A3.2 Analysis and Synthesis to Energy Efficiency Optimisation

Time: Tuesday, 14.09.2010
Location: Humboldt-Building, Lecture Room 011
Chairman: P. Bretschneider (DE-Ilmenau)

1:30 p.m.	S. Klaiber, S. Nicolai, P. Bretschneider (DE-Ilmenau)

Acquisition of Grid Losses Using Intelligent Forecast Methods

A part of electric power is lost at transmission due to transport, transformation and consumption in the transmission facilities. The energy used for compensation of these physical caused grid losses is known as grid losses energy. Operators of electricity grids are obliged to obtain losses energy at a market-based procedure. Transmission system operators (TSO) themselves occur in the market for electricity to acquire such energy services in their own procurement processes as a result of the unbundling required by law and regulations of the Federal Network Agency. For an acquisition of the energy necessary to compensate the grid losses in a control area as costs minimal as possible intelligent and efficient methods for the forecast of grid losses are needed. Within the framework of this article a method used for the forecast of grid losses in a transmission grid is presented. The amount of grid losses in addition to the grid load depends on a number of exogenous factors. In the modeling process the identification of the exogenous factors is of vital importance. Boundary conditions such as the availability of data affect the way in which exogenous factors in practice may be used for the forecast of grid losses. By situational changes in load flows in a transmission grid greatly time variant dependencies of the grid losses to its exogenous factors are detectable. The actual application necessitates specific requirements in forecast strategy and the concept of the forecast method. Artificial Neural Networks (ANN), which are able to map non-linear coherences at an incomplete describable process in a model, are used as model approach for the forecast method. In this context various special network architectures were investigated. The developed grid losses forecast method as the result of the work represents an extension of ANN at an auto-adaptive method for continuous evaluation of the input data and internal parameters. The method was implemented in software engineering and embedded in the energy management system PROPHET Solutions.

1:50 p.m.	S. Ritter, P. Bretschneider (DE-Ilmenau)

Stochastic Optimization of Power Supply Processes in Liberalized Energy Markets

State-of-the-art decision support systems are indispensable for the optimization of power supply processes. There is a variety of reasons for this e.g. the essential modifications in the energy policy in recent years and attended by this a continuously raised number of determining factors as well as ever increasingly complex boundary conditions of optimization models. At the optimization of power supply processes with the objective of minimizing total cost and under supply guarantee considerations determining factors such as the feeding-in of fluctuating renewable energy, the energy demand of private and industrial loads, the prices for energy trade (e.g. charges at the spot market or charges for primary energy carriers) or weather fore-casts are usually stochastic and hence are subject to risks and uncertainties to a great extent. The consideration of these uncertainties in the optimization models should therefore be an essential requirement for the decision support system used. Within the scope of this paper for a specially selected decision support system a possible way to make these stochastic optimization problems numerically solvable is presented, in particular by describing the stochastic of determining factors by a finite number of scenarios. This description is realized by state-of-the-art methods for construction and reduction of scenario trees which have to be constructed and reduced in such a way that information about the distributions of the stochastic determining factors are represented as precisely as possible. A summary and evaluation of the presented results constitute the finalization of this paper. In addition the finalization of this paper will give a prospect of continuative research activities in the field of stochastic programming to generate optimal decisions by randomness influences.

2:10 p.m.	H. Zhang, P. Li (DE-Ilmenau)

Chance Constrained Programming for Optimal Power Flow Taking Account of the Load Power Variation

In power system operations, the future power load is not known precisely as its value fluctuates from time to time. This stochastic nature of load makes load forecasting errors always exist. In this paper the load variation is taken into account to optimal power flow (OPF) problems and is considered as a random vector associated with normal distribution. Monte-Carlo simulation (MCS) is made to investigate effects of the random inputs to the system operation. Then, a solution strategy with chance constrained programming (CCP) is implemented to deal with the uncertainty with which the inequality constraints of the formulated optimization problem can be transformed into chance constraints with pre-defined confidence levels. In this way, relations between the aspects of reliability and optimality for the power system economic dispatch can be established, i.e. a compromise for an optimal decision can be made. A back-mapping approach and a multivariate integration method are incorporated into the CCP framework so that the probabilities of holding the constraints as well as their derivatives can be numerically computed in each iterate of the solution scheme. As the monotone relation between the dependent variable and an input random variable is a prerequisite for using the back-mapping approach, a linear approximation method is introduced to obtain these monotonies in the optimization process. Results of the IEEE 9-bus test system will be presented to demonstrate the effectiveness of the proposed approaches and the scope of the chance constrained OPF.

2:30 p.m.	Ch. Mattern, P. Bretschneider (DE-Ilmenau)

Predicting pattern-based time series using models derived from statistical data compression

This paper investigates the possibility of transferring forecasting methods motivated by data compression into the domain of pattern based time series prediction. Pattern based time series are characterized by typical, repeating signal subsequences. The investigations are done on the example of short term load forecast. Statistical data compression relies on pattern matching and the forecast of future patterns' probabilities. A subclass of statistical compression algorithms, Context Mixing (CM), combines the probability estimations of several individual predictors and obtains outstanding compression performance. Statistical compression and the prediction of pattern based time series share a similarity, i.e. the prediction of real-valued entities. Hence carrying over CM concepts to time series prediction is of interest. The outline of a CM model is constituted of several specialized submodels and a mixing function to combine the individual predictions. All components rely on discrete contexts to divide a situation into distinct classes. In order to use CM concepts in time series prediction the CM model components and the context construction are investigated. A sample of electrical load data is analyzed to identify its typical characteristics. Subsequently a CM forecasting system is derived, taking the datas' properties into account. A simulation and an evaluation of the prediction error indicate very accurate forecasts.

2:50 – 3:10 p.m. Coffee break

3:10 p.m.	Y. Bodyanskiy, P. Otto (DE-Ilmenau), A. Babenko, S. Popov (UA-Kharkov)

Neural Network Approach to Signals´ Parameters Estimation in Electric Power Systems
Monitoring and full control of electricity flows is an important factor of an effective operation of electric power systems. It provides the possibility of an on-line analysis and optimal management of electricity distribution on the basis of modern achievements of power engineering and computer sciences. Computational intelligence techniques (mostly artificial neural networks and fuzzy inference systems) are widely used in this area during the last decades. However, specific character of signals in power systems (high levels of uncertainty and nonstationarity) makes the use of traditional neural networks inefficient and pave the way for the development of specialized architectures and learning algorithms aimed at the processing of polyharmonic nonstationary signals distorted by various types of stochastic and deterministic disturbances. In this paper, new architectures of neurons, networks and algorithms for their learning in real time are proposed. The obtained results allow improving reliability and efficiency of monitoring and diagnostic systems, especially under the circumstances of faults in the electric networks and in the presence of outliers in observations.

End of Lecture Session