



Technology and Infrastructure

Regional Renewable Energy Grid Integration training workshop in West Africa



in collaboration with



July 2023

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17-18 July 2023

Background

West Africa is a region characterised by a growing need for reliable and sustainable electricity access. The demand for electricity is increasing due to population growth, urbanisation, and economic development. However, the existing electricity infrastructure in many West African countries is often outdated, inadequate, and reliant on fossil fuels, resulting in limited access, frequent power outages, and high energy costs. Moreover, West Africa faces unique challenges in terms of grid development and energy access. The region is characterised by a fragmented grid system with multiple small-scale, isolated grids that lack interconnections. This fragmentation restricts the ability to efficiently transmit and distribute electricity across borders and hinders the optimal utilisation of energy resources. Additionally, the reliance on traditional fossil fuel-based power generation exacerbates environmental concerns and contributes to greenhouse gas emissions. To address these challenges, there is a growing recognition of the need to transition towards a more sustainable and resilient energy sector in West Africa.



The integration of renewable energies into the power grid is viewed as a key solution to diversify the energy mix, reduce carbon emissions, and enhance energy security. Renewable energy sources, such as solar, wind, hydro, and biomass, are abundant in the region and offer significant potential for clean and affordable electricity generation. However, the successful integration of renewable energies into the grid requires overcoming technical, regulatory, and institutional barriers. West African countries need to develop robust grid codes, establish clear regulatory frameworks, and enhance technical capacities to ensure the smooth integration and operation of intermittent renewable energy sources. There is also a need for knowledge sharing, capacity building, and collaborative efforts among utilities, regulators, policymakers, and developers to exchange best practises, lessons learned, and innovative approaches.

The regional training workshop on integrating renewable energies into the power grid for G5 Sahel countries, organised by IRENA and the USAID-funded West Africa Energy Programme (WAEP), aims to address these specific needs. By providing practical tools, best practises, and capacity enhancement opportunities, the workshop seeks to empower key stakeholders in the region to navigate the complexities of renewable energy integration and drive the transition towards a sustainable and resilient energy future in West Africa.

Context of the training

The G5 Sahel countries face significant energy challenges, including limited access to reliable and affordable electricity, reliance on fossil fuels, and vulnerability to climate change. The workshop aims to address these challenges by equipping key stakeholders with the knowledge and tools required to effectively integrate intermittent renewable energies into the power grid. The context surrounding the integration of renewable energies into the power grid in West Africa is shaped by several factors that highlight the urgency and importance of this endeavour.

- **Energy Access Challenges:** Many countries in West Africa still grapple with limited access to electricity, particularly in rural and remote areas. The existing centralised grid infrastructure often fails to reach these underserved communities, leading to disparities in energy access and hindering socio-economic development. By integrating renewable energies into the grid, decentralised and off-grid solutions can be deployed to provide reliable electricity access to these marginalised regions.
- **Climate Change and Environmental Concerns:** West Africa is highly vulnerable to the impacts of climate change, including the increased frequency and severity of droughts, floods, and heatwaves. The region's heavy reliance on fossil fuels for electricity generation contributes to greenhouse gas emissions and exacerbates climate change. Integrating renewable energy sources into the grid offers a sustainable and climate-friendly alternative, helping to reduce carbon emissions, mitigate climate risks, and preserve the region's natural resources.
- **Abundant Renewable Energy Potential:** West Africa is endowed with abundant renewable energy resources, including solar, wind, hydro, and biomass. The region has vast solar irradiation levels, consistent wind patterns, significant hydroelectric potential, and biomass resources from agricultural and forestry activities. Harnessing these indigenous resources for electricity generation presents an opportunity to diversify the energy mix, reduce dependence on fossil fuels, and promote energy self-sufficiency.
- **Regional Cooperation and Integration:** West Africa has recognised the benefits of regional cooperation and integration in the energy sector. Initiatives such as the West African Power Pool (WAPP) and the ECOWAS Renewable Energy Policy provide frameworks for regional energy collaboration, including cross-border electricity trade and the development of regional power projects. Integrating renewable energies into the grid facilitates the harmonisation of technical standards, promotes cross-border electricity exchanges, and fosters regional energy security and stability.



G5 Sahel countries

The G5 Sahel countries consist of Burkina Faso, Chad, Mali, Mauritania, and Niger. These countries form a region that is situated in the transition zone between the Sahara desert in the north and the more fertile region to the south. Each of these countries has unique features and challenges when it comes to their energy sectors and socio-economic development.

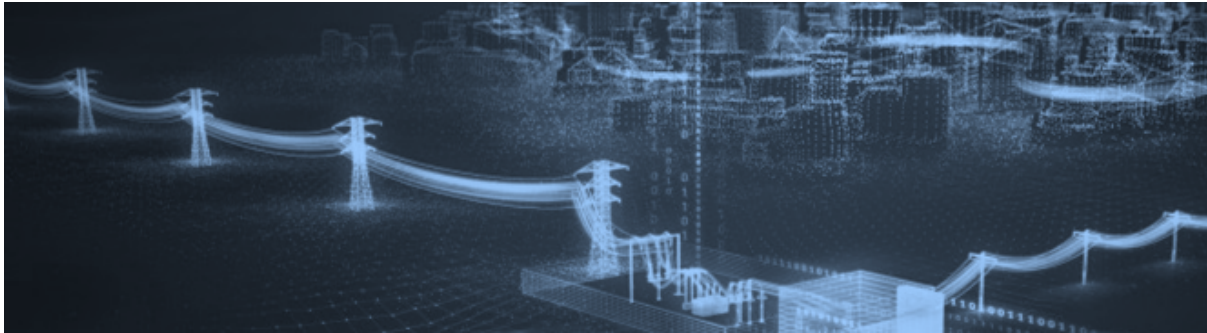


- **Burkina Faso** has a largely rural population, with a significant portion relying on subsistence farming. Access to electricity is limited, particularly in rural areas. The country is seeking to develop its renewable energy potential, especially solar and bioenergy, to improve access to electricity and stimulate economic growth.
- **Chad** is one of the poorest countries in the world, and the vast majority of its population relies on biomass for their energy needs. The country has significant solar and hydroelectric potential, which is largely untapped. Given the country's low electrification rate, renewable energy development could be key to enhancing energy security and stimulating economic development.
- **Mauritania's** economy is largely based on the extractive industries, including mining and oil and gas. However, the country has started to explore its renewable energy potential, particularly wind and solar. Renewable energy development could help to diversify the economy and improve energy security.
- **Niger** is another country where access to electricity is limited, especially in rural areas. The country has substantial uranium resources, which have been used for electricity generation. However, there is also significant potential for solar power development, which could help to increase access to electricity and stimulate economic growth.
- **Mali** has a largely rural population with limited access to electricity. The country has a diverse energy mix, with a significant proportion of its electricity generation coming from hydropower. However, there is also substantial potential for solar and wind energy development.

The regional training workshop serves as a critical platform for knowledge sharing, capacity building, and collaborative action to address the specific challenges and opportunities associated with integrating renewable energies into the power grid in West Africa. It seeks to empower stakeholders with the necessary tools, insights, and networks to navigate the energy transition, accelerate sustainable development, and build a resilient and inclusive energy future for the region.

Objectives

The primary objective of the training workshop is to provide utilities, regulators, policymakers, and developers from G5 Sahel countries with practical tools and best practises for successfully integrating renewable energies into the grid. By enhancing their understanding and capabilities, participants will be empowered to navigate technical and regulatory challenges, optimise renewable energy integration, and promote sustainable energy development in their respective countries.



Specific objectives include:

- **Enhance Grid Integration Knowledge:** Provide participants with a comprehensive understanding of the technical and regulatory aspects of integrating renewable energies into the power grid in West Africa. This includes exploring grid codes, standards, and best practises specific to the region, with a focus on ensuring the reliable and efficient integration of renewable energy sources.
- **Build Technical Capacity:** Equip utilities, regulators, policymakers, and developers in West Africa with the necessary technical skills and knowledge to effectively plan, design, and operate grid integration projects. This involves enhancing their understanding of system stability, grid balancing, grid reinforcement, and other key technical considerations for successful renewable energy integration.
- **Fostering Regulatory Frameworks:** Support participants in developing robust regulatory frameworks that facilitate the smooth integration of renewable energies into the grid. This includes addressing policy and regulatory barriers, harmonising grid codes, and ensuring a level playing field for renewable energy developers while maintaining grid stability and security.
- **Promote Grid Planning and System Flexibility:** Enable participants to integrate renewable energies into grid planning processes and enhance system flexibility. This involves understanding renewable energy resource assessment, transmission expansion planning, demand-side management, energy storage options, and grid management strategies to accommodate variable and intermittent renewable energy sources effectively.
- **Encourage Knowledge Exchange and Collaboration:** Facilitate the sharing of experiences, lessons learned, and best practises among participants from different West African countries. Promote collaboration between utilities, regulators, policymakers, and developers to foster regional cooperation, harmonisation, and joint efforts in overcoming common challenges related to grid integration.

Partners

The three partners in this initiative, namely the African Development Bank (AfDB), the International Renewable Energy Agency (IRENA), and the West African Energy Programme (WAEP), each bring their unique strengths and expertise to the table :

- **The African Development Bank (AfDB)**, established in 1964, is a leading development finance institution in Africa. Its main objective is to spur sustainable economic development and social progress in its member countries, thus contributing to poverty reduction. A pivotal initiative that the AfDB has undertaken is the "Desert to Power" programme. This ambitious project aims to produce 10,000 MW of electricity and provide 250 million people across the Sahel region with access to clean and affordable energy. By harnessing the Sahara Desert's vast solar potential, this initiative intends to turn Africa's largest desert into the world's largest solar power zone, ultimately serving as a blueprint for how renewable energy can be utilized to combat climate change and promote sustainable development.
- **The West Africa Energy Program (WAEP)** is another key player in this partnership. Supported by USAID and Power Africa, WAEP focuses on enhancing power system stability in the West African region, promoting technical solutions for the integration of high-capacity renewable energies, and expanding transmission networks. USAID, the U.S. Agency for International Development, is a major force in international development and humanitarian efforts to save lives, reduce poverty, and build strong, resilient societies. Power Africa, a USAID-led initiative, seeks to double access to electricity in sub-Saharan Africa by providing financial, technical, and logistical assistance. Their partnership with WAEP illustrates their commitment to fostering growth and reducing poverty in the region by improving access to reliable, affordable, and sustainable power. Through strategic partnerships and the promotion of innovative solutions, WAEP is making significant strides towards a cleaner, more sustainable energy future for West Africa.
- **IRENA, the global intergovernmental agency in renewable energy**, has proven to be a champion in renewable energy grid integration, particularly in West Africa. Their knowledge of grid stability, network studies, and the technical constraints involved in integrating variable renewable energies is unparalleled. Their experience in these areas is essential to understanding and addressing the challenges of integrating large renewable energy capacities into existing systems. IRENA's role in the development and implementation of grid codes, assessing system flexibility, and the overall future power systems ensures that the most advanced and effective strategies are used. With a strong focus on sustainability and innovation, IRENA is driving the development of renewable energies and their successful integration in West Africa.



Target audience

The regional training workshop on integrating renewable energies into the power grid in West Africa targets 100 African energy stakeholders and is specifically tailored for key stakeholders from Burkina Faso, Mauritania, Niger, and Chad. This targeted approach aims to engage personnel from various institutions, ministries, and regulatory bodies within these countries.



Typical organizations include national utilities such as Burkina Faso National Electricity Company, Société Mauritanienne d'Electricité in Mauritania, Niger Electricity Company, and Société Nationale d'Electricité du Tchad in Chad. Regulatory agencies, including the Regulatory Commission for Electricity in Burkina Faso, the Regulatory Authority for Electricity and Drinking Water in Mauritania, the Niger Electricity Regulatory Commission, and the Regulatory Authority for Electricity in Chad, will also actively participate.

Policy-making bodies like the Ministry of Energy in Burkina Faso, the Ministry of Petroleum, Energy, and Mines in Mauritania, the Ministry of Petroleum and Energy in Niger, and the Ministry of Petroleum and Energy in Chad are key stakeholders in the training.

Furthermore, renewable energy development agencies such as the National Agency for Renewable Energy and Energy Efficiency in Burkina Faso, Mauritanian Agency for Solar Energy in Mauritania, National Agency for Renewable Energy and Energy Efficiency in Niger, and National Renewable Energy Development Agency in Chad will contribute to the diverse audience.

Programme

The two-day training workshop features a comprehensive programme designed to address various aspects of integrating renewable energies into power grids. It includes modules covering topics such as renewable energy production, technical constraints in integrating variable renewable energies, technical solutions for high-capacity renewable energy integration, and the integration of renewables into transmission and distribution networks. The programme incorporates case studies, presentations, discussions, and interactive sessions to enhance learning and practical application of the concepts.

Day 1

| Time | Description | Facilitator |
|---------------|--|---|
| 09:30 – 10:00 | Introduction and welcoming remarks | Simon Benmarraze, Team Lead, Technology and Infrastructure, IRENA |
| 10:00 – 11:30 | Renewable Energy Generation - The Present, Future and Challenges of Integration | Emmanuel Boujiek, WAEP Senior Specialist, Power Africa |
| 11:30 – 12:30 | Identifying the technical constraints in integration of variable renewable energy | Simon Benmarraze, Team Lead, Technology and Infrastructure, IRENA |
| 12:30 – 13:30 | Lunch break | |
| 13:30 – 14:15 | Enabling Frameworks for integration of VRE | Simon Benmarraze, Team Lead, Technology and Infrastructure, IRENA |
| 14:15 – 14:45 | Integration of renewable energies into transmission and distribution networks – Case Studies | Simon Benmarraze, Team Lead, Technology and Infrastructure, IRENA |
| 14:45 – 16:45 | Technical solutions for integrating high-capacity renewable energy-Part 1 | Emmanuel Boujiek, WAEP Senior Specialist, Power Africa |
| 16:45 – 17:00 | Closing remarks | Simon Benmarraze, Team Lead, Technology and Infrastructure, IRENA |

Day 2

| Time | Description | Facilitator |
|---------------|--|---|
| 09:30 – 10:00 | Introduction and recap of Day 1 | Emmanuel Boujiek, WAEP Senior Specialist, Power Africa |
| 10:00 – 11:00 | Technical solutions for integrating high-capacity renewable energy-Part 2 | Emmanuel Boujiek, WAEP Senior Specialist, Power Africa |
| 11:00 – 12:30 | Integration of renewable energies into transmission and distribution networks and country case studies | Emmanuel Boujiek, WAEP Senior Specialist, Power Africa |
| 12:30 – 13:30 | Lunch break | |
| 13:30 – 15:00 | Grid flexibility - the key to integrating renewable energies | Isaline Court, Associate Program Officer, Power System Flexibility, IRENA |
| 15:00 – 16:30 | Integrating renewable energies into smart grids and microgrids | Emmanuel Boujiek, WAEP Senior Specialist, Power Africa |
| 16:30 – 17:00 | Closing remarks | Simon Benmarraze, Team Lead, Technology and Infrastructure, IRENA |

Outcomes

The workshop on grid integration in West Africa will lead to short-term knowledge acquisition, networking opportunities, and immediate practical application for participants, while also fostering medium- and long-term outcomes such as strengthened regulatory frameworks, improved grid integration practices, increased renewable energy capacity, energy transition, enhanced energy security, socio-economic benefits, and climate change mitigation.

Short-term Outcomes:

- **Enhanced Understanding:** Participants will gain a comprehensive understanding of the technical and regulatory aspects of integrating renewable energy sources into the grid.
- **Knowledge Acquisition:** Participants will acquire new knowledge and insights into best practises, tools, and solutions for grid integration in West Africa.
- **Networking Opportunities:** The workshop will provide a platform for participants to network, share experiences, and establish connections with professionals and experts in the field.
- **Immediate Application:** Participants will be equipped with practical skills and resources that can be immediately applied in their work to improve grid integration efforts in their respective countries.

Medium-term Outcomes:

- **Strengthened Regulatory Frameworks:** The knowledge and insights gained from the workshop will contribute to the development and enhancement of regulatory frameworks for renewable energy integration in West African countries.
- **Improved Grid Integration Practises:** Participants, armed with best practises and case studies, will be able to implement more effective strategies for integrating renewable energy sources into the grid, leading to improved grid stability and reliability.
- **Increased Renewable Energy Capacity:** The workshop will foster the adoption of grid integration strategies that promote the growth of renewable energy capacity in West Africa, contributing to a more sustainable and diversified energy mix.

Long-term Outcomes:

- **Energy Transition:** The knowledge and skills acquired by participants will support the transition to a cleaner and more sustainable energy sector in West Africa, reducing dependence on fossil fuels and increasing the share of renewable energy in the overall energy mix.
- **Enhanced Energy Security:** Improved grid integration practises will contribute to enhanced energy security by ensuring a stable and reliable electricity supply, reducing the vulnerability to fuel price fluctuations and supply disruptions.
- **Socio-economic Benefits:** The increased deployment of renewable energy and improved grid integration will stimulate economic growth, create job opportunities, and contribute to poverty reduction and socio-economic development in West African countries.
- **Climate Change Mitigation:** The workshop outcomes will contribute to the reduction of greenhouse gas emissions through the increased use of renewable energy sources, supporting global efforts to mitigate climate change.

IRENA Contact points

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