Future power grid planning in urban distribution system structures

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Motivation and Goals

- Change in electrical energy supply away from central, conventional power plants to renewable, decentralized generation plants
- In the future, stronger sector coupling through politically driven electrification of the transport and heating sector (e.g. e-mobility, heat pumps, CHP unit)
- Strong effects on regional and local distribution systems (grid levels 4-7, see Fig. 1) and thus influence on grid areas of many municipal utilities
- Investigation of scenarios for future distribution system development and grid customer behavior using real distribution grid models from the municipal utilities Forchheim and Waldmünchen
- Development and validation of new options for planning and operating urban distribution systems
- Deriving recommendations for action and developing a guideline for distribution system operators

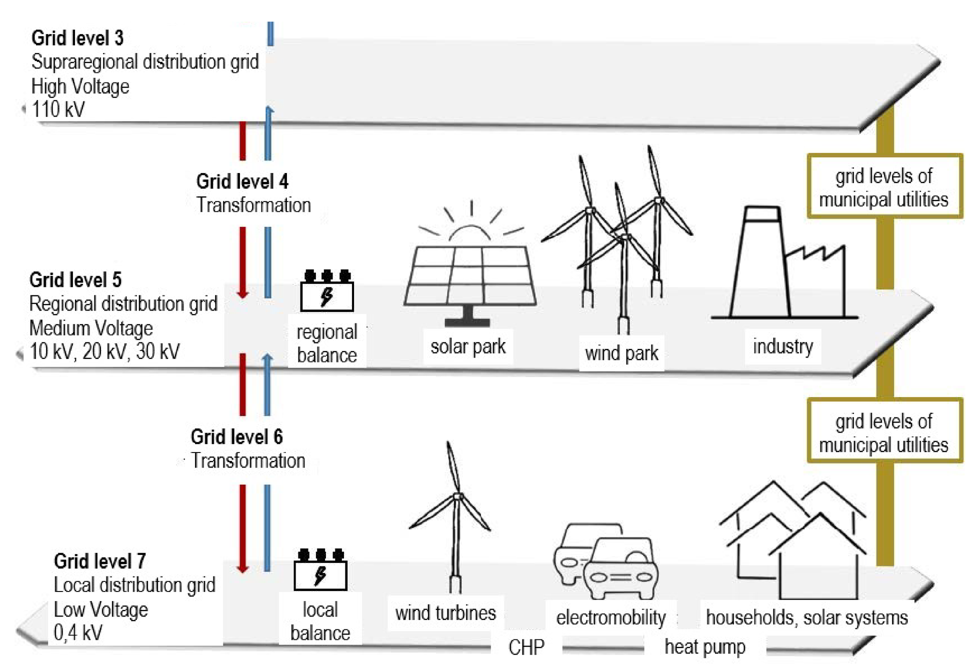

Figure 1: Voltage levels (HV-LV) in the German power grid (Reference: RCER, OTH Regensburg)

Research network "STROM"

- Research association consisting of various research / industry partners (see Fig. 2) investigating sector coupling for the future decades
- Sub-project of OTH is grid planning and operation of urban distribution systems with the municipal utilities Forchheim and Waldmünchen as industrial partners

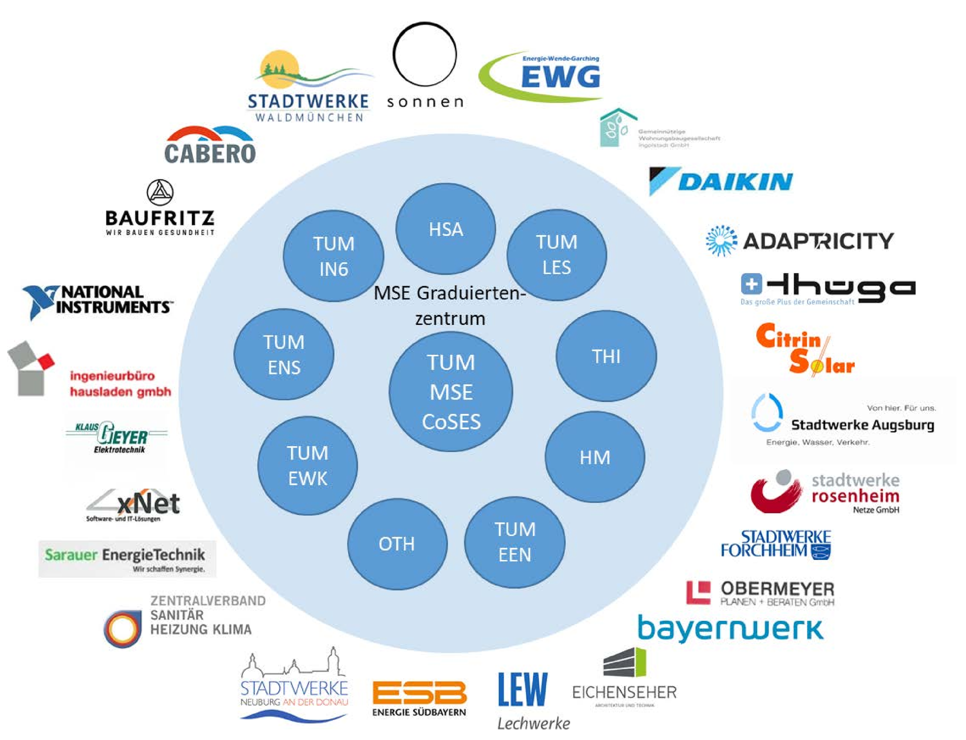

Figure 2: Overview of academic and industrial partners in STROM (Reference: MSE, TU München)

Research Questions und Working Objectives

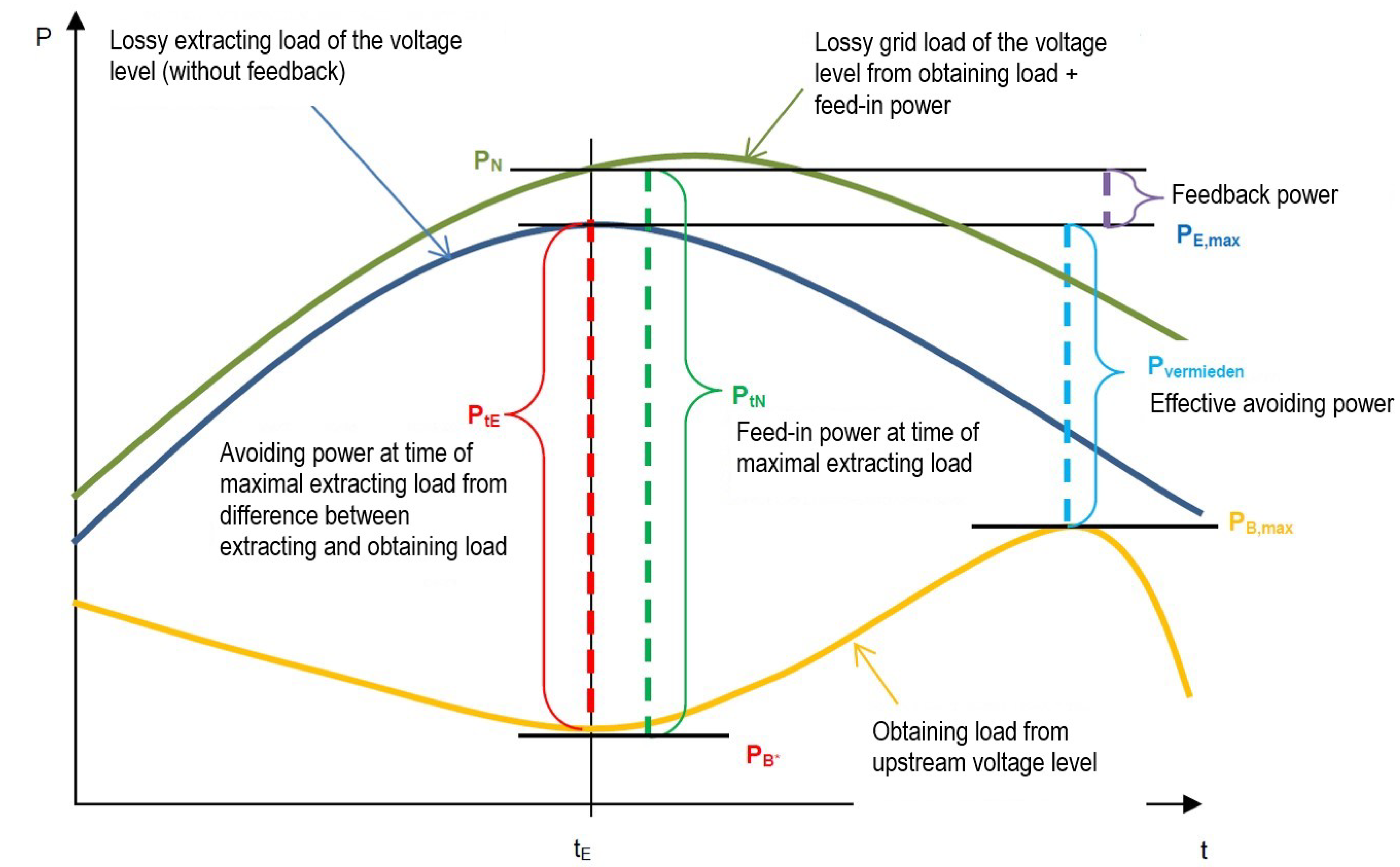

Figure 3: Illustration of avoiding power (Reference: https://www.regulierungskammer-bayern.de/veroeffentlichungen/2021-03-16_Tool_vermiedene_Netzentgelte_fuer_StromNB.xlsm)

Research Questions:

- How does a realistic development of the CHP systems (heat pumps and CHP unit) and e-mobility in the grid areas of the municipal utilities Forchheim and Waldmünchen look like?
- What effects does the higher sector coupling have on the considered grid areas and where do bottlenecks arise?
- Which grid restrictions (voltage limits, utilization limits, exchange of services with the upstream system operator, etc.) are relevant today and what development can be foreseen on the basis of the specified scenarios?
- With which grid planning measures can arising load and voltage problems from a technical and economic point of view be efficiently solved?

Working Objectives:

- Digitalization of the grid areas of the municipal utilities Forchheim and Waldmünchen with the aim of realistic modeling and use for quasi-dynamic load flow simulations and sensitivity analyzes
- Validation of the modeling methods based on measured values at the substation to the upstream system operators
- Analysis of the current and voltage conditions, the active and reactive power balances, the electrical losses and the short-circuit conditions in the considered grid areas
- Consideration of scenarios for the temporal and spatial development of generation and load systems, heat consumers, small storage facilities, residential and commercial areas as well as e-mobility with different degrees of penetration and simultaneity factors
- Determination and evaluation of the investment and operating costs of the considered scenarios, depending on the used grid expansion and grid optimization measures
- Investigation of the use of large storage facilities as grid equipment with a suitable gird connection and grid-supporting control
- Determination of the potential for avoiding peak loads when using a large storage system and the influence on the composition of the resulting gird fees (see Figure 3)
- Analysis of the current grid fee systematic and elicitation of optimization potentials with regard to the current grid situation and the development of the considered gird areas based on the future scenarios
- Deriving recommendations for action and developing a general guide for distribution system operators
- Implementation of the preparation, calculation, grid expansion and grid optimization routines required for the grid planning process with a high degree of automation

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STROM