



EES-UETP

Electric Energy Systems University Enterprise Training Partnership

Course on:

**Smart Cities: Planning and operation of future
urban energy systems**

**Course organiser: School of Electrical & Electronic
Engineering of the University of Manchester**

(Course Leaders: P. Mancarella and J.V. Milanovic)

November 5-7, 2012



MANCHESTER
1824

The University
of Manchester

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1. Course outline

Cities are rapidly getting on top of the agendas of various initiatives worldwide aimed at decreasing the cost and carbon footprint of energy products, services and activities. In fact, as it is expected that by 2050 about 70% of the world population will live in cities, it is crucial to identify strategic plans to make cities more energy efficient and environmentally friendly in a cost effective manner. At the same time, the advent of the Smart Grid associated to the use of Information and Communication Technologies (ICT) in conjunction to networks and services is changing the perspectives of the way we operate power and energy systems. In this context, the concept of a *Smart City* is emerging whereby the urban Smart Grid can be optimally designed and controlled so as to facilitate a cost-effective development of a sustainable urban energy system, also taking into account heat (usually as a predominant component of environmental impact), cooling, transportation, waste, water, people's security, and so on besides electricity. This is well recognized for instance by the European Commission through its funding initiative on Smart Cities, with emphasis on the three areas of buildings, energy networks (heating and cooling, electricity) and transport. However, in many cases these areas are treated as separate by energy planners and policy makers, while there are closer and closer interactions that need to be addressed, with clear potential for techno-economic and environmental resource optimization from both operational and planning perspectives.

This three-day course will present and discuss an overview of key issues within the Smart Cities context with manifold topics, from urban energy planning to ICT requirements. Technical, environmental, economic, reliability and policy aspects of the relevant topics will be discussed in detail.

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2. Scope and objectives

The course is designed to give both industrial practitioners (technicians, engineers and managers) and young academics and researchers a fundamental understanding of the major issues that are behind the emerging concept of Smart Cities that will see the simultaneous presence and interactions of highly distributed generation, demand response, storage, multi-energy networks, smart devices, and new business models.

The following topics will be addressed:

- Fundamentals of urban energy system planning;
- Impact analysis and optimal integration of distributed generation, demand response, and storage in low and medium voltage networks;
- Techno-economic and environmental assessment of district energy systems and multi-generation;
- Impact of the electrification of heating and transport in urban areas and smart control for system support;
- ICT requirements and integrated power and ICT analysis;
- Power quality and protection issues and solutions in future urban networks;
- Innovative concepts for reliability assessment of future distribution networks;
- Technical and commercial aggregation concepts (such as microgrids and virtual power plants) for distributed energy resources;
- Business models, commercial, regulatory and policy issues of future cities.

3. Who should attend

This course is intended for all technical staff, engineers and managers from electrical power and gas and utilities, Energy Service Companies, independent generating companies, electricity regulators, industry, manufacturing, consulting companies, new market actors such as distributed energy resources and demand aggregators, as well as educational, research, and government institutions who deal with the issues, services and products aimed at delivering affordable and clean energy to urban areas.

4. Course duration

Three-day course, from Monday 5th to Wednesday 7th of November, 2012.

5. Course venue

The University of Manchester, School of Electrical & Electronic Engineering
Ferranti Building, Manchester, M60 1QD, United Kingdom

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6. Course program

Day 1 – 5 November

11:00 Registration

11:30 Welcome, introduction and course overview (Dr P Mancarella and Prof J Milanovic, UoM, UK),

12:20 Lunch

13:30 Energy modelling and planning of complex urban systems (Prof N Shah, Imperial College London, UK)

14:30 Smart urban distribution networks: impacts and optimal control of distributed energy resources (Dr N Ochoa, UoM, UK)

15:20 Coffee break

15:50 ICT requirements: opportunities & challenges in Smart Cities (Dr D Wilson, Intel, Ireland)

16:50 End of day 1

Day 2 - 6 November

9:00 Smart multi-energy systems for district energy: techno-economic and environmental analysis (Dr P Mancarella, UoM, UK)

9:50 Reliability models for future urban networks (Prof R Allan, UoM, UK)

10:50 Coffee break

11:20 Flexible energy supply systems for residential areas (Prof A Monti and Mr C Molitor, E.ON Research Centre, RWTH Aachen University, Germany)

12:10 lunch

13:10 Visit to HV and control laboratory, Ferranti Building

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14:00 Integrated power and ICT risk models and analysis for Smart Cities (Prof F Pilo, University of Cagliari, Italy)

15:00 Managing distributed environments: Microgrids, aggregation concepts and decentralized intelligence (Prof N Hatzigiorgiou, NTUA, Athens, Greece)

16:00 Coffee break

16:20 Integrating electrical and transport sectors in urban areas: benefits and challenges (Prof J Pecos Lopes and Mr Luis Seca, INESC Porto, Portugal)

17:20 End of day 2

19.30 Course Dinner

Day 3 - 7 November

9:00 Power quality in future urban networks: issues and solutions (Prof J Milanovic, UoM, UK)

9:50 Protecting an evolving urban network with distributed resources: challenges and innovative approaches (Prof P Crossley, UoM, Manchester, UK)

10:40 Coffee break

11:10 Who's delivering the Smart City? Business models and commercial, regulatory, and policy issues (Dr P Mancarella, University of Manchester, UK)

12:10 Closing remarks and end of course (Dr P Mancarella and Prof J Milanovic, UoM, UK)

12:30 Lunch

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7. Course presenters

Pierluigi Mancarella (Course Leader) is Lecturer in Future Energy Networks in the School of Electrical and Electronic Engineering at The University of Manchester, Manchester, UK. After receiving his MSc and PhD degrees from the Politecnico di Torino, Torino, Italy, and being a visiting researcher at NTNU in Trondheim, Norway, and a Post-Doc at Imperial College London, UK, he joined the University of Manchester where he now teaches “Power System Operation and Economics” and “Smart Grids and Sustainable Electricity Systems”. Dr Pierluigi Mancarella’s areas of expertise include multi-generation and integrated energy systems, economic and environmental analysis of future technologies, distribution network analysis and planning, integration of distributed energy resources into power systems, operation and planning of integrated energy infrastructures under uncertainty, and business models for new technologies. He is involved in a number of research activities in several UK and European projects in the area of sustainable development of energy networks and systems. Dr Mancarella is author of two books, five book chapters, and more than 70 research papers.

Jovica V. Milanović (Course Leader) is Professor of Electrical Power Engineering and Director of Research in the School of Electrical and Electronic Engineering at The University of Manchester, Manchester, UK. He received his Dipl.Ing. and M.Sc. degrees from the University of Belgrade, Yugoslavia, his Ph.D. degree from the University of Newcastle, Australia and his Higher Doctorate (Doctor of Science degree) from the University of Manchester, UK, all in electrical engineering. His research work over the years has been mainly in two areas, power system dynamics and control and power quality with a common, underlying stream of probabilistic / stochastic modeling of uncertainties of events and system parameters. He is editor or member of editorial boards of 5 international journals, member of international technical committees of 25 international conferences and member of 5 past or current international CIGRE / CIRED / IEEE working groups in the areas of power quality and power system dynamics. Professor Milanović has published over 200 research papers. He is a Chartered Engineer in the UK, a Foreign Fellow of the Serbian Academy of Engineering Sciences, a Fellow of the IET and a Fellow of the IEEE for contributions to power system dynamics and power quality.

Ron Allan is Emeritus Professor of Electrical Energy Systems at the University of Manchester. His primary interests for nearly 40 years has centred on the development and application of probabilistic methods to the planning, design and operation of power systems, in particular the reliability assessment of power generation, transmission and distribution. He has developed concepts, methodologies, models and evaluation techniques in this area, including both analytical and simulation-based approaches. His research has also been concerned with evaluating the economic impact of system interruptions on customers; a concept now known as customer interruption costs and worth of supply. He has lectured on these subjects at universities and industry in many countries around the world and was a visiting professor to KTH in Stockholm from 1996 to 2002. He is the author and co-author of over 240 technical

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papers, co-author of three reliability textbooks, and co-editor of an IEEE Press Book. As a result of his research, he was awarded the DSc in 1987, the IEE Institution Premium in 1996 and the PMAPS International Society Award in 2000. He is a Fellow of the IET, of the IEEE and of the UK Safety and Reliability Society.

Peter Crossley is Professor of Electrical Power Systems and Head of the Electrical Energy and Power Systems group at the University of Manchester. He is a well-renowned expert of power system protection, security and control, and was until late 2011 Director of the Joule Centre for Energy Research. The aims of the Joule Centre were to develop and deliver a programme of research to support the North West Development Agency (NWDA), stimulate interdisciplinary research in the energy sector and to increase the R&D capacity of NW England in the disciplines and skills required for a sustainable energy future. He has published over 200 technical papers, received over £8m of research funding and is Convenor of CIGRE Working Group on Management of Protection Settings, a Member of the Greater Manchester Energy Advisory Group, Chair of the IET Manchester Division and vice-Chair of the IEEE ISGT Europe 2011 Conference.

Nikos D. Hatziaargyriou is Professor at the Power Division of the Electrical and Computer Engineering Department of NTUA. From February 2007 to August 2012, he was Deputy CEO of the Public Power Corporation (PPC) of Greece, responsible for Transmission and Distribution Networks, island DNO and the Center of Testing, Research and Prototyping. He is Fellow Member of IEEE, past Chair of the Power System Dynamic Performance Committee and Chair of CIGRE SCC6. He was member of the EU Advisory Council of the Technology Platform on SmartGrids. He has participated in more than 60 R&DD Projects, and was coordinator of the EU funded “Care”, “More Care”, “Rise”, “Microgrids”, “More Microgrids” and “Merge”. He is author of more than 250 scientific publications. His research interests include Smartgrids, Microgrids, Distributed and Renewable Energy Sources and Power System Security.

Luis Nando Ochoa is Lecturer in Smart Distribution Networks at the University of Manchester. He is an expert in network integration of distributed energy resources and future distribution networks. He has more than 60 research papers in top ranked journals and conferences, including a patent filed by Psymetrix Ltd (part of Alstom Grid). Currently, Dr Ochoa is PI and co-PI of two projects funded by Electricity North West Limited, through Ofgem’s Low Carbon Network Fund, and PI of a project funded by EDF R&D (France). He has been invited to give talks and workshops on Active Network Management and Smart Distribution Networks in USA, UK, Ireland, Portugal, Brazil and Peru. He has also been part of a recent FCO Asia-Pacific Mission on Smart Grids to China, Taiwan, and Korea. Dr Ochoa is Chair of the IEEE UK and Republic of Ireland Power & Energy Society Chapter, Chair of the IEEE-PES Modern and Future Distribution System Planning Working Group, and Co-chair of the CIGRE Task Force on Methods for Active Network Planning.

Joao Pecas Lopes is Full Professor at the Faculty of Engineering of Porto University (FEUP). He is presently Director of INESC Porto. He is also the Director of the Sustainable Energy

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Systems PhD program at FEUP. He is Scientific Coordinator of the EU FP7 research project MERGE – Mobile Energy Resources for Grids of Electricity and the convener of the CIGRE WG C6.20 on Integration of electric vehicles in electric power systems. His main domains of research are presently related with large scale integration of renewable power sources in power systems (namely wind generation), power system dynamics, microgrids, smart-metering and electric vehicle grid integration.

Christoph Molitor is a researcher at RWTH Aachen, Germany. He received his diploma degree from RWTH Aachen in 2010. In August 2010 he joined the Institute for Automation of Complex Power Systems, E.ON Energy Research Center, RWTH Aachen University, as a Research Associate and he is currently working towards the Ph.D. degree. During his diploma program, he was a visiting student at UCC Cork, Ireland, from September 2007 to May 2008. His research activities mainly concern Hardware-in-the-Loop testing of home energy systems and flexible energy supply systems of residential areas.

Antonello Monti is Professor at the RWTH Aachen and Director of the Institute for Automation of Complex Power Systems in the E.ON Energy Research Center, Aachen. Before joining RWTH, Prof Monti was Professor of Electrical Engineering at the University of South Carolina (USA). During his tenure at USC he has been Associate Director of the Virtual Test-bed (VTB) project, which focuses on computational simulation and visualization of modern power distribution systems that fully integrate power electronics into the network design. He has developed the real-time extension of VTB for Hardware-in-the-Loop applications and has designed innovative tools supporting the automatic generation of VTB native models. He worked on expanding the limits of real-time simulation thanks to the application of PC clusters and FPGA technology. He was the director of the Real-time and Electromechanics Laboratory (REM Lab). He started his academic career at Politecnico di Milano after 4 years of industrial experience in Ansaldo Industria.

Fabrizio Pilo is an Associate Professor of electrical power systems at the University of Cagliari, which he joined in 2001, and is responsible for the Power System Research Group. He received the Laurea degree (magna cum laude) in electrical engineering from the University of Cagliari, Cagliari, Italy, in 1992 and the Ph.D. degree from the University of Pisa, Pisa, Italy, in 1998. From 2006 to 2012 he was the Director of the Department of Electric and Electronic Engineering at the University of Cagliari. He is author of more than 100 papers in international journals and national and international conference proceedings. His research interests include power systems, electric power distribution, distribution planning, and distributed generation. Dr. Pilo is member of the IEEE and AEIT. He is member of the CIRED Technical Committee and Chairman of CIRED S5 (System development), invited expert of CIGRE SC C6 and Convener of the CIGRE WG SC6.19. He is the Secretary of the Italian Association of the University Professors of Power Systems. He is one of the advisors of the Italian Regulator for the assessment of the Italian SmartGrid projects.

Luís Seca was born in Porto, Portugal, in 1977. He received an electrical engineering degree (five-year course) and a M.Sc. (two-year course) from the Faculty of Engineering, University of

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Porto, Porto, Portugal in 2002 and 2006, respectively. Presently, he is pursuing the Ph.D. degree in Sustainable Energy Systems from University of Porto, under the MIT Portugal Program. He is currently the Unit Coordinator Assistant and Senior Researcher (S'02) in the Power Systems Unit of the Institute of System Engineering and Computers of Porto, Porto, Portugal. His current research interests focus on the integration of distributed energy resources (renewable, EV, Storage, etc.) in distribution systems, dynamic stability in isolated systems and smart grids.

Nilay Shah is Professor of Process Systems Engineering at Imperial College London, London, UK. Prof Shah is well known internationally for both his creative research in model-based systems engineering and leadership in energy research. He is the Director of the multi-institution, interdisciplinary and award-winning Centre for Process Systems Engineering, which currently has 23 academics and 80 researchers. NS is also the Co-Director of the Urban Energy Systems project, Co-Director of the Porter Institute for Bioenergy, and Director of Imperial's Manufacturing Futures Lab (www.imperial.ac.uk/manufacturingfutureslab). He has authored over 100 journal papers on areas including energy systems engineering, bio-energy systems, and hydrogen infrastructures.

Duncan Wilson is the recently appointed Principle Investigator of the Intel Collaborative Research Institute for Sustainable Connected Cities. Duncan is headquartered out of Intel Labs Ireland and as Intel PI leads collaboration with PI's from Imperial College London and University College London to drive new frontiers in the application of computing technologies to advance the social, economic and environmental wellbeing of cities. Duncan was previously an Associate Director at Arup in London and was responsible for researching medium and long term futures with a focus on social and technology factors. He developed foresight and innovation capability within Arup, co-created the Drivers of Change concept (<http://www.driversofchange.com>) and has a personal research focus on ubiquitous computing in the built environment (<http://www.driversofchange.com/emtech/>). His EU and nationally funded research merges interests in sensing and monitoring and creating interactive, ambient displays that solicit and feedback information with the intent of influencing behaviour. He is currently a member of the European Commission Expert Group on the Internet of Things. Duncan is a Chartered Engineer (IET), has a PhD from University College London in Artificial Intelligence and Machine Vision and comments on work at <http://twitter.com/djdunc> and can also be found at <http://www.linkedin.com/in/duncanwilson/>.

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8. Travel information

8.1 How to get to the University of Manchester

The University of Manchester (www.manchester.ac.uk), Sackville Street area (Northern Campus), is located close to both Piccadilly main line station (about two and a half hours from London) and Oxford Road train station, with Victoria train station a little further away.

For details of timetables, tickets and other rail information, please ring National Rail Enquiries on +44 (0)20 7278 5240 from overseas or check <http://www.thetrainline.com/buytickets/>.

From **Manchester Piccadilly** railway station (main station in Manchester)
The Sackville Street area of the campus is within 5 minutes' walk (see Sackville Street area map below).

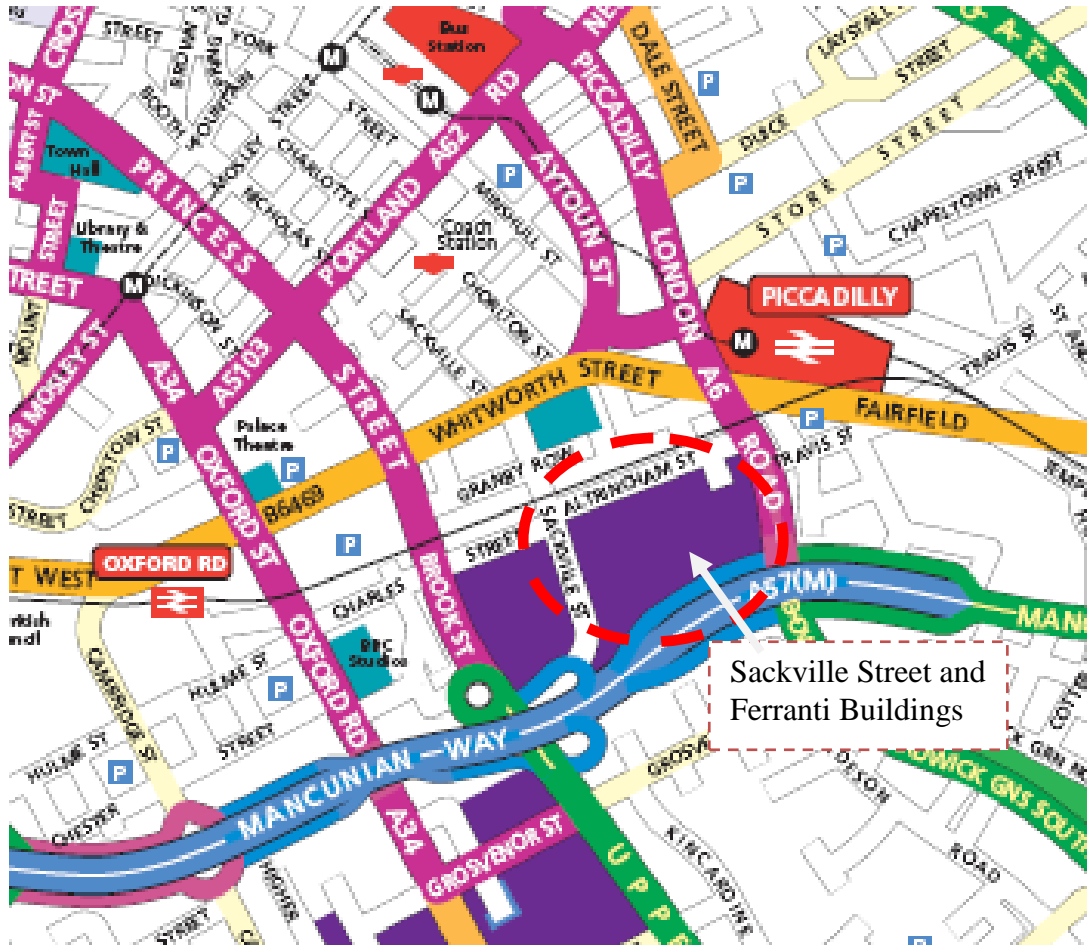
From **Manchester airport**:

Manchester Airport is one of the largest and busiest in the country. It is located about 10 miles (16km) south of the city centre, about 30 minutes from the university.

The airport has a number of transport links to the city:

- Train - The airport's three terminals are linked directly to the city centre by a fast (20 minutes), frequent 24 hour train link to both Piccadilly and Oxford Road stations.
- Taxi - A taxi from the airport to the University will cost approximately £30.
- Bus - Local buses also run to the Oxford Road and Sackville Street areas of the campus.

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Sackville Street area map

For more (fun) maps see <http://www.manchester.ac.uk/aboutus/travel/maps/> and the interactive campus map (Ferranti Building is number 20).

8.2 How to get to the course location

Ferranti Building is number 20 on the campus map:

<http://documents.manchester.ac.uk/display.aspx?DocID=6507>

Room C18 is located at the end of the corridor in the first floor.

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9. Accommodation

Recommended Hotels

Days Hotel Manchester City (Highly recommended)

Weston Bldg, Sackville Street

Sackville St, City Center

Manchester, M13BB UK

Maps & Directions

http://www.daysinn.com/DaysInn/control/Booking/check_avail?variant=&id=15068&propBrandId=DI&force_nostay=false&tab=tab4

Phone: 44-161-9558400

Fax: 44-161-9558050

E-Mail: reservations@days-mcc.co.uk

McDonald Hotel, Manchester

Hotel & Spa, London Road, Manchester, M1 2PG

Tel: (+44) 0844 879 9088

<http://www.macdonaldhotels.co.uk/manchester/index.htm>

Ibis, Charles Street, Manchester

Charles Street, Manchester M1 7DG

Tel : (+44) 161 2725000

<http://www.ibishotel.com/gb/hotel-3143-ibis-manchester-charles-street/index.shtml>

Novotel China Town, Manchester

21 Dickinson Street, Manchester M1 4LX

Tel (+44)161/2352200

<http://www.accorhotels.com/gb/hotel-3145-novotel-manchester-centre/index.shtml>

Please make sure to book your rooms in due time.

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10. Organisation and contacts

10.1 Course fees

Fees for three-day course:

- 367.5 Euro for attendees coming from member universities of EES-UETP;
- 900 Euro for attendees coming from non-member universities of the EES-UETP;
- 1500 Euro for attendees coming from non-member industrial enterprises of the EES-UETP.

Course fees will include lectures, course aids (lectures on CDs, leaflets, brochures, etc), coffee breaks, lunches, and course dinner.

10.2 Payment details

Both UK and International attendees should make their payments to:

Bank: National Westminster Bank Plc

Branch Name: University Union Branch

Address: 323 Oxford Road

Account number: 47125160

Sort Code: 01-06-57

Bank Swift Code: NWBKGB2L

Bank Iban Code: GB71 NWBK 01065747 1251 60

Reference code CA01307 (to be added on the payment form)

Note

- Please clearly indicate the code **CA01307** on the bank payment form;
- Participants have to provide course organisers with the proof of course fee payment (i.e., invoice, copy of bank transfer form, etc) by email to Ms Abigail Webb (abby.webb@manchester.ac.uk) or fax not later than **1 week** before the course date;
- Notifications of participation cancellation should be sent in writing to the course coordinators. Cancellations received less than one week before the course will not be refunded.

10.3 Dinner

On the 6th of November, 2012, a course dinner will be held at one of the city restaurants (information will be provided during the first morning session).

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Please inform Ms Abigail Webb (abby.webb@manchester.ac.uk) if you will be attending.

10.4 Contacts

Registration forms (see below), proofs of payment, and administrative inquiries about the course should be sent to:

Ms Abigail Webb

School of Electrical & Electronic Engineering,
University of Manchester, UK
Phone: +44 (0)161 306 28 24
Fax: +44 (0)161 306 48 20
Email: abby.webb@manchester.ac.uk

Also, for any specific inquiry please do not hesitate to contact the course leaders:

Dr Pierluigi Mancarella

School of Electrical & Electronic Engineering,
University of Manchester, UK
Phone: +44 (0)161 306 46 54
Fax: +44 (0)161 306 48 20
Email: p.mancarella@manchester.ac.uk

Prof Jovica V. Milanović

School of Electrical & Electronic Engineering,
University of Manchester, UK
Phone: +44 (0)161 306 87 24
Fax: +44 (0)161 306 48 20
Email: jovica.milanovic@manchester.ac.uk

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11. Registration form

Name	
Surname	
Attendee position	
Attendee main activity	
Address	
Phone	
Fax	
E-mail	
Main activity of the Company	

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