U. S. Department of Energy
EPSCoR State Implementation Award Program - West Virginia

Final Report

Integrated Computing, Communication and Distributed Control of
Deregulated Electric Power Systems

Sponsoring Agency: US DOE, Coal Conversion and Utilization
Agency Number: DE-FG02-00ER45829

West Virginia EPSCoR

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Program Status Report
West Virginia EPSCoR

Introduction

The continuation award for the West Virginia DOE EPSCoR State Implementation Award Program [hereafter called the Program] focused on continuing support of the research cluster, *Integrated Computing, Communication and Distributed Control of Deregulated Electric Power Systems,* directed by Ali Feliachi, Power Professor, Department of Computer Science & Electrical Engineering, West Virginia University.

The Administrative Principal Investigator for the second phase of the implementation award was Richard A. Bajura, director of the National Research Center for Coal and Energy. This report provides a summary of the overall program, which was in effect from July 1, 2000 through December 31, 2007.

Financial Information and Participants

The original official funding period for the first three year award period started on July 1, 2000 although funding was not actually available for spending until December 14, 2000. The funding amount was $390,000 with cost share of $494,570. The second funding period officially started on July 1, 2001 although funding was not actually available for expenditure until August 23, 2001. The award amount was $390,000 with cost sharing of $482,153. The third funding period officially started on July 1, 2002 with funding available for expenditure by July 19, 2002. The award amount was $390,000 with cost sharing of $472,153. The award period officially ended June 30, 2003 with a total award of $1,170,000 with cost sharing of $1,448,876.

The second three-year award period started July 1, 2003 and was continued through December 31, 2007. The first sixteen (16) months of Phase II were funded at a level that allowed expansion of the research team from eight faculty members to eighteen. WVU received $1,000,000 with a cost share commitment of $1,022,849. Due to federal budget constraints, the total West Virginia award was reduced by half during the execution of the Phase II project, so WVU received only $30,000 in additional funding of what was to have been a $650,000 continuation award. This necessitated reducing the research team to nearly its original size. In spite of these constraints, the research team has continued to perform beyond any expectations.

Participants in the program to date have included:
> ➤ undergraduate students and graduate students in a course co-taught by a power engineering professor and an economics associate professor entitled *Power Systems Analysis and Economics*;

- ➢ 39 graduate students, including 7 women; 14 students have completed the MS, two of those have gone on to the PhD program; 9 have completed the PhD; one graduate student left the program; two who completed the PhD have stayed on as research assistant professors;
- ➢ twelve tenure track research faculty members from five departments in four colleges on two campuses and four non-tenure track research assistant professors; a fifth non-tenure track research assistant professor, a female in the Economics department, was appointed to a tenure track position in the last year in part due in part to her participation in this program. (She is counted among the twelve.)
- ➢ two faculty equivalent professionals who manage the state DOE EPSCoR program part-time; and,
- ➢ three professional staff.

Faculty members who have participated in the initial three interrelated projects dealing with generation, transmission, and distribution systems as shown in the table below. Those shown in bold face have been able to remain with the program. Those shown in regular typeface have had to be released given the downturn in funding.

Personnel Table

Investigator	Affiliation	Project I	Project II	Project III	Management
Richard A. Bajura	NRCCE				✓
Trina Karolchik Wafle	NRCCE				✓
Ali Feliachi	CEMR LDCSEE	✓	✓	✓	✓
Karl Schoder	CEMR LDCSEE	✓	✓	✓	
Y.V. Ramana Reddy	CEMR LDCSEE	✓	✓		
Srini Kankanahalli	CEMR LDCSEE	✓	✓		
Kourosh Sedghisigarchi	CEMR LDCSEE			✓	
Powsiri Klinkhachorn	CEMR LDCSEE		✓	✓	
Don McLaughlin	CEMR LDCSEE		✓	✓	
Afzel Noore	CEMR LDCSEE		✓	✓	
Sumitra Reddy	CEMR LDCSEE	✓	✓		
John E. Sneckenberger	CEMR MAE	✓		✓	
Jerald J. Fletcher	Davis College Resource Econ	✓			
John E. Saymansky	Davis College, Resource Econ	✓	✓	✓	
Tim T. Phipps	Davis College Resource Econ	✓			
Hong-Jian Lai	Eberly College, Math	✓	✓		
Hyungna Oh	B&E Econ	✓		✓	
Stratford Douglas	B&E Econ.	✓		✓	
Asad Davari	WVUIT CoE ECE		✓	✓	
William Guyker	CEMR LDCSEE	✓	✓	✓	✓

Legend

NRCCE	National Research Center for Coal and Energy at WVU
CEMR LDCSEE	WVU College of Engineering and Mineral Resources Lane Department of Computer Science and Electrical Engineering
CEMR MAE	WVU College of Engineering and Mineral Resources Department of Mechanical and Aerospace Engineering
B&E Econ	WVU College of Business and Economics Department of Economics
A&S Mathematics	WVU Eberly College of Arts & Sciences, Department of Mathematics
Ag. Sci. Resource Management	WVU Davis College of Agriculture, Forestry, and Consumer Sciences, Department of Resource Management
WVUIT CoE ECE	WVU Institute of Technology College of Engineering Department of Electrical and Computer Engineering

The industry advisory committee continues to provide input to the research team. Advisors met in person in March, 2005, and continued to meet via periodic conference calls. The most recent meeting was in Spring, 2008 to summarize the results of the program. Regular participants on the advisory committee included:

Advisory Committee Members

Fred Frank, Allegheny Power
James Markowsky, RDS
Randall West, Concurrent Technologies Corp.
Richard Bajura, WVU NRCCE
John Paserba, Mitsubishi Power

Advisors described APERC as being an outstanding program in which WVU should take great pride. They were very pleased and interested in the excellent quality and innovativeness of the research.

They noted that APERC's strengths include its multidisciplinary approach and its melding of theory with a practical applications orientation making it unique among such programs to the knowledge of the advisors. Incorporating business issues into the research program will continue to be an essential ingredient in APERC's success since many issues facing the industry are social, economic, or political and not necessarily technical in nature. Students who graduate from APERC are valuable and will be highly sought after for their understanding of, and experience with, actual problems facing the industry as a whole.

Advisors encourage APERC to go to the next level by getting greater industry involvement, which would bring a greater sense of urgency to the research and increase the likelihood that the results will truly have a positive impact on the electricity sector. Researchers should seek industry feedback as early as the design phase of a project. Joint research projects with industry were highly encouraged as well.

Research timelines should be established in the 1-to-3-year, 3-to-5-year, and 10-year range. Specific recommended research topics included: a variety of risk and cost-benefit business analyses; social structure barriers (e.g., industry fragmentation) that affect policy development and physical operations; monitoring underground systems for wear; characterizing RF transmissions as a means for identifying system problems; plug-n-play distributed generation; a better understanding of microgrids (e.g., Chambersburg, Penna.'s system) and making an economic case for microgrids; over-voltage protection; and electricity storage.

The program has received additional support through an internal award from the WVURC Program to Stimulate Competitive Research and work on two Smart Grid projects pertinent to the needs of West Virginia and the surrounding region. We are currently working with the National Energy Technology Laboratory on related research pertinent to the national grid.

Summary of Accomplishments

The research program was organized around three project thematic areas of focus.

Project I

Project I addresses generation and energy balancing issues. Econometric models have been designed to explain and assess the patterns and prices of power plant divestiture by regulated utilities and changes in the efficiency of dispatch under deregulation.

Financial options models have been adapted to valuation of power plants in a deregulated market, and to assess the importance of market power in the valuation of power plants. Economists and engineers have found common areas of interest and complementarities of expertise in modeling markets for energy and ancillary services.

The following two questions have been addressed recently by the research team: Has the restructuring of the electricity industry in the United States accomplished any of its goals? If so, how can we build upon those successes? The results obtained partially answer those questions by measuring the changes in efficiency of dispatch of coal-fired power plants in different regions of the eastern United States, since FERC Order 888 in 1996. If market reforms increase efficiency of dispatch, utilization rates of high-cost plants should have fallen relative to those of low-cost plants.

Using plant-level panel data on operating cost and capacity factor, an econometric model was used to detect and measure efficiency gains from market-oriented restructuring. Results indicate that utilization rates of low-cost plants did indeed increase relative to those of high-cost plants after 1996, but only in regions where there was active participation in restructured wholesale power markets. This result provides evidence that trade across utility boundaries, stimulated by restructuring, increases the ability of the system to utilize more efficient plants. Simulations based on the econometric results indicate cost savings on the order of three percent.

The simulations used parameters estimated in two regimes: before Order 888 ("Traditional") and after Order 888 ("Market"). The largest and most consistent gains occurred in MAAC and NPCC, where PJM, NEPOOL, and the NY Power Pool are located. The SERC region, which resisted market reforms, did not shown any increase in efficiency since 1996. ECAR, which increased trade but did not implement regional ISOs, showed less improvement than MAAC or NPCC. These results are limited in scope, but strongly indicate that reforms

that increase the breadth and intensity of wholesale power market activity can increase system efficiency.

Project II

Project II is the integrated computing, communication and distributed control of power systems. It deals with control, and stability, of the dynamics of electric power systems in the event of considerable structural changes and loading conditions.

A Power Analysis Toolbox (PAT) simulation package has been developed in a MATLAB/SIMULINK environment. It is a stability package that is used to test the different control strategies being developed. The research team has developed control algorithms that enhance the dynamic performance of the electric grid. These controllers are implemented at the generation stations by sensing local signals such as generator's speed and output electricity and modifying the field voltage of the generator appropriately to dampen oscillations in the system. The designed controllers work under a wide range of operating conditions, i.e. various loading conditions and fault occurrences.

Simulation has shown that more power could be transmitted over the American Electric Power system for some scenarios if the APERC design is adopted.

Project III

Project III is on distribution systems.

The research team has shown that so-called distributed generators (DGs) such as fuel cells and microturbines can be used to "balance" electricity supply and demand at the distribution network level, opening the possibility for distribution networks to operate autonomously from the transmission system, in effect becoming "microgrids." For such microgrids to work, the DG must be able to track electricity demand in real time, producing more or less electricity to exactly meet the current demand or risk losing the network causing a blackout.

Today's DGs are not able to continuously vary the amount of electricity they produce. To address this issue, APERC researchers have developed control design algorithms that would allow DGs to adjust their output and provide energy balancing in a distribution system. Today, the transmission grid performs this balancing act (topics addressed in Project I). Consumers get their electricity from the grid through distribution networks. If a portion of the grid blacks out, so do all distribution networks attached to that portion of the grid, and so do all customers attached to those distribution networks.

EPRI predicts that by 2010 25% of all power will be generated by DGs at the distribution network level. If DGs could track supply and demand, the distribution network potentially could function independently from the grid offering increased system reliability at the consumer level.

Highlights of the success of the research cluster include:

- A new university-wide center, the Advanced Power and Electricity Research Center (APERC), has been established.
- 39 graduate students have been associated with the program to date producing 20 theses and dissertations. Five graduate students have received national awards from the IEEE Power Engineering Society.
- 106 papers have been published in journals and conferences (IEEE Transactions on Power Systems, Electric Power Research Journal, IEEE conferences, Energy Studies Review, International Journal of Energy Technology and Policy, etc.)
- A course on power system analysis and economics has been developed.

Details of the overall accomplishments are given in the following lists and tables.

Summary Information on Program Accomplishments

Graduate Students Supported

Karl Schoder (PhD***)	Lingling Fan (PhD*)	Vladimir Starkov (PhD*)
Kourosh Sedghisigarchi (PhD**)	Amer Hasanovic (MS*,PhD*)	Dulpichet Rerkpreedapong(PhD
Liang Tian (PhD*)	Amer Al-Hinai (PhD*)	Serhiy Kotsan (PhD*)
Nedzad Atic (MS*)	Ramanujam Srinivasan (MS)	Aniruddha Paradkar (MS*)
Padha Srinivasan (MS*)	Sampath Yerramalla (MS*)	Scott Zemerick (MS*)
Bongani Malinga (MS*)	Azra Hasanovic (MS*)	Guillaume Raux (MS*)
Ali Karimi (MS**)	Abishek Sakhare (MS*)	Biju Naduvathuparambil (MS*)
Dilip Nataraja Kumar	Na Li	Anand Vedam
Ramesh Vedantam	Prashanti Varre	Raghu Chandra Sankarayogi
Joshua Robinson	Julia Popova	Wei Zhang
Vijayanand Bharadwaj	Arvinth Chandramouli	Shilpa Ganesh
Asawari Moholkar	Jesse Twardus	Adahu Tekle
Karthick Thyagarajan	Thomas Maming	Vamsi Paruchuri
Ram Praveen Saladi (MS*)	Srinivas Mangue (MS*)	Anisha M. Fernandes (MS*)
Ramesh Kumar Khajjayam (MS	Talpasai Lakkaraju (MS*)	Silpa Parnandi (MS*)
Pinak Tulpule (MS*)	Pradeep Pant (MS*)	Rabie Belkacemi
Sridhar Chouhan	Sara Eftekharnejad	Summiya Moheuddin
Koushaly Nareshkumar	Michael Spencer	Bernard McGee

(*) graduated   (**) Graduated MS, enrolled in Ph.D. (***) Graduated and still on the project

Awards/Recognition to Date

1. Kourosh Sedghisigarchi, (Feliachi's PhD Student) **IEEE PES Student Poster Award**, July 2002.
2. Padha Srinivasan, Ali Feliachi, John E. Sneckenberger, **First place prize paper award, IEEE North American Power Symposium**, October 2002.
3. Nedzad Atic, Amer Hasanovic, **2002 IEEE T. Burke Hayes PES prize paper** contest winner, July 2003, Toronto, Canada.
4. Ali Feliachi, **2002 IEEE T. Burke Hayes PES Faculty Recognition Award** (Advisor, student paper prize), July 2003, Toronto, Canada.
5. Serhiy Kotsan, "Efficient Tariffs for Cost Revelation in a Price and Quantity Constrained Electric Power Market," **Best Student Paper** competition at the USAEE/IAEE/AMEE North American meetings in Mexico City, October 19th – 21st, 2003.
6. Julia Popova, "Spatial Patterns in Modeling Electricity Prices: Evidence from the PJM Market," **Best Student Paper** in competition at USAEE/IAEE North American Meetings in Washington, DC, July 8-10, 2004.
7. Ali Feliachi, **Outstanding Researcher of the Year**, West Virginia University, College of Engineering and Mineral Resources, April 2004.
8. Ali Feliachi, **Outstanding Researcher of the Year**, West Virginia University, College of Engineering and Mineral Resources, April 2005.
9. Shilpa Ganesh, "Energy Management System with Automatic Reconfiguration for Electric Shipboard Power Systems," 3rd place poster award, Sigma Xi Graduate Research Day, West Virginia University, April 25, 2005.

List of Publications to Date

Refereed Journals

1. A. Feliachi, A. Hasanovic, K Schoder, *"Unified Power Flow Controllers,"* Chapter 20, *The Power Electronics Handbook*, ISBN 0-8493-7336-0, CRC Press LLC: Boca Raton, Florida, 2002.

2. L. Fan, A. Feliachi, K. Schoder "Selection and Design of a TCSC Control Signal in Damping Power System Inter-Area Oscillations for Multiple Operating Conditions," *Electric Power Systems Research Journal,* Vol. 62, pp.127-137, August 2002.

3. K. Schoder, Amer Hasanovic, A. Feliachi, Azra Hasanovic, "PAT—A Power Analysis Toolbox for MATLAB/Simulink," *IEEE Transactions on Power Systems*, Vol. 18, No. 1, pp. 42-47, February 2003.

4. D. Rerkpreedapong, A. Hasanovic, A. Feliachi, "Robust Load Frequency Control Using Genetic Algorithms and Linear Matrix Inequalities," *IEEE Trans. Power Systems*, Vol.18, pp. 855-861, May 2003.

5. L. Mokhnache, A. Boubakeur, A. Feliachi, "Thermal Ageing Prediction of Transformer Oil and PVC of High Voltage Cables Using Neural Networks," *IEE Proc. – Science, Measurement & Technology,* Vol. 150, Issue 03, pp. 107-112, May 2003.

6. S. Yerramalla, A. Davari, A. Feliachi**,** T. Biswas, "Modeling and Simulation of the Dynamic Behavior of a Polymer Electrolyte Membrane Fuel Cell," *J. of Power Sources*, Vol. 124, No.1, pp. 104-113, Oct. 2003.

7. A. Paradkar, A. Davari, A. Feliachi, T. Biswas "Integration of a Fuel Cell Into the Power System Using an Optimal Controller Based on Disturbance Accommodation Control Theory", *Journal Power Sources,* Vol. 128, Issue 2, Pages 218-230, 5 April 2004.

8. A. Boubakeur, L. Mokhnache, S. Boukhtache, A. Feliachi, "Barrier Effect on Point-Plane Air Gap Breakdown Voltage Based on Streamers Criterion," *IEEE Proceedings – Science, Measurement and Technology,* Vol. 151, No. 3, pp. 167-174, May 2004.

9. K. Sedghisigarchi, A. Feliachi, "Dynamic and Transient Analysis of Power Distribution Systems with Fuel Cells, Part I: Fuel Cell Dynamic Model," *IEEE Trans. on Energy Conversion,* Vol. 19, pp. 423-428, June 2004.

10. K. Sedghisigarchi, A. Feliachi, "Dynamic and Transient Analysis of Power Distribution Systems with Fuel Cells, Part II: Control and Stability Enhancement," *IEEE Trans. on Energy Conversion*, Vol. 19 pp. 429-434, June 2004*.*

11. L.Tian and A. Noore, "Software Reliability Prediction Using Recurrent Neural Network with Bayesian Regularization," *International Journal of Neural Systems*, Vol. 14, no. 3, pp.165–174, June 2004.

12. Amer Hasanovic, A. Feliachi, Azra Hasanovic, N.B. Bhatt, A.G. DeGroff, "Robust PSS Control Design or Practical Robust PSS Control Design

Through Low Order Transfer Function Identification," *IEEE Transactions on Power Systems*, Vol. 19, No. 3, pp. 1492-1500, August 2004.

13. A. Sakhare, A. Davari, A. Feliachi, "Fuzzy Logic Control of Fuel Cell Stand-alone and Grid Connection," *Journal of Power Sources*, Vol. 135, Issues 1-2, pp. 165-176, 3 September 2004.

14. L. Tian and A. Noore, "Short-term Load Forecasting Using Optimized Neural Network with Genetic Algorithm," *Proceedings of the 8th International Conference on Probabilistic Methods Applied to Power Systems*, Ames, IA, Sep.2004.

15. L. Tian and A. Noore, "A Novel Approach for Short-term Load Forecasting Using Support Vector Machines," *International Journal of Neural Systems*, vol.14, no.5, pp.329–335, Oct.2004.

16. L. Tian and A. Noore, "Online prediction of software reliability using an evolutionary connectionist model," *Journal of Systems and Software*, in press, available online Oct.2004.

17. L. Tian and A. Noore, "Evolutionary neural network modeling for soft-ware cumulative failure time prediction," *Reliability Engineering and System Safety*, vol.87, no.1, pp.45–51, Jan.2005.

18. A. Feliachi, D. Rerkpreedapong, "NERC Compliant Load Frequency Control Design Using Fuzzy Rules," *IEEE Transactions on Power Systems*, Available online 30 Sept. 2004, Vol. 73, pp. 101-106, Feb. 2005.

19. K. Sedghisigarchi, A. Feliachi, "Impact of Fuel Cells on Load-Frequency Control in Power Distribution Systems," *IEEE Transactions on Energy Conversion*, (provisional acceptance)

20. A. Feliachi, "On the Control of Re-Structured Power Systems," *International Journal of Control, Automation, and Systems,* accepted for publication (to appear mid 2005).

21. S.M. Douglas, S. Kotsan, "Efficient Tariffs for Cost Revelation in a Price and Quantity Constrained Electric Power Market." Resubmission requested and submitted, *Energy Studies Review,* December 2004.

22. S. Kotsan, "Pricing Real and Reactive Power as a Bundled Product." Forthcoming, *International Journal of Energy Technology and Policy*.

23. S. Douglas, "Utilization Rates of Eastern US Coal-Fired Power Plants and the Efficiency of Electricity Market Reforms" Submitted to *The Energy Journal,* October 2004, Revision requested March 2005.

24. L.Tian and A. Noore, "Dynamic Software Reliability Prediction: An Approach Based on Support Vector Machines," *International Journal of Reliability, Quality and Safety Engineering*, Vol.12, no.2, June 2005.

25. L. Tian and A. Noore, "Dynamic Optimization of Artificial Neural Networks for Real-time Electric Load Forecasting," *International Journal of Electrical Power and Energy Systems*, submitted and under review.

26. K. Sedguisigarchi, A. Feliachi, "Impact of Fuel Cells on Load-Frequency Control in Power Distribution Systems" IEEE Transactions on Energy Conversion, Vol. 21, No. ', pp. 250-256, March 2006.

27. A. Karimi, A. Feliachi, "Decentralized adaptive backstepping control of electric power systems" Electric Power Systems Research Journal, Available on line, to appear

28. Amin Hajizadeh, Masoud Aliakbar Golkar, Ali Feliachi, "Power Management Strategy of a Hybrid Distributed Generation System" International Journal of Distributed Energy Resources, ISSN 1614-7138, Vol. 3, No. 2, pp. 139-156, April-June 2007.

29. S. Zebirate, A. Chaker, A. Feliachi, "Neural Network Generalized Predictive Control of the Unified Power Flow Controller" Journal of Applied Sciences 7, ISSN 1812-5654, pp. 1078-1084, 2007.

30. S. Zebirate, A. Chaker, A. Feliachi, "State Space Neural Network Adaptive Control of the Unified Power Flow Controller" International Journal of Computers and Their Applications, to appear.

Refereed Conference Proceedings

1. K. Schoder, A. Hasanovic, A. Feliachi, "Load-Flow and Dynamic Model of the Unified Power Flow Controller (UPFC) within the Power System Toolbox (PST)," *Proceedings of MWSCAS,* Lansing, MI, Aug. 8-10, 2000.

2. K. Schoder, A. Hasanovic, A. Feliachi, " Enhancing Transient Stability using a Fuzzy Control Scheme for the Unified Power Flow Controller (UPFC)," *Proceedings of MWSCAS,* Lansing, MI, Aug. 8-10, 2000.

3. L. Fan, A. Feliachi, "Decentralized Stabilization of Nonlinear Electric Power Systems Using Local Measurements and Feedback Linearization," *Proceedings of MWSCAS*, Lansing, MI, Aug. 8-10, 2000.

4. D. Rerkpreedapong, A. Feliachi, "Decentralized Control of Nonlinear Electric Power Systems Thru Excitation and Governor Systems Using Local Measurements and Feedback Linearization," *Proceedings of MWSCAS,* Lansing, MI, Aug. 8-10, 2000.

5. S. Douglas, "Why are US Utilities Selling their Power Plants?", *21st Annual North American Conference of the US Association for Energy Economics / International Association for Energy Economics, (USAEE/IAEE)*, Philadelphia, PA, September 25-27, 2000.

6. K. Schoder, A. Hasanovic, A. Feliachi, "Fuzzy damping controller for the Unified Power Flow Controller (UPFC)," *Proc. North American Power Symposium,* Waterloo, Canada, Oct. 23-24, 2000.

7. L. Fan, A. Feliachi, "Improving Power System Damping Characteristics by Thyristor Controlled Series Compensation," *Proc. of 2000 North American Power Symposium,* Waterloo, Canada, Oct. 23-24, 2000.

8. K. Sedghisigarchi, A. Feliachi, "A New Decentralized Nonlinear Controller Design Using Genetic Algorithms to Enhance Transient Stability and Voltage Regulation in Multimachine Power Systems," *Proceedings of 2000 North American Power Symposium,* Waterloo, Canada, Oct. 23-24, 2000.

9. K. Schoder, A Hasanovic, A. Feliachi, "Power System Damping Using Fuzzy Controlled Unified Power Flow Controllers," *Proc. of IEEE Power Eng. Society 2001 Winter Meeting,* Columbus, OH, p. 617, Jan. 2001

10. L. Fan, A. Feliachi, A. Davari, "Decentralized Control of Power Systems Using Disturbance Accomodation Techniques," *Proc. of 2001 American Control Conference,* Arlington, VA, June 2001.

11. L. Fan, A. Feliachi, "Robust TCSC Control Design for Damping Inter-Area Oscillations," *Proc. of IEEE Power Eng. Society 2001 Summer Meeting,* Vancouver, BC, July 2001.

12. L. Fan, A. Feliachi, "Phasor Measurement Unit Application To Power System Damping," *Poster presentation at the IEEE Power Eng. Society 2001 Summer Meeting,* Vancouver, BC, July 2001.

13. L. Fan, A. Feliachi, A. Davari, K. Schoder "Linear Adaptive Control Application in Power System," *Proc. 2001 North American Power Symposium,* College Station, TX, Oct. 15-16, 2001.

14. Z. Miao, L. Fan, A. Feliachi, "Decentralized Load Frequency Control with Wedge Shaped Area Control Error (ACE)," *Proc. 2001 North American Power Symposium,* College Station, TX, Oct. 15-16, 2001.

15. D. Rerkpreedapong, A. Feliachi, "Decentralized Load Frequency Control in a Deregulated Environment," *Proc. 2001 North American Power Symposium,* College Station, TX, Oct. 15-16, 2001.

16. L. Fan, A. Feliachi, "Effective Signal Selection in Decentralized Control Design of Nonlinear Interconnected Systems," *Proc. of IEEE CDC Conference,* Orlando, FL, Dec. 2001.

17. L. Fan, A. Feliachi, "Damping Enhancement by TCSC in the Western US Power System," *Proc. IEEE Power Engineering Society Winter Meeting,* New York, NY, Jan. 2002.

18. D. Rerkpreedapong, A. Feliachi, "Decentralized Load Frequency Control for Load Following Services," *Proc. IEEE Power Engineering Society Winter Meeting,* New York, NY, Jan. 2002.

19. K. Sedghisigarchi, A. Feliachi, "Control of Grid-Connected Fuel Cell Power Plant for Transient Stability Enhancement," *Proc. IEEE Power Engineering Society Winter Meeting,* New York, NY, Jan. 2002.

20. B. Naduvathuparambil, M.C. Valenti, A. Feliachi, "Communication Delays in Wide Area Measurement Systems," *Proc. Southeastern Symp. on System Theory,* pp. 118-122, Huntsville, AL, March 18-19, 2002.

21. S. Zemerick, P. Klinkhachorn, A. Feliachi, "Design and Implementation of a "Personal" Static Var Compensator," *Proc. Southeastern Symp. on System Theory,* pp. 311-315, Huntsville, AL, March 18-19, 2002.

22. A. Al-Hinai, A. Feliachi, "Dynamic Model of a Microturbine used as a Distributed Generator," *Proc. Southeastern Symp. on System Theory,* pp. 209-213, Huntsville, AL, March 18-19, 2002.

23. A. Paradkar, A. Davari, A. Feliachi, "Temperature Control of a Solar Furnace with Disturbance Accommodating Controller," *Proc. Southeastern Symp. on System Theory,* pp. 431-434, Huntsville, AL, March 18-19, 2002.

24. K. Sedghisigarchi, A. Feliachi, A. Davari, "Decentralized Load Frequency Control in a Deregulated Environment using Disturbance Accommodation Control Theory," *Proc. Southeastern Symp. on System Theory,* pp. 302-306, Huntsville, AL, March 18-19, 2002.

25. D. Rerkpreedapong, A. Feliachi, "Fuzzy Rule Based Load Frequency Control in Compliance with NERC's Standards," *Proc. IEEE Power Eng. Society 2002 Summer Meeting,* Chicago, IL, July 2002.

26. A. Hasanovic, A. Feliachi, "Genetic algorithm based inter-area oscillation damping controller design using MATLAB," *Proc. IEEE Power Eng. Society 2002 Summer Meeting,* Chicago, IL, July 2002.

27. S. Yerramalla, A. Davari, A. Feliachi, "Dynamic Modeling and Analysis of Polymer Electrolyte Fuel Cell Part 1: Nonlinear Analysis," *Proc. IEEE Power Eng. Society 2002 Summer Meeting,* Chicago, IL, July 2002.

28. S. Zemerick, P. Klinkhachorn, A. Feliachi, "Design of a Microprocessor-Controlled *Personal* Static Var Compensator (PSVC)," *Proc. IEEE Power Eng. Society Summer Meet.* Chicago, IL, July 2002.

29. K. Sedghisigarchi, A. Feliachi, "Dynamic Modeling and Analysis of a Grid - Connected Solid Oxide Fuel Cell," *Poster presentation at the IEEE Power Eng. Society 2002 Summer Meeting,* Chicago, IL, July 21-25, 2002.

30. A. Al-Hinai, K, Schoder, A. Feliachi, "Dynamic Modeling and Simulation of Microturbines as Distributed Generators," *Poster presentation at the IEEE Power Eng. Society 2002 Summer Meeting,* Chicago, IL, July 21-25, 2002.

31. S. Douglas, "Coal Power Plant Utilization in the Eastern US Since Restructuring," 2002 *23rd Annual USAEE/Intl Association for Energy Economics* North American Conf, Vancouver BC, Oct 6-8, 2002.

32. A. Hasanovic, N. Atic, D. Rerkpreedapong, A. Feliachi, "Load Frequency Control Using Model Predictive Control," Proc. 2002 North American Power Symposium, Tempe, AZ, Oct. 13-15, 2002.

33. K. Sedghisigarchi, A. Feliachi, "Dynamic Model of a Grid - Connected Solid Oxide Fuel Cell (SOFC)," Proc. 2002 North American Power Symposium, Tempe, AZ, Oct. 13-15, 2002.

34. P. Srinivasan, A. Feliachi, J.E. Sneckenberger, "Polymer Electrolyte Membrane (PEM) Fuel Cell Dynamic Model" *Proc. 2002 North American Power Symposium,* Tempe, AZ, Oct. 13-15, 2002.

35. N. Atic, A. Hasanovic, "Model Predictive Control Design for Load Frequency Control Problem," 2002 IEEE/PES Prize Paper Contest Winner.

36. R. Srinivasan, D.Rerkpreedapong, S. Kankanahalli, A. Feliachi, "Implementing an Auction Market for Regulation Service using Software Agents," *Proc. SSST,* pp. 58-63, Morgantown, WV, March 16-18, 2003.

37. A. Al-Hinai, K. Schoder, A. Feliachi, "Control Of Grid-Connected Split-Shaft Microturbine Distributed Generator for Transient Stability Enhancement," *Proc. SSST,* pp.84-88, Morgantown, WV, March 16-18, 2003

38. W. Zhang, A. Feliachi, "Communication Technology Options in Real-Time Pricing System for Residential Customers in Electricity Market," *Proc. SSST,* pp. 89-92, Morgantown, WV, March 16-18, 2003.

39. A. Paradkar, A.Davari, A. Feliachi, "Disturbance Accommodation Controller versus Conventional, in LFC of a Two Area Distribution System," *Proc. SSST,* pp. 98-102, Morgantown, WV, March 16-18, 2003.

40. B. Malinga, J.E. Sneckenberger, A. Feliachi, "Modeling and Control of a Wind Turbine as a Distributed Power Resource," *Proc. Southeast Symp. Syst Theory,* pp. 108-112, Morgantown, WV, March 16-18, 2003

41. A. Karimi, A. Feliachi, "Spline-Based Nonlinear Controller for the Duffing Oscillator," *Proc. Southeastern Symp. on System Theory,* pp. 191-195, Morgantown, WV, March 16-18, 2003.

42. P. Srinivasan, J.E. Sneckenberger, Ali Feliachi, "Dynamic Heat Transfer Model Analysis of the Power Generation Characteristics for a PEM Fuel Cell Stack," *Proc. Southeastern Symp. on System Theory,* pp. 252-258, Morgantown, WV, March 16-18, 2003.

43. D. Rerkpreedapong, A. Feliachi, "PI Gain Scheduler for Load Frequency Control Using Spline Techniques," *Proc. Southeastern Symp. System Theory,* pp. 259-263, Morgantown, WV, March 16-18, 2003.

44. W. Zhang, A. Feliachi, "Residential Load Control through Real-Time Pricing Signals," *Proc. Southeastern Symp. on System Theory,* pp. 269-272, Morgantown, WV, March 16-18, 2003.

45. K. Sedghisigarchi, A. Feliachi, "H-infinity Controller for Solid Oxide Fuel Cells (SOFCs)," *Proc. Southeastern Symp. on System Theory,* pp. 464-467, Morgantown, WV, March 16-18, 2003.

46. A. Sakhare, A. Davari, A. Feliachi, "Control of Stand Alone and Grid Connected Solid Oxide Fuel Cell using Fuzzy Logic," *Proc. Southeastern Symp. System Theory,* pp. 473-476, Morgantown, WV, March, 2003.

47. D. Rerkpreedapong, N. Atic, A. Feliachi, "Economy Oriented Model Predictive Load Frequency Control," *Proc. 2003 Large Engin. System Conf. Power Engineering*, pp. 12-16, Montreal, Canada, May 7 -9, 2003.

48. A. Karimi, A. Feliachi, "Spline-Based Controller for Power System Stability Enhancement," *Proc. 2003 Large Engineering System Conf on Power Engineering*, pp. 90-94, Montreal, Canada, May 7-9, 2003.

49. D. Rerkpreedapong, A. Feliachi, "Decentralized H Power System Load Frequency Control Using LMI," Proceedings *IEEE Intern Symp. Circuits & Systems*, pp. 411-414, Bangkok, Thailand, May 25-28, 2003.

50. A. Hasanovic, A. Feliachi, "Low Order Transfer Function Identification and Robust PSS Control Design," *Proc. 2003 Power Engineering Society General Meeting*, Toronto, Canada, July 13-17, 2003.

51. N. Atic, D. Rerkpreedapong, A. Hasanovic, A. Feliachi, "NERC Standards Compliance with Model Predictive Control," *Proc. Power Engg Society General Meeting*, Toronto, Canada, July 13-17, 2003.

52. A. Al-Hinai, A. Feliachi, "Control Of Microturbines In A Power Distribution System Using Particle Swarm Optimization," *Proc. 2003 IEEE PES North American Power Symposium,* Oct. 2003.

53. G.J. Raux, A. Feliachi, M.C. Valenti, "Telecommunication of Stabilizing Signals in Power Systems," *Proc. 2003 IEEE PES North American Power Symposium,* Oct. 2003.

54. S. Douglas, "Efficient Tariffs in a Price and Quantity Constrained Electric Power Market," 2003 Meetings of the *Southern Economic Association*, San Antonio, Texas, November 23, 2003.

55. A. Feliachi, "Agent Based Control of Electrical Systems," *Intelligent Control of Ship Systems Workshop,* Johns Hopkins University Applied Physics Lab, Laurel, MD, Dec. 4, 2003.

56. T. Biswas, A. Davari, A. Feliachi, "Detection of Discrete Event Faults in Power Systems Using Petri Nets," Proceedings, *2004 SSST*, Atlanta, GA, March 13-16, 2004.

57. A. Sakhare, A. Davari, A. Feliachi, "Control of Solid Oxide Fuel Cell for Stand Alone and Grid Connection using Fuzzy Logic Technique," Proceedings, *2004 SSST*, Atlanta, GA, March 13-16, 2004.

58. J.E. Saymansky, T.T. Phipps, "Evaluation Methodologies for Determining the Economic Feasibility of Coal Derived Hydrogen Fuels" 29th International Technical Conference on Coal Utilization & Fuel Systems, April 2004, Clearwater, FL.

59. A. Al-Hinai, A. Feliachi, "Intelligent Agent Control Concept of Distributed Generators," *Proc. Baha Technical Conference,* May 3-5, 2004.

60. A. Al-Hinai, K. Sedghisigarchi, Ali Feliachi, "Effects of DGs on Stability," *2004 IEEE PES General Meeting,* Denver, CO, June 2004.

61. A. Boubakeur, L. Mokhnache, A. Feliachi, "Breakdown Voltage Prediction in Point-Barrier–Plane Air Gap Arrangement using Self-Organizing Neural Nets," *PES General Meeting*, Denver, CO, June 2004.

62. K. Schoder, A. Feliachi, "Simulation and Control of Electric Shipboard Power Systems using Modelica and MATLAB/Simulink," *2004 IEEE PES General Meeting*, Denver, CO, June 2004.

63. N. Atic, A. Feliachi, D. Rerkpreedapong "Wedge Shaped Model Predictive Load Frequency Control," *2004 IEEE PES General Meeting*, Denver, CO, June 2004.

64. J.E. Saymansky, T.T. Phipps, "Efficiency Criteria for Environmental Evaluation of Power Technologies", *2004 IEEE, PES General Meeting*, Denver, CO, June 2004.

65. S. Zebirate, A. Chaker, A. Feliachi, "Neural Network Control of the Unified Power Flow Controller," *2004 IEEE PES General Meeting*, Denver, CO, June 2004.

66. A. Al-Hinai, K. Sedghisigarchi, A. Feliachi, "Stability enhancement of a distribution network comprising a fuel cell and a microturbine," *2004 IEEE PES General Meeting,* Denver, CO, June 2004.

67. A. Al-Hinai, A. Feliachi, "Application of Intelligent Control Agents in Power Systems with Distributed Generators," *Proceedings, 2004 IEEE PES PSCE04*, New York, NY, Oct 2004.

68. T. Biswas, A. Davari, A. Feliachi, "Application of Discrete Event Systems Theory for Modeling and Analysis of a Power Transmission Network," *Proceedings, IEEE PES PSCE04*, New York, NY, Oct 2004.

69. A. Hasanovic, A. Feliachi, "Robust PSS tuning through multiobjective optimization," *Proceedings, 2004 IEEE PES PSCE04*, New York, NY, Oct 2004.

70. A. Karimi, K. Schoder, A. Feliachi, "Decentralized Backstepping Control of Power Systems with Observation Decoupled State Space Method," *Proceedings, IEEE PES PSCE04*, New York, NY, Oct 2004.

71. A. Moholkar, P. Klinkhachorn, A. Feliachi, "Effects of Dynamic Pricing on Residential Electricity Bill," *Proceedings, 2004 IEEE PES PSCE04*, New York, NY, Oct 2004.

72. S.B. Ganesh, K. Schoder, H.J. Lai, A. Al-Hinai, A. Feliachi, "Energy Management System with Automatic Reconfiguration for Electric Shipboard Power Systems*," Proceedings, Reconfiguration and Survivability Symposium 2005*, Atlantic Beach, FL, Feb. 16-18, 2005.

73. V.K. Paruchuri, A. Davari, A. Feliachi, "Hybrid Modeling of Power System using Hybrid Petri nets," *Proc. 2005 IEEE SSST*, Tuskegee, AL, March 20-22, 2005.

74. K. Thyagarajan, A. Davari, A. Feliachi, "Load Sharing Control in Distributed Generation System," *Proc. 2005 IEEE SSST*, March 20-22, 2005.

75. S. Zebirate, A. Chaker, O. Traiaia, A. Feliachi, "State Space Hybrid Control of the Unified Power Flow Controller,"*18th Annual Canadian Conference on Electrical and Computer EngineeringCCECE05*, Saskatoon, Saskatchewan Canada, May 1-4, 2005.

76. A. Al-Hinai, K. Schoder, A. Feliachi, "Multi-agent Control of Electric Power Distribution System," *Sigma Xi Graduate Research Day*, April 25, 2005, West Virginia University.

77. S. Ganesh, A. Feliachi, K. Schoder, H.J. Lai, A. Al-Hinai, "Energy Management System with Automatic Reconfiguration for Electric Shipboard," *Sigma Xi Graduate Research Day*, April 25, 2005, West Virginia University.

78. A. Karimi, A. Feliachi, "Enhancement of Electric Power System Dynamics," *Sigma Xi Graduate Research Day*, April 25, 2005, West Virginia University.

79. A. Moholkar, P. Klinkhachorn, H. Oh, "Computer Aided Home Energy Management," *Sigma Xi Graduate Research Day*, April 25, 2005, West Virginia University.

80. A. Karimi, A. Al-Hinai, K. Schoder, Ali Feliachi, "Power System Stability Enhancement Using Backstepping Controller Tuned by Particle Swarm

Optimization Technique," *Proceedings, 2005 IEEE PES General Meeting,* San Francisco, CA, June 2005.

81. S.B. Ganesh, K. Schoder, A. Feliachi, "Improving Automatic Reconfiguration of Electric Shipboard Power Systems by Adding Situational Awareness Capabilities," *Proceedings, Intelligent Ship Symposium VI*, Villanova University, June 1-2, 2005.

107. H. Oh, S. Douglas, A. Moholkar, and P. Klinkhachorn, "System Reliability and Price Responsiveness of Residential Loads," 2nd Carnegie Mellon Conference in Electric Power Systems, January 12, 2006.

108. A. Feliachi, K. Schoder, S. Ganesh, H.J. Lai, "Distributed Control Agents Approach to Energy Management in Electric Shipboard Power Systems," Proc 2006 IEEE PES General Meeting, Montreal, Canada, June 2006.

109. A. Karimi, A. Feliachi, "Decentralized Extended-Backstepping Control of Power Systems," Proc 2006 IEEE PES General Meeting, Montreal, Canada, June 2006.

110. A. Karimi, A. Feliachi, "PSO-tuned Adaptive Backstepping Control of Power Systems," Proc 2006 IEEE PES PSCE06, Atlanta, GA, Oct 2006

111. Talpasai Lakkaraju, Ali Feliachi, "Selection of Pilot buses for VAR Support Considering N-1 Contingency Criteria," Proc 2006 IEEE PES PSCE06, Atlanta, GA, Oct 2006

112. Soraya Zebirate, Abdelkader Chaker, Belahcne Mazari, Ali Feliachi, "Neural Network Generalized Predictive Control of the Unified Power Flow Controller,," Proc. ICEEA Conference, Sidi Bel-Abbs, 22 23 May 2006

113. Soraya Zebirate, Abdelkader Chaker, Halima Benaicha, Ali Feliachi, "Predictive Control of the Unified Power Flow Controller using Neural Networks," Proc IMESE'06 Conference, Nov 4-6, 2006, Djelfa, Algeria.

114. A. Al-Hinai, A. Feliachi, "mpact Of Microturbines On Load Following Control In Deregulated Power Distribution Systems," Proc. Ninth IASTED Int Conf on Power and Energy PES 2007, Jan 3-5, 2007, Clearwater, FL.

115. Ali Feliachi, "Electric Power System Resiliency: Engineering or Economics Problems," Int. Conf. on Communication, Computer and Power - ICCCP07, Plenary Talk, Muscat, Oman, Feb 19-21, 2007

116. Karl Schoder, Ali Feliachi, Pinak Tulpule, Hong-Jian Lai, "Distributed Approaches for Determination of Reconfiguration Algorithm Termination," Electric Ship Technologies Symposium, Arlington, Virginia, May 21-23, 2007

117. Pradeep Pant, Karl Schoder, Ali Feliachi, "Electric Shipboard Power System Testbed," Electric Ship Technologies Symposium, Arlington, Virginia, May 21-23, 2007

118. Talpasai Lakkaraju, Ali Feliachi, John Saymansky, "Voltage Stability Risk Analysis," IEEE PES General Meeting, Tampa, FL, June 2007.

119. Ramesh Khajjayam, Ali Feliachi, "Impact of VAR Support on Electricity Pricing in Voltage Stability Constrained OPF Market Model," IEEE PES General Meeting, Tampa, FL, June 2007.

120. Kourosh Sedghisigarchi, Ali Feliachi, Anisha Fernandes, Karl Schoder, "Gas Turbine Control and Load Sharing for Shipboard Power Systems," IEEE PES General Meeting, Tampa, FL, June 2007.

121. Karl Schoder, Ali Feliachi, "Object-Oriented Modeling and Simulation of AC/DC Systems," IEEE PES General Meeting, Tampa, FL, June 2007.
122. Pinak Tulpule, Ali Feliachi, "Online Learning Neural Network based PSS with Adaptive Training Parameters," IEEE PES General Meeting, Tampa, FL, June 2007.
123. A. Karimi, A. Feliachi, M.A. Choudhry, "On an SVC Backstepping Damping Nonlinear Controller Design for Power Systems," Proc 2007 IREP, August 19-24, 2007, Charleston, South Carolina.
124. Sara Eftekharnejad, A. Feliachi, "Stability Enhancement through Reinforcement Learning: Load Frequency Control Case Study," Proc 2007 IREP, August 19-24, 2007, Charleston, South Carolina.
125. Stephanie L. Hamilton, Charles K. Vartanian, Michael E. Johnson Jr., Ali Feliachi, Karl Schoder, Paul Hines, "Circuit of the Future: Interoperability and SCE's DER Program," Proc 2007 IREP, August 19-24, 2007, Charleston, South Carolina.
126. Rabie Belkacemi, Ali Feliachi, "Decentralized Immune Based Design of Load Frequency Controller in Power Systems," STaR Symposium, Sept. 17-18, 2007, Morgantown, WV.
127. A. Karimi, M.A. Choudhry, A. Feliachi, "PSO-based Evolutionary Optimization for Parameter Identification of an Induction Motor," Proc IEEE NAPS 2007, Sept 30 - Oct 2, 2007, Las Cruces, New Mexico.
128. Silpa Parnandi, Karl Schoder, Ali Feliachi, "Power Market Analysis Tool for Congestion Management," Proc. International Conference on Electrical Engineering Design and Technologies: ICEEDT, Nov. 4-6, 2007 Tunis, Tunisia.
129. Rabie Belkacemi, Ali Feliachi, "Immune Based Design of a Load Frequency Controller in Power Systems," Proc. International Conference on Electrical Engineering Design and Technologies: ICEEDT, Nov. 4-6, 2007 Tunis, Tunisia.
130. Soraya Zebirate, Abdelkader Chaker, Ali Feliachi, "A Hybrid Approach Control of the Unified Power Flow Controller," Proc. International Conference on Electrical Engineering Design and Technologies: ICEEDT, Nov. 4-6, 2007 Tunis, Tunisia.
131. Ali Feliachi, "Are Blackouts Avoidable," Proc. International Conference on Electrical Engineering Design and Technologies: ICEEDT, Plenary Talk, Nov. 4-6, 2007 Tunis, Tunisia.
132. Paul Hines, Stephanie L. Hamilton, Robert Yinger, Ali Feliachi, Karl Schoder, "Integrated, Agent-Based, Real-time Control Systems for Transmission and Distribution Networks," Proc 2007 Grid-Interop, November 7-9, 2007, Albuquerque, NM.
133. Karl Schoder, Ali Feliachi, Pinak Tulpule, Hong-Jian Lai, "Distributed Approaches for Determination of Reconfiguration Algorithm Termination," Automation Controls Symposium, December 10-11, 2007, Biloxi, MS

Theses/Dissertations

1. Lingling Fan, "*Robust Decentralized Control of Power Systems Through Excitation Systems and Thyristor Controlled Series Capacitors,*" Ph.D. Dissertation, Electrical Engineering, WVU, December 2001.

2. Amer Hasanović. "*An Analysis and Simulation Toolbox for Power System and Genetic Algorithm Based Damping Controller Design,*" MSEE Thesis, Electrical Engineering, WVU, December 2001.

3. Vladimir Starkov, "*Essays on the Restructuring in the United States Electricity Industry,*" Ph.D. Dissertation, Economic, WVU, May 2001.

4. Bongani Malinga, "*Modeling and Control of Wind Turbines in a Deregulated Electric Power System,*" MSME Thesis, Mechanical Engineering, WVU, December 2001.

5. Yerramalla Sampath, *"Nonlinear Modeling of PEM Fuel Cells,"* MS Thesis, ECE Dept., WVUIT, Feb. 2002

6. Karl Schoder, "*Analysis and Robust Decentralized Control of Power Systems Using FACTS Devices,*" PhD Dissertation, LDCSEE, WVU, April 2002.

7. Scott Zemeric, "Design of A Prototype Personal Static Var Compensator," MSEE, WVU, May 2002.

8. Biju Naduvathuparambil, *"Telecommunications for a Deregulated Power Industry,"* MSEE Thesis, Electrical Engineering, WVU, July 2002.

9. Ramanujam Srinivasan, *"Operating Market based Regulation Service Using Software Agents Compliant with NERC's Performance Standards,"* MSEE Thesis, Electrical Engineering, WVU, Dec. 2002. (Feliachi)

10. Aniruddha Paradkar, *"Effects of Fuel Cell in LFC,"* MS Thesis, ECE Dept., WVUIT, Dec. 2002

11. Dulpichet Rerkpreedapong, "*Novel Control Design and Strategy for Load Frequency Control in Restructured Power Systems,*" PhD Dissertation, Electrical Engineering, LDCSEE, WVU, May 2003 (Feliachi).

12. Guillaume Raux, "*Telecommunication of Stabilizing Signals in Power Systems,*" MSEE Thesis, Electrical Engineering, LDCSEE, WVU, May 2003. (co-advisors: Feliachi, Valenti)

13. Ali Karimi, "*Spline Based Controller for Nonlinear Systems,*" MSEE Thesis, LDCSEE, WVU, Dec. 2003. (Feliachi)

14. Nedzad Atic, "*Model Predictive Control Design for Load Frequency Control Problem,*" MSEE Thesis, LDCSEE, WVU, Dec. 2003. (Feliachi)

15. Padmanabhan Srinivasan, "*Dynamic Modeling and Control of a Proton Exchange Membrane Fuel Cell as a Distributed Generator,*" MSME Thesis, Mechanical Engineering, WVU, December 2003. (Sneckenberger)

16. Amer Hasanovic, "*Practical Modern Control Design Techniques for Power Systems,*" PhD Dissertation, Electrical Engineering, LDCSEE, WVU, May 2004. (Feliachi)

17. Kourosh Sedghisigarchi, "*Solid Oxide Fuel Cell as a Distributed Generator: Dynamic Modeling, Stability Analysis and Control*," PhD Dissertation, Electrical Engineering, LDCSEE, WVU, May 2004. (Feliachi)

18. Amer Al-Hinai, "Multi-agent Control and Operation of Electric Power Distribution Systems," PhD Dissertation, Electrical Engineering, LDCSEE, WVU, May 2005. (Feliachi)

19. Liang Tian, "Dynamic Learning and Optimization with Neural Networks and Support Vector Machines," PhD Dissertation, Electrical Engineering, LDCSEE, WVU, May 2005. (Noore)

20. Serhiy Kotsan, "Three Essays on Pricing and Risk Management in Electricity Markets," PhD Dissertation, Economics, WVU, May 2005. (Douglas)

21. Implementation of Computer Aided Home Energy Management System," MSEE Thesis, LDCSEE, WVU, August 2005. (Klinkhachorn)

22. Ali Karimi, "Nonlinear Backstepping Control of Electric Powers Systems," PhD Dissertation, In progress. (Feliachi)

23. Srinivas Mangue, "Robust PSS Tuning through Multi-Objective Optimization - A Comparison between the GA and PSO Techniques," MSEE Problem Report, LDCSEE, WVU, May 2006. (Feliachi)

24. Ram Praveen Saladi, Object Oriented Shipboard Electric Power System Library," MSEE Thesis, LDCSEE, WVU, May 2006 (Feliachi)

25. Anisha M. Fernandes, "Gas Turbine Control and Load Sharing of a Shipboard Power System," MSEE Thesis, LDCSEE, WVU, December 2006 (Feliachi)

26. Ramesh Kumar Khajjayam, "Gas Turbine Control and Load Sharing of a Shipboard Power System," MSEE Thesis, LDCSEE, WVU, December 2006 (Feliachi)

27. Talpasai Lakkaraju, "Selection of Pilot Buses for VAR Support and Voltage Stability Risk Analysis,"MSEE Thesis, LDCSEE, WVU, December 2006. (Schoder)

28. Ramesh KumarKhajjayam, "Gas Turbine Control and Load Sharing of a Shipboard Power System," MSEE Thesis, LDCSEE, WVU, December 2006 (Feliachi)

29. Silpa Parnandi, "Power Market Analysis Tool for Congestion Management," MSEE Thesis, LDCSEE, WVU, May 2007. (Schoder)

30. Pinak Tulpule, "Multi Agent Approach for Power System Reconfiguration," MSEE Thesis, LDCSEE, WVU, August 2007 (Schoder)

31. Pradeep Pant, "Test Bed for Shipboard Power System," MS Thesis, LDCSEE, WVU, December 2007. (Schoder)

Conference Attendance

Name	Date	Place	Paper
IEEE Midwest Symp. Circuits and Sys.	Aug. 9-11, 2000	Lansing, MI	Yes
USAEE/IAEE North American Conf.	Sept 25-27, 2000	Philadelphia, PA	Yes
IEEE North Amer. Power Sym. (NAPS)	Oct. 22-24, 2000	Waterloo, Canada	Yes
Int. Conf. Electrotechnics (ICEL 2000)	Nov 12-15, 2000	Oran, Algeria	Yes
IEEE PES Winter Meeting	Jan 29, 2001	Columbus, OH	Yes
2001 SSST	March, 2001	Athens, OH	Yes
2001 American Control Conference	June, 2001	Arlington, VA	Yes
IEEE PES Summer Meeting	July 15-19,2001	Waterloo, Canada	Yes
IEEE North Amer. Power Sym. (NAPS)	Oct. 15-16, 2001	College Station, TX	Yes
Fuel Cells for Stationary, Automotive and Portable Applications Seminar (FES, Inc)	Nov 13-14, 2001	Fort Lauderdale, FL	Poster
IEEE PES Winter Meeting	Jan. 26-31,2002	New York, NY	Yes
IEEE SSST	Mar 17-18, 2002	Huntsville, AL	Yes
USAEE/IAEE North American Conf.	Oct 6-8, 2002	Vancouver, BC	Yes
IEEE PES Summer Meeting	July 21-25,2002	Chicago, IL	Yes
IEEE North Amer. Power Sym. (NAPS)	Oct. 13-15, 2002	Tempe, AZ	Yes
2003 IEEE SSST	Mar. 16-18, '03	Morgantown, WV	Yes
Large Engn. System Conf. Power Eng.	May 7 -9, 2003	Montreal, Canada	Yes
IEEE Intern. Symposium Circuits and Systems	May 25-28, 2003	Bangkok, Thailand	Yes
Power Engineering Society General Meeting	July 13-17, 2003	Toronto, Canada	Yes
IEEE North American Power Symposium	Oct. 13-15,2003	Rolla, MO	Yes
2004 IEEE SSST	Mar. 13-16, 2004	Atlanta, GA	Yes
International Technical Conference on Coal Utilization and Fuel Systems	Apr., 2004	Clearwater, FL	Yes
IEEE PES General Meeting	Jun. 2004	Denver, CO	Yes
USAEE/IAEE North American Conf.	Jul. 8-10, 2004	Washington, DC	Yes
2005 IEEE SSST	Mar. 20-22, 2005	Tuskegee, AL	Yes
Canadian Conference on Electrical and Computer Engineering	May 1-4, 2005	Saskatoon, Canada	Yes
IEEE PES General Meeting	Jun. 2005	San Francisco, CA	Yes

Workshop Attendance

Name	Date	Place
EPRI/DOE: Ensuring Electric Power Reliability-Challenges Ahead	May 24, 2000	Washington, DC
WV EPSCoR Conference	Feb. 26-27, 2001	Charleston, WV
The Electric Utility in Transition	May 9-10, 2001	Morgantown, WV
DOE EPSCoR Workshop	May 30-31, 2001	Brookhaven, NY
Mid-Atlantic Distributed Energy Resources Workshop (USDOE/Energitics, Inc)	Feb. 21-22, 2002	Philadelphia, PA
Power Conditioning Systems Workshop: Basic and Advanced Fuel Cell (USDOE NETL)	March 25-27 2002	Morgantown, WV
NSF/EPRI Workshop	April 10-14, 2002	Cancun, Mexico
Wind Energy Workshop	Sept. 12, 2002	Morgantown, WV
Solid Oxide Fuel Cells (electroceramics materials)	June 16-17, 2003	Morgantown, WV
Energy Storage Technology for Distributed Energy Resources	Aug. 14-15, 2003	Morgantown, WV
NSF/ONR Awardees Workshop	Oct 23-24, 2003	Orlando, FL
Intelligent Control for Ship Systems Workshop	Dec. 4, 2003	Laurel, MD
WV Energy Road Map Workshop Series Coal Bed Natural Gas	Oct. 29, 2003	Roanoke, WV
WV Energy Road Map Workshop Series Hydrogen Workshop	Nov. 19, 2003	Roanoke, WV
WV Energy Road Map Workshop Series Energy Infrastructure	Dec. 11, 2003	Roanoke, WV
Ship Survivability Workshop	Aug. 10-11, 2004	Laurel, MD
NETL Fuel Cell Short Course on Processing Reliability for Solid Oxide Fuel Cells	July 22-23, 2004	Morgantown, WV
NSF Workshop on Power Engineering Education	Feb. 11-13, 2005	Orlando, FL

Short Course

Charles Bayless (Instructor), Ali Feliachi (Coordinator), The Electric Utility in Transition, Morgantown, WV, May 9-10, 2001

External Speakers Invited to Address the Team

1. Randall Gemmen, NETL, DoE, *Fuel Cells,* April 11, 2001
2. Robert (Bob) Mills, Titian Systems: Fairmont, WV, "*Object-Oriented Design Applied to a Wind Turbine,*" January 23, 2002.
3. Mark Williams, NETL, US DOE, Morgantown: "*Fuel Cells,*" April 3, 2002.
4. Wathiq Abdul-Razzaq, Physics Dept., WVU, "what is dangerous: power lines or magnetic particles?" Feb. 27, 2002.
5. H.J. Lai, C.Q. Zhang, Mathematics Dept., WVU, "Graph theory and reliability," Aug. 28, 2002
6. J. Fuller, Business, WVU, "An Analysis of Combustion System Concerns," Oct. 23, 2003
7. Abbie Layne, NETL, US DOE, Morgantown, WV, "*Power System Security,*" June 25, 2003.
8. Ben Hobbs, Johns Hopkins, "Power Market Design: Are Our Products Crashworthy?" Oct. 8, 2003.
9. Mark Gilrain, PJM, "PJM Tutorial," March 3, 2004.
10. John Paserba, Mitsubishi Electric, "How FACTS Controllers Benefit AC Transmission Systems," April 7, 2004.
11. Steve Armentrout, Parabon Computing, "Global Grid Exchange," Sept. 29, 2004.

Panels/Invited Talks

1. Ali Feliachi, NSF Panel on Power System Management, Washington, DC, March 27-28, 2002
2. Ali Feliachi, "Challenges in Distributed Control of Re-Structured Power Systems," NSF/EPRI Workshop on Global Optimization of Power Systems, Playacar, Mexico, April 11-12, 2002
3. Ali Feliachi, Moderator of session on "Models and Computational Methods," NSF/EPRI Workshop on Global Optimization of Power Systems, Playacar, Mexico, April 11-12, 2002
4. Ali Feliachi, "Advanced Power & Electricity Research Center," Nov.19, 2003, CSEE Seminar, WVU.

5. Ali Feliachi, "Challenges and Opportunities in Distributed Control of Re-Structured Power Systems," University of Batna, Algeria, Dec. 2003.

6. Ali Feliachi, "Operation and Control of Power Systems in a Restructured Environment," Plenary session, Baha Technical Meeting BTM04, Al Baha, Saudi Arabia, May 2004.

2005-2007 Proposals Submitted

1. "A Power Systems Approach to Testing the Efficiency and Viability of a Price Responsive Load Management Program in the Residential Sector," *Submitted to National Science Foundation,* $326,556, February 2005 (Investigators: Stratford Douglas, Hyungna Oh, Powsiri Klinkhachorn, Ali Feliachi)

2. "DRU-Creating Secure, Reliable, and Sustainable Electric Power Systems," *Submitted to National Science Foundation*, $747,768, February 2005 (Investigators: Randall Jackson, Stratford Douglas, Ali Feliachi, Jerald Fletcher, Hyungna Oh)

3. "Control, Reliability, and Security Enhancement of Future Power Distribution Systems," *Submitted to National Science Foundation*, $445,350, April 2005 (Investigators: Kourosh Sedghisigarchi, Ali Feliachi)

4. "Modeling Cognitive Processes of Strategic Firm Behavior Using Autonomous Adaptive Agents," *Submitted to National Science Foundation,* $487,616, April 2005 (Investigators: Hyungna Oh, Stratford Douglas, Hong-Jian Lai, Afzel Noore)

5. "Modeling, Simulation, Analysis, and Control of Advanced Generation Resources for a New Era of Integrated Electric Power Systems," *Submitted to Department of Energy/EPSCoR*, $450,000, April 2005 (Investigator: Ali Feliachi)

6. "Control with Fault Detection and Isolation Capabilities Based on Wide-Area Measurement Systems," *Submitted to Department of Energy/EPSCoR*, $450,000, April 2005 (Investigators: Karl Schoder, Ali Feliachi)

7. "Advanced Technologies to Improve Load Following Operation of Fuel Cell Power Plant," *Submitted to Department of Energy/EPSCoR*, $450,000, April 2005 (Investigators: Kourosh Sedghisigarchi)

8. "Developing Instruments to Evaluate Electric Power System Risk, Impact, and Mitigation Strategies for Undesirable Events," Submitted to *Department of Energy/EPSCoR*, $450,000, April 2005 (Investigators: Hyungna Oh, Stratford Douglas)

Funding

1. **DOE/EPSCoR: WV State Implementation Award** "Integrating Computing, Communication and Distributed Control of Deregulated Electric Power Systems," Oct. 2003 – October 2006 ($4.5 million total including cost share; funding for the next two years is going to be cut because of DoE budget problems, not the research) Research PI: Dr. Feliachi, Administration: Dr. Bajura

2. **DOD/EPSCoR:** "Intelligent Agents for Reliable Operation of Uncertain Complex Interactive Warship Power Systems," June 2003- June 2006, ($1.162 million with cost share) PI: Dr. Feliachi.

3. **WVU Research Corporation:** "Advanced Power & Electricity Research Center," July 2003- June 2006, ($ 450,000) PI: Dr. Feliachi.

4. **DoE NETL:** "Grid stability studies," ($82,000) Aug. 04-Nov. 04, PI: Dr. Feliachi.

5. **Donations:** American Electric Power ($105,000: $25,000 pledge per year for 3 years +$35,000)

6. **USDOE/OE/NETL:** "Integrated Control of Next Generation Power Systems," December 2005 Awarded: November 2006. Extended to June 2009, 1.5 Years $770,000 ($230,000) PI: Dr. Feliachi.

For additional information, please contact the Administrative Principal Investigator or the Technical Principal Investigator at the addresses provided on the cover sheet.