D6.3. Compilation of course materials

WP6 – Network-wide training

Author: Tallinn University of Technology (TUT)

March 2026

SMARTGYSUM project has been funded by the European Commission's Horizon 2020 Programme

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SMARTGYsum has been funded by the European Union's Horizon 2020 Programme under the Grant Agreement GA 955614

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Versions:

Version No.	Person in charge	Institution (acronym)	Date	Comments
1	Eva González	UEX	23.03.2026	First template of the deliverable report
2	Enrique Romero	UEX	25.03.2026	SMARTGYsum Open Course Platform edit
2	Eva González	UEX	25.03.2026	Proofreading and minor corrections
3	Dmitri Vinnikov	TUT	27.03.2026	Revision and Approval by Network Training Chair
4	Enrique Romero	UEX	27.03.2026	Approval and PDF creation for uploading

SMARTGYSUM project has been funded by the European Commission's Horizon 2020 Programme

Technical References:

Project Acronym	SmartGYsum
Project Title	Research and Training Network for Smart and Green Energy Systems and Business Models
Project Coordinator (PC)	Enrique Romero (eromero@unex.es) Universidad de Extremadura (UEX)
Project Duration	1 October 2021 – 31 March 2026

Deliverable No.	D6.3
Dissemination Level	Public
Work Package	WP6 – Network-wide training
Tasks	
Lead Beneficiary	8 - TUT
Contributing beneficiary (ies)	UEX, TUT
Data due of deliverable	31 March 2026
Actual submission date	30 March 2026

Table of Contents

SMARTGYSUM project has been funded by the European Commission's Horizon 2020 Programme

List of abbreviations

CYU	Cergy Paris University
Dn	Deliverable (number)
DS	Doctoral School
ESR	Early Stage Researcher
ETN	European Training Network
GUT	Gdansk University of Technology
ITN	Innovative Training Network
MSCA	Marie Sklodowska-Curie Actions
UEX	University of Extremadura
UNL	University Nova of Lisbon
USA	University of Salerno
TUT	Tallinn University of Technology
WPn	Work Package (number)

SMARTGYSUM project has been funded by the European Commission's Horizon 2020 Programme

1. Executive summary

The present deliverable provides the first report about the training activities developed during the project. A list of delivered courses and a report about the material repository are added.

WP6: Network-wide training, includes three tasks:

- Task 6.1: Elaboration of course plans (Leader: TUT, participants: all)
- Task 6.2: Compilation of delivered course materials and standardisation for SMARTGYsum Open Course Platform (SOC) (Leader: TUT)
- Task 6.3: Organization of DSs (Participants: TUT, UNL, USA, CYU, GUT, UEX)

Training courses have been delivered during the Doctoral Schools (DSs). Seven DSs have been held in different locations and organised by different beneficiaries along the project duration:

- DS1: Organised by TUT. Held in Pärnu (Estonia) 12-16 June 2022.
- DS2: Organised by UEX. Held in Badajoz (Spain) 6-12 November 2022.
- DS3: Organised by UNL. Held in Caparica (Portugal) 3-7 July 2023.
- DS4: Organised by USA. Held in Salerno (Italy) 29 January – 2 February 2024.
- DS5: Organised by CYU. Held in Paris (France) 17-20 September 2024.
- DS6: Organised by TUT. Held in Pärnu (Estonia) 20-25 January 2025.
- DS7: Organised by GUT. Held in Gdańsk (Poland), 25-30 May 2025.

During each DS, several courses were delivered for ESR as well as for external trainees. Beneficiaries, partners and collaborating companies and institutions delivered those courses.

1.1. Objectives of the deliverable

The objective of this deliverable is to gather course materials provided to ESR during the training courses delivered in DSs.

1.2. Organisation of the deliverable

Once the section 1 of this deliverable summarizes the context and the objective of the deliverable, section 2 lists the courses delivered in the seven DSs held. Next, section 3 reports the material provided to ESR and the platform where they accessed to them. Section 4 summarizes the conclusions and Append 1 gather the flyers of the different courses.

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2. List of delivered courses

As a general rule, 6-7 courses have been delivered during each DS, except for DS1. When DS1 was held, all the ESR had not been hired or had not reached their host institution yet. For that reason, only 2 courses were delivered during DS1 and the final number of DSs was decided to extend up to seven.

Along the seven DSs, 48 courses have been delivered with a dedication of 1 ECTS. The courses are listed in the following table. From left to right, the information included is:

- DS number
- title of the course
- Organizer name

DS	Course title	Organiser name
DS1	Galvanically isolated impedance source DC-DC converters for REEGs	TALLINNA TEHNIKAÜLIKOOL
	NZE Buildings: Grid integration and Cooperative community	UNIVERSIDADE NOVA DE LISBOA
DS2	Grid forming Power Converters, Smart Transformers and Hybrid Grids (Part-1)	CHRISTIAN-ALBRECHTS-UNIVERSITAET ZU KIEL
	New Electric Agents and Procedures for a Reliable and Efficient Smart Grid (2/2)	SENERGY PRODUCTS AND SERVICES SL
	Understand How to Write Good Papers for High Level Journals	AALBORG UNIVERSITET
	Workshop on Rapid Control Prototyping and Hardware-in-the-loop Simulations	Plexim GmbH
	Key stakeholders in energy management - Smart grid innovative services and applications	UNIVERSITA COMMERCIALE LUIGI BOCCONI
	Converter Topologies and Control Strategies for Photovoltaic Systems	POLITECHNIKA WARSZAWSKA
	Comparison of Power Quality Control Strategies to Integrate Generation into Existing Grids	UNIVERSIDAD DE EXTREMADURA
DS3	FPGA-based controllers for Power Electronics and Drives Applications]	CY CERGY PARIS UNIVERSITE
	Collaborative Networks	UNIVERSIDADE NOVA DE LISBOA
	Modelling of Photovoltaic arrays operating in uniform and mismatched conditions	UNIVERSITA DEGLI STUDI DI SALERNO
	Optimization Theory Applied to Power Electronic and Energy Management in Microgrids	CENIDET - Centro Nacional de Investigación y Desarrollo Tecnológico de México
	PCB design techniques for power electronic devices to ensure reliability and resilience]	CHERNIHIV POLYTECHNIC NATIONAL UNIVERSITY, CPNU
	Power electronics in electric vehicle charging infrastructure	SENERGY PRODUCTS AND SERVICES SL
	Ethics in Higher Education, Funding and Research Centres (Soft Skill)	UNIVERSIDADE NOVA DE LISBOA
DS4	Entrepreneurship and social entrepreneurship in local energy production and consumption: Innovative business models for Energy Communities	UNIVERSITA COMMERCIALE LUIGI BOCCONI
	Power converters for Hydrogen energy systems	Hochschule Bonn-Rhein-Sieg
	Smart Transmission and Smart Transformer	CHRISTIAN-ALBRECHTS-UNIVERSITAET ZU KIEL
	Maximum power point tracking (MPPT) techniques for renewable energy sources	Consiglio Nazionale delle Ricerche-Istituto di Ingegneria del Mare
	Real-time modelling and power in the loop testing (Giovanni De Carne)	KARLSRUHER INSTITUT FUER TECHNOLOGIE
	Battery modelling and identification based on EIS	UNIVERSITA DEGLI STUDI DI SALERNO
	Patents and intellectual property rights	SEXTANT
DS5	Innovation management in the power electronics industry - the technology product-market dynamic	BrightLoop
	Industry-Oriented Research in Power Electronics in Europe	ECPE-European Center for Power Electronics
	Sensorless Control of AC Drives	CY CERGY PARIS UNIVERSITE
	Control of Power Converters and Drives	Universidad de Sevilla
	Integration methods of photovoltaic and battery storage systems for EV charging infrastructures	University of Bologna

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	Power MOSFET Gate Drivers	Ecole Nationale d'Ingénieurs de Tunis - Université de Tunis El Manar
	Small energy storage system for electric vehicles and distributed energy systems	POLITECHNIKA GDANSKA
DS6	AI in Power System Reliability Monitoring	Delft University of Techonolgy
	Energy Storage Systems Reliability Monitoring	POLITECHNIKA WARSZAWSKA
	Cyber Security for Microgrids	AALBORG UNIVERSITET
	Energy Efficiency Policy Packages	UNIVERSITA COMMERCIALE LUIGI BOCCONI
	Energy Efficient DC Electrification Technologies for Buildings and Neighbourhoods	TALLINNA TEHNIKAÜLIKOOL
	System Simulation: from Mechatronic to Digital Twin	SIEMENS INDUSTRY SOFTWARE SAS
	Women in Sustainability	IEEE- Women in Enginering
DS7	Power theory in electrical systems]	POLITECHNIKA GDANSKA
	Digital control of power electronic systems	CHRISTIAN-ALBRECHTS-UNIVERSITAET ZU KIEL
	Current source converters in industrial applications]	INFINEON TECHNOLOGIES
	EU opportunities and proposals writing. Capitalizing SMARTGYsum efforts	UNIVERSIDAD DE EXTREMADURA
	From LAB to Market: Implementing Business Plans for Energy Systems Innovators	UNIVERSIDAD DE EXTREMADURA
	Talkative Power Conversion: An Introduction	CHRISTIAN-ALBRECHTS-UNIVERSITAET ZU KIEL

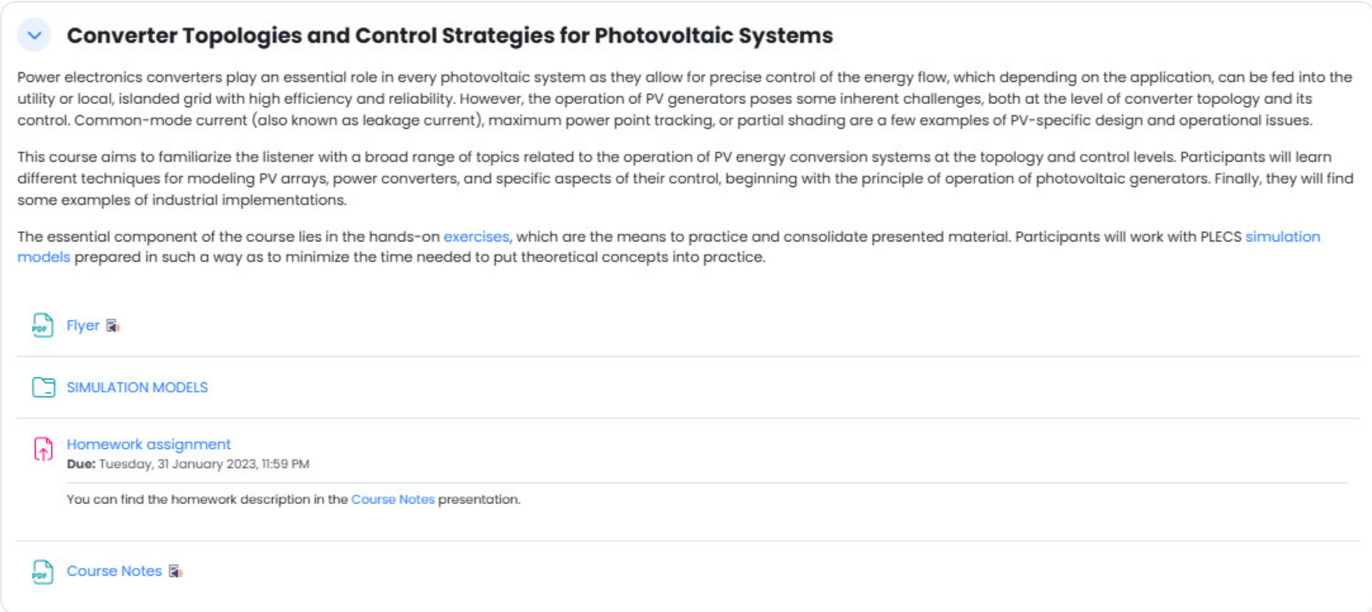
3. Course materials

3.1. Moodle-based platform by UEX

During the celebration of the DS, access to course materials was granted to ESR and other attendees by means of a Moodle-based platform hosted in UEX server (.

The flyer of the course, the slides used by the lecturer, practical applications or additional materials were uploaded to this platform for the attendees to consult or download them.

The figure below shows, as an example, the information included in one of the courses.

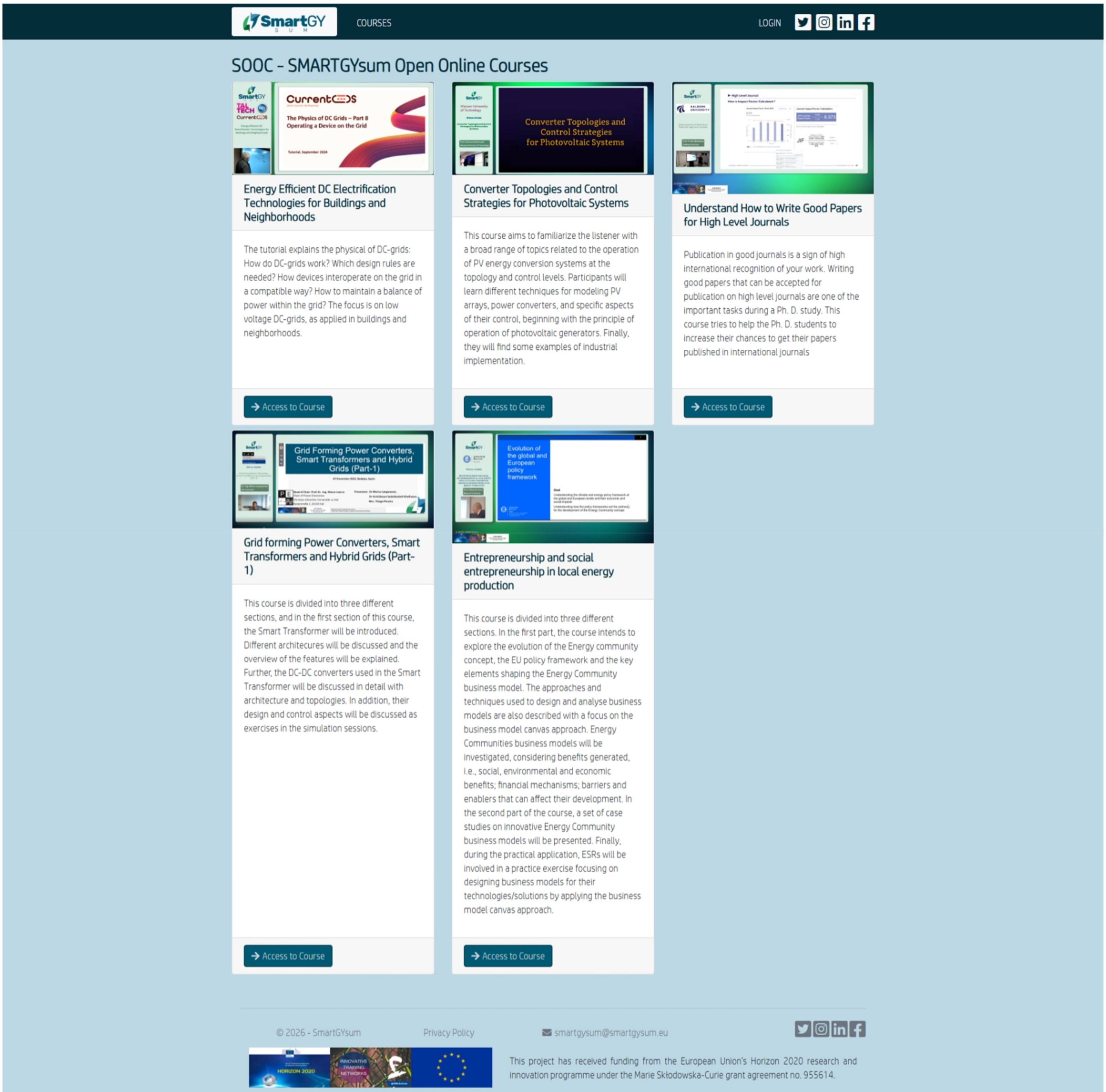


The space for the SMARTGYsum project in the Moodle-based platform by UEX can be accessed in the link:

https://campusvirtual.unex.es/zonauex/evuex/course/view.php?id=12705

3.2. SMARTGYsum Open Course Platform

Besides the Moodle-based platform hosted in UEX, the consortium has decided to move the course materials to a open access platform. Videos of the delivered courses have been edited and uploaded to be delivered on an open-access base.


SmartGY SUM
COURSES
LOGIN
SOOC - SMARTGYsum Open Online Courses
Energy Efficient DC Electrification Technologies for Buildings and Neighborhoods
The tutorial explains the physical of DC-grids: How do DC-grids work? Which design rules are needed? How devices interoperate on the grid in a compatible way? How to maintain a balance of power within the grid? The focus is on low voltage DC-grids, as applied in buildings and neighborhoods.
Access to Course
Converter Topologies and Control Strategies for Photovoltaic Systems
This course aims to familiarize the listener with a broad range of topics related to the operation of PV energy conversion systems at the topology and control levels. Participants will learn different techniques for modeling PV arrays, power converters, and specific aspects of their control, beginning with the principle of operation of photovoltaic generators. Finally, they will find some examples of industrial implementation.
Access to Course
Understand How to Write Good Papers for High Level Journals
Publication in good journals is a sign of high international recognition of your work. Writing good papers that can be accepted for publication on high level journals are one of the important tasks during a Ph. D. study. This course tries to help the Ph. D. students to increase their chances to get their papers published in international journals
Access to Course
Grid forming Power Converters, Smart Transformers and Hybrid Grids (Part-1)
This course is divided into three different sections, and in the first section of this course, the Smart Transformer will be introduced. Different architecures will be discussed and the overview of the features will be explained. Further, the DC-DC converters used in the Smart Transformer will be discussed in detail with architecture and topologies. In addition, their design and control aspects will be discussed as exercises in the simulation sessions.
Access to Course
Entrepreneurship and social entrepreneurship in local energy production
This course is divided into three different sections. In the first part, the course intends to explore the evolution of the Energy community concept, the EU policy framework and the key elements shaping the Energy Community business model. The approaches and techniques used to design and analyse business models are also described with a focus on the business model canvas approach. Energy Communities business models will be investigated, considering benefits generated, i.e., social, environmental and economic benefits; financial mechanisms; barriers and enablers that can affect their development. In the second part of the course, a set of case studies on innovative Energy Community business models will be presented. Finally, during the practical application, ESRs will be involved in a practice exercise focusing on designing business models for their technologies/solutions by applying the business model canvas approach.
Access to Course
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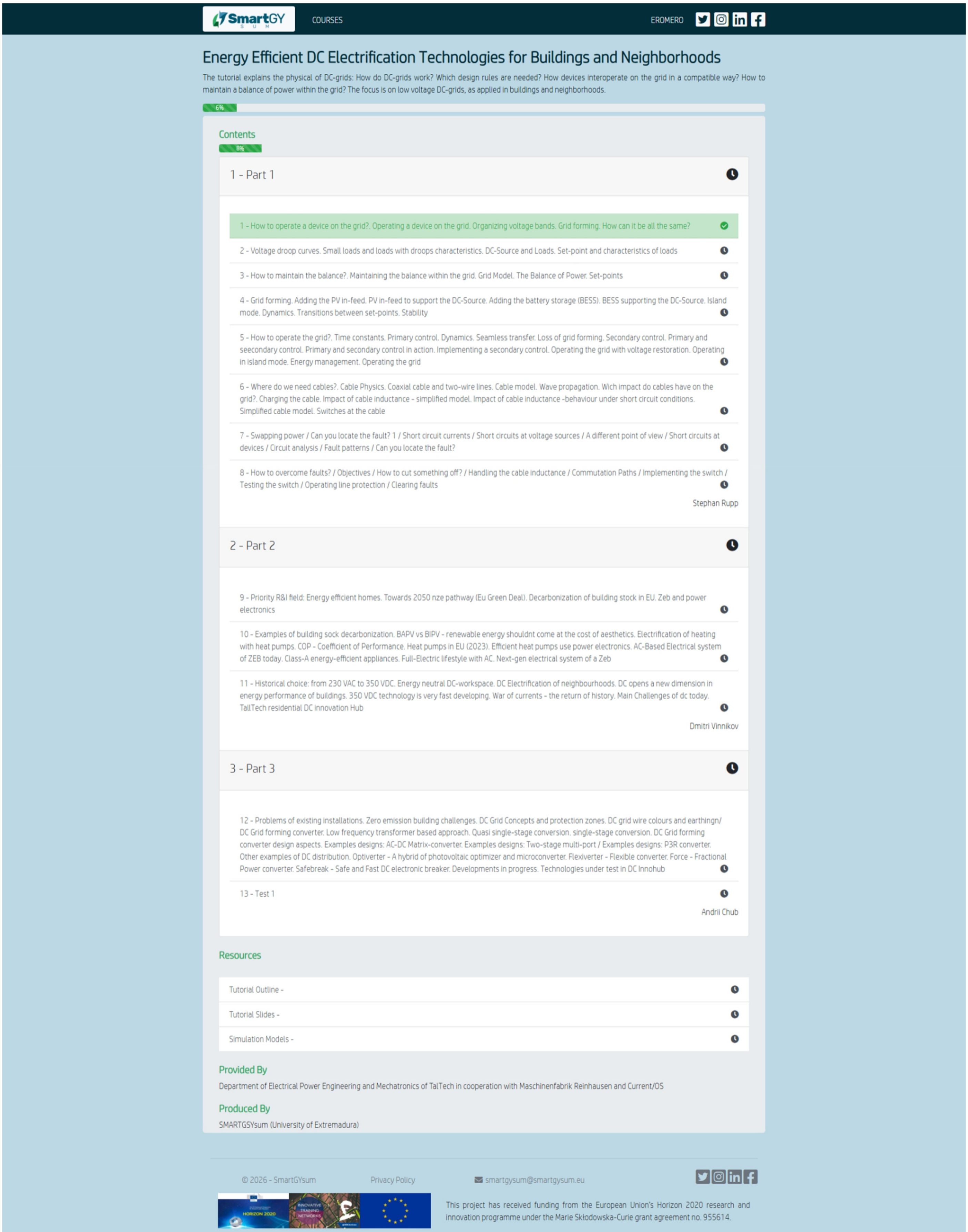
smartgysum@smartgysum.eu
This project has received funding from the European Union's Horizon 2020 research and innovation programme under the Marie Skłodowska-Curie grant agreement no. 955614.


SmartGYSUM
COURSES
EROMERO
Energy Efficient DC Electrification Technologies for Buildings and Neighborhoods
The tutorial explains the physical of DC-grids: How do DC-grids work? Which design rules are needed? How devices interoperate on the grid in a compatible way? How to maintain a balance of power within the grid? The focus is on low voltage DC-grids, as applied in buildings and neighborhoods.
6%
Contents
8%
1 - Part 1
1 - How to operate a device on the grid?. Operating a device on the grid. Organizing voltage bands. Grid forming. How can it be all the same?
2 - Voltage droop curves. Small loads and loads with droops characteristics. DC-Source and Loads. Set-point and characteristics of loads
3 - How to maintain the balance?. Maintaining the balance within the grid. Grid Model. The Balance of Power. Set-points
4 - Grid forming. Adding the PV in-feed. PV in-feed to support the DC-Source. Adding the battery storage (BESS). BESS supporting the DC-Source. Island mode. Dynamics. Transitions between set-points. Stability
5 - How to operate the grid?. Time constants. Primary control. Dynamics. Seamless transfer. Loss of grid forming. Secondary control. Primary and seecondary control. Primary and secondary control in action. Implementing a secondary control. Operating the grid with voltage restoration. Operating in island mode. Energy management. Operating the grid
6 - Where do we need cables?. Cable Physics. Coaxial cable and two-wire lines. Cable model. Wave propagation. Wich impact do cables have on the grid?. Charging the cable. Impact of cable inductance - simplified model. Impact of cable inductance -behaviour under short circuit conditions. Simplified cable model. Switches at the cable
7 - Swapping power / Can you locate the fault? 1 / Short circuit currents / Short circuits at voltage sources / A different point of view / Short circuits at devices / Circuit analysis / Fault patterns / Can you locate the fault?
8 - How to overcome faults? / Objectives / How to cut something off? / Handling the cable inductance / Commutation Paths / Implementing the switch / Testing the switch / Operating line protection / Clearing faults
Stephan Rupp
2 - Part 2
9 - Priority R&I field: Energy efficient homes. Towards 2050 nze pathway (Eu Green Deal). Decarbonization of building stock in EU. Zeb and power electronics
10 - Examples of building sock decarbonization. BAPV vs BIPV - renewable energy shouldnt come at the cost of aesthetics. Electrification of heating with heat pumps. COP - Coefficient of Performance. Heat pumps in EU (2023). Efficient heat pumps use power electronics. AC-Based Electrical system of ZEB today. Class-A energy-efficient appliances. Full-Electric lifestyle with AC. Next-gen electrical system of a Zeb
11 - Historical choice: from 230 VAC to 350 VDC. Energy neutral DC-workspace. DC Electrification of neighbourhoods. DC opens a new dimension in energy performance of buildings. 350 VDC technology is very fast developing. War of currents - the return of history. Main Challenges of dc today. TallTech residential DC innovation Hub
Dmitri Vinnikov
3 - Part 3
12 - Problems of existing installations. Zero emission building challenges. DC Grid Concepts and protection zones. DC grid wire colours and earthingn/ DC Grid forming converter. Low frequency transformer based approach. Quasi single-stage conversion. single-stage conversion. DC Grid forming converter design aspects. Examples designs: AC-DC Matrix-converter. Examples designs: Two-stage multi-port / Examples designs: P3R converter. Other examples of DC distribution. Optiverter - A hybrid of photovoltaic optimizer and microconverter. Flexiverter - Flexible converter. Force - Fractional Power converter. Safebreak - Safe and Fast DC electronic breaker. Developments in progress. Technologies under test in DC Innohub
13 - Test 1
Andrii Chub
Resources
Tutorial Outline -
Tutorial Slides -
Simulation Models -
Provided By
Department of Electrical Power Engineering and Mechatronics of TalTech in cooperation with Maschinenfabrik Reinhausen and Current/OS
Produced By
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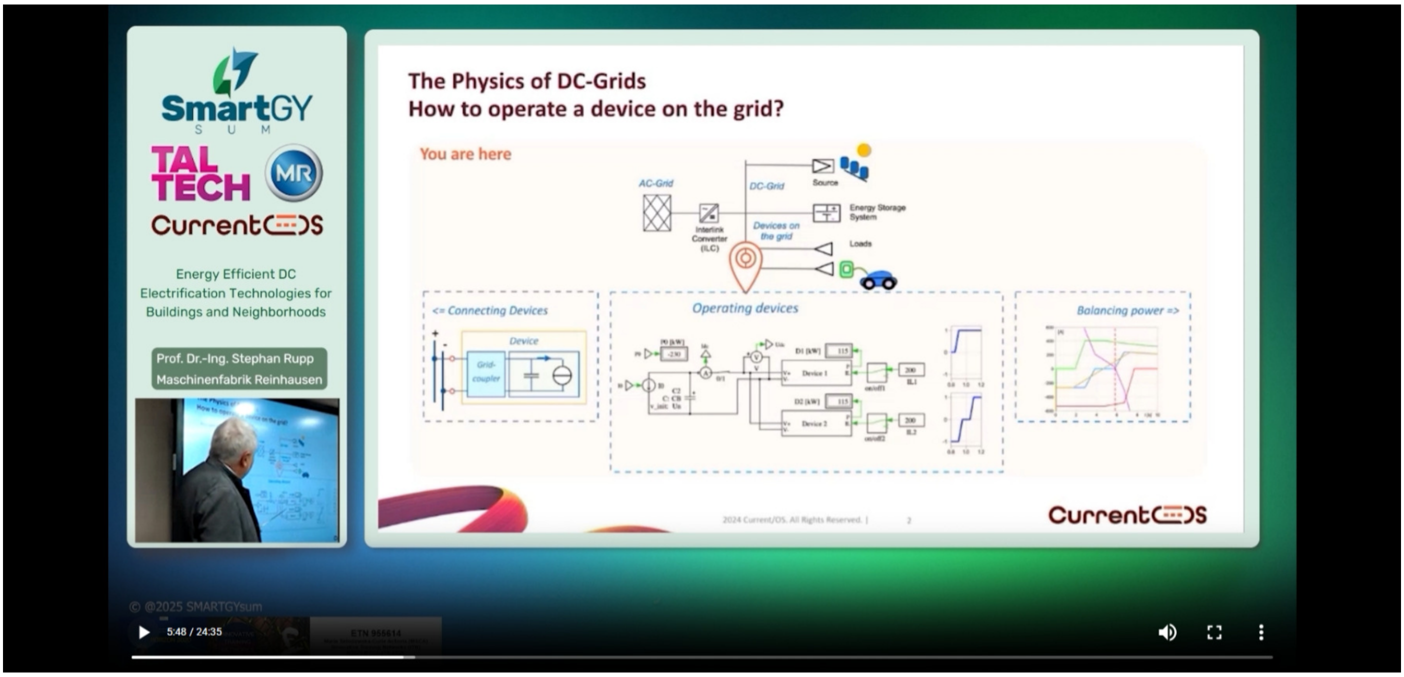

SmartGY SUM
TAL TECH
MR
CurrentOS
Energy Efficient DC Electrification Technologies for Buildings and Neighborhoods
Prof. Dr.-Ing. Stephan Rupp
Maschinenfabrik Reinhausen
The Physics of DC-Grids
How to operate a device on the grid?
You are here
AC-Grid
DC-Grid
Source
Energy Storage System
Interlink Converter (ILC)
Devices on the grid
Loads
<= Connecting Devices
Device
Grid-coupler
Operating devices
Balancing power =>
CurrentOS
© @2025 SMARTGYsum
5:48 / 24:35

4. Conclusions

ESR training in technical, business and soft skills has been granted by means of a complete collection of courses focused on the topics of the project.

Beneficiaries, partners and other collaborating companies and other institutions have been involved in the course delivering, thus providing ESR with both academic and industry visions regarding energy transition.

As a result of the training process, every ESR has improved research skills.

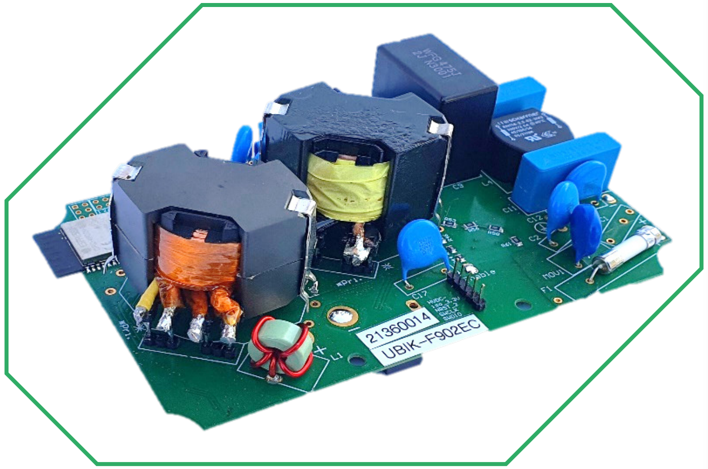
By means of the SMARTGYsum Open Course platform, the knowledge generated thanks to the participation of the whole consortium may be shared to other research, under the open science philosophy.

Appendix

This appendix gathers the flyers of the courses delivered during SMARTGYsum DSs and listed in section 2.

SPECIAL COURSE

Galvanically Isolated Impedance Source DC-DC Converters for Renewable Electric Energy Generation



14 June 2022
Pärnu, Estonia

COURSE PROGRAM

9:00 **Welcome and Course Introduction** (Dmitri Vinnikov)

9:15 **Impedance-Source Networks** (Oleksandr Husev)
- a. Operation principle
- b. Derivation
- c. Comparison

11:00 *Coffee break*

11:30 **Galvanically Isolated DC-DC Topologies** (Andrii Chub)
- a. Classification
- b. Simplified topologies
- c. Advanced topologies

13:00 *Lunch*

14:00 **Application Examples** (Dmitri Vinnikov)
- a. Low-cost PV microconverter
- b. Shade-tolerant PV microconverter
- c. Battery interface converter

15:30 *Coffee break*

16:00 **Laboratory Session** (Hamed Mashinchi, Omar Abdel-Rahim)
- a. Introduction of test-bench
- b. Assembly of prototype
- c. Testing of prototype

17:45 **Summary and Discussion**

18:00 **End of Course**

Prerequisites: basic knowledge of electrical engineering and power electronics. Registered attendees will receive a list of recommended literature to prepare for the course.

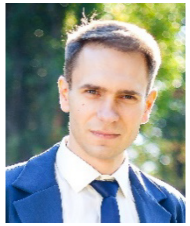
English will be the working language.

COURSE DESCRIPTION

Impedance-source converters are an emerging technology in electric energy conversion, which overcomes the limitations of conventional voltage and current source converters by using specific impedance-source networks. These converters are particularly appropriate for renewable electric energy generation systems, which require input voltage and load regulation in a wide range. Course attendees will gain knowledge about the impedance source networks and basic galvanically isolated dc-dc converters, their classification according to the element that transfers energy from the input to the output: a transformer, a coupled inductor, or their combination.
The course will convey the practical application examples to illustrate the benefits of the impedance source technology. After that, attendees will be split into three groups to engage in a laboratory exercise where participants will get hands-on experience that shall result in the final test report.
Course grading: *Pass/Fail.*

COURSE INSTRUCTORS


Dmitri Vinnikov


Oleksandr Husev


Andrii Chub


Omar Abdel-Rahim


Hamed Mashinchi

SmartGY SUM

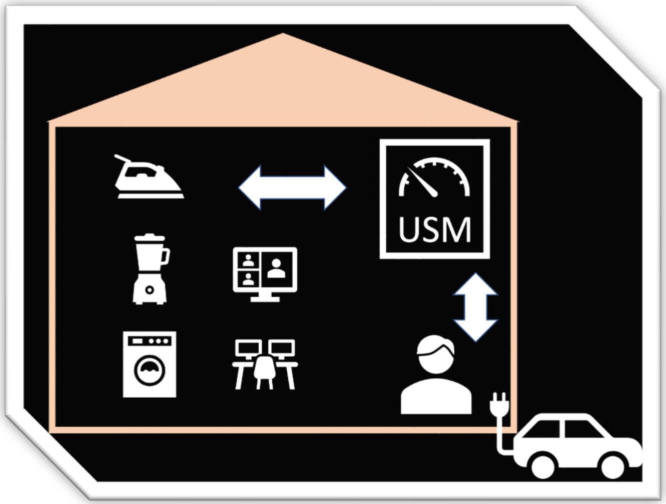
TALTECH

Special Course

NZE Buildings: Grid integration and Cooperative community

13 June 2022

Pärnu, Estonia



Course Program

9:00 **Welcome and Course Introduction**

9:15 **The Rise of the Prosumer**

a. Definition of Prosumers
b. Smart Infrastructure
c. Non-Intrusive Load Monitoring

11:00 *Coffee break*

11:30 **Nearly Zero-Energy Building (nZEB) Framework and implementation**

a. Legal Definitions
b. Technical Definitions
c. System Boundaries
d. Weighting Systems
e. Assessment Periods
f. Passive Solutions
g. Active Solutions
h. Renewables
i. Barriers and Benefits

13:00 *Lunch*

14:00 **Grid Impact, Performance Metrics and Energy Flexibility**

a. Performance Indexes
b. Grid Impact Issues
c. Mitigation Strategies
d. Energy Flexibility Core Concepts
e. Supply vs. Demand-Side
f. Flexibility Mechanisms

15:30 *Coffee break*

16:00 **Practical Exercises**

a. Achieving nZEB status
b. Loss of Life (LOL) for a transformer servicing nZEB houses
c. Sizing battery capacity for a nZEB

17:45 **Summary and Discussion**

18:00 **End of Course**

Course Description

This course explores the technical and strategic transition toward a decarbonized European building stock. Designed for students and professionals, the program examines Nearly Zero-Energy Buildings (nZEB) within the context of modern smart grids and decentralized energy systems.

Participants begin by analyzing the legislative landscape and the environmental urgency of renovating existing structures. The curriculum defines rigorous physical and time-based boundaries required to achieve net-zero status, utilizing weighting systems like primary energy factors and CO2 emissions. As the focus shifts to the "Prosumer," students explore smart infrastructure, including unbundled smart meters and energy routers, alongside techniques like Non-Intrusive Load Monitoring.

Central to the course is the challenge of grid integration. You will learn to use performance metrics such as Load Matching and Self-Sufficiency to quantify building-grid interactions. The program highlights technical strains like voltage fluctuations and the thermal "Loss of Life" in power transformers. Finally, the course covers Energy Flexibility, teaching participants to identify and model flexible resources like thermal mass and battery storage. Ultimately, you will understand how to leverage flexibility to support cooperative energy communities and a stable, green power grid.

Course grading: *Pass/Fail.*

Course Instructor

João Martins

NOVA FACULDADE DE CIÊNCIAS E TECNOLOGIA

UNINOVA

SmartGY SUM

C | A | U
Kiel University
Christian-Albrechts-Universität zu Kiel
Faculty of Engineering

SPECIAL COURSE

Grid forming Power Converters, Smart Transformers and Hybrid Grids (Part-1)

SmartGY SUM

HORIZON 2020

INNOVATIVE TRAINING NETWORKS

ETN 955614
Marie Skłodowska-Curie Actions (MSCA)
Innovative Training Networks (ITN)
H2020-MSCA-ITN-2020

07 November 2022
Badajoz, Spain

COURSE PROGRAM

8:45	Welcome and Course Introduction
9:00	Introduction to Smart Transformer 1. Problems in electric grid 2. The solid-state transformer 3. Smart Transformer features
10:15	*Coffee break*
10:45	Smart Transformer Architectures 1. B2B vs ST 2. Overview and Architectures 3. Power Converter Topologies
12:00	DC-DC Converters for Smart Transformer 1. Modularity 2. Overview and Architectures 3. Power Converter Topologies
13:15	*Lunch*
14:30	Exercises: PLECS/MATLAB simulations 1. Design of DC-DC Converters
16:30	*Coffee break*
17:00	Exercises: PLECS/MATLAB simulations 1. Control of DC-DC Converters
19:00	End of Course

Prerequisites: Basic knowledge on electrical engineering, power electronics and control. Elementary knowledge on MATLAB and PLECS is also expected.

English will be the working language

COURSE DESCRIPTION

The use of DC in transmission and distribution is leading the way to more efficient and controllable grids and it reduces the size and cost of the infrastructure. The AC systems are already established, and provide reduced challenges in protection systems and voltage adaptions. The future would be a coexistence of AC and DC infrastructures at various voltage levels leading to a hybrid system using the advantages of both. As the renewable energy source and electric vehicle penetrations are increasing in the distribution levels both MV and LV systems also require a substantial transformation. The Smart Transformer has emerged as a solution in this scenario for enabling the hybrid grid in the distribution grid.

This course is divided into three different sections, and in the first section of this course, the Smart Transformer will be introduced. Different architecures will be discussed and the overview of the features will be explained. Further, the DC-DC converters used in the Smart Transformer will be discussed in detail with architecture and topologies. In addition, their design and control aspects will be discussed as exercises in the simulation sessions.

COURSE INSTRUCTORS

Marco Liserre

Marius Langwasser

Hrishikesan V M

Special Course

New Electric Agents and Procedures for a Reliable and Efficient Smart Grid

7 November 2022

Badajoz, Spain

Course Program

9:00 Power Systems and Smart Grids (Eva González)

1. Current power system
2. Smart grid concepts
3. Agents in smart grids

10:45 *Coffee break*

11:15 Photovoltaic Plants (Víctor Miñambres)

1. Photovoltaic plants concepts
2. Architerctures and inverter Topologies
3. Modulation techniques and control strategies

13:00 *Lunch*

14:30 Practical application. PowerWorld simulations (Eva González)

1. Simulation of a microgrid of prosumers

16:30 *Coffee break*

16:45 Practical application. Photovoltaic Plant emulation (Víctor Miñambres)

1. Programmable power laboratory description and basic operation mode
2. Commercial photovoltaic grid connected inverter analysis under power laboratory emulation environment

19:00 End of Course

Prerequisites: basic knowledge of electrical engineering and power electronics. Registered attendees will receive a list of recommended literature, slides and a practical application handbook.

English will be the working language

Course Description

Day by day the electrical grid is changing into a new paradigm where centralized carbon and nuclear power plants, are leading to distributed green, smart and renewable power sources. In this sense, various literature have focused on studying the new smart grid scenario. Old consumers are now "prosumers" as they could not only draw energy from the grid, but also could inject power from renewable, storage energy, perform ancillary services… In order to have balance in the system a strong grid is required, so big photovoltaic plants bassed on renewable energy are the key when including energy storage system for obtaining manageability.

The course will convey the main issues related to the smart grids, its agents involved and renewable power plants, mainly photovoltaics. The paradigm of smart grids evolving new agents and market strategies are explained together with grid connected photovoltaic inverters with energy storage systems.

After that, practical implementation in simulation will be conducted to consolidate the theoretical expositions, analysing the economic management of a cooperative prosumers smart grid. Then a programmable power laboratory will be shown and programmed with the aim of testing a commercial grid connected photovoltaic.

Course Instructors

Víctor Miñambres

Eva González

SmartGY SUM

UNIVERSIDAD DE EXTREMADURA

Special Course

Understand How to Write Good Papers for High Level Journals

SmartGY SUM

ETN 955614
Marie Skłodowska-Curie Actions (MSCA)
Innovative Training Networks (ITN)
H2020-MSCA-ITN-2020

8 November 2022

Badajoz, Spain

Course Program

Morning session: Frede Blaabjerg

8:45	Introduction and motivation for doing high level papers
10:00	How to write a good paper
11:00	Journal operation and review
12:00	Writing a paper – in a systematic way – to be successful
13:00	*Lunch*

Afternoon session: Ariya Sangwongwanich

14:30	Exercise 1: Abstract and conclusion preparation
16:00	Presentation
16:30	*Coffee break*
17:00	Tips & Tricks
17:30	Exercise 2: Reviewing scientific papers
19:00	End of Course

Prerequisites: No

English will be the working language

Course Description

Publication in good journals is a sign of high international recognition of your work. Writing good papers that can be accepted for publication on high level journals are one of the important tasks during a Ph. D. study. This course tries to help the Ph. D. students to increase their chances to get their papers published in international journals. To serve the goal, in this course:

- First, the procedure about how the paper review process is carried out will be explained (starting from the moment you submit your paper to the time that you get the reviewers' comments and until the final decision).
- How will the paper is reviewed by reviewers.
- Standard evaluation forms that will be filled in by the reviewers for different journals.
- Important aspects to consider when you write your paper. (Paper structure, what to do and what not to do)
- How to include citations to other work in a paper
- How to write the reply to the response from reviewer.
- Several concrete case studies.
- Exercise. Examples will be given mainly in the Energy Technology area in terms of journals – but most of it has a generic structure in terms of peer review process

Course Instructors

Frede Bjaabjerg

Ariya Sangwongwanich

UNIVERSIDAD DE EXTREMADURA

Special Course

Workshop on Rapid Control Prototyping and Hardware-in-the-loop Simulations

plexim electrical engineering software

HORIZON 2020

INNOVATIVE TRAINING NETWORKS

ETN 955614
Marie Skłodowska-Curie Actions (MSCA) Innovative Training Networks (ITN) H2020-MSCA-ITN-2020

9 November 2022
Badajoz, Spain

Course Program

8:45 Welcome and Course Introduction

9:00 Advanced Concepts for Simulation of Power Electronics Systems

1. Switch models
2. State-space modeling
3. Solvers
4. Stiffness and step-size calculation

10:15 *Coffee break*

10:45 Introduction to Real-Time Simulations

1. HIL/RCP concepts and applications
2. Real-Time workflows
3. I/O latencies (Hands-on)

13:00 *Lunch*

14:30 Hands-on HIL Development

1. From offline to real-time implementation
2. Model optimization

16:30 *Coffee break*

16:45 Hands-on Development of a DC Microgrid Model

19:00 End of Course

Prerequisites:

- Basic knowledge of electrical engineering and power electronics.
- Basic knowledge on PLECS software.
- Laptop with a valid PLECS installation to operate the HIL/RCP simulator. Full-trial licenses will be provided for the course.

Course documentation will be provided to the attendees. English will be the working language.

Course Description

Control schemes of any modern power electronic applications are comprehensive and challenging to test on real hardware targets under various operation conditions. Hardware-In-the-Loop (HIL) simulations allow the replacement of the actual plant with an appropriate dynamic model, allowing testing of the control algorithm in a safe environment.
In a similar manner, Rapid Control Prototyping (RCP) solutions allow to quickly implement new control schemes and iterate over the designs, by automatically generating code and programming the control hardware with the contrrol scheme from a simulation model.

In this course we will cover the fundamentals of PLECS simulation software, focusing on the relevant aspects related to real-time simulations. Then we will discuss about the RCP/HIL concepts, real-time workflows, the importance of I/O latencies and model optimizations, while working on the HIL simulator. Then we will work in teams to develop a complete HIL & RCP model of a modern power electronic system.

Course Instructors

Enrique Rodríguez Díaz

Engineer and Project Manager at Plexim GmbH

SmartGY SUM

Università Bocconi MILANO

Special Course

Key stakeholders in energy management: Smart grid innovative services and applications

SmartGY SUM

HORIZON 2020 — INNOVATIVE TRAINING NETWORKS

ETN 955614
Marie Skłodowska-Curie Actions (MSCA)
Innovative Training Networks (ITN)
H2020-MSCA-ITN-2020

9 November 2022
Badajoz, Spain

Course Program

8:45 Welcome and Course Introduction (Edoardo Croci)

9:00 Smart grids regulatory and policy framework in the EU (Edoardo Croci)

1. EU policies for Smart grids
2. The evolution of Smart grid concept: from energy distribution network to innovative service enabler

10:30 *Coffee break*

11:00 Smart grids application domains, impacts and value creation (Edoardo Croci)

1. Smart network management
2. Demand-side management
3. Integration of distributed generation and storage
4. Integration of largescale RES
5. Electric Mobility

13:00 *Lunch*

14:30 Key stakeholders' roles, interaction and benefits of two innovative smart grid applications (Tania Molteni/Annamaria Bagaini)

1. What is a stakeholder?
2. Key stakeholders in two smart grid applications
   i. Renewable Energy Communities
   ii. Electric mobility systems

16:00 *Coffee break*

16:30 Practical application (stakeholders identification and analysis) (Tania Molteni/Annamaria Bagaini)

19:00 End of Course

Prerequisites: Registered attendees will receive a list of recommended literature, slides and a practical application handbook.

English will be the working language

Course Description

Smart grids are considered one of the most promising and compelling technology and systems for a green energy transition. Not only do they combine efficient energy management with avant-garde technologies related to renewable energies, but they are also capable of providing several innovative services, benefits and new value to the energy chain, from consumer empowerment to new business opportunities for traditional and additional stakeholders involved in the electricity energy network (such as DSOs, TSOs, aggregators, customers, ICT solutions providers, Energy Service Companies-ESCOs, etc.). Smart grids enable to offer and manage new types of services becoming the means for the wide adoption of electrical vehicles, the catalysts for increased involvement of end-user in the energy scene, and the facilitator for a sustainable lifestyle.

First, the course analyses European policies implemented to foster smart grids implementation and the evolution of smart grids concept: from smart energy distribution networks to a tool enabling innovative services for the energy transition. Smart grids can operate on different domains, which represent macro areas of smart grid implementation. Each domain will be presented and described looking at services provided and benefits generated for the environment, society and economy. Each domain can involve different types of stakeholders. The course presents traditional and additional stakeholders in the energy chain, analysing the value generated through smart grids for these stakeholders in two innovative applications. During the practical application, the ESRs will identify and analyse stakeholders associated with their Individual Research Projects and their potential role in deploying, generating value, and scaling up innovative technical solutions in green energy systems.

SmartGY SUM

Warsaw University of Technology

SPECIAL COURSE

Converter Topologies and Control Strategies for Photovoltaic Systems

SmartGY SUM

ETN 955614
Marie Skłodowska-Curie Actions (MSCA)
Innovative Training Networks (ITN)
H2020-MSCA-ITN-2020

11 November 2022
Badajoz, Spain

COURSE PROGRAM

8:45 Welcome and Course Introduction (Mariusz Malinowski)

9:00 Renewable energy conversion systems (Mariusz Malinowski, Radek Kot)
1. Introduction
2. PV energy conversion systems
3. Modeling of PV modules and arrays

10:15 *Coffee break*

10:45 Topologies and control for DC-DC converters (Radek Kot)
1. Overview of selected PLECS features
2. Exercise: modeling a PV module using PLECS
3. Overview of selected topologies
4. Averaged converter model for control design and simulation
5. A cascaded control scheme w/ MPPT

13:00 *Lunch*

14:30 LAB PLECS simulations (Radek Kot)
1. Implementation of a cascaded control scheme w/ MPPT

16:30 *Coffee break*

16:45 Topologies and Control for DC-AC Converters (Mariusz Malinowski, Radek Kot)
1. Overview of control methods
2. LAB: Implementation of a selected control scheme
3. Example of an industrial implementation

19:00 End of Course

Prerequisites: basic knowledge of electrical engineering and power electronics. Registered attendees will receive a list of recommended literature, slides and a practical application handbook.

English will be the working language

COURSE DESCRIPTION

Power electronics converters play an essential role in every photovoltaic system as they allow for precise control of the energy flow, which depending on the application, can be fed into the utility or local, islanded grid with high efficiency and reliability. However, the operation of PV generators poses some inherent challenges, both at the level of converter topology and its control. Common-mode current (also known as leakage current), maximum power point tracking, or partial shading are a few examples of PV-specific design and operational issues.

This course aims to familiarize the listener with a broad range of topics related to the operation of PV energy conversion systems at the topology and control levels. Participants will learn different techniques for modeling PV arrays, power converters, and specific aspects of their control, beginning with the principle of operation of photovoltaic generators. Finally, they will find some examples of industrial implementations.

The essential component of the course lies in the hands-on exercises, which are the means to practice and consolidate presented material. Participants will work with PLECS simulation models prepared in such a way as to minimize the time needed to put theoretical concepts into practice.

COURSE INSTRUCTORS

Mariusz Malinowski

Radek Kot

SmartGY SUM

UNIVERSIDAD DE EXTREMADURA

Special Course

Comparison of Power Quality Control Strategies to Integrate Generation into Existing Grids

SmartGY SUM

HORIZON 2020

INNOVATIVE TRAINING NETWORKS

ETN 955614
Marie Skłodowska-Curie Actions (MSCA)
Innovative Training Networks (ITN)
H2020-MSCA-ITN-2020

11 November 2022
Badajoz, Spain

Course Program

8:45 Welcome and Course Introduction

9:00 Power Quality Issues (Carlos Roncero)
1. Introduction to power quality
2. Disturbances in electrical grids
3. Main codes

10:15 *Coffee break*

10:45 Non Sinusoidal Systems (Maribel Milanés)
1. Analysis of non sinusoidal systems
2. New power definitions
3. Correction of non sinusoidal systems
   a. Passive and active solutions
   b. Power control strategies for shunt active power filters (APFs)

13:00 *Lunch*

14:30 Practical application. PLECS simulations (Maribel Milanés)
1. Implementation of *p-q*, UPF, PHC strategies and i_d-i_q method for reference current generation

16:30 *Coffee break*

16:45 Practical application. PLECS simulations (Carlos Roncero)
1. Three-phase four-wires two-level shunt APF
2. Three-Level T-Type Quasi-Z Source PV Grid-Tied Inverter With APF

19:00 End of Course

Prerequisites: basic knowledge of electrical engineering and power electronics. Registered attendees will receive a list of recommended literature, slides and a practical application handbook.

English will be the working language

Course Description

Modern power grid have a large penetration of distributed generation at the distribution level, as well as electronic equipment that seriously affect the power quality and grid stability. In this sense, various literature have focused on defining the modern power grid as the power electronics-dominated grid, which implies challengues on its study, design and control. New knowledge and advances on these toppics are critical to assure the transition of a green energy paradigm, assuring the electricity supply in a reliable and uninterupted way. The course will convey the main issues related to the power quality, common disturbances both in the voltage and the current, and the main standards as the IEEE 1547. Theory and design of traditional power control strategies to generate the current references for shunt APFs based on the *p-q* theory, i_d-i_q method, unity power factor (UPF) and perfect harmonic cancelation (PHC) are explained in details. After that, practical implementation in PLECS by block programming will be conducted to consolidate the theoretical expositions, achieving the current references based on the above strategies. Finally, the implemented controls are applied to a 3-phase 4-wire 2-level shunt APF, and to a PV inverter based on an impedance-source network in multi-level configuration, with the corresponding current synchronization and current controller loops.

Course Instructors

Maribel Milanés

Carlos Roncero

SmartGY SUM

CY Cergy Paris Université

Special Course

FPGA-based controllers for Power Electronics and Drives Applications – An Introduction

SmartGY SUM

HORIZON 2020 · INNOVATIVE TRAINING NETWORKS

ETN 955614
Marie Skłodowska-Curie Actions (MSCA)
Innovative Training Networks (ITN)
H2020-MSCA-ITN-2020

03 July 2023
Lisboa, Portugal

Course Program

8:45	Welcome and Course Introduction
9:00	Hardware Descriptive Laguage 1. Introduction to FPGA Design 2. VHDL Reminders
10:15	*Coffee break*
10:45	FPGA Technology & RTL Developpment Chain 1. FPGA Architecture 2. RTL Design and VerificationTools 3. Hands on a basic design – Introduction to Vivado (Lab0)
13:00	*Lunch*
14:30	Practical Applications part 1 1. Implementation of a basic sawtooth-based PWM (Lab1) 2. Implementation of a more realistic PWM with dead-time management and triangular carrier (Lab2)
16:30	*Coffee break*
16:45	Practical Application part 2 & Review 1. Implementation of a full Sinusoidal PWM with Bipolar Switching for Single Phase Full-Bridge Inverters (Lab3) 2. FPGA-based Controllers for Drive Applications, a review 3. Conclusions, to go further
19:00	End of Course

Prerequisites: Basic knowledge of digital electronics, control and power electronics. Registered attendees will receive a list of recommended literature, slides and files to complete practical labs on Vivado. <u>To take full advantage of this course, it is strongly recommended to all attendees to install the latest version of Vivado software from AMD-Xilinx pior to this course.</u>

English will be the working language

Course Description

Today's digital controllers are extremely powerful. With the current Field Programmable Gate Array (FPGA), designing a controller is no longer limited to the programming of a microprocessor but includes also the programming of the architecture of the processor itself along with its peripherals and its computing accelerators. As a consequence, the control designer should be now a system architect who also needs a deep understanding of the final system to be controlled.

As a first step, this one day course aims to propose an introduction to the use of current FPGA-based reconfigurable platforms for controlling power electronic and drive applications.

The objective of this course is mainly practical. It is intended to give to the students the basics in order they can later design by their own an RTL (Register Transfert Level) project on FPGAs for controlling power electronics applications, mainly designing any specific PWM function… It is also intended to be an introduction to better understand the benefits and limits of using this technology for such kind of applications.

Worth to be mentioned, auto-coding generation from Simulink or from C/C++ codes (High Level Synthesis, HLS approach) is not treated here due to the lack of time, since one day is not enough to cover all these topics. However, a second part of this lecture which will focus on HLS design is foreseen next year.

Course

Course Instructors

Eric Monmasson

SmartGY SUM

NOVA UNIVERSIDADE NOVA DE LISBOA

NOVA SCHOOL OF SCIENCE & TECHNOLOGY

TECHNICAL COURSE

Collaborative Networks

SmartGY SUM

HORIZON 2020 INNOVATIVE TRAINING NETWORKS

ETN 955614
Marie Skłodowska-Curie Actions (MSCA)
Innovative Training Networks (ITN)
H2020-MSCA-ITN-2020

03 July 2023
Lisboa (Caparica), Portugal

COURSE PROGRAM

8:45 Welcome and Course Introduction

9:00 Concept and motivation

1. Motivation examples
2. Notion of collaborative network

10:15 *Coffee break*

10:45 Classes of Collaborative Networks and support platforms

1. Towards a taxonomy of collaborative networks
2. Support platforms
3. Security issues

13:00 *Lunch*

14:30 Collaborative ecosystems and virtual organizations

1. Strategic networks and ecosystems
2. Creation of dynamic virtual organizations
3. Partners selection exercise

16:30 *Coffee break*

16:45 Management of CNs and Energy application

1. Issues in management of virtual organizations
2. Collaboration incentives
3. Collaborative networks in Industry 4.0
4. Applications to energy systems
5. Conclusions and future directions

19:00 End of Course

Prerequisites: Basic knowledge of information technology and familiarization with recent trends in energy systems.

Registered attendees will receive a list of recommended literature, slides and files to complete practical work.

English will be the working language

COURSE DESCRIPTION

Modern energy systems involve a diverse range of stakeholders, such as producers, distributors, consumers, prosumers, regulators, markets, and service providers. To ensure effective operation of such systems, a collaborative multistakeholder perspective and new business models are increasingly required. This is evident from the emergence of concepts such as energy communities, virtual powerplants, energy ecosystems, and collaborative smart grids.

Furthermore, with the rapid convergence of technologies such as Internet of Things, Artificial Intelligence/Machine Learning, smart sensors, and smart home appliances, future energy infrastructures are becoming smarter, composed of autonomous subsystems, and can be viewed as Collaborative Cyber-Physical Systems.

It is therefore essential to promote the convergence between the Energy and the Collaborative Networks communities.

To this end, this introductory course aims to provide a basic understanding of Collaborative Networks and involved models and tools. The application of these concepts and mechanisms to the energy sector will also be discussed, making a bridge to recent trends in Industry 4.0 and Industry 5.0/Society 5.0.

Consequently, this course expects students to gain a comprehensive understanding of the field and develop the ability to identify the challenges and promising approaches within the different collaborative energy ecosystems.

COURSE INSTRUCTORS

Luis M. Camarinha-Matos

Ana Inês Oliveira

SmartGY SUM

UNIVERSITÀ DEGLI STUDI DI SALERNO

Special Course

Modelling of Photovoltaic arrays operating in uniform and mismatched conditions

SmartGY SUM

HORIZON 2020 · INNOVATIVE TRAINING NETWORKS

ETN 955614
Marie Skłodowska-Curie Actions (MSCA)
Innovative Training Networks (ITN)
H2020-MSCA-ITN-2020

04 July 2023
Lisboa, Portugal

Course Program

8:45	Welcome and Course Introduction
9:00	Photovoltaic cell modeling 1. Single Diode Model (SDM) 2. Irradiance and temperature dependecies
10:15	*Coffee break*
10:45	Photovoltaic arrays modeling 1. PV source operation in uniform and mismatched conditions 2. Partial shading and hot-spots 3. Bypass diodes for PV cells protection
13:00	*Lunch*
14:30	Practical Applications part 1 1. Matlab/Simulink models for PV simulation 2. Example of SDM parameters identification (Lab1) 3. Simulation of PV sources in uniform conditions (Lab2)
16:30	*Coffee break*
16:45	Practical Application part 2 1. Simulation of PV fields in mismatched conditions (Lab3) 2. Final comments and remarks
19:00	End of Course

Prerequisites: Background in the field of electrical and electronics engineering and basic skills in programming language for solving numerical problems. Registered attendees will receive a list of recommended literature, slides and files to complete practical labs on MATLAB and Simulink. To take full advantage of this course, it is strongly recommended to all attendees to install pior to this course the R2021a version (or latest) of MATLAB/Simulink with Simscape library.

English will be the working language

Course Description

The accurate modeling of a photovoltaic (PV) source is of paramount importance for analysing the behavior of PV systems operating in outdoor, where non-uniform conditions may appear among subsection of the same PV field. For example, residential PV applications are frequently subjected to the shading effect which may have a catastrofic impact on the energy production of the PV field.
This one day course provides the basic knowledge of how to model a PV sources with the most suitable equivalent electrical circuit and for different levels of granularity: single solar cell, panel, string of panels, arrays, also by accounting the presence of by-pass diodes.
The using of such numerical and circuital models allows to evaluate the impact of effects such as shadowing, dust, PV panel degradation, not only on the energy production of the PV system but also for detecting critical operating conditions, e.g the identification of hot-spots in the PV panels, as well as for better analysing the behaviour of the power converter connected to the PV field in a more realistic conditions for the source.
Guidelines on how to configure the basic circuits with PV sources in MATLAB/Simulink envoriment will be learned during the lab experiences planned in this one day course.

Course Instructors

Giovanni Petrone

SmartGY SUM

cenidet®
Centro Nacional de Investigación y Desarrollo Tecnológico

SPECIAL COURSE

Optimization Theory Applied to Power Electronic and Energy Management in Microgrids

SmartGY SUM

HORIZON 2020 | INNOVATIVE TRAINING NETWORKS

ETN 955614
Marie Skłodowska-Curie Actions (MSCA)
Innovative Training Networks (ITN)
H2020-MSCA-ITN-2020

6 July 2023
Lisboa, Portugal

COURSE PROGRAM

8:45 Welcome and Course Introduction

9:00 Basic concepts and applications about optimization
1. Review of concepts about optimization
2. Optimization approaches for designing power electronic interfaces and applications in microgrids

10:15 *Coffee break*

10:45 Metaheuristic Methods for Optimization
1. Review of metaheuristic methods for optimization problems
2. Particle Swarm Optimization (PSO)
3. Non Sorted Genetic Algorithm (NSGA)

13:00 *Lunch*

14:30 Practical Applications. Part 1
1. Basic examples to start solving optimization problems
2. Calculus of fire angles in a SHE PWM for an inverter
3. Determination of components values for an LCL filter for an inverter

16:30 *Coffee break*

16:45 Practical Applications. Part 2
1. Solving a problem of MPPT in a PV system with partial shading
2. Solving a problem of energy management for a microgrid
3. Final comments and remarks

19:00 End of Course

Prerequisites: Basic knowledge in the field of electrical and power electronics engineering, as such as in the use of MatLab. Registered attendees will receive a list of recommended literature and slides. To take full advantage of this course, it is strongly recommended to all attendees to install, prior to this course, MatLab/Simulink with Simscape library and PSIM or similar software.

English will be the working language

COURSE DESCRIPTION

Power electronic interfaces are key components in different applications. In general, there exist well known procedures to select all of the components of a power electronic converter, taking into account criteria like: gain, current ripple, harmonic content, etc.; but what happen if we want to take into account, in the design process, another criteria like: efficiency, power quality, cost, volume, etc. Clearly these criteria need to be maximized/minimized, taking into account some physical constraints; this means that the design can be managed as a multi-objective optimization problem.

Regarding microgrids, these gather a number of loads and DERs, and their operation is carried out by an energy management system (EMS). In a general perspective, the microgrid operation must accomplish generalized objectives like the operation cost. In this regard the EMS needs to define the optimal energy dispatch of every DER and/or load, in order to maximize or minimize the selected objectives. This can be also dealed as an optimization problem subject to physical constraints.

Then, the course emphasizes in the importance of the optimization approach for designing power electronic interfaces and microgrid applications, and provides concepts and metaheuristic methods, useful to solve optimization problems. The course addresses some basic problems related with power electronics and microgrids in order to attendees get basic understanding of this approach and can be able to apply it to more complex problems.

COURSE INSTRUCTORS

SmartGY SUM

CHERNIHIV POLYTECHNIC NATIONAL UNIVERSITY

Special Course

PCB design techniques for power electronic devices to ensure reliability and resilience

SmartGY SUM

HORIZON 2020

INNOVATIVE TRAINING NETWORKS

ETN 955614
Marie Skłodowska-Curie Actions (MSCA)
Innovative Training Networks (ITN)
H2020-MSCA-ITN-2020

6 July 2023
Caparica, Portugal

Course Program

8:45 Welcome and course introduction

9:00 Introduction: reliability and resilience of PCBs (Oleksandr Velihorskyi)

1. Factors affecting reliability and resilience of electronic device

09:45 PCB – parameters and characteristics (Oleksandr Velihorskyi)

1. Electrical parameters (traces, polygons)
2. Mechanical parameters (isolation, materials, mounting)

11:00 *Coffee break and discussion*

11:30 Basic considerations of EMC in PCB design (Oleksandr Husev)

1. Definition of EMC
2. “Physics origins” of PCB design
3. EMC considerations for mixed signals and power electronic (PE) PCBs

13:30 *Lunch*

14:30 Practical application. Altium Designer (Oleksandr Velihorskyi)

1. Tips and tricks in Altium Designer
2. Useful techniques in Altium for PE PCBs.

16:00 *Coffee break and discussion*

16:30 Practical application. EMC improvements (Oleksandr Velihorskyi and Oleksandr Husev)

1. Example of “bad PCB”
2. Experiments with “bad” PCB
3. EMC improvements of presented PCB
4. Presentation and discussion of results

19:00 End of Course

Prerequisites: basic knowledge of electrical engineering and power electronics, PCB design. Registered attendees will receive a list of recommended literature, slides and a practical application handbook.

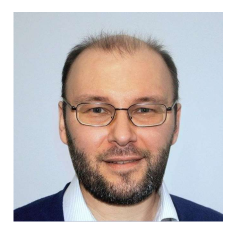
English will be the working language

Course Description

All modern electronic devices, including devices of power electronics, are based on printed circuit boards (PCBs). PCB is a key part of maintaining the device reliability and resilience, so the design of the board that takes into account all factors affecting the proper operation of PCB (thermal, mechanical, electromagnetic, etc.) is one of the most important practical competencies of researchers and developers in the field of power electronics.

The course will convey the main issues related to the development of PCB for power electronic devices, including reliability, resilience, and EMC issues. The first theoretical part will be devoted to the main factors that affect on reliability and resilience of PCB for power electronic devices, the basic consideration of EMC for PCB design. A lot of practical examples based on power and mixed-signal circuits and boards will help to understand theoretical explanations and utilize them in real life.

After that, the practical application of ECAD software Altium Designer for the design of reliable PCBs for power electronic devices will be considered to consolidate the theoretical expositions and provide useful tips and tricks that facilitate the design of complex boards. Finally, participants will emloy obtained new competencies on the practical example of PE PCB that was improperly designed. After a set of experiments, they should identify the main drawbacks and improve its design.



Oleksandr Velihorskyi

Oleksandr Husev

Special Course

Power electronics in electric vehicle charging infrastructure

6 July 2023
Caparica, Portugal

Course Program

9:00 Electric vehicle charging infrastructure overview

1. Basic concepts and standards
2. Different paradigms and implementations trends

10:45 *Coffee break*

11:15 Electric vehicles and electric vehicle chargers

1. Elements and topologies

13:00 *Lunch*

14:30 Electric vehicle chargers

1. AC and DC Protocols
2. OCPP and OCPI
3. Vehicle to grid and grid to vehicle

16:30 *Coffee break*

16:45 **Practical Applications**

1. Vehicle to grid / Grid to vehicle simulation

19:00 **End of Course**

Prerequisites: Basic knowledge in the field of electrical and power electronics engineering, as such as in the use of MatLab. Registered attendees will receive a list of recommended literature and slides. To take full advantage of this course, it is strongly recommended to all attendees to install, prior to this course, MatLab/Simulink with Simscape library and PSIM or similar software.

English will be the working language

Course Description

Plug-in electric vehicles, which include both battery electric vehicles and plug in hybrid electric vehicles are more efficient and less polluting than the majority of internal combustion engine vehicles. They will need to increase market shares to have an impact on urban air pollution, energy consumption, and climate change. The success of electric vehicle technology is partially reliant on the development of recharging infrastructure, among other constraints. Developing dedicated infrastructure can encourage more consumers to purchase electric vehicles and allow them to drive more electric kms.

The course will deal with the basic knowledge related to the electric vehicle charging infrastructure, including concepts, standards, paradigms, structures, topologies, protocols… An important characteristic, the vehicle to grid and grid to vehicle capabilities, which could lead to big benefits for grid stability, is also presented.

After that, a practical implementation will be conducted to consolidate the theoretical expositions, a vehicle to grid / grid to vehicle simulation.

Course Instructors

Víctor Miñambres

SmartGY SUM

NOVA UNIVERSIDADE NOVA DE LISBOA

NOVA NOVA SCHOOL OF SCIENCE & TECHNOLOGY

Special Course

Research Ethics and Proposal writing

SmartGY SUM

HORIZON 2020

INNOVATIVE TRAINING NETWORKS

ETN 955614
Marie Skłodowska-Curie Actions (MSCA)
Innovative Training Networks (ITN)
H2020-MSCA-ITN-2020

05 July 2023
Lisboa (Caparica), Portugal

Course Program

14:00 Notion and need of soft skills

14:30 Ethics and Responsible Research and Innovation
1. Basic concepts
2. Forms of misconduct
3. Professional responsibility
4. Policies
5. Ethics and cultural diversity
6. Open access
7. Inclusion equality

16:30 *Coffee break*

16:45 Funding acquisition and proposal writing
1. Identification of funding sources
2. Proposal writing
3. Roles in project consortium
4. Proposal evaluation
5. Negotiation

19:00 End of Course

Prerequisites: Basic knowledge of research methods and practices.

Registered attendees will receive a list of recommended literature, slides and files to complete practical work.

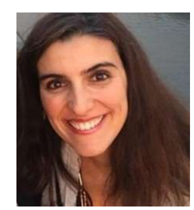
English will be the working language

Course Description

To enhance the training of early stage researchers, it is essential to provide them with not only technical skills but also soft and transferable skills. These skills play an increasingly vital role in ensuring a successful career. To achieve this, the training programs should include crucial issues such as research ethics and research proposal writing.
The first part of this course focuses on ethics and responsible research and innovation (RRI). This would give the students a comprehensive understanding of the challenges and mechanisms available in this field. While the level of RRI awareness may vary across different fields, there is a growing demand for accountability in society, especially when public funds support research. Additionally, the widespread use of the internet and social networks has made it easier to report cases of research misconduct, including plagiarism and fabrication. The emergence of "criminal science publishing gangs" has also highlighted the need for increased awareness and vigilance in the research community.
The second part of the course concentrates on another critical skill for a successful research career: attracting funds to support research activities. This involves writing research proposals, which require different skills than technical paper writing. Therefore, the course covers the main stages of the proposal writing process and provide practical examples to support learning.

Course Instructors

Luis M. Camarinha-Matos



Filipa Ferrada

Special Course

Entrepreneurship and Social Entrepreneurship in Local Energy Production and Consumption: Innovative Business Models for Energy Communities

HORIZON 2020

INNOVATIVE TRAINING NETWORKS

ETN 955614
Marie Skłodowska-Curie Actions (MSCA)
Innovative Training Networks (ITN)
H2020-MSCA-ITN-2020

30 January 2024
Salerno, Italy

Course Program

8:45 **Welcome and course introduction**

9:00 **Energy Communities**

1. The concept of Energy Community and its evolution
2. Energy Community policy framework at the EU level
3. Key elements for Energy Communities business model
4. Techniques and approaches for designing and analysing business models: the business model canvas

10:30 *Coffee break*

11:00 **Energy Communities business models**

1. Types of business models for Energy Communities
2. Financial mechanisms
3. Barriers and enablers

13:00 *Lunch*

14:30 **Exploring innovative business models for Energy Communities: case studies**

16:15 *Coffee break*

16:30 **Practical application using the business model canvas approach**

18:30 **End of course**

Prerequisites: Registered attendees will receive a list of recommended literature, slides and a practical application handbook.

English will be the working language

Course Description

The course aims to provide knowledge and insights on the business model concept with a focus on Energy Communities. Energy Communities are rising in relevance as their crucial role in shifting the actual energy system paradigm by accelerating RES production and citizens' active participation in the energy market. Energy Communities can operate according to different business models and generate different benefits based on their governance, services performed and technologies applied. In the first part, the course intends to explore the evolution of the Energy Community concept, the EU policy framework and the key elements shaping the Energy Community business model. The approaches and techniques used to design and analyse business models are also described with a focus on the business model canvas approach. Energy Communities business models will be investigated, considering benefits generated, i.e., social, environmental and economic benefits; financial mechanisms; barriers and enablers that can affect their development. In the second part of the course, a set of case studies on innovative Energy Community business models will be presented. Finally, during the practical application, ESRs will be involved in a practice exercise focusing on designing business models for their technologies/solutions by applying the business model canvas approach.

Course Instructors

Edoardo Croci
Professor of practice
at Bocconi University

Annamaria Bagaini
Researcher at
Bocconi University

SmartGY SUM

Hochschule Bonn-Rhein-Sieg
University of Applied Sciences

Special Course

Power Converters for Electrolyser Systems

SmartGY SUM

HORIZON 2020

INNOVATIVE TRAINING NETWORKS

ETN 955614
Marie Skłodowska-Curie Actions (MSCA)
Innovative Training Networks (ITN)
H2020-MSCA-ITN-2020

30. January 2024
Salerno, Italy

Course Program

8:45 **Welcome and Course Introduction**

9:00 **Introduction to Electrolysers**
1. Types of Hydrogen
2. How does it generate?
3. Different types of electrolyser cells

9:30 **Review of electrical requirements**
1. Power grid (today and future look)
2. Hydrogen electrolyser
3. Grid connection: Isolated, Non-isolated, Which is feasible!

10:00 **Semiconductor technologies**
1. Thyristor
2. IGBT
3. WBG- SiC

10:30 *Coffee break*

11:00 **System configurations and topologies**
1. System - state of the art
2. Thyristor based
3. Active Filter
4. Front-end topologies (IGBT/SiC-MOSFET based)

13:00 *Lunch*

14:30 **Modelling electrolyser systems**
1. Modelling of converters
2. Modelling of electrolysers stack (electrical part)

16:15 *Coffee break*

16:30 **Condition monitoring of electrolysers**

17:30 **Conclusive remarks**

18:30 **End of Course**

Prerequisites: Background in the field of electrical engineering and basic skills in programming language for solving numerical problems. To take full advantage of this course, it is strongly recommended that all attendees install prior to this course the latest MATLAB/Simulink with Simscape library and PLECS.

English will be the working language

Course Description

Hydrogen generation plays a pivotal role in transitioning to a clean energy future. Power converters are crucial in this process, as they adapt and control the flow of electrical energy from renewable sources to the electrolysers that produce hydrogen, optimising the efficiency and reliability of hydrogen generation. This course will delve into different aspects of power converter designs to meet the requirements of the electric grid side and the electrolysers. The state-of-the-art converters and the possible use of wide-band-gap devices will be discussed and illustrated with examples. Further, the aspect of condition monitoring will also be discussed comprehensively.

Course Instructors

Prof. Dr.-Ing. Marco Jung
Professorship for Electromobility and Electrical Infrastructure.
Bonn-Rhein-Sieg, University of Applied Sciences, Sankt Augustin, Germany.
and
Head of the Department,
Power Converters and Electric Drives, Fraunhofer IEE, Kassel, Germany

Dr.-Ing. Bikash Sah
Group Leader, Power Electronics for Mobility and Electrochemical Systems
Bonn-Rhein-Sieg, University of Applied Sciences, Sankt Augustin, Germany

Kiel University
Christian-Albrechts-Universität zu Kiel

Faculty of Engineering

Special Course

Smart Transmission and Smart Transformer

ETN 955614
Marie Skłodowska-Curie Actions (MSCA)
Innovative Training Networks (ITN)
H2020-MSCA-ITN-2020

31 January 2024
Salerno, Italy

Course Program

8:45 **Welcome and Course Introduction**

9:00 **Introduction to Smart Transformer**

1. Challenges in electric grid
2. From solid-state transformer to Smart Transformer
3. Advanced services of Smart Transformer

10:30 *Coffee break*

11:00 **Operation and Control of ST-based Meshed Grid**

1. ST-based meshe grid configurations
2. ST topologies in meshed and hybrid grids
3. Performance and resilience improvements by meshed grid operation
4. LVac grid fault management

13:00 *Lunch*

14:30 **HVDC ancillary services**

1. HVDC vs. HVAC
2. HVDC services to the AC grid
3. Advancements of HVDC services

16:15 *Coffee break*

16:30 **Exercises: PLECS/MATLAB simulations**

1. Ancillary services

18:30 **End of Course**

Prerequisites: Basic knowledge on electrical engineering, power electronics and control. Elementary knowledge on MATLAB and PLECS is also expected.

English will be the working language

Course Description

The use of DC in transmission and distribution is leading the way to more efficient and controllable grids and it reduces the size and cost of the infrastructure. The AC systems are already established, and provide reduced challenges in protection systems and voltage adaptions. The future would be a coexistence of AC and DC infrastructures at various voltage levels leading to a hybrid system using the advantages of both. As the renewable energy source and electric vehicle penetrations are increasing in the distribution levels both MV and LV systems also require a substantial transformation towards a smart behaviour. The Smart Transformer has emerged as a solution in this scenario for enabling the hybrid grid in the distribution grid and smart transmission in the form of HVDC systems is also gaining importance worldwide.

This course is divided into three different sections, and in the first section of this course, the Smart Transformer will be introduced. Further, the operation and control of Smart Transformer in meshed and hybrid grids will be discussed in details. In addition, recent advancements in HVDC ancillary services will be shown and an exercise on ancillary services with the presented assets will be held in the last hands-on part of the course.

Course Instructors

Dr.-Ing. Marius Langwasser

SmartGY SUM

Consiglio Nazionale delle Ricerche

INM ISTITUTO DI INGEGNERIA DEL MARE
INSTITUTE OF MARINE ENGINEERING

Special Course

Maximum Power Point Tracking (MPPT) techniques for renewable energy sources

SmartGY SUM

HORIZON 2020 · INNOVATIVE TRAINING NETWORKS

ETN 955614
Marie Skłodowska-Curie Actions (MSCA)
Innovative Training Networks (ITN)
H2020-MSCA-ITN-2020

31 January 2024
Salerno, Italy

Course Program

8:45 **Welcome and Course Introduction**

9:00 **Overview of PV and wind generators' characteristics**
1. Photovoltaic I-V, P-V curves under uniform irradiation and partial shading
2. Wind generator T-ω , P-ω curves for varying wind speed

9:30 **Overview of power electronic converters for PV and WGs**
1. Typical topologies for PV
2. Typical topologies for WGs

10:30 *Coffee break*

11:00 **Iterative MPPT techniques**
1. Application to PV
2. Application to WGs

11.45 **Model-based MPPT techniques**
1. Application to PV
2. Application to WGs
3. Other applications

13:00 *Lunch*

14:30 **Practice Exercises part 1**
1. Set up of Matlab/Simulink models for PV and WGs simulation
2. P&O-based MPPT of PV (Lab1)
3. LUT-based MPPT of WGs (Lab2)

16:15 *Coffee break*

16:30 **Practice Exercises part 2**
1. Model-based MPPT of PV (Lab3)
2. Model-based MPPT of WGs (Lab 4)
3. Final comments and remarks

18:30 **End of Course**

Prerequisites: Background in the field of electrical and electronics engineering and basic skills in programming language for solving numerical problems. Registered attendees will receive a list of recommended literature, slides and files to complete practical labs on MATLAB and Simulink. <u>To take full advantage of this course, it is strongly recommended to all attendees to install pior to this course the R2021a version (or latest) of MATLAB/Simulink with Simscape library.</u>

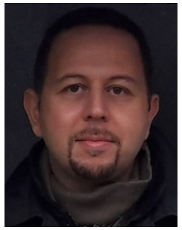
English will be the working language

Course Description

Maximum Power Point Tracking (MPPT) techniques are of paramount importance to exploit photovoltaics (PV) and wind generators (WGs) optimally, since they impact on the yielded energy from such renewable sources.
The course aims at providing knowledge and insights on the most relevant approaches (iterative and model-based) for the MPPT of renewable energy sources, such as PV and WGs. ESRs will learn how MPPT algorithms compute and provide suitable references to the power converters interfacing the sources with the load or power grid. ESRs will also be involved in practice exercises based on Matlab/Simulink simulations.

Course Instructors

Maria Carmela Di Piazza, PhD
Senior Research Scientist
Institute of Marine Engineering (INM)
National Research Council (CNR)
Palermo, Italy



Massimiliano Luna, PhD
Research Scientist
Institute of Marine Engineering (INM)
National Research Council (CNR)
Palermo, Italy

Karlsruher Institut für Technologie

SPECIAL COURSE

Real-time modelling and power in the loop testing

ETN 955614
Marie Skłodowska-Curie Actions (MSCA)
Innovative Training Networks (ITN)
H2020-MSCA-ITN-2020

01 Feb 2024
Salerno, Italy

COURSE PROGRAM

8:45 **Welcome and Course Introduction**

9:00 **Introduction on Real Time Simulation**
1. Reason for real time simulation
2. Overview of the current digital real time simulators: pro & cons

9:30 **Real Time Simulation Modelling: a matter of trade-off**
1. Accuracy vs. computational requirements: an introduction
2. Power Electronics Modelling: power converter example
3. Power Systems Modelling: dynamic load example

10:30 *Coffee break*

11.00 **Exercise on Real Time Modelling: let's apply it!**
1. Frequency variation case
2. Low-Voltage Ride Through case

12.30 **Introduction on Power Hardware In the Loop (PHIL)**
1. Reasons for Power Hardware In the Loop
2. Main components for PHIL
3. Revision of the IEEE Working Group P2004 on PHIL

13:00 *Lunch*

14:30 **PHIL Stability vs. Accuracy**
1. Stability and accuracy issues in PHIL evaluation
2. Classical stability approaches
3. Impedance-based stability approaches
4. Examples and applications

16:15 *Coffee break*

16:30 **Exercises on PHIL Stability**
1. Simple impedance case
2. Converter-connected case
3. Final Remarks

18:30 **End of Course**

Prerequisites: Background in the field of electrical and electronics engineering and basic skills in programming language for solving numerical problems. Registered attendees will receive a list of recommended literature, slides and files to complete practical labs on MATLAB and Simulink. To take full advantage of this course, it is strongly recommended to all attendees to install pior to this course the R2021b version (or latest) of MATLAB/Simulink with Simscape library.

English will be the working language

COURSE DESCRIPTION

To achieve a fast and effective energy transformations, new energy technologies are continuously developed. The main bottleneck for introducing them on the market is represented by their testing in realistic grid conditions, that usually involves the construction and installation of prototypes in the electrical grid. This may result to be time- and cost-expensive, and it may create disruption to local customers (e.g., during faults).
Real time simulation and power hardware in the loop enable a faster, safer and more flexible testing of the prototype hardware in realistic grid conditions replicated in a lab. Through the simulated real time networks, the hardware can be tested in any grid conditions, without waiting for them occuring naturally (e.g., day/night, winter/summer). This course provides an introduction on the real time modelling and on the concept of Power Hardware In the Loop. Accuracy and Stability concerns will be addressed for both topics, focusing on their trade-off. The course will provide 2 simulative examples, allowing the participants to exercise and become proficient on both topics.

COURSE INSTRUCTORS

TT-Prof. Giovanni De Carne
Head of Power Hardware In the Loop Lab
Institute for Technical Physics
Karlsruhe Institute of Technology (KIT)
Karlsruhe, Germany

UNIVERSITÀ DEGLI STUDI DI SALERNO

SPECIAL COURSE

Battery modelling and identification based on EIS

ETN 955614
Marie Skłodowska-Curie Actions (MSCA)
Innovative Training Networks (ITN)
H2020-MSCA-ITN-2020

1st February 2024
Fisciano (SA), Italy

COURSE PROGRAM

8:45 **Welcome and course introduction**

9:00 **Lithium-ion battery modelling**

1. Battery basics
2. Time-domain response to PCT
3. Equivalent circuit model (ECM)

10:30 *Coffee break*

11:00 **Practice 1: Battery time-domain simulation**

4. MATLAB implementation of a ECM
5. Simulation of PCT and UDDS response

12:00 **Electrochemical impedance spectroscopy (EIS) of Li-ion batteries**

6. Principle, theoretical premises and good practice
7. Equipment and stimuli
8. EIS-oriented battery modelling

13:00 *Lunch*

14:30 **Model-based identification of EIS response**

9. Fitting the complex impedance response
10. MATLAB tools, examples

15:15 **Practice 2: Model-based identification**

11. Identification of a simulated frequency-domain battery response in MATLAB

16:15 *Coffee break*

16:30 **Practice 3: Model-based identification (2)**

12. Identification of experimental data in MATLAB

17:30 **Application to monitoring and diagnosis**

13. Temperature, SoC and SoH dependence of EIS battery response
14. Diagnostic perspectives

18:30 **End of Course**

Prerequisites: Background in the field of electrical or electronic engineering; basic skills in Matlab programming. Registered attendees will receive a list of recommended literature, slides and files to complete practical labs on MATLAB and Simulink. To take full advantage of this course, attendees are recommended to bring their laptop with MATLAB/Simulink installed.

English will be the working language

COURSE DESCRIPTION

This is a one-day introductory course on Lithium-ion battery modelling and identification, with particular focus on the electric point of view. Batteries are modelled in time as well as in frequency domain. This lets the attendees learn how to simulate the battery behaviour through a simple equivalent circuit, and how to identify circuit parameters from the typical frequency-domain response obtained from the Electrochemical Impedance Spectroscopy (EIS). During the Practice sessions, attendees will use Matlab on their own laptop to test the proposed approaches in guided excercises. Monitoring and diagnosis perspectives based on EIS are finally presented.

COURSE INSTRUCTORS

Walter Zamboni, Ph. D.
Associate professor
DIEM
Università degli studi di Salerno
Fisciano (SA), Italy

SmartGY SUM

SEXTANT Intellectual Property

Special Course

Patents and intellectual property rights (Soft Skill)

SmartGY SUM

HORIZON 2020

INNOVATIVE TRAINING NETWORKS

ETN 955614
Marie Skłodowska-Curie Actions (MSCA)
Innovative Training Networks (ITN)
H2020-MSCA-ITN-2020

02 February 2024

Salerno, Italy

Course Program

8:45	**Welcome and Course Introduction**
9:00	**Patents and Intellectual property**
	1. Introduction to intellectual property
	2. Content of a patent
	3. International patent protection
	4. Patenting Procedures
10:30	*Coffee break*
11:00	**Practical Applications (part I)**
	5. Claim drafting
13:00	*Lunch*
14:30	**Practical Applications (part II)**
	6. Patent searches
16:00	**End of Course**

Prerequisites:

Basic knowledge of research methods and practices. Registered attendees will receive a list of recommended literature, slides and files to complete practical work.

English will be the working language

Course Description

Innovation is the driving force behind global technological and industrial development. The common perception that intellectual property, especially patents, only matters for industrially advanced nations or high-tech sectors is a serious misunderstanding: patented innovations permeate our daily lives in seemingly inconceivable ways.

A strategic approach to competition necessarily involves protecting innovative technical solutions through patents, even for small and medium enterprises. Intellectual property, especially patents, should not be viewed as an expense but rather as an investment. A portfolio of patents or intellectual property represents economic value and a competitive advantage: intellectual assets contribute to company valuation, access to tax benefits, and funding opportunities.

The course aims at providing knowledge and insights on the most relevant aspects related to patents and intellectual property rights.

Course Instructors

dr. Andrea Scilletta
Industrial property rights Consultant

IP Sextant s.r.l.
Via Antonio Salandra, 18 - 00187 Roma
Via Roberto Lepetit, 8/10 - 20147 Milano
Via Francia, 21/C - 37135 Verona

Special Course

Innovation management in the power electronics industry
The technology-product-market dynamic

17. Sep 2024
Paris, France

Course Program

9:00	**Welcome and Course Introduction**
9:30	**Introduction of participants**
	1. 2 min per person, on interests and expectations
9:45	**Introduction of BrightLoop**
	1. Product lines
	2. Applications
10:15	**Lab tour**
11:45	*Coffee break*
11:00	**Some theory on innovation types**
	1. Incremental and breakthrough
	2. External and internal
	3. Technology-pushed and application-pulled
	4. Risk management strategies to unleash ambitions
11:30	**Platform strategy**
	1. Maximizing component reuse
	2. Software-defined power
	3. Scale-up replication strategy
12:15	**Feedback of participation**
	1. 2 min per person, with an individual learnings
12:30	**Conclusive remarks**
13:00	*Lunch*
14:30	**End of Course**

Prerequisites: Passion on power electronics and innovation !

English will be the working language

Course Description

Innovation management in the power electronics industry - the technology-product-market dynamic

Power electronics is a domain prone to innovation, with a lot of different related fields, with deep technical challenges.

The innovation can be divided into 3 different main categories, which need to be combined and globally optimized to design the best products :

Topologies, with a lot of abstract, theory related challenges
Components, related with a very wide range of technologies
System, ie how the components are combined together in topologies to fit the application's requirements

As no individual nor organization has enough ressources to handle the development of all aspects, all components autonomously, an ecosystemic approach is mandatory.

We will explore the loop of emerging technologies enabling new market opportunities, and emerging applications funding back new technologies, and how to surf these waves to innovate best.

Course Instructors

Florent Liffran
CEO
BrightLoop

SmartGY SUM

ECPE

Special Course

Industry-Oriented Research in Power Electronics in Europe

SmartGY SUM

ETN 955614
Marie Skłodowska-Curie Actions (MSCA)
Innovative Training Networks (ITN)
H2020-MSCA-ITN-2020

18. Sept 2024
Paris, France

Course Program

8:45	**Welcome and Course Introduction**
9:00	**Introduction to ECPE Power Electr. Research Network** 1. Mission and Members 2. Pre-competitive Joint Research 3. Expert Workshops & Advanced Training 4. Public Relations for Power Electronics
9:30	**ECPE Joint Research Programme** 1. Structure and Procedure 2. Intellectual Property Rights (IPR) 3. Project Examples
10:30	*Coffee break*
11:00	**Research and Innovation Actions in the European ECSEL/KDT/CHIPS Joint Undertaking** 1. Joint Undertaking PPP - Structure and Mission 2. Technology Readiness Levels (TRL) 3. Project Examples
12.00	**Industry-Oriented R&D Project - How to Apply?** 1. Innovation, Step Beyond State-of-the-Art 2. Project Plan w. Gantt Chart, Deliverables, Milestones
13:00	*Lunch*
14:00	**Exercise in Small Groups: Develop a Project Proposal**
15:30	*Coffee break*
16:00	**Present your Project Proposal** 1. PPT Presentations of the Teams 2. Evaluation of the Proposals by the Participants according to a List of Criteria
17:30	**Conclusive remarks**
18:00	**End of Course**

English will be the working language

Course Description

ECPE is an industry-driven Research Network in the field of Power Electronics with more than 230 member organisations from industry and research institutes. The member companies represent the value chain of power electronics, from the materials and power devices up to the systems and applications.
The course will highlight industry-oriented R&D in Power Electronics in Europe in two domains:

- The ECPE Network-internal Joint Research Programme is based on research contracts with ECPE Competence Centres jointly financed by the ECPE partner companies.
- Publicly funded R&D projects in the Europ. KDT/CHIPS Joint Undertaking as a Public-Private-Partnership.

Course Instructor

Dipl.-Phys. Thomas Harder
General Manager of
ECPE European Center,
for Power Electronics,
Nuremberg, Germany.
www.ecpe.org

SmartGY
S U M

CERGY PARIS
UNIVERSITÉ

SPECIAL COURSE

Sensorless Control of AC Drives

SmartGY
S U M

HORIZON 2020

INNOVATIVE TRAINING NETWORKS

ETN 955614
Marie Skłodowska-Curie Actions (MSCA)
Innovative Training Networks (ITN)
H2020-MSCA-ITN-2020

September 18th 2024
Paris, France

COURSE PROGRAM

9:00 Introduction to the control of AC drives
1. Basics on AC drives, their control and their reliability
2. Healthy control of a PMSM drive
3. Sensorless faulty control of a PMSM drive

10h30 *Coffee break*

11:00 Healthy control of a PMSM drive
1. Introduction – Background
2. Validation of the PMSM model
3. Validation of the PI-based PMSM controller

13:00 *Lunch*

14:00 HF injection based sensorless controller
1. Introduction – Background
2. HF signal injection and frequency analysis of the feedbach currents
3. Signal processing and rotor position estimation

15:30 *Coffee break*

16:00 Back-EMF based sensorless controller
1. Introduction – Background
2. Back-EMF estimation
3. Signal processing and rotor position estimation

18:00 End of Course

Prerequisites: A minimum background is necessary in the field of electrical engineering, especially electrical AC machines, power electronics, their modeling and control. <u>To take full advantage of this course, it is strongly recommended that all attendees install prior to this course the MATLAB/Simulink.</u>

English will be the working language

COURSE DESCRIPTION

The objective of this course is to provide some basics on the sensorless control of AC drives. The case of synchronous machine will be focused on. Then, when a fault appears on the rotor position, and to ensure the service continuity of the system, this position is estimated using dedicated sensorless estimation techniques.

The first estimation technique that will be investigated in this course is based on high frequency signal injection for standstill and low speed operating conditions. The second one is adapted for higher speed and is based on the motor model that estimates the back-EMF signals, from which in turn the position will be extracted.

The first time slot of this course will provide some general discussion about the AC drives and their reliability problematics. In the other slots will be organized as Matlab/Simulink labs: validation of a PMSM drive controller in healthy mode, the HF injection based sensorless controller and finally a back-EMF based sensorless controller.

COURSE INSTRUCTOR

Lahoucine ID-KHAJINE

Full Professor
CY Cergy-Paris University
SATIE Laboratory
Head of MT2E department

SmartGY
SUM

Universidad de Sevilla

POWERUS
Power Electronics and Sustainable Energy Group Universidad de Sevilla

SPECIAL COURSE

Recent Advances In Model Predictive Control Of Power Converters And Drives

SmartGY
SUM

HORIZON 2020
INNOVATIVE TRAINING NETWORKS

ETN 955614
Marie Skłodowska-Curie Actions (MSCA)
Innovative Training Networks (ITN)
H2020-MSCA-ITN-2020

19. Sept 2024
Paris, France

COURSE PROGRAM

8:45 **Welcome and Course Introduction**

9:00 **Introduction to Finite Control Set Model Predictive Contro (FCS-MPC)**

1. Basic principles of FCS-MPC
2. Application examples

9:30 **FCS-MPC algorithm with one prediction horizon**

1. Current control for an RL Load with a two-level converter
2. Averaged switching frequency control
3. Multi-objective problem for the Neutral Point Clampe Three-level converter

10:30 *Coffee break*

11:00 **Exercise on FCS-MPC with one prediction horizon: Case study**

1. Current control for an RL Load with a two-level converter
2. Averaged switching frequency control

13:00 *Lunch*

14:00 **FCS-MPC algorithm with long prediction horizon**

1. Definition and basic characteristics
2. Long Prediction Horizon FCS-MPC (LPH-FCS-MPC): ILS transformation
3. Sphere Decoding Algorithm (SDA)

15:30 *Coffee break*

16:00 **Exercise on FCS-MPC with long prediction horizon: Case study**

1. SDA-FCS-MPC current control for an RL Load with a two-level converter

17:30 **Conclusive remarks**

18:00 **End of Course**

Prerequisites: Background in the field of electrical and power electronics engineering and basic skills in programming with Matlab-Simulink. To take full advantage of this course, it is strongly recommended to install pior to this course the R2019b version (or latest) of MATLAB/Simulink with Simscape and SimElectrical library.

English will be the working language

COURSE DESCRIPTION

Finite Control Set Model Predictive Control (FCS-MPC) is one of the most promising control strategies for power converters. On the one hand, for short prediction horizon the FCS-MPC formulation fits with the discrete nature of power converters, allowing its general use for any application. On the other hand, several studies highlight the benefits that long prediction horizons achieve in terms of closed-loop stability, harmonic distortions, and switching losses. However, the practical implementation is not straightforward due to its inherently high computational burden.

The course will address both the basics for FCS-MPC implementation with short and long prediction horizon. The course will introduce the theoretical aspects of FCS-MPC with short prediction horizon and the formutation to achieve a practical implementation with a long prediction horizon. Practical examples with Matlab-Similink will be also developed by the participants to clarify the concepts

COURSE INSTRUCTOR

Dipl.-Phys. Sergio Vazquez
Associate Professor,
Universidad de Sevilla.
www.us.es

SmartGY SUM

ALMA MATER STUDIORUM
UNIVERSITÀ DI BOLOGNA

Special Course

Integration of photovoltaic and battery storage systems for EV charging infrastructures

SmartGY SUM

HORIZON 2020

INNOVATIVE TRAINING NETWORKS

ETN 955614
Marie Skłodowska-Curie Actions (MSCA)
Innovative Training Networks (ITN)
H2020-MSCA-ITN-2020

19 September 2024

Paris, France

Course Program

9:00	**Beginning of the Lecture**
9:30	**Photovoltaic Systems (PV) and data source**
	1. Solar energy and PV technology
	2. Market trends
	3. PV database
10:30	*Coffee break*
11:00	**Electric Vehicle charging demand**
	1. Charging stations and electric vehicles
	2. EV battery charging behavioral models
	3. Algorithms to calculate EV charging demand
12:00	**Battery Storage System (BESS)**
	1. BESS technology and market trends
	2. BESS modeling
13:00	*Lunch*
14:00	**Introduction to Optimization Problems**
	1. System modeling
	2. System's KPI and optimization algorithms
15:30	*Coffee break*
16:00	**Practical training on system modeling and sizing**
	1. Introduction to Python and Jupiter Notebook
	2. Data analysis and optimization tools
	3. Development of a sizing dashboard using Python
17:30	**Conclusive remarks**
18:00	**End of Course** *(the lecture may end before if needed)*

Prerequisites: Background in the field of electrical engineering and basic skills in programming language for solving numerical problems. To take full advantage of this course, it is strongly recommended that all attendees install prior to this course the latest ANACONDA distribution: https://www.anaconda.com/download.

English will be the working language

Course Description

The growing penetration of distributed renewable sources and the increasing number of electric vehicle registrations play a significant role in energy transactions. However, the ever-larger share of intermittent renewables, combined with the high and uncontrolled aggregate EV charging demand, requires an evolution toward new planning and management paradigms of electrical systems. In this context, this course will provide an overview of the possible solutions to optimize the integration of aggregate EV charging with renewable sources in urban scenarios. The first part of the course will analyze the system elements, such as photovoltaic plants, EV charging hubs, and stationary storage systems. Tools for modeling and optimizing system sizing in open-source environments will then be provided.

Course Instructors

Dr.-Ing. Francesco Lo Franco
Assistant Professor.
Department of Electrical Electronic and Information Engineering (DEI)
University of Bologna, Italy

SPECIAL COURSE

Power MOSFET gate driver and thermal design

20. Sept 2024

Paris, France

COURSE PROGRAM

9:00 **Introduction of the course**

9:05 **Power MOSFET description and modeling**

1. Physical structure
2. Equivalent power circuit
3. Mathematical model

9:30 **Power MOSFET switching process**

1. Turn-on process
2. Turn-off process
3. Required gate charge for switching process

10:00 **Power MOSFET Thermal design guidelines**

1. Power MOSFET Losses
2. Thermal vs Electrical model
3. Heatsink selection

10:30 *Coffee break*

11:00 **Power MOSFET Gate Driver**

1. Why a Gate Driver is necessary?
2. Fundamental elements of a gate driver ciruit
3. Gate driver design methodology

13:00 *Lunch*

14:00 **LTSpice Simulation (Thermal Design)**

1. Simulation of a a synchronous buck converter
2. Simulation of MOSFET power losses
3. Simulation of the heat sink thermal dissipation

15:30 *Coffee break*

16:00 **LTSpice Simulation (Gate driver Design)**

1. Gate driver design – A case study
2. Simulation of the designed gate driver circuit
3. Analysis of the gate driver performances

18:00 **End of Course**

Prerequisites: Background in the field of electrical engineering and basic skills in power elctronics. To take full advantage of this course, it is strongly recommended that all attendees install prior to this course the latest version of LTSpice simulation software tool.

English will be the working language

COURSE DESCRIPTION

Gate driver circuits are key components for ensuring the reliable turn-on and turn-off of power MOSFETs. These circuits consist of various essential elements such as gate drive ICs, gate resistors, bypass capacitors, isolated power supplies, etc. The accurate selection of these elements, along with the appropriate heat sink, is crucial to guarantee the safe operation of power MOSFETs.. With these objectives in mind, the proposed course aims to cover the following points:

- Understanding the structure and operation of power MOSFETs.
- Exploring the mathematical equations of power MOSFETs.
- Examination of the power MOSFET switching process (turn-on and turn-off).
- Exploting the thermal constraints of power MOSFETs.
- Introducing the fundamental elements of a gate drive circuit.
- Presenting a systematic design approach for gate drive circuits.

The course will incorporate computer simulation exercises utilizing LTSpice software for SPICE simulation.

COURSE INSTRUCTORS

Prof. Dr.-Ing. Mohamed Wissem NAOUAR

Professorship for the Project Smart and Green EnergY Systems and BUsiness Models.

University of Tunis El Manar, Ecole Nationale d'Ingénieurs de Tunis, LR11ES15 Laboratoire des Systèmes Electriques,

Special Course

Small Energy Storage System for EV and Distributed Energy Systems

ETN 955614
Marie Skłodowska-Curie Actions (MSCA)
Innovative Training Networks (ITN)
H2020-MSCA-ITN-2020

20 September 2024
Paris, France

Course Program

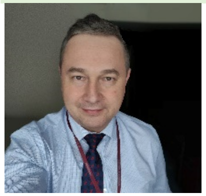
9:00	**Welcome and course introduction**
9:15	**Introduction to small energy storage systems** 1. Types of Batteries 2. Which batteries to choose for small energy storage systems ? 3. The cost of the battery or the cost per cycle ?
10:00	**Small energy storages in distributed energy system** 1. Self-balancing hybrid energy systems 2. The demand for grid flexibility 3. BESS connection to grid: grid forming, grid following and grid enabling converters
10:45	*Coffee break*
11:15	**BESS integration with EV charging systems** 1. Power quality problems 2. Integration with urban DC traction grids 3. Vehicle to grid
12:00	**Converter topologies for integrating BESS/DER/EV** 1. Hybrid inverters 2. Hybrid transformers 3. AC grid/DC grid/EV charging interfaces 4. SmartGridEnabler
13:30	*Lunch*
14:30	**Modelling small energy storage systems** 1. Urban DC traction grid connected BESS / EV. 2. Hybrid AC/DC connected BESS / EVs.
16:15	*Coffee break*
16:30	**Modelling small energy storage systems - continued** 3. Storage system ancillary services.
17:30	**Conclusive remarks**
18:00	**End of course**

Prerequisites: Background in the field of electrical engineering and skills in modelling and simulation. To take full advantage of this course, it is strongly recommended that all attendees install prior to this course the PLECS simulation package.

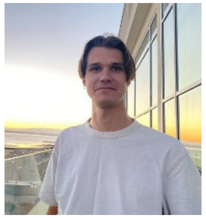
Course Description

Small energy storage systems mitigate the effects of the unstable operation of photovoltaic power plants and wind turbines. When installed in a distributed manner, they stabilize the power grid and increase its flexibility. In the case of charging stations, especially fast EV charging, energy storage systems help to mitigate voltage drops caused by a sudden increase in power consumption. Power electronic converters play a key role in the interaction between energy storage systems and the grid. This course will delve into various aspects of the design and practical operation of modern converters for integrating small energy storage systems with grids that have high penetration of renewable energy sources and EV charging stations.

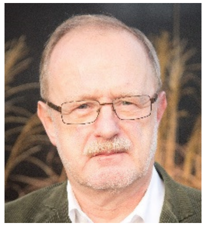
Course Instructors



Dr.Hab.-Ing Marek Adamowicz
Professorship for Power Electronics, Gdańsk TECH, Poland



MSc.-Ing. Mykola Lukianov
Assistantship for Power Electronics Gdańsk TECH, Poland



Tit. Prof. Dr.Hab.-Ing. Ryszard Strzelecki
Full Professor. Gdańsk TECH, Poland
and
Scientific Consultant to the Board, AREX Ltd (WB Group), Gdynia, Poland.

SmartGY SUM

TU Delft

Special Course

AI in Power System Reliability Monitoring

SmartGY SUM

HORIZON 2020

INNOVATIVE TRAINING NETWORKS

ETN 955614
Marie Skłodowska-Curie Actions (MSCA) Innovative Training Networks (ITN) H2020-MSCA-ITN-2020

January 21, 2025
Pärnu, Estonia

Course Program

8:45 **Welcome and Course Introduction**

9:00 **Security assessment and data in control rooms**

1. Balancing datasets
2. Optimisation-based sampling
3. Model requirements in control rooms

10:30 *Coffee break*

11:00 **Learning models for secure system operation**

1. Interpretable models
2. CNNS and Graph Neural Networks
3. Learning with domain knowledge
4. Cost-sensitive learning
5. End-to-end learning for secure operation

13:00 *Lunch*

14:00 Exercise: G**raph Neural Networks (GNN)**

1. Introduction to graphs with Pytorch Geometric and Networkx
2. Introduction to Graph Neural Networks (GNN)

15:30 *Coffee break*

16:00 Exercise: **Solving Optimal Power Flow (DCOPF) problem with GNN**

1. Creating power system graphs
2. Training DCOPF model
3. Improving constraint satisfaction

18:00 **End of Course**

Prerequisites: basic knowledge of electrical engineering, and intuition about programming languages. We will use Python for the workshop.

Course Description

This course addresses the challenges and opportunities of applying AI to power system reliability amid renewable energy integration and electrification. It covers neural networks (including convolutional and graph-based), techniques to handle data imbalances and noise, and applications for distribution and transmission systems. Key topics include dynamic stability assessment, state estimation, and AI's trustworthiness, reliability, and generalization for future-ready systems. The course equips researchers with insights and tools to leverage AI effectively in addressing power system challenges.

Course Instructors

Jochen Cremer

Olayiwola Arowolo

Delft AI Energy Lab
Delft University of Technology
The Netherlands

SmartGY SUM

Warsaw University of Technology

Special Course

Energy Storage Systems for Residential Applications

SmartGY SUM

ETN 955614
Marie Skłodowska-Curie Actions (MSCA)
Innovative Training Networks (ITN)
H2020-MSCA-ITN-2020

January 21, 2025
Pärnu, Estonia

Course Program

8:45 **Welcome and Course Introduction**

9:00 **Energy Storage Systems**

1. Overview of Energy Storage technology
2. Modeling and circuit representations for selected energy storage types
3. Converter topologies and control for residential energy storage systems

10:30 *Coffee break*

11:00 **Exercise: Implementation of the circuit—based models and their parameters**

1. Li-ion battery
2. Ultracapacitor bank

13:00 *Lunch*

14:00 **Control Strategies and Energy Management Systems**

1. Overview of control methods for hybrid, grid-connected energy storage systems
2. Energy management techniques and optimization criteria

15:30 *Coffee break*

16:00 **Exercise: Applying selected control techniques for hybrid energy storage systems**

1. Cross-coupled current control
2. Voltage control for the islanded mode of operation

18:00 **End of Course**

Prerequisites: basic knowledge of electrical engineering and power electronics. PLECS simulation software will be used for the course exercise parts.

English will be the working language

Course Description

Energy storage has become an essential complement to renewable energy systems, particularly in residential applications. Beyond simply storing energy, these systems provide enhanced flexibility for energy management, enabling controlled power flow and improving overall efficiency. This course provides a comprehensive overview of storage technologies, from foundational components like batteries and ultracapacitors to advanced control techniques and optimization algorithms crucial to modern energy management systems.

Course Instructors

Luis Martínez Caballero

Adam Milczarek

Radek Kot

Institute of Control and Industrial Electronics,
Warsaw University of Technology

SPECIAL COURSE

Cybersecurity for Microgrids

ETN 955614
Marie Skłodowska-Curie Actions (MSCA)
Innovative Training Networks (ITN)
H2020-MSCA-ITN-2020

21 Jan 2025
Parnu, Estonia

COURSE PROGRAM

8:45 **Welcome and Course Introduction**

9:00 **Impact of cyber attacks**

1. Advanced controllers in microgrids
2. Vulnerability/risk assessment

9:30 **Modeling of cyber attacks**

1. Stealth cyber attacks in microgrids
2. Attack variants in DC and AC microgrids

10:30 *Coffee break*

10:50 **Detection of cyber attacks**

1. Voltages
2. Currents
3. Frequency

13:00 *Lunch*

14:30 **Mitigation of cyber attacks (and Demonstration)**

16:00 *Coffee break*

16:15 **Anomaly detection between faults and cyber attacks**

16:45 **Exercises: Design for Security**

Based on the lecture contents, two black-box models will be provided to decode the presence of attacks with limited measurements. You will be divided into groups to solve these simulation exercises.

18:00 **End of Course**

Prerequisites: Background in the field of electrical engineering, power electronics, control theory and basic skills in programming language for solving numerical problems. To take full advantage of this course, it is strongly recommended that all attendees install prior to this course the latest MATLAB/Simulink with Simscape library.

English will be the working language

COURSE DESCRIPTION

Microgrids are becoming a cornerstone of power distributions systems that will facilitate the realization of a carbon-neutral electric power systems. Alongside their flexibility to be operated in both grid-connected and autonomous modes, they also provide natural interfaces with many types of RES and ESSs and good compliance with consumer electronics. Moreover, microgrids can be grid-interactive by providing grid supportive functions such as frequency response and, regulation, reactive power support and voltage regulation, etc. All these facts lead to more and more deployment of microgrids in transmission and distribution levels. Furthermore, with proliferation of communication technologies, microgrids are evolving into cyber-physical systems (CPS) that use sophisticated software-based networked control. This increased sophistication imposes numerous new challenges involving coordination, operation philosophy and vulnerability to cyber-attacks.

COURSE INSTRUCTORS

Dr. Subham Sahoo
Assistant Professor and Vice-Leader, Reliability of Power Electronic Converters (ReliaPEC),
Aalborg University
Aalborg, Denmark.

SmartGY SUM

Università Bocconi MILANO

SPECIAL COURSE

ENERGY EFFICIENCY POLICY PACKAGES

SmartGY SUM

ETN 955614
Marie Skłodowska-Curie Actions (MSCA)
Innovative Training Networks (ITN)
H2020-MSCA-ITN-2020

22 Jan 2025
Pärnu, Estonia

COURSE PROGRAM

8:45 **Welcome and course introduction**

9:00 **Climate and energy policy framework**

1. Evolution of climate and energy policies in the EU
2. Key challenges of energy transition in the EU: electrification, decentralization, energy equity, and systems integration
3. Energy efficiency for the building and transport sectors: policies, measures, barriers and enablers

10:30 *Coffee break*

11:00 **Solutions for boosting energy efficiency in the building and transport sectors**

4. Clean energy technologies innovation for energy efficiency in the building and transport sectors.
5. Economic and financial mechanisms for energy efficiency in the building and transport sectors.

13:00 *Lunch*

14:30 **Exploring business models for innovative clean energy technologies**

1. The business model concept and the business model canvas.
6. Innovating the business models for energy efficiency in the building and transport sectors.

16:15 *Coffee break*

16:30 **Practical application using the business model canvas approach**

18:30 **End of course**

Prerequisites: Registered attendees will receive a list of recommended literature and slides. **English will be the working language**

COURSE DESCRIPTION

The course aims to explore the EU's climate and energy policy frameworks and analyse economic, financial and technological solutions to boost energy efficiency in the building and transport sectors. The course begins by exploring the evolution of climate and energy policies within the EU, followed by an in-depth discussion of key challenges faced in the EU's energy transition, including electrification, decentralization of energy production, energy equity, and systems integration. Participants will then delve into energy efficiency in the building and transport sectors, highlighting the critical role of urban areas as hubs for innovative and synergistic solutions. Then the morning session explores cutting-edge solutions for boosting energy efficiency, from innovations in clean energy technologies to economic and financial mechanisms. Special attention is given to electric vehicles (EVs), solar photovoltaics (PV), and heat pumps, while examining barriers and leveraging opportunities at the urban level. In the afternoon, the course turns to business innovation. Participants will explore the fundamentals of business model creation, focusing on the business model canvas and "Energy-as-a-Service" models as innovative strategies for energy efficiency. A hands-on session will allow participants to apply these concepts directly, reinforcing the day's lessons through practical experience.

COURSE INSTRUCTORS

Edoardo Croci
Professor of practice at Bocconi University

Annamaria Bagaini
Researcher at Bocconi University

Special Course

Energy Efficient DC Electrification Technologies for Buildings and Neighborhoods

ETN 955614
Marie Skłodowska-Curie Actions (MSCA)
Innovative Training Networks (ITN)
H2020-MSCA-ITN-2020

January 24, 2025
Pärnu, Estonia

COURSE PROGRAM

8:45 Welcome and Course Introduction

9:00 Running DC-Grids

- Balancing power: set-points and droop curves of devices, stability
- Device types: battery storage systems, charging stations, PV stations and interlink converters
- Control of DC-grids: inertia, primary control, secondary control, dynamics

10:30 *Coffee break*

11:00 Physical Basics

- Cables and speed of light
- A community of capacitors
- Fault effects and fault clearance
- Design rules

13:00 Lunch

14:00 DC-Grid Codes

- Device protection (loads and in-feed)
- Coupling a device to the grid
- Operating a device on the grid

16:00 Coffee break

16:30 DC-Applications in Buildings and Neighborhoods

- Energy performance regulations
- DC opportunities and challenges
- DC enabling power electronic systems

18:00 End of Course

Prerequisites: Basic knowledge of electrical engineering. PLECS simulation software will be used for the course exercise parts. Pls. install the free demo version of PLECS standalone and bring your computer to the course.

English will be the working language

COURSE DESCRIPTION

PV-stations, battery storage systems, electric vehicles and machines with variable speed have one thing in common: They are DC-systems. The most efficient way to interconnect them and to ease stress on utility grids is by using DC-grids. The tutorial explains the physical of DC-grids: How do DC-grids work? Which design rules are needed? How devices interoperate on the grid in a compatible way? How to maintain a balance of power within the grid? The material is available on the web, including simulation models to illustrate operation and to develop your own concepts. The focus is on low voltage DC-grids, as applied in buildings and neighborhoods.

COURSE INSTRUCTORS

Stephan Rupp

Dmitri Vinnikov

Andrii Chub

Department of Electrical Power Engineering and Mechatronics in cooperation with Maschinenfabrik Reinhausen and Current/OS

SmartGY SUM

SIEMENS

SPECIAL COURSE

System Simulation: from Mechatronic to Digital Twin – Application on Smart Grid

HORIZON 2020

INNOVATIVE TRAINING NETWORKS

ETN 955614
Marie Skłodowska-Curie Actions (MSCA)
Innovative Training Networks (ITN)
H2020-MSCA-ITN-2020

24 Jan 2025
Pärnu, Estonia

COURSE PROGRAM

8:45	**Welcome and Course Introduction**
9:00	**Introduction to System Simulation** 1. Context 2. Mechatronics definition 3. Design Cycle 4. History of the simulation tool 5. Interest of simulation platform 6. System simulation 7. New Challenges
10:30	*Coffee break*
11.00	**Introduction to Simcenter Amesim** 1. How to use Simcenter Amesim? 2. Electric libraries overview 3. Preliminary modeling activities
13:00	*Lunch*
14:30	**SMART grid modeling workshop - Part 1** 1. PV Subsystem model 2. Hydrogen Subsystem model 3. Battery system model 4. Complete Grid Model (system integration) 5. Control development
16:15	*Coffee break*
16:30	**SMART grid modeling workshop - Part 2** 1. Model Analysis 2. Virtual assessment 3. Feedback & Take-away
18:30	**End of Course**

Prerequisites: Background in electrical and electronics engineering and basic skills in system simulation (Simulink, Simcenter Amesim, ...). Registered attendees will receive a list of recommended literature, slides, and files to complete practical labs on Simcenter Amesim. <u>To take full advantage of this course, it is strongly recommended that all attendees install Simcenter Amesim 2410 before this course.</u>

English will be the working language

COURSE DESCRIPTION

System Simulation has been one element of the 3rd industrial revolutionary. After defining the purpose of the system simulation, we will explain how System simulation is still necessary in the new context of Sustainability, and how it can leverage the design and the development of a Digital twin for a more electrical society with more and more smart grids.
A key challenge is how to handle properly a multi-physics approach to allow for a better understanding of complex system, especially through interaction with control.
An example of a Smart Grid will illustrate the capability of this simulation tool, by connecting different subsystems altogether.
This course will also provide a workshop to model and run your own model of a SMART grid and allowing the attendees to exercise and become proficient in these topics.

COURSE INSTRUCTORS

Franck Sellier
Simcenter System simulation Principal Research Engineer
Siemens Industry Software SAS, France

Special Course

Women in Sustainability

ETN 955614
Marie Skłodowska-Curie Actions (MSCA) Innovative Training Networks (ITN) H2020-MSCA-ITN-2020

January 23, 2025
Pärnu, Estonia

Course Program

13:00	Gender equality: why to care and what to do.
14:15	**Women in sustainability**

- **Why sustainability.**
- **Main contributions.**

15:30	Reflections from the participants

- Working group

16:15	**Guided discussion on the participants reflections**
17:00	**End of Course**

Prerequisites: No prerequisites are required.

English will be the working language

Course Description

Today, sustainability in technology is a global concern, and one of the strategic objectives of any organization. Within this field, women have played and continue to play a fundamental role.

This course aims to present good practices so that women who want to work within sustainability, and in any field, can do so. In addition, different inclusion strategies and policies will be worked on with the attendees.

Course Instructors

Dr. Silvia Muceli **Dr. Belen Bermmejo**

Department of Signal Processing and Biomedical Engineering, Electrical Engineering (Chalmers University)

Department of Computer Science (University of the Balearic Islands)

POLITECHNIKA GDAŃSKA

Gdansk University of Technology

Faculty of Electrical and Control Engineering

Course I

Power Theory in Electrical Systems

SmartGY SUM

HORIZON 2020

INNOVATIVE TRAINING NETWORKS

ETN 955614
Marie Skłodowska-Curie Actions (MSCA)
Innovative Training Networks (ITN)
H2020-MSCA-ITN-2020

May 26, 2025
Gdansk, Poland

Course Program

8:45 Welcome and Course Introduction

9:00 Power Theory - different approaches and physical interpretation *(Lecture):*

- effective value of voltage/current and function norm
- power flow or energy transfer
- calculation of power in electrical circuits with non-sinusoidal voltage and current - Buneta's, Fryze's, Budeanu's, and Czarnecki's concepts.

10:30 *Coffee break*

11:00 Powers in autonomous systems based on the case of measurements of a ship's electricity network *(Lecture):*

- maritime microgrid as a special case of power system.
- measurement of electrical parameters in the present of power electronics devices in shipboard microgrid.
- modelling as the important part of maritime microgrids operation analysis.

13:00 Lunch

14:00 Identification of power quality and electromagnetic compatibility issues in power electronic converters. *(Lab demonstration)*

15:30 Coffee break

16:00 High frequency interactions of interconnected AC and DC networks. (*Lab demonstration)*

18:00 End of Course

Course Description

This seminar provides an in-depth exploration of key theoretical and practical aspects of modern electrical power networks and selected power electronic systems. Through a combination of lectures and laboratory demonstrations, participants will gain a comprehensive understanding of power theory, including different analytical approaches, physical interpretations, and real-world applications in autonomous electrical systems such as ship networks. Special emphasis will be placed on the interaction of AC and DC networks and the measurement and identification of power quality and electromagnetic compatibility issues.

Course Instructors

Marek Hartman, professor emeritus

Mariusz Górniak, Gdynia Maritime University

Jarosław Łuszcz, Gdansk University of Technology

Andrzej Augusiak, Gdansk University of Technology

Krzysztof Szwarc, Gdansk University of Technology

SmartGY SUM

CHERNIHIV POLYTECHNIC NATIONAL UNIVERSITY

POLITECHNIKA GDAŃSKA

Special Course

Digital Control in Power Electronics to Enhance Efficiency and Robustness

SmartGY SUM

HORIZON 2020

INNOVATIVE TRAINING NETWORKS

ETN 955614
Marie Skłodowska-Curie Actions (MSCA)
Innovative Training Networks (ITN)
H2020-MSCA-ITN-2020

26 May 2025
Gdansk, Poland

Course Program

9:00 **Welcome and course introduction**

9:10 **Representation and controllers of control systems**
(Oleksandr Velihorskyi)

- The main objectives during control system design;
- Transfer functions in s-domain, state space representation, solutions/stability/robustness of the control system, delay in control systems;
- Controllers: feedback/feedforward, disturbance decoupling, full-state feedback.

10:45 *Coffee break and discussion*

11:15 **Design of digital control systems**
(Oleksandr Husev)

- Discretization and sampling, representation of ADC and DAC, Z-transform, types of Z-transform;
- Selection of sampling rate, design methods: emulation and direct design.

13:00 *Lunch*

14:00 **Controllers for power electronics and its robustness**
(Oleksandr Velihorskyi)

- Optimal design: design of Linear Quadratic Regulator (LQR);
- Discrete-Time Kalman Filter.

15:30 *Coffee break and discussion*

16:00 **Simulation evaluation of the control algorithm with and without discretization**
(Oleksandr Husev)

18:00 **End of Course**

Prerequisites: basic knowledge of electrical engineering and power electronics, control theory. Registered attendees will receive a list of recommended literature, slides and a practical application handbook.

English will be the working language

Course Description

All electronic devices, including devices of power electronics requires control system, which should ensure precise, stable and robust control of all desired variables, despite external disturbances or changes of system parameters. Digital control systems are widely used now, they utilize discrete signals and digital computation for controlling the behavior of power electronic equipment, in contrast to analog control systems that use continuous signals.

The definition and representation of digital control in power electronics are explored in the first section of the course, alongside with its significance.

Approaches of digital controller's design for power electronic systems will be deeply analyzed in the second part of the course. Recommendations for the selection of sampling rate, design methods such as emulation of the continuous system and direct design of discrete controller will be introduced with the practical examples. Finally, optimal controllers (LQR) and optimal estimators (Kalman Filter) will be presented in the first section of the course.

The second section will be devoted to the practical training, covering simulation in PSIM software and Python. During practical implementation, the students will learn how to tune the closed loop system for power electronics converter taking into account sampling frequency and delay in digital system.

Dr. Oleksandr Velihorskyi

Dr. Oleksandr Husev

UNIVERSIDAD DE EXTREMADURA

FUNDECYT PCTEX

Course

EU opportunities and proposals writing. Capitalizing SmartGYsum efforts

SmartGY SUM

ETN 955614
Marie Skłodowska-Curie Actions (MSCA)
Innovative Training Networks (ITN)
H2020-MSCA-ITN-2020

May 27, 2025
Gdansk, Poland

COURSE PROGRAM

10:45 Welcome and Course Introduction

11:00 EU and International Funding Framework

- Bottom-Up Thematic Opportunities
- Top-Down Thematic Opportunities
- Understanding a topic: "looking the ring for your finger"

13:00 Lunch time and reflection

14:00 From an idea to a project proposal: "The project of writing a project"

15:30 Healthy break

16:00 Practice workshop: designing the skeleton of a real project proposal

18:00 End of Course

Prerequisites: Basic knowledge of projects elaboration and implementation of grants.

English will be the working language

COURSE DESCRIPTION

Knowing the basics of European and international funding, learning to make the right choice considering the different requirements without constraining the research topic will be the main objective of the training. In addition, the skills to plan the process of writing a competitive proposal will be worked on. The course ultimately hopes serves as a guide to understanding the key factors and specific requirements to increase the success possibilities in the competitive framework of research and innovation financing.

COURSE INSTRUCTOR

Cristina Gallardo Rey
Project Manager
European Project Office
Fundecyt-Pctex & University of Extremadura
www.opesecti-es
EU Funding Expert and PMI Certified Project Manager

UNIVERSIDAD DE EXTREMADURA

Course

From Lab to Market: Implementing Business Plans for Energy Systems Innovators

SmartGY SUM

HORIZON 2020

INNOVATIVE TRAINING NETWORKS

ETN 955614
Marie Skłodowska-Curie Actions (MSCA) Innovative Training Networks (ITN) H2020-MSCA-ITN-2020

May 28, 2025
Gdansk, Poland

Course Program

8:45	*Welcome and Course Introduction*
9:00	Business Planning

- What is a business plan?
- What is a business plan for?
- The business concept
- Practical activity: pitch elevator

10:30	*Coffee break*
11:00	Business Plan Contents

- The promotors
- Strategic analysis
- Marketing
- Operations
- Human Resources
- Economic and Financial Analysis
- Risk Analysis

13:00	*Lunch*
14:00	Implementing a Business Plan (I)

- Developing a Business Plan
- Practical activity: My Business Plan

15:30	*Coffee break*
16:00	Implementing a Business Plan (II)

- Presenting a Business Plan
- Practical activity: Role-playing for investors pitches

18:00	*End of Course*

Prerequisites: Basic knowledge of business management, entrepreneurship and economics.

English will be the working language

Course Description

This intensive, hands-on course has been designed for doctoral students specializing in energy management systems. The course's primary objective is to facilitate the translation of scientific innovations into commercially viable enterprises. To this end, participants will be provided with the requisite tools and practical skills to transform their technological breakthroughs into sustainable business ventures. The course will employ a pragmatic methodology, underpinned by the development of a business plan, which serves as a comprehensive roadmap for the establishment and growth of a business. This course will provide useful insights about how to face the process of starting a business venture in research-academic contexts. The material of this course will be available on the web.

Course Instructors

Dr. José M. García-Gallego **Prof. Sergio Rubio**

Department of Business Management & Sociology
School of Industrial Engineering
Universidad de Extremadura, Spain

Chair of Power Electronics

Kiel University

Course

Talkative Power Conversion: An Introduction

ETN 955614
Marie Skłodowska-Curie Actions (MSCA)
Innovative Training Networks (ITN)
H2020-MSCA-ITN-2020

May 28, 2025

Gdansk, Poland

Course Program

8:45 Welcome and Course Introduction

9:00 Talkative Power Conversion (TPC)

- Communication Infrastructure in Smart Grids
- Power Line Communication (PLC)
- Talkative Power Converters

10:30 *Coffee break*

11:00 Overview of TPC

- Operating Principles
- Modulations
- Demodulations
- TPC in Diverse Converters
- Networking in TPC

13:00 Lunch

14:00 TPC and EMI

- EMI Definitions
- EMI Mitigation Methods
- Converter Modeling for EMI Design
- Case Study

15:30 Coffee break

16:00 Multicarrier TPC

- Sigle Carrier Modulation
- Dual-Carrier Modulation
- Fourier Analysis and Design
- Case Study

18:00 End of Course

Prerequisites: Basic knowledge of electrical engineering. PLECS simulation software will be used for the course exercise parts. Pls. install the free demo version of PLECS standalone and bring your computer to the course.

English will be the working language

Course Description

Talkative Power Conversion (TPC) is an emerging technology in power electronics that uses the power converter itself for communication. Unlike widely used communication systems such as Power Line Communication (PLC), TPC does not require additional hardware to superimpose the data signals on the power signals. Therefore, it is expected that converters that interface batteries, photovoltaics, etc., can directly send the status to other nodes in the systems. This data can be used to optimize the grid while avoiding the additional cost of communication infrastructure. This course will familiarize you with TPC, modulation, implementation and potential challenges related to EMI.

Course Instructors

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