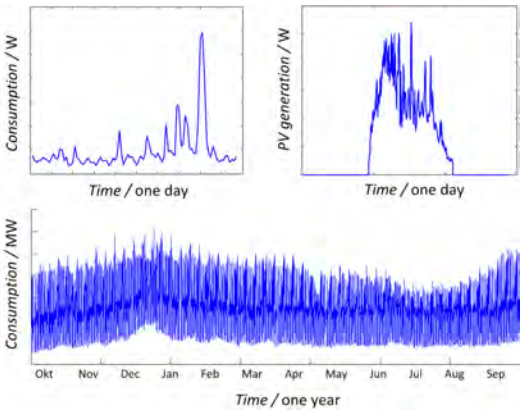
Current practice and key issues

- Network utilities should always provide sufficient network capacity to meet peak demand
- The network planning consists of using estimated peak values for loads and empirically defined simultaneity factors, worst case scenario is usually assumed
- Especially LV networks are usually oversized (cost inefficiency, environmental aspects, …)
- Penetration of DG is increasing, especially photovoltaic (PV)
- New technologies (ICT, MV/LV OLTC, …)

Stochastic modelling approach

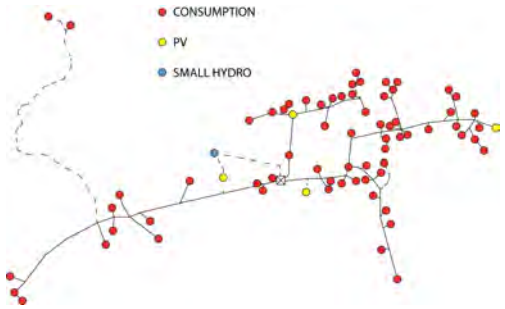
- Network planning with assumption of worst possible condition in the network is too pessimistic
- Due to stochastic nature of LV networks, statistical approach seems adequate
- Use of actual load diagrams
- The location of future PV in the grid cannot or is hard to determine; a statistical approach to PV placement is used
- The obtained data is statistically analysed, maximum PV penetration levels are defined

Use of actual load diagrams

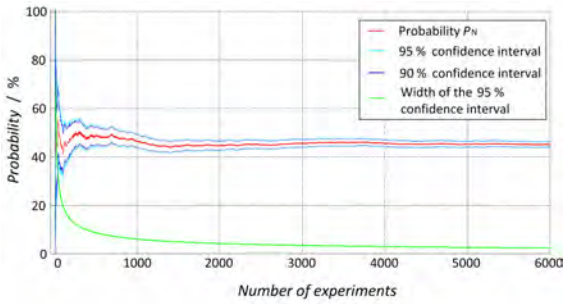


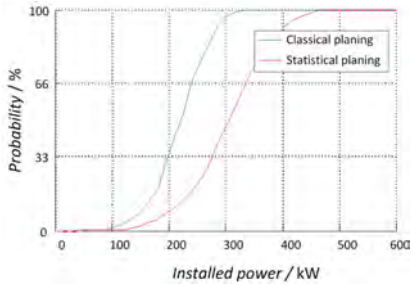
Study case

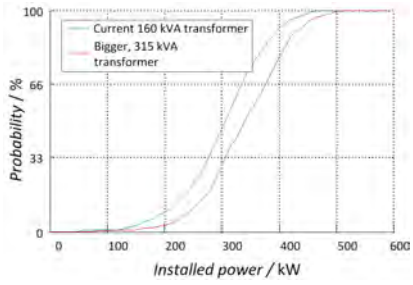
Actual LV distribution network

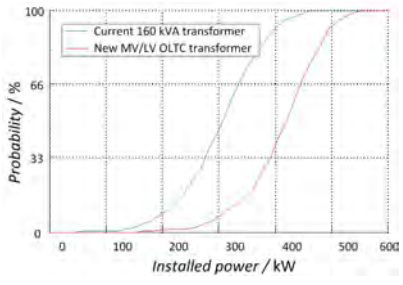


Dependence of the solution upon the number of experiments









Comparison of simulation cases

Action / operation mode	Max. amount of installed DG in the network at the 5 % acceptable risk / kW	Max. amount of installed DG in the network at the 15 % acceptable risk / kW
Classic (conservative) network planning (DG → 0 & P_{LOAD} → max.; DG → max. & P_{LOAD} → 0)	96	130
New probabilistic network planning DG operate by $Q(U)$	185	220
Installation of bigger transformer (315 kVA)	225	270
Installation of MV/LV OLTC transformer, rated power of 160 kVA	285	340

Conclusion

- Accuracy of planning relies heavily on assumptions relating the predicted customer load profiles and the network model
- With new technologies new data become available which could be taken into account when planning
- Worst case scenario planning results in oversizing of the network
- Different possible solutions to minimize the future network problems can be economically evaluated

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