CAPACITY BUILDING ON PLANNING AND OPERATION OF WESTERN AFRICAN POWER GRIDS WITH HIGHER SHARES OF VARIABLE RENEWABLE ENERGY

Regional Training on the Economics of System Planning and Operation with Variable Renewable Energy

CONCEPT

I. Background

The International Renewable Energy Agency (IRENA) is an inter-governmental organisation, mandated by member states around the world to promote the widespread and increased adoption, and sustainable use of all forms of renewable energy. This concerns all forms of energy produced from renewable sources in a sustainable manner, which include bioenergy, geothermal energy, hydropower, ocean, solar, and wind energy.

The energy system in West Africa is faced with a number of interrelated challenges: low energy access, insecure energy supply, and growing environmental degradation. The installed power generation capacity of the region is in the order of 16 GW comprising of 32% of hydro and 68% of thermal capacity, which covers only 37% of the power demand. Only 42% of ECOWAS population have access to electricity, concentrated in urban areas, which drops down to single digits in rural areas.

The power system in West Africa is confronted with the challenges arising from the supply deficit and thus growing demand is unmet. Furthermore, the region faces the difficulty of raising sufficient funds internally or attracting outside investors willing to incur the high perceived risk in the electricity sector in the region. Overall, unreliable power holds back the region's industrial development and has a negative impact on productive activities. The weighted regional average for technical losses is 14.5%, while the non-technical losses in the region are 21%[1]. The cost of providing backup power using fossil fuel powered captive generators handicaps productive industries and blackouts reduce annual economic growth in Africa by around 2%.

The region has vast renewable energy potential to cover the unmet power demand and reach the universal access to electricity while supporting the region's transition to a low carbon growth path. In that regard, in July 2013 the ECOWAS Authority of Heads of State and Government adopted the ECOWAS Renewable Energy Policy (EREP) that aims to increase the share of renewable energy in the region's overall electricity mix to 35% by 2020 and to 48% by 2030 (excluding large hydro (≥ 30MW), to 10% and 19%, respectively). The EREP is complemented with the ECOWAS Energy Efficiency Policy (EEEP) that targets to implement measures that would save an estimated 2000 MW of power demand through efficiency gains by 2020 and in the long term, more than double the annual improvement in energy efficiency, compared to 2010 levels.

With a view to supporting the operationalisation of a regional power market, IRENA, in collaboration with ECOWAS Centre for Renewable Energy and Energy Efficiency (ECREEE), West African Power Pool (WAPP), and ECOWAS Regional Electricity Regulatory Authority (ERERA), has initiated the West Africa Clean Energy Corridor (WACEC) initiative. Building on the ongoing efforts in the region, including, those of UEMOA, AfDB, and other development partners such as Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH and USAID. WACEC will promote the development of utility scale renewable power and its integration to the West African power systems.

[1] ECREEE (2016). Regional Progress Report on Renewable Energy, Energy Efficiency and Energy Access in ECOWAS Region – Monitoring Year: 2016

As endorsed by the ECOWAS Energy Ministerial in December 2016, the WACEC's implementation plan is built on the five pillars of (i) Zoning and Resource Assessment to identify sites for renewable power generation in areas with high resource potential and suitable transmission routes; (ii) National and Regional Planning to fully consider cost-effective renewable power options; (iii) Enabling Frameworks for Investment to open markets and reduce financing costs; (iv) Capacity Building to plan, operate and maintain power grids and markets with higher shares of renewables-based electricity; and (v) Public Information and Awareness Raising on how the corridor can provide secure, sustainable and affordable energy.

The WACEC initiative includes three strategies, exploiting the best available resources in the region:

- Hydropower strategy: includes West African countries with significant hydropower resources;
- Solar strategy: includes West African countries where large solar power plants could be built at low cost while benefiting from economies of scale;
- Wind strategy: West-African countries with large-scale wind resources.

The three strategies above were developed and validated during a regional workshop from 16 to18 September 2019 in Dakar.
ECREEE in partnership with IRENA, USAID, GIZ and the relevant regional institutions is developing WACEC program and its institutional implementation framework.

In March 2017, the Energy Ministers at the Specialized Technical Committee on Energy, Transport and Tourism of the African Union recommended the Member States to integrate the concept of the Clean Energy Corridors, which includes WACEC for the West Africa region, into their national renewable energy and climate change agendas as well as the process of creation of a sustainable and low-carbon power markets.

II. Rationale

Effective system planning is critical to building electricity systems that can accommodate renewable energy, and it is also important that the outputs from the system planning follow through into the definition of what characteristics need to be provided by new IPP projects that are being procured. A holistic approach to system planning that accounts for the nature and availability of renewables and the need of flexibility is essential for building stronger grids for increasing the share of variable renewables.

Where many of the ECOWAS electricity markets are very small in size, it could be difficult for these markets to absorb much variable renewable energy in an economically efficient manner in the context of a nascent regional electricity market that allows for short-term trading in a liquid wholesale market. While the regional market has recently been launched, it is likely to be at least several years until these requirements that will ensure the fluidity of a regional electricity market are met. It is imperative at this juncture to facilitate knowledge transfer and ensure best practices are considered when aiming for a functional regional electricity market.

Under the implementation of the WACEC, ECREEE, IRENA, in cooperation with GIZ, USAID, and together with the key regional institutions, has the ambition to support the strengthening of the capacities of the relevant stakeholders of the ECOWAS power sector through series of tailor-made capacity building activities. In this context, a regional capacity building programme focusing on the management of power grids with higher shares of variable renewable power was initiated in 2017. The scoping study and the first series of trainings provided a clear overview of the various issues and best practices in integrating renewables. The trainings were instrumental in identifying the areas that require further support. Based on the feedback received from participants and energy experts, the next phase of the capacity building program

will focus on two core streams, namely (i) the economics of power system planning and operation with an emphasis on economic generator dispatch, ancillary services, short-term markets and spot pricing, reserve calculations as well as grid codes; and (ii) the planning and operation, focusing on aspects related to forecasting, system adequacy, estimating reliability, hosting capacity, flexibility assessments, frequency and voltage regulation.

As part of the implementation of this follow-up programme, the proposed activity will focus on building capacities of electricity generators, Transmission System Operators (TSOs), Distribution System Operators (DSOs) and regulators of the region on the economics of system planning and operation with Variable Renewable Energy (VRE). The overarching goal is to ensure that the regional and national stakeholders have a good understanding of the technical and economic factors that impact the potential of grid and market systems to accommodate higher shares of VRE in both high voltage and low-voltage networks.

III. Objective and scope of the work

Moving forward with the first core stream of trainings, the main objective of this capacity building activity is to reinforce the understanding by the utilities, national grid operators – TSOs and DSOs, national regulators, the Information and Coordination Centre (ICC) of the Regional System Operator (WAPP), Regional Regulator (ERERA) and other relevant stakeholders of the ECOWAS region (ECREEE), of the prerequisites to find technically and economically optimal solutions to improving electricity reliability in the grid while accounting for an increased share of VRE, notably solar PV and wind energy technologies. At the same time, training staff of regional training centres should be enabled to continue and upscale capacity building activities on the same issue on a regular basis. The topics of discussion should include, but not limited to:

- Cost structure and technical constraints of different generation technologies (solar and wind) as well as data requirements and data collection, primary resource forecasting;
- Generator scheduling, with specific focus on Hydrothermal Scheduling, Unit Commitment and Economic Dispatch
- Accounting for generator characteristics (ramp rates, start-up time, shut-down time, black start capabilities) in generator dispatch;
- Improvement in operating reserve calculation to account for VRE
- Ancillary services (frequency control, voltage control, restoration services, interruptible loads services, etc.) for effective integration of VRE on both the transmission and distribution network;
- Structure of liberalized electricity markets, roles of system operators and real-time pricing
- Flexibility Assessment of the power system to evaluate the ability of generators to maintain demand-supply balance and minimise curtailment of renewable energy with high shares of renewables while maintaining the reliability of the system.
- Understanding of ECOWAS Regional Electricity Market

IV. Expected Outcomes

The trainings are expected to contribute to an improved understanding of the requirements for the planning of power grids with variable renewable power generation, based on the best practices from the region and beyond.

It is also expected that the (optional) accompanying Training of Trainers (ToT) activity will enable the trainers of WAPP's five regional training centres to conduct the training course independently. Accordingly, it is suggested to involve the trainers in the subsequent trainings for the utilities and other target groups, involving them as co-trainers who assume some parts of the training course in close cooperation with the consultant.

V. Detailed description of the work

The technical assistance to be conducted by the consulting entity will mainly target power system operators, utilities and regulators, while the consulting entity will work closely with IRENA, WAPP, ECREEE, and ERERA in the implementation of the assignment, as described in these Terms of Reference.

The consulting entity is expected to develop a technical offer with an appropriate methodology and specific work plan that will ensure the achievement of the assignment's objective **within an implementation period of 8 months**.

Before starting the assignment, the consulting entity will be required to attend a briefing meeting, with IRENA, GIZ and the ECOWAS counterparts (WAPP Secretariat, ERERA, ECREEE). This meeting could be held virtually. All outputs under the assignment will be both in English and French. All reports, working papers or other documents prepared for IRENA must conform to IRENA/OECD style requirements and their content will be aligned with other IRENA technical reports. These requirements are outlined in IRENA's style guide, which together with other guiding documents will be given to the consulting entity at the beginning of the assignment.

The project will focus on **two regular tasks and one optional task**:

Task 1: Development of trainings material

Building on the outcomes of the first phase of trainings, and notably on the scoping analysis, the conclusions of the trainings provided and the follow-up programme completed in the initial phase of the capacity building on the planning and operation of power grids with higher shares of variable renewable energy, the consulting entity shall design the technical content, including the material for a 5-day training workshop for the utilities and regulators of the 15 ECOWAS countries. The training material will be developed in both French and English and contents should cover priority aspects related to the economics of power system planning and operation with a focus on economic generator dispatch, ancillary services (frequency control, voltage control, restoration services, interruptible loads services, etc.) for effective integration of VRE, short-term markets and spot pricing, and reserve calculations with illustrative examples from Africa or other developing countries. The training materials and content should also cover the topic of power system flexibility[2] and how to best assess it with the use of modelling tools[3]. When available, IRENA publications should be the base for the development of training materials.

Task 2: Training delivery

The consulting entity will also be responsible, under the supervision of IRENA, for delivering the trainings (presentations, moderation of discussions) and compiling the workshop documentations, including summary and conclusions. The trainings will be organized for a total of around 40 participants[4] from the 15 ECOWAS countries and the ECOWAS Regional Energy institutions, thus the training material should be made available in both French and English. The training should be organised in a format that allows for each participant to follow the theoretical part of the training in their own language (French or English), while the practical sessions will be held jointly.

[2] See the IRENA publication "Power system flexibility for the energy transition" https://irena.org/publications/2018/Nov/Power-system-flexibility-for-the-energy-transition

[3] For example the IRENA FlexTool, which is an open-source, freely and publicly available tool that solves an economic dispatch and a capacity expansion problem with a focus on power system flexibility. The tool can be downloaded here: https://irena.org/energytransition/Energy-System-Models-and-Data/IRENA-FlexTool and can be used for any part of the training that would require the use of a software tool.

[4] Approx. 2 participants from each of the 15 ECOWAS countries, ERERA, WAPP as well as regional training institutions and relevant stakeholders (WAPP Secretariat 2, ERERA 2, ECREEE 2)

In designing the training, the consulting entity should account for the possible invitation of representatives of TSOs/DSOs from countries (even beyond the ECOWAS region) with relevant experience in the integration of high shares of variable renewable energy, for an exchange of best practices. It is also advised that the training schedule allows for a field visit to the dispatch centre of a utility with experience in operating grids with high shares of variable renewable energy.

IRENA, GIZ and the ECOWAS counterparts will be responsible for the selection of the venue and the date for the training, the invitation of the speakers and participants for the workshop and the associated costs (rental of venue, travel costs, catering and accommodation of participants). In light of the current pandemic situation, the consulting entity should also offer the option of delivering an initial introductory webinar (duly considering the varying degree of internet connection reliability across West Africa), to be followed by the in-person training. The service provider is invited to use the online platform *atingi* (https://www.atingi.org/) to share information and data and to organize the exchange between the participants. *atingi* is the new digital learning platform of the Federal Ministry for Economic Cooperation and Development (BMZ). It is free of change and offers an integrated webinar tool. If a webinar is integrated, it should be recorded and published in order to allow (absent) participants to follow the content independently at a later point.

After the final training, the consulting entity is expected to conduct an evaluation of the training course(s) together with the trainers from the regional training centres, including also feedback from IRENA, GIZ and the ECOWAS counterparts, and to hand over the evaluation to IRENA and GIZ. Based on the feedback received, the consulting entity will finalize the training course description and training materials (for trainers and participants), and hand them over to the five training centres.

Upon completion of the training(s) and the evaluation, the consulting entity will produce a final report highlighting the key outcomes of the training as well as potential areas of further follow-up under the larger topic of the planning and operation of power grids with higher shares of variable renewables.

<u>Optional Task:</u> Delivering a Training-of-Trainers course and engaging the trainers of WAPP's regional training centres in the development and implementation of the training course

The consulting entity will prepare and implement two trainings of trainers (ToT) for selected trainers of the five regional training centres of WAPP (one for French speaking participants from the training centres in Senegal, Côte d'Ivoire and Benin and one for English speaking trainers from Ghana and Nigeria) before running the training courses for the target group. Alternatively, the consulting entity might offer one single ToT including simultaneous translation for all participants.

The approach and content of the ToT(s) should be tailored to the needs of the trainers and consider the different experience levels of the trainers regarding the topic (e.g. by evaluating the existing knowledge and needs with a questionnaire before developing the ToTs). Existing capacities should be capitalised (e.g. by integrating peer-to-peer learning elements). The ToT(s) shall be organized in a virtual format (GIZ offers the consulting entity to use the online platform *atingi* for the ToT, see information above).

The consulting entity will propose an appropriate length (approximately 5 days or an equivalent number of hours spread over a longer period), content and structure of the training. The ToTs shall cover the technical content (including practical examples) as well as pedagogical aspects and shall enable the trainers to act as co-trainers in the following trainings, assuming some parts of the training course in close cooperation with the consultant. The trainers should receive the training material that is being developed for the participants as well as additional material tailored to their needs as trainers (further in-depth material on the technical issues, practical examples, FAQs regarding the training content, material on pedagogical aspects etc.).

For this optional task, the consulting entity will establish a separate contract directly with GIZ on the basis that the task will be completed before the end of December 2020.

VI. Expected Deliverables and Timeline

The two above-listed tasks are to be completed as per the following timeline:

	Deliverable	Timeline[5]	Contracting / Funding Responsibility
i	Development of Training materials for the target audience	*before 15.10.2020*	*IRENA*
ii	Tailoring training materials for the Training-of-Trainers training - optional	*before 15.11.2020*	*GIZ**
iii	Delivery of Training-of-Trainers training - optional	*before 31.12.2020*	*GIZ**
iv	A 5-day workshop	*before 31.03.2021*	*IRENA*
v	Final report	*before 15.04.2021*	*IRENA*

GIZ may contact the successful bidder, post evaluation /award of CONTRACT FOR deliverables – i, iv & v by IRENA; to contract for deliverables ii and iii. Such a GIZ contract for deliverables ii & iii will be subject GIZ rules and General Terms of Contract.

VII. Criteria for evaluation of offers

To assess best value for money, the technical qualitative evaluation of the bids will be based on:

Criteria	Weighting (%)
1. **Proposed work plan and approach:** Understanding of the task; sufficiently addressing the important aspects of the task according to the different components of the project, i.e. development of material and methodology of delivery of the training; Please provide full details on the structure as well as a full description of the proposed approach for implementing the work plan and the required tasks.	25
2. **Clarity and organization of activities**: Relating the scope of work to the Terms of Reference - clarity and organization of activities and whether the planning is logical and realistic.	5
3. **Overall experience on Capacity building for VRE grid integration:** Relevant knowledge and documented experiences in variable renewable energy grid	30

[5] The timeline is to updated depending on the start date of the project, with prior consent of IRENA.

integration studies and training in Sub-Saharan Africa or other developing countries – provide samples of similar work done in field over the last 3-5 years. Solid experience in in Sub-Saharan Africa or other developing countries designing capacity building programmes and providing trainings on technical aspects of variable renewable energy in the power sector, including, planning, designing and managing power grids with variable renewable power.	
4. **Team quality:** Composition, qualifications and experiences of team and knowledge of the region– Provide CVs of 5 experts, whom you propose to; (a) Develop training material, (b) Deliver the training. The Minimum qualification for the Project Manager is 10 years of relevant experience in designing and managing capacity building programmes on grid planning and operation issues. (15 points) The Minimum qualification for each of the remaining team members is 5 years of relevant experience in designing and managing capacity building programmes on grid planning and operation issues. (10 points per member) Proficiency of the team in speaking and writing both English and French is mandatory.	35
5. **Local network:** Involvement of local institutions/experts in ECOWAS in the consulting process – Indicate how your organisation will involve local institutions/experts and how they will benefit from the project. Provide details on the proposed plan to involve local institutions as well as samples based on past experience.	5

Bidders are requested to provide a technical and a financial proposal as separate documents. The financial proposal should include a breakdown of the costs (number of person days) associated with each task and sub-task.

This application is also open to consortia.