THE IMPORTANCE OF THE CAPACITY BUILDING FOR IMPLEMENTING ENERGY EFFICIENCY AND RENEWABLE ENERGY SOLUTIONS

by

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Original scientific paper
https://doi.org/10.2298/TSCI180115215V

Within the Climate and Energy Directive, the European Commission has set three main targets: reduction of GHG emissions, increase a share of renewable resources, and improvements in energy efficiency. This paper introduces needs and solutions for capacity building in cross-border regions of Slovenia-Croatia-Hungary in order to better implement energy efficiency and renewable resources potentials. It was identified that a lack of knowledge by the stakeholders represents a main obstacle for implementing more environmental and economic acceptable energy solutions on a local and regional levels. To address the competences gaps by the stakeholders, online training modules were designed and implemented. The results of trainings revealed the best evaluation scores, and consequently improved knowledge and competencies in Hungary, followed by Croatia and Slovenia.

Key words: *capacity building, competencies, energy efficiency, renewable resources*

Introduction

Supported by the statistical data, the share of renewable energy in gross final energy consumption in the EU member states (EU-28) reached 12.5% in 2014, representing around 70% of the EU 20% renewable target until 2020 [1]. The positive trends of using renewable resources were beside technological development supported by supply-side policies, where EU launched several policy initiatives to increase energy efficiency (EE) and usage of renewable resources. However, fostering the employment of EE and renewable depends not only on the supply (producer) side and technology development but also on the end user (consumer) knowledge, competences, and personal preferences (habits, behaviour). Furthermore, energy related projects and investments are long-term processes that require several conditions to be satisfied, such as legislative or technical [2].

Energy sector is one of the most intensive investments across Europe [3] and has impacts on economic performances, technology base, society and overall development of the country [4]. Thus, education and acquirement of competencies became inevitable. As claimed by Pantović *et al*. [5] the awareness raising of the EE measures is of utmost importance for the energy savings. To make stakeholders aware efforts of the educational institutions and the scientific community are needed. For example, Ouhajjou *et al*. [6] has

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showed the importance of providing stakeholders specific information from their points-of-view, regarding the impact of energy strategies on their interest, for better implementation of EE and renewable resource measures. Negro *et al*. [7] identified systemic problems towards the integration of renewables, claiming one of them to be *knowledge infrastructure*, where a wrong focus was given to the educational process at the university level, producing knowledge not applicable in the practice. Jennings [8] argues that the educational system has failed not fostering a basic education of energy supply options and their impact on society and environment. This has led to the problem of shortage of skilled professionals. Jennings [8] also further claims that formal education will not provide the needs of renewable energy technology during the rapid growth of the technology innovations and development and it is necessary to provide trainings for professionals to enhance their knowledge as well as other stakeholders dealing with the energy issues, such as citizens, students, employees at municipalities, decision-makers. Jennings [8] argue that education has one of the most important roles in development of a sustainable society and it is a powerful agent of social change, while Kandpal and Broman [9] add that attitudes by the public have to be changed embracing the whole population as its target and that both formal and informal education should be extensively used. Similar have showed preliminary studies and mapping of the regional renewable energy resources of the Croatians-Hungarian border region in the framework of the CHREN cross-border project [10] claiming that the main reason for not implementing resource efficient renewable energy solutions is a lack of knowledge among stakeholders to build up a local and operational renewable energy project. Van der Schoor and Scholtens [11] identified further factors to enhance energy related projects in local communities, such as creation of shared vision and concrete goals at the start of the project, financial, legal and organizational challenges, familiarization with technological options, relations with outside networks and governmental support. Another important issue identified by Kalkbrenner and Roosen [12] was a willingness to volunteer in energy community project and it is higher than the willingness to invest money. Their study showed that social norms, trust, environmental concern and community identity were important determinants for successful local energy projects. Several authors have published studies on technologies that improve EE and renewable energy sources [13-17]. Schneider *et al.* [18] claim that proper planning of systems with high penetration of intermittent renewable energy sources is the most important segment of future energy production development.

This paper represents the outcomes and results of the training for renewable energy network development (TREND) project, supporting the development of the renewable energy potential in the cross border region of Croatia-Hungary-Slovenia. Firstly, an identification and analysis of knowledge, skills and competences needed to prepare a successful project in the EE and renewable energy sector was carried out, comprehending twenty projects in four sectors (energy to biomass, renewable energy technology, refurbishment initiatives, and sustainable building initiative). These results also identified weakness and strengths of the target groups involved (local small medium enterprises – SME, non-governmental organizations – NGO, municipal decision-makers, and students), which presented a framework for the development of the learning material, in order to fill the gap in knowledge, skills and competences. Four different modules were developed, including project management (PM), EE, renewable energy and biomass energy. The trainings were carried out in Slovenia, Hungary, and Croatia, demonstrating benefits and improved capacities regarding EE and renewable resources.

Methods

Several methods were used, from mapping, analyses, and syntheses as well as comparisons and statistical methods. Based on the results of the mapping activities, a state-of-the-art regarding the EE and renewable energy competences has been identified, representing an entry point for designing the training modules to support the development of EE and renewable energy potential of the Drava River – Croatia-Hungary-Slovenia cross-border region.

Mapping

In order to identify common competency gaps on the regional scale the following two steps were taken: competences were defined, based on the best practice projects, and a self-assessment questionnaire to evaluate the competences and the gaps, which was designed and distributed to the target groups, consisting of students, SME, NGO, employees at the municipalities.

Best practice projects

A template for the best practice projects in the region was prepared to identify specific characteristics regarding the competences. Twenty projects from four sectors (energy to biomass, renewable energy technology, refurbishment initiatives, and sustainable building initiative) were analysed in details, where the lessons learnt were represented as well as analyses regarding the professional knowledge and competences needed. Table 1 shows the analysed projects.

Table 1. A list of best practices reviewed

Field of best practice	Title of the project
Biomass to energy	Biogas and bio ethanol plant at Kaposszekcso industry park
	Biogas utilization of sewage sludge in Zalaegerszeg
	Zero external energy need-fermentation plant capacity extension in the biogas production plant in Kaposvar
	Exchange of gas consumption by utilizing hard biomass – mainly woodchips – at the Univer Product Zrt
	Novi Agrar – biogas plant and utilization of manure and slurry from the surrounding farms
	Ritmic – local wood briquette recycling
	Strizivojna Hrast – cogeneration facility based on wooden biomass combustion and switchyard
Renewable energy technology initiatives	Building of small hydropower plant (220 kW) in the city of Pleternica
	Esus – energy self-sufficient street lamp
	Spiral wind turbine
	Development of geothermal based heating system
	PV net – photovoltaic metering solution
	Velenje – district cooling system from district heat supply
Refurbishment initiative aiming energy efficiency	Refurbishment of Ljudevit Gaj elementary school in Osijek
	House renovation with passive house components in Myhrerenga, Norway
	Sustainable refurbishment of military buildings – incubator-house and innovation centre of Nagykanizsa
Sustainable building initiative aiming EE	Building of 6 energy efficient elementary schools in Virovitica-Podravina county
	New building of agricultural faculty in Osijek
	Sport arena/hall “Gradski vrt” Osijek
	Rati – office and production plant with plus energy potential

Projects were elaborated, based on the following sections:
- title of project / best practice,
- basic data of investment,
- description of the best practice,
- milestones of implementation,
- what was the reason behind the technology option selection,
- what should be done differently,
- lessons learnt,
- professional knowledge required for replicability, and
- skills / competences required for success.

This enabled to summarize the state-of-the-art practice and competences of the EE and renewable energy in the Drava region.

A questionnaire to assess the competences

Self-assessment competence questionnaires were prepared to identify the competence gaps by the target groups (municipalities' decision makers, SME, students, and NGO). The survey was carried out in October and November 2015 in Croatia, Hungary and Slovenia. Table 2 summarizes the number of questionnaires per target group. In order to be able to prepare the training modules, the evaluation of competences needs was divided into nine categories:

(1) Organization and leadership
(2) Management
(3) Collaboration
(4) Innovation
(5) Interpersonal abilities personal characteristics
(6) Communication skills
(7) Analysis / research skills
(8) Planning skills
(9) Computer skills

Table 2. A number of distributed and evaluated questionnaires per country and target groups

Country	SME	Student	NGO	Municipality	Total
Croatia	10	10	10	10	40
Hungary	10	10	10	10	40
Slovenia	10	10	10	10	40
Total	30	30	30	30	120

Development of training modules and assessments

Four e-modules were developed: biomass to energy, renewable energy technology, EE, and PM, consisting of learning and training materials, covering the knowledge, and competences needed. The trainings in all the three countries were carried out from June till November 2016, including the online evaluation of the knowledge and competencies gained.

Results and discussion

This section represents the results obtained from the best practice regional case studies, national analyses of knowledge and competencies as well as contents and training materials of the modules developed.

Results of the best practice case studies

Twenty projects within four fields were reviewed in details. The main results obtained were that the EE and renewable energy related projects usually consist of a complex system of technological, social, economic and environmental dimensions. In order to implement successful projects, individuals need professional competences as well as competences in

the field of PM to be able to co-ordinate the project implementation. Within the mapping processes of the successful energy projects four main knowledge and competencies categories were identified, fig. 1, where all of the projects required knowledge and competences in the field of the best available technology options related to the EE and renewable resources, followed by legal, management and administration requirements, knowledge about the financing, and basic and general knowledge.

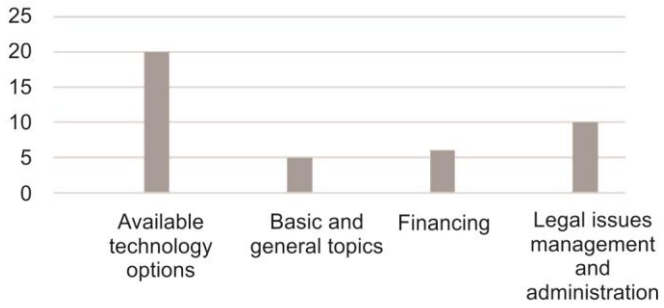

Figure 1. Knowledge and competences requirements

The mentioned four topics of knowledge and competences requirements were classified in details:

(1) Technology options:
- best available technologies, such as on recycling and energy recovery from wooden products,
- grid development practices,
- biomass incineration,
- energy production processes,
- renewable resources suitable technologies,
- possibilities of exploitation of renewable resources (*e. g.* location),
- energy consumption in buildings,
- sensors and signals processing,
- system design, measurements and monitoring,
- optimization of production and consumption of energy,
- designing passive, energy efficient and zero emissions houses, buildings,
- operating biogas plant systems, and
- renewable energy markets.

(2) Legal issues, management and administrative procedures:
- municipality decision-making process, municipality strategy,
- law regulations, acts and legislative procedures, also at national levels,
- public tender procedures,
- computer literacy, and
- collaboration with experts and subcontractors.

(3) Financing:
- energy refurbishment investment,
- available financing options to draft a financing plan, and
- financing a project scheme.

(4) Basic and general knowledge:
- material flow analyses,
- real data analyses of the buildings,
- logistics, and
- renewable energy potential in local environments.

Competencies assessments at the national level

Competencies have been assessed based on the self-evaluation questionnaire for each of the participating country and then aggregated into one output, tab. 3.

Table 3. The collated scores for each competency across all respondents is shown, the aggregated scores

Scoring	Organization and leadership	Management	Collaboration	Innovation	Interpersonal abilities	Communication skills	Analysis-research skills	Planning skills	Computer skills	Course total
Average score (out of 10)	6.95	6.99	6.97	6.31	6.45	6.17	6.77	7.01	7.47	61.08
Performance of competence based on average score (10 point = 100%) [%]	69.45	69.92	69.73	63.06	64.50	61.68	67.72	70.08	74.71	67.86
Competence deviation from competence average based on average score [%]	2.35	3.03	2.76	−7.07	−4.95	−9.10	−0.21	3.27	10.09	

Following the results of the competencies evaluation, the competencies' needs are similar in all the three countries and comprise of: innovation, interpersonal abilities, communication skills, and research (analysis) skills.

Training modules

Based on the competencies needs, e-learning training modules were designed:

(1) Biomass to energy module: involves energy crop production, land use questions of biomass production, bio-waste to energy option as a substitution possibility, human resource organization of biomass production, biomass to energy technology, options analysis of advantages, disadvantages regarding local agricultural and human circumstances.
(2) Renewable energy technology: focuses on the technological skills needed to analyse the different renewable energy technology options; this includes the presentation of the possible alternatives of renewable energy production (solar, wind, geothermal, water, heat pump, *etc.*), and the distribution issues (*e. g.* smart grid solutions); the focus was given to competences able to evaluate the different technological solutions based on their advantages or disadvantages with regards to the needs and possibility of the local community.
(3) The EE module: focuses on the technological skills needed to analyze the different EE technology options; this includes the presentation of the possible alternatives of refurbishment of existing building (insulation, refurbishment of heating/cooling system, smart energy solutions, *etc.*), and the sustainable construction possibilities of new housing (passive house technology, locally produced energy options, *etc.*); the focus was given to competences able to evaluate the different technological solutions based on their advantages or disadvantages with regards to the needs and possibility of the local community.
(4) The PM module focuses on the implementation and operations; this includes a properly management of the project (action planning, SMART objectives, *etc.*), the financing for both investment and operation phase insured (fund-raising possibilities, cost-benefit and business analysis), the public acceptance is ensured (public relations, dissemination issues), and a quality control mechanism (indicators, monitoring, risk assessment and intervention plan).

Training modules were implemented from June to November 2016, following the online assessment of knowledge and competences by the participants, fig. 2.

Within the PM module in Slovenia 100 individuals (n = 100) were participating in the online training, 8 participants did not complete the final assessment and 8 of them failed by the assessment, meaning that they have received less than 50% of the total score. In Hungary 31 individuals participated (n = 31), 2 assessments were incomplete and 3 have failed, while in Croatia 78 participated (n = 78), 12 assessments were incomplete and 6 have failed. The results have shown that most successful were Hungarians. The average score of the PM was 69.44, and both Slovenians (66.49) and Croatians (69.40) were below the average.

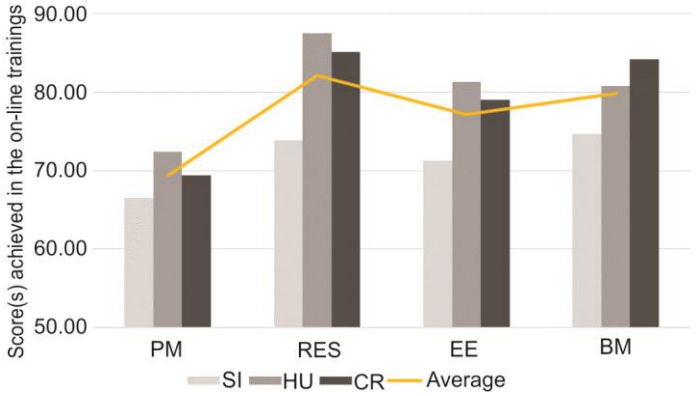

Figure 2. Results of the evaluation of the online trainings

Renewable resources technologies (RES) module has the highest average score (82.17). Again, the most successful were Hungarians (n = 29, failed = 0, incomplete = 2), followed by Croatians (n = 67, failed = 6, incomplete = 1). Slovenians were again below the average regarding the scores, achieving on average only 73.86.

The EE module results follow the same pattern, where Hungarians (n = 30, failed = 3, incomplete = 3) achieved the highest scores (81.30), followed by the Croatians with the average score of 79.02 (n = 72, failed = 8, incomplete = 3) and Slovenians with the average 71.29 (n = 73, failed = 4, 2 = incomplete).

The most familiar with in the biomass module (BM) were Croatians, with an average score of 84.23 (n = 67, failed = 2, incomplete = 4), followed by Hungarians (n = 28, failed = 1, incomplete = 2) and Slovenians (n = 73, failed = 1, incomplete = 3), which were again below the average score.

Competences gaps identified within the mapping processes and analyses of completed energy related projects in the region, revealed shortfalls in the fields of PM (personal abilities, communication) and energy fields related to innovations and research skills. However, the results have shown that participants in the trainings gain some new knowledge on innovations (*e. g.* available technology options), however, the PM skills remain vague.

Conclusions

This paper identifies competences needed to successfully implement energy related projects in the Drava River Croatia-Hungary-Slovenia cross-border region. Regarding the competencies gaps, two studies were carried out, a review of energy related regional projects and a self-assessment competence questionnaire. These two studies revealed a set of missing competences, which were from the content perspective gaps in innovations (technology options), management (legal requirements, administrative procedures, financing), analytical and research skill (basic and general knowledge, data analyses) to personal, such as effective communication and interpersonal abilities. In line with the gaps identified, four e-learning modules were prepared and tested on the target audience, comprehending students, SME,

NGO, and decision-makers at the municipalities. The results of testing revealed that by three out of four modules the best results (average scores) were achieved in Hungary, followed by Croatia and Slovenia. Croatians achieved the best results in the BM, while Slovenian results were in all the four modules below the average scores.

Considering the content of the modules, it can be concluded that the participants gained a new knowledge and competences to cover the missing gaps, especially from the content perspectives, such as innovations. The PM competences gained seemed unclear, since it cannot be defined to what extend the competences have been improved, and in comparison to the other modules, the PM has the lowest average score. Furthermore, it cannot be perceived to what extend the personal competences were improved (*e. g.* communication), since these modules were carried out online as well as the evaluation. However, the trainings prepared was suitable to improve the basic and specific knowledge and competences of the participants, but to improve the communication competences or interpersonal abilities, other tools, training and methods should be considered. An option would be to combine the online training with more active participation of individuals, such as workshops, seminars and project work, since communication competences could be improved when individuals will gain a direct experience. Another very important segment related to the development of competencies, in order to increase the sectors of renewable energy sources and EE is developing infrastructure for improving the management of flexibilities in the energy networks.

Acknowledgment

The research presented in this paper has been financed by the European Commission, Educational, Audiovisual and Culture Executive Agency, Erasmus +, project no. 2014-1-HR01-KA200-007212.

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Paper submitted: January 15, 2018
Paper revised: February 26, 2018
Paper accepted: February 28, 2018