

Remus Teodorescu received the Dipl.Ing. degree in electrical engineering from Polytechnical University of Bucharest, Romania in 1989, and PhD. degree in power electronics from University of Galati, Romania, in 1994. In 1998, he joined Aalborg University, Department of Energy Technology, power electronics section where he currently works as a professor. He has more than 130 papers published, 1 book and 3 patents. He is a Senior Member of IEEE, Associate Editor for IEEE Power Electronics Trans. and chair of IEEE Danish joint IES/PELS/IAS chapter.

He is the founder and coordinator of the Green Power Laboratory at Aalborg University focusing on the development and testing of grid converters for renewable energy systems. He is the coordinator of Vestas Power Program, involving 10 PhD students, 2 Post Doc and guest professors. His areas of interests are: design and control of power converters used in renewable energy systems, HVDC and FACTS for wind power plants and PV systems

Vitezslav Benda, Professor in Materials and Technology for Electrical and Electronics Engineering at the Czech Technical University in Prague, Czech Republic. He specialises in electronic materials and devices, especially in physics, technology and diagnostics of power semiconductor devices and photovoltaics. He graduated in solid state physics at the CTU Prague (MSc. level in 1967) and obtained doctoral degree in electrotechnology (Ph.D. 1976). From 1967 to 1973 he worked in R&D department of the CKD Semiconductors. Since 1973, he has been with the Department of Electrotechnology the Faculty of Electrical Engineering of the Czech Technical University in Prague, where he has been principally concerned with semiconductor device physics and technology oriented in power applications.

Since 2001 he has been a Professor at the Department of Electrotechnology. In the framework of project Socrates he gave lectures also at Bristol University, Swansea University and TEI Patras.

He was awarded with the State Premium for technology in 1980 and with the Merit Award for inventors in 1989. He is author or co-author of 11 textbooks, 19 Czechoslovak patents and more than 80 papers.

Pedro Rodriguez received the MSc and PhD degree in Electrical Engineering from the Technical University of Catalonia (UPC), Spain in 1994 and 2004, respectively. In 1990, he joined the Electrical Engineering Department, at the UPC, where he is currently an associate professor. Since 1998, he focused his interest on Power Electronics applied to Power Quality Conditioning and Distributed Energy Systems Integration. Currently, he is leading the Renewable Electrical Energy Systems (REES) research group at the UPC.

He stayed as a researcher in the Center for Power Electronics Systems CPES, at Virginia Polytechnic Institute and State University, Blacksburg, VA, USA, and in the IET, Aalborg University, in 2005 and 2006. He has 3 patents about active filtering and authored more than 50 technical papers published in international prestigious journals and conferences

Dezso Sera received his B.Sc. and M.Sc. degrees in Electrical Engineering from the Technical University of Cluj, Romania in 2001 and 2002, respectively.

In 2005, he graduated from the M.Sc. program at Aalborg University, Denmark, in the Department of Energy Technology (DET) and in 2008 he received his PhD degree from the same department. His main interest area is Photovoltaic energy generation, particularly modeling, diagnostics, MPPT, and control structures for PV systems. Since 2008 he has been an Assistant Professor in DET, and since 2009 has been the coordinator of the Photovoltaic Systems and Micro Grids Research Group.

Tamas Kerekes obtained his Electrical Engineer diploma in 2002 from Technical University of Cluj, Romania, with specialization in Electric Drives and Robots. In 2005, he graduated the Master of Science program at Aalborg University, Department of Energy Technology in the field of Power Electronics and Drives. In 2009 he received his PhD degree from Aalborg University. Currently he is working as an Assistant Professor at the same Department. Since he started his PhD at the Department of Energy Technology his main interest is on PV inverter modeling, control and topologies as well as modulation techniques with focus on transformerless PV inverter systems.

Fee

The fee is 12000.- DKK for industrial people and 8000 DKK for PhD students from outside Denmark (free for Danish PhD students). The fee includes coffee, lunch for all four days and copy of slides and articles.

Credits

4.0 ECTS

Registration

Preferably now and no later than April 23, 2010 by email to: Maria Hald: mha@iet.aau.dk. **25% registration fee reduction** can be achieved in case of registering for both Power Electronics for Renewable Energy Sources course 3-6 May 2010 and Photovoltaic Power Systems course 10-13 May 2010.

Accommodation

For hotel information and booking please check:

www.iet.aau.dk/events



Industrial/PhD Course in Photovoltaic Power Systems - in theory and practice

May 10- 13, 2010



**Department of Energy Technology
Aalborg, Denmark**

Further information

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Background of the course

There is a rapid development in Photovoltaics (PV) as a reliable source of renewable energy. Especially for grid-connected DPGS an exponential growth in terms of installation power can be observed mainly due to the subventions given by governmental policies around the world for clean “green” electricity production. Countries like Germany, Spain, Japan, and USA have the highest penetration of PV power.

The objective of this course is to give an understanding of the operation, design and control of Photovoltaic Power Systems.

The operating principle of the most common PV cells will be presented and their manufacturing processes will be described as well. Modeling, characterization and fault diagnostics for PV panels will also be included.

The most relevant PV converter topologies and control structures including MPPT methods in PV power generation connected to the grid will be presented.

Voltage monitoring to comply with grid connection requirements for PV systems and anti-islanding techniques will be covered.

In addition, different structures and control schemes for PV converters forming microgrids will be presented. Moreover, the interaction of PV converters with the low voltage distribution network will be studied, including voltage support in case of high penetration.

The last part of the course aims to give an insight into a PV plant design and structure. Determination of the solar resource for a given location and energy yield calculation will be presented. Likewise, the structure of distributed residential PV power system will be presented.

Control design experience will be gained by using advanced simulation models in Matlab-Simulink for grid converters. Hands-on experience will be provided in the state-of-the-art Green Power Laboratory, where all the participants will make experimental tests on PV array modeling, characterization and diagnostics, MPPT, anti-islanding, grid interaction using setups controlled by dSPACE (DS1103).

No less than 40% of the course time will be spent in the lab.

Keep yourselves updated at: [PVMG group](#)

Place

Aalborg University, Department of Energy Technology
Pontoppidanstraede 101, Room 23
DK-9220 Aalborg East, Denmark

Language

English

Prerequisites

A degree in electrical engineering or control engineering and Matlab/Simulink knowledge is strongly recommended.

Literature

A number of related articles and copy of slides are included in the course documentation (included in fee).

Day 1, 08.30-16.30

- L1 PV technology status and trends.
- L2 Physics of PV cells
- L3 PV cells and panels manufacturing
- L4 PV panels modelling and characterisation
- L5 PV panels diagnostics
- Lab I PV panels modelling and characterisation - SIM
- Lab II PV panels characterisation and diagnostics – EXP

Day 2, 08.30-16.30

- L6 PV inverter topologies
- L7 PV inverter control structures
- L8 Maximum Power Point Tracking for PV inverters
- L9 Advanced MPPT
- Lab III TL. PV inverter topology efficiency I
- Lab IV TL. PV inverter topology efficiency II
- Lab V MPPT design and evaluation - SIM.
- Lab VI MPPT design and evaluation - EXP.

Day 3, 08.30-15.40

- L10 Grid regulations for PV.
- L11 Islanding detection
- L12 Off-grid PV systems
- L13 Grid support with PV inverters
- Lab VII Voltage monitoring - SIM.
- Lab VIII Anti-islanding TL – EXP.
- Lab IX Voltage Control Design - SIM.
- Lab X Voltage Control Design - EXP.

Day 4, 08.30-15.40

- L14 PV power plant
- L15 Distributed residential PV generation
- Lab XI PV power plant planning
- Lab XIV Residential PV power system connected to the LV grid

Lecturers

Professor Remus Teodorescu, Aalborg University, Denmark

Professor Vitezslav Benda, Czech Technical University in Prague, Czech Republic

Associate Professor Pedro Rodriguez, Technical University of Catalonia, Spain

Assistant Professor Dezso Sera, Aalborg University, Denmark

Assistant Professor Tamas Kerekes, Aalborg University, Denmark

Lab facilities

The participants of the course will have the opportunity to work with the following equipments:

- Flexible grid converter setups controlled by dSpace
- Flashing solar simulator and IV curve tracer
- Programmable grid simulator and electronic loads
- PV simulator

