



Tutorial Title

Digital Twin of Renewable Energy Sources: Modernization and Renovation of Overloaded Power Systems

Instructor Team

Team Chair: Olena Rubanenko, Vinnitsya National Technical University
Co-Speakers: Milan Belik, University of West Bohemia

Abstract

The tutorial “Digital Twin of Renewable energy sources: modernization and renovation of overloaded power systems” is divided into two consecutive sections. Starting with a short overview of evolution in a Big Picture of Digital Twin (DT) of renewable energy sources (RES), various generations and implementations will be highlighted. DT concepts will be classified and structured for forming the definition DT RES. Practical solutions of existing DT’s and areas of implementation will be discussed. The Projects in DT, the solutions provided by well-known companies for DT such as General Electric, Siemens, ETAP, ORAL-TAP and etc. will be presented. General approaches of increasing the RES efficiency in power grid will be discussed. Compensation of instability photovoltaic and wind power plants in power grid will be shown on illustrative examples. Next, features of functioning power grids in modern conditions and during rebuild process will be described. The ways how ensure the balance and reliability in the power system for conditions of high-grade RES integration will be explained. Components of the optimality criterion to control the normal mode parameters of the electric power system with RES will be investigated. Digital transformation helps to decarbonize energy supply, to decrease dependency on fossil fuels and to integrate renewables in power system. The aim of the tutorial is to study the influence and results of the increasing number and power of particular renewable energy sources in electricity networks, their balance and efficiency. Further it develops theoretical and practical methods for optimization of the power costs, redundant electricity utilization and compensation of unstable power production from eolic and photovoltaic systems using the criterion programming and ANN methods. The main task of the second part is to provide knowledge which helps to develop the strategy of smart and efficient usage of newly build RES in preselected communities helping to stabilize the main network and to ensure higher energy resilience of particular municipalities. The speech deals with simulation and optimization of the energy community structure and with proposal of covering the energy needs. The case study is based on the set of preselected locations and shows the optimization process proposing sample photovoltaic system for power supply and high temperature battery for efficient energy storage. Efficient design of modern photovoltaic system using various software tools will be presented. Optimization of the PV system considering technical conditions, degradation, economic analyses and variable self-consumption will be studied. Off-grid and on-grid PV system optimization methods will be demonstrated on practical examples. Inverter topology, battery storage system technology and E-mobility calculations will be described. The last part of the presentation deals with PV system design for energy communities including tiny-houses, shelter city for war refugees, rural properties and green tourism projects. System efficiency and control issues will be also evaluated. Model



DT of photovoltaic system will be created step by step including exact 3D visualization, analyses of accumulation system and dependency on load chart and power generation.

Instructor Team Biographies

Prof. Olena Rubanenko, Doctor of Engineering Sciences is the researcher of Research and Innovation Center for Electrical Engineering (RICE) of the Faculty of Electrical Engineering at the University of West Bohemia, Univerzitni 8, 30614 Pilsen, Czech Republic. She is the Professor at the Department of Power plants and system at Vinnitsya National Technical University, 5 Khmelnytske shose, 21021 Vinnitsya, Ukraine. Next, she is the Leading researcher at Institute of Renewable Energy Sources in National Academy of Science in Ukraine. She is co-founder and chief of Technical Department of non-government organization Agency sustainable development SYNERGY (Ukraine). Phone/Fax number:+ 420 377 634315, e-mail: rubanenk@fel.zcu.cz

Qualifications most relevant to the proposal: Olena Rubanenko is expert in the field of implementation of renewable energy in power grids, ANN predictions, RES power generation, determination of PV modules technical conditions, main editor of tutor book for creating energy community. She has more than 12 years of teaching experiences in renewable energy for Ukrainian, Indian, Polish, Chinese and Czech students, green activists and energy managers.

Ing. Milan Belik, Ph.D. is the expert in the field of renewable energy source and computer simulation, optimization of power generation and consumption, RES technical condition analyses. He has over 20 years of experience in renewable energy sources and designing of photovoltaic systems. He is the Head of Section of environmental technologies at University of West Bohemia, Univerzitni 8, 30614 Pilsen, Czech Republic. He is also the Head of Department of renewable energy sources simulation in the Czech Photovoltaic Association. Phone/Fax number:+ 420 377 634315, e-mail: belik4@fel.zcu.cz

Qualifications most relevant to the proposal:

Milan Belik teaches regular courses at University of West Bohemia and professional courses of PV systems design at the Czech Photovoltaic Association. He also offers lectures and tutorials for industrial companies, conferences and professional events. Finally, Milan Belik has had more than 18 invited lectures in India, Ukraine, Germany and Spain dealing with design of PV systems and recommendations for power consumption optimization. He is the mentor in training course Electrician for Photovoltaic systems, mentor of Horizon Europe MSCA4Ukraine project and main investigator in 6 European projects dealing with digitalization of renewable energy sources.