

Discussion Deadline: January 2003

Online Risk-Based Security Assessment

Ni, M.; McCalley, J.D.; Vittal, V.; Tayyib, T.

Author Affiliations: Iowa State University, USA; EPRI, USA.

Abstract: The work was motivated by a perceived increase in the frequency at which power system operators are encountering high stress in bulk transmission systems and the corresponding need to improve security monitoring of these networks. Online risk-based security assessment provides rapid online quantification of the security level associated with an existing or forecasted operating condition. One major advantage of this approach over deterministic online security assessment is that it condenses contingency likelihood and severity into indices that reflect probabilistic risk. Use of these indices in control room decision-making leads to increased understanding of potential network problems, including overload, cascading overload, low voltages, and voltage instability, resulting in improved security related decision-making. Test results on large-scale transmission models retrieved from the energy management system of a U.S. utility company are described.

Keywords Security assessment, control center, probabilistic risk, uncertainty, voltage instability, cascading, overload, operations, decision-making.

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Software Implementation of Online Risk-Based Security Assessment

Ni, M.; McCalley, J.D.; Vittal, V.; Greene, S.; Ten, C.W.; Ganugula, V.S.; Tayyib, T.

Author Affiliations: Iowa State University, USA; Siemens Energy Management, Singapore; PricewaterhouseCoopers LLP, USA; EPRI, USA; ESCA, USA.

Abstract: This paper describes software implementation for online risk-based security assessment that computes indices based on probabilistic risk for use by operators in the control room to assess system security levels as a function of existing and near-future network conditions. Focus is on speed enhancement techniques that are essential for online application and result visualization methods that offer clear and meaningful ways to enhance human assimilation and comprehension of security levels. Results of testing on a series of 1600 bus power flow models retrieved from the energy management system of a large U.S. utility are presented and serve to illustrate the benefits of the software.

Keywords Security assessment, control center, probabilistic risk, uncertainty, voltage instability, cascading, overload, operations, decision-making, visualization.

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Optimal Reliable Operation of Hydrothermal Power Systems with Random Unit Outages

Amjady, N.; Farrokhzad, D.; Modarres, M.

Author Affiliations: Seman University, Iran; Sharif University of Technology, Iran.

Abstract: A new model for long-term operation of hydrothermal power systems is introduced, and a method for obtaining an optimal solution is developed. We assume both reservoir inflows and energy demand are stochastic and all units are exposed to random outages. The objective is to minimize the total cost of the system as well as the expected interruption cost of energy (EIC) during a given planning horizon. This goal is reached through simultaneous determination of hydro plant discharges, thermal units energy output, and the system reliability level. Long-term hydrothermal system operation planning and system reliability determination are integrated in a unified model. Since the resulting model is a large-scale stochastic nonlinear program, an algo-

rithm is especially developed to solve it. This algorithm, which includes decomposition technique, Lagrangian relaxation, nonlinear and dynamic programming, finds an optimal solution within three stages. To test the method, it is implemented for the Khuzestan power system in Iran, and the results are analyzed.

Keywords Optimization, reliability, hydrothermal, decomposition, outage, interruption cost.

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A New Horizon for System Protection Systems Schemes

Lachs, W.R.

Author Affiliations: University of New South Wales, Australia.

Abstract: Interconnected grid operation, control, and security will be revolutionized by a system protection scheme that safeguards the grid's integrity by adapting its responses to the most severe unforeseen disturbances. The new approach takes advantage of power system resilience to the initial impact of even the most severe disturbances. The disturbance causes changes of system vulnerability parameters that are used by the protection to direct preselected measures to affected locations. A system protection scheme that sustains system voltage stability and incorporates a simple emergency strategy is outlined. The approach allows practical and reliable, modest cost schemes that can gain considerable financial benefits in the operation and control of the grid.

Keywords: System voltage instability, multiple contingencies, system collapse, emergency control, system protection schemes, breakdown process.

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Power System Planning and Implementation

Performance Evaluation of Electric Distribution Utilities Based on Data Envelopment Analysis

Pahwa, A.; Feng, X.; Lubkeman, D.

Author Affiliations: Kansas State University; ABB, Inc.

Abstract: A method for benchmarking performance of electric distribution utilities based on data envelopment analysis (DEA) is presented. Basic theory of DEA is followed by case studies addressing performance analysis of 50 largest (based on MWh sales) electric distribution utilities in the USA. The results include performance efficiency, gaps in inputs and outputs of inefficient utilities, sensitivity based classification of utilities, and a gap report. Also, peer-to-peer comparison of inefficient with efficient utilities is provided. Based on these results inefficient utilities can develop strategic plans to improve performance

Keywords Strategic planning, decision-making, data envelopment analysis, performance benchmarking, gap analysis.

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A Comparative Analysis of Congestion Management Schemes Under a Unified Framework

Bompard, E.; Correia, P.; Gross, G.; Amelin, M.

Author Affiliations: Politecnico Di Torino, Italy; University of Illinois at Urbana-Champaign, USA; Royal Institute of Technology, Sweden.

Abstract: The restructuring of the electricity industry has spawned the introduction of new independent grid operators or IGOs, typically called transmission system operators (TSO), independent system operator (ISO) or regional transmission organizations (RTO), in various parts of the world. An important task of an IGO is congestion manage-

ment (CM) and pricing. This activity has significant economic implications on every market participant in the IGO's region. The paper briefly reviews the congestion management schemes and the associated pricing mechanism used by the IGO's in five representative schemes. These were selected to illustrate the various CM approaches in use: England and Wales, Norway, Sweden, PJM and California. We develop a unified framework for the mathematical representation of the market dispatch and redispatch problems that the IGO must solve in CM in these various jurisdictions. We use this unified framework to develop meaningful metrics to compare the various CM approaches so as to assess their efficiency and the effectiveness of the market signals provided to the market participants. We compare, using a small test system, side by side, the performance of these schemes.

Keywords: Congestion management and pricing, optimum power flow, market dispatch, congestion redispatch, economic signals.

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Fast Evolutionary Programming Techniques for Short-Term Hydrothermal Scheduling

Sinha, N.; Chakrabarti, R.; Chattopadhyay, P.K.

Author Affiliations: Jadavpur University, India.

Abstract: Fast evolutionary programming techniques are applied for solution of short-term hydrothermal scheduling problem. Evolutionary programming (EP) based algorithms with Gaussian and other mutation techniques have been developed and tested on a multireservoir cascaded hydroelectric system having prohibited operating zones and a thermal unit with valve point loading. Numerical results show that all EP algorithms are capable of finding very nearly global solutions within a reasonable time, but an EP-algorithm with the better of the Gaussian and Cauchy mutations appears to be the best among all EPs in terms of convergence speed, solution time, and cost.

Keywords Classical evolutionary programming, Gaussian mutation, Cauchy mutation, fast evolutionary programming, hydrothermal scheduling.

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A New Strategy for Transmission Expansion in Competitive Electricity Markets

Fang, R.; Hill, D.J.

Author Affiliations: University of Sydney, Australia; City University of Hong Kong.

Abstract: It will be important to develop a transmission network capable of handling future generation and load patterns in a deregulated, unbundled, and competitive electricity market. A new strategy for transmission expansion under a competitive market environment is presented. In the proposed strategy, a new transmission planning model considers a variety of market-driven power flow patterns while a decision-analysis scheme is incorporated to minimize the risk of the selected plan. Numerical examples are given to illustrate the potential of the proposed strategy to make a significant contribution to transmission planning in competitive markets.

Keywords Transmission planning, decision analysis, electricity markets, optimization.

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Simulated Annealing with Local Search: A Hybrid Algorithm for Unit Commitment

Purushothama, G.K.; Jenkins, L.

Author Affiliations: Indian Institute of Science.

Abstract: A hybrid algorithm was developed for the solution of the unit commitment problem. This hybrid technique uses simulated annealing as the main algorithm. At each temperature, fresh solutions are

generated randomly and with a high likelihood of being feasible. Local search is made in the neighborhood of the best solution using a heuristic decommitment technique. The hybrid algorithm is robust and has improved convergence as compared with earlier algorithms. The results obtained in system studies indicate its potential for solving the unit commitment problem.

Keywords Generation scheduling, local search, optimization techniques, simulated annealing, unit commitment.

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Customer Characterization Options for Improving the Tariff Offer

Chicco, G.; Napoli, R.; Postolache, P.; Scutariu, M.; Toader, C.

Author Affiliations: Politecnico Di Torino, Italy; Electrica Muntenia Sud Distribution and Supply Co., Romaniz; Universitatea Politehnica din Bucuresti, Romania.

Abstract: This paper deals with the classification of electricity customers on the basis of their electrical behavior. Starting from an extensive field-measurement-based database of customer daily load diagrams, we searched for the most appropriate indices or sets of indices to be used for customer classification. We propose two original measures to quantify the degree of adequacy of each index. Using the indices as distinguishing features, we adopt an automatic clustering algorithm to form customer classes. Each customer class is then represented by its load profile. We use the load profiles to study the margins left to a distribution company for fixing dedicated tariffs to each customer class. We take into account new degrees of freedom available in the competitive electricity markets, which increase flexibility in the tariff definition under imposed revenue caps. Results of a case study performed on a set of customers of a large distribution company are presented.

Keywords Electricity markets, load diagrams, load curve indices, customer classes, clustering.

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Determination of Optimal System Configuration in Japanese Secondary Power Systems

Hayashi, Y.; Matsuki, J.

Author Affiliations: Fukui University, Japan.

Abstract: In Japan, when a secondary radial power system (66 kV, 77 kV) has a number of connected feeders whose circuit breakers (CB) can be opened or closed, the combinatorial number of possible system structures created by switching CBs becomes very large. In order to determine the optimal configuration of a secondary radial power system in normal state and fault state, a new computation algorithm is proposed. The algorithm is based on enumeration and reduced ordered binary decision diagram (ROBDD). In order to verify the availability of the proposed approach, the authors obtain optimal configurations for both of normal and fault states on IEE of Japan secondary power system model (IEEJ model) by using the proposed method. The IEEJ model has the distinctive characteristics of practical Japanese power systems, the total number of configuration candidates is the 76th power of 2 (=75,000,000,000,000 billion approximately). The optimality of the system configuration obtained by the proposed method is mathematically guaranteed.

Keywords Optimal configuration, Japanese power systems, IEEJ secondary power system model, combinatorial optimization problem, enumeration method, reduced ordered binary decision diagram, optimality.

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