Sustainable Renewable Energy System Installations through Qualified and Skilled Workforce: TRAINEE Approach

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Abstract. Renewable energy and use of renewable energy sources (RES) is seen as part of the appropriate response to the global concerns for energy efficiency and greener world leading to a rapid increase in demand for renewable energy specialists who are able to design, install and maintain such systems. There are very few initiatives for more systematic approach for designing educational programs and developing curricula for training for designers and installers of RES systems in buildings. This especially refers to developing separate occupational standards, recognized by the national qualification frameworks, which will ensure formal validation of developed qualifications. The aim of this paper is to provide a model for training courses for designers and installers of small-scale renewable energy systems in buildings. This model is based on the experience of TRAINEE project, which had the aim to implement training courses for designers and installers of RES systems in buildings.

1. Introduction
Combating climate change and transforming the energy system are core challenges on the path to a sustainable future for business, society and the environment. The Paris Agreement has sent a decisive and global signal that the start of the transition to a thriving, clean economy is inevitable, irreversible and irresistible. The speed at which the energy sector can be decarbonized will critically influence our ability to limit the rise in global temperatures to well under 2°C. Decarbonizing energy consumption – from the way we heat and light buildings, to the way we transport goods, people and services – is at the center of addressing the climate challenge. Projects in this program area focus on implementation of low-carbon energy solutions through cross-sectoral collaboration in renewables and in electrification of heating, cooling and transport.

Many countries and industries are making steps toward mitigating climate change problems and reducing greenhouse gas emissions [1,2]. There is growing concern that buildings are one of the most energy-intensive sectors and contributors to greenhouse gas emissions. A new briefing published by the Buildings Performance Institute Europe (BPIE), the Global Buildings Performance Network (GBPN), the World Business Council for Sustainable Development (WBCSD), the Cambridge Institute for Sustainability Leadership (CISL) and the Cambridge Judge Business School (CJBS) distils the key findings from the recently released Intergovernmental Panel on Climate Change Fifth Assessment Report for the building sector [3-6]. The briefing concludes that:

- The world’s buildings accounted for 36% of global final energy use and 40% of all greenhouse gas (GHG) emissions. Under business-as-usual projections, use of energy in buildings globally could double or even triple by 2050.
• Widespread implementation of best practices and technologies could see energy use in buildings stabilise or even fall by 2050. Many mitigation options promise multiple co-benefits.
• Know-how exists on retrofitting and how to build very low- and zero-energy buildings, often at little marginal investment cost; and there is a broad portfolio of effective policy instruments available to remove barriers to uptake.
• A very important trend is the increased access for billions of people in developing countries to adequate housing, electricity, and improved cooking facilities. The ways in which these energy-related needs will be provided will significantly determine trends in building energy use and related emissions. In addition, population growth, migration to cities, household size changes, and increasing levels of wealth and lifestyle changes globally will all contribute to significant increases in building energy use. The substantial new construction that is taking place in developing countries represents both a significant risk and opportunity from a mitigation perspective.

There are many different ways to reduce greenhouse gas emissions from buildings. The successful implementation of high-performance building requires the application of renewable energy systems (RES), as well as passive building design approaches. Mitigation measures include RES integrating in buildings, fuel switching to low carbon fuels, solar electricity generation through photovoltaic systems etc.

2. Renewables and sustainability in construction
The overall target of supplying 20% of the European Union final energy consumption from RES by 2020 set by the renewable energy directive (2009/28/EC) [7], which establishes an overall policy for the production and promotion of energy from renewable sources in the EU. In December 2018, the revised renewable energy directive 2018/2001/EU [8] entered into force, as part of the Clean energy for all Europeans package, aimed at keeping the EU a global leader in renewables and, more broadly, helping the EU to meet its emissions reduction commitments under the Paris Agreement. The new directive establishes a new binding renewable energy target for the EU for 2030 of at least 32%, with a clause for a possible upwards revision by 2023. Under the new Governance regulation, which is also part of the Clean energy for all Europeans package, EU countries are required to draft 10-year National Energy & Climate Plans (NECPs) for 2021-2030, outlining how they will meet the new 2030 targets for renewable energy and for energy efficiency. Member States needed to submit a draft NECP by 31 December 2018 and should be ready to submit the final plans to the European Commission by 31 December 2019. Most of the other new elements in the new directive need to be transposed into national law by Member States by 30 June 2021.

The buildings and buildings construction sectors combined are responsible for 36% of global final energy consumption and nearly 40% of total direct and indirect CO₂ emissions. Energy demand from buildings and buildings construction continues to rise, driven by improved access to energy in developing countries, greater ownership and use of energy-consuming devices, and rapid growth in global buildings floor area, at nearly 3% per year [9]. The Efficient World Scenario highlights the potential for global building energy demand to decline between now and 2040, despite total building floor area growing by a further 60%. On average, buildings in 2040 could be nearly 40% more energy efficient than today.

Among the renewable energy resources, solar energy is the most essential and prerequisite resource of sustainable energy because of its ubiquity, abundance and sustainability. The systems that are usually employed in buildings are PVs and solar thermal collectors. The advantages of building integration of RES are that more space is available on the building for the installation of the required area of the RES systems and that the traditional building component is replaced by the RES one, which increases the economic viability of the systems. The adoption of building integration of RES can fundamentally change the accepted solar installation methodologies that affect residential and commercial buildings throughout the world.

3. Demand of RES skills
As technological breakthroughs rapidly shift the frontier between the work tasks, global labour markets are undergoing major transformations. These transformations, if managed wisely, could lead to a new age of good work, good jobs and improved quality of life for all, but if managed poorly, pose the risk of widening skills gaps, greater inequality and broader polarization [10].

Most important triggers toward modification of labor market are:

- Emerging in-demand roles
- Growing skills instability
- A reskilling imperative, according to which by 2022, no less than 54% of all employees will require significant re- and upskilling. Of these, about 35% are expected to require additional training of up to six months, 9% will require reskilling lasting six to 12 months, while 10% will require additional skills training of more than a year. Sharply increasing importance of skills such as technology design highlights the growing demand for various forms of technology competency.

In 2012, there are 5.7 million jobs worldwide in renewable energy industries, and the potential for job creation continues to be a main driver for renewable energy policies. This has led to a rapid increase in demand for renewable energy specialists who are able to design, install and maintain such systems. Most engineers and building professionals are not trained to use these renewable energy technologies and most are not aware of the principles of sustainability. From the other hand, the projections for use of RES, especially small-scale solar represent a significant opportunity for Europe in terms of economic and employment benefits – and could provide 150,000 jobs in 2021, according to SolarPower Europe’s Solar Jobs study 2017. High standard of qualification for RES technicians (installers) and designers is the key cornerstone for implementing RES systems in buildings. Training is a key in minimizing risks or technical failures during RES system installation and operation. The substantial need for training and qualification is acknowledged in EU RES directive 2009/28/EC, which includes obligation on the member states to make provision for the training and certification of RES installers. This effort was supported by actions such as EC initiative Build Up Skills, launched by the commission, which aimed to unite forces to increase the number of qualified workforce by promoting training and qualification in the field of energy efficiency and RES in building sector in Europe.

Likewise in other EU countries, in Macedonia, dispute the lack of wide awareness for greener construction [11], there were also actions towards meeting the needs for upskilling workforce in construction sector. The Republic of Macedonia has harmonized its energy efficiency policy with the European legislation and has set national energy saving targets that should be achieved by 2020. The building sector has a 36.13% share in the energy saving targets. In this sector, the preparatory activities were undertaken within Build Up Skills Pillar 1 (2012-2013): Status Quo Analysis for the building sector. It outlined the gaps between the current situation and the demand for skilled on-site workers, while the Roadmap, a document endorsed under the National Qualification Platform, uniting over 60 members, has addressed priority measures to help overcome the gaps and barriers. The shortage of 9,600 skilled workers for energy efficiency and renewable energy sources should be overcome with the implementation of priority measures defined in the Roadmap [12, 13] and aiming to: upgrade the national education system to provide EE (energy efficiency) and RES (renewable energy sources) qualifications; design training schemes for EE and RES in buildings; build capacity of education institutions, relevant to the needs of skilled workers, and overcome communication barriers in the implementation of the Roadmap goals. As identified in the Roadmap, the required number of skilled workers for RES system installations are:

- Solar thermal installers, installers of biomass boilers and stoves, solar photovoltaic and thermal systems, shallow geothermal systems and heat pumps – a minimum of 2,000 and a maximum of 3,000 workers

According to the Roadmap the priority actions towards ensuring minimum number of skilled workforce for RES installations are organized as presented in table 1.
Table 1 Need for upgrade of the national education system for the construction occupations in terms of providing EE and RES qualifications

| No. | Measure | Motivation | Goal |
|-----|---------|------------|------|
| 1.1 | Upgrade of the adult education system for: National Qualifications Framework | Informal education system |
| 1.1.1 | Use of new materials with a small heat transfer coefficient | Occupation upgrade |
| 1.1.2 | External wall insulation | Occupation upgrade |
| 1.1.3 | Roof insulation | Occupation upgrade |
| 1.1.4 | Replacement of windows | Occupation upgrade |
| 1.1.5 | Installation of energy management systems | Occupation upgrade |
| 1.1.6 | Reconstruction of the heating system | Occupation upgrade |
| 1.1.7 | Solar thermal installers | Occupation upgrade |
| 1.1.8 | Installers of biomass boilers and stoves | New occupation |
| 1.1.9 | Solar photovoltaic and thermal systems | New occupation |
| 1.1.10 | Shallow geothermal systems and heat pumps | New occupation |
| 1.2 | System for accreditation and certification of qualifications acquired through the informal education system | EE and RES education | Certification |
| 1.3 | Monitoring system of informal education |

The BUS Pillar 2 (2014-2016): project BUILD UP Skills BEET aimed to introduce qualification and training schemes for 5 groups of skills by encompassing all prioritized occupations in the building sector, previously identified in the National Roadmap, in order to meet the requirements for EE of buildings [12]. Training curricula, with projected learning outcomes and adequate training materials, were developed. These are intended to provide trainers and building workers with qualifications for EE building envelope (EE plaster and roof construction), thermal insulation of the building (carpentry and HVAC) and EE electrical installations [14-16].

4. Ensuring qualified and skilled workforce for RES system installations: TRAINEE approach

The project “TowaRd market-based skills for sustAlINable Energy Efficient construction” is EU funded project under HORIZON 2020 programme, topic: Construction skills, Type of action: CSA Coordination and support action. TRAINEE (2018-2020) is running in the frame of H2020 programme, as a follow-up action of the previous national projects in BUS initiative [17]. The overall objective is to increase the number of skilled building professionals according to recommendations from national qualification roadmap concerning two priorities, training of 4,500 building professionals and blue collar workers and overcoming barriers for implementation of EE measures in operation and maintenance.

Specific objectives (SO) include upgrading two qualification schemes for technicians, building managers and engineers and development of large scale of training schemes for 5 blue collar qualifications and two RES occupations (designers and installers) by establishing the Knowledge Centre for support in development of sustainable EE market-based construction skills with annual capacity to replicate it to 10 training providers and 600 qualified construction workers (200 through training and 400 through recognition of previous learning).

Vocational Qualification Schemes VQS for installation of solar-thermal and photovoltaic systems will be implemented, engaging both blue collar workers (qualification level IV and III from NQF) and building professionals (for upgrading skills on qualification level Vb from NQF). This implementation will be conducted by training programmes for design and installation of solar-thermal systems organized on two levels – for blue-collar workers and for building professionals. This will be a specific challenge for realisation since the national procedure for developing qualifications and
defining vocational training programs for qualification level higher than IV-th level in NQF is still not established. In fact the implementation of the law for NQF in Macedonia is still in the phase of development. For each training schemes and qualification level pilot training will be organized in order to test the relevance of the developed programs.

4.1. Stages in developing new qualifications
The process of developing qualifications is regulated by the Law on the National Qualifications Framework (NQF). One of the most important features of the Macedonian Qualifications Framework is its openness for all types of qualifications, at all levels of education: general education, vocational education and training (3-year or 4-year), post-secondary education, higher education and adult education.

Developing a standard of qualification is a complex process based on co-operation between different stakeholders (fig. 1). The working group that develops the final description of the standards of qualification may include the following participants: representatives of policy institutions relevant to a particular type of training (VETC, AEC, BDE, etc.), employers, training providers and training.

- Phase 1 - Basis for developing new qualifications
- Phase 2 - Submission of a proposal for a new standard of qualification
- Phase 3 - Implementation of the proposal
- Phase 4 - Develop a standard of qualification
- Phase 5 - Approval of the standard of qualification
- Phase 6 - Re-accreditation of the standard of qualification

Figure 1. Developing a standard of qualification

4.2. Development of qualifications in adult education
The qualifications in adult education are awarded on the basis of the Law on Adult Education and several other documents. Figure 2 below gives the procedure for developing qualifications for adult education. There are two main types of adult education programs: those based on the needs of the labor market and consequently occupational standards and those aimed at providing specific, usually soft skills that are not directly related to market needs on labor.

Qualifications for adult education typically develop accredited educational services, but also employers, as special programs and programs for specific skills.

Figure 2. Procedure for developing qualifications
The procedure for verification of special programs for adult education has four steps:

- Request for verification of a special adult training program
- Approval of an adult education program
- Request for verification of the institution for adult education
- Enrollment in the registers of verified programs and verified institutions and institutions.

### 4.3. Development of Occupational standard for Designer/installer of RES systems in buildings

A key element when creating training programme for certain qualification should be represented by a sectorial or domain-specific matrix of competences. The matrix is a planning and evaluation tool for trainees, teachers and educational institution that is providing the training. The focus of this matrix is at the level of an engineer (EQF level 6) and technician (vocational education and training) (EQF levels 3-4). For defining competence matrix for qualification Designer/installer of RES systems, the scope of the core work tasks should include four renewable energy systems (PV, ST, HP, BM). Here, the competency matrix of the partial area photovoltaic and solar thermal systems is presented, and it includes five areas of expertise / core work tasks:

| Core work tasks | Photovoltaic systems                                                                 | Solar thermal systems                                                                 |
|-----------------|--------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------|
| 1               | Providing advice to a customer while keeping in mind customer-specific requirements and conditions, in order to plan photovoltaic systems that meet demands, and to procure, install and maintain them. | Providing advice to a customer while keeping in mind customer-specific requirements and conditions, in order to plan solar thermal systems that meet demands, and to procure, install and maintain them. |
| 2               | Planning a consumer PV system according to recognized rules of the technology, the legal requirements and the safety provisions. | Planning a consumer ST system according to recognized rules of the technology, the legal requirements and the safety provisions. |
| 3               | Installation, start-up and hand over a consumer PV system inclusive of briefing the customer, documentation and maintenance reports. | Installation, start-up and hand over a consumer ST system inclusive of briefing the customer, documentation and maintenance reports |
| 4               | Maintain, repair, extend and adjust a consumer PV system in accordance with the guidelines of legislators, energy suppliers and manufacturers. | Maintain, repair, extend and adjust a consumer ST system in accordance with the guidelines of legislators, energy suppliers and manufacturers. |
| 5               | Plan, document and evaluate commercial consideration keeping in mind financial assets, ethical and social principles and the fundamental importance of sustainability, in order to be economically successful. | Plan, document and evaluate commercial consideration keeping in mind financial assets, ethical and social principles and the fundamental importance of sustainability, in order to be economically successful. |

In the frame of the matrix are defined both competences for Designer of PV/ST systems at the level of an engineer (EQF level 6) which include all areas of expertise 1-5 from table and competences for Installer of PV/ST systems at the level of technician (vocational education and training) (EQF levels 3-4), which include areas of expertise 3 and 4 from the above table.

Taking into account existing training programs that have their focus in electrical engineering, thermal engineering, or other educational goals, fundamentals of electrical engineering and thermal
engineering are included. Thus, the lateral entry into the qualification program should be possible. The matrix of competences contains no terms of reference, oriented towards research and development, but at level 6 of the EQF it is possible to find components out of the first cycle of a university study.

4.4. Training program for use of RES in buildings developed in TRAINEE

The trainings are developed in line with the requirements of the revised Directive 2018/2001/EU on the promotion of the use of energy from renewable resources. The content of training will include a detailed state-of-art of the subject treated in the particular training course, giving an overview of materials and techniques for implementation, basics of design and use of software, proper installation and maintenance of solar thermal and photovoltaic system installation, theoretical explanations of the processes, covering ecological aspects, components, characteristics and dimensioning of solar systems, providing good knowledge of ISO standards of quality, techniques for measuring energy savings and issues from work safety. The content of training will include a detailed presentation of the subject treated in the particular training course, involving materials, techniques for implementation, basics of proper installation and theoretical explanations of the process, recognition of ISO standards of quality of used materials and methods for their incorporation, achievements in the energy savings and subjects from work safety. It will specifically be devoted to recognition of new products in this field with promising specifications in order to achieve higher energy efficiency of the buildings and increase the safety. The training forms will be encompassed of 10% exam, 30% theoretical classes and 60% practical classes which will be organized in building sector companies. The total duration of the courses is 80 training hours. Afterwards, a pilot training will be realized in order to confirm the reliability and adequacy of the designed programme and training material. It will be organised on two levels: for blue collar workers and for professionals. For each training schemes and qualification level one training will be organized (one for 20 Installers of systems of solar-thermal energy, one for 10 Designers of systems of solar-thermal energy, one for 20 Installers of photovoltaic systems and one for 10 Designers of photovoltaic systems). The trainings will be a 10 day seminars with theoretical and practical classes which will be organized on-site.

This training program is organized in two modules:

- Module 1: Design and Installation of solar-thermal systems on two levels – for building professionals and blue collar workers
- Module 2: Design and Installation of photovoltaic systems on two levels - for building professionals and blue collar workers

The training course is targeting candidates with the following working experience, who have undergone, the following types of training:

- For 1st level (installers): a vocational training scheme corresponding to at least three years education in technical education (electrician, mechanic, construction technician etc.) or workplace learning/experience or non-formal training as plumber, electrician, and have relevant plumbing, electrical and roofing skills
- For 2nd level (designers): a higher education qualification corresponding to at least 180 ECTS in technical academic education (electrical engineer, mechanical engineer, civil engineer etc.)

A detailed structure of the program as well as the description of the module is explained below (fig. 3).
4.5. Training modules

The Module 1: Design and Installation of solar-thermal systems on two levels – for building professionals and blue collar workers. The first module covers the following areas:

- Introduction to solar energy and solar-thermal systems
- Collector & system types
- Installation of solar-thermal systems
- Solar-thermal design
- System maintenance
- Safety requirements at workplace
- Techno-economical analysis

This course will focus on the designer’s ability to complete a design from site survey and assessment through construction drawings and into permitting and commissioning. It provides the Solar-thermal designer, contractor or installer with a comprehensive understanding of Solar-thermal design. These skills are essential for designers of commercial systems and complex residential systems such as space heating applications. This course will provide an in-depth knowledge of the tools and best practices needed for complex Solar-thermal systems.

The first level - Design of solar-thermal systems for building professionals encompass of:

- Introduction to solar energy & solar-thermal systems
- Collector & system types
- Solar-thermal design
- Techno-economical analysis
- Safety requirements at workplace

The second level of the first module aiming installation of solar-thermal systems for blue collar workers includes the following chapters:

- Introduction to solar-thermal systems
- Collector & system types
- Installation of solar-thermal systems
- System maintenance
- Safety requirements at workplace

Module 2: Design and Installation of photovoltaic systems on two levels - for building professionals and blue collar workers. The second module covers the following areas:

- Photovoltaic Basics
- PV Modules and Other Components of Grid-Connected Systems
- Mounting Systems and Building Integration
• Installing
• Stand-alone Photovoltaic Systems
• Safety requirements at workplace

This course will focus on the designer’s ability to complete a design from site survey and assessment through construction drawings and into permitting and commissioning. It provides the PV Solar system designer, contractor or installer with a comprehensive understanding of PV Solar system design. These skills are essential for designers of commercial systems and complex residential systems such as space heating applications. This course will provide an in-depth knowledge of the tools and best practices needed for complex PV Solar systems.

The first level of module 2 is dedicated to design of PV solar systems for building professionals and includes the following chapters:

• Photovoltaic Basics
• PV Modules and Other Components of Grid-Connected Systems
• Site Surveys and Shading Analysis
• Planning and Sizing Grid-Connected Photovoltaic Systems
• System Sizing, Design and Simulation Software
• Mounting Systems and Building Integration
• Installing, Commissioning and Operating Grid-Connected Photovoltaic Systems
• Stand-alone Photovoltaic Systems
• Economics and Environmental Issues
• Procurement and legislation
• Safety requirements at workplace

And the second level of module 2 of training material will develop skills for installation of PV solar systems for blue collar workers through the following chapters:

• Photovoltaic Basics
• PV Modules and Other Components of Grid-Connected Systems
• Mounting Systems and Building Integration
• Installing
• Stand-alone Photovoltaic Systems
• Safety requirements at workplace

5. Conclusion
This paper presents a systematic approach for designing educational programs and developing curricula for training for designers and installers of RES systems in buildings. This especially refers to developing separate occupational standards, recognized by the national qualification frameworks, which will ensure formal validation of developed qualifications. This paper provides a model for training courses for designers and installers of small-scale renewable energy systems in buildings. This model is based on the experience of TRAINEE project, which had the aim to implement training courses for designers and installers of RES systems in buildings. The design and development of curricula intend to meet the learning outcomes of 4th and 5th level from European Qualification Framework (EQF), based on combination of knowledge, skills and competences. By the end of July 2019 piloting of the developed training programmes will be completed and we will be able to drawn more precise conclusions on the adequacy of the training content, to meet the need of market related RES-skills.

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