Energy Development and Power Generation

Steady-State Performance of a Grid-Connected Rooftop Hybrid Wind-Photovoltaic Power System with Battery Storage

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Abstract: This paper reports the performance of a 4 kW grid-connected residential wind-photovoltaic system (WPS) with battery storage located In Lowell, MA. The system was originally designed to meet a typical New England (TNE) load demand with a loss of power supply probability (LPSP) of one day in ten years, as recommended by the Utility Company. The data used in the calculation were wind speed and irradiance of Logan Airport Boston (LAB), obtained from the National Climate Center in North Carolina. The present performance study is based on two-year operation (May 1996 to April 1998) of the WPS. Unlike conventional generation, the wind and the sunrays are available at no cost and generate pollution-free electricity. At around noon the WPS satisfies its load and provides additional energy to the storage or to the grid. On-site energy production is undoubtedly accompanied with minimization of environmental pollution, reduction of losses in power systems transmission and distribution equipment, and supports the utility in demand side management (DSM). This paper includes discussions on system reliability, power quality, loss of supply, and effects of the randomness of the wind and the solar radiation on system design.

Keywords: Hybrid wind-photovoltaic system, grid-connected residential system, battery storage, loss of supply, system reliability.

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Power System Analysis, Computing & Economics

Z-Bus Loss Allocation

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Abstract: This paper presents a new procedure for allocating transmission losses to generators and loads in the context of pools operated under a single marginal price derived from a merit-order approach. The procedure is based on the network Z-bus matrix, although all required computations exploit the sparse Y-bus matrix. One innovative feature and advantage of this method is that, unlike other proposed approaches, it exploits the full set of network equations and does not require any simplifying assumptions. The method is based on a solved load flow and is easily understood and implemented. The loss allocation process emphasizes current rather than power injections, an approach that is intuitively reasonable and leads to a natural separation of the system losses among the network buses. Results illustrate the consistency of the new allocation process with expected results and with the performance of other methods.

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Enforcing Passivity for Admittance Matrices Approximated by Rational Functions

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Abstract: A linear power system component can be included in a transient simulation as a terminal equivalent by approximating its admittance matrix Y by rational functions in the frequency domain. Physical behavior of the resulting model entails that it should absorb active power for any set of applied voltages, at any frequency. This requires the real part of Y to be positive definite (PD). We calculate a correction to the rational approximation of Y that enforces the PD criterion to be satisfied. The correction is minimal with respect to the fitting error. The method is based on linearization and constrained minimization by quadratic programming. Examples show that models not satisfying the PD criterion can lead to an unstable simulation, even though the rational approximation has stable poles only. Enforcement of the PD criterion is demonstrated to give a stable result.

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Long-Term Thermal Power Planning at VEW Energie Using a Multi-Interval Bloom and Gallant Method

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Abstract: Bloom and Gallant have proposed an elegant model for finding the optimal thermal schedule subject to matching the load duration curve and general linear constraints. Their method is based on a linear program with some linear equality constraints and many linear inequality constraints. There are well-documented specialized linear programming algorithms that are able to solve this problem. This paper proposes the extension of the Bloom and Gallant model to several successive intervals with constraints on generation encompassing different intervals. A procedure for finding an initial feasible point—which is an essential part of the solution procedure—is described here, together with details of the modeling of several operational constraints and computational results with real test cases.

Keywords: Economics, linear programming, load modeling, active set optimization methods, long-term power generation scheduling, stochastic processes, thermal power generation.

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Reliability and Reserve in Competitive Electricity Market Scheduling

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Abstract: Power systems are typically scheduled at least cost subject to operational and security constraints. Generally, no account is taken of generator reliability when scheduling units. Also, the security criteria, which include reserve, are usually deterministic in nature. This paper proposes a method to consider generator reliability explicitly in the scheduling problem. A competitive structure is proposed that includes a market for reserve. This is formulated as an augmented Lagrangian dual function and is solved using a new recurrent neural network. The price for reserve is used, along with the unit reliability, to find a balance between the cost of reserve and the risk of not providing it.

Keywords: Power generation scheduling, ancillary services, reserve, reliability, neural network, augmented Lagrangian, competitive market.

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Auction Design in Day-Ahead Electricity Markets

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Abstract: Competition in day-ahead electricity markets has been established through auctions where generators and loads bid prices and