SECTION A:	***QUALIFICATION DETAILS***														
QUALIFICATION DEVELOPER (S)	New Era College of Arts, Science, and Technology														
TITLE	Bachelor of Engineering in Electrical Power and Energy Engineering.										***NCQF LEVEL***		*8*		
FIELD	Manufacturing, Engineering, and Technology		***SUB-FIELD***		Energy Engineering						***CREDIT VALUE***		600		
New Qualification		√									*Review of Existing Qualification*				
SUB-FRAMEWORK		*General Education*				*TVET*					*Higher Education*		√		
QUALIFICATION TYPE	*Certificate*	*I*		*II*		*III*		*IV*		*V*		*Diploma*		*Bachelor*	
	Bachelor Honours		√	*Post Graduate Certificate*							*Post Graduate Diploma*				
	Masters							*Doctorate/ PhD*							

RATIONALE AND PURPOSE OF THE QUALIFICATION

1.1 *Rationale for the Qualification*

The rationale for this qualification is divided based upon the following reasons, we are living in an era of the Industrial Revolution, an era that calls for the use of sustainable and clean energy, an era that calls for energy efficiency and management, an era that requires a periodic audit of energy usage in buildings, an era that calls for the end of energy poverty. Hence a need to have graduates who are trained across the energy sector. The era that we are living in also is an era of Climate change and global warming, which requires adaptation and mitigation measures, it has been discovered that Renewable and green energy technologies are the trusted mitigation and adaptation strategies towards climate change and global warming. There is a need to build capacity along the field of Renewable energy and energy generation, transmission, distribution, and utilisation at large. Botswana is at crossroads, in need of young men and women who can design Electric cars, Renewable energy charge stations, Solar mini-grids systems, Solar rooftop systems, Solar water pumping systems and many more.

Botswana government in line with the National strategic vision 2016 and 2036, the National development plan 10 and 11, and through the regional and international multi-bilateral agreements recognises the Energy sector as an important sector that plays an important role in the transformation and growth of the country's economy. The development of the Renewable energy sector in Botswana and the entire African Continent has been slow as compared to other regions such as the European region, mainly because there hasn't been capacity building, education, and training regarding Renewable and green energy technologies in Botswana and the African region at large, hence our lagging in that aspect. This qualification aims to bridge that gap, to produce graduates who will be active partakers in transforming the economy of Botswana and making Botswana a green energy hub in the region and the African government. Some of the National, Regional, Continental and International Institutions, Policies, Agreements, Accords, and NGOs/CSOs are advocating for the use of Renewable Energy, Capacity building in Renewable Energy, Policymaking on Renewable Energy and Energy Efficiency and management which can be accomplished by offering a qualification in Energy systems Engineering include but are not limited to United Nations. The qualification also aims to support the capacity building, awareness, and implementation of the international multi bilateral environmental agreements that Botswana is a signatory to, which include but are not limited to UNCBD – United Nations Convention on Biodiversity, UNPOP's – Stockholm, Convention on Persistent Organic Pollutants, UNFCCC – United Nations Framework Convention on Climate Change, Botswana National Development Plan (NDP).

The structuring of this Qualification is in line with the Botswana National Development plan that:
"During NDP 10, the Government of Botswana will concentrate on increasing the use of renewable energy as a way of augmenting existing energy sources and improving the security of supply for other fuels. The possibility of a solar thermal power station will be explored, private sector involvement in renewable energy will be encouraged, and renewable energy use will be enforced in governmental institutions. Regulations for solar and biofuels will be developed to guide the production and use of renewables. There is a need to develop and build capacity for these technologies, and training will be undertaken to achieve this. A comprehensive communication strategy is needed so as to reduce chances of non-acceptance by the general public". In NDP 11 it is stated that "Through the Renewable Energy Programme, Government will be up-scaling the use of renewable energy sources, with a view to meeting its climate change protocol targets". The National Strategic Vision 2016 and particularly long-term vision 2036 Pillar 3 - Sustainable Environment. "By 2036 sustainable and optimal use of natural resources will have transformed our economy and uplifted our people's livelihoods. This pillar includes the ecosystem functions and services, sustainable utilization of natural resources, water security, energy security, sustainable land use and management, sustainable human settlements, climate resilience and disaster risk reduction and pollution and waste" The government of Botswana's drive to transform the economy from a resource-based economy to a knowledge-based economy is anchored upon many branches, most importantly sustainable engineering practices to achieve a sustainable transformation. Recently the government of Botswana in collaboration with the United Nations Development Programme (UNDP) and Botswana Institute for Technology, Research and Innovation(BITRI) are implementing a project titled "Promoting production and utilization of biogas from Agro-waste in South-eastern Botswana(Biogas project). This is a project that seeks to facilitate low carbon investments and public-private partnerships in the production and utilization of biogas from agro-waste in the districts of South-Eastern Botswana. The use of waste to generate energy (Biogas) is an

opportunity that Batswana must tap into. Therefore, through this qualification, well-trained graduates will be produced, who will venture into renewable energy projects such as the aforementioned projects that will ultimately see Botswana sustainably transforming its economy. Renewable and green energy offers attractive sustainable business opportunities. Green Energy and Sustainability Association (GESA). The NGO is in pursuit to realize a Green Botswana, where there is the production of green and sustainable employment by energy systems engineering graduates. In support of the above mentioned, renewable and green energy offers attractive sustainable business opportunities. In this regard, this qualification is proposed and structured out of a dire need to create sustainable employment for Batswana. The Qualification is tailored in a way to build capacity and promote the Southern African Development Community (SADC) Renewable Energy and Energy Efficiency Strategy and Action Plan (REEESAP 2016-2030)

National Environmental Education Strategy and Action Plan:
The National Environmental Education Strategy and Action Plan (NEESAP), Objective 1 (Integrate Environmental Education into the formal Education system, Objective 2(Increase Public Environmental Awareness and participation, Objective 4(build capacity on Environmental Education) are all addressed in the Energy systems Degree qualification structure, which has important aspects such as Environmental Anatomy, Environmental Impact Assessment, Renewable energy technologies, Solar engineering and biofuels technologies. Renewable energy and environmental issues go hand in hand. The New Partnership for Africa's development African governments has committed themselves at the continental level to the Millennium Development goals under the framework of the New Partnership for Africa's Development (NEPAD). This is the initiative of the African Union and a commitment of African leaders to place their countries on a path of sustainable growth and development. This has led to the development of the NEPAD Environmental Action Plan under the leadership of the African Ministerial Conference on Environment. Through this Qualification, Botswana shall be a leading African country in capacity building and the implementation of the regional and international climate agreements, in the realization of the NEPAD goal of having sustainable growth and development.

PURPOSE OF THE QUALIFICATION

The main purpose of this qualification is to produce graduates with knowledge, skills, and competence to:

- Demonstrate understanding of how to bridge the gap between the industry and the community in terms of energy efficiency and management.
- Demonstrate knowledge of engineering in the industrial world, in government offices, locally and international enterprises, or as employment creators in the energy sector.
- Demonstrate understanding of Botswana's present and future energy needs and capabilities.
- Draft and implement energy policies.
- Demonstrate knowledge of energy supply and demand issues within the African region and on a worldwide scale.
- Analyse and solve problems in the production, processing, storage, distribution, and utilization of energy.

- Apply proper procedures prior to implementation of energy projects in appropriate contexts, e.g., conducting Environmental impact assessment.
- Mitigate the impacts of energy generation.
- Deploy computer-based energy engineering tools.

ENTRY REQUIREMENTS (including access and inclusion)

Minimum entry requirement:

Certificate IV, NCQF Level 4 (General Education or TVET) or equivalent with passes in 6 subjects including English, Mathematics and Sciences.

Access through Recognition of Prior Learning (RPL) and Credit Accumulation and Transfer (CAT) will be provided through ETP policies in line with National RPL and CAT Policies.

SECTION B	***QUALIFICATION SPECIFICATION***
GRADUATE PROFILE (LEARNING OUTCOMES)	***ASSESSMENT CRITERIA***
Register with the national, regional, and international practicing regulatory authorities in Energy Engineering and Engineering at large for the purpose of professional practice.	• Develop policy and national strategic plans regarding energy generation, transmission, distribution, and utilization • Enforce codes of conduct and best practices of Energy systems engineering based on regulatory authorities and the needs of the industry. • Register and be a member of a regulatory body, an advocacy body, and a standards body on energy engineering practices in the country of practice and residence.
Research and innovate new sustainable energy systems	• Understand and define the engineering problem • Perform Background Research regarding the problem • Specify the Engineering Requirements • Choose the Best Solution • Diligently perform the Development Work • Design, Build, Test and Redesign a Prototype • recommend modifications following prototype test results

	• use research, analytical, conceptual, and planning skills, particularly mathematical modeling and computer-aided design
Develop and improve processes in the industry and across the energy sector	• design and implement cost-effective equipment modifications to help improve safety and reliability • develop project specifications with colleagues, often including those from within and outside engineering disciplines • develop, test, and evaluate theoretical designs • discuss and solve complex problems with manufacturing departments, sub-contractors, suppliers, and customers • manage projects using engineering principles and techniques • plan and design new production processes • Monitor and commission plant and energy systems
Work effectively as part of the project team in multi-purpose project	• Work as a team during assigned tasks • Develop good communications skills during teamwork • Delegate and supervise assigned tasks • Critically evaluate peers and subordinates and recommend accordingly.
Analyse, Interpret, Troubleshoot, and perform data analysis and interpretation when designing solutions to unfamiliar ill-defined problems	• Investigate none working equipment using appropriate and relevant equipment • Applying theories and methods of electrical and electronics in troubleshooting none working equipment • Repair none working equipment by replacing it with relevant and appropriate working parts based on manufacturer specifications
Model mathematically or using specific software renewable energy systems	• Identify computer-based modeling tools and mathematical modeling to design and build prototypes in energy systems • Developing, programming, and verifying/validating mathematical models • Modelling renewable energy conversion process • Modelling energy storage and demand integrating individual models into a system-level model and its application to design.
Integrate Renewable energy technologies into the main grid	• understand and integrate the microgrid concept into renewable Energy systems • Apply the fundamental knowledge of science and engineering in power generation, transmission, distribution, and utilization

Apply Energy Engineering systems knowledge in the society, the environment, and the employment creation sector	• Understand how an engineering business is established and operated. • Apply costing techniques to determine the cost-effectiveness of engineering activity.
Specify and interpret specifications associated with the installation of renewable energy systems	• Analyse the key principles and theories in relation to use renewable energy systems • Interpret key terminology, symbols, and standard notation used in relation to renewable energy systems • Analyse current legislation including the key legal responsibilities in relation to the use of renewable energy systems • Analyse the characteristics and key components of a range of renewable energy systems to include solar, wind, hydro, biomass, and geothermal • Analyse the key principles and characteristics of passive house construction • Suggest health and safety initiatives aimed at reducing the risks associated with renewable energy systems • Utilize a range of calculations to assess the efficiency and output of a range of renewable energy systems.
Compare and contrast sustainable and renewable energy systems	• Evaluate the practical possibilities and limitations of renewable energies and compare them with conventional carbon-based energy systems • Design renewable/hybrid energy systems that meet specific energy demands are economically feasible and have a minimal impact on the environment • Compare different renewable energy technologies and choose the most appropriate based on local conditions • Perform techno-economical assessments of renewable energy systems • Perform and compare environmental assessments of renewable energy systems and conventional fossil fuel systems
Minimise risks to life, property, and the Environment	• Work safely in accordance with the regulations of the work environment • Identify hazards and assess the level of risk involved • Minimize the risks and implement control measures in the minimum agreed timescales

	• Inform all those who are affected of the risk control measures in place and clarify any implications for them as required • Ensure that information provided for safety system records is clear, accurate, and up to date • Monitor the effectiveness of the risk control measures and take prompt additional action where needed
Use research, analytical, conceptual, and planning skills	• Apply research skills to solve complex industrial processes • Model mathematically and using relevant software's to design a new or improved product • Use mechanical related software's to design and build new mechanical circuits and devices • Reverse engineer some established equipment and devices using mechanical related software's for knowledge transfusion
Interpret detailed mechanical information from technical sources	• Read and Extract Information from Mechanical Engineering Drawings and Specifications • Identify and Suggest Improvements to Working Practices and Procedures whilst Maintaining Energy Plant and Equipment • Establish that Maintenance Process has been Completed to Specification • Test and Monitor the Performance and Condition of Energy Plant and Equipment • Assess the Performance and Condition of Energy Plant and Equipment
Provide technical-level support for environmental remediation and litigation projects, including remediation system design	• Monitor the progress of environmental improvement programs. • Inspect industrial and municipal facilities and programs in order to evaluate operational effectiveness and ensure compliance with environmental regulations • Provide administrative support for projects by collecting data, providing project documentation, training staff, and performing other general administrative duties.
Devise creative solutions for renewable energy distribution and storage	• Evaluate, design, and implement innovative sustainable solutions using solar, wind, biomass, geothermal, and other renewable energy resources, storage and utilization technologies with a focus on power generation • Optimise the performance of existing renewable energy systems and improve their conversion energy efficiency

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SECTION C	***QUALIFICATION STRUCTURE***					
COMPONENT	***TITLE***	***Credits Per Relevant NCQF Level***				***Total (Per** Subject/ Course/ Module/ Units)*
		Level [5]	***Level [6]***	***Level [7]***	***Level [8]***	
FUNDAMENTAL COMPONENT *Subjects/ Courses/ Modules/Units*	Engineering Mathematics	***20***	***20***			***40***
	Engineering Science	***10***	***10***			***20***
	Professional Communication and Skills for engineers	***10***				***10***
	Engineering Ethics	**10**				**10**
	End-User computing	**10**				**10**
	Probability and Statistics			**10**		**10**
	Engineering Graphics		**10**			**10**
	Industrial Attachment			**50**		**50**
	Research Methodology in Engineering				**10**	**10**
	Project management for Engineers			**10**		**10**
	Fundamentals of Electrical and Electronics Engineering		**15**			**15**
	Energy Systems and Conversion Technologies		**10**			**10**

CORE COMPONENT *Subjects/Courses/ Modules/Units*	Introduction to programming Principles	**10**				10
	Mechanics		10			10
	Circuit Theory (DC +AC) Principles		15			15
	Fundamentals of power systems			15		15
	High Voltage Engineering			15		15
	Power System Protection and Switchgear				15	15
	Digital Electronics System		15			15
	Object oriented programming		15			15
	Electromagnetic Theory			15		15
	Heat and mass transfer			10		10
	Analogue Circuit Design			15		15
	Measurements and Instrumentation			10		10
	Thermodynamics			10		10
	Fluid mechanics			15	15	30
	Electrical Machines			15		15
	Power Electronics and Drives			15		15

	Entrepreneurship and Economic development				10	10
	Group Project			15		15
	Renewable Energy Systems Development			10		10
	Solar Energy Engineering				10	10
	Individual Project				30	30
	Biofuel's technologies				10	10
	Smart grid and distributed power systems			10		10
	Transmissions and Distributions			10		10
	Advanced Energy Materials				10	10
	Linear Control Systems		10			10
	Energy Economics		10			10
Elective/Option COMPONENT	Set 1 (Select 1)					
Subjects/Courses/ Modules/Units	Machine Design I				15	
Choose TWO Modules ONE from Set – I and	Reliability Engineering and Plant Maintenance				15	
ONE from Set - II	Environmental Risk Assessment				15	15

	Power Systems Operation and Control				15	
	Design of Wastewater Engineering Systems				15	
	Set – II					
	Machine Design II				15	**15**
	Refrigeration and Air Conditioning				15	
	Internal Combustion Engines				15	
	Environmental technology				15	
	Wastewater Treatment and Recycling				15	

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SUMMARY OF CREDIT DISTRIBUTION FOR EACH COMPONENT PER NCQF LEVEL	
TOTAL CREDITS PER NCQF LEVEL	
NCQF Level	***Credit Value***
NCQF Level 5 Modules	*70*
NCQF Level 6 Modules	*140*
NCQF Level 7 Modules	*250*
NCQF Level 8 Modules	*140*
TOTAL CREDITS	*600*
Rules of Combination:	

(Please Indicate combinations for the different constituent components of the qualification)
The qualification rules constitute a combination of: (a) Elective modules (b) Core modules which are compulsory (c) Fundamental modules which are also compulsory (d) To graduate a candidate should have completed 600 credits Qualification Combination Rules Based on Module Status per NCQF designation of: Fundamental, Core & Electives: ▪ Core modules have 365 credits ▪ Fundamental modules have 205 credits ▪ Elective modules have 30 credits

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ASSESSMENT ARRANGEMENTS
Formative Assessment Formative assessment contributes to **50%** of the final course grade. **Summative Assessment** The summative assessment shall contribute to **50%** of the final course grade.
MODERATION ARRANGEMENTS
Internal and external moderators to be engaged will be BQA accredited subject specialists in relevant fields with relevant industry experience and academic qualifications. Both internal and external moderation shall be done in accordance with applicable policies and regulations.
RECOGNITION OF PRIOR LEARNING
There will be provision for awarding of the qualification through RPL mode which will be in line with the national RPL Policy.
CREDIT ACCUMULATION AND TRANSFER
There will also be provision for Credit Accumulation and Transfer, CAT policies which is in line with National Policies.

PROGRESSION PATHWAYS (LEARNING AND EMPLOYMENT)

1. Learning Pathways

Horizontal articulation of the qualification

- Bachelor of Engineering/BSc (Hons) in Wastewater and Environmental Engineering
- Bachelor of Engineering (Hons) in Electrical Engineering
- Bachelor of Engineering (Hons) in Chemical Engineering
- Bachelor of Engineering (Hons) in Environmental Engineering

Vertical articulation of the qualification

The bachelor of Energy Engineering Systems Degree programme may lead to a graduate pursuing post-graduate studies in many engineering fields which include but are not limited to:

- Master of Engineering in Renewable energy Engineering
- Master of Engineering in Environmental Engineering
- Master of Engineering (Honours) in Energy conservation Engineering
- Master of Engineering (Honours) in Power Systems Engineering
- Master of Engineering in Wastewater and Environmental Engineering
- Master of Engineering (Honours) in Electrical Engineering
- Master of Engineering in Mechanical Engineering

2. Employment Pathways

Graduates of the course may find employment in Renewable Energy Engineering, Power Engineering, Mechanical Engineering, Environmental Engineering, Energy efficiency and management, Process engineering services within a range of public and private organisations. Possible positions include but are not limited to:

- Energy Engineer
- Energy management consultant
- Energy policy development officer
- Mechanical Engineer
- Electrical Engineer
- Power systems Engineer
- Environmental Engineer/Scientist
- Project Manager
- Environmental Consultant
- Process Engineer
- Academic lecturer/Instructor/Teaching Assistant

QUALIFICATION AWARD AND CERTIFICATION

Minimum Standard of achievement for the award of the qualification.

To be awarded the qualification the graduate must complete 205 Credits of the Fundamental Component, 365 Credits of the Core component and 30 credits of the Elective component to make a total of 600 credits.

Certification

Students should pass all modules for the **Bachelor of Engineering (Honours) Electrical Power and Energy Engineering** to be awarded the qualification according to the standards prescribed for the award of the qualification and applicable policies.

REGIONAL AND INTERNATIONAL COMPARABILITY

The findings are as indicated below, displayed in the Comparability matrix.

It was observed that the purpose of all the qualifications was to have access to employment, professional registration, and further study.

- The requirements for the award for all universities include course work, examination, and project
- The minimum duration for the proposed qualification is five years, and this is the same for the Carleton University qualification. It is only Cyprus University which has a minimum duration of four years. The level for all universities in each country is higher education.
- The minimum entry requirements are similar which is a school certificate or NCQF level IV. This is adequately comparable.

It was observed that for different universities/colleges for Bachelor of Engineering (Honors) Electrical Power and Energy Engineering qualification doesn't use the notional 10-hour learning for one credit. In this vein, the total credits awarded at the completion of the qualification are different for each university.

The proposed qualification compares favourably with qualifications offered in regionally and internationally renowned universities.
The qualification is contextualised by benchmarking the areas stated above and as follows:

REVIEW PERIOD
The qualification will be reviewed after 5 years

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