

2.1 Analysis of the state of higher education of RS in the field of green energy



The energy sector has changed significantly in the last decade. With the advent of renewable energy sources, electric cars, forms of efficient communication and management, there has been a transformation of the way the power grid is managed, but also changes in the way the electricity market works. There has been an emergence of electricity exchanges and liberalization and deregulation of the market. At the same time, small and micro energy networks are created, which are controlled by intelligent control and optimization algorithms.

The analysis of study programs in the Republic of Serbia, the Republic of Slovenia and the Republic of North Macedonia covering this area, showed a complete lack of familiarization with the concept of the development of the modern electricity market, as well as the rules and legalities in this market.

In the Republic of North Macedonia, the field of green energy is studied at six master's universities, through eight study programs mainly with 60 ECTS. In the Republic of Slovenia, similar master-level study programs are performed at three higher educational institutions, while in the Republic of Serbia this area of master studies is realized at five faculties, two academies of vocational studies and one higher school vocational studies. The conducted analysis included the structure of the program, objectives and outcomes, the level of competence and the scope of qualifications.

The common denominator for all analyzed study programs (a total of 21) at the master level is traditionalism, goals and outcomes that do not correspond to the current state and needs of the energy market, lack of innovation and adequate teaching approaches and methods. Study programs are comparable to those of the European Higher Education Area, in terms of structure, while in terms of content and level of competence there are a lot of differences.

In the first place analyzed study programs offer students' knowledge and methods for understanding energy flows and functional developments in thermal power systems and the construction industry; to analyze energy costs and identify potential sites for their reduction and control. Then, modern knowledge of concrete types of new materials, their relevant characteristics and possibilities of their applications in energy, as well as theoretical and practical knowledge of energy storage technologies,

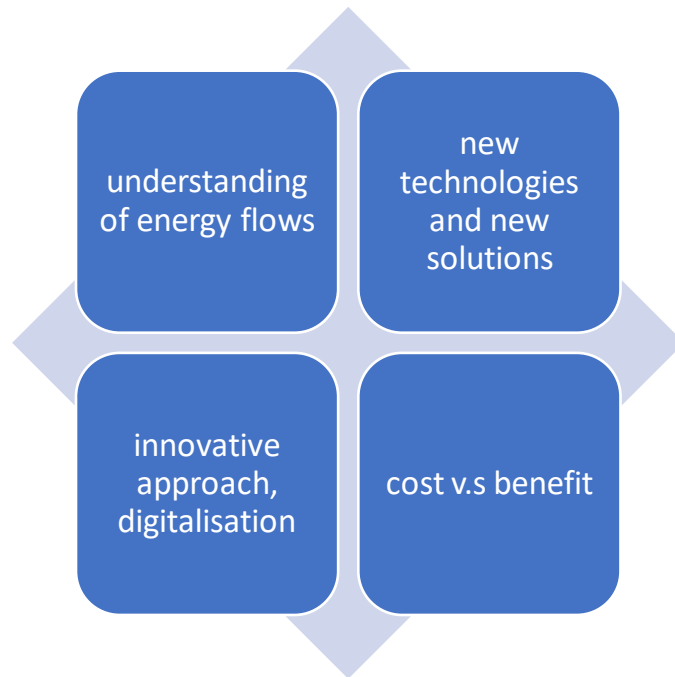
However, the analysis also indicated the uniqueness of study programs in terms of acquiring general competencies such as, developing talent, creativity and innovative thinking of each student, developing students' abilities for teamwork, thorough acquisition and knowledge and understanding of disciplines of all relevant professions, as well as the ability to solve specific problems using scientific methods and procedures, economical use of available natural resources in accordance with the principles sustainable development, research of the best available techniques, to write appropriately and to present the results of the work, individual and analytical approach

The analysis showed that there is a lack of additional knowledge related to the specificity of electricity as a commodity traded on the market. The electricity market, its organization and the reforms that have taken place in the last decade and which are reflected in liberalization, deregulation are also out of focus of study. With the concept of an open electricity market and the role of the state in it, i.e. the influence of each segment of society is something essential and driving in the processes of drafting study programs in this field. This is followed by the mechanisms of price formation, prevention of congestion and the mechanism for creating a balance of the market.

Concepts from optimization theory, demonstration of examples of their practical application, formulation and resolution of optimization problems with and without limitations, multi-step optimization, stochastic optimization with probabilistic constraints and decomposition optimization (Lagrangian and Benders decomposition) are integral parts of planning. Problems of optimal power flow, which is formulated and solved to find optimal adjustment of participants in the energy grid, as well as the problem of deployment with hydro power plants, solar power plants as well as gas power plants, which are in many countries a very important source of electricity supply.

Intelligent power grids, with particular emphasis on practical applications within existing power grids, smart grid technologies and opportunities for their implementation in different parts of the energy sector is also a missing factor.

A special problem is the development of renewable energy sources and their integration into the existing grid, as well as micro and nano networks and solutions to potential challenges that arise during the operation, management analysis, protection, and monitoring.



The digitalization of the energy sector enables a higher level of operational quality by adopting technologies with high potential to bring change to conventional approaches. The domain of big data in energy (eng. Energy Big Data as a framework of modern smart energy grids provides an ideal eco-system for the exploitation of knowledge extracted from data. The trend is solutions that enable the transition towards technologies that do not emit harmful greenhouse gases for corporations and local governments globally. To implement this transition, **integrated** solutions as a service are being sought with the aim of reducing energy consumption and improving energy efficiency.