

Research Application Summary

**Establishing an African Centre of Excellence in Energy for Sustainable
Development (ACEESD): A Centre of Excellence for Eastern
and Southern Africa**

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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 Centres 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 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.

Key words: Eastern and Southern Africa, Higher Education Centres of Excellence, Micro-grid, Renewable Energy, University of Rwanda

Résumé

Accès à l'énergie moderne agit comme un catalyseur pour le développement. Il relie la croissance économique avec l'équité sociale et la durabilité environnementale qui sont importants objectifs du Millénaire. Cependant, la grande majorité des Africains sub-sahariens n'a pas accès à l'énergie propre et abordable et des services énergétiques critiques. La sous-région manque aussi la masse critique de professionnels hautement qualifiés, ayant des connaissances spécialisées dans l'ingénierie et de la technologie (en particulier dans les systèmes d'alimentation et en génie électrique) qui est nécessaire pour générer les innovations nécessaires pour accroître la productivité dans le secteur de l'énergie. Cela pose un défi de taille qui exige des efforts soutenus pour former les professionnels de l'énergie hautement qualifiés, des décideurs et des praticiens, qui appliqueront la recherche vers le développement de technologies et de solutions d'énergie renouvelable pour les secteurs critiques / prioritaires de l'économie de la sous-région. Le Centre africain d'excellence en énergie pour le développement durable (ACEESD) dans le Collège des sciences et de la technologie, Université du Rwanda est mis en place pour relever ce défi critique. Le Centre est établi en vertu de l'Est et Afrique australe Enseignement supérieur Centres de la Banque mondiale du projet Excellence (ACE II) pris en charge par les gouvernements nationaux dans la région. La mise en œuvre du ACEESD devrait se traduire dans le renforcement des capacités de l'Université du Rwanda, Collège des sciences et de la technologie à entreprendre des recherches et de la formation interdisciplinaire dans les technologies énergétiques intelligents et micro-réseau adaptés pour servir à distance et / ou les zones rurales en utilisant des sources renouvelables, les systèmes d'alimentation et de gestion de l'énergie et de la politique commerciale, train 40 doctorants et 120 MSc experts en énergie et l'amélioration de l'environnement de recherche et d'enseignement.

Mots clés: Afrique orientale et australe, les centres d'enseignement supérieur d'excellence, Micro-réseau, les énergies renouvelables,. Université du Rwanda

Background

The importance of energy for sustainable development has been underscored by critical global actions such as the UN's Sustainable Energy For All initiative (SE4ALL), and the strong integration of energy into the Post-2015 Development Agenda¹. Modern energy access acts as a catalyst for development – in education, health, food security, productive enterprise, environment and participatory democracy – which in turn supports further improvements in energy access. 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 is home to over 48% of the 1.3 billion people worldwide lacking access to electricity², and 80% of the population do not have access to clean and safe cooking facilities³. Furthermore, a large proportion of these are in rural areas in the region, with electrification rate of only 16%, where the majority of food and raw materials are produced, resulting in tremendous loss of productivity. Within the East African sub region, most of the countries have more than 90% of their population relying on biomass while electrification access rates

remain low ranging from 12% in Uganda to 14% in Tanzania and 18% in Kenya⁴ (UNECA, 2014). This presents a significant challenge to addressing the global energy access problem. Renewable energy adoption (through micro-grids using solar, micro-hydropower, wind, geothermal etc.) and energy trading are two critical areas requiring huge investment and multi-stakeholder partnership to help address this challenge. In 2012, “the conference of the United Nations Rio+20 stated that since 1992, the global energy crisis had aggravated the lack of progress in sustainable development, particularly in developing countries, and urged countries to address the challenges posed by access to sustainable modern energy services” (SE4ALL, 2012; UNECA, 2014).

However, the challenge is that the sub-region 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 (World Bank, 2015 & 2016). For example, UNESCO data for 2012 show that only 11.2% of graduates from Rwanda were in the fields of engineering, manufacturing and construction (UNESCO Institute of Statistics, 2015). The situation is similar or worse in other East and Southern Africa countries (0.78% in Burundi, 6.4% in Uganda, 3.82% in Mozambique, 17.45 % in Kenya and 4.88% in Ethiopia) and especially at the Masters and PhD levels⁵ (*ibid*). This scarcity of expertise, coupled with inadequate state-of-the-art laboratories and infrastructure to facilitate such training and research, points to the shortage of requisite intellectual expertise required to train such specialized personnel for the energy sector.

Compounding these is the issue of developing and harmonizing energy trade policies within the sub-region, which is often beset by breakdowns in policy dialogue, changes in policy priorities of governments, among others (Brew-Hammond, 2010; UNECA, 2014). Also, there needs to be clear policy frameworks that ensure that investors who venture into the renewable energy sector within the region enjoy attractive and robust tariffs and pricing arrangements to reassure them of a fair return for their output. Appropriate feed-in tariff designs for example is crucial to the success of distributed systems such as micro and mini-grids being championed by the ACEESD.

Beyond legal, regulatory and policy frameworks, market stimulation, growth and scale-up is another critical area that needs to be addressed as most countries in East Africa lack well-functioning markets (both consumer and commercial) for the accelerated development and adoption of renewable energy technologies and systems. To adequately handle these, it is envisioned that the new and alternative approach would be to provide home grown solutions by developing expertise in the field smart and micro-grid power generation and systems (using Solar or PV Systems, Mini or Micro Hydro, Geothermal, Wind, Biomass and Biodiesel energy resources) that are customised to each remote area with the ability to upgrade.

The World Bank and national governments in Eastern and Southern Africa in response to the above launched the Higher Education Centres of Excellence Project for Eastern and Southern African countries (ACE II). This initiative aims among other things to “strengthen longer-term African capacity to train at the highest level a new generation of Africans who

can develop and apply science and technology to solve Africa’s most pressing challenges” (World Bank, 2016). The Eastern and Southern Africa region currently lacks any Centre with the capacity to provide the relevant programs and training in smart and micro-grid renewable energy systems at the PhD level. The region will therefore benefit from a first-of-its-kind Regional Energy Centre in the University of Rwanda, College of Science and Technology focused on training experts in smart and micro-grid renewable energy technologies and inter-state energy trading.

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

The Africa Centre of Excellence in Energy Sustainable Development (ACEESD) is an approved ACE II project centre of excellence⁶ 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 (World Bank, 2016). 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 and 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 curricula for the training of high level MSc and PhD students (Table 1).

The curricula will be implemented initially at the College of Science and 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). The CST’s resident academic staff will teach the MSc and PhD courses,

Table 1. ACEESD Masters and PhD Programmes

Program	Level	Focus areas
Renewable Energy Technologies	MSc & PhD	Smart & Micro-grid Technologies (Wind, Solar, Mini-Hydro, Biomass, Geothermal)
Electrical Power Systems	MSc & PhD	Power system dynamics, Power Electronics for renewable energy, generation, transmission and distribution systems
Energy Management Trade Policy	MSc & PhD	Economic Evaluation of Renewable Energy & Technologies, Inter-State Energy Trade Policy, Utilities Management

complemented by visiting faculty from partner universities across the world. These will include, Colorado, Carnegie Mellon University in Rwanda, Turbitak, Adger and East and Southern Africa universities.

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:

1. To provide national and regional capacity-building (MSc and PhD) for the establishment and implementation of energy systems using local energy sources and appropriate technologies to cover energy needs for sustainable development.
2. 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.
3. To provide energy research, consultancy and advisory services to both public and private organizations at national, regional and international levels;
4. To develop and transfer appropriate energy technologies for sustainable development at the national and regional levels;
5. 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, and (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 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.

Governance and management of ACEESD. The ACEESD will have a Centre Leader (CL) and a Deputy Centre Leader (DCL) who doubles as Principal Investigator (PI) to be in charge of the Centre. The CL will report to the Principal of UR-CST. The CL will be assisted by members of the ACEESD Steering Committee and the International Scientific Advisory Board. The ACEESD will be managed and governed under the College of Science and Technology. The organogram for the centre is shown in Figure 1. In the initial quarter of the project implementation, all these teams/groups will be brought together to develop the work plan and schedule of activities for the first year. All staff (administrative and faculty) will undergo training in World Bank procedures, in the management of large donor-funded projects, as well as in UR-CST's administrative, financial and procurement procedures. In the first year, all administrative processes and procedures for the management of ACEESD's units and the Secretariat will be established. These processes and procedures which will be developed into Comprehensive Procedures Handbooks will cover procurement, monitoring and evaluation, accounting, and program implementation and reporting.

The day-to-day running of the Centre will be managed by the ACEESD Secretariat (composed of the Executive Advisor, MSc/PhD Coordinators, Finance and Administration Personnel – M&E, Procurement, ICT and Account Officers). The Secretariat will oversee activities

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

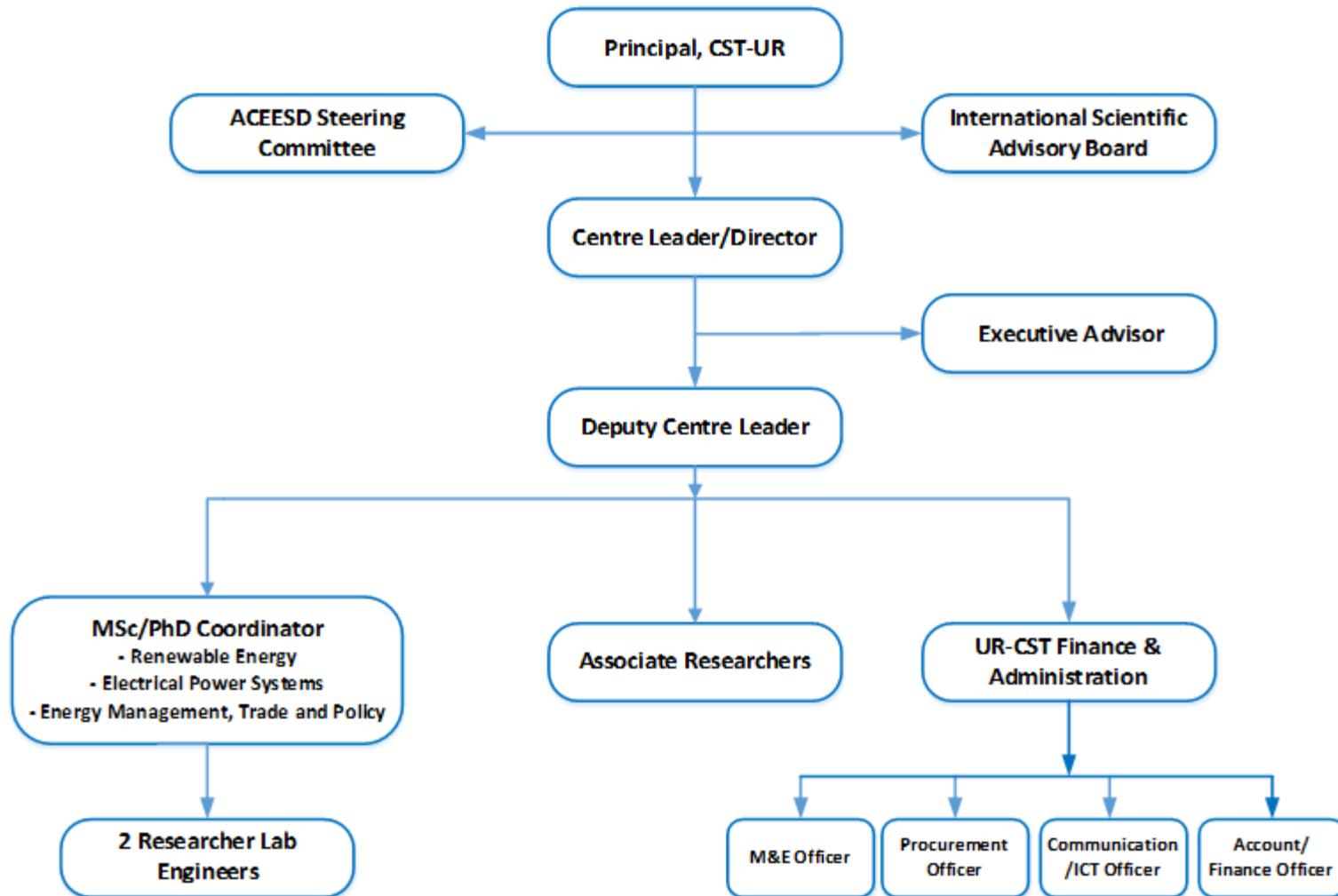


Figure 1. Organisational chart for the ACEESD

such as program administration, coordination of performance contracts and Memorandum of Understandings (MoUs) with all partners, and the development of work schedules with and for all units. The Associate Researcher & MSc/PhD Coordinators in the Secretariat will also engage in capacity development and liaise with industry, government sector agencies as well as community leaders and local authorities across the East Africa region. This is for purposes of field testing of developed technologies, as well as research work of PhD and Master's students. The Secretariat will report to the DCL.

The UR-CST management personnel with extensive experience in the management of large donor-funded projects will provide oversight monitoring services to the Secretariat. These include CST's Director of Finance; Procurement Officer and the Director of Administration and HRM Unit.

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.

There are also 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 (CJC) 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.

It is planned that 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, the 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.

Acknowledgement

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