The Energy Saving Challenge in the Contemporary Formal Courses Development

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***Abstract* — Improvements in energy efficiency can reduce the need for investment in energy infrastructure, cut energy bills, improve health, increase competitiveness and improve consumer welfare. The new market opportunities should be covered by a new generation of electrical engineers and specialists in energy efficient technologies able to develop market-oriented products from an idea till the end product. However, competences offered by standard educational approach are not enough flexible in order to support market oriented developers preparation. The challenges in contemporary formal courses development, experience, methods, technological and business skills for efficient energy management, which have been implemented and tested in Tempus and ERASMUS+ projects, are analyzed and discussed in this work.**

Keywords—energy saving; course development; technology; education; electrical engineering

I. INTRODUCTION

The technological development and industry interests open new opportunities for the collaboration, development new business oriented products for energy efficient applications and implement it on international level. The new market opportunities need to be covered by new generation of electrical engineers and specialists in energy efficient technologies able to develop market oriented products from idea till the end product. The competences offered by standard educational approach are not enough flexible in order to support market oriented developers preparation. The standard energy saving course content is significantly amended and it is used in new study programs. The joint content development practice was tested during the past several projects, and it was really helpful in development courses in energy saving as for international students as for national students. This approach makes a good contribution and positive input for students' career development in all dimensions: national, international, private business, as well as gives an input in mutual recognition of study program expertise in EU and EU neighborhood areas. During Tempus and Erasmus + KA 2 projects the relevant tools supporting technological and business skills in efficient energy management is implemented and tested in EU, Azerbaijan, Belarus and Kosovo educational approach during Tempus Energy project and other development activities.

II. ENERGY SAVING

The Energy Saving is a priority in many practical areas of engineering. The core content development for defined course as well as development of example set is an issue for study programs in engineering areas. The modules based education, in combination with Project Based Learning approach will be used. The standardization of core expertise in existing theoretical background, legal bases and best practice examples on existing Energy Saving Technologies is applied [3].

According to the definition given by International Energy Agency (IEA) Energy efficiency is a way of managing and restraining the growth in energy consumption. Something is more energy efficient if it delivers more services for the same energy input, or the same services for less energy input.

Energy efficiency offers a powerful and cost-effective tool for achieving a sustainable energy future. Improvements in energy efficiency can reduce the need for investment in energy infrastructure, cut energy bills, improve health, increase competitiveness and improve consumer welfare. Environmental benefits can also be achieved by the reduction of greenhouse gases emissions and local air pollution. Energy security – the uninterrupted availability of energy sources at an affordable price – can also profit from improved energy efficiency by decreasing the reliance on imported fossil fuels.

The IEA Recommendations [7] promote energy efficiency policy and technology in buildings, appliances, transport and industry, as well as end-use applications such as lighting. IEA analysis has led to the development of 25 energy efficiency recommendations, which identify best practice, highlighting the opportunities for energy efficiency improvements, and

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policy approaches in each sector to realize the full potential of energy efficiency for EU member countries [7].

The energy efficiency is very important almost for all technical disciplines as well as for business and planning. The deployment of national rules and international standards in the daily life of engineers from university time is important to introduce the efficiency understanding and habit to use it for standard technology application and event more important for new technology development.

III. International Standards

The international recommendations, published by IEEE-USA [1] Position statement on Energy Efficiency the efficiency means the ability to provide the same or better, product or service, using less energy, in contrast to conservation -- reducing energy use by no longer performing a task or not delivering a service. Further, demand response – a capability to modify customers' energy use over time, to provide a resource for power system operations, is not covered in this document. However, as the demand response and energy efficiency are closely intertwined, some of the measures discussed below include a demand response component.

The ISO 50 001 standard on energy management, as well as EU level energy efficiency directives provide a legislative basis for academic education content.

The basis on energy saving course content includes the following main topics: Energy Saving Technologies in Generation; Energy Saving Technologies in Transmission; Energy Saving Technologies: in Industry; Energy Saving Technologies: in Public and Private Sector; Legal Bases on Existing Energy Saving Technologies.

Fig.1 shows several priorities based on demand-response.

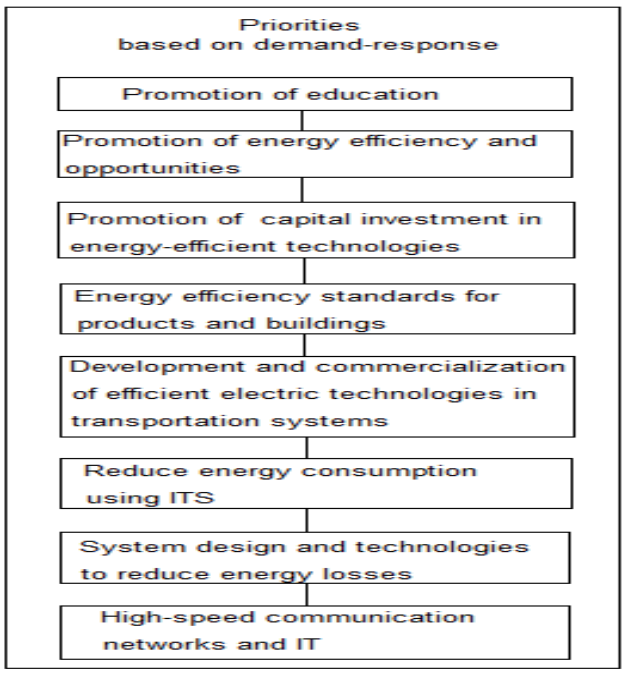

Fig. 1. Priorities based on demand-response.

Below it is possible to see these priorities in more details:

- Promote education and user awareness of energy efficiency opportunities;
- Promote capital investment in energy-efficient technologies and processes for residential, commercial, transportation and industrial sectors;
- Promulgate minimum efficiency standards for products and buildings consistent with lifecycle analysis
- Develop, commercialize and use efficient electric technologies in transportation systems;
- Adapt intelligent transportation systems to reduce energy consumption;
- Develop system designs and technologies to further reduce energy losses in electric power generation, transmission and distribution;
- Promote the use of high-speed communications networks and information technologies to substantially improve controls, and access to information and systems efficiencies;

IV. The Priorities

The energy transformation sector uses about one third of all primary energy, yet the average energy yield for transformation facilities is around 40 %. There is great potential for improving this, which would substantially help to reduce energy loss. Energy distribution and transport are also sources of energy losses where action could potentially be taken [8].

With almost 20 % of total primary energy consumption and the fastest growth in consumption, the transport sector represents both a major environmental risk (greenhouse gas emissions) and one of the main factors of dependency on fossil fuels. To solve these problems, it is vital to take action on car use and on promoting cleaner alternative transport.

The Commission plans to set a binding target to reduce polluting car emissions to achieve the threshold of 120g of CO2/km by 2012. It also intends to address the issue of car components, such as air conditioning and tires, in particular by issuing a European standard for rolling resistance and by promoting tire pressure monitoring. Moreover, strengthening the rules on vehicle labeling will help to promote the most energy-efficient vehicles as well as proper awareness-raising campaigns and public authorities purchasing clean vehicles.

The development of new equipment is rather priority as from technical, as from economic analysis and synthesis.

V. The Regional Cooperation

The development and implementation of new generation technology solutions for energy saving are essential.

The total energy production in Latvia increases by 30% in last two years [9]. The number of students, defended the thesis in power supply, electrical engineering and related topics is not growing. In order to cover the natural gap in the related expertise the not specialist become a good source of

employees in power supply sector. This tendency is also actual, because the de- monopolization of power supply market requires a lot of market–oriented experts to join the industry. The market conditions require the market–oriented power supply engineers.

The technological concept of new energy generation of self – sustainable region foreseen integration of small energy amount production on sites, concept called smart grids. Fig.2 shows attributes which would need to be addressed in smart grids.

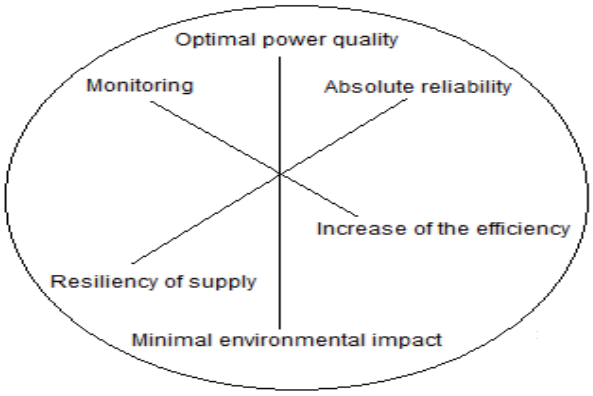

Fig. 2. Attributes which would need to be addressed in smart grids.

These attributes will be described below:

- Absolute reliability of supply and optimal use of power generation and storage;
- Minimal environmental impact of electricity production and delivery;
- Reduction in electricity used in the generation of electricity and an increase in the efficiency of the power delivery system and effectiveness of end users;
- Resiliency of supply and delivery from physical and cyber-attacks and major natural phenomena (e.g., hurricanes, earthquakes, tsunamis, etc.);
- Assuring optimal power quality for all consumers who re-quire it;
- Monitoring of all critical components of the system and outage prevention.

The optimal solution could be bachelor grade in engineering fellow by MBA, but the number of such specialists is not high enough. This market gap could be covered by introduction of new set of courses shared Latvian and International experience. The new initiative, jointly with Nordic partners is planned in 2017 in Riga Technical University. BALTECH was set up with the aim to be the solid base for wider partnership and closer cooperation between universities in the Baltic Sea Region within the area of natural sciences, technology and industrial management and as a strategic resource for long-term development of education and research in accordance with the needs of the region. The extension of BALTECH cooperation in the way of new energy sawing courses development through of The Central Baltic Program 2014-2020. The program finances projects in Finland (including Åland), Estonia, Latvia and Sweden, that aim to solve common challenges together and across borders. In total, 115 million Euros are available for funding. The funds can be applied for in calls, two of which have already been realized. The third and likely the last full-fledged call will open on 2 January 2017. [10]. The thanks Baltic cooperation university network BALTECH [10]. The aim of BALTECH coincides with policies on the highest political level on pro-found and intense cooperation in the region, the importance of this, is not the least underlined by the EU Commission. One of the main BALTECH objectives has been to focus on topics with a common interest for all member universities involved. BALTECH is an important forum of exchange of information and ideas on what is going on within education, research and administration between the member universities in the region. Long-term goal of BALTECH consortium is to develop a virtual Baltic Sea University of Science and Technology. The integration of energy saving knowledge's from business and technological aspects will give a key to success in technology deployment on regional bases.

VI. International Study Programs Development

The voluntary standardization of undergraduate education in EU and Non EU level brings a huge benefit of baccalaureate diploma and engineering qualification mutual recognition in electrical engineering in EU and neighborhood regions towards mobility of young engineers on EU and non EU levels: standardization of educational and professional standards toward industrial needs by using Erasmus plus, Tempus as well as bilateral agreements for strengthened electrical engineering industry. The first step of harmonization knowledge platform and knowledge in energy efficiency by e – learning platform development experience in a frame of Tempus Energy projects among eastern and western EU members as well as universities from Post Soviet area and EU neighborhood region has been discussed. The future steps for the long term sustainable development approach in the region have been planned in Erasmus plus Capacity building project Physics.

In the result of Tempus Energy project [2] the joint student's book [3] was issued by the international group of authors. The overview of Energy Saving Technologies, and its application of practice examples promoted by European strategies in power supply. The technological overview for energy transmission, distribution, such as flexible AC transmission systems, DC transmission systems, efficient control and metering system. Thee overview of Electric drives as Energy Saving Technologies are given in particular: optimal selection of electric motor power and application of frequency regulated electric drives are described as well as SCADA system application; monitoring of unauthorized connections. The technological overview of efficient lighting, energy consumption by transport, street lighting system as a practical example of energy saving technologies. The overview of EU Directives on Energy Efficiency, on Promotion of the use of energy in Energy Effective Lighting, and Energy Performance of Buildings Directive are described; the main concept and application areas as well as benefits from using those concepts.

During Tempus ENERGY [11] project the international group of experts identified 10 main energy saving related topics. These course materials are used in different energy saving related areas, by all of the partners. Here formulated main energy saving related topics are:

- Distribution of power energy
- Wind energy
- Energy effective materials
- Heat pumps
- Solar energy and photovoltaic
- Effective lightening
- Energy saving Technologies
- Power Electronics
- Gas- and Hydrodynamics
- Hydrogen energy

University of Kosovska Mitrovica submitted to the accreditation body Commission for Accreditation and Quality Assurance for new master study module. Module: Power Engineering; Qafqaz University's team is working on primary strategy touching different factors such as labor market requirements, local legislation of the Ministry of Education of Azerbaijan, accreditation requirements, program outcome, marketing and awareness raising techniques, student recruitment, literature definition, etc. Currently the progress is going on the development of chapters for three courses: Distribution of power energy, Gas and Hydrodynamics and Wind energy. To assure sustainability these courses have been confirmed at the Scientific Board of the Engineering Faculty to implement as elective courses at QU. Target audience for this activity are bachelor and master students of Mechanical Engineering and Industrial Ecology programs of QU. Wind energy – Renewable energy as a master program at the Industrial Ecology. The course is going to be taught in spring semester and course credit is CP 3/ECTS 6. Gas and Hydrodynamics – Fluid Mechanics as a bachelor program at the Mechanical Engineering. The course was taught in fall semester and will also be taught in spring semester. Credit of the course is CP 4/ECTS 6. National Aviation Academy of Azerbaijan 3 Books have been written and 3 new Lecture and Practical Courses (hereinafter – Courses) have been organized. "II-III2-VI4 (II-Ca, Sr, Ba; III- Ga, In, Al; VI- S, Se, Te) Luminophors". These subjects are concerned with a well-known new class of ternary semiconductors perspective for applications in optoelectronics. Courses were organized at undergraduate level (credit point 70). "Algorithm of Thermo-gas Dynamic End Heat Transfer Modeling for Turbine Blades". Subjects of these Courses are as follows:

- overview of existing theoretical background of thermo-gas dynamic end heat transfer modeling principles for turbine blades;
- justification of scientific and modeling principles of the thermo-gas dynamic end heat transfer processes.

In these Courses the thermo-gas dynamic end heat transfer processes and modeling principles in turbine blade cooling technology were explained. Internal convective flows and film cooling methods were analyzed primarily. Lectures and practical courses were organized at undergraduate level "Physical Properties and Application of Photosensitive Semiconductor Converters". Subjects are as follows:

- physical principles of creating the converters based on photosensitive semiconductors;
- physical principle of operation of semiconductor converters;
- influence of ionizing radiation on physical properties of the compound semiconductors.

Lectures and practical courses were organized at undergraduate level. The results of all above given Courses definitely will contribute to the project objectives by improving the theoretical and practical understanding of respective subjects in Energy Production and Saving.

Training process in Belorussian State University by the direction "Energy efficiency" is carried out on the Chair of Energy Physics (CEP) of Physics Faculty in accordance with the approved first degree (specialist) academic Education Plan (EP) for specialty "1-31 04 01 - Physics" since 2001 up to now. This process is executed on CEP up to 2016 on 3-5 courses by the Diploma Program for three qualifications (skills) - "research activity", "engineering (industrial) activity" and "management activity" in framework of specialization "Energy Physics".

Since 2016, training process on CEP by the direction "Energy efficiency" will be principally changed and carried out by two different high-education training systems: System 5+1 and System 4+2. For the System 5+1 all students with qualification "research activity" will be trained in framework of specialization "Energy Physics" for 5 years by Specialist Program and 1 year by Master Program. For the System 4+2 all students with qualifications "engineering activity" and "management activity" will be trained in framework of specialization "Rational Power Industry" for 4 years by Specialist Program and 2 years by Master Program. The last system will be more close to Bologna process acting in EU countries. Belarusian National Technical University starts specialty "Energy Effective Technologies and Power Engineering management" with modernized study programs "Mechanics of Fluids and Gases", "Non-Conventional and Renewable Energy Sources", and "Secondary Power Resources". The program "Fuel and its usage" where tested with one group of 25 students in accordance with curricula.

A project «Physics» [5] aims to reform applied physics disciplines nanotechnology, nonmaterial and photonics training programs to promote the emergence of innovation and economic growth in Belarus. Academic institutions and industrial partners' cooperation will result in creation of new muster level study programs, training courses and appropriate teaching materials. The project will set up a virtual platform, where all partners will have access to training materials, virtual lectures and electronic library. The project scope is to

modernize academic programs in the topic of energy efficiency; the project will contribute to education process in such aspects of this topics energy saving like enhancement of energy efficiency, use of renewable sources.

A project APPLE is a new Erasmus plus project, which was officially launched on 15-th of October 2016, aims to develop course of Energy Efficiency of Onboard Systems and Equipment. It will be based on IEEI team has expertise in Latvian satellite development "Venta-1" and teaching of elements of automatics, control theory and energy efficiency. The course will be developed on basis of existing course Energy Effective Technologies 3.0 ECTS credits.

VII. The National Study Programs Development

The development and improvement of curricula's is in a scope of university's staff daily responsibilities. The technology development and labor market requires the frequent adjustment of study program. The formal national legal requirements states that study program should be accredited for 6 years. During this 6 years the study process should be performed according to approved list of study subjects, however in order to fulfill market requirements the content of study subject could be adjusted. The improvement of laboratory base and introduction new testing methodologies and approaches facilitate significant improvements in the methodology of education, which bring immediate result. [6].

In the result of Tempus Energy project [2] in RTU Energy Effective Technologies Courses of Free Choice for Under-graduate Studies where developed it is 3.0 ECTS credits course of free choice. The course gives an overview of technologies providing saving of energy and some practical examples in power supply. The topics considered in the course are energy transmission and distribution, electrical drives are given in particular - optimal selection of electric motor power and application of frequency-regulated electric drives; modern technologies applied in lighting, application of supercapacitors. EU Directives on energy efficiency, the use of energy and Energy performance of buildings directive, the main concept and application areas as well as benefits from using those concepts are considered in the course.

The new subject for newly developed study program "Biotechnology" such topics will be offered: Electrical engineering and automation: Electrical circuits of direct current, Calculation and analysis of magnetic circuits, Electrical circuits of alternating current, Basics of AC electrical circuits, Resonance phenomenon in AC electrical circuits, Single-phase transformer, Basic realization of electrical motor. Three-phase electrical circuits: Basics of three-phase electrical circuits, Measurement of power in three-phase electrical circuits, Three-phase electrical motor, Three-phase transformer, Means of automation in electrical systems, Parameters and characteristics of elements, Converters of voltage, current and frequency, Sensors, Microprocessor means of automation.

VIII. The Case Study of Voluntary Standardization

RTU is the first higher educational establishment in Latvia, which has been approved as a coordinator of the Joint Projects Actions [12]. The main target of the project was to enhance networking among higher education institutions across the Partner Countries and EU Member States for improving the education in the field of the energy efficiency enhancement, energy saving and use of renewable sources of energy. The high level of IEEI expertise allows to share experience of study program Computerized control of electrical technologies within EU and Partner Countries. The project is focused on the development/modernization of a set of compatible study programs (including lecture courses, laboratory classes and appropriated didactic materials) in 4 declared directions: enhancement of energy efficiency, energy saving, energy effective materials and use of renewable sources. The benefits from networking and usage of common IT platform among partners allow increasing of study programs quality not only in the project partner countries, but also across EU countries. The benefits for students, achieved thanks to common approach versus traditional national approach, is obvious, because it allows developing international carrier just after graduating.

The voluntary standardization between partners with Bologna and non-Bologna based education programs is a driver of the project team. The two approaches are used in the project: topic based and, related with this common e - study process approach.

IX. Energy and Environment

In order to develop successful carrier of students, and get optimal market uptake of new engineers in frame of professional branch of study program „Computer control of electrical technologies" student practice is foreseen and is very popular among students [6]. The relevant practice during the studies gives possibilities to students to find appropriate job in Latvia, but for study program administration gives feedback from employers. In last 10 years, the structure of industrial practice has been strictly defined and standardized in a frame of study program. Besides that, nine projects financed by European Social Fund were implemented in IEEI for improvement of practice for professional bachelor and study program Computerized Control of Electrical Technology.

For the further improvement of the studies in this field and taking into account all the growing requirements in safety and energy efficiency improvement the Institute of Industrial Electronics and Electrical Engineering organised a new Bachelor professional program of Engineering Sciences in Adaptronics. This is realized since 2015.

The students are taught the underlying principles of how circuits work, learn how to develop and test system prototypes, the calibration of instruments or the preparation of systems reports.

This study program provides a blend of knowledge from electrical technologies and computer sciences focusing on state-of-the-art electrical technological equipment, including how to apply the latest automation devices in traditional electro-technical systems and microprocessor control systems.

The basis of the program is the progressive research based learning with a permanent use of flexible testing system [19]. The students are encouraged to be involved in the activities under the control of Doctoral Researchers, with a belief that their minds will bring new dimensions to the research

activities in the field and add to their experience prior to entering the workforce.

Students completing the Bachelor in Adaptronics are expected to get a fundamental working knowledge of the theoretical and practical issues related to the implementation of the various electrical technologies in differing economic sectors, modern automation principles, adaptive systems of different purposes and expected implementation.

Employers, which were involved into the implementation of the projects, provided practice places for students. Therefore each student was provided with a mentor – a head of the practice from the enterprise – who performed the teaching of the students and provided everything necessary for the successful process of the practice realization. Among industrial partners where famous Latvian companies: „ABB", Power supply company A/S Latvenergo Highvoltage networks Latvenergo sub branch TEC-2, SIA „ETM", SIA „Beijer Electronics", SIA „OMS", SIA „Amerilat-MD", SIA „BST", Concern " Latvian railways".

The specialists from enterprises provided the students with some additional teaching of information technologies and software used for control of electrical technologies.

The close contact with enterprises and other employers from Latvia allows developing study programs according to the industry requirements for baccalaureate and master level students. Often PhD students are working directly to improve existing technology in order to increase efficiency of a company, or its operations. For example U. Sirmelis has practical results achieved during PhD for improving of public transport vehicles parameters. Installation of energy storage devices in public electrical transport system allows recovering the braking energy of vehicles, thus increasing system efficiency. Energy storage devices have obvious advantages, for example: saving the braking energy decreases operating expenditures and shortens payback period, flattens the power peaks from substation, etc. In case of transport model optimization vehicles schedule, parameters of traction substation, energy storage devices.

Latvian power industry and industry association's requirement related to managerial, social skill and ability of problem situation resolving are taking into account by IEEI. Therefore project – based learning [13] principles (PBL) become an inherent part of student's education. According to [14] cognitive skills via PBL is associated with increased capability on the part of students for applying those learning's in novel, problem-solving contexts. A systematic bachelor, master and particular doctoral course students' involvement into collaborative projects appears as a more effective approach. Firstly a student participates in a project as an assistant or sometimes as a young researcher among more experienced researchers. At the next step the students develop their skills in student project team headed by experienced senior researcher. Finally the most advanced students could be authorized to independently manage a project team. Therefore student step by step moves forward starting from the projects, in which he or she acts as an assistant, by the state when the student is authorized to manage an entire project [15].

In 2003, the European Council called for a strengthening of the European research and innovation area by creating European technology platforms bringing together technological know-how, industry, regulators and financial institutions to develop a strategic agenda for leading technologies. Since that time European Energy Technology Platform for the Electricity Networks of the Future – Smart Grids has developed Vision Document – April 2006;

Strategic Research Agenda – February 2007, and Strategic Deployment Document – April 2009. Those documents are helpful for development study topics for baccalaureate and master students, since industrial platforms actively take part in up-taking of industry interest in European research programs.

Nowadays life and economic activity are not imaginable without electricity, thermal energy, and transport fuel, and, respectively, power supply [16].

The economic development, growing population, and urbanization pose even greater challenges for power supply systems. Besides, being aware of the fact that the amount of non-renewable energy sources (oil, coal, natural gas etc.) is gradually decreasing, sustainable power supply has become one of the main challenges.

Within research platform «Energy and environment», researchers of Riga Technical University develop technologies and solutions related to the following issues:

- electric power supply, heat supply, assurance of stable, qualitative, and optimal power supply of transport systems and their elements;
- renewable energy sources, transformation and accumulation technologies for usage in electric power supply, heat supply, and transport;
- power supply chains, i.e., energy efficiency of production, delivery, and consumption sector;
- decrease of the environmental impact of climate technology energy supply;
- energy system analysis and planning taking into consideration technical, environmental, and socio-economic aspects.

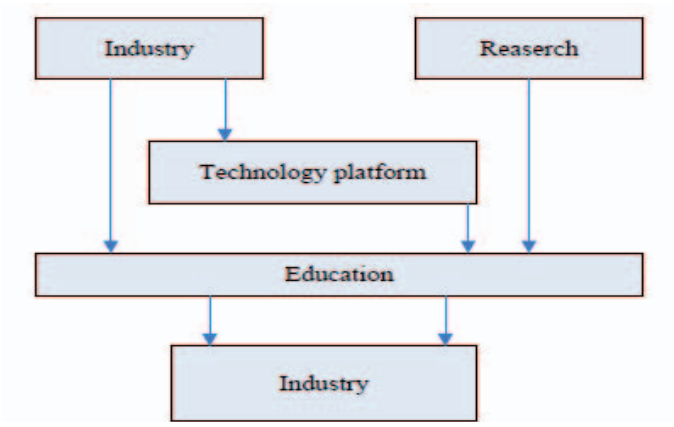

Fig. 3. Technological platforms impact in education process development.

RTU researchers study and develop control, diagnostics, management, analysis and forecasting technologies and instruments for stable, qualitative, and optimal energy supply system performance. The diagnostics methods for power networks, transformers, and electric engines are being developed, as well as semi-conductor transformers for electric drive and combustion process control technologies in thermal energy production equipment.

In the field or renewable energy sources, the scientist's research bio-fuel and biogas production methods and technologies, which allow using different kinds of bio-energy, wind and solar energy in power supply more effectively. As a result, new technologies are developed, which use the synergy between several power resources, for example, solar energy and wood pellet combined usage in heat supply. The industrial electronics technologies are a significant research field, there technologies are required for development of smart electric supply systems, as well as for broader renewable energy source technology usage in electric supply.

RTU develops energy efficiency technologies for electric and thermal energy production equipment, management systems, i.e., for power grids and their components, heat distribution networks, as well as end consumption sectors, industry, transport, households, etc. Taking into account the fact that a significant proportion of the state end consumption is constituted particularly by the building sector, active research takes place in the field of building energy efficiency, for example, heat insulation solutions, interior climate control and management technologies. Research in the field of industrial electronics allows one to decrease electric energy consumption in the industry and other sectors, for example, by developing smart lighting systems.

In order to decrease the negative impact of power supply on the environment, different climate technologies are being researched with the purpose to decrease the power supply generated emissions into air, water, and soil. Particular attention is paid to technologies and equipment decreasing the amount of gases causing the greenhouse effect, which simultaneously allows decreasing power equipment fuel gas emissions and increasing energy efficiency.

In order to determine the optimal combination and performance of energy system technologies, analysis and optimization methods and instruments are being developed. The mentioned modeling instruments are made also for particular power supply system elements, for example, power network systems, electric insulation materials, and electric engines, district heating systems, and thermal power engineering equipment. In many cases, the analysis instruments comprise not only technical aspects, but also the aspects of socio-economic and environmental impact to get a comprehensive system analysis results.

In order to determine the renewable power resource usage possibilities in power supply, heat supply, and transport systems, the possible synergy among these power supply systems is analyzed, for example, wind power station produced electric energy usage in the centralized heat supply systems for heat production and in electric transport.

X. Project Based Learning Methodology Application

The use of Project Based Learning (PBL) [17], [18] method is one of the most important methodological issues for acquisition of transferable skills by the students of electrical engineering branch. The PBL approach in RTU is extremely important, for developing innovations and technical progress in Latvia.

PBL in general provides complex tasks derived from challenging questions or problems that involve the students in problem solving, decision making, investigative activities, and reflection that include teacher facilitation, but not direction.

PBL is focused on the questions that drive students to encounter the central concepts and principles of a subject hands-on.

According to [14], cognitive skills via PBL is associated with increased capability on the part of students for applying those learning's in novel, problem-solving contexts. PBL approach supports students learning and practicing skills in problem solving, communication, self-management, it encourages the development of habits of mind associated with lifelong learning, civic responsibility, and personal or career success. PBL integrates curriculum areas, thematic instruction, and community issues, it helps to assesses performance on content and skills using criteria similar to those in the work world, thus encouraging accountability and improved performance.

Application of PBL in RTU encouraged creation positive communication and collaborative relationships among diverse groups of students, because it met the needs of learners with varying skill levels and learning styles. However the main problem of introducing PBL in RTU is changing the thinking way of academic staff and students [15].

XI. The Energy Saving Concept Development Constraints

The energy saving concept is interrelated with deployment plans of EU Smart Cities and Communities initiative the main targets are:

- deploy wide-scale, innovative replicable and integrated solutions in the energy, transport, and ICT;
- trigger large scale economic investments with the re-payment of implementation costs in acceptable time lines (to facilitate the bankability of the projects);
- increase the energy efficiency of districts and of cities and foster the use of renewable and their integration energy system and enable active participation of consumers;
- increase mobility efficiency with lower emissions of pollutants and CO2;
- reduce the energy costs;
- decarbonizes the energy system while making it more secure and stable;

- create stronger links between cities in EU Member States with various geographical and economical positions through active cooperation.

Many technologies capable of improving energy efficiency exist today. Some have been established for several decades (e.g., fluorescent lamps), others are new to the market-place (e.g., white LED task lighting), still others have been available for a while, but could still benefit from increased penetration (e.g., lighting controls).

The majority of the technologies listed consume less energy than conventional alternatives. Some of the technologies listed are electro technology alternatives to thermal equipment.

In many cases they are more energy efficient than conventional thermal alternatives. One of the primary advantages of electro technologies is that they avoid on-site emissions of pollutants.

The buildings technologies are broken down into categories of building shell, cooling, heating, cooling and heating, lighting, water heating, appliances, and general. The industry technologies are divided into the end-use areas of motors, boilers, process heating, waste treatment, air and water treatment, electrolysis, membrane separation, food and agriculture, and general.

The numbers of specific courses are developed in RTU in the last 5 years, it allows actively making students ex-change in frame of international cooperation agreements and Erasmus plus mobility activities.

XII. Conclusions

The implementation and continuous development of e – learning approach for electrical engineers, and in particular for subjects covered by study programs „Computerized control of electrical technologies" and "Adaptronics" will bring useful results for other education topics.

The development of mutually recognized curricula, based on principle of mutual recognition of the content in native languages, will take a step forward in the development of the sufficient content.

The early involvement of the students into the scientific and methodological projects development and realization give an outstanding results and motivation for scientific and engineering design activities. It is significantly important to involve the students into the energy saving problems solutions from the very staring steps of their education.

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