



Education for Digitalization of Energy

Deliverable 6.5

First update of E-Learning platforms and pilot activities

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Abstract:

This report aims to provide a first presentation of established E-learning Platforms with relevant courses in digital energy topics and the E-learning platforms deployed in the piloting activities. Moreover, the content of each piloting activity with supporting material is presented to be published on the EDDIE website.

Keywords:

D6.4, D6.5, E-learning platform, piloting activity, learning material, online course, MOOC, EDDIE-Website

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14	NTT Data Italia SPA	NTT	Italy
15	NOVEL Group	NOVEL	Luxembourg
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17	Institute of Energy Economics at the University of Cologne	EWI	Germany

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Definitions, Acronyms and Abbreviations

AI	Artificial Intelligence
IoT	Internet of Things
LEGOS	Lite Emulator of Grid Operations
ML	Machine Learning
MOOC	Massive Open Online Courses
POK	Polimi Open Knowledge
VET	Vocational Education Training

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Executive Summary

This deliverable builds upon the previous presentation of E-Learning Platforms and Pilot Activities (D6.5) and aims to share targeted information on the piloting activities and relevant e-learning courses through dedicated sections on the EDDIE website.

The "Pilots" section provides a brief summary of the 17 different piloting activities, sorted by the piloting sites Aachen (Germany), Cologne (Germany), Athens (Greece), Milan (Italy) and Madrid (Spain). Furthermore, this section with its subsections contains the available educational material, links for additional information, and, if applicable, the E-Learning Platform used for each piloting activity. This supports the dissemination of the piloting activities and gives a place to share the content of the pilots.

On the other hand the "Relevant Online Courses" section showcases online courses on the identified E-Learning platforms from D6.4, aligning with the skill needs for digital energy identified in WP2. This aims to provide a comprehensive and accessible educational resource for individuals interested in digital energy topics, regardless of their location, through established E-Learning Platforms. The courses are categorized by the following skill gap areas:

- Big Data/Data Analytics
- Artificial Intelligence
- Cybersecurity
- Blockchain
- Energy management systems
- Internet of things
- Virtual product development and testing
- Digital Platforms
- Communication technologies
- Cloud services
- Other relevant courses on digital energy topics

1. Introduction

In the rapidly evolving landscape of the digital age, the energy sector is undergoing a profound transformation. As technology continues to advance, the need for professionals equipped with the knowledge and skills to navigate the realm of digital energy has become increasingly critical. E-learning courses dedicated to digital energy offer a unique opportunity for individuals to gain a comprehensive understanding of this dynamic field from the convenience of their own homes or workplaces. These courses provide an immersive learning experience, blending theoretical concepts with practical applications, and empowering learners to stay ahead of the curve in harnessing the potential of digital technologies in the energy sector. E-learning courses on digital energy provide a gateway for both industry professionals looking to enhance their skills and aspiring energy enthusiasts eager to delve into this emerging field, unlocking the potential for a sustainable future driven by digital technologies. These courses for digital energy topics are offered on already established E-Learning Platforms and making it available for everyone with an internet connection and a computer.

This deliverable is a complementation and update of the deliverable D6.5 “First presentation of E-Learning Platforms and Pilot Activities”. The main objective is to present the piloting activities and relevant e-learning courses on the EDDIE website to share this targeted information. Hence two dedicated sections have been created on the EDDIE website to simulate a platform with educational material and to disseminate the pilots. In this deliverable the contents of these two sections on the EDDIE-website are presented. The first section is called “Pilots” and contains a brief summary depicting the available educational material of the piloting activities and related links for additional information on said activities to support the dissemination of the field tests. In addition, the E-learning Platform used for the piloting activity will be linked, if there is a Platform used. The second section is called “Relevant Online Courses” and presents relevant online courses on the identified E-Learning platforms in D6.4 targeting the identified skill needs for digital energy in WP2.

2. Presentation of Pilot Activities

A new dedicated section for the piloting activities called “Pilots” has been created on the EDDIE website (link: <https://www.eddie-erasmus.eu/pilots-eddie/>). You can reach the section by selecting it from the drop down menu under “The Project” as shown in Figure 1.

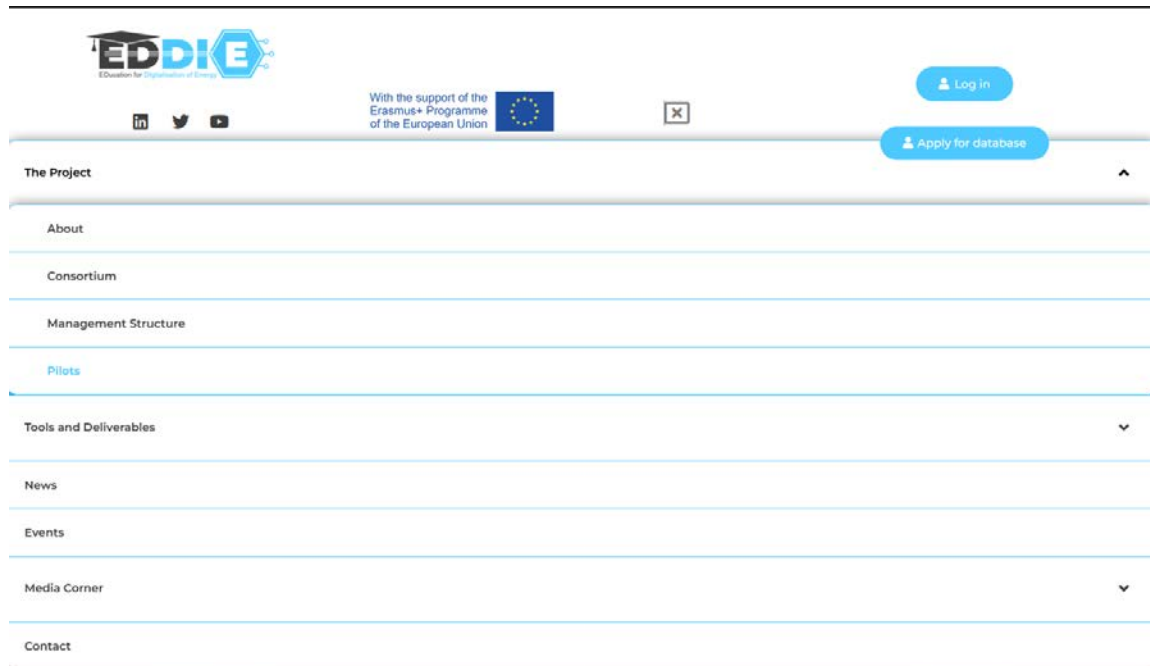


Figure 1 - Drop-Down Menu with the presentation section of the pilots

In the section “Pilots” first a general information text is shown about the piloting. For each of the piloting sites in Aachen, Athens, Milan, Cologne and Madrid, there is a separate tile with some general information and a button for more information. By clicking on the button the user reaches the dedicated section of the pilot site listing all the pilot activities at this site. The activities are described with a summary, information box, complementary links and available educational material. This information will be adjusted to the current development of the pilots and corrected if needed.

2.1. Field Test Aachen

2.1.1. Archimedischer Sandkasten with city of Aachen

The “Archimedean Sandbox” event is a 3-week summer vacation program for school children from 10-16 years old organized by the city of Aachen and supervised by the local educational institution Bleiberger Fabrik in Aachen. Children can sign up for the program on individual days, weeks or the full period. The overall topic of the program is the energy generation through wind power. The Institute for Automation of Complex Power Systems (ACS) is one of the technical supporters of the program next to other institutes of the RWTH. As a Kick-Off event, the children will visit ACS and interact with a small wind park and energy grid model. This is a starting point for children to design and build their own wind setup. ACS will give advice to the children in two follow up meetings on their own wind setup project in the city center of Aachen. Furthermore, another part of the program will be an open fair for the public. At this event, ACS presents the same wind park and energy grid model to interested pedestrians. In the following, you can find two links disseminating the program (in German) and a picture of the model.

Information Box

Target group: 10-14 years, general public

EQF Level: 1, 2

Main stakeholders: RWTH, Stadt Aachen, Bleiberger Fabrik

Part/s of Blueprint Strategy tested: Levers to reduce skill gaps, Design of recommendations and overall action set, general templates, best practices
Results delivered to EC: Teaching/learning material on renewable energy and Smart grid concepts
Contents: Introduction on topics related to smart grids, energy transition challenges and digitalisation, supported by practical demonstration. Tailored to kids.

Links

- <https://www.acs.eonerc.rwth-aachen.de/cms/E-ON-ERC-ACS/Das-Institut/Aktuelle-Meldungen-Institut/~vxjqw/Archimedischer-Sandkasten/?lidx=1>
- <https://aachenerkinder.de/archimedischer-sandkasten-auf-dem-katschhof/>
- <https://futurelab-aachen.de/archimedischer-sandkasten-2022/>

Documents

- Picture of the model

2.1.2. Gymnasium Workshop

The Gymnasium Workshop is a workshop provided by the Institute for Automation of Complex Power Systems (ACS) to pupils of the lower secondary level in a STEM group. The aim is for students to understand the challenge of the energy transition and to develop possible solutions offered by the digitalisation of the energy sector. In the first part of the workshop, they acquire basic knowledge on the topics of the energy transition and digitalisation in the form of an interactive presentation. In the second part, participants have the opportunity to visualise the effects of small changes in the power grid using the Lite Emulator of Grid Operations (LEGOS) platform developed by RWTH. LEGOS is a multi-layer learning platform for demonstrating use cases of smart energy services. By means of some simple tasks, the students independently learn about the basic interrelationships in the power grid. First, they reconstruct a simple power grid by connecting the individual nodes and branches. They learn how to recognise the correlation between voltage, current and resistance and how to determine the power generated and consumed. After this introduction, they gain an initial understanding of the stability in the power grid by simulating short circuits at different locations and working together to find the best solutions to ensure security of supply in the event of a short circuit. The last part deals with the integration of renewable energy resources as decentralised power plants.

Information Box

Target group: High school students

EQF Level: 2, 3

Main stakeholders: RWTH, Anne Frank Gymnasium Aachen

Part/s of Blueprint Strategy tested: Levers to reduce skill gaps, Design of recommendations and overall action set, general templates, best practices

Results delivered to EC: Teaching/learning material on renewable energy and Smart grid concepts

Contents: Introduction on topics related to smart grids, energy transition challenges and digitalisation, supported by practical demonstration. Tailored to high school students and teachers.

Links

- <https://git.rwth-aachen.de/acs/public/teaching/legos/concept> (Concept of Legos)
- <https://vimeo.com/539204880> (LEGOS demo video)

Documents

- Presentation slides of the workshop

2.1.3. Workshop on Data Platforms for the Energy Infrastructure

Together with the Institute for Electro Mobility of the Bochum University of Applied Sciences, the ACS organized a workshop on open source data platform for the energy infrastructure in the IDEASFORUM e.V. of the City of Herne. The workshop will give a general overview of the challenges of data management. The focus will be the presentation of smart city applications with FIWARE and Message Queue Telemetry Transport (MQTT) and the display of different functions with demonstrators. Part of the workshop will be a general introduction to FIWARE as well as

MQTT, practical examples and demonstrations of smart city applications and the presentation of smart energy business models. To find out more about the IDEASFORUM e.V. of the City of Herne or the FIWARE platform visit the websites linked below.

Information Box

Target group: Industry, municipality, citizens

EQF Level: 3 to 8

Main stakeholders: RWTH, Stadt Herne, Hochschule Bochum

Part/s of Blueprint Strategy tested: Levers to raise awareness and to reduce skill gaps, Design of recommendations and overall action set, general templates, best practices

Results delivered to EC: Computing tools and platforms

Contents: Workshops on open source data platform for smart cities

Links

- IDEASFORUM: <https://ideasforum.org/>
- FIWARE: <https://www.fiware.org/>

Documents

- Presentation slides of the workshop

2.1.4. Future energy systems lecture on energy digitalisation

The lecture 'Future Energy System – Part 2' is a highly interdisciplinary lecture series presented by different chairs. The lecture gives a comprehensive overview of the essential elements of the future energy system as well as important topics of sector coupling. In the individual lecture units, detailed knowledge about important technologies and evaluation systems of the energy system is conveyed. Interrelationships between the technologies of the different sectors are taught and the potentials of both the individual technologies and their effect in combination are evaluated and quantified. The main part of this pilot activity is the lecture "Digitalisation of the Energy System" from the Institute for Automation of Complex Power Systems highlighting topics such as cybersecurity, blockchain, and IoT.

Information Box

Target group: Master students

EQF Level: 7

Main stakeholders: RWTH

Part/s of Blueprint Strategy tested: Levers to reduce skill gaps, Design of recommendations and overall action set, general templates, best practices

Results delivered to EC: Computing tools and platforms, Learning Outcomes in terms of skills and knowledge, will be in line with ESCO and EQF framework

Contents: Lecture on Digital Energy

Links:

- <https://www.iaew.rwth-aachen.de/cms/IAEW/Studium/Lehrveranstaltungen/~npibp/Future-Energy-System-II/?lidix=1>

2.1.5. Leonardo lecture on energy transition

The Leonardo lecture series "Energy Transition – Potential Tension between Economy, Politics and Science" at RWTH is an interdisciplinary teaching series of lectures open to all students. Lecturers from different scientific backgrounds and industry collectively offer this course to a broad audience by highlighting different parts of the energy transition. Depending on the study regulations and performance, 2 ECTS credits can be acquired through

participation and a protocol with a critical analysis. In addition, a Certificate of Participation (0 CP, not graded) is possible. The main part of this pilot activity is the lecture “Digital Energy Revolution” by Prof. Monti from the Institute for Automation of Complex Power Systems highlighting the topic digitalization of the energy system and the lecture “Urban Electrical Energy Systems” by Prof. Ponci from the Teaching and Research Area Monitoring and Distributed Control for Power Systems. The presentation of these lectures are available below. To get access to the E-learning Platform Moodle with all the material of the lecture series, contact the organizer listed on the Leonardo website.

Information Box

Target group: Bachelor students, Master students

EQF Level: 6, 7

Main stakeholders: RWTH

Part/s of Blueprint Strategy tested: Levers to reduce skill gaps, Design of recommendations and overall action set, general templates, best practices

Results delivered to EC: Teaching/learning material on renewable energy and Smart grid concepts

Contents: Lecture on Digital Energy Revolution

Links:

- Leonardo website: <https://www.leonardo.rwth-aachen.de/modules/wise-2022/energy-transition/>
- E-learning Platform: <https://moodle.rwth-aachen.de/course/view.php?id=28859>

Documents:

- Slides from the lecture “Digital Energy Revolution”
- Slides from the lecture “Urban Electrical Energy Systems”

2.1.6. ACS lecture on automation of complex systems

The lecture Automation of Complex Power Systems is an elective master course at RWTH University. Students from 13 different master programs can take this elective course. Other RWTH student can apply for this course as well following the predefined procedure for their enrolment.

The ACS lecture provides an introductory course of hot research topics in modern power systems. Through this course, students have a basic understanding of the technologies that are used to achieve monitoring, control, and communication of complex power systems. It contains twelve theoretical lectures and six exercise sessions. In this course besides regular course material, for better understanding of topics such as constant power load, characteristics of power flow, Park transformation, Jupyter notebooks are used. For better understanding of a voltage control topic, a demo is prepared and showed to students. Since ACS covers many topics related to modern power systems, a uniform literature is difficult to be found. Because of this, a written script which will cover all the topics is in preparation as an additional material for studying. In addition, all lectures are recorded and published on Moodle platform.

Information Box

Target group: Master students

EQF Level: 7

Main stakeholders: RWTH

Part/s of Blueprint Strategy tested: Levers to reduce skill gaps, Design of recommendations and overall action set, general templates, best practices

Results delivered to EC: Computing tools and platforms, Learning Outcomes in terms of skills and knowledge, will be in line with ESCO and EQF framework

Contents: Introductory course of current research topics in modern power systems, use of interactive computation sheets

Links

- ACS website: <https://www.acs.eonerc.rwth-aachen.de/cms/E-ON-ERC-ACS/Studium/Lehrveranstaltungen/~dsci/Automation-of-Complex-Power-Systems/?lidx=1>
- E-learning platform: <https://moodle.rwth-aachen.de/course/view.php?id=21644>
- Jupyter notebooks: <https://jupyter.rwth-aachen.de/user/ens8f0pa/lab/workspaces/auto-l/tree/acps>

Documents

- Voltage control panel

2.1.7. Science Night at RWTH

On one night of the year, scientific institutions hold lectures and demonstrations for the public in order to present themselves and a general overview of their research topics. In 2022, RWTH organised this event on 11th November, and from 7pm to midnight, special features intertwining science with music, the arts, and other cultural aspects let young and old alike understand scientific topics in a fun and tangible way. These topics were explained via numerous lectures, experiment stands, and exhibit booths. The program addressed answers to everyday questions and also showcased cutting-edge research.

The E.ON energy research centre at the Science Night 2022 had the motto "The energy transition in today's situation from the perspective of science", and it hold the following lectures:

1. "Energy transition in today's situation from the perspective of science", and
2. "Reducing Gas Consumption, Saving Heating Costs".

In addition, the institute for automation of complex power systems (ACS) participated with two demonstrators; (1) LEGOS (Lite Emulator of Grid OperationS), and (2) cARMA (Car multi-Agent contROl system and energy Management demonstrAtor). With these two demos, participants of all ages had the opportunity to play with smart energy services and car control system.

Information Box

Target group: High school students, Bachelor students, Master students, general public

EQF Level: 3 to 8

Main stakeholders: RWTH

Part/s of Blueprint Strategy tested: Levers to raise awareness and to reduce skill gaps, Design of recommendations and overall action set, general templates, best practices

Results delivered to EC: Teaching/learning material on renewable energy and Smart grid concepts

Contents: Introduction to digitalisation of the energy grid, energy grid demonstrator, dissemination events and material

Links

- <https://www.eonerc.rwth-aachen.de/cms/E-ON-ERC/Das-Center/NEU-Veranstaltungen/~ureew/RWTH-Wissenschaftsnacht-5-vor-12-/?lidx=1>
- <https://www.rwth-aachen.de/cms/root/Die-RWTH/Aktuell/Veranstaltungen/~btgg/RWTH-Wissenschaftsnacht-5-vor-12-/lidx/1/>
- <https://vimeo.com/539204880> (LEGOS demo)
- <https://www.youtube.com/watch?v=5du4cv-mfOA&t=39s> (cARMA demo)

Documents

- The schedule of the event
- Presentation slides

2.1.8. Girls' Day at ACS

The Girls' Day is a career orientation day that takes place once a year. All girls from the fifth grade can take part. On Girls' Day, girls get to know jobs that have so far mostly been done by men – e.g. IT specialist, industrial mechanic, carpenter, etc. Schools decide whether to take part in Girls' Day. Nevertheless, girls/pupils can apply for a leave of absence for Girls' Day by themselves. Pupils have to register via the My Girls' Day website, and there, they can find on-site and digital offers for which they can register online or by telephone. The Institute for Automation of Complex Power Systems (ACS) participates in this event next to other institutes of the RWTH. ACS Institute explains to girls what electricity from renewable causes to the grid. Furthermore, how to control the interaction between electricity production and power consumption is explained. For this purpose, a plug-and-play demo is made, and girls have the opportunity to control the consumption and production of electricity by themselves. All four institutes under the E.ON. research centre participated and explained different topics related to energy and the environment. More about this event can be found in the links below.

Information Box

Target group: 10-14 years

EQF Level: 1, 2

Main stakeholders: RWTH

Part/s of Blueprint Strategy tested: Levers to reduce skill gaps, Design of recommendations and overall action set, general templates, best practices

Results delivered to EC: Teaching/learning material on renewable energy and Smart grid concepts

Contents: Introduction on topics related to smart grids, energy transition challenges and digitalisation, supported by practical demonstration. Tailored to kids.

Links

- <https://www.eonerc.rwth-aachen.de/go/id/vakno?lidx=1#aaaaaaaaavakzi>
- <https://www.girls-day.de/.oO/Show/rheinisch-westfaelische-technische-hochschule-rwth-aachen.2/aachen/praktische-uebungen-zum-thema-energie-lernen-ausprobieren-spass-haben.2>
- <https://www.girls-day.de/maedchen/was-ist-der-girls-day>

Documents

- Picture of the setup

2.2. Field Test Cologne

2.2.1. EWI Academy

The course program of the EWI Academy which aims to pass on knowledge from EWI scientists and experts from the energy field to (early career) employees, specialists and executives is becoming increasingly important. These employees, specialists and executives stem from the energy industry, associations and politics as well as from other areas and industries for which an understanding of the energy industry is needed. The course program consists of several modules, which can be taken individually or subsequently, depending on a company's training needs. Topics cover the regulation of electricity markets, all steps of the energy value chain, energy and climate scenarios, energy system modelling, an introduction to the gas market and hydrogen economy, digitization and decentralization in the electricity sector, and an introduction to e-mobility.

Information Box

Target group: Companies interested in trainings for own employees

EQF Level: 4-5

Main stakeholders: EWI, Companies affected by energy transition and markets

Part/s of Blueprint Strategy tested: levers to reduce skills gaps, general templates, best practices

Contents: modularized lectures on different contents of the energy value chain; booked by companies as trainings for employees who are new to the energy domain or interested in trainings on specific topics: electricity value chain (basics), hydrogen economy (basics), e-mobility (basics), scenario generation (advanced) and energy system modelling (advanced)

Links

- <https://www.ewi.uni-koeln.de/de/ewi-academy/>

Documents

- Slides from the workshop "E-Mobility".
- Slides from the lecture "Introduction to Energy Economics"

2.2.2. Certificate in Future Energy Business

The Future Energy Business event series is designed to connect advanced students from all disciplines with current and relevant knowledge about the concrete transformation of the energy system. This will enable students to gain firsthand knowledge about the unique challenges and opportunities in the Future Energy Business and make their first contacts in this exciting industry.

Experts from science, public authorities and industry give interactive lectures and supervise practical projects on various topics of the energy industry, sustainability and digitalization. The events are usually held in the presence of the participants, partly at the Alte Wagenfabrik in Cologne-Ehrenfeld, partly on site at the participating partner companies. The events are thematically complementary. A certificate of attendance can be issued. If a minimum number of events (30 time hours (10x 3h) and practical project) are attended, a Certificate of Future Energy Business will also be awarded.

Information Box

Target Group: Master Students

EQF Level: 6

Main stakeholders: Prof. Marc-Oliver Bettzüge, EWI, EWI e.V., 13 companies out of the energy field

Part/s of Blueprint Strategy tested: levers to reduce skills gaps, and others to be discussed and determined.

Results delivered to EC: Skills and knowledge levels will be in line with EQF frameworks

Contents: two-semester, flexible programme for students interested in energy; blend of theoretical contents on energy economics and relevant research methods combined with two practical projects in collaboration with energy companies

Links

- The main website: <https://www.ewi-future-energy.de/2023/04/13/das-zertifikat-future-energy-business/>
- A LinkedIn post we shared: https://www.linkedin.com/posts/ewi-koeln_future-energy-certificate-ewi-future-activity-7052622196619276288-dA3i?utm_source=share&utm_medium=member_desktop

Documents

- Program Brochure summer semester
- Program Brochure winter semester
- Presentation of the program objectives and contents

2.2.3. Smart Energy Certificate Programme

The fast transition of the energy sector, combined with digitization, puts pressure on existing business models. However, at the same time, it brings new opportunities. Companies need new knowledge in management positions to leverage untapped business potentials. The Certificate targets employees of energy companies and industry who want to deepen their knowledge on digitalization and energy economics. Participants can choose from a wide-range of courses ranging from theoretical courses on energy economics, trading, design thinking, and modelling. In order to receive the certificate, participants have to obtain 39 credits (worth of 9 work of training).

Information Box

Target group: University student

EQF Level: 6

Main stakeholders: Prof. Marc-Oliver Bettzüge, EWI, EWI e.V: 11 companies out of the energy field

Part/s of Blueprint Strategy tested: levers to reduce skills gaps, TBD

Results delivered to EC: Skills and knowledge levels will be in line with EQF frameworks

Contents: two-semester programme for students interested in energy; blend of theoretical contents on energy economics and relevant research methods combined with two practical projects in collaboration with energy companies

2.3. Field Test Athens

2.3.1. Lectures on Local energy markets, energy communities and Blockchain applications

The lectures on Local energy markets, energy communities and Blockchain applications will be part of the MSc program “Energy Production and Management” of the National Technical University of Athens (NTUA). The program aims to cover a wide range of scientific areas, from conventional & RES production, thermal production and electrical installations to energy economics, energy savings, sustainable environmental management, energy markets and digitalization of energy systems. The successful completion of the whole MSc program provides the students with 60 ECTS credits and the preparation and successful examination of the postgraduate thesis offers additional 30 ECTS credits. This pilot activity is presented as two lectures during the ‘Digitalization of Energy Systems course’ at the second semester of the MSc program.

The lectures will focus on Local Energy Markets (LEMs) and the role of Blockchain technology in securing the decentralized coordination of distribution grids. The content of the lectures is being developed with the aim to mitigate part of the skill gaps identified through the EDDIE project on the skill gaps that these lectures are targeting, which are digital platforms, Blockchain, computing tools & platforms, mathematical optimization, and data analysis. The first lecture contains an overview on smart grids structure, basic components, and stakeholders in the flexibility market, followed by the basic structure of the Greek energy market and the relevant stakeholders, focusing on

Energy Communities. This overview is followed by a further analysis of LEMs, trading methods inside them and some LEM formulation methods as examples, concluding to a case study of the operation of a LEM, to elaborate on the problem of optimization. The second lecture contains an overview of distributed computer network protocols and Blockchain technologies, followed by an analysis of Bitcoin and Ethereum examples. Ethereum example is then connected to smart contracts and the definitions of transactive energy & decentralized energy markets. The lecture also includes two examples that connect LEM operation with decentralized applications, protocols, smart contracts and Ethereum based applications.

Information Box

Target group: Master's students

EQF Level: 7

Main stakeholders: NTUA, MSc on Energy production and management, EDDIE

Part/s of Blueprint Strategy tested: Levers to reduce skills gaps, Design of recommendations and overall action set, general templates, best practices

Results delivered to EC: Teaching/learning material on local energy markets, energy communities and Blockchain applications

Contents: Two 45-minute lectures on local energy markets and blockchain applications

Links:

MSc program “Energy Production and Management” website: <http://epm.ntua.gr/>

Documents:

- Slides from the lecture “Local Energy Markets in the context of smart grids”
- Slides from the lecture “Securing the Decentralized Coordination of Active Distribution Grids with Blockchain”

2.3.2. Lectures on Artificial Intelligence applications on energy systems: Dynamic security and forecasting

The lectures on Local energy markets, energy communities and Blockchain applications will be part of the MSc program “Energy Production and Management” of the National Technical University of Athens (NTUA). The program aims to cover a wide range of scientific areas, from conventional & RES production, thermal production and electrical installations to energy economics, energy savings, sustainable environmental management, energy markets and digitalization of energy systems. The successful completion of the whole MSc program provides the students with 60 ECTS credits and the preparation and successful examination of the postgraduate thesis offers additional 30 ECTS credits. This pilot activity is presented as two lectures during the Digitalization of energy systems course at the second semester of the MSc program.

The lectures will focus on AI applications on energy systems and specifically on dynamic security and forecasting. The content of the lectures is developed based on artificial Intelligence, mathematical optimization, forecasting, data analysis, machine learning as identified skill gaps. The first lecture contains an overview of machine learning and dynamic safety of power systems and the benefits that machine learning can offer in the power systems dynamic safety assessment. The lecture continuous with further analysis of machine learning, containing training sets, classifiers, decision trees and evaluation, ending with an example of classifiers application into a Greek island's power system. The second lecture contains an introduction to power predictions and mathematical formulation of forecasting, based on power conversion functions. Artificial neural networks, as a valuable tool for power forecasting, are described and their training process analysed, complemented by an actual example. The model training process evaluation and the basic evaluation metrics are presented and elaborated through an example that applies various metrics for the evaluation into a power prediction application.

Information Box

Target group: Master's students

EQF Level: 7

Main stakeholders: NTUA, MSc on Energy production and management, EDDIE

Part/s of Blueprint Strategy tested: Levers to reduce skills gaps, Design of recommendations and overall action set, general templates, best practices

Results delivered to EC: Teaching/learning material on artificial intelligence & dynamic security and forecasting on energy systems

Contents: Two 45-minute lectures on "Application of supervised machine learning for dynamic safety assessment in electrical power systems" and "Introduction to RES production forecasting".

Links:

- MSc program "Energy Production and Management" website: <http://epm.ntua.gr/>

Documents:

- Slides from the lecture on "Application of supervised machine learning for dynamic safety assessment in power systems"
- Slides from the lecture "Introduction to RES production forecasting"

2.3.3. Introductory lecture into MOOC on advanced validation methods for smart grids

The MOOC will be hosted in the Moodle platform developed in the context of ERIGrid 2.0 project (H2020 project). It will be developed to act as a learning program on using advanced laboratory testing methods for the validation of electrical and multi-energy systems targeting students, researchers, and professionals. The MOOC will be comprised of 4 core seminars, together with an introductory one and a conclusion. Each one of the seminars will consist of a 30-40 min video presentation and additionally, some of the core seminars will utilize tools developed in the frame of the project to include them as tutorials. EDDIE will participate in the MOOC with an introductory lecture presenting the main targets of EDDIE projects, the identified skill gaps, as well as the Blueprint Strategy for the mitigation of these skill gaps.

Information Box

Target group: Bachelor and master students, professionals

EQF Level: 6-7

Main stakeholders: NTUA, EDDIE, ERIGrid 2.0

Contents: MOOC.

Links:

- ERIGrid 2.0 website: <https://erigrad2.eu/>

2.3.4. Participation in ERIGrid 2.0 Summer School

The summer school is organized in the context of ERIGrid 2.0 project (H2020 project) and will take place during summer 2023, lasting 3-4 days. The summer school aims to reach a wide range of EQF level participants, focusing on modern power systems and smart grids. Topics to be covered during summer school are microgrids, real-time simulation of modern power systems, control and power hardware-in-the-loop simulation setups, adaptive power system protection, ancillary services provision by DERs, operation and control of distribution networks, power system / smart grids resilience, small wind turbines construction. EDDIE will take part in summer school with a presentation, focusing on the dissemination of the targets and outcomes of the project, and especially on the skill gaps identified at the digitalization procedure of the energy sector.

Information Box

Main stakeholders: NTUA, EDDIE, ERIGrid 2.0



Contents: Presentations, educational material, workshops.

Links:

- ERIGrid 2.0 website: <https://erigrid2.eu/>

2.4. Field Test Milan

The pilot activity conducted by Politecnico di Milano aims to produce and test an online learning program (MOOC), open-access and free of charge. The course is designed to respond to some of the skill gaps that emerged from the analyses conducted in WP2 and to test part of the Blueprint Strategy objectives formulated in WP5.

2.4.1. MOOC on Energy management for real estates

The pilot action focuses on the design, development, delivery, and monitoring of correct Massive Open Online Course (MOOC). The course, titled "Energy management for real estates - Fundamentals, methods and digital tools" delves into the figure of the energy manager and is targeted at all those professionals who revolve around energy management in the real estate field. The course will be delivered online, distributed under a Creative Common Licence (CC-BY 4.0), to ensure the opportunity of reuse and remix.

Information Box

Target group: Professionals

EQF Level: 7

Main stakeholders: Politecnico di Milano Departments, Company associations

Part/s of Blueprint Strategy tested: Training program marketplace. (MOOC: reduction of skill gaps, drafting of best practices, development of general templates)

Results delivered to EC: Job profile addressed: Energy Manager

Skills covered: Define the energy profile of buildings, Analyze energy consumption, Identify energy needs, Conduct energy audit, Advise on heating systems energy efficiency, Promote environmental awareness

Contents: Video Lectures, quizzes, case studies, online exploration, peer discussion

MOOC results

Feedback from participants is collected and analysed in a report that offers a panoramic view on how the course works and on the impact learners recognized on their skills' improvement.

Practical Introduction to energy audit

In the frame of the MOOC "Energy management for real estate - Fundamentals, methods and digital tools", an online event was organized for participants but open to anyone interested. The webinar took place on May 3, 2023 thanks to the contribution of Daniele Forni, Chief Technology Officer of FIRE - Italian Federation for the Rational Use of Energy. Following this lesson, you will figure out what the steps of an energy audit are, from data collection to energy analysis and modelling, to evaluating energy efficiency opportunities, with a practical approach and simplified examples.

Links

- POK: <https://www.pok.polimi.it/>

Documents:

- Video of the pilot

2.5. Field Test Madrid

2.5.1. Home Energy Efficiency and Electrical Installations

This training develops a complementary training module to the VET offer of electrical technicians, addressing the restructuring of the electrical installation of a home, the application of energy efficiency measures, and the adoption of energy management. The training aims to fill in the current gap in the official training of general electrical installers, as tend to be mainly based on domotic systems for reducing energy consumption in air conditioning and lighting equipment, leaving aside the possible adaptation of the installation of the dwelling to improve energy consumption, the use of smart devices for continuous monitoring and control, and the training in the use of applications to allow such smart operation by both the installer and the user.

Information Box

Target group: Students, employee and /or professionals

EQF Level: 4, 5

Main stakeholders: Piquer

Part/s of Blueprint Strategy tested: Best practices, levers to reduce skills gaps, general templates

Results delivered to EC: Teaching/learning material on electrical installations for smart homes

Contents: VET course for electrical installators

Links

- Piquer website: <https://padrepiquer.es>

Documents

- Slides

3. Presentation of relevant online courses

A new dedicated subsection for the presentation of relevant online course called “Relevant Online Courses” will be created on the EDDIE website as part of the section “Tools and Deliverables”. In this subsection online courses targeting the following areas of skill needs will be listed and linked:

- Big Data/Data Analytics
- Artificial Intelligence
- Cybersecurity
- Blockchain
- Energy management systems
- Internet of things
- Virtual product development and testing
- Digital Platforms
- Communication technologies
- Cloud services

This will create a reference list for interested students and professionals to re- and upskill their knowledge.

In the following subchapters the relevant courses are presented for each of the skill need areas. An additional subchapter is listing the courses in digital energy, which are not directly connected to one of the skill need areas classification but are yet relevant. In total there are 79 courses identified through desk research.

3.1. Big Data/Data Analytics

Table 1 Online courses on big data/data analytics

Platform	Online Course	Link
Udemy	Big Data in Economics/Energy	https://www.udemy.com/course/data-engineering-for-electrical-energy-systems/?kw=big+data+ene&src=sac
	Data Management in Oil and Gas Industry	https://www.udemy.com/course/data-management-in-oil-and-gas-industry/
IEEE - Academy	Big Data Application in Smart Grids: Benefits and Challenges	https://iln.ieee.org/Public/ContentDetails.aspx?id=FE8635C15B5E43B48DE1587870A6F12F
	Focus on Africa: Asset Performance Management (APM): Session 2	https://iln.ieee.org/Public/ContentDetails.aspx?id=53A211E2A1F64E959D443F5945A0C314
	Technological Advancements Beyond Smart Grid - Session 4	https://iln.ieee.org/Public/ContentDetails.aspx?id=75656C80615747ECBC4E6A6C47DE248B
	Predictive Analytics for Power Systems Decision Making	https://iln.ieee.org/Public/ContentDetails.aspx?id=E9A4855C20D9464C86F785F6E36E8ED9

3.2. Artificial Intelligence

Table 2 Courses on artificial intelligence

Platform	Online Course	Link
Coursera	Reinforcement Learning	https://www.coursera.org/specializations/reinforcement-learning?
IEEE - Academy	Artificial Intelligence & Machine Learning for Demand-Side Response	https://iln.ieee.org/Public/ContentDetails.aspx?id=4D54865514494690B5751FD07E41C027
TU Delft Online Learning	AI-Based Data and Machine Learning Approaches	https://online-learning.tudelft.nl/programs/intelligent-and-integrated-energy-systems/
	Technology of Intelligent and Integrated Energy Systems	https://online-learning.tudelft.nl/courses/technology-of-intelligent-and-integrated-energy-systems/
	Virtual Lab: Photovoltaic Conversion, Systems and Components	https://online-learning.tudelft.nl/programs/virtual-lab-photovoltaic-conversion-systems-and-components/
Stanford Online	Building Energy Efficiency: Technology, Policy & Finance	https://online.stanford.edu/courses/xeiet203-building-energy-efficiency-technology-policy-finance
	Transforming the Grid: AI, Renewables, Storage, EVs, and Prosumers	https://online.stanford.edu/courses/xeiet237-transforming-grid-ai-renewables-storage-evs-and-prosumers

3.3. Cybersecurity

Table 3 Courses on cybersecurity

Platform	Online Course	Link
Coursera	Industrial-IOT-Markets-Security	https://www.coursera.org/learn/industrial-iot-markets-security#syllabus
EdX	Cybersecurity for Critical Infrastructure Urban	https://www.edx.org/course/cybersecurity-clinic?index=product&queryID=7dd1386e311a6ee47ed2c6ac573d30fb&position=3&search_index=product&results_level=first-level-

		results&term=energy+cybersecurity+&campaign=Cybersecurity+for+Critical+Urban+Infrastructure&source=edX&product_category=course&placement_url=https%3A%2F%2Fwww.edx.org%2Fsearch
IEEE - Academy	Cybersecurity of Battery Energy Storage Systems	https://iln.ieee.org/Public/ContentDetails.aspx?id=89607B1519A347429B6BEA4E83B50471
	Cyber-Physical Security Analysis for Transactive Energy Systems	https://iln.ieee.org/Public/ContentDetails.aspx?id=6D54A2B3B78F4C94AB1AA717E7B03356
	Cyber Resiliency & Incident Management for Critical Energy Infrastructure	https://iln.ieee.org/Public/ContentDetails.aspx?id=096A6A2A6E2B412B8C651476757CF8EE
DNV Online Training	Utility cyber security: Trends in the grid	https://www.dnv.com/cybersecurity/on-demand-webinars/utility-cyber-security-trends-in-the-grid.html

3.4. Blockchain

Table 4 Courses on blockchain

Platform	Online Course	Link
EdX	Digitalization of Intelligent Integrated Energy Systems	https://www.edx.org/course/intelligent-integrated-energy-systems-2?index=product&queryID=80d8fb3e2d0e53fbdebd3fcd5c572c85&position=4&search_index=product&results_level=first-level-results&term=energy+blockchain&campaign=Digitalization+of+Intelligent+and+Integrated+Energy+Systems&source=edX&product_category=course&placement_url=https%3A%2F%2Fwww.edx.org%2Fsearch
Udemy	Blockchain Energy & Utilities	https://www.udemy.com/course/blockchain-energy-utilities/?kw=Blockchain+energ&src=sac
IEEE - Academy	Blockchain Technology for Transactive Energy: A New Framework	https://iln.ieee.org/Public/ContentDetails.aspx?id=62351B77E95B45CF8063A2929B791560
	Demystifying Blockchain for Energy & Utilities	https://iln.ieee.org/Public/ContentDetails.aspx?id=14229BC28DE944A899FE3A809DD5AEBE

	Blockchain Technology in the Energy Sector: A Systematic Review of Challenges and Opportunities	https://iln.ieee.org/Public/ContentDetails.aspx?id=5822656713ED4F429AD73298FD9E9693
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3.5. Energy management systems

Table 5 Courses on energy management systems

Platform	Online Course	Link
EdX	Sustainable Energy	https://www.edx.org/course/sustainable-energy?index=product&queryID=1bb89303c70587aa20d16f334001fb0d&position=1&search_index=product&results_level=first-level-results&term=energy&campaign=Sustainable+Energy&source=edX&product_category=course&placement_url=https%3A%2F%2Fwww.edx.org%2Fsearch
	Future Energy Systems	https://www.edx.org/xseries/mitx-future-energy-systems?index=product&queryID=9402c20e500b03ab39f6b1b87c324eeb&position=2&search_index=product&results_level=first-level-results&term=energy&campaign=Future+Energy+Systems&source=edX&product_category=xseries&placement_url=https%3A%2F%2Fwww.edx.org%2Fsearch
Udemy	Ultimate Wind Energy Course for Electrical Engineering	https://www.udemy.com/course/wind-energy-course/?kw=Ultimate+Wind+Energy+Course+for+Electrical+Engineering&src=sac
	Energy Audit	https://www.udemy.com/course/energy-audit/
	Optimal Sizing of Hybrid Renewable Energy Systems with Homer	https://www.udemy.com/course/optimal-sizing-of-hybrid-renewable-energy-systems-with-homer/
	ISO 50001:2018. Energy management system	https://www.udemy.com/course/iso-50001-energy-management-system/
	Transactive Energy Systems	https://iln.ieee.org/Public/ContentDetails.aspx?id=0DF6520F8827468FBA09B3F19775C0BA

IEEE Academy	IEEE Standards for Emerging Customer Energy Systems	https://iln.ieee.org/Public/ContentDetails.aspx?id=378E31323AC34F698E93A8C0DBEB5F0F
	Distributed Energy Resources and Bulk Power System Reliability	https://iln.ieee.org/Public/ContentDetails.aspx?id=EACD4EE7FB934B32AC118B8F4F7CF92B
Stanford Online	Clean, Renewable Energy & Storage for a Sustainable Future	https://online.stanford.edu/courses/xeiet100-clean-renewable-energy-storage-sustainable-future
	Energy Storage	https://online.stanford.edu/courses/xeiet139-energy-storage

3.6. Internet of Things

Table 6 Courses on internet of things

Platform	Online Course	Link
Coursera	Industrial IoT Markets Security	https://www.coursera.org/learn/industrial-iot-markets-security#syllabus
EdX	Computer Systems Design for Energy Efficiency	https://www.edx.org/course/computer-systems-design-for-energy-efficiency?index=product&queryID=2783607e870aa3b779d0f466634f1217&position=3&results_level=second-level-results&search_index=product&term=energy+&campaign=Computer+Systems+Design+for+Energy+Efficiency&source=edX&product_category=course&placement_url=https%3A%2F%2Fwww.edx.org%2Fsearch
IEEE Academy	Unlocking the Value of IoT: A Cognitive Energy System Future by Liang Downey	https://iln.ieee.org/Public/ContentDetails.aspx?id=90C97D5B9B0D4B22BE18D16272F84B5B
	The Internet of Things: Advanced Smart Inverters for Solar & Distributed Energy	https://iln.ieee.org/Public/ContentDetails.aspx?id=156239B44186480D9D9ACA380F228F69
TU Delft Online Learning	Solar Energy: Integration of Photovoltaic Systems in Microgrids	https://online-learning.tudelft.nl/courses/solar-energy-integration-pv-systems-microgrids/

	Virtual Lab: Small-Scale PV Systems with Electrical Storage	https://online-learning.tudelft.nl/courses/virtual-lab-small-scale-pv-systems-with-electrical-storage/
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3.7. Virtual product development and testing

Table 7 Courses on virtual product development and testing

Platform	Online Course	Link
IEEE - Academy	The Growing Virtual Grid: Non-Wires Alternatives Emerge - Part 1	https://iln.ieee.org/Public/ContentDetails.aspx?id=19CF3DBE54C548148F9358F91FF761FE
TU Delft Online Learning	Solar and Chemical Energy Conversions for Green Hydrogen	https://online-learning.tudelft.nl/programs/virtual-lab-solar-and-chemical-conversions-for-green-hydrogen/

3.8. Digital Platforms

Table 8 Courses on digital platforms

Platform	Online Course	Link
Udemy	Digital Oil and Gas	https://www.udemy.com/course/digital-oil-and-gas/
IEEE - Academy	Digital Twin and its Application to Power Grid Online Analysis	https://iln.ieee.org/Public/ContentDetails.aspx?id=36B2898F82564DE0A554B92005A038D2

3.9. Communication technologies

Table 9 Courses on communication technologies

Platform	Online Course	Link
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EdX	Smart Cities, Management of Smart Urban Infrastructures	https://www.edx.org/course/smart-cities-management-of-smart-urban-infrastru-2?index=product&queryID=ae1a48e6a6b30f3832065568b7acaf20&position=23&results_level=second-level-results&search_index=product&term=energy+communication&campaign=Smart+Cities%2C+Management+of+Smart+Urban+Infrastructures&source=edX&product_category=course&placement_url=https%3A%2F%2Fwww.edx.org%2Fsearch
Udemy	Digital for the Front Line Worker in Oil and Gas	https://www.udemy.com/course/digital-for-the-front-line-worker-in-oil-and-gas/?kw=Oil+and+Gas+digital&src=sac
IEEE - Academy	IEEE Smart Energy	https://iln.ieee.org/Public/ContentDetails.aspx?id=AD9C8631FA9C45FD9B8639B5AEC19994
	Challenges of the Existing Security Measures Deployed in the Smart Grid Framework	https://iln.ieee.org/Public/ContentDetails.aspx?id=E27CAFCB57F04C0AB357E15D4AAD70D6
	Communications For the Modern Grid-Session 1-4	https://iln.ieee.org/Public/ContentDetails.aspx?id=6E91E8B06CB8412FBC6CC0CCC6320DB8
	Planning and Operation of the Utility of the Future	https://iln.ieee.org/Public/ContentDetails.aspx?id=46CB395B0C8549598EE4D8B459E602B3

3.10. Cloud services

Table 10 Course on cloud services

Platform	Online Course	Link
IEEE - Academy	How the Cloud can transform the energy business: the Future Internet Approach	https://iln.ieee.org/Public/ContentDetails.aspx?id=85B1A74E342D49238F548C7E46C45B0C

3.11. Other relevant courses

Table 11 Other relevant online courses on digital energy

Platform	Online Course	Link
Coursera	Photovoltaic solar energy	https://www.coursera.org/learn/photovoltaic-solar-energy
	21st Century Energy Transition: how do we make it work?	https://www.coursera.org/learn/21st-century-energy-transition
EdX	Digitalization of Intelligent and Integrated Energy Systems	https://www.edx.org/course/intelligent-integrated-energy-systems-2?index=product&queryID=2783607e870aa3b779d0f466634f1217&position=2&results_level=second-level-results&search_index=product&term=energy+&campaign=Digitalization+of+Intelligent+and+Integrated+Energy+Systems&source=edX&product_category=course&placement_url=https%3A%2F%2Fwww.edx.org%2Fsearch
	Beyond Smart Cities: Emerging Design and Technology	https://www.edx.org/course/mit-media-lab-beyond-smart-cities-emerging-design-and-technology-online-short-course?index=product&queryID=1cb16e8406d71b383cb14a376f0ebaad&position=1&search_index=product&results_level=first-level-results&term=energy&campaign=Beyond+Smart+Cities%3A+Emerging+Design+and+Technology&source=2u&product_category=executive-education&placement_url=https%3A%2F%2Fwww.edx.org%2Fsearch
Udemy	Power Electronics: Control and Simulation of PWM Inverters	https://www.udemy.com/course/control-and-simulation-of-three-phase-inverters/
	Digital Transformation 2023 - Masterclass	https://www.udemy.com/course/digital-transformation-masterclass/
LinkedIn Learning	Der Aufstieg der Öko-Unternehmen	https://de.linkedin.com/learning/grune-kompetenzen-fur-eine-umweltfreundlichere-wirtschaft/der-aufstieg-der-oko-unternehmen?trk=learning-serp_learning-search-card_search-card&upsellOrderOrigin=default_guest_learning

IEEE Academy	Data Science and Smart Grid Applications	https://iln.ieee.org/Public/ContentDetails.aspx?id=9690C1938D314A6886C3753A9A53A444
	Smart Grid Research at NREL's Energy Systems Integration Facility	https://iln.ieee.org/Public/ContentDetails.aspx?id=F6C501AF709F41178995AE99A04F3563
	New Directions for Energy Storage	https://iln.ieee.org/Public/ContentDetails.aspx?id=CBDB208A802E4F1198CF1B7CFFFC4A6E
	Grid Energy Storage - Consumer & Utility Roles	https://iln.ieee.org/Public/ContentDetails.aspx?id=2A552A34D7EE4FCEA73948B63D1046D9
	Flexibility provision from distributed multi-energy systems	https://iln.ieee.org/Public/ContentDetails.aspx?id=EEB3154E95AD415AB6A171135AB11D1D
	Flexibility provision from distributed multi-energy systems Part 1 + 2	https://iln.ieee.org/Public/ContentDetails.aspx?id=EEB3154E95AD415AB6A171135AB11D1D
	The Evolution of the Smart Grid Part 1-3	https://iln.ieee.org/Public/ContentDetails.aspx?id=8211E4F0AC2D4515AA58A0A43A97B06F
	Energy Storage as an Emerging Smart Grid Asset	https://iln.ieee.org/Public/ContentDetails.aspx?id=C4116A4DA66342A2B0517BF3B4461B69
	The Valuation of Distributed Energy Resources	https://iln.ieee.org/Public/ContentDetails.aspx?id=33ECFCE711054090924AB8E2008791F5
	Data Services for Low Voltage Network Operations	https://iln.ieee.org/Public/ContentDetails.aspx?id=6710A23FC0544AB4AE7FE3DE2030B0B1
	Ancillary Services for Transmission Systems by Tap Stagger Operation in Distribution Networks	https://iln.ieee.org/Public/ContentDetails.aspx?id=B1875C5BA38D4BD5AE9AFF602065F4A
	Predictive Analytics for Power Systems Decision Making	https://iln.ieee.org/Public/ContentDetails.aspx?id=E9A4855C20D9464C86F785F6E36E8ED9
TU Delft Online	Computational Methods for Energy Networks	https://online-learning.tudelft.nl/courses/digitalisation-of-intelligent-and-integrated-energy-systems/

Learning	Cybersecurity of Digital Energy Systems	https://online-learning.tudelft.nl/courses/digitalisation-of-intelligent-and-integrated-energy-systems/
	Intelligent and Integrated Energy Systems	https://online-learning.tudelft.nl/programs/intelligent-and-integrated-energy-systems/
	Photovoltaic Material and Device Modeling	https://online-learning.tudelft.nl/courses/photovoltaic-material-and-device-modeling/
FutureLearn	Energy Systems Integration: An Introduction	https://www.futurelearn.com/courses/introduction-to-energy-systems-integration
	Renewable Energy Microgrids: Market and Policy	https://www.futurelearn.com/microcredentials/microgrid-market-and-policy
IIEC Online Certification Courses	Executive MBA in Digital Energy and Utilities	https://thebestmba.org/program/digital-energy-utilities-executive/
	Digital transformation in Energy and Utilities Certification Program	https://thebestmba.org/program/digital-transformation-energy-utilities-certification/