EURYDICE
Collaborating towards a future in renewable energy

eurydice@cut.ac.za | eurydice.cut.ac.za

WP 2.3: Implementation of curriculum enhancement

D: 2.3.2. Documentation of the enhanced bachelor curriculum as a proposal

Month Year: June 2021

Disclaimer: This publication has been produced with the support of the European Union under the Erasmus+ Programme. The contents of this document are the sole responsibility of EURYDICE consortium and can under no circumstances be regarded as reflecting the position of the European Union or the Programme management structure.

Co-funded by the Erasmus+ Programme of the European Union

EURYDICE
Collaborating towards a future in renewable energy

eurydice@cut.ac.za | eurydice.cut.ac.za

Deliverable author: Raath, J

Contributors: Vermaak, H / Memane, N / Sewsunker, R

Due date	15/06/2021
Submission date	06/09/2021

Review history

Review type Formal (or) Walkthrough (or)Offline

Version	Date	Reviewer/s
V0.1	27/07/2021	Momir Tabakovic (UASTW)
V0.2	06/08/2021	TUT and DUT
V0.3	25/8/2021	BME
1.0 (Final)	06/09/2021	CUT, TUT and DUT

Dissemination level

PU	Public	**X**
RE	Restricted to a group specified by the Consortium (including the Commission Services)	
CO	Confidential, only for members of the consortium (including the Commission Services)	

Co-funded by the Erasmus+ Programme of the European Union

EURYDICE
Collaborating towards a future in renewable energy

eurydice@cut.ac.za | eurydice.cut.ac.za

Copyright

Consisting of

Coordinator	P1	Ulm University of Applied Sciences (UUAS)	Germany
Partners	P2	Durban University (DUT)	South Africa
	P3	Budapest University of Technology (BME)	Hungary
	P4	Central University of Technology, Free State (CUT)	South Africa
	P5	University of Applied Sciences Technikum Wien (UASTW)	Austria
	P6	Tshwane University of Technology (TUT)	South Africa
	P7	Deloitte Limited (DT)	Cyprus

Co-funded by the Erasmus+ Programme of the European Union

Table of Contents

Co-funded by the Erasmus+ Programme of the European Union

1. Introduction

One of the main objectives in the Eurydice project is to enhance the employability of students in the field of renewable energies, based on closer collaboration between university and industry. In specific, work package 2.3 seeks to improve the education curricula on diploma, bachelor and postgraduate level by enhancing the aspect of work-integrated-learning (WIL) through industrial exposure. As a preamble to this document D:2.3.2, the reader is encouraged to read D:2.3.1

1.1. Goal of WP 2.3.2

The goal of WP:2.3.2 is to analyse the Bachelor programs as presented by the respective South African UoTs and use it as basis to propose enhancements to the educational process and curriculum documentation.

1.2. Process

Each UoT considered their individual educational programs and identified the learning modules therein which are relevant to renewable energy technologies. A workshop followed where all UoTs presented their identified modules and proposed ideas which, when incorporated in the educational process, will enrich the student's experience. A list of the proposed ideas/enhancements, grouped per objective are as follow:

Increase industrial exposure (X)

- Industry visits to partners (real or virtual)
- Guest lecturing (Industry partners)
- Projects/practical work in conjunction with international university partners
- Incorporate career portal
- Interaction with remote & mobile labs (advanced technologies)
- Networking for university staff to build trust with industry partners
- Bachelor thesis topics from the industry

Enhance entrepreneurial skills (E)

- Guest lecturing (Professionals & visiting Internationals).
- Include workshops on skills - communication, motivation, creativity, leadership, financials, legal.
- Promote accelerated short courses.
- Subject students to real industry problems.
- Development of Startup Accelerator Program with the industry

Other (O)

- Opportunities offered by new learning technologies
- Trends in employment
- Student feedback

Considering the proposed enhancements in conjunction with the survey results from D2.3.1, each UoT matched specific enhancements to their identified learning modules. Following this approach ensured that the proposed enhancement

(a) supports the institutional curriculum and
(b) adheres to the ECSA expectations introduced in D:2.3.1.

To conclude the process, the documentation, i.e. syllabi of the respective learning modules are updated. Hereafter, this process is presented for each UoT in the form of a design summary and module specific enhancements.

2. Central University of Technology (CUT)

Programs at the Central University of Technology, which address renewable energy technologies or aspects thereof, are as follow:

- HIGHER CERTIFICATE : RENEWABLE ENERGY TECHNOLOGIES (NQF[1]: 5)
- DIPLOMA : ENGINEERING TECHNOLOGY IN ELECTRICAL ENGINEERING (NQF: 6)
- BACHELOR : ENGINEERING TECHNOLOGY IN ELECTRICAL ENGINEERING (NQF: 7)

2.1. Design summary

Modules in the respective programs, which include aspects of renewable energy, are listed and for each, some enhancements are proposed. The selected enhancements (introduced in section 1.2) are categorized in columns which denotes the industrial expectations of a candidate Alternative Energy Technician (defined in D:2.3.1, Appendix A).

[1] NQF= National Qualification Framework

Co-funded by the Erasmus+ Programme of the European Union

	Investigation	Research and development	Product design	Risk and impact	Project management	Commissioning	Maintenance
Certificate							
Solar PV						X	X
Installation Practice						X	X
Diploma							
Energy Systems III	X					X	X
Bachelor							
Technology Management III			E		E		
Energy Management III		E		E			
Energy Technologies III	X					X	X

Identifiers: Increase industrial exposure = **X** / Enhance entrepreneurial skills = **E** / Other = **O**

2.2. Curriculum enhancements

For the identified modules, selected enhancements are proposed to feature in specific content areas of the module syllabus. The area of interest in the respective syllabus is highlighted and tagged with the specific enhancement.

Co-funded by the Erasmus+ Programme of the European Union

Certificate: Solar PV

		Current curriculum	Proposed enhancements	Outcome
1	**Purpose of this module in relation to the programme/s**	• To introduce students to solar irradiation energy and its effect on the earth's climate. • To enable students to quantify the availability of solar energy and identify possible applications. • To impose the importance of energy conservation and energy efficient practices. • To equip students with the necessary skills for load analysis and photovoltaic system sizing.		
2	**Module content**	The following topics are covered in this module: • Solar radiation and the earth's climate • Solar thermal heating systems & applications • Photovoltaic electricity generation* • Load calculation • Energy conservation and efficiency • PV system design and sizing**	* **Enhancement (X)** - Visit to industry partners or installed site. ** **Enhancement (X)** - Interaction with remote & mobile labs.	Visual confirmation of theory principles. Real world load analysis, system design and performance evaluation.

Co-funded by the Erasmus+ Programme of the European Union

Certificate: Installation Practice

		Current curriculum	Proposed enhancements	Outcome
1	**Purpose of this module in relation to the programme/s**	• To provide a knowledge base of the electrical, mechanical and regulatory requirements for installing a renewable energy (RE) source. • To equip students with the necessary skills for the sizing and protection of the relevant energy systems.		
2	**Module content**	The following topics are covered in this module: • Regulatory codes* • Construction requirements – mechanical* • Construction requirements – electrical* • System installation and commissioning*	* **Enhancement (X)** - Visit to industry partners or installed site.	Visual confirmation of regulatory requirements. Experience real world influences that affect installation and maintenance.

Co-funded by the Erasmus+ Programme of the European Union

Diploma: **Energy Systems III**

		Current curriculum	Proposed enhancements	Outcome
1	**Purpose of this module in relation to the programme/s**	• To develop knowledge and understanding of energy generation, transmission and distribution systems. • To equip engineering students with the necessary skills for analysis and simulation of relevant energy systems.		
2	**Module content**	The following topics are covered in this module: • Electrical power generation – technologies* • Transmission of electrical power • Distribution of electrical power • Protection principles • Power economy and tariffs • Alternative energy generation technologies and grid parity**	* **Enhancement (X)** - Visit to industry partners or installed site (virtual). ** **Enhancement (X)** - Guest lecturing (Industry partners).	Visual confirmation of theory principles. Exposure to real world tariff structures associated with alternative energy solutions.

Co-funded by the Erasmus+ Programme of the European Union

Bachelor: Technology Management III

		Current curriculum	Proposed enhancements	Outcome
1	**Purpose of this module in relation to the programme/s**	• To provide engineering students with the attributes in order to manage the development of technology in an effective, ethical and efficient way. • To enable engineering students to obtain relevant interdisciplinary theory and practice in order to contribute to the socio-economic development of communities, industry and the country.		
2	**Module content**	The following topics are covered in this module: • Innovation strategies* • Entrepreneurial skills • Engineering economics • Quality management • Operations management • Human resource management • Project management**	* **Enhancement (E)** - Workshop on product design and development. ** **Enhancement (E)** - Guest lecturing (Professionals & visiting Internationals).	Gain knowledge relating to product development in the renewable energy sector. From concept to sellable product (device or service). Exposure to issues that influence the management alternative energy projects.

Co-funded by the Erasmus+ Programme of the European Union

Bachelor: Energy Management III

		Current curriculum	Proposed enhancements	Outcome
1	**Purpose of this module in relation to the programme/s**	• To advise on the systematic assessment of energy systems and identification of savings opportunities. • To familiarise with the fundamentals of product strategy management. • To study methods of energy accounting and energy auditing.		
2	**Module content**	The following topics are covered in this module: • Energy Accounting and Economics • Energy Audits and Instrumentation • Electrical Systems • Alternative Energy Systems* • Lighting Systems • Renewable energy policies and finance**	* **Enhancement (E)** - Accelerated short course on financial accounting. ** **Enhancement (E)** - Subject students to real industry problems.	Improve accounting skills that will support research in alternative energy systems. Financial viability of an AE system relies on an accurate financial model or investment strategy. Application of policies and the financial impact it has on alternative energy projects.

Co-funded by the Erasmus+ Programme of the European Union

Bachelor: Energy Technologies III

		Current curriculum	Proposed enhancements	Outcome
1	**Purpose of this module in relation to the programme/s**	• To provide an understanding of renewable energy technologies, their design processes and application for both domestic and industrial applications. • To promote a research culture into sustainable and innovative future energy trends.		
2	**Module content**	The following topics are covered in this module: • System sizing and design* • Sustainable development • Solar Energy • Wind and Hydro • Thermal energy • Bio-energy • Commission, maintenance & monitoring**	* **Enhancement (X)** - Subject students to real problems from industry and international partners. ** **Enhancement (X)** - Visit to industry partners or installed site (virtual).	Follow the design process for domestic and industrial applications. Visual confirmation of theory principles.

Co-funded by the Erasmus+ Programme of the European Union

3. Tswane University of Technology (TUT)

Programs at the Tswane University of Technology, which address renewable energy technologies or some aspects thereof, are as follow:

- HIGHER CERTIFICATE : SOLAR PV (NQF: 5)
- DIPLOMA : IN ELECTRICAL ENGINEERING (NQF: 6)
- BACHELOR : ENGINEERING TECHNOLOGY IN ELECTRICAL ENGINEERING (NQF: 7)

3.1. Design summary

Modules in the respective programs, shown above, which include aspects of renewable energy, are listed in the table below and for each, some enhancements are proposed. The selected enhancements (introduced in section 1.2) are categorized in columns which denotes the industrial expectations of a candidate Alternative Energy Technician (defined in D:2.3.1, Appendix A).

	Investigation	Research and development	Product design	Risk and impact	Project management	Commissioning	Maintenance
Certificate							
Solar PV						X	X
Diploma							
Renewable Energy	X		X		E	X	X
Bachelor							
Green energy systems	X	E	E	E	E	X	X

Increase industrial exposure = **X** / Enhance entrepreneurial skills = **E** / Other = **O**

3.2. Curriculum enhancements

For the identified modules, selected enhancements are proposed to feature in specific content areas of the module syllabus. The area of interest in the syllabus is highlighted and tagged with the specific enhancement.

Co-funded by the Erasmus+ Programme of the European Union

Certificate: Solar PV

		Current curriculum	Proposed enhancements	Outcome
1	**Purpose of this module in relation to the programme/s**	• This module covers the design, installation and commissioning of solar power systems. The emphasis is on both the theoretical and practical hands-on experience with the objective to maximize the power collection from the sun through photovoltaic conversion based on the environmental conditions of the installation sites.		
2	**Module content**	The following topics are covered in this module: • Solar radiation and the earth's climate • Photovoltaic electricity generation* • Energy conservation and efficiency PV system design and sizing**	* **Enhancement (X)** - Visit to industry partners or installed site. ** **Enhancement (X)** - Interaction with remote & mobile labs.	Visual confirmation of theory principles. Real world load analysis, system design and performance evaluation.

Co-funded by the Erasmus+ Programme of the European Union

Diploma: **Renewable Energy (REN316D)**

		Current curriculum	Proposed enhancements	Outcome
1	**Purpose of this module in relation to the programme/s**	• The subject exposes the learners to various energy resources, and ground them in methods of developing clean, reliable, efficient, and economical energy systems for a sustainable environment. • The students will learn to analyse, design and implement solar, hydro and wind energy systems as well as evaluate and design energy storage systems. • To equip engineering students with the necessary skills for analysis and simulation of relevant energy systems.		
2	**Module content**	The following topics are covered in this module: • Electrical power generation (From different energy sources) – technologies* • Transmission of electrical power • Distribution of electrical power • Protection principles • Power economy and tariffs Alternative generation technologies and grid parity**	* **Enhancement (X)** - Visit to industry partners or installed site (virtual). ** **Enhancement (X)** - Guest lecturing (Industry partners).	Visual confirmation of theory principles. Exposure to real world scenarios and tariff structures associated with alternative energy solutions.

Co-funded by the Erasmus+ Programme of the European Union

Bachelor: Green Energy Systems

		Current curriculum	Proposed enhancements	Outcome
1	**Purpose of this module in relation to the programme/s**	• To equip the students with knowledge and understanding of various renewable energy sources and how they are harnessed to generate electric power. • To expose students to the societal need of energy provisions in sustainable and economical form. To engage students in case studies, practical implementation of renewable energy systems and scientific research.		
2	**Module content**	The following topics are covered in this module: • Introduction to green energy systems • Solar and geothermal energy systems* • Wind Energy systems • Water Power systems • Energy integration, storage and economics**	* **Enhancement (X)** - Visit to industry partners or installed site (virtual). ** **Enhancement (X)** - Guest lecturing (Industry partners).	Visual confirmation of theory principles. Exposure to real world scenarios and tariff structures associated with alternative energy solutions.

Co-funded by the Erasmus+ Programme of the European Union

4. Durban University of Technology (DUT)

The programs at the Durban University of Technology, which address renewable energy technologies or some aspects thereof, is as follows:

- BACHELOR : ENGINEERING TECHNOLOGY IN ELECTRONIC ENGINEERING (NQF: 7)

4.1. Design summary

Modules in the program, which include aspects of renewable energy, are listed and for each, some enhancements are proposed. The selected enhancements (introduced in section 1.2) are categorized in columns which denotes the industrial expectations of a candidate Alternative Energy Technician (defined in D:2.3.1, Appendix A).

	Investigation	Research and development	Product design	Risk and impact	Project management	Commissioning	Maintenance
Bachelor							
Power Engineering 2A	X						
Renewable Energy 3B	X	X		X			

Increase industrial exposure = **X** / Enhance entrepreneurial skills = **E** / Other = **O**

4.2. Curriculum enhancements

For the identified modules, enhancements are proposed to feature in specific content areas of the module syllabus.

Co-funded by the Erasmus+ Programme of the European Union

Bachelor: **Power Engineering 2A**

		Current curriculum	Proposed enhancements (Category X)	Outcome
1	**Purpose of this module in relation to the programme/s**	This subject introduces the subject of Power Electronics, that is, the switching, control and conversion of electrical power using semi-conductor devices. It requires the student to demonstrate an integrated knowledge of Power Electronics in general electrical systems. The student will access, process, and manage information in respect of which the student will be assessed on the, "ability to develop appropriate processes of information gathering for a given context in Power Electronics and demonstrate an ability to use, evaluate, and manage sources of information to demonstrate a well-developed ability to engage in independent and life- long learning".		

Co-funded by the Erasmus+ Programme of the European Union

2	**Module content**	The following topics are covered in this module: • Introduction to power electronics? • Power semiconductor diodes and circuits • Diode Rectifiers • DC-DC converters • PWM inverters • Resonant pulse inverters • Thyristors • Controlling power using rectifiers	Guest (academic or industry) lecture on any of the topic points Improve student assimilation of knowledge through focussed practical exercises Site visits or site videos to see the power systems in action in industry	Sharing of global best practice in power electronics practice. Closer collaboration with industry Assimilation of theoretical concepts Apply ideas and data based on industry use of power systems in problem interpretation and solving.

<u>Bachelor:</u> Renewable Energy

Co-funded by the Erasmus+ Programme of the European Union

		Current curriculum	Proposed enhancements(Category X)	Outcome
1	**Purpose of this module in relation to the programme/s**	This subject introduces the subject of Renewable Energy and includes the study of renewable energy resources, the AC and DC technologies involved as well as the applications in a modern energy conscious society. It requires the student to demonstrate an integrated knowledge of general physical theories, electrical power engineering knowledge and the integration strategies to a national power grid. A key focus will be on a holistic approach in the subject to foster the development of considerations in the wider impact and knock on effects of renewable energy to the energy industry and society at large. The latter through case studies comparisons and evaluations based on maximising beneficial outcomes to rural energy impoverished communities. The student will access, process, and manage information in respect of which the student will be able to demonstrate: an ability to develop appropriate processes of information gathering for a given context within the Renewable Energy knowledge domain and demonstrate an ability to use, evaluate, and manage sources of information to demonstrate a well-developed ability to engage in independent and life-long learning.		

Co-funded by the Erasmus+ Programme of the European Union

2	**Module content**	The following topics are covered in this module: Energy resources and technologies Energy transfer Sustainable design Power conversion and integration technologies Wind turbines Solar power Marine energy Energy generation from biomass Geothermal energy Waste and energy DC energy generation and systems System integration and automation Exploitation of renewable energy resources Socioeconomics of renewable energy	Guest (academic or industry) lecture on any of the topic points	Sharing of global best practice in renewable energy (RE) practice. Closer collaboration with industry
			Improve student assimilation of knowledge through focussed practical exercises. This includes use of the mobile and open labs as test beds for specific practical investigations	Assimilation of theoretical concepts and corroboration of theoretical analysis and practical investigations. Collaboration with industry and academic partners.
			Site visits or site videos to see the RE systems in action in industry	Apply ideas and data based on industry use of RE systems in problem interpretation and solving
			Apply real-world and industry investigations in the module assignment (project) task. Include industry partners in project supervision and assessment	Closer collaboration between industry and university. Solving of real-world problems

Co-funded by the Erasmus+ Programme of the European Union

5. Conclusion

The curriculum enhancements proposed in this document considered the objective of WP:2.3.2 whereby the curriculum of the bachelor program as a proposal, is enhanced through industrial exposure. As a continuation of WP:2.3.1, enhancements resulting from the design process are incorporated into the curriculum at each individual UoT, with the common goal of improving the student's learning experience while proactively addressing the industrial expectations of the South African governing body, ECSA. In addition, it also address the need of the industry for students or future employees with relevant knowledge and experience. Some of the proposed enhancements and outcome expectations are similar at the three South African Universities. This can be attributed to the challenges and regulatory framework which South African UoTs face. A summary of the proposed enhancements is as follow:

- Visit to industry partners or installed site (virtual). The expected **outcome** is visual confirmation of theory principles, regulatory requirements and real world influences that affect installation/maintenance.Guest lecturing (Industry partners). The expected **outcome** – exposure to real world scenarios in terms of load analysis, system design, performance evaluation. Grid parity and tariff structures related to alternative energy solutions.

From the above, it is clear that the partnership/s between a University and Industry is of utmost importance to realise the proposals made in this document. The industry portal (WP 2.5) realised in this project, facilitate, support and enhance the interaction between industry, university and students. Another exciting prospect is the upcoming work package 2.6 wherein International collaboration and access to remote and mobile labs are featured. Upon completion, these shared facilities can be included to enhance the respective curriculums even further.

Co-funded by the Erasmus+ Programme of the European Union

6. Contact

Project coordinator

THU Ulm University of Applied Sciences (UUAS)

Address: Prittwitzstr. 10, 89075 Ulm, Germany

Work Package Leader

P4 Central University of Technology, Free State (CUT)

Raath, J.H., Lecturer

Address: Pres. Brand Street, City central, Bloemfontein, 9300

Email: jraath@cut.ac.za

Phone: +27824603817

Co-funded by the Erasmus+ Programme of the European Union