NEST4WB

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CATALOG OF COMPETENCIES

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SUMMARY

- The project “New energy competence system and technology for WB energy stability system curricula reform“– NEST4WB, aims to modernize the study programs of the Higher Education Institutions of the WB through the introduction of new courses related to the Energy Sector and the ICT sector at the bachelor and master levels of education.
- This will include setting up of new laboratories which will enable laboratory practices for students.

- This report contains the following parts:
  - National-level analysis of the energy sector in Western Balkan countries as a basis for the list of new competences
  - Displaying the study programs and the existing list of competences in project countries (PC) HEIs
  - Displaying the existing content of study programs of the WB HEIs and proposing new or innovated study programs together with the list of competences

ANALYSIS OF THE STATE OF THE ENERGY SECTOR IN THE WESTERN BALKANS

- Kosovo:
  - Installed production capacities are 1,568 MW of which thermal power plants (TPP) with lignite make up about 77.69%.
  - There is still no organized one-day-ahead or intraday market.
  - Overall electricity demand at the country level is 6,547 GWh (including transmission and distribution losses).
  - Domestic generation is not sufficient to cover the maximum load in Kosovo's electric power system.
  - This lack of energy to meet the national demand is covered by electricity imports.

- The total operational capacity of generators in Kosovo is 1,236 MW, while the maximum load this year was 1,429 MW, so the ratio of adequacy of generation to the maximum load is 86.5%.
- The transmission network of the electricity system of Kosovo is quite developed and offers sufficient security of the system and is well inter-connected with the regional and European system through interconnecting lines
- DSO is in the process of implementing investments in revitalization, SCADA implementation and in transitioning the 10 kV outputs to operation at the 20 kV voltage level.
- In 2020, the goal of 25% of installed renewable energy sources was met.
- In the region, the modernization and automation of the power system began in 2011.
- By 2022, 137 MW of wind power units were put into operation in Kosovo, resulting in a wind share of 9% of the combined installed energy. Hydropower is also an important element of the power system with about 8.4% of the total installed capacity.

- Montenegro:
  - Montenegro serves approximately 396,000 customers, with an overall electricity demand of about 3,000 gigawatt hours (GWh) annually.
  - The most important development project in the transmission system was the construction of an underwater electricity cable to transport the power to and from Italy (MONITA).
  - Montenegro's interconnections with neighboring countries play a vital role in maintaining grid stability.
  - According to the EUROSTAT, as of 2022, renewable energy accounted for 39.944% of the total energy production, showcasing a significant shift towards sustainable sources.
  - Montenegro signed the Agreement of the Electro-Energetic Community for Southeastern Europe on January 1, 2015, which resulted in opening its energy market to competitors.
  - Montenegro only uses approximately 20 percent of its hydro potential.

- Solar Montenegro is a significant project aimed at harnessing the abundant sunlight in Montenegro for electricity production.
- According to Montenegro's Fourth Action Plan for Energy Efficiency covering the period 2019-2021, efficiency measures have been categorized across various sectors (municipality of Pljevlja).
- Montenegro has two wind farms – Krnovo, which came online in 2017 and Mozura which followed in 2019.
- In 2018 a tender for a 250 MW solar farm was completed, however its construction has been delayed by spatial planning issues.

- Albania:
  - The launch of the day-ahead electricity market by the power exchange ALPEX in April 2023 marked a significant milestone in Albania's efforts towards market liberalization.

- Albania's energy production is predominantly based on hydroelectric power, making it unique in the region for its high dependence on renewable energy sources.
- As of recent data, Albania has an installed hydroelectric capacity of approximately 2,160 MW (Koman, Fierza, and Vau i Dejës dams).
- The annual hydroelectric production varies significantly with hydrological conditions but generally ranges from 5,000 to 7,000 GWh.
- The wind farm in Dropull, in the country's south, is seen at 69.3 MW.
- Biopower Green Energy and Marseglia Group got a strategic investment status in Albania for a EUR 244 million project for two wind farms. The firms intend to install wind turbines with a combined capacity of 234 MW.
- The total installed capacity for solar energy was approximately 50 MW by the end of 2022, with plans to increase this capacity significantly.

- Notable projects include the Karavasta Solar Park, which is expected to add 140 MW to the grid upon completion.
- Total electricity consumption in Albania fluctuates around 7,500 GWh per year.
- Peak electricity demand in Albania has reached up to 1,600 MW during cold spells in winter due to heating needs.
- Albania has set ambitious targets to increase the share of renewable energy in its total energy consumption to 38% by 2030, up from the current estimate of around 31%.
- Investments are aimed at upgrading the transmission network to reduce losses and accommodate the integration of renewable energy sources.
- Approximately €70 million has been allocated for grid modernization and expansion projects over the next five years.

- A new 400 kV line between Albania and Kosovo is planned, estimated to cost €150 million, which will strengthen the regional energy market and provide stability.

- Bosnia and Herzegovina:
  - Out of the total 14 330 GWh produced in 2022, hydroelectric plants generated 4 398 GWh, or 31%, while thermal power plants produced 9 540 GWh, or 67% of the electricity. Wind power plants produced 392 GWh, or 3% of the electricity.
  - The total installed capacity of production facilities is 4 632.62 MW, of which larger hydroelectric plants account for 2 076.6 MW, thermal power plants for 2 065 MW, and larger wind power plants for 134.6 MW. The installed capacity of small hydroelectric plants is 181.89 MW, solar power plants 78.56 MW, biogas and biomass power plants 2.71 MW, small wind power plants 0.40 MW, while industrial power plants have an installed capacity of 92.85 MW.

- Total electricity consumption amounted to 11 635 GWh in 2023.
- Regarding the power grid in Bosnia and Herzegovina, 400 kV and 220 kV transmission systems are operated by Independent system operator (ISO), while 110 kV transmission system is operated by Transmission system operator (TSO). There are four TSO operational units, for the operation, maintenance, and expansion of the transmission system.
- The maximum hourly load of the power system in the previous year amounting to 1 851 MW was reported on 9 February 2023 at the 19th hour.
- BiH came close to reaching its renewable energy targets, amounting to 36,56 % in 2021.
- An amount of 14.4 GWh was produced by the Petnjik solar power plant, while the wind power plants connected to the transmission system produced 356 GWh.

- On 5 September 2023 the Petnjik solar power plant was put into trial operation with installed capacity of 29.9 MW.
- Small-scale renewable generation (small hydropower plants, wind, solar and biofuel power plants connected to the distribution system) amounted to 742.87 GWh. Industrial power plants produced 19.22 GWh.
- Trebinje 1 Solar PV Park is a 72.92 MW solar PV power project planned in Trebinje, Bosnia and Herzegovina. The project is currently at the permitting stage.
- Aggregation of distributed energy sources is experiencing an expansion in Bosnia and Herzegovina. Currently there are seven virtual power plants in the country, aggregating facilities with a total capacity of 214 MW.
- A competitive market for balancing energy and ancillary services has already been established in BiH in 2016.

- However, an organized electricity market has not been established yet. There is no organized day-ahead and intraday electricity market.
- Regarding infrastructure, ISO (NOSBiH) is equipped with a new suit of SCADA (Supervisory Control and Data Acquisition) and EMS (Energy Management Software) hardware and software and related IT and communication infrastructure through the project ”ISO-EMS, SCADA & IT Upgrade” implemented by Siemens AG Austria.
- 110 kV power grid in BiH, which is operated by ISO, has a moderate digital infrastructure. OPGW cables are not used in all parts of the grid. Standard SCADA hardware and software is used to remotely operate the substations and to measure the power flows. Digital relay protection systems are used. Substations are not completely digitalized.

- Digitalization of DSOs in BiH is a mandatory topic. There are a number of good, isolated examples:
  - Schweitzer Engineering's FDIR technology pilot project implemented in 2016 by utility Komunalno Brčko.
  - Rollout of smart meters by DSO "Elektroprivreda Hrvatske Zajednice Herceg-Bosne (EPHZHB)". More than 50% of customers are equipped with smart meters and remotely billed.

PROPOSED LIST OF COMPETENCIES FOR WB HEIs

- The goal of this task and deliverable is to define and develop new competencies in the energy sector through the application of digital tools and ICT.
- All WB HEIs and PC HEIs have joined together and exchanged available experiences, resources, and tools to implement this task.
- It has synergized existing resources and subjects and defined new or improved existing syllabi that will produce new competencies in the field of energy.

- Associated partners have the role of presenting the most valuable competencies in accordance with the information received from their respective HEIs and study programs, which is based on their respective labor markets and business sectors.
- Then, on the basis of both the current needs of the energy sector and PC HEIs good practice, the list of WB HEIs proposed competencies will be shown.
- Based on them, WB HEIs will conduct the creation of new study programs or the improvement of existing study programs.

- The Academy of Applied Technical and Preschool Studies (AATPS) – Partner HEI
  - AATPS presented two studies and the competences which they develop in attending students:
    - Computer-Communication Technologies and Systems (bachelor vocational study lasting 3 years and having 180 ECTS credits),
    - Information Technology and Systems (master vocational study lasting 2 years and having 120 ECTS credits).
  - Starting from the third semester, students can choose more specialized areas within two modules:
    - RTS Module: Computer Technologies and Systems
    - KTS Module: Communication Technologies and Systems

- By completing the program within the Computer Technologies and Systems module, the student will acquire specific professional competencies, enabling them to independently and/or as part of a team:
  - Design, test, and maintain various computer systems through the application of programming languages (S, JAVA, C#, Node.JS, Python), object-oriented, and scripting languages.
  - Design and administer relational and distributed databases.
  - Manage microcomputer architectures and interfaces.
  - Design and test embedded and IoT systems.
  - Configure passive and active network devices within systems.
  - Develop intelligent systems (machine learning).
  - Maintain and manage computer systems.

Academy of Technical and Art Applied Studies Belgrade (ATUSS) – Partner HEI

- ATUSS presented one study program and the competences which it develops in attending students:
  - New Energy Technologies (bachelor study lasting 3 years and having 180 ECTS credits)
- By mastering the study program New Energy Technologies, the student acquires general and subject specific skills:
  - to apply the basic laws of electricity;
  - to apply the principles of electricity production from renewable and conventional energy sources;
  - to apply basic knowledge about the structure of the electric power system and functioning of the basic elements of the electric power system;
  - to design and calculate the main elements of electrical equipment of the electric power system and industrial plants;
  - to use electrical measuring equipment in power systems and industrial plants;
  - to calculate costs in the production, transmission and distribution of electricity;
  - to maintain elements of electric power systems and electric equipment of industrial plants;
  - to exploit and maintain facilities for the production and transmission of electricity;
  - to exploit and maintain distribution facilities and networks, perform appropriate measurements and calculate consumed electricity;
  - to exploit and maintain power plants to renewable energy sources;
  - to prepare programs for maintenance and testing of electrical energy equipment;
  - to apply the basic principles of environmental preservation.

National and Kapodistrian University of Athens (NKUA) – Partner HEI

- NKUA presented an integrated 5-year electrical engineering study program held in National Technical University of Athens (NTUA).
- Indicative competency framework for Electrical Engineers is based on:
  - Expertise:
    - Specialized theoretical knowledge along with fundamental applications in the field of Electrical Engineering and Computer Engineering.
    - Basic and specialized knowledge with an emphasis on three main areas of specialization: Energy Electrical Engineering and Computer Engineering, Electronic Electrical Engineering and Computer Engineering and Telecommunication Electrical Engineering and Computer Engineering.
    - Specialized knowledge to carry out all necessary measurements (electrical, electronic, electromechanical, data flow) and their evaluation, development and interconnection of monitoring systems, simulation and operation of electrical, electronic, electromechanical systems as well as computer and telecommunications systems.
    - Expertise in the design, supervision and construction, certification, control, inspection, maintenance and calibration of systems for the generation, transmission, distribution, storage, processing, control and utilization of energy and information critical to the protection and improvement of life, the health and property of citizens and improve the quality of human life, such as electrical and other installations, electronic applications, telecommunications, IT and computer systems, etc.

- Skills:
  - Laboratory skills in the field of technology related to the field of Electrical Engineering and Computer Engineering.
  - Skills of evaluating results, developing scientific hypotheses and experimental design following the scientific method.
  - Skills of written and oral presentation of scientific data and ideas.
  - Educational and communication skills at all levels of education and training.
- Abilities:
  - search, analyze and synthesize data and information using appropriate modern technologies
  - to adapt to new situations, to be informed about developments and to make decisions,
  - work independently or participating in teams in a local, international and interdisciplinary environment,
  - plan and manage projects of various sizes and complexity
  - generate new ideas in research and generally promote free and creative thinking
  - describe and apply the basic concepts and principles of electrical and computer engineering science in related professional activities.

- Faculty of Engineering, University of Rijeka (UNIRI RITEH) – Partner HEI
  - UNIRI RITEH presented two study programs and the competences which they develop in attending students:
    - Undergraduate University Study of Electrical Engineering (bachelor 3-year study with 180 ECTS credits),
    - Graduate University Study of Electrical Engineering (master 2-year study with 120 ECTS credits).
  - Learning outcomes of the former are divided into:
    - Basic knowledge – electrical engineering
      - Characterize technical systems in the field of electrical engineering,
      - Characterize technical processes in the field of electrical engineering,
      - Evaluate the results of calculations, computations, and measurements on the basis of critical thinking and intellectual integrity

- Specialist qualifications – electrical engineering
  - Apply basic and specialist knowledge in addressing specific requests in the field of electrical engineering,
  - Select criteria for the dimensioning and building of technical systems in electrical engineering,
  - Select criteria for the dimensioning and forming of technical processes in electrical engineering.
- Applied skills
  - Estimate the application of appropriate procedures for solving engineering problems,
  - Solve a given engineering problem by using acquired methods with the possibility of applying appropriate engineering tools,
  - Apply the principles of ethics and ethical responsibility and understand the influence of engineering solutions on society and the surroundings.

- Learning outcomes of the latter are divided into:
  - Scientific approach – electrical engineering
    - Apply specialist knowledge based on the scientific approach in the field of mechanical engineering for solving engineering problems
    - Critically assess and discuss specific engineering problems
    - Develop new solutions for set engineering problems through independent research in the field of electrical engineering

- Specialist competencies – electrical engineering
  - Evaluate conceptual solutions for designing technical systems
  - Evaluate conceptual solutions for designing technical processes
  - Critically assess the influence of characteristic parameters on the results of procedures and/or processes in the field of electrical engineering
- Contribution to development – electrical engineering
  - Recommend an approach for improving technical systems in the field of electrical engineering
  - Recommend an approach for improving technical processes in the field of electrical engineering
  - Manage technical systems/procedures/processes
- Soft skills
  - Assume ethical responsibility during task execution
  - Communicate appropriately to the business environment, negotiate, and present functional parts

- Universidad Politécnica de Madrid (UPM) – Partner HEI
  - UPM presented two study programs and the competences which they develop in attending students:
    - Bachelor´s Degree in Electrical Engineering (4-year study program with 240 ECTS credits),
    - Official Master's Degree in the Electric Power Industry from Comillas Pontifical University in Madrid (1-year study program with 60 ECTS credits).
  - The specific competencies of the former to be acquired are listed below:
    - Ability to solve mathematical problems that may arise in engineering. Aptitude for applying knowledge of: linear algebra, geometry, differential geometry, differential and integral calculus, differential equations and partial differential equations, numerical methods, and numerical algorithms.
    - Understanding and mastery of basic concepts related to the general laws of mechanics, thermodynamics, fields and waves, and electromagnetism, and their application to solving engineering problems.
    - Basic knowledge of computer use and programming, operating systems, databases, and software applications relevant to engineering.
    - Ability to understand and apply the principles of general chemistry, organic and inorganic chemistry, and their applications in engineering.

- Spatial vision and knowledge of graphical representation techniques, both traditional methods of metric geometry and descriptive geometry, as well as computer-aided design applications; fundamentals of industrial design.
- Ability to understand and apply the principles of applied statistics.
- Knowledge of applied thermodynamics and heat transfer. Basic principles and their application to solving engineering problems.
- Knowledge of the basic principles of fluid mechanics and their application to solving engineering problems. Calculation of pipes, channels, and fluid systems.
- Knowledge of the fundamentals of materials science, technology, and chemistry. Understanding the relationship between microstructure, synthesis or processing, and material properties.
- Knowledge and application of principles in circuit theory and electrical machines.
- Knowledge of the fundamentals of electronics.
- Knowledge of the fundamentals of automation and control methods.
- Knowledge of the principles of machine and mechanism theory.

- Knowledge and application of principles in material strength.
- Basic knowledge of production and industrial manufacturing systems.
- Basic knowledge and application of environmental technologies and sustainability.
- Adequate understanding of the concept of business, the institutional and legal framework of business. Organization and management of businesses.
- Knowledge and skills to organize and manage projects. Understanding the organizational structure and functions of a project office.
- Ability to calculate and design electrical machines.
- Knowledge of the control of electrical machines and drives and their applications.
- Ability to calculate and design low and medium voltage electrical installations.
- Ability to calculate and design high voltage electrical installations.
- Ability to calculate and design electrical lines and electric power transmission.
- Knowledge of electrical power systems and their applications.
- Applied knowledge of power electronics.

- Knowledge of automatic regulation principles and their application to industrial automation.
- Ability to design power plants.
- Applied knowledge of renewable energies.
- Ability to individually complete, present, and defend a project before a university tribunal, integrating and synthesizing the competencies acquired in the specific technologies of Industrial Engineering.

- The specific competencies of the latter to be acquired are listed below:
  - To have a general understanding of the structure and functioning of electrical power systems, as well as an awareness of future trends from a technological perspective in electrical power systems.
  - Understanding the importance of decision support models in the area of power systems, and why it is necessary to develop planning and operation decisions according to a temporal and functional hierarchy.
  - Explain the functions of the various models used in the planning and operation of power systems in a market environment, and know what optimization/simulation techniques are more suited for each case.

- Understand the regulatory role and instruments available to regulate monopolies and to promote competition.
- Knowing the market economic principles and different approaches to the regulation of monopolies and oligopolies and the differential aspects of the electricity sector.
- Being able to transfer theoretical concepts of Microeconomics to the study and analysis of the real markets.
- Understand the accounting and financial regime of a company and know the general mechanisms for settlement of the sector. To be able to realize the investment analysis in an electricity company and understand the main aspects of strategic management of the sector.
- To understand the role of the transmission and distribution network in the supply of electricity, as well as their integration with other electrical activities, both from a technical and a regulatory or economic standpoint.
- Acquire a technical, economic and legal understanding of the power business in a liberalized context, from the perspective of the different agents acting in power markets: generators, market operators, retailers, traders, consumers and regulators.

- To understand the impact that distributed generation has on conventional networks, and the technical, economic, and regulatory implications that smart grids will have in the future.
- Understand the role of consumers in wholesale and retail markets and the mechanisms implemented in perfect and imperfect electricity markets
- Completion, presentation, and defense, upon obtaining all the credits from the study plan, of an original exercise carried out individually before a committee, consisting of a Master's Thesis of a professional nature, in which the student can demonstrate that they have acquired and integrated the competencies specific to the teachings.

- Technical University of Ostrava (VSB) – Partner HEI
  - VSB presented two study programs and the competences which they develop in attending students:
    - Electrical Engineering (Bachelor 3-year study program with 180 ECTS credits),
    - Electrical Power Engineering (Master 2-year study program with 120 ECTS credits).
  - Hard skills developed in students for the former study program are:
    - SW - MATLAB/Simulink (creation of simulation models and system simulation)
    - Electrical machines and appliances
    - Measurement of electrical quantities
    - Control electronics (control systems with microprocessors)
    - IP communication protocols
    - Power electronics (design, knowledge and use of semiconductor converters)
    - Optical sensors and networks

- Hard skills developed in students for the latter study program are:
  - Design of non-rotating electrical machines
  - Lighting systems
  - Renewable energy sources
  - Knowledge of electroenergetics in transport
  - Energy balances
  - Designing electroenergetic devices
  - Orientation in electrotechnical, construction, and building diagrams
  - Measurement of electrical quantities
  - LV networks and wiring in buildings
  - Electrothermal devices
  - Electrical machines and appliances
  - Creation of technical reports in the field of electrical engineering

- Design of rotating electrical machines
- Electricity networks
- Distribution networks
- Electricity safety
- Orientation in the field of thermal energy equipment
- Design of electrical devices
- Design of lighting

- Academy of Applied Studies Kosovo and Metohija (ASSKM) – WB HEI
  - ASSKM will improve one study program on the basis of competences which they will develop in attending students:
    - Electrical Engineering (Master's 2-year study program with 120 ECTS credits)
  - New competencies that are to be developed are:
    - Smart Grid Technology: The equipment ASSKM plans to acquire through the NEST4WB project includes RTUs, PLCs, and network infrastructure, which supports the development of competencies in smart grid technology, data management, and the analysis and visualization of critical energy system operations. These components are essential for understanding network automation, real-time control, and communication within modern electrical power systems.
    - Decarbonization and Promotion of Renewable Energy: The implementation of smart grids facilitates the integration of renewable energy sources. These systems require sophisticated control mechanisms to stabilize the grid due to the variability in energy production from these sources.

- Cybersecurity for Energy Systems: Cybersecurity in energy systems is critically important due to the increasing digitalization and integration of smart technologies into energy infrastructure. Key aspects of this field include:
  - Protection of Critical Infrastructure: Ensuring that essential energy infrastructure is safeguarded against cyber threats.
  - Threat Prevention and Detection: Implementing measures to prevent cyber attacks and detect potential threats.
  - Maintenance and Enhancement of Security Protocols: Regularly updating and improving security protocols to address emerging risks.
  - Employee Training and Awareness: Educating and raising awareness among employees about cybersecurity best practices.
  - Use of Security Standards and Regulations: Adhering to established security standards and regulatory requirements to ensure compliance and protection.
- Project Management in the Energy Sector: Understanding the economic aspects of energy markets, including incentive policies, market mechanisms, and renewable energy project financing models.

Faculty of Applied Sciences (FPRN) – WB HEI

- FPRN will improve one study program on the basis of competences which they will develop in attending students:
  - Electrical Engineering and computer science (Batchelor's 3-year study program with 180 ECTS credits)
- New competencies that are to be developed are:
  - IoT Systems and Applications:
    - Knowledge: Understand the principles and architecture of IoT systems, including sensors, actuators, and communication protocols.
    - Skills: Develop, implement, and manage IoT solutions for energy monitoring and management.
    - Application: Use IoT for real-time data collection and analysis to optimize energy consumption and efficiency.
    - Course integration: In the course Computer Networks and Telecommunications add modules on IoT protocols, communication and security. Encourage final thesis based on IoT-projects focusing on energy monitoring and management.
  - AI and Machine Learning for Energy Management:
    - Knowledge: Grasp the fundamentals of AI and machine learning algorithms and their applications in the energy sector.

- Skills: Develop AI models to predict energy demand, optimize energy usage, and enhance grid stability.
- Application: Apply machine learning techniques to analyze energy consumption patterns and improve energy efficiency.
- Course integration: In the course Data Structures and Algorithms include AI and ML algorithms specific to energy data analysis. In the course Software Engineering introduce AI/ML software development kits (SDKs) and tools for creating energy management solutions. In the course Digital Transformation incorporate AI and ML techniques in energy efficient projects.

- AR/VR Technologies for Energy Systems:
  - Knowledge: Understand better the energy sector by using AR/VR technologies.
  - Skills: Develop AR/VR simulations for training, system visualization, and operational planning in energy projects.
  - Application: Use AR/VR to create immersive learning environments for students to explore and interact with complex energy systems.
  - Course integration: Implement virtual labs in courses such as Electrical Engineering, Analog Electronics, Robotics and Automation.
- Robotics in Energy Infrastructure:
  - Knowledge: Understand the design and functioning of robotic systems and their applications in energy sector operations.

- Skills: Design, build, and program robots for tasks such as maintenance of renewable energy installations and automated energy management.
- Application: Deploy robotic solutions to improve efficiency and safety in energy production and distribution.
- Course integration: in the course Robotics and Automation expand the curriculum to include robotics applications in energy infrastructure, such as maintenance of renewable energy installations. Integrate the use of simulation software and tools such as MATLAB/Simulink for modeling and simulating maintenance scenarios.

- Advanced Simulation and Modeling:
  - Knowledge: Understand advanced simulation techniques and modeling tools for energy systems.
  - Skills: Create and analyze simulations of energy scenarios, including renewable energy integration and grid operations.
  - Application: Use simulations to predict system behavior, test new technologies, and optimize energy systems design.
  - Course integration: In the course Signals and Systems use simulation software to model and analyze energy systems. Include dedicated sessions for simulation and modeling into curriculum. Develop laboratory exercises that utilize simulation software to solve real-world problems.

- Smart Grid Technologies and Applications:
  - Knowledge: Learn about smart grid technologies, including advanced metering infrastructure, grid automation, and demand response.
  - Skills: Develop and manage smart grid solutions to enhance grid reliability and integrate renewable energy sources.
  - Application: Implement smart grid projects to improve energy distribution, reduce losses, and enhance grid stability.
  - Course integration: In the course Telecommunications and Computer Networks integrate smart grid communication protocols and network management. Include hands-on labs and projects related to IoT and smart grid technologies.
- Sustainable Energy Solutions:
  - Knowledge: Understand sustainable energy technologies and their role in reducing carbon footprints.
  - Skills: Develop and implement solutions for integrating renewable energy sources and enhancing energy efficiency.
  - Application: Promote sustainability in energy projects by adopting green technologies and practices.

- Course integration: In the course Alternative Energy Sources and Power Supply focus on sustainable practices and technologies. Update course content with lectures on introduction to sustainable energy solutions and case studies / real-world applications. Shift a portion of the assessment to project-based learning where students work on designing sustainable energy solutions for real-world problems. Encourage final thesis on sustainable energy solutions.

- Project Management for Technological Innovations:
  - Knowledge: Learn project management methodologies and tools specific to technology and energy projects.
  - Skills: Plan, execute, and manage projects involving advanced technologies like IoT, AI, AR/VR, and robotics.
  - Application: Lead multidisciplinary teams to deliver innovative energy solutions on time and within budget.
  - Course integration: Expand the course Project Management to include case studies and projects related to technological innovations in the energy sector. For final thesis encourage students to undertake projects that involve managing technological innovation.

- Luarasi University (LRS) – WB HEI
  - LRS will improve one study program on the basis of competences which it will develop in attending students:
    - Bachelor's in Information Technology and Innovation (3-year study program with 180 ECTS credits)
  - Upgraded courses and new competencies that are to be developed are:
    - Introduction to the Theory of Databases (Third Year, 6 ECTS)
      - This course will be updated to include a new module on "Data Management and Analytics for Energy Systems," reflecting the growing importance of big data in this sector, by incorporating a new topic focused on the specialized application of data management in the energy sector.
      - Key Learnings:
        - Understand the role of data analytics in energy efficiency and renewable energy integration.
        - Gain insights into the use of smart grid data to improve system reliability and performance.
        - Explore case studies on how large-scale data management is implemented in modern energy systems.

- Security and Risks of Information Systems (Second Year, 5 ECTS)
  - This course will incorporate a segment on "Cybersecurity for Energy Systems and will explore critical aspects of cybersecurity specifically applied to energy systems, alongside the broader area of cloud computing security. It will focus on the unique challenges and solutions related to securing cloud-based energy management systems, which are increasingly prevalent due to the digital transformation of the energy sector.
  - Key Learning Outcomes:
    - Understand the unique cybersecurity challenges faced by the energy sector, especially in the context of smart grids and renewable energy systems.
    - Learn about specific security measures and technologies that can protect cloud-based energy data and infrastructure.
    - Explore the integration of robust cybersecurity practices into cloud computing environments to ensure data integrity and system reliability.
- Introduction to Project Management (Third Year, 6 ECTS)
  - Adjustments will be made to integrate "Project Management in the Energy Sector," providing insights into the unique aspects of managing energy projects. Students will explore how energy projects are planned, executed, and controlled, emphasizing the unique aspects of managing projects in this vital industry. The module will cover topics such as regulatory compliance, stakeholder engagement in energy projects, and the challenges of managing renewable energy projects.

- Key Learning Outcomes:
  - Understand the specific requirements and challenges of project management in the energy sector, including regulatory and environmental considerations.
  - Learn about the project lifecycle for energy sector projects, from conception through to decommissioning.
  - Gain insights into effective stakeholder management and communication strategies tailored for energy projects.
  - Analyze case studies on successful and failed energy projects to identify best practices and common pitfalls.
- Leadership and Ethics in Decision-Making (Second Year, 5 ECTS)
  - This course will be replaced by the newly introduced Smart Grid Technology course, which also carries 5 ECTS. The new course is designed to equip students with specialized knowledge about smart grid systems, their operation, and the technological advancements impacting this field. Students will explore the integration of modern information and communication technologies with traditional electrical power systems to enhance grid management, reliability, and efficiency. The objectives of the course are to equip students with the knowledge to:
    - Understand the architecture and operation of smart grids.
    - Analyze the impact of renewable energy sources on smart grid operations.
    - Develop skills in managing data generated from smart grid components.
    - Evaluate cybersecurity measures necessary for protecting smart grids.

- Key Concepts:
  - 1. Smart Grid Basics
  - 2. Renewable Energy Integration
  - 3. Data Management
  - 4. Cybersecurity in Smart Grids
  - 5. Grid Automation
  - 6. Demand Response
  - 7. Advanced Metering Infrastructure
  - 8. Electric Vehicles and Grid Integration
  - 9. Power Electronics
  - 10. Regulatory and Policy Framework
  - 11. Energy Storage Solutions
  - 12. Grid Resilience and Reliability
  - 13. Consumer Engagement
  - 14. Emerging Technologies in Smart Grids
  - 15. Project Management in Smart Grid Deployment

- University of Mostar (SUM) – WB HEI
  - SUM will improve two study programs based on competences which it will develop in attending students:
    - Undergraduate Studies in Electrical Engineering (Batchelor's 3-year study program with 180 ECTS credits),
    - Graduate Studies in Electrical Engineering (Master's 2-year study program with 120 ECTS credits).
  - The specific goals of NEST4WB project are twofold:
    - 1. To improve study programs by introducing new elective course and upgrade existing course:
      - Photovoltaic power plants – first year of graduate study
      - Renewable energy sources – third year of undergraduate study
    - 2. To introduce laboratory for renewable energy sources

- Competences to be acquired by the course Photovoltaic power plants are:
  - 1. calculate the components of solar radiation on an inclined surface,
  - 2. explain the physical principle of solar cell operation,
  - 3. compare existing technologies for the production of solar cells,
  - 4. design a networked photovoltaic system,
  - 5. calculate the expected electricity production from the photovoltaic system.
- Advanced competences to be gained are:
  - 1. IoT Integration for Photovoltaic Systems:
    - Competence in IoT Communication Protocols: Understanding and applying communication protocols (e.g., MQTT, CoAP) for integrating IoT devices in photovoltaic power plants.
    - IoT-based Predictive Maintenance: Skills in using IoT sensors and devices for predictive maintenance of photovoltaic systems to monitor performance and detect potential failures before they occur.
  - 2. Smart Grid Technologies:
    - Smart Grid Integration: Ability to integrate photovoltaic power plants with smart grid technologies, including grid-tied inverters, advanced metering infrastructure (AMI), and demand response systems.

- Energy Management Systems (EMS): Knowledge of designing and implementing energy management systems to optimize the operation and energy distribution in smart grids.

- 3. Energy Efficiency:
  - Energy Auditing and Optimization: Ability to conduct energy audits and implement optimization strategies to improve the energy efficiency of photovoltaic power plants.
  - Advanced Photovoltaic Materials and Technologies: Understanding of the latest advancements in photovoltaic materials (e.g., perovskite solar cells) and their impact on energy efficiency.
  - Virtual Power Plants (VPP): Understanding the concept and implementation of virtual power plants that aggregate distributed energy resources, including photovoltaic systems, to act as a single power plant.

- Competences to be gained by the course Renewable energy sources are:
  - Knowing the basics of Internet of Things (IoT) technology and its role in monitoring and controlling renewable energy systems,
  - Being able to integrate smart grid technologies to enhance the efficiency and reliability of power distribution network,
  - Understanding the concepts and implementation of energy-efficient technologies in both residential and industrial applications,

  - Understanding the role of big data analytics in predicting and optimizing energy consumption patterns,
  - Being familiar with advanced metering infrastructure (AMI) and its role in smart energy management.
- Finally, the objective of NEST4WB project is to establish a state-of-the-art laboratory called Hybrid renewable energy trainer for renewable energy systems that will enhance the educational and research capabilities of the faculty.
- With this Laboratory students will acquire a range of competences, including but not limited to:
  - Understanding the fundamentals of photovoltaic (PV) and wind energy systems.
  - Practical skills in measuring and analysing solar irradiation, PV panel characteristics, and wind turbine outputs.
  - Competence in regulating and managing energy storage systems.

- Advanced competences are:
  - Smart Grids: Students will learn about the integration of renewable energy sources into smart grids, focusing on efficient and reliable energy distribution.
  - IoT in Renewables: Understanding how IoT technologies can be utilized to optimize the performance and monitoring of renewable energy systems.
  - Energy Efficiency: Ability to conduct energy audits and implement optimization strategies to improve the energy efficiency of photovoltaic power plants and understanding of the latest advancements in photovoltaic materials (e.g., perovskite solar cells) and their impact on energy efficiency.

- University of East Sarajevo (UES) – WB HEI
  - UES will improve one study program based on competences which it will develop in attending students:
    - Renewable Energy Sources and Smart Power Grids (Master's 1-year study program with 60 ECTS credits)
  - The modernization of the study program within NEST4WB project will be relied on the development of the 3 totally new courses and updating 2 existing courses.

O.N.	Subject name EN-1.1, EN-1.2, EN-1.3, EN-1.4, EN-1.4, EN-1.5	Semester		
		I (IX)		
		LECTURES	EXERCISES	ECTS
1.	Digital Relay Protection	3	2	6.0
2.	Microgrids	3	2	6.0
3.	Electric Vehicles in Smart Grids	3	2	6.0
	TOTAL	9	6	18

- New course Digital Relay Protection is based on the fact that digital protection relays are now extensively deployed in almost every transmission system substation, and their implementation is rapidly expanding to distribution substations across the power system of Bosnia and Herzegovina. By the end of the Digital Relay Protection course, students will be able to:
  - 1. Understand Digital Relay Principles (Comprehend the fundamental principles and operation of digital relays, including their advantages over electromechanical relays).
  - 2. Analyze Protection Algorithms (Design and analyze protection algorithms used in digital relays, ensuring their accuracy and reliability in fault detection and isolation).
  - 3. Configure and Set Digital Relays (Configure digital relays for various protection schemes such as overcurrent, differential, and distance protection, using industry-standard software tools).
  - 4. Perform Relay Testing (Conduct thorough testing and commissioning of digital relay systems using specialized testing equipment and simulators to verify their functionality and performance).
  - 5. Implement Communication Protocols (Implement and test communication protocols such as IEC 61850, DNP3, and Modbus, ensuring seamless integration with other substation automation systems).
  - 6. Analyze Fault Records (Analyze fault records and relay event data to identify fault characteristics, assess system performance, and propose improvements).

- 7. Troubleshoot and Maintain Relays (Diagnose and troubleshoot issues in digital relay protection systems, performing routine maintenance and updates to ensure optimal operation).
- 8. Design Protection Schemes (Design comprehensive protection schemes for different types of power systems, considering factors such as system configuration, fault types, and coordination requirements).
- 9. Ensure System Reliability and Security (Apply best practices for ensuring the reliability and security of digital relay systems, including cybersecurity measures to protect against threats).

- Another course titled Microgrids will be based on the fact that microgrids are expected to rise significantly in Bosnia and Herzegovina as distributed renewable energy sources, especially photovoltaic (PV) systems, are rapidly integrated into the national power grid. By the end of the Microgrids course, students will be able to:
  - 1. Understand Microgrid Concepts (Comprehend the fundamental principles, components, and configurations of microgrids, including their benefits and challenges).
  - 2. Design Microgrid Systems (Design microgrid systems incorporating various distributed energy resources (DERs) such as solar PV, wind turbines, and energy storage systems, ensuring optimal performance and reliability).
  - 3. Analyze Power Flow and Stability (Perform power flow analysis and assess the stability of microgrids under different operating conditions, utilizing simulation tools and software).

- 4. Implement Control Strategies (Develop and implement control strategies for microgrids, including voltage and frequency control, load balancing, and islanding detection).
- 5. Integrate Renewable Energy Sources (Integrate renewable energy sources into microgrids, understanding the technical and economic implications of high penetration of renewables).
- 6. Optimize Energy Management (Apply energy management systems (EMS) to optimize the operation of microgrids, ensuring efficient use of resources and minimizing costs).
- 7. Ensure Grid Interoperability (Ensure interoperability between microgrids and the main grid, addressing issues related to synchronization, protection, and communication).
- 8. Assess Economic Viability (Evaluate the economic viability of microgrid projects, including cost-benefit analysis, financial modeling, and assessment of different business models).
- 9. Implement Cybersecurity Measures (Implement cybersecurity measures to protect microgrid infrastructure from potential cyber threats, ensuring data integrity and system resilience).

- Finally, the last new course proposed will be Electric Vehicle in Smart Grids and is based on the fact that electric vehicles (EVs) are anticipated to play a crucial role in the advancement of smart grids, particularly as the integration of distributed renewable energy sources accelerates. As smart grids evolve to accommodate a higher penetration of renewable energy, the incorporation of EVs becomes increasingly important. By the end of the Electric Vehicle in Smart Grids course, students will be able to:

- 1. Understand the basic physical principles of electric vehicles operation, their mechanical construction, dynamics, etc.
- 2. Understand the working principles of various power electronics converters and their control structures in electric vehicles.
- 3. Understand the working principles of various electric drives and their control structures in electric vehicles.
- 4. Understand the working principles of energy storage systems (batteries) and their management systems in electric vehicles.
- 5. Understand the working principles of embedded systems in electric vehicles, including sensors, actuators, measurements modules and automatic control systems.
- 6. Learn basics of different software tools for modelling, analysis and simulation of electric vehicles.
- 7. Create technical solutions in the field of electrical mobility and all related fields.

O.N.	Subject name EN-1.1, EN-1.2, EN-1.3, EN-1.4, EN-1.4, EN-1.5	Semester		
		I (IX)		
		LECTURES	EXERCISES	ECTS
1.	Electricity Market	3	2	6.0
2.	Measurement and Monitoring Systems in Smart Grid	3	2	6.0
	TOTAL	6	4	12

- Also, a modernization of the existing course Electricity Market is planned, which will ensure that students are well-prepared to understand and navigate the complex interplay between energy policies and electricity markets. By the end of the course, students will be able to:
  - 1. Analyze and Interpret Energy Policies (Critically analyze and interpret national and international energy policies and their implications for the electricity market in Bosnia and Herzegovina).
  - 2. Evaluate Policy Impact (Evaluate the economic, social, and environmental impacts of different energy policies on market dynamics and stakeholder interests).
  - 4. Engage with Stakeholders (Effectively engage with and influence key stakeholders in the energy policy environment, developing sustainable and efficient market practices).
  - 5. Adapt to Policy Changes (Adapt to rapid policy changes by continuously updating knowledge and skills, ensuring readiness to address new challenges and leverage emerging opportunities in the electricity market).

- Finally, the modernization of the existing course Measurement and Monitoring Systems in Smart Grid is based on the fact that including competencies related to smart meters and advanced metering infrastructure (AMI) in the Measurement and Monitoring Systems in Smart Grid course is essential due to the growing industry need in distribution networks in Bosnia and Herzegovina. By the end of the course, students will be able to:
  - 1. Understand Smart Metering Technology (Comprehend the fundamental principles, components, and functions of smart meters and advanced metering infrastructure (AMI) in the context of a smart grid).
  - 2. Analyze Data from Smart Meters (Analyze and interpret data collected from smart meters to assess energy consumption patterns, detect anomalies, and support decision-making processes for grid management).
  - 3. Implement AMI Systems (Design and implement advanced metering infrastructure systems, ensuring seamless integration with existing grid infrastructure and compliance with industry standards).

- 4. Optimize Grid Operations (Utilize data and insights from AMI to enhance the efficiency, reliability, and sustainability of grid operations, including demand response and load management strategies).
- 5. Ensure Data Security and Privacy (Apply best practices for securing smart meter data and protecting consumer privacy, understanding the regulatory and ethical considerations involved).

- Universiteti Metropolitan Tirana (UMT) – WB HEI
  - UMT will propose one new study program based on competences which it will develop in attending students:
    - Renewable Energy Production and Management (Master's 2-year program with 120 ECTS credits)
  - The draft version of the courses by semesters is displayed in the following table:

1. Semester a. Core modules	1. Fundamentals of Renewable Energy Technologies a. Solar PV, wind, hydropower, geothermal, bioenergy. b. Resource assessment, system design, integration. 2. Energy Policy and Regulation a. EU and national renewable energy policies. b. Regulatory frameworks, incentives, barriers.

2. Semester a. Core modules	1. Project Management for Renewable Energy a. Project planning, risk management, financing. b. Procurement, construction, commissioning. 2. Energy Systems and Grid Integration a. Power system modelling, grid codes, storage. b. Distributed generation, c. Microgrids d. Smart Grids e. IoTs f. Sensors
3. Semester a. Elective modules	1. Energy Economics and Finance 2. Energy Efficiency and Demand-Side Management 3. Renewable Energy Entrepreneurship 4. Energy Data Analytics and Visualization 5. Sustainable Urban Energy Systems
4. Semester a. Elective modules b. Capstone project	1. Individual or group research project: a. Focused on a real-world renewable energy challenge in the Balkans. b. Opportunity for industry collaboration.

- Through this Master's study program, students will acquire a diverse range of competencies:
  - 1. Renewable Energy Technologies
    - Knowledge of energy sources: Deep understanding of renewable energy sources (solar, wind, hydropower, biomass, geothermal, etc.).
    - Energy production systems: Competency in designing, operating, and maintaining renewable energy production systems like solar PV systems, wind turbines, bioenergy plants, etc.
    - Energy storage technologies: Knowledge of energy storage methods, including battery systems, pumped storage, and hydrogen-based systems.
    - Grid integration: Understanding of how renewable energy systems interact with electrical grids, grid balancing, and the challenges of integrating variable energy sources.
  - 2. Energy Management and Efficiency
    - Energy audits: Ability to conduct energy audits for both residential and commercial facilities to identify inefficiencies and suggest improvements.
    - Demand-side management: Knowledge of methods to optimize energy consumption, including smart grids, load shifting, and demand response systems.

- 3. Project Management and Planning
  - Project lifecycle management: Understanding of project planning, design, execution, and maintenance in renewable energy projects.
  - Feasibility studies: Skills to assess the technical, financial, and environmental feasibility of renewable energy projects.
  - Risk management: Ability to identify, evaluate, and manage risks in energy production projects (technical, financial, regulatory).
  - Circular economy principles: Understanding of how to minimize waste and promote recycling and resource efficiency in energy systems.
- 4. Economic and Financial Aspects of Energy Production
  - Energy economics: Understanding of the economic principles governing energy markets, pricing mechanisms, and subsidies.
  - Cost-benefit analysis: Ability to perform cost-benefit analysis for renewable energy projects, including lifecycle costing.
  - Financing energy projects: Knowledge of different financing models for renewable energy projects (e.g., public-private partnerships, green bonds, carbon credits).

- 5. Policy, Legislation, and Regulation
  - Energy policy: Understanding of national and international policies and regulations impacting renewable energy development.
  - Regulatory compliance: Knowledge of legal frameworks governing energy production, including permits, environmental standards, and safety regulations.
  - Incentives and subsidies: Familiarity with government and international financial incentives for renewable energy projects.
- 6. Digital and Analytical Skills
  - Data analysis and simulation tools: Proficiency with tools such as MATLAB, PVsyst, HOMER, and other software used for energy systems modeling, analysis, and simulation.
  - IoT and smart grids: Understanding the role of IoT technologies in energy management and the operation of smart grids.
  - Big data in energy: Ability to analyze big data from energy systems for optimizing production and consumption patterns.

- 7. Climate Change Mitigation
  - Carbon footprint reduction: Understanding methods to reduce carbon emissions through renewable energy and energy efficiency.
  - Climate policy frameworks: Familiarity with global climate change agreements and frameworks, such as the Paris Agreement, and how renewable energy fits into these initiatives.
  - Carbon trading and offset mechanisms: Competency in carbon markets, including carbon trading and offset mechanisms as part of renewable energy development.

- University of Mitrovica (UPKM) – WB HEI
  - UPKM will improve one study program based on competences which it will develop in attending students:
    - Electrical and Computing Engineering (Batchelor's 4-year study program with 240 ECTS).
      - Module: Power Engineering (PE), within which the areas of production, transmission, distribution and use of electricity are studied.
  - The list of courses planned for modernization on Power Engineering module is displayed in the following table:

Num.	Code	Course name	Status	ECTS	Sem
1	20.OE16	Electrical Measurements 2	Comp.	6	4
2	20.OE29	Low-voltage Electrical Installations	Comp.	6	5
3	20.OE37	Electrical Machines 3	Comp.	7	6
4	20.OE52	Power Plants	Comp.	5	7
5	20.OE57	Power Systems Substations	Comp.	5	8
			Sum:	29	

- Some of the key competences acquired by this study program improvement are:
  - 1. Smart Grids
    - Advanced Metering Infrastructure (AMI)
    - Grid Automation and Control Systems
    - Distributed Energy Resources (DERs) Integration
    - Demand Response and Energy Efficiency Programs
  - 2. Renewable Energy Integration
    - Advanced Modeling and Simulation
    - Energy Storage Integration
    - Microgrid Development
    - Grid Modernization Initiatives
    - Data Analytics and AI
  - 3. Data Analytics and Predictive Maintenance
    - Data Collection and Integration
    - Descriptive and Diagnostic Analytics
    - Predictive Maintenance Modeling
    - Asset Health Monitoring

- Fault Detection and Diagnosis
- Optimization and Decision Support

- 4. Cybersecurity and Resilience
  - Risk Assessment and Threat Detection
  - Security-by-Design Principles
  - Incident Response and Recovery
  - Continuous Monitoring and Threat Intelligence
  - Training and Awareness Programs
  - Regulatory Compliance and Standards
- 5. Energy Efficiency and Demand-side Management
  - Predictive Analytics for Load Forecasting
  - Demand Response Technologies
  - Energy Management Systems (EMS)
  - Building Automation and Controls
  - Grid Modernization and Distributed Energy Resources

- 6. Digital Twin Technology
  - Design and Simulation
  - Predictive Maintenance
  - Real-time Monitoring and Control
  - Asset Performance Optimization
  - Integration with AI and Machine Learning
- 7. Internet of Things (IoT) and Edge Computing
  - IoT devices embedded in power equipment
  - IoT-enabled energy management systems enable users to monitor, control, and automate energy
  - Enhancing grid resilience
  - Remote Monitoring and Control

Univerzitet Sinergija Bijeljina (USB) – WB HEI

- USB will will propose one new study program and innovate an existing study program based on competences which it will develop in attending students:
  - Software electro energetics (new Batchelor's 4-year programme with 240 ECTS credits),
  - Contemporary Information Technologies (existing Master's 1-year programme with 60 ECTS credits).
- The preliminary proposal of a possible study program of the first cycle of studies is displayed in the following tables:

First year					
1. semester	1	OB	Basics of electrical engineering 1	3+2	8 ECTS
	2	OB	Mathematics 1	3+2	8 ECTS
	3	OB	Basics of computer technology	3+2	8 ECTS
	4	OB	Physics	2+2	6 ECTS
2. semester	5	OB	Basics of electrical engineering 2	3+2	8 ECTS
	6	OB	Mathematics 2	3+2	8 ECTS
	7	OB	Basics of programming	3+2	8 ECTS
	8	OB	English language 1	2+2	6 ECTS

Second year					
3. semester	1	OB	Probability and Statistics	3+2	8 ECTS
	2	OB	Theory of electric circuits	3+2	8 ECTS
	3	OB	Electronics in the electro energetics	2+2	6 ECTS
	4	Ch 1	Data structure and algorithms	3+2	8 ECTS
			Computer networks	3+2	8 ECTS
4. semester	5	OB	Electromagnetics	3+2	8 ECTS
	6	OB	Electrical measurements	3+2	8 ECTS
	7	OB	Signals and systems	3+2	8 ECTS
	8	OB	English language 2	2+2	6 ECTS

Third year					
5. semester	1	OB	Power plants and switchgear	3+2	8 ECTS
	2	OB	Electric transformers	3+2	8 ECTS
	3	OB	Electric rotary machines	3+2	6 ECTS
	4	CH 2	Solar energy sources	2+2	8 ECTS
			Designing renewable energy sources	2+2	8 ECTS
6. semester	5	OB	Energy converters	3+2	8 ECTS
	6	OB	Electrical installations and lighting	3+2	8 ECTS
	7	CH 3	Smart electrical installations	3+2	8 ECTS
			Wind generators	3+2	8 ECTS
	8	OB	English language 3	2+2	6 ECTS

Fourth year					
7. semester	1	OB	Electric vehicles	3+2	8 ECTS
	2	OB	Quality of electricity	3+2	8 ECTS
	3	IZ 4	Transmission and distribution of electricity	3+2	8 ECTS
			Relay protection	3+2	8 ECTS
	4	IZ 5	Smart distribution networks	2+2	6 ECTS
			Smart measuring devices in the power industry	2+2	6 ECTS
8. semester	5	OB	Energy storage	3+2	8 ECTS
	6	IZ 6	Electric vehicles	3+2	8 ECTS
			Integration of renewable energy sources	3+2	8 ECTS
	7	IZ 7	Measuring transducers in the power industry	2+2	6 ECTS
			Software tools in electrical engineering	2+2	6 ECTS
	8	OB	Final work	3+2	8 ECTS

- A list of competences that students will develop during such a program:
  - 1. Core Technical Competencies:
    - Software Development & Programming: Proficiency in languages such as Python, C++, Java, or MATLAB for creating software solutions related to energy systems.
    - Embedded Systems & Microcontrollers: Understanding of embedded systems (e.g., Arduino, Raspberry Pi) used in energy monitoring and control applications.
    - Power Systems Engineering: Knowledge of electrical power generation, transmission, distribution, and the design of energy-efficient systems.
    - Control Systems: Ability to design and implement control algorithms for energy systems (e.g., PID controllers, fuzzy logic, and real-time control).
    - Signal Processing: Competence in analyzing and processing signals from electrical systems and sensors for energy-related applications.
    - Data Analytics & Machine Learning: Using data science and machine learning techniques to optimize energy consumption, predict system behavior, or detect faults in energy networks.
    - Energy Conversion & Storage: Understanding of renewable energy sources, energy storage systems (e.g., batteries), and their software-controlled integration into grids.
    - Smart Grids & IoT for Energy: Knowledge of smart grid technologies, IoT, and sensors for monitoring and managing energy networks.
    - Simulation & Modeling: Proficiency in simulation tools (like MATLAB/Simulink, PSpice, or ANSYS) to model energy systems and optimize performance.

- Electronics & Circuit Design: Design and troubleshooting of electronic circuits used in energy control systems and power electronics.

- 2. Domain-Specific Competencies:
  - Renewable Energy Systems: Competence in designing and optimizing software for solar, wind, and other renewable energy applications.
  - Energy Efficiency & Optimization: Ability to develop and apply software algorithms that optimize energy consumption in industries, buildings, or grids.
  - Energy Management Systems (EMS): Design and implementation of EMS for the efficient operation of power generation, distribution, and consumption.
  - Power Electronics: Proficiency in power converters, inverters, and motor drives, and understanding how to control them using software.
  - Grid Stability & Integration: Understanding how to ensure the stability of energy grids when integrating renewable energy sources.
- 3. Mathematical & Analytical Competencies:
  - Numerical Methods & Algorithms: Ability to apply numerical techniques to solve complex energy-related problems (e.g., optimization, simulation).
  - Electrical Circuit Analysis: Competence in analyzing and designing complex electrical circuits for power systems.

- Thermodynamics & Electromagnetic Fields: Knowledge of thermodynamics and electromagnetic fields as applied to energy systems.
- Systems Engineering: Applying systems thinking to integrate software and electrical components into coherent energy solutions.

- 4. Regulatory & Industry Knowledge:
  - Energy Policy & Regulation: Familiarity with energy policies, safety standards, and regulations that govern energy systems in various regions.
  - Cybersecurity in Energy Systems: Understanding of security challenges related to digital energy networks and how to secure them against cyberattacks.

- The existing study program at the University of Sinergija Bijeljina that will be innovated is called Contemporary Information Technology.
  - The study program could be improved by introducing a special focus on the Smart Electric Power Grid. The main goal of this direction would be the education of professional staff who will be able to work in various areas related to renewable sources of electricity, their integration into smart power grids and the use of artificial intelligence and IoT resources in power grid modeling.

- This staff would be able to get involved in the activities of state agencies such as the Regulatory Agency for Energy at the entity and state level, the Institute for Standardization of BiH and other state bodies in the preparation of legal and by-laws related to intelligent Electric Power Grid and the liberalization of the electricity market.
- This direction would focus on special aspects of designing modern computer networks in power systems (within the compulsory subject of Contemporary Computer Networks).
- Introduction of new subjects would follow two electoral blocks:
  - Election block 1:
    - Integration of renewable energy sources into the Electric Power Grid;
    - Software modeling of the use of solar energy and wind energy.
  - Electoral block 2:
    - Smart systems for measurement and monitoring in Electric Power Grids;
    - IoT infrastructure in Smart Electric Power Grids

- This upgraded study program would develop the following competencies:
  - 1. Core Technical Competencies:
    - Smart Grid Architecture & Design: Understanding the components, layers, and communication protocols of smart grid architecture, including distributed energy resources and microgrids.
    - Power System Fundamentals: Solid knowledge of power generation, transmission, distribution, and load balancing in traditional and smart grids.
    - Energy Management Systems (EMS): Competence in designing and developing energy management systems to optimize grid performance, ensure reliability, and reduce costs.
    - SCADA (Supervisory Control and Data Acquisition) Systems: Proficiency in SCADA technologies for remote monitoring and control of smart grid infrastructure.
    - Communication Protocols for Energy Systems: Understanding of protocols like IEC 61850, Modbus, DNP3, and others used for real-time communication between grid components.
    - Automation and Control Systems: Ability to implement automation solutions (e.g., distributed control systems) to increase the efficiency and responsiveness of the grid.
    - Cyber-Physical Systems (CPS): Competence in developing integrated hardware and software systems that monitor and control physical grid infrastructures.

- Power Electronics for Smart Grids: Knowledge of power electronics and their role in energy conversion, storage, and distribution within the smart grid.
- IoT in Smart Grids: Design and implementation of IoT devices and sensors for real-time data collection and grid monitoring.

- 2. Data Analytics & AI Competencies:
  - Big Data & Data Analytics in Energy Systems: Skills in handling large datasets generated by smart meters and other sensors, applying data analytics for grid optimization and forecasting.
  - Machine Learning & AI in Smart Grids: Application of machine learning models to predict energy demand, detect anomalies, and optimize the operation of energy systems.
  - Predictive Maintenance: Using analytics to predict and prevent failures in grid infrastructure by monitoring equipment health.
  - Real-Time Data Processing: Proficiency in processing and analyzing real-time data streams for energy management and grid stability.
- 3. ICT & Networking Competencies:
  - Networking in Smart Grids: Knowledge of advanced networking technologies (e.g., 5G, Wi-Fi 6, LPWAN) to enable communication between devices and control centers in smart grids.
  - Cloud Computing & Edge Computing: Proficiency in cloud and edge computing solutions for storing and processing smart grid data and implementing distributed control mechanisms.

- Distributed Systems & Blockchain: Understanding of decentralized technologies like blockchain to enhance grid security, flexibility, and peer-to-peer energy trading.
- Smart Metering & Sensor Networks: Knowledge of smart meters and sensor networks used for monitoring grid performance, energy consumption, and integration with billing systems.
- Energy IoT Platforms: Competence in developing and managing IoT platforms for smart grid applications.

- 4. Cybersecurity Competencies:
  - Cybersecurity in Energy Systems: Understanding of potential cyber threats to smart grids and proficiency in developing and implementing security strategies to safeguard critical infrastructure.
  - Secure Communication Protocols: Knowledge of encryption, authentication, and other secure communication protocols used to protect data and control signals in smart grids.
  - Incident Response & Resilience: Competence in designing grids that are resilient to cyberattacks and can recover quickly from security incidents.
- 5. Regulatory & Policy Competencies:
  - Energy Markets & Regulation: Familiarity with the economic and regulatory frameworks governing energy markets, including pricing, tariffs, and grid regulation.

- Energy Policy & Smart Grids: Understanding of international and local policies promoting the adoption of smart grid technologies and the integration of renewables.
- Standards and Compliance: Knowledge of technical standards related to smart grid technologies and systems (e.g., IEEE, IEC standards).

CONCLUSION

- As a result of this report, a list of competencies was developed, proposed and approved. The combined list for all WB HEIs is displayed as follows:
  - Smart Grid Technology,
  - Decarbonization and Promotion of Renewable Energy,
  - Sustainable Energy Solutions,
  - Energy Management and Efficiency,
  - AI and Machine Learning for Energy Management,
  - AR/VR Technologies for Energy Systems,
  - IoT Systems and Applications in the Energy Sector,

- Cybersecurity for Energy Systems,
- Robotics in Energy Infrastructure,
- Smart Metering and Communication Technology,
- Data Management and Analytics for Energy Systems,
- Protection of Advanced Power Systems,
- Electric Vehicles in Smart Grids,
- Project Management in the Energy Sector,
- Electricity Market and Energy Policy, and
- Digital Twin Technology.

- It can finally be concluded that, despite some differences between the organization structure and nomenclature of the study programs, the list of competences overlaps between all WB HEIs and is mutually similar.
- That means that all WB HEIs are on the same path to energy transition and decarbonization and have already decided to incorporate digitalization of the energy sector in their syllabi, which should keep up-to-date their students with the technology advancement and policy changes.

NEST4WB

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