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HIGHER ENGINEERING EDUCATION FOR SUSTAINABLE DEVELOPMENT

Societal needs, related to the environmental challenges, require relevant human resource and, therefore, must be adequately addressed in both the content and the teaching methodology of higher engineering education. The approach to redefine the content of the engineering curriculum while addressing current and future needs of the sustainable development has been analysed with respect to shift of the techno-economic development paradigm from the "cleaner production" concept to the "industrial transformation" concept. Consortium comprising Ukrainian and EU academic, industrial, R &D and policy-level stakeholders in the scope of the ongoing TEMPUS project "Higher engineering training for environmentally sustainable industrial development" aims at addressing sustainability challenges through the set of activities, including introduction of new taught disciplines.

1. Introduction

Ukraine, similarly to the countries of the European Union, faces common problems of the modern world, related to environmental footprint of industrial development such as depletion of mineral resources, anthropogenic pollution, excessive land use, climate change and alike. Borderless biosphere and globalised economy make it impossible for any country to take up such challenges on its own. Therefore international and cross-European cooperation is increasingly important to ensure future sustainable development.

Current and future societal needs, related to environmental challenges, require relevant human resource and, therefore, must be adequately addressed in both the content and the teaching methodology of higher engineering education, including also lifelong training.

The nature of emerging qualifications is not very well understood by educators. In-depth knowledge within the own professional field, awareness of best available technologies (aimed at saving energy and resources, preventing pollution and recovery of wastes) are, of course, very important, though not sufficient to fully address the environmental challenges. Therefore, the new content for the engineering curriculum, addressing the needs of the sustainable development is yet to be defined.

2. Methodology and analysis

During several decades in higher engineering education the content of training modules, related to environmental issues, was shaped around so called "cleaner production" concept. However, reaching of the environmental targets, established by the society, requires a synergy of more complex measures. For example, analysis [1] shows that global reduction of greenhouse gas (GHG) emissions for 15-20% by the year 2050 compared to 1990 emission levels or by 50-60% compared to a ''business as usual'' scenario [2] will not be possible only by improvement of existing technologies. Recently published 5th report of the Intergovernmental Panel for Climate Change [3], summarising studies of over 800 experts from all over the world, makes obvious the need for urgent action in development of radically new technologies, enabling to mitigate the anthropogenic effect on the climate systems.

Therefore, a shift of the techno-economic development paradigm is needed to ensure sustainable future. This will require reshaping the trajectories of technological innovation. Following issues must be highlighted:

necessary CO_2 emissions reductions require major technological changes– improvement of existing processes will not be sufficient;

shift from the "cleaner production" concept to the "industrial transformation" concept in innovations development and in education is required;

more complex efforts to address synergies related to all levels of systems of industrial production, distribution and consumption are needed;

future industrial transformation, aimed at the climate stabilization, will have considerable effects on economic activities, markets and behaviours.

New generation of university graduates must be equipped with knowledge and skills needed to effectively respond to current and emerging societal challenges. To address these needs the project entitled "Higher engineering training for environmentally sustainable industrial development" (HETES)

has been developed in the consortium of following organisations, representing academic, industrial, R &D and policy-level sectors of both EU and Ukraine:

Katholieke Universiteit Leuven (Belgium);
Buckinghamshire New University (UK);
Universidad de Granada (Spain);
Royal Institute of Technology (Sweden);
Volvo Cars Gent (Belgium);
National Metallurgical Academy of Ukraine;
Donetsk National Technical University;
Ivano-Frankivsk National Technical University of Oil and Gas;
Kryvyi Rih National University;
Sevastopol National Technical University;
Ministry of Education and Science of Ukraine;
Ukrainian Research & Technology Center of Metallurgy Industry "Energostal".

The project is funded by the European Union under the TEMPUS programme with duration from December 2013 through November 2016[*].

General aim of the project is to help improve relevance of higher engineering education in Ukraine towards the challenges of current and future industrial transformation aimed at sustainable development and climate stabilisation. Reaching of this aim will help deliver new generation of engineers and will reinforce integration of Ukraine within the scope of cross-European efforts in mitigation of the climate change, enhancing the resource efficiency and sustaining the raw materials supply.

"Climate action, resource efficiency and raw materials" [4] are identified by the European Commission as important societal challenges. Moreover, National Indicative Programme of the European Neighbourhood and Partnership Instrument for Ukraine stipulated urgent need for integration of environmental considerations, improvement of energy efficiency in industrial sector and raising the environmental awareness among consumers. Therefore, HETES addresses EU priorities and development strategy of Ukraine. It also addresses higher education priorities and the labour market needs.

Important innovative features of the HETES project, compared to other initiatives that exist in a field are:

focus on interdisciplinary issues with the potential to bring technological synergies and radically new technologies, needed for environmentally-driven industrial transformation and enabling mitigation of climate change;

strong ties with European Union's strategy towards societal challenges, established for TEMPUS, Erasmus+ and Horizon 2020 programmes, providing synergy of efforts in combining the training and research activities;

emphasis on building capacity to address concerned societal challenges in a sustainable way through development of relevant human resource, establishing training centres and professional networks;

industrial relevance, achieved by involvement of non-academic partners and universities with expertise in different industrial fields;

addressing broad spectrum of training, covering graduate, post-graduate and lifelong learning audiences.

Based on the analysis performed the target groups and their needs within the scope of the HETES project are identified as follows:

educators need to learn experience of the EU universities in addressing concerned societal needs by training;

students need to be equipped with skills and knowledge demanded by society and needed for their future careers;

lifelong learning audience needs to update skills and knowledge and to acquire new qualifications for future career;

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industry needs to remain competitive under conditions of carbon-constrained economy, to be capable to uptake the technological innovations;

society at large needs to establish societal dialog that will result in defining the strategy for sustainable development.

3. Results and discussion

The project has commenced in December 2013 with major focus within its first year on study of the experience of the European partners. In order to acquaint the Ukrainian academics with hands on experience and practices short study visits were organised during the spring of 2015 with focus on the following issues:

Reform of university towards the needs of education for sustainable development

structural units, responsible for sustainability components (centres, departments, chairs)

overview of the documents, stipulating the strategy for sustainability (development concepts, action plans)

Curriculum for sustainable development

overview of relevant degree programmes dedicated to sustainable development

methodology for embedding sustainability components to the curriculum

Skills, qualifications and learning outcomes for sustainable development

procedures and actors involved in definitions of skills, qualifications and learning outcomes

role of multidisciplinary approach

Role of practical training and partnership with enterprises

how practical training is organised and how the sustainability issues are focused

how enterprises take part in definition of sustainability component in education

Feedback from sustainability research and innovation to education

R & D policy for sustainable development

knowledge triangle: focus on sustainability

Based on the experience acquired the project partners developed the vision for the reform that will be outlined in the development strategies of the Ukrainian project participants. Project partners will develop the new discipline "Environmentally sustainable industrial development" (4 ECTS credits). The content of this discipline is defined as follows.

1. The first module is common for all engineering profiles and aims at following pedagogical targets:

to raise environmental and climate change awareness (5^{th} IPCC report might be used as the most comprehensive study in a field);

to introduce international initiatives and economic tools for sustainable development - Kyoto Protocol, UN FCCC, flexibility mechanisms such as Clean Development Mechanism, International Emissions Trading, Joint Implementation;

to introduce interdisciplinary analytic tools such as Life-Cycle Assessment and alike.

2. The second module will be industry specific and will involve following components

Innovations and Best Available Technologies – potential for emissions reduction;

Innovations and Best Available Technologies (BAT) and analysis of their potential for emissions reduction and mitigation of climate change;

Introduction to ongoing industry-specific EU initiatives, aimed at development and implementation of environmentally drive innovations. In the field of iron and steelmaking examples of such initiatives are ULCOS - ultra-low CO_2 steelmaking) and non-EU (COURSE 50 in Japan (CO_2 Ultimate Reduction in Steelmaking Process by Innovative Technology for Cool Earth 50 [5]);

Carbon accounting methodology.

3. The third module is defined as an interdisciplinary team project aimed to explore environmentally-driven technological innovations, involving students of different majors.

The new discipline will be validated in discussion with industrial stakeholders and implemented to teaching from 2015/16 academic year. Future project activities will include also establishing of the Interfaculty Sustainable Development Centres in the Ukrainian universities.

Summary

The approach to higher engineering education reform was analysed in a view of reaching the environmental targets, established by the society. A need for curricular reform aimed to equip graduates with skills and qualifications needed to address the challenges of current and future sustainability have

been stipulated. The content of the interdisciplinary discipline "Environmentally sustainable industrial development" was defined.

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УСОВЕРШЕНСТВОВАНИЕ ПРОЦЕДУРЫ ПОЛУЧЕНИЯ ДОПУСКА ДЛЯ ВЫПОЛНЕНИЯ РЕМОНТНЫХ РАБОТ НА ТЕХНОЛОГИЧЕСКОМ ОБОРУДОВАНИИ С ЭЛЕКТРОПРИВОДОМ

Практика показывает, что причиной тяжелых форм электротравм являются несогласованные и ошибочные действия персонала, ошибочная подача напряжения на установку, где работают люди, нарушение правил безопасной эксплуатации электроустановок потребителей. С целью профилактики электротравматизма на горных предприятиях обоснована необходимость пересмотра и модернизации существующего подхода к контролю подачи электрического напряжения при производстве ремонтных работ, совершенствованию действующей бирочной системы допуска к ремонтам технологического оборудования, внесения дополнений в технические мероприятия по разбору электрических схем с использованием опыта передовых мировых технологий – внедрения международного стандарта БМП (Блокировка – Маркировка – Проверка). Как показал анализ, действующая бирочная система на горнорудных предприятиях Кривбасса уступает своей эффективностью системе Lockout-tagout (LOTO). LOTO позволяет практически полностью устранить риски, связанные с человеческим фактором, при обесточивании оборудования и блокировании подачи опасной энергии, снижая производственный травматизм до 0%. Обосновано направление дальнейших исследований по усовершенствованию существующей бирочной системы с внедрением в нее элементов системы Lockout-tagout (LOTO) или легализации стандарта Lockout-tagout (LOTO) на государственном уровне и целесообразности введения блокирующих устройств, как элементов технических мероприятий для подготовки рабочего места к работе, требующей снятия напряжения.

Проблема и ее связь с научными и практическими задачами. Согласно данным статистики, в общей массе травм на производстве с временной утратой трудоспособности вес электротравм незначителен - лишь 2 %. Однако среди травм со смертельным (летальным) исходом электротравм занимают ведущее место - 12,2%, т.е. каждая седьмая смертельная травма вызвана электрическим током при наличии огромного количества других опасных производственных факторов, таких как станки, транспортные и грузоподъемные средства, возможность падения с высоты при монтаже зданий, сооружений и транспортных объектов, наличие взрывоопасных и токсичных химических веществ и т.п.

Каждый несчастный случай является в конечном счете результатом опасного развития технологического процесса, организации работ, определенных конструктивных недостатков оборудования, невыполнения требований промышленной безопасности и невнимания к ним рабочих и инженерно-технических руководителей.

Как известно, правилами промышленной безопасности, инструкциями по эксплуатации электрооборудования и другими регламентирующими документами категорически запрещается