



EPE tutorial

TITLE Marine Microgrids
Control, Optimization, Power Quality and the Role of Power Electronics

NAME AND AFFILIATION OF THE AUTHORS

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SCOPE AND BENEFITS

Nowadays, an important kind of islanded microgrids can be found in marine power systems. For example, under normal operating conditions, the ship power system can be considered as a typical isolated microgrid and its characteristics, including variable frequency, are matched to islanded microgrids. This tutorial provides an overview of the present and future architectures of such microgrids, associated control technologies, optimization methods, power quality issues and state of the art solutions. The significant role of power electronics in realizing marine microgrids, challenges in meeting high power requirements and regulations in the maritime industry, state of the art power electronic technologies and the trend towards the use of medium voltage power converters in marine microgrids are also discussed.

CONTENTS

Monday, 5 September 2016 - Tutorial day (Location: KIT, Karlsruhe, Germany)

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|----------------------|--|
| 08:00 - 09:30 | Registration for full day and morning Tutorials |
| 9:30 – 10:15 | 1. Overview of marine microgrids <ul style="list-style-type: none">1.1. Architectures and characteristics of ship microgrid as a part of her energy system1.2. Fuel economy on shipboard1.3. Ships with hybrid propulsion and all-electric ships1.4. Renewable energy resources and energy storage1.5. Green shipping |
| 10:15 – 11:00 | 2. Control and optimization for marine microgrids <ul style="list-style-type: none">2.1. Hierarchal control in marine microgrids2.2. Droop and isochronous control strategies to coordinate generators in AC or DC marine microgrids2.3. Power Management system and protections2.4. Supervisory control for optimal use of different sources2.5. Communication systems required onboard. |
| 11:00 - 11:30 | Coffee break |



- 11:15 – 12:00** **3. Power quality issues in marine microgrids**
- 3.1. Introduction – how to define the power quality in marine microgrids?
 - 3.2. Power quality in rules of ship classification societies and related IEEE and IEC standards
 - 3.3. Frequency variations as key feature of electricity characteristic in marine microgrid
 - 3.4. Assessment of power quality in ship systems – measurement techniques and procedures
 - 3.5. Control of power quality in ship systems
- 12:00 – 12:45** **4. Power electronics in marine microgrids**
- 4.1. Power electronic as the key enabling technology for interfacing alternative energy sources, energy storage systems and various receivers
 - 4.2. Power converter topologies: Synchroconverters (CSIs) and PWM VSI topologies
 - 4.3. Low frequency operation of high power converters and associated filtering requirements
 - 4.4. High voltage power systems in large ships and the resultant need for high voltage power converter systems
 - 4.5. State of the art device technologies and limitations
 - 4.6. Advances and trends in device technologies and converter topologies to push the boundaries
- 12:45 – 13:00** **5. Summary and conclusions**
Questions and answers
- 13:00 - 14:00** **Lunch break and registration for the afternoon tutorials**

WHO SHOULD ATTEND

We would like to encourage researchers and engineers from both industry and academia working in power electronics, islanded microgrids or marine power systems to attend the tutorial session. We invite also persons not familiar with marine microgrids at all, since basic introduction to the realm of ship energy systems will be provided.

Technical Level: From beginners to advanced engineers and researchers are welcome. Concepts are simple, easy to understand and related to practical applications. The content is designed in a way to start simple and gradually take the audience to the advanced level of marine microgrids.

ABOUT THE INSTRUCTORS



Tomasz Tarasiuk received the M.S. degree in marine electrical engineering from the Gdynia Maritime University in 1989, the Ph.D. degree in electrical engineering from the Gdańsk University of Technology in 2001 and the D.S. degree in electrical engineering (metrology and signal processing) from Warsaw University of Technology in 2010. He has been employed by Polish Steamship Company in years 1989-1994 and by Swan Shipping Company in 1996 as electro-technical officer. He is employed by Gdynia Maritime University since 1994, currently as professor in Department of Marine Electrical Engineering and leader of newly established research team (under grant of National Science Center, Poland) in competences with marine microgrids, especially characteristics of electricity assessment and the grids modeling. Prof. Tarasiuk has been elected as member of Council of Gdynia Maritime University for the term 2012-2016. He has been hired as visiting professor by Shanghai Maritime University in years 2013-2015. His research interest is focused on marine microgrids, particularly power quality and its assessment, including signal processing tools and methods.



Josep M. Guerrero received the B.S. degree in telecommunications engineering, the M.S. degree in electronics engineering, and the Ph.D. degree in power electronics from the Technical University of Catalonia, Barcelona, in 1997, 2000 and 2003, respectively. Since 2011, he has been a Full Professor with the Department of Energy Technology, Aalborg University, Denmark, where he is responsible for the Microgrid Research Program. From 2012 he is a guest Professor at the Chinese Academy of Science and the Nanjing University of Aeronautics and Astronautics; from 2014 he is chair Professor in Shandong University; and from 2015 he is a distinguished guest Professor in Hunan University. His research interests is oriented to different microgrid aspects, including power electronics, distributed energy-storage systems, hierarchical and cooperative control, energy management systems, and optimization of microgrids and islanded minigrids; recently specially focused on maritime microgrids for electrical ships, vessels, ferries and seaports. Prof. Guerrero is an Associate Editor for the IEEE TRANSACTIONS ON POWER ELECTRONICS, the IEEE TRANSACTIONS ON INDUSTRIAL ELECTRONICS, and the IEEE Industrial Electronics Magazine, and an Editor for the IEEE TRANSACTIONS on SMART GRID and IEEE TRANSACTIONS on ENERGY CONVERSION. He received the best paper award of the IEEE Transactions on Energy Conversion for the period 2014-2015. In 2014 and 2015 he was awarded by Thomson Reuters as Highly Cited Researcher, and in 2015 he was elevated as IEEE Fellow for his contributions on “distributed power systems and microgrids.”



Shantha Gamini received his B.Sc. degree in Electronics and Telecommunication Engineering from University of Moratuwa in Sri Lanka, in 2003, and his Ph.D. degree in Electrical Engineering from Nanyang Technological University in Singapore in 2013. From 2011 to 2015 he worked as an Electrical Systems Engineer at Rolls Royce Advanced Technology Centre in Singapore. Currently, he is a lecturer in maritime electrical engineering at the Australian Maritime Collage which is a specialist institute of the University of Tasmania. His research interests include power electronic converters, renewable energy technologies, grid integration of energy systems, shipboard power systems and electric propulsion.