

African Center of Excellence in Energy for Sustainable Development (ACE-ESD)

Abstract:

Modern energy access acts as a catalyst for development. It connects economic growth with social equity and environmental sustainability which are important Millennium Development Goals. However, the vast majority of sub-Saharan Africans lack access to affordable clean energy and critical energy services. The sub-region also lacks the critical mass of highly skilled professionals, with specialized knowledge in engineering and technology (especially in power systems and in electrical engineering) that is required to generate the innovations needed to boost productivity in the energy sector. This presents a significant challenge which requires sustained efforts to train highly skilled energy professionals, policy makers and practitioners, who will apply research towards the development of renewable energy technologies and solutions for the critical/priority sectors of the economy in the sub-region.

The Africa Centre of Excellence in Energy for Sustainable Development (ACEESD) in the College of Science and Technology, University of Rwanda is being established to address this critical challenge. The Centre is being established under the World Bank's Eastern and Southern Africa Higher Education Centers of Excellence Project (ACE II) supported by national governments within the region. The implementation of the

ACEESD is expected to result in building capacity of the East and Southern African region through the University of Rwanda, College of Science and Technology to undertake interdisciplinary research and training in smart and micro-grid energy technologies tailored to serve remote and/or rural areas using renewable sources, power systems and energy management and trade policy, train 40 PhD and 120 MSc energy experts and improve research and teaching environment.

The ACE II Project at the University of Rwanda, College of Science and Technology

The Africa Centre of Excellence in Energy for Sustainable Development (ACEESD) is an approved ACE II project center of excellence¹ envisioned to address key economic challenges resulting from low rural energy access, poor adoption of energy technologies in rural areas, and poor inter-state energy trading in the Eastern and Southern Africa region.

The ACE II project is a partnership between the World Bank and Rwandan government to support the government to strengthen selected Institutions of Higher Education to deliver quality post-graduate education and build collaborative research capacity in four regional priority areas (Energy, Internet, Data Sciences and Mathematics & Science).

This will provide the much-needed critical mass of MSc and PhD graduates who are fit-for-purpose, and who will serve as the backbone of this transformation. The ACEESD will build on its existing Renewable Energy Master's program, which will be revised (with a PhD component) and tailored to micro-grid renewable energy development tailored to serve remote and/or rural areas using renewable sources and inter-state energy trading. ACEESD will develop two additional excellent curricula for the training of high level MSc and PhD students. (Table 1).

The curricula will be implemented initially at the College of Science & Technology, University of Rwanda, and will be developed and shared with staff at partner universities in East and Southern Africa. ACEESD's courses will be accredited by the Energy Institute, UK in the short term and in the long-term by the Accreditation Board for Engineering and Technology (ABET). CST's resident academic staff will initially teach the MSc and PhD courses, complemented by visiting faculty from partner universities across the world. These will include, Colorado, Carnegie Mellon University in Rwanda, Tubitak Marmara Research Centre Energy Institute, University of Adger and East and Southern Africa universities.

Table 1. ACE-ESD Masters and PhD Programmes

PROGRAM	LEVEL	FOCUS AREAS
RENEWABLE ENERGY	MSc & PhD	<p>Smart & Micro-grid Technologies (Wind, Solar, Mini-Hydro, Biomass, Geothermal); Battery management systems (BMS): This involves the renewable energy control, embedded system and power electronics skills; Energy storage system (ESS): This involves the renewable energy control, embedded system and power electronics skills; Renewable energy (bioenergy including bio-fuels, solar energy, wind energy, etc.):</p> <ul style="list-style-type: none"> • Energy impact on the environment; • Energy for socio-economic development; • Energy system planning and modelling; • Energy infrastructure optimization; • Energy efficiency and demand side management; • Alternative energy
ELECTRICAL POWER SYSTEMS	MSc & PhD	<p>Power system dynamics, Power Electronics for renewable energy, generation, transmission and distribution systems, Control systems (stochastic systems, stability analysis, system identification), industrial controls, and optimization Smart & micro-grid system, Grid connected inverter optimization, Off grid connected inverter design ,testing and control, Grid connected multilevel inverter design, Electrical Vehicle(EV): This involves the renewable energy control, embedded system and power electronics skills</p>
ENERGY ECONOMICS	MSc & PhD	<p>Economic Evaluation of Renewable Energy Technologies, Inter-State Energy Trade Policy, Utilities Management, Energy environment, Energy benchmarking, Energy pricing</p>

Table 2. ACEESD's International, Regional and National Strategic Partners

NO.	PARTNER	CATEGORY TYPE OF PARTNERSHIP	COUNTRY
1	Colorado State University	University, International	USA
2	University of Agder	University, International	Norway
3	Tubitak Marmara Research Centre Energy Institute	Research Institution, International	Turkey
4	Makerere University	University, Regional	Uganda
5	Addis Ababa Institute of Technology	University, Regional	Ethiopia
6	The Nelson Mandela Africa Institution of Science and Technology	University, Regional	Tanzania
7	Strathmore Energy Research Centre	Research Institution, Regional	Kenya
8	Carnegie Mellon University, Rwanda (CMU-R)	University, National	Rwanda
9	Rwanda Energy Group (REG)	Industry Institution, National	Rwanda
10	Rwanda Utility Regulatory Authority (RURA)	Industry Institution, National	Rwanda
11	National Industrial Research and Development Agency (NIRDA)	Research Institution, National	Rwanda
12	Ngali Energy Ltd	Private Business	Rwanda
13	Great Lakes Energy Ltd.	Private Business	
14	Mobisol-Rwanda	Private Business	Rwanda
15	Barefoot Power Rwanda Ltd.	Private Business	Rwanda
16	Institution of Engineers, Rwanda	Professional Institution	Rwanda

Goals and Project

Objectives:

The mission and vision of ACEESD is to create a world-class energy centre that will be a regional hub for research and training of African engineers, policy makers and energy utility managers (in micro-grid energy systems using renewable energy sources and interstate energy trading, management and policy); contribute to rural development through technology transfer; and nurture and promote entrepreneurship development in the energy sector towards sustainable development.

The specific project objectives of ACEESD are:

- To provide national and regional capacity-building (MSc & PhD) for the establishment and implementation of energy systems using local energy sources and appropriate technologies to cover energy needs for sustainable development.

- To provide policy development skills training for students, policy-makers and utility managers aimed at building policy and monitoring capacity in the region which is critical for effective interconnection of energy systems.

- To provide energy research, consultancy and advisory services to both public and private organizations at national, regional and international levels;

- To develop and transfer appropriate energy technologies for sustainable development at the national and regional levels;

- To contribute and strengthen cooperation between industry and academia in the field of clean energy.

Expected outputs of ACEESD:

At the end of the five year period of the World Bank grant, ACEESD is expected to achieve the following outcomes: (i) transform an existing Renewable Energy Master's program at the UR-CST and develop new specialized graduate programs (2 masters and 3 PhD programs), (ii) obtain international accreditation for at least one new specialized graduate program, (iii) Train 40 PhD and 120 Master students, of which 30% would be regional and 30% female, (iv) train 80 practitioners and policy-makers through short term courses, of which 30% would be regional and 30% female, (v) establish a modern well-equipped micro-grid research laboratory, (vi) published 30 peer-reviewed research publications, of which at least 60% include regional and international co-authors, (vii) attract an average of \$0.5M per year in externally mobilized funds, (viii) improved research and teaching environment through a lecture rooms and students workstations to provide new lecturer and seminar rooms, high performance computing unit and e-learning platform.

Implementation Arrangements

Guiding rules and regulations.

The University of Rwanda, College of Science and Technology (UR-CST) (formerly Kigali Institute of Technology – KIST) was

officially inaugurated in April 1998, and four years after its inception, it was legally enacted by Law No. 48/2001 of 26/12/2001. It initially came into existence as a UNDP project on November 1st, 1997 with a clear mandate to produce technical and scientific professionals of high calibre for the country's rebuilding efforts after the genocide in 1994 against the Tutsis. In 2013, the Government of Rwanda through Law No. 71/2013 of 10/09/2013 established the University of Rwanda which merged KIST and six other public Higher Learning Institutions. It is the foremost science and technology institution in the country.

The establishment of ACEESD within the UR-CST and its framework to undertake an improvement in education, research and scholarship in off-grid energy generation using Micro-Grid systems is well aligned with the University of Rwanda's strategic plan to support research and training that encourages knowledge mobilization for sustainable development and subsequent improved quality of life. To this end, the University management will play an active role in signing financing agreements, MoUs, contracts, and control of ACEESD funds through its financial management team including Finance, Audit, Advancement and Procurement Units that will provide accounting and financial oversight and periodic reporting for the Centre.

The centre will avail itself of the UR-CST's existing partnerships while forging new partnerships with international, regional and

national academic, research and industry partners (Table 2). These partnerships will result in improved training and education for the centre's students. It would also strengthen the Centres teaching and research capacity to deliver its programs effectively, ultimately creating an international academic experience for students. National and private sector partner's support in curriculum development, capacity development in applied research in Micro Grid Energy systems, hosting students for research experiences and internships will also ensure relevant hands-on and practical learning for participants.

The Way Forward

The African Centre of Excellence in Energy for Sustainable development is highly motivated and prepared to lead the transformation needed in smart and micro-grid renewable energy technologies training and capacity building. This is relatively uncharted waters as far training in this area is concerned. This is addressed through the strong and extensive collaborations with our strong international academic partner institutions who all have extensive experience with Masters and Doctoral programs. This will help the ACEESD cooperate in international research and training while getting supervision for Doctoral and Masters Students. All programmes of the Centre will be developed, approved and taught with the collaboration of faculty from our esteemed academic partners. The Centre will also participate in the Partnership of Applied Sciences,

Engineering and Technology (PASET) benchmarking exercise to assure high quality postgraduate programmes are offered to students.

Challenges of inadequate staffing also need to be addressed. Under the project, two faculty members will be recruited on full time basis to supplement the Centre's faculty and faculty from partner universities. Dedicated research lab engineers will also be recruited to manage the Micro-grid laboratory to be established under the project.

Finally, there are challenges relating to graduate retention, labour and employment opportunities for students within Rwanda, the East and Southern Africa Region and Africa at large.

Industry-relevant curriculum coupled with strong emphasis on entrepreneurial skill development and support is required to address this. The Centre will adapt and implement the Creating Job Creators Programme by the host institution UR-CST, to expose students to industry early in their studies. Students shall be equipped with entrepreneurial and managerial skills that will help them start business enterprise or enter the workforce more easily. ACEESD will also liaise with its industry and public-sector partners to actively seek and establish opportunities for its graduates to establish start-ups with the aim of transferring the skills and knowledge acquired from the Centre into workable everyday solutions to community. This culminates to the development of a future of human resources in the energy sector within the Region.

Meanwhile, the best graduating students from the Centre will be directly employed as Tutorial Assistants, demonstrators and Lecturers not only by the Centre but in the University of Rwanda as well. Also, best graduating Masters Students will have an automatic enrolment onto PhD programmes of their choice either in the Centre or in UR-CST as a way of retaining them for the region.

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