Master's Thesis Engineering Technology

2019-2020

Modelling the impact of DERs in LV grids

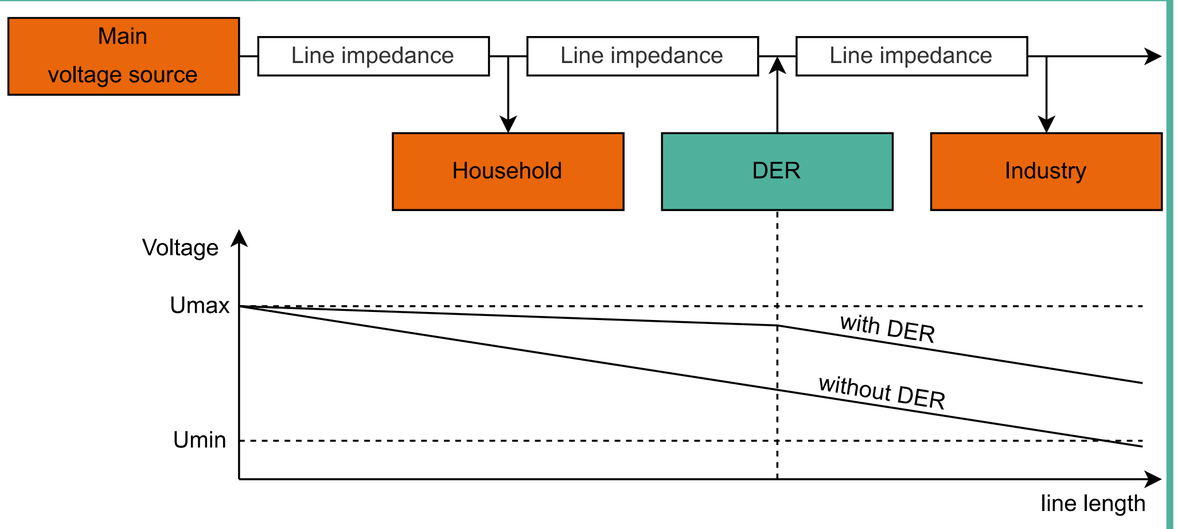
Arjen Mentens

Master of Energy Engineering Technology

Introduction

Our distribution grid is becoming a bidirectional lane for power. Distributed energy resources (DERs) are integrated at locations where distribution grid operators (DSOs) cannot control voltage and frequency levels. For local voltage control, **DERs can play an important role to provide extra grid support**.

This thesis focuses on low-voltage (LV) grids where inverter-based DERs, such as photovoltaic (PV) inverters, are often connected.



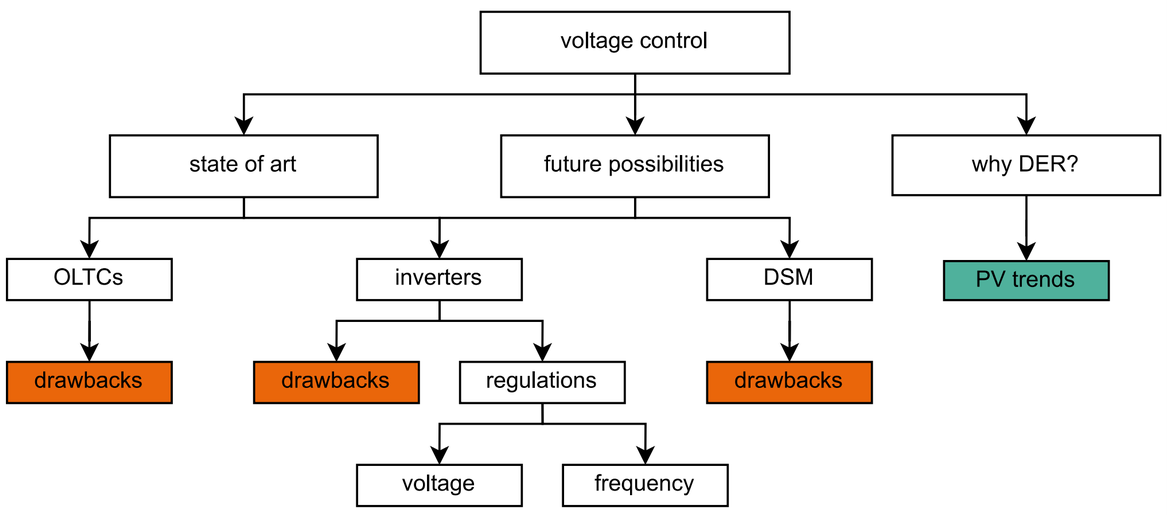
Overview

ON-LOAD TAP CHANGERS still play an important role, but they do not suffice anymore.

INVERTERS are widespread due to industrial and household installations, but there is a **lack of correct simulation models**

DEMAND SIDE MANAGEMENT can have a positive effect, but requires a great effort from the demand side itself.

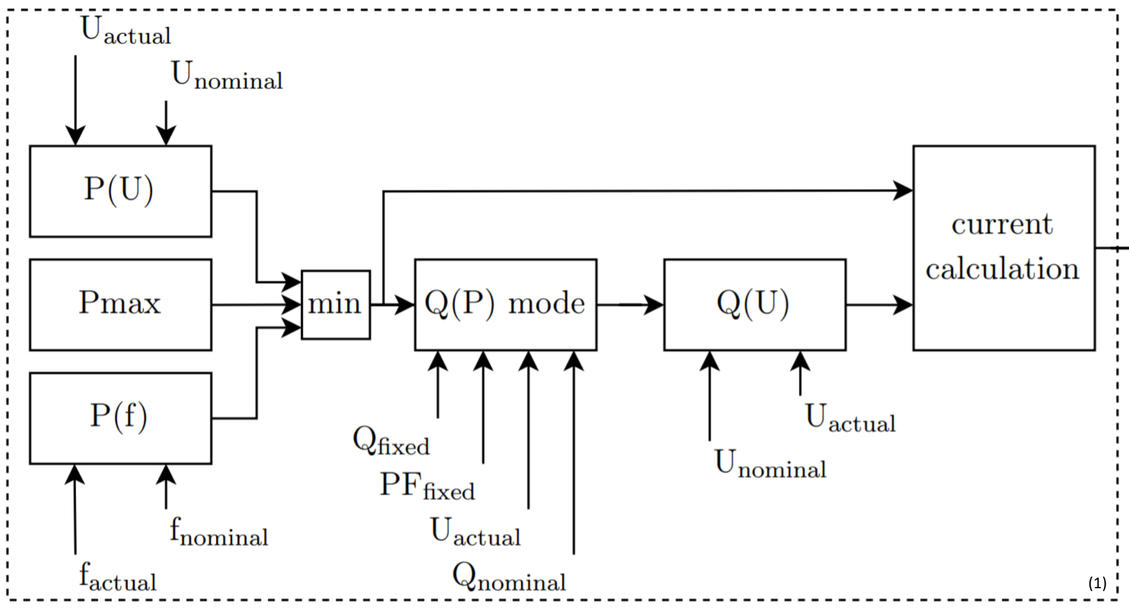
PV provides only 4.3 % of the total energy consumption in Belgium, but they are widespread and therefore **ideal for providing grid support**.



Every discussed possibility has its drawbacks. The main drawback of correctly implementing (PV) inverters is tackled in this master's thesis.

Implementation using Simulink

The simulation model comes down to this scheme. First, the available active power is calculated as a function of the actual voltage and frequency level. Second, the reactive power can be chosen using different reactive power modes. Third, current is calculated using the available active and reactive power. Finally, the output is limited and fed in.



For this model to function as expected, a correct equivalent grid diagram has to be developed. Values provided by DSOs are used for transformer and grid impedances so that **test results can be compared to real-life results**. The model uses the phasor simulation method. Only the magnitude and phase of the signal are of importance. This can undoubtedly reduce the computing time.

Conclusion

DERs can play an important role in providing support for the grid. The lack of simulation models made the impact on the grid uncertain and for this reason, the Simulink model is developed:

- grid dynamics can be evaluated by imitating voltage and frequency deviations;
- support functions can either be adjusted according to the situation or turned off and different levels of DER integration can be set;
- case studies show that the model corresponds to expected behavior and can be used for further development;
- together with adjustable function settings according to DSO requirements,
  this model offers flexibility and insight in the capabilities of DERs to solve voltage and frequency issues.

Supervisors / Cosupervisors: Prof. dr. ir. Wilmar Martinez
Dr. ing. David Topolánek

(1) C. Dierckxsens, "METAPV: technical project overview and results," 2015. [Online]. Available: http://www.metapv.eu/sites/default/files/PR_PR104282_FullProjectReport_F.pdf. [Accessed: 31-Dec-2019].

UHASSELT

KU LEUVEN