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2009 Power and Energy Society

Student Poster Contest

Advanced Program – D R A F T

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CALGARY TELUS CONVENTION CENTRE

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Welcome

On behalf of the IEEE PEEC Student Activities Subcommittee, I am very pleased that as part of the student program at the 2009 Power & Energy Society General Meeting in Calgary, Alberta there is both a student poster session and contest. This document has been put together to serve as a record of the outstanding work that has been prepared by students from around the world. The student program at the 2009 General Meeting is a true testament of the IEEE Power & Energy Society's commitment to internationalization and the development of future engineers. The student program at the General Meeting is made possible because of the support received from the Grainger Foundation.

The organization of the student events for the 2009 General Meeting has been a team effort involving Dr. Siddharth Suryanarayanan, Dr. Anurag Srivastava, Dr. Ganesh Venayagamoorthy, Dr. Henry Louie, Dennis Ray and Mazana Armstrong.

The Student Poster Session presents the works of students from universities around the world. The material presented in the over 70 posters represents most all topics in power and energy engineering.

The 2009 General Meeting Student/Faculty/Industry Luncheon will be held on Wednesday 29 July, from 12:00 p.m. to 2:00 p.m. in Hyatt Regency. The guest speaker for the luncheon will be Robin Podmore. Robin is the President of Incremental Systems Corporation.

Finally I would like to thank the leadership and support received from the 2009 General Meeting Local Organizing Committee, IEEE staff, and PES members, including Catherine Paull, Randi Scholnick, Susan Sacks, Manford Kwan, Bill Kennedy, and John Paserba. I hope all participants have an enjoyable and memorable experience at the General Meeting.

William (Bill) Rosehart, P.Eng, PhD
Chair, IEEE PES Student Activities Subcommittee
Professor, Schulich School of Engineering
University of Calgary

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Abstracts

1. Anita Ann Jose
   Kansas State University
   Poster Title: Wind for Schools-Wind Power
   Abstract: The poster would summarize the Wind for Schools Project.Kansas State University, a Wind Application Center has taken up the Wind for Schools Project supported by the National Renewable Energy Laboratories(NREL). As part of the project we install five turbines per year at rural schools throughout Kansas, and provide assistance to schools in educating their students about renewable energy,especially wind power.The project aims to promote Renewable Energy Resources and helps switch towards the growing field of Green Energy.

2. Jing Ma
   Virginia Tech
   Poster Title: Wave-Front Arrival Time Analysis Using Wide-Area Frequency Measurements
   Abstract: Due to the influence of the local noise at the distribution level, the frequency curve obtained from the frequency disturbance recorder (FDR) unit is too non-stationary to observe its wave-front directly, which causes some problems in the event location estimation method. In this paper, a morphological filter (MF) is employed to extract the wave-front arrival time and the trend of the frequency curve. With the help of the MF, the accuracy of the event location method is greatly improved.

3. Peng Yu, and Bala Venkatesh
   Ryerson University
   Poster Title: Unit Commitment Incorporating Wind Generators
   Abstract: Day-ahead unit commitment (UC) solution methods seek to determine the status and output of all available generators. In a world with an increasing integration of renewable energy sources such as wind electric generators (WEG), the UC solution process must model and include WEGs too in the decision-making process. Power output of WEGs in a day-ahead decision-making process is usually modeled using a short-term probabilistic forecast. Inclusion of WEGs introduces uncertainty in the solution that may be quantified through an imbalance risk function. Thus a UC solution method should seek a solution to minimize cost and risk in schedule. Stochastic characteristic of the WEGs is captured in this work. It is used to compute expected energy not served (EENS), a measure which quantifies the amount of output that may not become online from WEGs at any given hour. Two strategies are proposed to minimize costs and handle risks introduced due to WEGs. These formulations are solved using the mixed integer linear programming (MILP) technique.

4. Luke Dosiek and Dr. John W. Pierre
   University of Wyoming
   Poster Title: The Estimation of Electromechanical Mode Shape and Coherence in Real-Time Using a Recursive Least Squares Algorithm
   Abstract: A natural occurrence in electric power systems, electromechanical modes are low frequency oscillations that are caused by generators' reactions to variations in electrical loading. They are characterized by frequency, damping ratio, mode shape, and coherence. Knowledge of the electromechanical modal properties of a power system is of great importance for its safe and reliable operation. If a mode is allowed to become unstable, it will grow in magnitude causing a power outage. A method of estimating a power system's electromechanical mode shape and coherence from time synchronized phasor measurements is presented. The approach uses a parametric estimate of the transfer function (TF) between signals at different buses throughout the power system. The relationship between the TF and mode shape and coherence is reviewed. A non-causal autoregressive exogenous (ARX) model is used in a recursive least squares (RLS) adaptive channel matching algorithm to estimate both the TF parameters and the magnitude squared coherence function in real-time. The method is applied to both a simulated system and measured data from the western North American power system and compared to the traditional Welch periodogram averaging approach.

5. Y. Pipelzadeh, B. Chaudhuri, T.C. Green
Imperial College London
Poster Title: System Impacts and opportunities of HVDC upgrades
Abstract: "With the deregulation of power system, many tie lines between controls areas are driven to operate near their maximum capacity. Stressing operating conditions can increase the inter-area oscillation between different areas. In most power grids the oscillation between two areas becomes the main reason that constrains the power transfer capability, and major oscillation can result in system collapse.

The oscillation of one or more generator in an area relative to the rest of the system are referred to as local modes which can be damped by traditional methods such as Power System Stabilisers. However, damping in the system is always insufficient for the oscillation between two areas, which becomes the main restriction on the power transfer. This growing concern has enabled power system utilities and researchers to investigate HVDC systems and design robust controllers to damp inter-area oscillations.

The aim is to present an adaptive control that integrates the features of the HVDC and applies its benefits when the dc link is connected in parallel with ac transmission lines. These benefits are: damping of power oscillations as well as improving the transient stability, voltage stability and power flow control.

In this poster, we show the benefits of HVDC by illustrating the stability and power transfer capability improvement of the network through modelling and simulation of a hybrid AC-DC multi-machine system in Power Factory DIgSILENT.

By implementing supplementary damping controllers we demonstrate the effectiveness of HVDC to mitigate low frequency oscillations under a range of operating conditions. Modal analysis and non-linear simulations are applied to verify the designed damping controller performance.

A major concern in control design of power systems is the robustness of the damping controller. In other words, how effective is the controller under a broad range of operating conditions (such as sudden change in load or generation) and also in the existence of other uncertainties such as contingencies. We investigate control design techniques that guarantee robust controller performance at these conditions."

6. Robert Eriksson, Valerijs Knazkins and Lennart Sder
Royal Institute of Technology, KTH
Poster Title: Subspace System Identification Techniques in Large-scale AC/DC Power Systems
Abstract: "Low frequency oscillations have become a serious bottleneck limiting power transfer. For large synchronously interconnected systems inter-area oscillations are a global problem. The use of Power System Stabilizers (PSS) is the most common way to improve system damping, the use of HVDC power modulation is another effective approach. In addition, various FACTS devices can be used. As more devices are used to improve damping, the coordinated strategies must be employed in the controller design.

Weak damping problem belongs to small signal stability, thus, a linear model representation of the power system dynamic behavior is enough. However, for large power systems, detailed linear models are often unavailable; Even if a linear model is available for one equilibrium point changes in the system, which often are unknown, changes the linear model. The fact that large systems are represented by large state-space models make the analysis and control design difficult. In these situations system identification techniques are necessary to achieve full or reduced linear models, which are adequate to describe the dominant dynamic behavior. With an appropriate model the controller can be design to enhance the damping.

This idea is concerned with the use of subspace system identification techniques for estimating low-order black-box state-space models of power systems. The proposed idea uses low-energy pulses generated by the HVDC links to excite the system. The used system identification methods are time-based, using input-output data. The data consists of the input signals, which are the set-point active power or the set-point current through the HVDC links and the measured speed of the generators as the outputs. The chosen outputs signals are based on the participation values for the most important modes.

A model of 5th order captures the main dynamics of the test system. However, a 9th order model is preferable. The 9th order model provides enough accuracy incorporating the most important eigenvalues and thereby the inherent behavior of the system. It shows good results in the evaluation process, comparing the estimated model's outputs with the actual outputs. It also shows proper results for independence and whiteness of its correlation functions. As a model has been estimated a controller for power modulation of the HVDC links can be designed to improve system damping.

Future work would be to develop controllers for each model and evaluate the performance of the models for different control design. This idea can also be used for designing adaptive regulators that will operate on the fly. Identify a linearized model of a power system and schedule the gains of the feedback in such a way that the desired damping is achieved, no matter how the power system behaves."

7. Sadik Kucuksari
Arizona State University
Poster Title: Study on Distributed Generation Interconnect Techniques and Standars
Abstract: "Alternative power sources are becoming more popular and common due to the increase in power demand worldwide. Distributed Generation (DG) is one of the sources, which is able to meet a small amount of this increasing demand. Utilization of DG sources is not new and it has been the practice of a small number of consumers. They have been using DG for decades for their own individual purposes. The applications are becoming more widespread, however, when the power demand becomes a global problem. As a result, a utility company that provided ""clean power"" started to incorporate with the DG sources and their owners in order to continue to supply the clean power to the customers. The incorporation needed an interconnection of the DG sources to a distribution network that had existed for many years. The interconnection gives the definition of DG as being any source of electrical energy (e.g. photovoltaic systems, wind turbines, fuel cells, micro turbines) of a limited size interconnected to a general distribution system. DG differs from the central generation as it can be located near customer, inside a building or in a certain area. Accurately designed and operated DG can provide for end users with benefits that include economic savings, greater reliability, and better environmental performance.

DG interconnection is a composite electrical configuration. The terms ""synchronized operation"" or ""parallel operation"" are also used identically with ""interconnection"". The interconnection is performed while the DG unit generates electricity. Since distribution system components have been designed for the estimated arrangement of generation on one end only, adding different sources would cause potential system flaws. DG may possibly alter the operation and topology of a distributed system. Voltage control, protection management, and safety could be negatively affected as a result. At this point, it is necessary to have a common standard make sure that the power quality is not corrupted by adding a DG source.

In this study, interconnecting a DG source to the existing power system is simulated. The effects of interconnections were investigated according to the IEEE 1547 standard. Power system Analysis Toolbox (PSAT) was used as a simulation program. Western System Coordinating Council (WSCC) 3-Machine 9 Bus System and a two-bus distribution system were simulated. Two different types of DG source models (wind turbine and fuel cell) are used as DG sources."

8. Hariharan Subramanian, Dr. Karen Butler-Purry
Texas A & M University
Poster Title: Study of Communication and Data transfer between Remotely connected RTDS units
Abstract: "The real time digital simulator (RTDS) is a combination of specialized computer hardware and software designed specifically for the solution of power system electromagnetic transients. RTDS is used to conduct: closed-loop testing of physical devices to perform analytical system studies, etc. Distributed simulation reduces simulation complexity by allowing the partitioning of a large complex system into two or more smaller subsystems. Distributed simulation, aims to separately and concurrently compute the dynamics of several parts of a system, provides a way to share the computational load by multiple computers and, thus, effectively reduce the simulation time. In this work reported in this poster we are investigating the possible use of two RTDS units to simulate a large scale power system by partitioning it into two sub-systems that are simulated using two remotely connected RTDS systems. In this research the communication and data consistency issues are discussed. The communication delay and the processing delay at each step will add to the overall delay involved in the data transfer. Further a two bus system with a source, transmission line and a load is divided into two sub-systems and simulated. The split system performances are discussed.

The remotely located RTDS units have to be connected by a good communication channel for seamless data transfer between them. RTDS does not have the capability to directly communicate data over the internet. A communication channel using a personal computer (PC) and a National Instruments Real-Time Controller (NI cRIO/NI PXI) for end to end communication between the two RTDS units was set up. The data flows from RTDS1 to a PC in the local area network (LAN), from the PC to a NI cRIO/NI PXI in another network via the internet, and then from the NI cRIO/NI PXI to RTDS2. The NI cRIO/NI PXI is used to perform data processing and conversion to analog signals.

A two bus system model with a source, transmission line and loads was split into two sub system models identified as System1 and System2. System1 has the source, transmission line and an equivalent model of the loads in system2. System2 has an equivalent model of the source from System1 and the loads connected to it. The split system was simulated on the same rack on one RTDS with the continuous transfer of analog voltage values from Sytem1 and the load values (P & Q) from System2 between the two systems.

Programs were developed in LabView as well as C# to perform the data transfer from RTDS to PC in the LAN and for data transfer from the PC to NI cRIO/NI PXI. Three different types of client/server programs using LabView and C# were tested and the data rate was observed under various conditions. Average throughput and average delay were also observed for each experiment. In the split system simulation in RTDS, the settling time for the voltage and load on the both the systems to reach the steady state was measured."

9. Linash Kunjumuhammed, Ravindra Singh
   Imperial College London
   Poster Title: Speed Sensorless Control of Induction Motor Using Extended Kalman Filter
   Abstract: Elimination of shaft mounted speed, position sensor has long been an attractive possibility in motor control, since the transducers and associated signal wiring are a significant source of failure, additional cost and weight. Moreover, the speed sensorless control of motor offers advantage of easy control for motors placed in inaccessible location. An Extended Kalman Filter (EKF) based algorithm is presented to estimate state (speed, position and current) of motor. The estimated values are fed to a vector control algorithm for accurate control of speed and torque. Detailed simulation results under different operating conditions are presented to validate the performance of the algorithm.

10. Michael Kleinberg, Karen Miu, Hsiao-Dong Chiang
    Drexel University
    Poster Title: Service Restoration of Power Distribution Systems Incorporating Load Curtailment
    Abstract: Modern power distribution systems are being embedded with distributed intelligence in the form of smart meters connected to intelligent appliances, dimmable lighting, and controllable HVAC. These technologies allow for widespread implementation of demand response and direct load control. One distribution automation technique which can benefit from this technology is service restoration. This poster will present a service restoration problem formulation and solution algorithm for power distribution systems which incorporates load curtailment. A ranking based heuristic search algorithm is proposed which prioritizes the multi-objective service restoration problem and returns a new system configuration and load curtailment scheme to restore power to out-of-service customers following fault isolation. This operating paradigm enables the utilitarian objective of maximum restoration of priority load and ensures a maximum number of non-priority customers receive at least a minimum level of service during an emergency situation.

11. Ahmad Arshan Khan
    Florida International University
    Poster Title: Sensorless Control of Permanent Magnet Machines at Low Speed
    Abstract: The control of electric motor at low speed is a very challenging task and can be realized only if the rotor position is known. The electromagnetic resolver or digital encoder is usually used to detect the rotor position. Position sensors are fragile in nature and add significant cost to the drive system. Other alternative is to use sensorless control algorithm. In our research, we used a saliency based sensorless approach, in which we excite the motor by injecting high frequency voltage signal onto the d-axis of the rotating reference frame. The sensorless control algorithm is realized in real time using dSPACE DS1103 controller board.

12. Donald Fentie
    University of Saskatchewan
    Poster Title: Sen Transformer Protection
    Abstract: The Sen Transformer is a relatively new device that has future application to the Electrical Power Industry in the area of reactive power control. Using existing transformer technology that the industry is already familiar with, the Sen Transformer can be used in a much more economical way than other typical Flexible AC Transmission Systems (FACTS) devices. With any new device comes the challenges of protection and which methods may be used or developed in order to achieve an appropriate solution.

13. Meghana Mukerji
    University of Waterloo
    Poster Title: Security Constrained Optimal Power Flow on Cigre Test System
    Abstract: An optimal power flow analysis will be conducted on a Cigre test system. Security constraints will be applied and evaluated. A sensitivity analysis, results and conclusions will also be presented.

14. Naresh Acharya and Chen-Ching Liu
Iowa State University
Poster Title: Security Assessment of Power System Considering Uncertainty in Wind Power Forecast and Correlation Between Wind Farm Outputs
Abstract: With increasing wind penetration into the system, it has become necessary to incorporate the uncertainty in wind power generation into the security assessment procedure. This is to make sure that the probable wind generation pattern that affects the security for the base case and n-1 contingency cases has been considered. The traditional security assessment procedure is based on deterministic n-1 contingency criteria. Each line contingency is considered as an independent event. This concept of n-1 contingency will then have to be extended to take into account the variation in wind power. For wind farms that are close to each other, the output power can be correlated. The correlation adds additional complexity to the problem. So, for realistic n-1 security assessment of the power system, it is necessary to remodel the generator part of the contingency in order to account for the wind variability and output correlation. Coupled with the same problem is the problem of scheduling the transmission outage due to an uncertain wind pattern. From an analysis perspective, this is an n-1-1 type of contingency, which is generally known as trip-maintenance. If proper account of the wind generation pattern is not acknowledged, then the system operator might have to initiate the curtailment of output of some wind farms. The main idea is to identify the secure region for power system operation for various wind generation patterns and to calculate risks for those generation patterns. In this context the poster presents the method to model the uncertainty in wind power along with its statistical dependence for use in security assessment including outage scheduling. The value at risk (VaR) concept is introduced in this research to measure the risk associated with the low probability/high consequences events (represented by the tail of the probability distribution function). The tail regions are the extreme cases that the system has to withstand. It is expected that this risk measure will give important information for the system operator in the decision-making process.

15. Ramtin Hadidi
Memorial University of Newfoundland
Poster Title: Reinforcement Learning Approach for Controlling Power System Stabilizers
Abstract: In this poster, a near optimal coordinated design for several power system stabilizers (PSS) is achieved using reinforcement learning. Also a sub-optimal control policy to design multiple PSSs in a power system is proposed. The single agent approach is used, but the design procedure can be applied to a multi-agent system. Using this control policy the agent can change the gain of PSSs in such a way that always a pre-defined goal is satisfied, i.e. in any condition of the system agent can lead PSSs' gain to an optimal design for defined objective. The objective of the control policy is to enhance the stability of a multi-machine power system by increasing the damping ratio of the least damped modes. Selective initial state criteria are also used in this poster to enhance convergence rate of Q-Learning algorithm in power system applications. They change random selecting of initial states at each episode. The results show an improvement in number of iterations to find the near optimal control policy. Since power system after serve disturbance tends to become unstable in short period of time, finding control policy in less iteration is useful in enhancing the overall stability by implementing suitable control actions. The off-line mode of operation is used in this work after achieving the near optimal policy. The proposed method is implemented to design PSSs in 4 generator 2 area power system. Based on the results, one agent can effectively control one or two PSSs in an appropriate time period. Nonlinear simulation validates the proposed method and shows its performance in comparison with conventional design of PSS under serve disturbances.

16. A. Carpinone, V. Carpentiero
Second University of Naples
Poster Title: Probabilistic Forecastinf of Wind Power by Means of Markov Chain Models
Abstract: "Better modelling and forecasting short-term power fluctuations of wind farms may significantly enhance control and management strategies of their power output.

The poster deals with the use of Markov chain models for wind power forecasting and their role in developing control and management strategies for storage units and other forms of backup generation coupled with the wind farm."

17. E.L. Wong, A.K.S. Jardine, D. Banjevic
University of Toronto
Poster Title: Predicting the Remaining Useful Life of Power Transformers
Abstract: "This research focuses on predicting the remaining useful life (RUL) of power transformers. Repair and maintenance action (RMA) data and condition monitoring (CM) data for over 500 power transformers is provided by a major energy utility company.

    Power transformers are repairable systems and large capital assets. RUL predictions help engineers assess whether a unit should be replaced or repaired, and when. For example, long lead times and specialized storage required for transformers can result in financial loss if units are replaced too early or too late. Power utilities can optimize maintenance planning while minimizing overall costs by using accurate RUL predictions and economic considerations.

    Our objective is to incorporate available RMA and CM data into calculations for the RUL. Challenges include data acquisition and data quality, estimating the effects of RMA on the 'health' of the transformers, and accounting for the dependence/independence of components.

    The initial analysis for the power transformer data is presented. Approaches to the listed challenges are also discussed. Planned future work includes the development of a general maintenance decision model that incorporates both the RUL and cost factors."

18. Juan Li and Chen-Ching Liu
Iowa State University
Poster Title: Power System Reconfiguration Based on Multilevel Graph Partitioning
Abstract: Area partitioning that splits a power network into self-sufficient islands is an emergency control to stop the propagation of disturbances and avoid cascading failures. This poster introduced the application of a multilevel graph area partitioning algorithm that are applicable to very large power grids and the architecture of the proposed control system. As an emergency control, network partitioning enhances the capability of a power system to withstand extreme and vulnerable operating conditions. The proposed algorithm has been simulated on two test systems, one with 200 buses and the other with 22,000 buses. The results indicate that the proposed algorithm is highly efficient.

19. Tao Yang, Hongbin Sun, and Anjan Bose
Washington State University
Poster Title: PMU based Two-Level Linear State Estimator
Abstract: The State Estimator function in a control center today is a suite of three programs solved sequentially: Topology Processing, State Estimation, and Bad Data Detection-Identification. The state estimation equations are nonlinear because the inputs are mostly real and reactive power measurements. A linear state estimator is possible if the inputs are only complex currents and voltages and if there are enough such measurements to meet observability and redundancy requirements. The main contribution in this paper is the suggestion that the Topology Processing function and the Bad Data Detection-Identification be done at each substation rather than at the control center. It is shown how this two-level processing is faster and more accurate leaving the control center level state estimator solution free of the bad data errors that are major problems today.

20. Mert Korkali and Ali Abur
Northeastern University
Poster Title: Placement of PMUs with Channel Limits
Abstract: Synchronized phasor measurements are changing the way power systems are monitored and operated. Their efficient incorporation into various applications which are executed in energy management control centers, require strategic placement of these devices. Earlier studies which consider placement of PMUs to be used for state estimation, assume that these devices will have unlimited channel capacities to record as many phase voltages and currents as needed. However, all existing PMUs come with a limited number of channels and their costs vary accordingly. In this study, a revised formulation of the placement problem and its associated solution algorithm will be presented. Examples will be used to illustrate the impact of having limited number of channels on the location and number of required PMUs to make the system observable. Developed methods will take into account existing injections measurements, in particular the virtual measurements such as zero injections that are available at no cost at electrically passive buses.

21. A. Hajimiragha, C. Canizares, M. Fowler
University of Waterloo
Poster Title: Optimal Transition to Fuel-Cell and Plug-in Hybrid Electric Vehicles in Ontario-Canada Considering the Electricity Grid Limitations
Abstract: The transport sector is one of the largest and fastest growing contributors to both energy demand and greenhouse gases; e.g., in Canada, the transport sector represents almost 35% of the total energy demand and is the second highest source of greenhouse gas emissions. In view of these issues and the problems with the supply of oil, the subject of alternative fuels for meeting the future energy demand of the transport sector has gained much attention. The main goal of this research is to determine how Ontario's electricity network can be optimally exploited during the base-load periods for electrolytic hydrogen production used by Fuel-Cell Vehicles (FCVs) or charging the batteries in Plug-in Hybrid Electric Vehicles (PHEVs) without jeopardizing the reliability of the system or developing new and separate electricity infrastructure. Based on a simplified zonal model of Ontario's electricity transmission network and a zonal pattern of base-load generation capacity from 2009 to 2025, optimization models are developed to find the optimal as well as maximum penetrations of FCVs and PHEVs into Ontario's transport sector. Concerning the FCVs, optimal size of electrolytic hydrogen production to be developed in different zones of Ontario and the optimal hydrogen transportation routes are also found. The presented studies show that almost 1.2% to 2.8% FCV penetration (depending on the location of new nuclear units) can be achieved in Ontario by 2025; these penetrations translate into 103,000 to 240,000 FCVs in Ontario's transport sector. Also, the present and projected electricity grid in Ontario can be optimally exploited for charging almost 6% of the total vehicles in Ontario or 12.5% of the vehicles in Toronto's transport sector by 2025; this corresponds to approximately 500,000 PHEVs that can be charged from the grid without any additional transmission or power generation investments beyond those currently planned.

22. Sudipta Lahiri, Dagmar Niebur, Harry Kwatny
Drexel University
Poster Title: Optimal Power Management Strategies for Autonomous Microgrids
Abstract: "Microgrids are networks of small electric power systems that can operate independently or as a part of a larger utility grid. This work presents the design of intelligent power management system for a microgrids, based on the hybrid systems modeling framework. A power management system for a microgrid aims to maintain service and power quality under potential disturbance, by optimizing certain pre-specified design criteria.

A hybrid system is characterized by the interaction of continuous time dynamics and discrete time events. The continuous time model consist of the differential algebraic equations of the microgrid including dynamics of distributed generation such as diesel generators and energy storage devices as well as static and dynamic loads The discrete event dynamics include failures, reconfiguration and other changes in operating conditions. The hybrid automaton model consists of transitions between discrete modes with continuous dynamics existing in each mode.

The feedback policy of the power management system controller is computed recursively offline by backward in time, finite horizon, dynamic programming at each point in the discretized state space of the hybrid system. The controller is implemented as a state feedback controller and an application of the controller is demonstrated."

23. Ranjana Sodhi, S. C. Srivastava and S. N. Singh
Indian Institute of Technology Kanpur
Poster Title: Optimal PMU Placement to Ensure System Observability under Contingencies
Abstract: Optimal placement of Phasor Measurement Units (PMUs), to ensure complete observability of power system, should not only be decided at the base case operating conditions but also must consider the contingency cases. This paper presents a simple and effective method for optimal placement of PMUs considering critical contingencies. A voltage stability based contingency screening method has been utilized to select critical contingency cases. An Integer Linear Programming (ILP) based algorithm for the PMU placement has been modified to determine optimal PMU locations under the system intact and the critical contingency cases. The proposed method is tested on the IEEE 14-bus system, New England 39-bus system and Northern Region Power Grid (NRPG) 246-bus Indian system and the test results have been compared with three more modified PMU placement methods viz. depth first search, direct spanning tree and direct N-1 spanning tree methods.

24. Wei Sun, Chen-Ching Liu
Iowa State University
Poster Title: Optimal Generator Start-up Strategy for Bulk Power System Restoration
Abstract: One of the most important objectives for system restoration is to maximize the generation capability with the limited black start power available. An algorithm that takes advantage of the quasi-convex property of the generation ramping curves to formulate the generator start-up sequence problem to a Mixed Integer Quadratically Constrained Programs (MIQCP) is proposed. The method breaks the restoration horizon into intervals and develops the restoration plan by finding the status of each generator at each time interval. Optimality of the algorithm is achieved if each generator is either started or required to wait so that other more beneficial units can be started first in order to maximize the system generation capability during the restoration horizon. While the solution provide system operators the start-up sequence of the generators as the first step in system restoration stage, system operators will continue identify transmission paths and pick up load according to the generation capability with system constraints checked.

25. Xunning Yue
Washington State University
Poster Title: Online Voltage Stability Assessment Using PMU measurements
Abstract: With more and more deployment of Phasor Measurement Units (PMUs), it is feasible to assess the voltage stability of a power grid in reasonable time. The poster proposes a method using Support Vector Machine to analyze the massive data of off-line power flow simulations and yield a classifier that is able to address the online system status in three categories: lightly loaded, alerted, and alarmed. The poster will describe the methodology and procedure, and show its application on the famous IEEE-39 bus system.

26. S. Ali Arefifar and Wilsun Xu
University of Alberta
Poster Title: Online Measurement of Power System Impedance Parameters
Abstract: "The power system impedance parameters are important information for power system planning and operation. The system impedance data has the following applications: Model verification and fault level, Power quality improvement, Increasing efficiency of power electronic devices, Determination of maximum loadability of the system, Determination of voltage stability margin. This research proposes a new algorithm for online tracking of power system impedance parameters. The algorithm uses the natural variations of loads connected to substations for impedance estimation."

27. Haoen Li, Anjan Bose
Washington State University
Poster Title: On-line short circuit current analysis and control
Abstract: As the rapid economic development recently, the high power demand and the limited capacity of 500KV transmission line requires us to make more lines, which lead the power network densely and complex, which causes the short circuit current increasing, the short circuit current in some hub substation is closing to there limit. Some measure should be done to reduce the risk of damages due to short circuit currents. All of the current measures are planned system changes and expensive. A new method based on the on-line short circuit current analysis is introduced here. And a simple IEEE-39 buses system and a real east china power system are also tested. And the result shows the efficiency of the new method.

28. Xinghua Liu, Jin Zhong, Chongqing Kang
The University of Hong Kong
Poster Title: Multiple-Interval Power System Dispatch Considering Probabilistic Wind Generation
Abstract: This poster presents a dispatch method considering the power output variations of wind turbines in power systems. Both analytic method and Monte Carlo simulation have been used to calculate the probability of real power outputs of wind turbines. For the reactive power, asynchronous wind turbine model is used to describe the relationship between the injected reactive power and the active power. In the dispatch model, both Monte Carlo method and analytical expected wind power output method are used and the results are compared with each other. Simulation results, considering different operational cases, are presented to analysis the impacts of wind power in power system dispatch.

29. Yao Duan, Ronald G. Harley and Thomas G. Habetler
Georgia Institute of Technology
Poster Title: Multi-objective Design Optimization of Surface Mount Permanent Magnet Machine with Particle Swarm Intelligence
Abstract: First an analytical model for Surface Mounted Permanent Magnet Motors (SMPM) has been developed, then PSO is successfully applied to analytical model for high efficient multi-objective optimization in SMPM machine design. The major merits of this method are its fast implementation-50s for 6 particles with 200 iterations, and its ability to generate all major design parameters for a SMPM machine design.

30. Zhi Zhou, W.K. Victor Chan, Joe H. Chow, and Serhiy Kotsan
Rensselaer Polytechnic Institute
Poster Title: Modeling the Electricity Markets Using Agent-based Simulation and Equilibrium Analysis
Abstract: Electricity markets are complex systems due to their deregulation and restructuring. We model a general deregulated electricity market as a continuous, repeated game and present it as a two-level mathematical programming model with competitive individual objectives. Based on this model, we analyze the equilibrium theoretically for a duopoly market with heterogenous generation suppliers. We then develop an agent-based simulation model for a stylized electricity pool market and simulate the market as a repeated game as well. Finally, we report the results of two experiments based on this simulation model. In the first experiment, an online hill-climbing learning algorithm is applied to generator agents to guide them to bid strategically and the clearing prices are compared under different market scenarios. The second experiment reports the observation and analysis on the collusive bidding behavior on a duopoly market with estimated market share information.

31. Sheng Yang, Venkataramana Ajjarapu
Iowa State University
Poster Title: Modeling and Real-Time Simulation of DFIG-based Wind Turbine Applications
Abstract: This poster will present an innovative infrastructure for the testing and integration of the control system for megawatt-range wind turbines. Based on the real-time hardware-in-the-loop simulation on the state-of-the-art digital simulator and controller hardware, various research including advanced control strategies for active and reactive powers, and low voltage ride-through strategies, can be studied. Development of a sensorless controller for DFIG-based wind turbines will be used as an example in the poster to demonstrate this test bench.

32. Mohammad Chehreghani bozchalui, Claudio Canizares, Kankar Bhattacharya
University of Waterloo
Poster Title: Mathematical Optimization Modeling of Energy Hub Management Systems
Abstract: "This work presents the mathematical models for Energy Hub Management Systems (EHMS) to optimally control their operational decisions. The energy hub could be a single or multi-career energy system with differing objectives. In the residential sector, the energy system of a single detached house has been modeled. Mathematical models for major household demand are proposed. Associated models of auxiliary systems are also developed and thereby a fairly generic model for energy storage and supply is built. A mixed integer optimization model for the energy hub is proposed wherein the end-user preferences are also defined taking into consideration practical aspects. This model helps in integrating the residential customers within the smart grid developments which are currently in place in Ontario and elsewhere."

33. Ran Xu, Gary Kobet , Vaithianathan "Mani" Venkatasubramanian
Washington State University
Poster Title: Loss of Field Protection and its impact on Power System Stability
Abstract: The objective of the paper is to study the impact of Loss Of Field (LOF) protection at generators on the grid stability of the interconnected power system. Specifically, we will show the relationship between the operational speed of the partial loss of field protection at critical plants on voltage stability of the neighboring power grid near the plants. We also propose a back-up LOF protection scheme for such a generator using synchrophasors, which could trip the generator under LOF conditions by observing the line measurements out of the plant.

    TVA has experienced three LOF related generator-tripping events in the last two years at a Paradise thermal unit. Loss of excitation condition on a generator with large MW output forces the generator to absorb large reactive power from the neighboring system, which can drain reactive power supplies in the area that can in turn can drive the voltages low. For instance, during the December 3, 2006 event, Paradise plant absorbed nearly 1000 MVAR for about 15 seconds from the TVA system before the LOF relay tripped the unit. If the LOF condition persists over a substantial period of time, it can potentially lead to internal damage within the generator as well as a fast voltage collapse in the system near the generator. Evidence of large reactive power flow into the Paradise generator and fast declining voltages can be seen in PMU and DFR responses near the Paradise plant during all three events. Fortunately, the loss of excitation relays operated correctly during all three events preventing damage to the voltage stability of the TVA system. However, if the conditions were more stressed at that time (possibly from outage of some transmission lines) or if the LOF relay responds more slowly, the impact of LOF conditions on voltage stability needs to be studied and understood. In the proposed paper, we will study of the power-flow conditions during the three events using stability models and illustrate the impact of LOF conditions at Paradise on TVA system voltage stability.

    We also propose the design of a back-up protection at Paradise for potential failure of the generator LOF relay by using PMU real and reactive power-flow measurements on the 500 kV transmission line Montgomery to Paradise near the Paradise plant. A simple algorithm will be proposed and tested on dynamic simulations of TVA stability modes."

34. Pajuelo, Eli; Ramakrishna. G.; Sachdev, Mohindar
University of Saskatchewan
Poster Title: Loss of Excitation Protection for Generators Using a Support Vector Machine Technique
Abstract: This poster describes a new method for identification of a loss of excitation condition in synchronous generators from disturbances such as external faults and power swing conditions. The proposed method makes use of the support vector machines pattern recognition technique. In this new approach only one zone of loss of excitation is required and the time coordination is reduced significantly. The selection of features for the classification is based on the physical meaning and distinctive behavior of these. Several operating conditions within the generator capability are used to verify the generality of the resulting classifier. Improvements obtained over existing methods are illustrated.

35. Valentina Cecchi, Aaron St. Leger, Karen Miu, and Chika Nwankpa
Drexel University
Poster Title: Loading Studies for Power Transmission Line Models in the Presence of Non-Fundamental Frequencies
Abstract: This work describes simulations used to investigate electric power transmission line models. Specifically, the paper focuses on studying the effects of different line model segmentation schemes over non-fundamental frequencies and at varying loading conditions. Comparison among the distributed line model and three differently segmented models was made in terms of their performance, characterized through waveform propagation, including attenuation and phase shift.

36. Hui Yuan, Kevin Tomsovic
Washington State University
Poster Title: Investigating the Dynamics of Transmission Investment under different Incentives with System Dynamics
Abstract: "Over the past several decades the electric power industry around the world underwent a restructuring process, which is still ongoing. Restructuring liberalizes the power industry in the following ways: unbundles the vertically integrated and centralized structure; and introduces greater competition.

In the integrated and centralized structure, utilities control almost everything concerning the electric power industry, but they are also fully overseen by regulators. Traditional economic equilibrium models can meet most of the requirement of this kind of industry structure. This is not true for the non-integrated and decentralized power industry after restructuring. Restructuring introduces more players into this industry, and the inter-relationship between them is complex. With more competition, the market participants are more active so that they can maintain or gain advantage. In this restructured industry, not everything can be planned and fully overseen. There are far more unpredictable activities. All of these make the restructured industry less manageable. Under such circumstances, simple equilibrium models alone can not meet the requirements of the unbundled and competitive electric power industry. We need dynamic models to better investigate and understand the dynamic performance of different market components in this industry.

System Dynamics(SD) is a kind of methodology that can meet the challenges introduced by the restructuring. It is a methodology for studying and managing complex information feedback control systems, which is realized through investigating the dynamic behavior of system components. It is a qualitative but not quantitative methodology. SD modeling has two key characteristics: a. Closed-loop information feedback control - it helps modelers to simulate dynamics of researched systems in the given time horizon b. Whole system level modeling - it helps study and manage complexity from the system level.

In the wholesale electricity markets, the transmission network plays a pivotal role. It not only provides a route to transfer electric energy from generation plants to consumers, but also supports competition and can mitigate market power. Today, the transmission network in the US lags behind the requirements of the competitive markets. There is more and more congestion in the transmission system after the introduction of wholesale competition. According to PJM interconnection, its total congestion costs increased by $271 million or 15 percent, from $1.846 billion in calendar year 2007 to $2.117 billion in calendar year 2008. On the other hand, the transmission investment incentives are not strong enough to stimulate adequate investments in transmission assets. In order to better understand issues concerning transmission investment and to alleviate system congestion rent in the restructured industry, we use

SD to model the dynamic transmission planning process in our research. We built several different SD models for different investment incentives: FTR (CRR) based merchant transmission investment and ROE based regulated transmission investment. These models are used to investigate the transmission investment dynamic behavior under different investment incentives."

37. Javier de la Cruz Soto, Guillermo Gutirrez Alcaraz, Jos Horacio Tovar Hernandez
Instituto Tecnolgico de Morelia
Poster Title: Integrated Model of Fuel Supply Control for Short-term Electric Generation Scheduling with Emission Constraints and Take-or-pay Contracts
Abstract: Controlling greenhouse gas emissions may be perceived as one of the most important milestones in recent years, because they originate undesirable outcomes for both the environment and human health. The short-term generation scheduling with control greenhouse gas emission is of crucial importance for the new restructured electricity industry, besides the fuel supply contracts. This paper presents an integrated supply-chain multi-objective model by considering both economy and emission simultaneously. The model also considers different types of transportation networks for fuel supply. Numerical examples are provided.

38. Vipin Prajapati, Herbert L. Hess
University of Idaho
Poster Title: Instrumentation of Advanced Personal State-of-Charge Assessment in Primary Battery
Abstract: Create an instrumentation system for assessing the charge state of lithium-carbon-fluorine batteries. Includes sensors, signal processing from sensor to microprocessor, and formatting for interface to neural network algorithm. Application to personal electric power system.

39. Vasista S Majji, Dr Chika O Nwankpa
Drexel University
Poster Title: Insight into Analog Computation and Power System Uncertainties
Abstract: "This work provides an insight into the analog representation of a stochastic model of a power system based on the introduction of perturbations in the swing equations as random noise processes. Analog computation, though being quick and realizable, is a technology that was beset by the need for bulky hardware and constant manual reconfiguration of parameters.

Power System models being inherently non-linear, are difficult to analyze numerically. The iterative processes or the exhaustive search algorithms used in the digital analysis are time consuming and assume linearization of the system. They are used extensively in the present day because they are easy to operate and precise.

Power Systems can generate phenomena that cannot completely be analyzed by digital analysis. Their behavior may be represented by a scheme that combines both the deterministic and stochastic source. Analog realization of uncertainties provides instantaneous system response to perturbations in the power system network. This work uses recent advancements in analog computation to miniaturize the hardware circuitry required along with the implementation of remote processing of circuit parameters and at the same time provide faster than real time analysis to boost security system analysis during faults or contingency."

40. Qiang Zhang, Guoping Liu, Mani Venkatasubramanian
Washington State University
Poster Title: Implementation of Oscillation Monitoring System
Abstract: Low frequency electromechanical oscillations have been widely experienced in power systems around the world. Such oscillations, particularly the mode frequencies and damping ratios, are of special interest to operators, due to its great impact on stability of power systems. The following illustrates the work on detection of oscillating modes that is done in Washington State University (WSU). Both Prony type methods, which are used for analyzing ring down type post-disturbance data, and frequency domain decomposition (FDD) method, which is used to analyze normal operating ambient data, are considered. This poster summarizes the implementations of both methods on BPA and TVA systems, through several cases. Real PMU recorded data, as well as model based simulation data are used for comparison. The results show that the proposed Oscillation Monitoring System (OMS) can detect the oscillating modes in normal operating condition and after disturbance.

41. Juan C. Jimenez and Chika O. Nwankpa
Drexel University
Poster Title: Implementation of Field-Programmable Analog Arrays (FPAA) for Emulation of Tap Changing Transformers
Abstract: Analog computation (emulation) is an area of continued interest and has certain advantages over traditional digital computation - primarily faster computation time and physically realizable solutions. Prior work in power system analog computation has modeled generators, transmission lines and loads and has examined the development of hardware prototypes and PC boards. In this work the authors study the implementation of field-programmable analog arrays (FPAA) for power system components emulation, specifically tap changing transformers. The FPAA's programmability and dynamic reconfiguration ability considerably reduces the effort and time required to develop a functioning prototype and VLSI design.

42. Kenny K. Y. Poon, Anjan Bose
Washington State University
Poster Title: Implementation Issues for Hierarchical, Distributed State Estimators
Abstract: "The availability of PMUs allows for the potential of developing a control center for the whole interconnection, and in fact, this idea of having a single monitoring center for an entire interconnection is also recommended by FERC since it is believed that with enough PMU measurements, it would be possible to time synchronize data. Such an implementation would allow local monitoring and state estimation results to be moved up to the higher level central control center. In fact, the real benefit of such an implementation of a hierarchical and distributed state estimator would be that the real time model of the entire interconnection being available to the lower level entities, which would help in their decision making.

Conventionally, studies in solving such a hierarchical and distributed state estimator have been from an algorithmic viewpoint, and it is noted from literature that such hierarchical and distributed SEs can indeed be solved. However, there are many issues which need to be investigated for the actual implementation such a hierarchical SE. These issues include time skew of data and accuracy of network data base. A key part of the studies is in determining the amount of data exchange needed to obtain a sufficiently high accuracy of the SE solutions. For preliminary studies, numerous experiments are devised and tested on the IEEE 118 bus system to investigate the aforementioned issues and their effects on the accuracy of the SE solutions. Some of these results are presented in the poster, and provide important information on the experiments which can be performed on the Entergy/TVA system to obtain the objective of providing the description of the minimum requirements for the feasibility of a real time model of a large interconnection. Some potential benefits and applications of such a hierarchical and distributed state estimator are also presented in the poster."

43. JiLi Wang, Dong Han
North China Electric Power University
Poster Title: Impacts of DFIG-based wind farm on load modeling
Abstract: "It is expected that increasing amounts of new generation technologies will be connected to electrical power systems in the near future. Most of these technologies are of considerably smaller scale than conventional synchronous generators and are therefore connected to distribution grids, as the DFIG-based wind farm.

When connected in small amounts, the impact of wind farm on power system transient stability can be negligible. However, if its penetration level becomes higher, wind farm may start to influence the dynamic behavior of the power system as a whole. In this paper, the impact of DFIG-based wind farm on the load modeling is investigated. It is found if the influence of wind farm is not negligible, the composite induction motor load model fails to describe the actual load characteristic effectively. A new load model–asynchronous generator +ZIP is used in this paper. The validity of the load model is also verified via various simulations. Then, composite induction-motor and asynchronous generator +ZIP load models are unified in one program."

44. Renmu He, Jili Wang, Yanhui Xu, Dong Han
North China Electric Power University
Poster Title: Impacts of DFIG-based wind farm on load modeling
Abstract: "It is expected that increasing amounts of new generation technologies will be connected to electrical power systems in the near future. Most of these technologies are of considerably smaller scale than conventional synchronous generators and are therefore connected to distribution grids, as the DFIG-based wind farm.

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45. Ming Dong; Joey Gallant; Xun Long
University of Alberta
Poster Title: Impact of Earth Hour on Voltage Quality
Abstract: "Earth Hour is a global event and is held on the last Saturday of March annually, asking households and businesses to turn off their non-essential lights and other electrical appliances for one hour to raise awareness towards the need to take action on climate change. This year,88 countries and more than 4,000 cities joined Earth Hour.

On March 28,2009, we conducted measurements of voltage before, during and after the earth hour in three houses in Edmonton, AB and also in Manitoba Hydro office building remotely. It was reported 5.2% electricity consumption drop was realized in Edmonton. This poster presents data analysis based on these measurements and demonstrates some variations and discoveries on voltage quality like harmonics and magnitudes around Earth Hour. These discoveries display positive effects and imply possible measures public can take to enhance power quality of our electrical power system in the future."

46. Durga Gautam, Vijay Vittal
Arizona State University
Poster Title: Impact of DFIG based Wind Turbine Generators on Transient and Small Signal Stability of Power Systems
Abstract: The emergent pace of wind energy in various countries around the world has put wind energy at the forefront of energy destiny. Among several wind generation technologies, the variable speed wind turbines utilizing doubly fed induction generators (DFIGs) are gaining momentum in the power industry. As the performance is largely determined by the converter and the associated controls, a DFIG is an asynchronous generator. Moreover, with the conventional control, inertia of the turbine is effectively decoupled from the system. Consequently, with the increase in penetration of these wind turbines, the power system dominated by synchronous machines will experience a change in dynamics and operational characteristics. Given this assertion, the poster presents an approach to analyze the impact of increased penetration of DFIG based wind turbines on transient and small signal stability of a large power system. The primary basis of the method is to replace the DFIG machines into equivalent conventional round rotor synchronous machines and then evaluate the sensitivity of the eigenvalues with respect to inertia. In this regard, modes that are detrimentally affected by the change in inertia are identified. These modes are then excited by appropriate disturbances and the impact of reduced inertia on transient stability performance is examined. The proposed technique is tested on a large test system representing the Midwestern portion of the U.S. interconnection.

47. Jing Dai, Ganesh K. Venayagamoorthy, Ronald G. Harley
Georgia Institute of Technology
Poster Title: Harmonic Identification using an Echo State Network for Indirect Adaptive Control of an Active Filter
Abstract: An active filter is a power electronic device used in a power system to decrease "harmonic current pollution" caused by nonlinear loads. The Echo State Network (ESN) has been widely used as an effective system identifier with much faster training speed than the other Recurrent Neural Networks (RNNs). However, only a few attempts have been made to use an ESN as a system controller. As the first attempt to use an ESN in indirect neurocontrol, this paper proposes an indirect adaptive neurocontrol scheme using two ESNs to control a shunt active filter in a multiple-reference frame. As the first step in the proposed neurocontrol scheme, an online system identifier using an ESN is implemented in the Innovative Integration M67 card consisting of the TMS320C6701 processor to identify the load harmonics in a typical power system. The active filter and the ship power system are simulated using a Real-Time Digital Simulator (RTDS) system. The required computational effort and the system identification accuracy of an ESN with different dynamic reservoir size are discussed, which can provide useful information for similar applications in the future. The testing results in the real-time implementation show that the ESN is capable of providing fast and accurate system identification for the indirect neurocontrol of a shunt active filter.

48. Josune M. Armas, Dr. Siddharth Suryanarayanan, Renata Carnieletto, and Dr. Marcelo Simoes
Colorado School of Mines
Poster Title: Guided Decision Making for a Customer-Driven 'Smart' Inverter Installation
Abstract: Residential distributed energy resource (DER) installations are gaining prevalence in the electric power grid, where the success of their future implementation partially depends on their economic and technical appeal to consumers. Title XIII of the Energy Independence and Security Act (EISA) of 2007, known as the Smart Grid Initiative, represents the official modernization policy of the US transmission and distribution grid. This poster serves to illustrate the operational implementation of a customer-driven residential DER installation using a guided decision making methodology. The DER installation consists of a single phase 5 kVA Voltage Source Inverter used to interconnect a roof top photovoltaic system and the residential loads to the utility grid. The objective of the decision making procedure is to maximize the profit of the residential DER installation to the consumer by providing various options, including the ability to sell both active and reactive power to the grid, provide voltage support at the point of common coupling (PCC), and schedule 'smart' loads. The benefits achieved by using the decision making process for controlling the 'smart' inverter relate to making the residential DER more customer-driven, thus contributing to the informed participation of consumers in demand response. The illustrated installation in the poster addresses the following topics of the Smart Grid Initiative: deployment of renewable DERs, demand side response, 'smart' technologies, 'smart' loads, and real-time electricity pricing.

49. Janak Acharya, Wilsun Xu
University of Alberta
Poster Title: Ground Potential Rise Characteristics of Multigrounded Neutral Distribution Lines
Abstract: The multi-grounded neutral (MGN) lines are most common distribution configuration. However, these configurations make it difficult to understand their characteristics and assess performances. In this poster, the ground potential rise (GPR) mechanism is illustrated and an approximate method has been proposed to estimate the maximum GPR. Analytical findings are confirmed by the simulation results.

50. Jonathan Berardino, Chika Nwankpa
Drexel University
Poster Title: Generator Two-Axis Dynamic Model for Analog Power System Analysis
Abstract: Previous research in the area of analog computation methods for performing power system analysis has demonstrated several advantages over popular simulation methods, including computation times that are significantly faster than typical numerical solvers. Accurate power system component models are necessary to fully realize a useful analog computation engine. Previous systems have successfully implemented a classical generator model for use in analog power system analysis. By developing a model based on the two-axis generator model, the excitation system dynamics can be included in the system analysis, thereby improving the accuracy of the solution obtained from both steady-state and transient analysis.

51. Irina Ciornei, PhD studnt; Elias Kyriakides, IEEE member
University of Cyprus
Poster Title: GAAPI - a robust solution for continuous global optimization: application to the non-convex generation dispatch
Abstract: The foraging strategy of the pachycondyla apicalis ant (API) is hybridized with a genetic algorithm (GA) strategy to incorporate key features of a relatively simple, but robust global optimization algorithm. Many real-life optimization problems often face an increased rank of non-smoothness (many local minima) which could trap a searching algorithm from moving towards the real global solution. The novel GAAPI algorithm proposed deals with adopting the downhill behavior of API (a key characteristic of optimization algorithms) and a good spreading in the solution space of the GA search strategy. Numerical results for unconstrained, continuous global optimization problems are reported and compared to the existing results in the literature to validate the feasibility and the effectiveness of the proposed algorithm. The results are encouraging and the proposed algorithm is effective and efficient for most of the test functions. The algorithm is afterwards customized for the non-convex generation dispatch problem. It is shown that GAAPI gives good solutions in a computationally reasonable time proving its applicability for a real time application.

52. Fanjun Meng
Missouri University of Science and Technology
Poster Title: FREEDM microgrid energy management
Abstract: This poster is going to show the recent work on microgrid energy management, which is developed based on the installation of SST in renewable energy microgrid. Coordinated by 'agent', SSTs can balance the energy flow within microgrid and increase the power quality at gateway to the local grid.

53. Jie Yan, Chen-Ching Liu, Umesh Vaidya
Iowa State University
Poster Title: Dynamic Security Monitoring Based on Phasor Measurements Units
Abstract: The past several years have witnessed an increasing interest in synchronized phasor measurement units (PMUs) and their applications. In this project, a new method for dynamic security monitoring of power systems based on PMU data is proposed. The technique of Lyapunov exponents is employed to determine whether or not a power swing will cause system instability. The theoretical development about the relationship between power swing stability and Maximal Lyapunov exponent (MLE) is established mathematically. A fast algorithm is used to calculate MLE in a finite time window. The effectiveness of the monitoring scheme is demonstrated by simulations with data from a 200-bus test system.

54. Noel N. Schulz, Anurag K. Srivastava, Tomasz Haupt and Qinghua Huang
Mississippi State University
Poster Title: Distributed State Estimation with PMU using Grid Computing
Abstract: "State estimation is an essential tool in monitoring the power system. As the size of the electric power system continues to grow, a state estimator has to be more computationally efficient and robust. This can be achieved by technical advancement in computational science and improving the state estimation algorithm. Distributed state estimation (DSE) decomposes the power system into smaller subsystems. This provides a way to simultaneously poll the measurements and execute the state estimation for a smaller size power system. PMUs can synchronize the measurements between different areas which are perfectly suited for distributed state estimation. The results obtained by local state estimation will be sent to the coordinator for further processing with consideration of the reference angle and boundary estimates. The phase angles and voltages estimated in each sub-area are usually based on their own area reference bus. Considering there are PMUs in the power system, this paper proposes a new method of calculating the reference angle difference between different areas. Grid computing has been used to help in DSE computation as a novel approach. The preliminary test results have presented for a small scale test case."

55. Minnan Wang
The University of Hong Kong
Poster Title: Distinguishment
Abstract: After large wind farms are connected into power grid, the harmonic emission is an important problem that affects their effective operation. In order to better regulate wind farms from the aspect of power quality, responsibilities should be clarified. The author has utilized various methods to identify harmonic contribution at the connecting point of a studied wind farm, compared and evaluated their effectiveness.

56. John Rossmaier, Dr. Badrul Chowdhury
Missouri University of Science and Technology
Poster Title: Development of a New System Vulnerability Index for Determining the Risk of Cascade Failures
Abstract: "The research information presented in this poster details the development of a new system vulnerability index designed to determine the risk of a cascade failure for a given power system. This research is based upon the previous derivation of an index describing the risk of line overloads in a power system. Further development has lead to a new index which incorporates a sequential Monte Carlo simulation process, optimal generation dispatch and ac load flow analysis, and event trees that stem from failure instances and hours of insufficient power generation capability. The event trees in the test simulation process will incorporate tests of the relay protection system, tests of the system's stability, load shedding and other mitigation practices, tests of thermal limits due to fault durations, human error, and other hidden failures. The associated monetary cost of failure at each instance is estimated, weighted, and accumulated into an annual vulnerability index for the power system, and significant instances and modes of failure are recorded to help identify weak points in the power system. This data would then be used to describe the vulnerability of a power system to severe failure and the likelihood and instances of severe cascade failure possibilities.

The poster will detail the process of calculating the index and will showcase some preliminary tests on a case study of the RTS-96 power system."

57. Mariya Babiy, Rama Gokaraju
University of Saskatchewan
Poster Title: Detecting internal faults in transformers using negative sequence currents
Abstract: This poster presents a new protection technique for detecting internal faults in transformers. The proposed technique is based on the negative sequence currents. Using this method, it is possible to detect minor internal turn to turn faults and involve 1% of turns. The proposed method is currently being studied using simulated data obtained using PSCAD software and is also being compared with a traditional differential protection algorithm. The preliminary results indicate that the new technique provides a fast and sensitive approach for identifying minor internal faults.

58. Cheten Kumar Dev, Herbert L. Hess
University of Idaho
Poster Title: Design of Electric Vehicle Charging Interface to Public Utility Grid
Abstract: Design of an electric vehicle interfaced to the public utility electric power grid. Model development for a Real Time Digital Simulator. Simulation and test results for interface to analog model electric power grid.

59. Mohan Lal Meena, Herbert L. Hess
University of Idaho
Poster Title: Design of an Automated Battery Charging System for an Electric Underwater Vehicle
Abstract: "Design and build an automated battery charging system for an electric underwater vehicle. Create appropriate models and test cases to verify the effectiveness of the charger."

60. H. Brown and S. Suryanarayanan
Colorado School of Mines
Poster Title: Design of a survey seeking a definition of smart distribution systems
Abstract: Under the Energy Independence and Security Act of 2007 (EISA07), the US government stipulated the Smart Grid initiative as the policy of modernization of the electricity transmission and distribution infrastructure in the US. Following this, approximately $ 4 billion was allocated from the American Recovery and Reinvestment Act of 2009 (ARRA09) - popularly known as the "economic stimulus package" - for projects related to the smart grid. However, achieving a Smart Grid requires enhancements of existing infrastructure and the incorporation of intelligence at all levels of the electric grid, especially at the distribution level. A primary task under a collaborative research venture on the quantification of the impact of the Smart Grid initiative on distribution engineering was to seek a definition of the smart distribution system from the perspective of the industry. Consequently, a survey was designed using the eight philosophies of a "smart" electric grid as it appears in the Title XIII of EISA07. The objectives of this survey are: 1) to provide a definition of a smart distribution system, 2) to identify existing tools from transmission engineering that can be applied at the distribution level and 3) to guide investigation into the technical requirements and implications of a smart distribution system. The motivation and methods used in the design of this survey, which is currently being circulated among potential respondents in academia and the industry, are presented in this poster.

61. Yi Yang, Deepak Divan, Ronald G. Harley, Thomas G. Habetler
Georgia Institute of Technology
Poster Title: Design and Implementation of Power Line Sensornet for Overhead Transmission Lines
Abstract: The task of monitoring asset status and optimizing asset utilization for the power grid, given millions of assets and hundreds of thousands of miles of power lines distributed over millions of square miles, seems costly, if not impossible. Given the traditionally high cost of sensing and communications, the current grid has minimal 'smarts' with much of the intelligence located at major substations. Dramatic reductions in sensor, computing and communications costs, coupled with significant performance enhancements has increased the possibility of realizing widely and massively power line sensor networks (PLSNs) to monitor utility asset status. A NSF funded a project, "Power Line Sensornet for Enhancing Line Reliability and Utilization", has led to the development of an integrated multi-task power line sensor (PLS) module. This poster mainly addresses the design and implementation issues for such a sensor module.

62. Michael Knauff, Dagmar Niebur, Chika Nwankpa
Drexel University
Poster Title: Derivation and Validation of a valve regulate lead acid (VRLA) battery model
Abstract: Dynamic simulation is increasingly used in the development of electrical systems. It is therefore important to develop more accurate models for such simulations. Recent public interest in hybrid electric vehicles necessitates a better understanding of the operation of systems with multiple power sources (hybrid power systems). Several types of novel energy storage devices have been proposed for such systems, but it is also possible that valve regulated lead acid (VRLA) batteries will be used in such systems due to their low cost. This poster depicts the derivation and validation of a dynamic VRLA battery model using data obtained using an automated battery testing platform.

63. Huijuan Li, Fangxing Li, Yan Xu,Tom Rizy, John Kueck
University of Tennessee
Poster Title: Decentralized Adaptive Voltage Control with Distributed Energy Resources
Abstract: "Distributed energy resources (DE) with power electronics interfaces and logic control using local measurements are capable of providing reactive power related ancillary services. In particular, local voltage regulation has drawn much attention in regards to power system reliability and voltage stability. In this paper the challenges of controlling DEs to regulate local voltage in distribution systems is addressed. A decentralized adaptive voltage control method has been developed and tested showing great promise in this area. Both simulation and field experiment test results at the Distributed Energy Communication and Control (DECC) laboratory show that this adaptive voltage control method is capable of satisfying the fast response speed requirement for operational use without causing oscillation or inefficiency problems. The application of this method with multiple DEs is also discussed. Since this method has a high tolerance to the shortage of the real-time system parameters and is widely adaptive to variable power system operational situations, it is very suitable for broad utility application."

64. Sunan Huang, Herbert L. Hess, Brian K. Johnson
University of Idaho
Poster Title: DC-DC Converter with Large Step-Down Voltage Ratio for Electric Vehicle Emergency Operations
Abstract: In electric vehicles, there is a significant requirement for stepping down battery voltages to power convenience loads and emergency loads. This poster describes design and building of a DC-DC converter designed for large step-down voltage ratios, for example, 240V to 5V. In this configuration, a buck converter with a 240V DC input is placed in series with a boost converter with the same 240V output. The low-voltage load is located in series, floating between the buck and boost converters. Because a midrange duty cycle is used, filtering requirements are much less than for the conventional method of two series buck converters. There is no transformer. Applications are in high temperature DC generation and regulation in oil drilling and in emergency augmentation of DC drive voltage in electric vehicles. Simulation shows comparable performance to conventional methods. The poster will present experimental results.

65. Qun Zhou, Leigh Tesfatsion, Chen-Ching Liu
Iowa State Univesity, University College Dublin
Poster Title: Day-ahead Price Forecasting by ANN combined with time series models
Abstract: Artificial Neural Network (ANN) and Time Series Models (TSM) are the two most used models in statistical price forecasting. ANN is considered as black-box forecasting which is suitable for complicated non-linear system, while TSM has an explicit form and models linear systems. In ANN forecasting, there is no requirement that residual terms should be a white noise process. However, if not, the indication is there is still room to refine the ANN model through additional extraction of information from the data. With this understanding, TSM is combined with ANN model resulting in white noise residual terms.The project proposes the combined ANN/TSM model to forecast electricity price. The MISO case is used to validate this model. The results demonstrate the strength of the combined ANN/TSM model.

66. Karthikeyan Balasubramaniam, Dr.Paul Hines
University of Vermont
Poster Title: Criticality in a Cascading Failure Blackout Model
Abstract: "A 20 year time series analysis of north american electric power transmission system blackout data shows a power law or heavy tail distribution. If risk associated with a blackout is dened as probability times the size of the event, then the risk associated with bigger blackouts is considerably higher with a power law distribution than with a Gaussian distribution. The presence of power law suggests that the system operates near critical points or in other words the system shows criticality. We examine and verify criticality in a IEEE 118 bus network with a dynamic AC blackout model. The model represents many of the interactions of a real power network, modeling both the continuous and discrete dynamics of power systems during a cascading failure."

67. Steven Wong, Kankar Bhattacharya, David Fuller
University of Waterloo
Poster Title: Coordination of Investor-Owned DG Capacity Growth in Distribution Systems
Abstract: "With governments pushing for the sustainable development of energy resources and, thus, providing generous feed-in tariffs to producers, there is the potential for significant growth in distributed generation (DG). In jurisdictions open to private investment, the participation of competing investors could lead to the penetration of investor-owned DG capacity exceeding the ability of the electric distribution systems to absorb it. Under such circumstances, there must be a transparent arrangement put in place to fairly assess and approve competing projects while ensuring the function of the distribution system.

In this poster, a process for coordinating DG-unit investment proposals submitted by multiple, and competing, private investors is presented. Employing a feedback mechanism between the local distribution company and private investors, this process seeks to maximize investor participation while complying with the technical operational limits of the host system. The commons and domains algorithm, which has been used to identify the largest transgressors to system function, forms the basis for revisions to investor proposals. This process' viability is demonstrated on a 32-bus radial distribution system."

68. Jin Yang, Student Member, IEEE, John E. Fletcher, and John O'Reilly, Senior Member, IEEE
The University of Glasgow
Poster Title: Converter Protection Scheme for Doubly-Fed Induction Generator during Various Fault Conditions
Abstract: "This poster summarises a new converter protection method, primarily based on a series dynamic resistor (SDR), that avoids the doubly-fed induction generator (DFIG) control being disabled by crowbar protection during fault conditions.

A combined converter protection scheme based on the proposed series dynamic resistor and conventional crowbar is analysed and discussed. The main protection advantages are due to the series topology when compared with crowbar and DC-chopper protection.

Various fault over-current conditions (both symmetrical and asymmetrical) are analysed and used to design the protection in detail, including the switching strategy and coordination with crowbar, and resistance value calculations.

PSCAD/EMTDC simulation results show that the proposed method is advantageous for fault over-current protection, especially for asymmetrical faults, in which the traditional crowbar protection may malfunction."

69. Sarina Adhikari, Student Member, IEEE, Fangxing Li, Senior Member, IEEE, and Zhenyuan Wang, Member, IEEE
University of Tennessee at Knoxville
Poster Title: Constructive Back-Feed Algorithm for Online Power Restoration in Distribution Systems
Abstract: The poster is about a simple yet effective back-feed restoration algorithm to restore supply to the loads following a distribution system fault. The algorithm considers the balancing of load served by the individual substations as main criteria to decide the post fault restoration strategy. It is essentially a constructive network tracing algorithm which results in final network restoration strategy by determining the switching sequences of the feeder switches like circuit breakers, sectionalizers, etc.

70. Surajit Midya, Dierk Bormann, Ziya Mazloom Thorsten Schutte and Rajeev Thottappillil
Royal Institute of Technology, KTH
Poster Title: Conducted and Radiated Emission from Pantograph Arcing in AC Traction System
Abstract: "It highlight atras: 1. The buiseness cases: requirement from the raialway industry (including the vehicle manufaturer, railway boards and operators) 2. Technical Difficuties 3. Experimental details 4. Results and Analysis Pantograph arcing is experienced by almost all high speed speed trains, especially in the cold climates. This leads to EMC issues related to power, signalling and communication. We performed an experimental investigation involving experts from world leaders from railway and power industries. This is an industrial problem and will eventually result in benifits the railway compoanies. The reviewer highly appreciated this paper."

71. Palak Jain
New Mexico State University
Poster Title: Capacity Discovery of Customer-Driven MicroGrids
Abstract: Micro-grids for electric power delivery are emerging as a challenge to today's technology in the sense that they are considered as an approach towards decentralization of conventional Power System and can be operated by the customers themselves hence, given the name "Customer Driven Micro-grids". We present and investigate a completely decentralized architecture for the control of a customer driven micro-grid. The control operations of a micro-grid are carried out by using agents based approach. An agent is a software or hardware entity which has a certain degree of intelligence. A group of two or more agents is called a Multi Agent System (MAS). The attributes required to manage and control a modern power system are scalability, openness, flexibility and reliability. MAS seem to be a solution having all the required attributes. We have used a completely decentralized approach of MAS which is the most basic building block of any system. Challenging problem is the operation of a micro-grid as an island by discovering the available capacity of the network, when it is disconnected from the central grid due to a fault in the distribution feeder. This paper demonstrates the finding of the available capacity of the network and the identification of viable islands prior to the disturbance or disconnection of distribution feeder using a decentralized multi-agent system with only neighbor-neighbor communication of agents. We investigate a 13 bus IEEE test system for the islanding problem.

72. Xing Liu;Vaithianathan "Mani" Venkatasubramanian;Tae-Kyun Kim
Washington State University
Poster Title: Automatic Voltage Controllers for South Korean Power System
Abstract: The paper proposes two automatic voltage controllers for the South Korean power system. Simulation results from detailed Korean power-flow models show that the controllers can provide significant improvements in security, quality and efficiency of power system voltage monitoring and control. Operating within a time scale ranging from tens of seconds to a few minutes, the controllers can act upon voltage alarms and voltage insecure conditions to maintain prescribed voltage profile and adequate VAR margins. The control actions include continuous adjustment of generator VAR outputs as well as switching of discrete VAR support devices such as shunt capacitor banks. This paper extends an earlier discrete version of the controller developed at Washington State University and tested at Bonneville Power Administration into a hybrid voltage controller. This paper tests the implementation and application of the previously developed discrete as well as the proposed hybrid controllers in Korean power system models.

73. Hieu Pham
Iowa State University
Poster Title: Auto-Steered Information-Decision Processes for Electric System Asset Management
Abstract: A rough estimate of the numbers of power transformers and circuit breakers comprising the US transmission system (138-765 kV) are 150,000 and 600,000, respectively; in addition, there are 254,000 miles of high voltage transmission lines. The total replacement value of the US transmission lines alone (excluding land) is conservatively estimated at over $100 billion dollars and triples when including transformers and circuit breakers. Investment in new transmission equipment has significantly declined over the past 15 years. Some of the equipment is well beyond intended life, yet is operated under increasing stress, as load growth, new generation, and economically motivated transmission flows push equipment beyond nameplate limits. Maintaining acceptable electric transmission system reliability and delivering electric energy at low energy prices requires innovations in sensing, diagnostics, communications, data management, processing, algorithms, risk assessment, decision-making (for operations, maintenance, and planning), and process coordination. Our goals are to develop methods and processes in these areas, driven by three ultimate objectives; to develop a hardware-software prototype capable of auto-steering the information-decision cycles inherent to managing operations, maintenance, and planning of the high-voltage electric power transmission systems, to focus on the most critical electric transmission equipment, including power transformers, circuit breakers, and transmission lines, and to increase ability and confidence therein to handle and use the massive data streams associated with owning and operating transmission equipment, resulting in better investment, maintenance, and operating decisions, and ultimately, more economic and more reliable electric delivery of electric power. Ultimately, in fulfilling these three objectives we are complying with the seven smart grid objectives identified by the DOE.

74. Scott Ghiocel, Joe H. Chow
Rensselaer Polytechnic Institute
Poster Title: Applied Sensitivity Analysis for Voltage Stability Assessment
Abstract: Sensitivity calculations provide valuable insight into voltage stability issues. In this research, we compute sensitivities for the Korean power system to determine the voltage security operating points, based on contingency analysis. The coordinated real-time control of multiple FACTS controllers will be based on this voltage stability assessment.

75. Trevor Sawatzky
University Of Saskatchewan
Poster Title: Application of a Pattern Recognition Technique for Identifying Power Swing Conditions on a Power System with STATCOM
Abstract:

76. Ritwik Majumder, Arindam Ghosh, Gerard Ledwich, Firuz Zare
Queensland University of Thechnology
Poster Title: Angle Droop versus Frequency Droop in a Voltage Source Converter Based Autonomous Microgrid
Abstract: This poster compares the performance of angle and frequency droops in an autonomous microgrid that only contains voltage source converter (VSC) interfaced distributed generators (DGs). As a VSC can instantaneously change output voltage waveform, power sharing in a microgrid is possible by controlling the output voltage angle of the DGs through droop

77. Theresa Odun-Ayo, Mariesa Crow
Missouri University of Science and Technology
Poster Title: An Analysis of the Impact of Plug-In Hybrid Electric Vehicles on Power System Stability
Abstract: Rising gas prices, carbon constraints, fuel economy standards, and the desire for energy independence are driving the development of PHEV which are expected to achieve the equivalent of 100miles per gallon of gasoline. If they achieve significant market potential, they will have a huge impact on the electric industry, increasing load by an amount which could put the grid at risk. The challenges faced by todays power system are severe. It is designed for moderate load increase due to long time investments in electricity generation, lines and cables but faces in the future a large new load with different patterns. This paper investigates the stability of system by using the potential energy generated at and around the equilibrium points.

78. Jin Hur, Manho Joung, Minqi Zhong, Ross Baldick, and Stephen S. Miller
University of Texas at Austin
Poster Title: An Advanced Cascading Outage Analyzer for Analyzing and Preventing Large Blackouts
Abstract: "Cascading outages have been the main cause of a large area blackout. The cascading outages are initiated by one or multiple disturbances such as transmission outage, generation outage, substation outage and load bus trip in the system. The process of cascading outages leading to the large scale blackout is very complicated and it is usually very hard to analyze.

This poster presents the advanced Cascading Outage Analyzer tool to identify critical lines and to forecast the cascading process that might lead to a large scale blackout. In order to monitor the system status when the initial disturbance occurs, three cascading outage checkers, a line overload, an under voltage and under frequency checkers are implemented. The COA tool has its own graphical user interface and various design patterns are adopted in order for more flexibility and expandability. To verify the developed outage checkers, scenario based simulation results of COA tool applied to a 9 bus 3 machine system and 39 bus system are reported.

The proposed cascading outage analysis tool can identify vulnerable or critical lines and forecast the cascading process leading to the large scale blackout. Consequently, this tool can provide the trace patterns of cascading events and enhance the system reliability and secure system operation. In additions, since the cascading outage analyzer considers N-1-1 contingency, it can provide the establishment of new credible contingency lists comparing the existing critical contingency list."

79. Urvi Malhotra, Rama Gokaraju
University of Saskatchewan
Poster Title: An Adaptive Controller for a Static VAR Compensator
Abstract: "Large scale power systems comprise of several long distance transmission lines that are vulnerable to various types of faults. Power is generally transmitted as alternating current over such transmission lines. The rate of development of transmission systems is not able to keep up with the increasing power demand. This gap leads to overloading of transmission lines which further hampers the reliability of a power system. In order to improve the control and power transfer capability of the network, power electronics based system called FACTS (Flexible AC Transmission System) is used. This system provides reactive power compensation over such transmission networks. Static VAR Compensators (SVCs) are a part of the family of FACTS devices. SVCs, along with line commutated thyristor technology are used to increase the stability as well regulate the voltage of an AC transmission system. The stability is enhanced by introducing a supplementary external control signal to the SVC voltage control loop. This control signal improves the stability of the system by damping the power system oscillations during unstable conditions.

Usually a power system is a highly nonlinear system; its dynamic behavior is best described by a high-order discrete model. This introduces a considerable amount of computation at a higher sampling rate. Such nonlinear characteristics can be modeled by neural networks. The ability of a neural network to learn directly from the data being modeled makes it beneficial in adaptive control techniques. However, external controllers based on neural networks are questioned for their stability and robustness. Such a problem is overcome by using an adaptive controller that comprises of a Radial Basis Function (RBF) network identifier and the numerically stable Pole Shifting (PS) feedback control system . Such external controllers provide stability and desired control over a wide range of operating conditions. RBF represents the nonlinear model of the power system and stability is achieved using a PS controller. RBF operates on past output samples taken from a particular bus. It consists of a hidden layer and output of hidden layer is weighted before connecting to a linear output layer. Such linearized outputs are used by PS controller to achieve a constant set-point in the shortest period of time.

The objective of this research is to develop an adaptive controller using RBF and PS control system described above for a SVC. The designed adaptive controller will be evaluated using a 12-bus FACTS benchmark test power system, simulated using Real Time Digital Simulator (RTDS). RTDS is a digital power system simulator that performs real time simulations with a typical time step of 50s using a combination of hardware and software2. The designed adaptive controller will help in the voltage regulation and oscillation control at any desired point in a power system. This will help in damping the transients/oscillations, thus reducing the injection of transient energy into the power system during a fault or a disturbance. This will thus lead to a more robust system which is relatively stable for various disturbances."

80. N.P. Yu, C.C. Liu and J. Price
Iowa State University
Poster Title: Agent Modeling for Integrated Power Systems
Abstract: "California power crisis has shown what could happen to a poorly designed electricity market that did not go through comprehensive testing before implementation. Due to the complicated nature of market structure, strategic interaction between the market participants, and the underlying physical infrastructure, it is hard to fully evaluate the implications on potential changes to market rules. This poster presents a novel method to assess market designs through agent-based modeling. The day-ahead electricity market is modeled as multi-agent system with interacting agents including market operator, supplier agents and Load Serving Entities. Three simulation scenarios are constructed and tested to evaluate the potential market power mitigation rules of California electricity market. It is shown that the agent-based modeling approach is very promising in assessing market designs."

81. Yunfei Wang, Wilsun Xu
University of Alberta
Poster Title: Advanced Load Shedding Scheme for Voltage Collapse Prevention
Abstract: "As one of the major concerns in power system planning and operation, the voltage stability protection has received increasing attention due to a number of instability events that occurred during the last couple of decades. The objective of this presentation is to present a new multi-port voltage stability indicator to guide the advanced load shedding. Through the analysis on UVLS (Undervoltage load shedding) and single-port impedance matching method, two practical and relative accurate voltage stability indicators are proposed. They are based on the multi-port Thevenin equivalent circuit, which can be obtained by taking only one snapshot measurements. The simulation results show that these indicators could be used to guide the advanced load shedding schemes."

82. Billy Endusa Muhando, Tomonobu Senjyu, Aki Uehara
University of the Ryukyus
Poster Title: Addressing Grid Integration Issues for DFIG-Based WECS via Multiobjective H_infinity Paradigm
Abstract: "Recent advancement in size and technology of wind energy conversion systems (WECSs) require sophisticated control systems to effectively optimize energy conversion and enhance grid integration. Doubly-fed induction generators (DFIG)-based WECS are the most promising and widely utilized technology. This presentation focuses on advanced controls development to identify and assess the critical loads and instabilities, and improve the WECS's dynamic response and quality of power output by designing an H_infinity control scheme. Building on the theory of LPV convex decomposition, the WECS is transformed into a LPV model with a convex polyhedron structure. The proposed controller is designed to meet H1 performance and dynamic characteristics by solving a set of LMIs to synthesize the feedback gain for each vertex of the convex polyhedron. This realizes local, linear controllers that yield a global, parameter-dependent or nonlinear time-varying controller by interpolation."

83. Hui Wang
University of Alberta
Poster Title: A novel Strategy to Establish Time Series Harmonic Model
Abstract: A time series harmonic load modeling strategy is proposed. This kind of model is based on the measurement data. Principle component analysis (PCA) and autoregressive moving average model (ARMA) have been used to establish the model. Among others, this kind of model has two highlight features: 1) it's a process simulation model rather than traditional frequency domain model. 2) PCA and ARMA help to exploit the patter incorporated in the original data, reduce the number of models and make the model credible. Its applications have been identified as aiding the design of harmonic. Its advantages are prominent when engineering requires a multi-scenario system in order to perform system-dependent tasks. Its capability for generating a random but feature included time series harmonic load is a powerful tool in the context of power systems harmonic simulation.

84. Lisheng Shi, M. L. Crow
Missouri University of Science and Technology
Poster Title: A Novel Phase-Locked-Loop System Based on Decoupled Synchronous Reference Frame Transformation
Abstract: Phase-Locked-Loop (PLL) is one of the key technologies extensively used in grid connected power electronics system. A good PLL system can detect the grid phase angle and frequency fast and accurately, and additionally it can extract the positive sequence (or fundamental component for single phase system) exactly. In real applications, source signal (voltage or current) sensed for PLL usually includes harmonic distortion, unbalanced components, noises and frequency variations. Conventional PLL strategy cannot solve all the problems, especially the unbalanced and harmonic distortion. There is a trade-off between the dynamic response and phase angle tracking accuracy. Different PLL solutions are proposed in literature in recent years, especially software based synchronous reference frame based PLLs (SRF-PLLs). In this paper, a simpler decoupled SRF-PLL system is proposed (DSRF-PLL). The DSRF-PLL has good performances in filtering harmonics and noises, eliminating unbalanced components and auto-adjusting frequency change. The dynamic response may be higher than conventional SRF-PLL. The principle of the MAF-PLL is analyzed in detail. The simulation model is built in Matlab/simulink and the simulation results are given to verify the mathematical analysis.

85. Chunyi Guo, Chengyong Zhao
North China Electric Power University
Poster Title: A New Technology for HVDC Start-up and Operation Using VSC-HVDC System
Abstract: This paper proposed a new technology for HVDC start-up and operation using VSC-HVDC system. The new concept of the technology is to start HVDC when its receiving side is passive network. The motivation of choosing this technology is to enable HVDC to operate under small amount of power delivery condition as the receiving side is passive network. A physical model of starting HVDC by VSC-HVDC is developed. Moreover, a control system is designed in dq reference frame. In order to testify this technology, the dynamic performance of starting HVDC using VSC-HVDC is investigated. Simulation results obtained using PSCAD/EMTDC show that with the use of the proposed technology, the HVDC system can start successfully and feed small amount of power to passive network. The technology proposed exerts the advantage of VSC-HVDC system and increases the availability ratio of supplying power to passive network.

86. Abdelrahman Abbas Hagar, Peter W. Lehn
University of Toronto
Poster Title: A New Approach for Integrating Renewable Energy Sources into DG grids
Abstract: While catching power form renewable energy sources became technically possible, many challenges still exist in terms of integrating this green power into electrical transmission and distribution systems. The poster presents a promising converter topology that addresses this challenge. The proposed solution depends on the concept of DC distributed generation which is very suitable for power distribution in both rural areas and mega-cities alike.

87. Andrew Armenia
Rensselaer Polytechnic Institute
Poster Title: A Flexible Integrated Phasor System using Open-Source Software
Abstract: The poster will include information on the design of an integrated phasor system using open source software. This system will encompass the functionality of traditional phasor data concentrators, in addition to providing a flexible user interface for data access and visualization.

88. Eduardo Cotilla Sanchez
University of Vermont
Poster Title: A complex networks approach to analyzing the structure and dynamics of the power grid
Abstract: Electrical energy systems are good examples of complex systems. They include continuous, discrete, and social dynamics. They are operated by millions of human and non-human (or electro-mechanical) agents, and they show statistical properties found in other complex systems, such as power-law distributions in failure sizes. A number of recent large blackouts in Europe and North America have emphasized the societal importance of understanding these dynamics. Classical electromagnetic analysis alone frequently does not provide the insight required to characterize and mitigate risks in the electricity infrastructure. The objective of this study is to obtain insights into the dynamics of power grids using tools from the science of complex systems. In particular, this study will compare the topology, electrical structure, and attack/failure tolerance of power grids with those of theoretical graph structures such as regular, random, small-world, and scale-free networks. Simulation results will describe the cost of the disturbances as a function of failure or attack sizes. The cost associated to network perturbations is often measured by changes on the diameter or average path length, whereas in the field of electric systems, the losses of power demand is the main cost indicator.

89. Edward James William
Univ of Idaho
Poster Title: A Comparative Study of Li/CFx and LiFePO4 Battery Chemistry for State of Charge Indicator (SOCI) Design
Abstract: This paper determines if Li/CFx or LiFePO4 is beneficial for state of charge indicator (SOCI) design for military applications. This is achieved by analyzing and comparing data from the battery chemistry of Lithium Carbon Monoflouride (Li/CFx) and Lithium Iron Phosphate (LiFePO4).

90. Tuo Ji
Washington State University
Poster Title: Missing
Abstract:

91. Xiaomeng Li
Missouri University of Science and Technology
Poster Title: Missing
Abstract: