ACE Impact
Pre-identified Regional Development Challenge
Power

Terms of Reference

Guidance

Proposals that respond to the Power Pre-Identified Regional Development Challenge should address the following Terms of Reference (ToRs) in the appropriate section of the proposal. While it is unlikely that a single proposal can address all of the ToRs, the proposal should make a substantial, credible effort to respond in a way that presents a cohesive, integrated program of education, research and partnership activities that aligns both with the ToRs and with the goals of the ACE Impact project.

Background

In pursuit of its strategic goal of regional energy integration and efforts to be self-sufficient in electricity supply in the West African sub-region and to increase access to stable and reliable electricity at affordable costs to its citizens, the 15-member states of the Economic Community of West Africa States (ECOWAS) established a cooperative power pooling mechanism known as the West African Power Pool (WAPP). WAPP has been helping countries in the ECOWAS region to develop and implement regional priority projects that are identified in the regional Electricity Master-plan endorsed by WAPP in December 2011; the plan is currently undergoing updates to reflect current trends and recent developments in renewable energy. A critical component of the regional effort is to ensure there is a ready supply of well-trained, utility-minded power engineers who can support WAPP in efforts to plan, design, expand and operate the grid in the most efficient manner.

In addition to WAPP's efforts, other institutions (governments, utilities, development and financial institutions, etc.) involved in the energy sector planning, project preparation, project implementation, and infrastructure operation and maintenance are facing difficulties in recruiting skilled professionals in the power sector. The training currently available in the region does not address all the needs, and the risk of skilled professional shortage is looming ahead because of an ageing workforce that is approaching retirement. Therefore, it is urgent to identify and fill the gaps in technical and management capacity in utilities in sub-Saharan Africa. In particular, while there are many programs that produce well-trained electrical engineers, a utility mindset – one that emphasizes the principles behind operating synchronously and maintaining a large international, interconnected system – is essential to the success of a future workforce.

In addition to the pressing retiring workforce challenge, the power sector is also undergoing a major revolution worldwide driven by issues such as climate change and environmental quality, energy conversion efficiency, use of renewable energy sources, introduction of advanced consumers who can actively participate in the management of the supply-demand balance and of the grid, etc., which call for innovative tools, equipment and solutions for the planning, design, operations and maintenance of power systems. Hence, new competencies are needed for smart grid engineering and the traditional curriculum of power engineering must be expanded and adapted to effectively train a new generation of engineers and technical specialists, and tailored capacity building programs should be implemented to enhance the skills of the utility engineers and professionals. Finally, it is important to create and maintain a bilingual (English and French) program to strengthen inter-regional cooperation among the electricity utilities of all African countries.

Terms of Reference

I. The selected Africa Center of Excellence in Power will address the following skills related aspects of the Development Challenge:
   1. Lack of skills in power utility specific operations;
   2. Lack of skills in power utility specific infrastructure design (including integration of variable renewable energy);
   3. Lack of skills and technical expertise on advanced technologies for grid modernization; and,
   4. Lack of skills in power business and national and regional markets, risk and resiliency management, costing and human resource management.

II. To address the long-term skills needs, degree programs available through the Center should include programs that help provide both an understanding of the fundamentals of the power system – from generation, transmission, distribution and consumption of power – and applications of these in a utility or similar context. Examples of such longer degree programs could include:

Master’s Degree Programs
1. M.S. in Electrical (power) Engineering
2. M.S. in Electromechanical Engineering
Ph.D. Programs
1. Ph.D. in Power Engineering
2. Ph.D. in Renewable Energy

Such programs may be designed as a single monolithic program which is highly prescriptive and follows a strictly regimented set and order of courses. Alternatively, to provide flexibility and the ability for individuals to narrow their studies according to their career needs, as well as reduce costs by sharing courses between degree and non-degree certificate programs, could consist of a core that helps provide a solid foundational understanding of electricity and choice of electives from the example courses below in the professional training. The length and delivery modalities of the program should reflect best practices elsewhere in the world.

It is critical to note that such programs must address short-comings in existing programs around utility operational aspects – it is not just sufficient to learn the basics of each individual component in a power system but how these parts come together and function in an integrated system. Emphasis should be placed on real-world applications of technologies and processes in a functional power system. Such topics could include, for example, HVAC technology and equipment, power plants, transmission lines, substations, the types and uses of relays, reclosers, transformers, sensors, real-time automation controllers (RTACs), metering equipment, and other similar components; power quality and reliability, including event analysis and rectification; wide-area protection and control systems, including protection systems, remote communication systems and cybersecurity; and, understanding of standards (such as IEC 61850) widely used in real-world systems. Complementary or elective courses should offer real-world perspectives on other topics such as power markets, energy economics, best practices on non-technical systems, and power system planning across generation, transmission and distribution.

III. To address professional training needs and provide a program that utilities, governments, financial and development institutions could request to ensure professional competency for hiring or promotion, it is recommended that the Center offer non-degree certificate programs. Examples of such non-degree or certificate courses could include:

Non-degree / certificate programs:
1. Power system planning and advanced applications – including at least generation and transmission planning and least-cost electrification planning.
2. Wide-area power system protection and control.
3. Power generation fundamentals – including heat rate efficiency, gas and steam turbines, hydropower generation, power plant subsystems, plant economics.
4. Power Transmission Fundamentals – including transmission lines and substations
5. Communications and interoperability – including basic considerations of cybersecurity.
6. Power markets, energy economics and strategic planning – including establishing and operating in merit-order dispatch, and participating in markets (day-ahead, real-time, ancillary services).
7. SCADA / EMS – including using SCADA and Energy Management Systems to effectively control large systems.
8. Emerging generation technologies – including advances in thermal, renewable and storage sources that increase plant or grid efficiency or can help grid stability.
9. Power system analysis and dynamics – including ensuring a system remains stable under dynamic conditions.
10. Synchronous / induction motors
11. Renewable energy fundamentals – including basics of how non-hydro renewable systems generate power, integration of renewables and characteristics of such sources in grids.
12. Energy storage systems – including both chemical (battery), thermal and mechanical (such as pumped-hydro, kinetic, compression) storage systems.
13. Power electronics fundamentals and applications – using high-voltage direct current (HVDC) system and flexible alternating current transmission systems (FACTS) to provide efficient and reliable long-distance power transmission.
14. Power quality and reliability – including basic concepts, measurements, corrective measures.
15. Active power and frequency control.
16. Primary droop control.
17. Reactive power compensation and voltage control.
18. Smart grid technologies – including SCADA/EMS, SCADA/DMS, distribution automation, smart metering.
19. Distribution systems planning and engineering.
20. Mini-grids.

It is understood that some of these courses will build on each other and have pre-requisites that potential course participants will need to prove/acquire before enrolling. It is essential, however, that the sequencing of courses should reflect both the need for pre-requisites that make the course material useful to students, as well as options to prove needed knowledge in ways that allow capable students to bypass unneeded courses. Finally, it should be possible to combine the courses in order to develop a specific expertise in a given field.

IV. The selected Africa Center of Excellence in Power will address the following applied research related aspects of the Development Challenge:

1. Lack of research in innovative approaches on energy transformation (e.g. variable renewable energy development and integration);
2. Lack of research in smart grids and distributed power generation technology and modelling;

3. Planning and design of interfaces between large (backbone) grids, mini- and nano- grids, with a focus on enhancing reliability and resilience of power systems; and,
4. Low cost technologies for rural electrification.

V. The selected Africa Center of Excellence in Power will undertake an applied research program that includes the following themes:

Applied Research Themes
1. Planning and design of interfaces between large (backbone) grids, mini- and nano- grids, with a focus on enhancing reliability and resilience of power systems.
2. Low cost technologies for rural electrification (utility and private sector).
3. Renewable energy integration into small and poorly-controlled power systems.
4. Development of high capacity transmission technologies for congested urban areas.
5. Application of advanced technologies for cost-effective power system operation and management.

VI. The selected Africa Center of Excellence in Power will have an established network of core industry/sectoral partners identified in the proposal, including:
1. Regional power pools;
2. Industry associations, manufacturing/heavy industries, other key anchor customers;
3. Power utilities in West Africa;
4. Electrical equipment suppliers; and,
5. International organizations with significant activities focused on power system infrastructure development

VII. The selected Africa Center of Excellence in Power will have an established network of academic and/or research institute partners identified in the proposal, including:
1. Regional universities that maintain active education and/or research activities focused on power system engineering and relevant fields; and,
2. Recognized global universities that maintain active international research collaborations focused on power system engineering and relevant fields.