

# Europe: Improving Transmission Capacity of Power Systems with a High Level of Distributed and Renewable Generation---Dynamic Protection and Security Assessment

Tom Hammons, Rainer Krebs and Zbigniew Styczynski

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Chairs: Tom Hammons, University of Glasgow, Scotland, UK

Rainer Krebs, Siemens AG, E D SE PTI, Erlangen, Germany

Zbigniew Styczynski, Otto-von-Guericke-University, Magdeburg, Germany

## Track 1: Transmission Capacity Enhancements in the 21<sup>st</sup> Century

### INTRODUCTION

The increase of penetration of stochastic renewable generation requires new strategies for power system operation. On the one hand transmission capacity of the power system must be reserved for unplanned green energy transients which occur sometimes for a long period and requires operational coordination between different TSOs. On the other hand some new indicators for power system stability should be developed and tested which allow predicting “*the dynamic condition*” of the power system.

These indicators must be calculated continuously and in parallel to power system operation taking into account information coming from SCADA or new- SCADA.

Important are new protection schemes and concepts that must be introduced to current power system operation practices. Those new protection schemes must be based on wide area measurements and should not replace the usual protection function or replace them but should build a new independent part of the protection philosophies and rather work in coexistence with the current protections.

Some power utilities have already implemented new strategies for power system operations taking into account the new operation condition.

The general trend is to develop a dynamic protection and security assessment system that can help the power system operator in the daily work in the control room.

The Panelists and Titles of their Presentations are:

1. **Rainer Krebs, Edwin Lerch and Olaf Ruhle**, SIEMENS AG Energy Sector, Germany. *Dynamic Protection and Security Assessment for Highly Loaded Power Systems* (Invited Panel Presentation Summary 09GM0827)
2. **Uros Kerin, Edwin Lerch and Grega Bizjak**, University of Ljubljana, Slovenia, and **Edwin Lerch**, SIEMENS AG Energy Sector, Germany. *Small Signal Security Quantification of Highly Loaded Power Systems*; (Invited Panel Presentation Summary 09GM0362)
3. **Chris Heyde and Zbigniew Styczynski**, Otto-von-Guericke University Magdeburg, Germany. *Voltage Stability Analysis as Part of an Online DSA System*; (Invited Panel Presentation Summary 09GM0112)
4. **Johann Jäger, R. Lubiowski, Rainer Krebs and G. Ziegler**, University of Erlangen, Germany. *Protection Coordination - an Important Task for Network Security*; (Invited Panel Presentation Summary 09GM0542)

5. **Florin Grigore Balasiu, Felicia Mihaela Lazar and Rodica Balaurecsu**, Transelectrica, Romania. **Defense Plan against Major Disturbances on the Romanian Transmission System;** (Invited Panel Presentation Summary 09GM0895)
6. **Wilhelm Rojewski and Jan Izykowski**, Wroclaw University of Technology, Poland, and **Zbigniew Styczynski**, University of Magdeburg, Germany **Selected Problems of Protective Relaying for Distribution Network with Distributed Generation;** (Invited Panel Presentation Summary 09GM0871)
7. **Stefan Geretshuber and Hermann Dellwing**, Industrieranlagen-Betriebsgesellschaft, IABG, Munich, Germany, **Christine Schwaegerl and Olaf Seifert**, Siemens AG, Energy Sector, Germany. **Power System Survivability Increase with Intelligent Support Tools;** (Invited Panel Presentation Summary 09GM0849)
8. Invited Discussers.

Each Panelist will speak for approximately 20 minutes. Each presentation will be discussed immediately following the respective presentation. There will be a further opportunity for discussion of the presentations following the final presentation.

The Panel Session has been organized by Tom Hammons (Chair of International Practices for Energy Development and Power Generation IEEE, University of Glasgow, UK), Rainer Krebs (Principal Expert in the field of Power Systems and Director, Siemens AG, Germany) and Zbigniew A. Styczynski (Director of Center for Renewable Energy Sachsonia-Anhalt and Professor at the Otto-von-Guericke-University Magdeburg, Germany).

Tom Hammons and Rainer Krebs will moderate the Panel Session.

Rainer Krebs, Edwin Lerch and Olaf Ruhle, Siemens AG, Germany makes the first presentation. It is entitled: **Dynamic Protection and Security Assessment for Highly Loaded Power Systems**

**Rainer Krebs** received his Dipl.-Ing. Degree from the University of Erlangen in 1982. From 1983 to 1990 he worked as an assistant professor at the Institute for Electrical Power Supply at the same University. In 1990 he received his Dr.-Eng. degree in Electrical Engineering. In 1990 he joined Siemens AG, Power Transmission and Distribution, System Planning Department. Since 1998 he is director of the System-Protection and System-Analysis Tools Department and since 2006 he is 'Principal Expert for Power Technologies'. In parallel he started in 2003 as lecturer at the University of Magdeburg. Since 2008 he is honorary Professor for System Protection and Control at the same University. He is member of IEEE, board member of VDE Bavaria, and a member of numerous CIGRE, IEC and DKE working groups.

He is author of more than 90 national and international papers.

**Edwin Lerch** received his Dipl.-Ing. Degree from the University of Wuppertal/Germany in 1979, where he also completed his PhD (Dr.-Ing.) in electrical engineering in 1984. Since 1985 he has been a member of the systems planning department at Siemens in the industrial power system and machine group. He is currently working in the areas of power system stability, dynamics of multi-machine systems, control, and optimization and identification problems in electrical power systems. Since 1994 he is a deputy director of the department group 'Industrial Systems, Dynamics of Grid and Machine'.

**Olaf Ruhle** received his Dipl.-Ing. and his Ph.D. Degree in electrical engineering from the Technical University of Berlin in 1990 and 1994, respectively. Since 1993 he is a member of the Power Transmission and Distribution Group and the System Planning and Consulting Department at Siemens in Erlangen, Germany. He is working on power system stability, dynamics of multi-machine systems, and control, optimization and identification problems in electrical power systems. He is responsible for the NETOMAC program system support, sale and training worldwide.

Uros Kerin and Grega Bizjak, University of Ljubljana, Slovenia, and Edwin Lerch, SIEMENS AG Energy Sector, Germany, make the second presentation. It is entitled: **Small Signal Security Quantification of Highly Loaded Power Systems**. Uros Kerin will present it.

**Uros Kerin** (1979) received the B.Sc. Degree from the University of Ljubljana, Slovenia, in 2004. Since 2004, he is with the laboratory for power networks and devices at the Faculty of electrical engineering. In 2004 and 2007, he was a guest researcher at Siemens AG PTD SE, Erlangen, Germany, and Arsenal Research, Vienna, Austria, respectively. His main research interest is power system modeling, system operation and system security studies.

**Grega Bizjak** received the B.S. (1990), M.S. (1993) and Ph.D. (1997) Degrees in Electrical Power Engineering at the University of Ljubljana, Faculty of Electrical Engineering. He started his career as a teaching assistant at the Laboratory for power networks and devices at the same faculty. In 1991 and 1992 he was a guest researcher at Siemens AG PTD SE, Germany. Currently he is an Assistant Professor and Head of Laboratory of Lighting Engineering and Photometry at University of Ljubljana. He is active in the field of lighting and photometry as well as in the field of electrical power engineering. His main research interest in power engineering is power system modeling, modeling of system devices, modeling of circuit breakers and operation dynamics of distribution and industrial networks. He is author of more than 90

scientific and conference papers, member of IEEE and CIE.

**Edwin Lerch** received his Dipl.-Ing. Degree from the University of Wuppertal/Germany in 1979, where he also completed his PhD (Dr.-Ing.) in electrical engineering in 1984. Since 1985 he has been a member of the systems planning department at Siemens in the industrial power system and machine group. He is currently working in the areas of power system stability, dynamics of multi-machine systems, control, and optimization and identification problems in electrical power systems. Since 1994 he is a deputy director of the department group 'Industrial Systems, Dynamics of Grid and Machine.

The third presentation is by Chris Heyde and Zbigniew Styczynski, Otto-von-Guericke University Magdeburg, Germany. It is entitled: *Voltage Stability Analysis as Part of an Online DSA System*. Chris Heyde will present it.

**Chris Heyde** graduated in 2005 from Otto-von-Guericke University in Magdeburg, Germany, in electrical engineering. Since then he is a researcher at the Chair of Electric Power Networks and Renewable Energy Sources at this University. His primary field of interest is power system security.

**Zbigniew Styczynski** became in 1999 the Head and Chair of Electric Power Networks and Renewable Energy Sources of the Faculty of Electrical Engineering and Information Technology at the Otto-von-Guericke University, Magdeburg, Germany. Since 2006 he is also the president of the Center of the Renewable Energy Saxonia Anhalt. His special field of interest includes electric power networks and systems, expert systems and optimization problems. He is senior member of IEEE PES, member of CIGRE SC C6, VDE ETG und IBN and fellow of the Conrad Adenauer Foundation.

Johann Jäger, Rafal Lubiowski, University of Erlangen-Nuremberg, Germany and Rainer Krebs and Gerhard Ziegler, Siemens AG, Energy Sector, Germany has prepared the fourth presentation. It is entitled: *Protection Coordination - an Important Task for Network Security*. Johann Jäger will present it.

**Johann Jäger** was born in 1964 in Erlangen, Germany. He received the Dipl.-Ing. and Dr.- Ing. Degrees in 1990 and 1996, respectively, in Electrical Engineering and Power Systems from the University of Erlangen. In 1990 he joined the Institute for Power Systems at the same University working on the analysis and calculation of FACTS-devices. From 1996 he was with the Power Transmission and Distribution Group and the System Planning Department at Siemens AG in Erlangen, Germany. He was working on different fields of network planning

and protections in worldwide projects. Since 2004 he is in charge of a full professorship for Power Systems at the University of Erlangen. He is member of VDE/ETG, IEEE and CIGRE as well as convener or member of several national and international working groups.

**Rafal J. Lubiowski** received his double diploma (M.Sc. and Mgr inż.) in Electrical Engineering at the Wroclaw University of Technology and the Otto-von-Guericke-University Magdeburg. Since 2007 he is working at the University of Erlangen as scientific assistant on field of network protection analysis.

**Rainer Krebs** received his Dipl.-Ing. Degree from the University of Erlangen in 1982. From 1983 to 1990 he worked as an assistant professor at the Institute for Electrical Power Supply at the same University. In 1990 he received his Dr.-Eng. Degree in Electrical Engineering. In 1990 he joined Siemens AG, Power Transmission and Distribution, System Planning Department. Since 1998 he is director of the System-Protection and System-Analysis Tools Department and since 2006 he is 'Principal Expert for Power Technologies'. In parallel he started in 2003 as lecturer at the University of Magdeburg. Since 2008 he is honorary Professor for System Protection and Control at the same University. He is member of IEEE, board member of VDE Bavaria, and a member of numerous CIGRE, IEC and DKE working groups. He is author of more than 90 national and international papers.

**Gerhard Ziegler** (Grad. Eng), born in 1939 and has been working in the area of power system protection with SIEMENS AG in Erlangen/Nuremberg, Germany for period of 35 years. He was active in the areas of product support, application and project planning, marketing and sales, on a worldwide basis. He retired in 2002 but continues to work as consultant. G. Ziegler has published numerous national and international contributions in the area of power system protection. He served in international organizations for many years. From 1993 to 2001 he was the German delegate to the IEC TC95 (measuring relays and protection equipment). He is past chairman of the Study Committee 34 (protection and local control) and Honorary Member of CIGRE.

The fifth presentation is entitled *Defense Plan against Major Disturbances on the Romanian Transmission System*. Florin Grigore Balasiu, Rodica Balaurescu and Felicia Mihaela Lazar, Transelectrica, Romania has prepared it.

**Florin Grigore Balasiu** has an engineer diploma in Electrical Engineering from Polytechnic University Bucharest, Romania, 1979 and a Ph.D. diploma from Polytechnic University Timisoara, Romania, 1997. He has almost 30 years of experience in the area of Transmission and Distribution protection and control systems engineering, commissioning and

maintenance. He is an observer member of CIGRÉ, Study Committee B5 – protection and automation and has authored over 30 technical papers on protective relaying and is co-author of a Hand Book on Numerical Protection devices.

**Rodica Balaurescu.** Diplomat Engineer from 1978 when graduating from the Bucharest Polytechnic University – Electro Energetic Department. She worked since graduation as an engineer at the National Dispatch Center (former Ministry of Energy). In 1991 she obtained the PhD Degree from the Bucharest Polytechnic University.

**Felicia Mihaela Lazar.** First two years of activity were as an engineer in “Electromontaj” Company-Bucharest. From the beginning of 1984 worked as an engineer in the Protection and Automation Department, National Dispatch Center (former Ministry of Energy). In 1994 became the Expert in Protection and Automation in the above-mentioned department. In March 2002 was appointed Head of Protection & Automation Department, the Romanian National Power Grid Company - "Transelectrica" S.A.

The sixth presentation is entitled: *Selected Problems of Protective Relaying for Distribution Network with Distributed Generation* and has been prepared by Wilhelm Rojewski and Jan Izykowski, Wrocław University of Technology, Poland and Zbigniew Styczynski, University of Magdeburg, Germany. Jan Izykowski will present it.

**Wilhelm Rojewski** received his M.Sc. and Ph.D. Degrees from the Faculty of Electrical Engineering, Wrocław University of Technology (WrUT) in 1973 and 1977, respectively. In 1973 he joined Institute of Electrical Engineering of the WrUT. Presently he is an Assistant Professor, and Vice Director of this Institute in charge of research and cooperation with industry. His research interests are in power system protection and control, power system analysis, and distributed generation.

**Jan Izykowski (SM'04)** received his M.Sc., Ph.D. and D.Sc. Degrees from the Faculty of Electrical Engineering, Wrocław University of Technology (WrUT) in 1973, 1976 and in 2001, respectively. In 1973 he joined Institute of Electrical Engineering of the WrUT. Presently he is a Professor and Director of this Institute. His research interests are in power system protection and control, power system simulation, transient performance of instrument transformers, and fault location.

The final (seventh) presentation is by Stefan Geretshuber and Hermann Dellwing, Industrieanlagen-Betriebsgesellschaft, IABG, Munich, Germany, and Christine Schwaegerl and Olaf Seifert, Siemens AG, Energy Sector, Germany. It is entitled: Power System Survivability Increase with Intelligent Support Tools.

## PANELISTS:

### 1. Mr. Rainer Krebs, Prof.

Siemens AG  
Energy Sector  
E D SE PTI NC  
Freyeslebenstr. 1  
91058 Erlangen,  
Germany  
E-mail: [rainer.krebs@siemens.com](mailto:rainer.krebs@siemens.com)  
Tel.: +499131733515

### Mr. Edwin Lerch, Dr.

Siemens AG  
Energy Sector  
E D SE PTI NC  
Freyeslebenstr. 1  
91058 Erlangen,  
Germany  
E-mail: [edwin.lerch@siemens.com](mailto:edwin.lerch@siemens.com)  
Tel.: +499131734052

### Mr. Olaf Ruhle, Dr.

Siemens AG  
Energy Sector – E D SE PTI SW  
Freyeslebenstr. 1  
91058 Erlangen,  
Germany  
E-mail: [olaf.ruhle@siemens.com](mailto:olaf.ruhle@siemens.com)  
Tel.: +499131732982  
Fax: +499131735017

### 2. Mr. Uros Kerin, Dipl.-Ing.

University of Ljubljana, Faculty of Electrical Engineering  
Trzaska cesta 25  
Ljubljana SI-1000  
Slowenien  
E-Mail: [uros.kerin@fe.uni-lj.si](mailto:uros.kerin@fe.uni-lj.si)  
Tel.: +38614768932

### Mr. Grega Bizjak, Dr.

University of Ljubljana, Faculty of Electrical Engineering  
Trzaska cesta 25  
Ljubljana SI-1000  
Slowenien  
E-Mail: [grega.bizjak@fe.uni-lj.si](mailto:grega.bizjak@fe.uni-lj.si)  
Tel.: +38614768446

### Mr. Edwin Lerch, Dr.

Siemens AG  
Energy Sector  
E D SE PTI NC  
Freyeslebenstr. 1  
91058 Erlangen,  
Germany  
E-mail: [edwin.lerch@siemens.com](mailto:edwin.lerch@siemens.com)  
Tel.: +499131734052

### 3. Mr. Chris Heyde, Dipl.-Ing.

Otto-von-Guericke University Magdeburg,  
FEIT, IESY, LENA

Universitaetsplatz 2  
D- 39106 Magdeburg,  
Germany  
E-mail: [chris.heyde@ovgu.de](mailto:chris.heyde@ovgu.de)  
Tel.: +493916720134  
Fax: +493916712408

**Mr. Zbigniew Styczynski, Prof.**  
President Center for Renewable Energy  
Sachsen-Anhalt, and  
Chair Electric Power System and Renewable  
Energy  
Faculty of Electrical Engineering and Information  
Technology  
Otto-von-Guericke University Magdeburg,  
Universitaetsplatz 2  
D-39106 Magdeburg,  
Germany  
E-mail: [sty@ovgu.de](mailto:sty@ovgu.de)  
Tel.: +493916718866  
Fax: +493916712408

4. **Mr. Johan Jäger, Prof.**  
Universität Erlangen-Nürnberg, Lehrstuhl für  
Elektrische Energieversorgung  
Cauerstr. 4  
91058 Erlangen  
Germany  
E-Mail: [jaeger@eev.e-technik.uni-erlangen.de](mailto:jaeger@eev.e-technik.uni-erlangen.de)  
Tel.: +4991318529513

**Mr. Gerhard Ziegler, Dipl.-Ing.**  
Siemens AG  
Energy Sector – E D SE PTI NC  
Freyeslebenstr. 1  
91058 Erlangen  
Germany  
E-Mail: [gerhard-hans.ziegler@t-online.de](mailto:gerhard-hans.ziegler@t-online.de)

5. **Florin Grigore Balasiu, Dr.**  
Romanian Power Grid Company  
Transelectrica, NDC Division  
Bucharest 3, 16-18 Hristo Botev Blvd.  
Romania  
E-mail: [florin.balasiu@transelectrica.ro](mailto:florin.balasiu@transelectrica.ro)  
Tel.: +40213035619  
Fax: +40213035630

**Mrs. Felicia Mihaela Lazar,**  
Romanian Power Grid Company  
Transelectrica, NDC Division  
Bucharest 3, 16-18 Hristo Botev Blvd.  
Romania  
E-mail: [felicia.lazar@transelectrica.ro](mailto:felicia.lazar@transelectrica.ro)  
Tel.: +40213035641  
Fax: +40213035740

**Mrs. Rodica Balaurecsu,**  
Romanian Power Grid Company  
Transelectrica,  
Bucharest 3, 16-18 Hristo Botev Blvd.  
Romania

E-mail: [felicia.lazar@transelectrica.ro](mailto:felicia.lazar@transelectrica.ro)  
Tel.: +40213035652  
Fax: +40213035630

6. **Mr. Jan Izykowski, Prof.**  
Director of the Institute of Electrical Power  
Engineering (I-8)  
Faculty of Electrical Engineering (FEE)  
Wroclaw University of Technology  
Wyb.Wyspianskiego 27  
50-370 Wroclaw  
Poland  
E-mail: [jan.izykowski@pwr.wroc.pl](mailto:jan.izykowski@pwr.wroc.pl)  
Tel.: +48713202658  
Fax: +48713203493

**Mr. Wilhelm Rojewski, Dr.**  
Vice Director of the Institute of Electrical Power  
Engineering (I-8)  
Faculty of Electrical Engineering (FEE)  
Wroclaw University of Technology  
Wyb.Wyspianskiego 27  
50-370 Wroclaw  
Poland  
E-mail: [wilhelm.rojewski@pwr.wroc.pl](mailto:wilhelm.rojewski@pwr.wroc.pl)  
Tel.: +48713203724  
Fax: +48713202656

**Mr. Zbigniew Styczynski, Prof.**  
President Center for Renewable Energy  
Sachsen-Anhalt, and Chair Electric Power  
System and Renewable Energy  
Faculty of Electrical Engineering and Information  
Technology  
Otto-von-Guericke University Magdeburg,  
Universitaetsplatz 2  
D-39106 Magdeburg,  
Germany  
E-mail: [sty@e-technik.uni-magdeburg.de](mailto:sty@e-technik.uni-magdeburg.de)  
Tel.: +493916718866

7. **Mr. Stefan Geretshuber, Dipl.-Ing.**  
IABG  
Einsteinstr. 20  
85521 Ottobrunn  
Germany  
E-Mail: [stefan.geretshuber@iabg.de](mailto:stefan.geretshuber@iabg.de)  
Tel.: +49 89 6088-0

**Mr. Hermann Dellwing, Dipl.-Ing.**  
IABG  
Einsteinstr. 20  
85521 Ottobrunn  
Germany  
E-Mail: [hermann.dellwing@iabg.de](mailto:hermann.dellwing@iabg.de)  
Tel.: +49 89 6088-0

## PANEL SESSION CHAIRS

**Tom Hammons**  
Chair International Practices for Energy  
Development and Power Generation

University of Glasgow  
11C Winton Drive  
Glasgow G12 0PZ  
UK  
E-mail: [T.Hammons@ieee.org](mailto:T.Hammons@ieee.org)  
Tel.: +44 1413397770

**Rainer Krebs, Prof.**  
Siemens AG  
Energy Sector  
E D SE PTI NC  
Freyeslebenstr. 1  
91058 Erlangen,  
Germany  
E-mail: [rainer.krebs@siemens.com](mailto:rainer.krebs@siemens.com)  
Tel.: +49 9131 733515

**Zbigniew Styczynski, Prof.**  
Executive Director  
Institute of Electric Power System  
President Center for Renewable Energy  
Sachsonia-Anhalt, and Chair Electric Power  
System and Renewable Energy  
Faculty of Electrical Engineering and Information  
Technology  
Otto-von-Guericke University Magdeburg,  
Universitaetsplatz 2  
D-39106 Magdeburg,  
Germany  
E-mail: [sty@e-technik.uni-magdeburg.de](mailto:sty@e-technik.uni-magdeburg.de)  
Tel.: +493916718866

## BIOGRAPHIES



**Thomas James Hammons** (F'96) received the degree of ACGI from City and Guilds College, London, U.K. and the B.Sc. degree in Engineering (1st Class Honors), and the DIC, and Ph.D. degrees from Imperial College, London University.

He is a member of the teaching faculty of the Faculty of Engineering, University of Glasgow, Scotland, UK. Prior to this he was employed as an Engineer in the Systems Engineering Department of Associated Electrical Industries, Manchester, U. K. He was Professor of Electrical and Computer Engineering at McMaster University, Hamilton, Ontario, Canada in 1978-1979. He was a Visiting Professor at the Silesian Polytechnic University, Poland in 1978, a Visiting Professor at the Czechoslovakian Academy of Sciences, Prague in 1982, 1985 and 1988, and a Visiting Professor at the Polytechnic University of Grenoble, France in 1984. He is the author/co-author of over 400 scientific articles and papers on electrical power engineering. He has lectured extensively in North America, Africa, Asia, and both in Eastern and Western Europe.

Dr Hammons is Chair of International Practices for Energy Development and Power Generation of IEEE, and Past Chair of United Kingdom and Republic of Ireland (UKRI) Section IEEE. He

received the IEEE Power Engineering Society 2003 Outstanding Large Chapter Award as Chair of the United Kingdom and Republic of Ireland Section Power Engineering Chapter (1994~2003) in 2004; and the IEEE Power Engineering Society Energy Development and Power Generation Award in Recognition of Distinguished Service to the Committee in 1996. He also received two higher honorary Doctorates in Engineering. He is a Founder Member of the International Universities Power Engineering Conference (UPEC) (Convener 1967). He is currently Permanent Secretary of UPEC. He is a registered European Engineer in the Federation of National Engineering Associations in Europe.



**Rainer E. Krebs**, born 1958 in Germany (Member of VDE, CIGRE, IEC and DKE), received his Dipl.-Ing. Degree from the University of Erlangen in 1982. From 1983 to 1990 he worked as an assistant professor at the Institute for Electrical Power Supply at the same University. In 1990 he received his Dr.-Eng

Degree in Electrical Engineering. 1990 he joined Siemens AG, Power Transmission and Distribution, System Planning Department. Since 1998 he is Director of the System-Protection and System-Analysis Tools Department and since 2006 he is 'Principal Expert for Power Technologies'. In parallel he started in 2003 as lecturer at the University of Magdeburg. Since 2008 he is honorary Professor for System Protection and Control at the same University.



**Zbigniew Styczynski** (SM '01) received his MSc and PhD Degrees at the Technical University of Wroclaw and served there from 1973 until 1991, last as an Assoc. Prof. and a deputy in the Institute of Power Systems. From 1991 until 1999 he worked at the Technical University of

Stuttgart, Germany. In 1999 he became Professor and Chair of Electric Power Networks and Renewable Energy Sources of the Faculty of Electrical Engineering and Information Technology at the Otto-von-Guericke University, Magdeburg, Germany. From 2002 until 2006 he was the dean of the EE Faculty and since 2006 he is the president of the Center of the Renewable Energy Sachsonia Anhalt, Germany. His special field of interest includes modeling and simulation of the electric power networks systems, renewable, and optimization problems. He is author of more than 150 scientific papers, senior member of IEEE PES, member of CIGRE SC C6, VDE ETG und IBN and fellow of the Conrad Adenauer Foundation.