REPORT ON THE CAPACITY BUILDING TRAINING ON SMALL HYDRO POWER DEVELOPMENT STANDARDS FOR POLICY MAKERS, STANDARDIZATION BUREAUS, AND RENEWABLE ENERGY PROJECT DEVELOPERS IN ECOWAS

UNDER THE FRAMEWORK OF TECHNICAL GUIDELINES FOR THE DEVELOPMENT OF INTERNATIONAL STANDARDS FOR SMALL HYDROPOWER PLANTS AND GEF FUNDED PROJECT SCALING UP SMALL HYDROPOWER IN NIGERIA

THEME: SMALL HYDROPOWER DEVELOPMENT STANDARDS

ORGANIZED BY THE UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION (UNIDO) IN COLLABORATION WITH ECOWAS CENTRE FOR RENEWABLE ENERGY & ENERGY EFFICIENCY (ECREEE), EAST AFRICA CENTRE FOR RENEWABLE ENERGY & ENERGY EFFICIENCY (EACREEE), INTERNATIONAL CENTRE FOR SMALL HYDROPOWER (ICSHP), & FEDERAL GOVERNMENT OF NIGERIA

HELD ON THE 19TH – 22ND MARCH, 2024

AT

THE ROCKVEIW HOTEL (ROYALE),

ABUJA, NIGERIA

1.0 INTRODUCTION

The workshop was organized by United Nations Industrial Development Organisation (UNIDO) in collaboration with ECOWAS Centre for Renewable Energy & Energy Efficiency (ECREEE), East Africa Centre for Renewable Energy & Energy Efficiency (EACREEE), International Centre for Small Hydropower (ICSHP), & Federal Government of Nigeria under the framework of technical guidelines for the development of international standards for small hydropower plants and Global Environment Facility (GEF) funded project scaling up small hydropower in Nigeria. The aim of the workshop is to boost the capacities of technical experts, Standards Bureaus, and Small Hydropower (SHP) project developers for effective and efficient planning, management and operationalization of SHP based on the technical guidelines. It also aimed to encourage the Standards Bureaus to join the International Standards Organization's Technical Committee (ISO/TC 339) on technical guidelines for SHP development. The objectives of the workshop are to:

1. To enhance participants' understanding of the current global landscape and technical challenges in small hydropower development, emphasizing the critical importance and urgency of establishing international small hydropower standards.
2. To familiarize participants with the comprehensive framework and key components of the "Small Hydropower Technical Guidelines" (SHP/TC), as well as to provide wider adoption and application of the "Small Hydropower Technical Guidelines" (SHP/TC) while actively addressing any issues encountered during its implementation.
3. To equip participants with a foundational knowledge of the primary tasks, methodologies, essential technical requirements, and significant achievements involved in site selection, planning, and design within the realm of small hydropower development.
4. To provide an overview of ISO/TC339 and leveraging countries' support to join ISO/TC 339.
5. To promote exchange of experiences and knowledge - base in SHP development as well as enable participants review the strategic importance of SHP within the context of rural development.
6. To identify new funding opportunities through the development of joint programmes.
7. To exchange case studies, best practices and lessons learned from processes, programs and projects in various regions.

2.0 DAY 1: OPENING

The workshop commenced at 9:35am with self-introduction of participants facilitated by the Master of the Ceremony (MC) Ms. Joy Asange. This was followed by the introduction of the moderator of the session Elder Boma Benebo, a Development Banker who retired from the Central Bank of Nigeria. He welcomed participants and reiterated that the workshop serves as a platform to share experience and build capacity. The workshop was attended by over 90 participants from different Western, Eastern and Central Africa countries. Among them were Minister of Power, Chief A. A. Adelabu who was ably represented by Assistant Director, Renewable and Rural Power Access Department, Engr. S.B. Ayangeaore; Permanent Secretary, Federal Capital Territory Administration (FCTA), Mr. Ibe Prospect who represented the Honourable Minister of FCT, Barrister Nyesom Wike; MD/CEO Nigeria Bulk Electricity Trading (NBET), Mr. Nnaemeka Ewelukwu; MD, Niger River Basin Development Authority, Dr. A. S. Adamu; MD, Plateau State Energy Corporation, Mr. Ponzing Gamde; the Executive Director, ECREEE, represented by Mr. Guei G. F. Kouhie; Former DG/CEO, Energy Commission of Nigeria, Professor E. J. Bala; representatives of International Centre for Small Hydropower (ICSHP) China, European Union, Centre for Renewable Energy and Energy Efficiency for Central Africa (CEREEAC), Volta River Authority Ghana, Liberia Standards Authority, Kenya Bureau of Standards, Uganda National Bureau of Standards. Other participants were representatives of Energy Commission of Nigeria (ECN), Nigerian Electricity Management Services Agency (NEMSA), Nigeria Hydrological Services Agency, Nigerian Geological Survey Agency, Federal Ministry of Industry, Trade & Investment (FMITI), Nigeria Electricity Regulatory Commission (NERC), Federal Ministry of Environment, Development Bank of Nigeria, Federal Ministry of Water Resources, Standard Organisation of Nigeria (SON), National Agency for Science and Engineering Infrastructure (NASENI), National Environmental Standards and Regulations Enforcement Agency (NESREA) etc.

The Regional Director and UNIDO representative to ECOWAS who was ably represented by Dr. Otu Osuji gave the welcome and opening address. In his address, he welcomed all participants to the workshop and commended UNIDO for the good representation from both Eastern and Western Africa regions. He also thanked all collaborating Ministries, Departments & Agencies (MDAs) and stakeholders for their firm support and effective partnership with UNIDO in the development of SHP standards. He further emphasized that Africa is endowed with tremendous amount of renewable energy resources such as hydropower, solar, wind and biomass. Among these renewable energy sources, small hydropower holds great potential towards increasing access affordable electricity and addressing climate change. However, despite this abundant energy potential, electricity access in Eastern and Western Africa is still low, resulting in a significant gap between supply and the demand. According to the World Small Hydropower Development report (WSHPDR) 2022, West and East Africa has an average electricity access rate of below 50% and 42% respectively and display significant disparities between urban and rural areas. This was followed by a remark by the GEF operational manager, Mr. Stanley Jonah, who appreciated UNIDO & other partners for tirelessly supporting SHP projects and urged participants to actively engage in fruitful deliberations and explore innovative approaches that will accelerate SHP development in the African region.

In addition, the representative of Executive Director, ECREEE, Mr. Guei G. F. Kouhie expressed his appreciation to UNIDO and other partners for making the workshop a success and stressed that the workshop is very welcomed as there are indications that it may be impossible to achieve the Sustainable Development Goals by 2030 if the challenges of low electricity access are not addressed. He further commended UNIDO & ICSHP for their constant support in the development of SHP in the ECOWAS region. Also, in his remark, the former DG/CEO ECN, Prof. E. J Bala noted that SHP has great potential in supporting the energy mix of the African region. Nigeria has benefitted from SHP since 1929 and UNIDO has contributed significantly in the development of SHP in Nigeria. However, most of the SHP plants have not been operational due to financial, technical and human challenges. He believed that the workshop would provide the necessary information on how to overcome some of these challenges both in the development, operations, and maintenance of SHP systems within the African region. Similarly, the DG/CEO, Plateau State Energy Corporation, Mr. Ponzing Gamde stated that the Plateau state is endowed with abundant renewable energy sources including hydropower, and expressed the State willingness to collaborate with UNIDO and other partners in the development of SHP as the State identified over 30 potential SHP sites for development.

Thereafter, the representative of the Minister of Power, Engr. S.B. Ayangeaore, who declared the workshop open posited that SHP is relevant and essential in the plans of his Ministry, especially as regards to the Electricity Act 2023 and in achieving the climate change objectives, Energy Transition Plans (ETPs), and the provision of energy access. He further explained that Nigeria has the potentials for SHP what is lacking is the investments, the right policies and regulations, right incentives and hoped that these gaps can be bridged in this workshop. Equally, the representative of the Minister of FCT, Mr. Ibe Prospect, who also declared the workshop open emphasized that there will be no meaningful development without reliable and affordable electricity supply.

3. 0 TECHNICAL SESSIONS

3.1 SESSION 1

The session was moderated by Elder Boma Benebo.

Mr. Alvin Tepo Togba representative of UNIDO presented the first paper which focused on UNIDO'S contributions to Small Hydropower (SHP) development standards. He explained that the development of SHP standards in collaboration with International Organisation on Standards (ISO) is in progress. An International Workshop Agreement (IWA) for SHP was held in collaboration with ISO at Geneva in March, 2021 which was both virtual and in-person. At the workshop, the technical guidelines for the development of small hydropower plants were presented and adopted as ISO/TC339. Since then, capacity building workshops have been organized for policy makers and standards organizations in Jan-March, 2024. Another ISO/TC339 workshop is scheduled for May, 2024 in Hanzhou, China to harmonize received inputs before the final validation in the last quarter of 2024.

Ms. Yingnan Zhan from ICSHP presented the second paper who provided an Overview of SHP International Standard Development. She gave a brief on the ICSHP which has created a unique form of international "triangular" cooperation among developing countries, developed countries and international organizations. It has provided technical advice and guidance for small hydropower projects across over 80 countries and regions and has held more than 100 small hydropower training courses for developing countries. She further explained the status of SHP, the technology, definition, use, implications and the global status. Her presentation also highlighted the barriers of SHP development and way forward as follows:

Barriers to SHP development

1. Lack of accurate and up-to-date data;
2. Lack of political focus on SHP development;
3. Difficulties in finding sustainable sources of financing;
4. Lack of policies and regulations supporting SHP development;
5. Lack of incentives for investors and developers;
6. Lack of local technology, standards and skills;
7. Lack of infrastructure and difficulties in providing grid access;
8. Environmental regulations restricting SHP development;
9. Bureaucratic barriers;
10. Negative public perception;
11. Impacts of climate change.

Way forward

1. Green SHP;
2. Smart SHP;
3. Detailed resource assessments;
4. Development of appropriate policies and regulations;
5. Facilitation of access to sustainable sources of financing;
6. Facilitation of access to equipment and technology;
7. Provision of reliable infrastructure;
8. Improvement of local skills and expertise;
9. Strengthening of international and regional cooperation;
10. Rehabilitation of historical sites, existing dams and waterways;
11. Adaptation to changing climate, precipitation and runoff patterns;

12. Development of international standards for SHP

Furthermore, she discussed the development stages of the technical guidelines for the development of SHP Plants as follows:

1. Technical Guidelines: In 2019, INSHP and UNIDO jointly released the Technical Guidelines for the Development of Small Hydropower Plants, which became the first comprehensive international guiding document for SHP planning, design, units, construction, and management.
2. International Workshop Agreement (ISO/IWA33): Workshops were held in 2019 & 2020 which confirms the need to develop specific guidelines or standards for SHP plants and thereby recommend to ISO to consider the constitution of a Technical Committee (TC) with the scope of developing standards for SHP development.
3. IWA 33 standard documents: As of 2021, 3 IWA 33 standard documents were published by ISO, which are: the Technical Guidelines for the Development of Small Hydropower Plants-Part 1: Vocabulary (IWA 33-1), Part 2: Site Selection Planning (IWA 33-2), and Part 3: Design Principles and Requirements (IWA33-3).
4. ISO/TC339: ISO/TC339 on Small Hydropower Plants was approved and established by ISO in May 2022
5. 1st plenary meeting: ISO/TC339 Small hydropower plants- 1st plenary meeting was held on 14 June, 2023.

Mr. Yunus Alokore Technical Expert, EACREEE presented the third paper on the Role of SHP and Energy Policy Planning in the East African Community (EAC). He highlighted the SHP potential and installed capacity of the EAC. The EAC is endowed with vast SHP potential estimated at over 5000 MW with DR Congo having the highest potential and majority of the SHP potential of EAC is unexploited. Several projects at various stages: Kenya 144 sites, Uganda 64 potential sites, Burundi 15 sites identified, South Sudan 6 feasibility studies, Tanzania support for feasibility study. The presenter also discussed the capacity building, policy and standards in the region and the role of SHP in environment and socioeconomic development. He further stated some of the opportunities in EAC which include Investment opportunities, Capacity building, Research, knowledge management and dissemination, & Policy, regulation and standards.

Mr. Guei G. F. Kouhie, Program Officer-RE Technologies, ECREEE presented the fourth paper on the Role of SHP and Energy Policy Planning in ECOWAS. He highlighted the objectives of the ECREEE, the SHP initiatives, & the barriers in the small-scale hydropower sector in ECOWAS. The barriers include: Lack of hydrological data and know-how of measurement campaigns; Expertise in hydro resource assessments is quite poor; Limited expertise for equipment manufacturing, construction, operation and maintenance; Missing institutional capacities and lobbying efforts for Small-Scale

Hydropower Sector; Lack of SHP appropriate policy framework and incentives (such as Feed in tariff); and Financial barriers include little or no incentives to attract investors. He further explained the ECOWAS Small-Scale Hydropower Program (ECOWAS SSHP) which was Jointly developed and implemented by ECREEE and UNIDO. The ECOWAS SSHP aims to Strengthen policy and regulatory SSHP frameworks; Strengthen and apply capacities of different SSHP market enablers; Strengthen knowledge management and awareness raising on SSHP; and Promote SSHP investments and businesses. He concluded by stating the achievements of the ECREEE which include identification of 146 sites for small hydro power projects (<30MW) with a total capacity of 1.6 GW across West Africa, development of Small Hydro Power Strategy in the framework of the implementation of the West African Clean Corridor (WACEC), and pre-feasibility study of the Kourougnan hydroelectric development project in Siguiri, Upper Guinea, on the Tinkisso River in the Republic of Guinea.

Engr. Ochieng Julius, Senior Energy Officer, Ministry of Energy and Mineral Development, Uganda presented the fifth paper on SHP development in Uganda: Harnessing Sustainable Energy for Development. He provided an overview of Uganda's energy landscape, regulatory framework for hydro power development, and importance of SHP. He further stated the challenges facing SHP development in Uganda, which include financial, technical, and regulatory challenges. The Ugandan government recognizes the importance of small hydro power and has implemented various initiatives to support its development. These include incentives for investors, streamlined permitting processes, and capacity-building programs for local stakeholders. He rounded off by stressing the opportunities for growth, these include policy reforms, public-private partnerships, technological innovation and community engagement.

After the presentations, there were discussions on the barriers to SHP development led by Prof. E. J. Bala, particularly barriers applicable to Nigeria which include lack of accurate and up-to-date data, lack of local technology, standards and skills, and bureaucratic barriers. He noted that policies and regulations supporting SHP development are in place but incentives for investors and developers need to be enhanced.

3.2 SESSION 2

The second session was also moderated by Elder Boma Benebo.

Mr. Daniel Baffoe from Volta River Authority (VRA), Ghana, presented the sixth paper who provided an Overview of Small Hydropower Development in Ghana. He highlighted the impacts of hydropower, SHP Development in Ghana, the laws governing Renewable Energy (RE) in Ghana, particularly the provision of regulatory licensing regime and imposition of an obligation on utilities and bulk customers to purchase part of their electricity requirements from renewable resources. He further explained the Renewable Energy Development Programme (REDP) developed by VRA in 2011 to assist in achieving the government's Renewable Energy (RE) Policy objective and to meet the demand from its customers for renewable energy.

Prof. Li Zhiwu from ICSHP presented the seventh paper on SHP development in China-Lessons and Experiences. He expatiated the SHP development process, and the four (4) stages of SHP development in China. Each stage has a main function, consumers, and annual average installation. He further explained the three (3) major national programs in SHP development, and mechanism & incentive policies. The major incentive policies supporting SHP development from 1960s-1970s are self-construction, self-management and self-consumption; in 1980s is to raise electricity with electricity, who invests who benefits; and 1990s- date is preferential policy on taxation, loan subsidy, finance subsidy. He shared that under the present situation of further development of market economy, the SHP's development is facing new challenges, both internally and externally. Besides, the shortage of SHP itself, such as limitation of small scale which results in a higher cost per kW than large power plants, problem of high seasonal variation and low firm power etc. And by now the main critical issues that constrain SHP development is of environmental issue and safety problem.

Mr. Izaiah Mukenga, Technical Expert, CEREEAC presented the eighth paper on Central Africa – SHP Interventions/Potentials. He provided an overview of the CEREEAC which was officially inaugurated on 10 March 2023. The Central African is known for its vast and diverse hydrological resources, and hydroelectric power is the most commonly used technology for generating electricity. A notable example is the Congo River in the Democratic Republic of the Congo, which boasts one of the world's highest potentials for hydroelectric power generation. He further discussed the potential for SHP development and the challenges for the development. These challenges include: Policy and Regulatory Issues (lack of supportive policies and complex bureaucracy), Financial and Economic Barriers (high initial costs and limited access to financing), and Technical and Infrastructural Limitations (grid connectivity, energy demand uncertainty, lack of technical expertise).

4.0 CLOSING

The session was rounded off with discussions on the pricing of SHP power in China for rural people, local manufacturing of components, and management of SHPs in low water season.

5.0 DAY 2: OPENING

The second day of the workshop began at 9:48am with an opening remark by the MC Ms. Joy Asange, who welcomed participants to the day's activities. Thereafter, the technical session commenced.

6.0: TECHNICAL SESSION

6.1: SESSION 1

The session was moderated by the MC, Ms. Joy Asange.

Ms. Yingnan Zhan from ICSHP presented the first paper on the Introduction to SHP Technical Guidelines. She pointed that SHP is increasingly seen as an important renewable energy solution to adequately respond to the challenge of electrification in remote rural areas. The potential of SHP in many developing countries remains untapped and SHP development is often hindered by the lack of good practices as well as SHP standards on a global level. SHP development is a systematic engineering practice and requires technical support of multiple disciplines. She further explained that the Technical Guidelines (TG) for SHP design comprised 11 parts. These are:

1. Part 1: Site Selection Planning
2. Part 2: Hydrology
3. Part 3: Engineering Geology
4. Part 4: Hydraulic Engineering and Energy Calculation
5. Part 5: Engineering Layout and Hydraulic Structure
6. Part 6: (i) Hydraulic Machinery and Turbine Generator
   Part 6: (ii) Electrical system
   Part 6: (iii) Hydro Mechanical Works
7. Part 7: Construction Planning,
8. Part 8: Social and Environmental Impact Assessment
9. Part 9: Project cost estimates
10. Part 10: Economic appraisal
11. Part 11: Report Preparation.

In addition, the contents of the technical guidelines are:

1. The Terms and Definitions specify the professional technical terms and definitions commonly used for SHP plants.
2. The Design Guidelines provide guidelines for basic requirements, methodology and procedure in terms of site selection, hydrology, geology, project layout, configurations, energy calculations, hydraulics, electromechanical equipment selection, construction, project cost estimates, economic appraisal, financing, social and environmental assessments—with the ultimate goal of achieving the best design solutions.
3. The Units Guidelines specify the technical requirements for SHP turbines, generators, hydropower turbine governing systems, excitation systems, main valves as well as monitoring, control, protection and DC power supply systems.

4. The Construction Guidelines can be used as the technical guidance document for the construction of SHP projects.
5. The Management Guidelines provide technical guidance for the management, operation, maintenance, technical renovation and project acceptance of SHP projects.

Prof. Li Zhiwu from ICSHP delivered the second paper on Site Selection Planning (SHP/TG002-1:2019), which is the first part of the TG for SHP design. In his presentation, he presented the feasibility study report on Otukpo Small Hydropower Project which was conducted under UNIDO's project- "Scale Up Small Hydropower Development in Selected Countries to Contribute to Inclusive and Sustainable Industrial Development (ISID)". The project was jointly implemented by UNIDO and the International Center on Small Hydro Power (ICSHP), with cooperation of the National Focal Point (NFP)-Department of Reservoir & Dam, Ministry of Water Resources Nigeria. He highlighted that the first part of the TG for SHP design (site selection planning) contains 11 Chapters and 3 Appendices. The chapters are Scope, Normative references, Terms and definitions, General provisions, Basic Data Collection and Analysis, Computation of river basin or sub-basin hydropower potential, Preliminary Planning of Site, Site surveys and investigations, Preparation of Site Construction Plan, Assessment and prediction, Preparation of site selection planning report. And the Appendices are Computation of Theoretical Potential of River Water Energy, Estimation Formula for Installed Capacity on Planned Site; Schematic Diagram of Development Types and Special Terrain Utilization of Small Hydropower Stations; and Site Selection Planning Report (Outline). The Scope part of the design guidelines specifies the general principles of site selection planning for Small Hydropower (SHP) projects, the methodologies, procedures and outcome requirements of the SHP plant site selection. He further explained the chapters of the design guidelines.

Prof. Li Zhiwu from ICSHP presented the third paper on Hydrology (SHP/TG002-2 :2019), which is the second part of the TG for SHP design. The second part consists of 12 Chapters and 1 Appendix. The chapters are Scope, Normative references, Terms and definitions, General provisions, Basic Data, Runoff, Flow duration curve, Low-water analysis, Flood, Stage-discharge relation curve, Sediment, evaporation, ice regime and others, & Rationality check of the outcomes. The Appendix is Computation of storm and runoff yield and runoff concentration. He emphasized that the Scope part of the design guidelines covers the basic hydrological data as well as the computation methods and rationality analysis of the main hydrological parameters such as rainfall, runoff, flood and sediment applicable during the planning, design, construction and operation of a small hydropower (SHP) plant. He further discussed the remaining chapters in the design guidelines.

Mr. Alex S. Mboa from Kenya Bureau of Standards (KeBS) presented the fourth paper which focused on SHP Standards development from the Kenyan Perspective. He stated that in Kenya, almost half the electricity consumed is generated from geothermal energy, and about 45% of electricity generated is from geothermal, 23% from Small Hydropower, 17% from wind, and 10% from thermal and the rest from Solar and Imports. Kenya's drainage system consists of five major basins, these basins contain the bulk of the country's hydro resources for power generation, and the potential for small, mini, and micro-hydro systems (with capacities of less than 10MW each) is estimated at 3,000MW nationwide, and less than 5% of this potential has been exploited. He further shared Kenya's SHP development journey which started when the Ministry of Energy requested KeBS to initiate the process of developing standards and proposed the experts to form part of a technical committee for SHP in April 2002, but was unsuccessful until September 2011. In November 2011, a hydropower technical sub-committee was constituted and in January, 2012, a survey of 5 SHP stations and data collection for standards development was carried out. In June 2018, guidelines for the development of small hydropower were published as Kenya Standards, and in June 2022, ISO Technical guidelines for the development of small hydropower were adopted as Kenya Standards.

Prof. Li Zhiwu from ICSHP presented the fifth paper on Engineering Geology (SHP/TG002-3 :2019), which is the third part of the TG for SHP design. The third part consists of 10 Chapters and 5 Appendices. The chapters are Scope, Normative references, Terms and definitions, General provisions, Regional geology, Engineering geology investigation of the reservoir area, Engineering geological investigation of the dam area, Engineering geological investigation of the water conductor project, Engineering geological investigation of the power plant area, Geological investigation of natural construction materials. The appendices are Engineering geologic classification of the dam foundation rock mass; Surrounding rock engineering geologic classification; Rock and soil permeability classification; Slope engineering geologic classification; and Environmental water-based corrosion evaluation. He reiterated that the Scope part of the design guidelines clarifies the basic provisions on engineering geological investigation of SHP station; specifies the technical requirements for investigation in terms of aspects of regional geology and reservoir engineering geology, and defines specific requirements for investigation technologies and methods to be applied in various stages in relation to aspects of engineering geology of the dam area, water delivery way, power plant area and natural construction materials. He further elaborated on the remaining chapters of the Design Guidelines.

6.2: SESSION 2

The second session was also moderated by Ms. Joy Asange.

Prof. Li Zhiwu from ICSHP presented the sixth paper on Economic Appraisal (SHP/TG002-10:2019), which is the tenth part of the TG for SHP design. The tenth part consists of 10 Chapters and 2 Appendices. The chapters are Scope, Normative references, Terms and definitions, General provisions, Cost calculation, Benefits calculation, Economic cost benefit evaluation, Financial evaluation, Uncertainty analysis, Methods of scheme comparison. The appendices are (Normative) Economic cost-benefit evaluation form; and (Normative) Financial evaluation form. He noted that the Scope part of the design guidelines sets forth the principles, contents, methods and parameters of the economic appraisal of small hydropower (SHP) projects; and the document is applicable to the economic appraisal at the pre-feasibility study and feasibility study stages of SHP projects. He further discussed the remaining chapters of the design guidelines.

Engr. I. A Lawal representative of Standard Organization of Nigeria (SON), presented the seventh paper on Mandate and Role of SON in the SHP Project. SON is the apex standardization body in Nigeria, with a vision to improve life through Standardization and Quality assurance. He pointed that the procedure for standards development include Proposal stage, Technical Committee (TC), Study, Consensus, Public review, TC final draft, Approval, Publish, Enforcement, & Standard maintenance. The SON works with both the International Standard (ISO, IEC, ITU) and Regional Bodies (ARSON, ECOWAS) in the development of Standards globally, as well as regional standards harmonization which are adopted by all member countries respectively. He further revealed that SON has already adopted all the IEC/TCs Standards and ready for the adoption of the ISO/TC 339 Technical Guidelines for the development of SHP plants Parts 1, 2 and 3 for implementation in Nigeria.

Engr. Tango Bright Kwaku representative of Ghana Standards Authority (GSA), presented the eighth paper on Standardization on Renewable Energy Infrastructure/Small Hydro Power (SHP): Goals and Challenges. The goals of the Authority are to establish and promulgate standards with the object of ensuring high quality of goods produced in Ghana, whether for local consumption or for export; to promote standardization in industry and commerce; industrial efficiency and development; and standards in public and industrial welfare, health and safety. He stated that the renewable energy resources in Ghana are hydro (small, mini and medium capacity), biomass, solar, wind, and tidal energy. In addition, SHP plant studies and research initiatives have been undertaken for over two decades in the country, aimed at harnessing the power generation potential of small rivers to supplement the large Akosombo, Bui and Kpong power plants. There are 21 prospective micro/mini-hydro sites & small and medium plants with generating capacities between 4kW and 325kW & 40 MW and 90 MW respectively. He further highlighted the challenges in RE development, which include Lack of proper /regulatory frameworks; Inadequate Institutional structure; Lack of or inadequate capacity building in the areas of training to design, install, operate, maintain and manufacturing of renewable energy infrastructure.; and Lack of Research and development (R&D) that is both efficient and well-focused to accelerate the development of the RE sector.

7.0: CLOSING

After the paper presentations, there was questions and answers session. Thereafter, the second day concluded with a closing remark by the MC who thanked participants for their active participation.

8.0 DAY 3: OPENING

The third day of the workshop began at 9:55am with an opening remark by the MC Ms. Joy Asange, who welcomed participants to the day's activities. Afterwards, the technical session commenced.

9.0: TECHNICAL SESSION

9.1: SESSION 1

The session was moderated by Ms. Joy Asange.

Prof. Li Zhiwu from ICSHP presented the first paper on Project Cost Estimates (SHP/TG002-9:2019), which is the ninth part of the TG for SHP design. The ninth part consists of 9 Chapters and 2 Appendices. The chapters are Scope, Normative references, Terms and definitions, General provisions, Project division, Costs and unit price, Engineering budget preparation, Composition of cost estimate documents, Preparation of investment estimation for the construction part. The appendices are (Normative) Project division in construction part; and ((Normative) Project cost estimate table. He pointed that the Scope part of the design guidelines specifies how to estimate costs for small hydropower (SHP) projects and details how to prepare cost estimation documents. He further elaborated on the remaining chapters of the design guidelines.

Mr. Roland Joseph Folley, Energy Strategy Officer, representative from Liberia, presented the second paper which focused on Small Hydropower Plants in the Region. He emphasized that Small Hydro is an appropriate technology for tackling the issues of energy security, access to clean energy and the mitigation of climate change simultaneously and in a sustainable way. Small hydro technology can make a significant contribution to meeting the electricity needs of urban and peri-urban areas as well as remote rural areas. Liberia has more than 2.3 GW of hydro potential identified under the Rural Energy Strategy and Master Plan (RESMP). The country's hydro potential includes numerous potential small hydropower sites with indicative capacities of less than 10 MW, twenty-four (24) of these sites have an estimated combined total capacity of 86 MW. He stressed that by leveraging the abundant hydropower potential in the region, small hydropower mini-grids can provide for an economically viable, environmentally sustainable and climate-friendly power supply alternative to fossil fuel-based energy sources.

Prof. Li Zhiwu from ICSHP presented the third paper on Engineering Layout and Hydraulic Structure (SHP/TG 002-5: 2019), which is the fifth part of the TG for SHP design. The fifth part consists of 9 Chapters and 2 Appendices. The chapters are Scope, Normative references, Terms and definitions, Flood control standard, General engineering layout, Water retaining structure, Water release structure, Water diversion structure, Powerhouse, Engineering safety monitoring, Concrete strength, durability and steel performance. The Appendix is Calculation of the wave run-up. He discussed the first five chapters of the TG, which include the Scope, Normative references, Terms and definitions, Flood control standard, & General engineering layout. He further stressed that the Scope part of the design guidelines clarifies the flood control standards for the hydraulic structures of a small hydropower (SHP) station; defines specific requirements for the general engineering layout as well as the type selection and the design of the water retaining structure water releasing structure, diversion structure, powerhouse and switchyard; and specifies the technical requirements for engineering safety monitoring, and concrete and steel performance. He further discussed the remaining chapters of the design guidelines.

9.2: SESSION 2

The session was also moderated by Ms. Joy Asange.

Mr. Williams Nicholas, Mechanical Engineer, Liberia Divion of Standards presented the fourth paper who gave an Overview of the Liberia Standards Authority & the Current Liberia Electricity Situation. He stated that the Liberia Standards Authority (LiSA) was established in June, 202 as Liberia's premier quality infrastructure hosting under its umbrella conformity assessment, Metrology, Standards and Quality promotion. LiSA coordinate the activities of the standard development and adoption process through the Liberia Standard Harmonization Module (LiSHAM). In addition, the LiSA Standard adoption process for SHP guidelines comprises eight (8) processes, namely Presentation of proposal for the adoption of the SHP Guidelines; Solicit Support and resources for the adoption of the SHP Guideline; Incorporating Relevant Stakeholders into the NEC (MLME, EPA, MPW); Conduct 1st NEC meeting on the SHP guidelines (Guideline is presented to stakeholders for familiarization , inputs and comments); Conduct 2nd NTHC meeting (Review inputs and comment from stakeholders and developed draft; Conduct LiSHAM review and endorsement meeting (Review and Endorsement of draft SHP standard/ guideline); Conduct Standard Endorsement Program (Awareness on the Adopted guideline); and Gazetting and publication. He further explained that access to electricity is very limited with only 30%, making it one of the lowest electricity access rate in the world, Due to the high demand for electricity in Liberia, the country has one of the highest electricity tariff in Africa with consumers paying $0.240 /KWH. The electricity access in Liberia can be fully achieved only during rainy season with 57% Hydropower of total Grid, followed by 25% thermal, and 18% purchase from Cote d' Ivoire, while in the dry season only 10% hydropower of the total grid, with 48% gap compare to rainy season. The Government of Liberia is considering building a reservoir up stream of the Hydro to enable store water for the dry season, also considering to increase the amount of electricity purchased from Cote d' Ivoire from 27 MW to 50 MW not only to reduce the gap but also to increase access to electricity as well. Liberia has 6 major rivers that provide potential for SHP plants and this potential when utilize can help address some of electricity needs.

Prof. Li Zhiwu from ICSHP presented the fifth paper who took a deep dive into Engineering Layout and Hydraulic Structure (SHP/TG 002-5: 2019), with emphasis on Dam types. He discussed three (3) types of dams. Firstly, the Concrete Facing Rockfill dam which is one of the fastest developing dam types. It has good performance in terms of economy, safety and environment. The presenter discussed the foundation design, reinforced concrete facing and embankment design of the concrete facing rockfill dam. Secondly, the Rubber dam which is characterized by cost-effectiveness; short construction period; no reduction in passing flood capacity in the river; inferior solidification & durability; Dam height limited; and more daily maintenance needed. It can be used as water storage for irrigation; for retaining water for generation; as tide-retaining gate along the coast; and be adopted for gardens projects in cities. Thirdly, the Arch dam which has the following features: arch and beam work together; stability relies on the reaction of abutment; high requirements of base; fully exploit material; overloadable; discharge in dam; no permanent expansion Joint; and good aseismic performance.

10: CLOSING

The session concluded with a closing remark by the MC who thanked participants for their active participation.

11.0 DAY 4: OPENING

The fourth day of the workshop began at 9:39am with an opening remark by the MC, Ms. Joy Asange, who welcomed participants to the day's activities. Thereafter, the technical session commenced.

12.0: TECHNICAL SESSION

The session was moderated by Ms. Joy Asange.

Prof. Li Zhiwu from ICSHP presented the first paper who took a deep dive into another aspect of Engineering Layout and Hydraulic Structure (SHP/TG 002-5: 2019), the Powerhouse. The first part of the presentation focused on constitution & classification of powerhouse. In accordance with structure and stress characteristics, there are three (3) types of powerhouse, these are: Powerhouse at the dam toe, Diversion powerhouse, and Riverbed powerhouse. The powerhouse of the hydropower station composed of two parts, namely the main powerhouse and the auxiliary powerhouse, including five major systems, i.e. the water flow system, electrical current system, electrical control equipment system, mechanical control equipment system and the auxiliary equipment system. The main structures in the hydro plant area are: Machine Hall main generator room, Auxiliary building, Main transformer site, and High voltage switchyard. In addition, the layout of the powerhouse and the plant area designed according to the topographical, geological and environment conditions, and in combination with the general layout of the entire project, and shall comply with the following principles. The second part of the presentation focused on powerhouse for horizontal shaft units, where the presenter discussed the Reaction-turbine Powerhouse and the Impulse-turbine Powerhouse. While the last part of the presentation focused on powerhouse for vertical shaft units, which include the ground floor, intermediate floor, block structure, and spiral case.

Mr. Kouadio-Edouard KOFFI, Director of Power Generation Department, CIE, Cote d'Ivoire presented the second paper on CODINORM (Standardization Body in Cote d'Ivoire) and Hydroelectric Energy Planning 2014 -2030. He explained that CODINORM (Côte d'Ivoire Normalization), an Ivorian Standardization association, is a non-profit association, recognized as public utility, created on September 24, 1992 by the Private Sector upon authorization of the Council of Ministers of August 26, 1992. It brings together experts from private and state companies, and is saddled with the responsibilities of standardization, certification, and representation of Cote d'ivoire in both regional and international standardization bodies. He added that the association is faced with some challenges which include: establishing a working group for ISO TC/339; searching for new experts to replace those who have retired, collecting standardization needs for mini hydropower, develop standardization on SHP, and keeping in touch with other countries. The development of standards is based on the principle of consensus, through discussion and comments from members and experts on the proposal, adoption and approval of the standards by the competent authorities, but consensus does not necessarily imply unanimity. In the context and challenges of the energy sector in Ivory Coast, he explained that the demand of electricity in Cote d'ivoire is growing per year, the need to increase the installed capacity 100MW/year or the production 1000GWH/year, to reduce power gap. The growth in electricity consumption (average of 8%), is driven by GDP, Rural electrification programme and connection of new industry and mining. Furthermore, 19 potential SHP sites were identified and prioritized with the total capacities and average annual energy of 1006.5MW and 5446GWh respectively. He further revealed some challenges facing the energy sector in Cote d'Ivoire which include: mobilization of resources for financing projects at identified potential sites, balance of the energy mix with the development of hydro, solar and biomass (renewable energies), balance of production and consumption at the peak of load, management of major environmental and social risks, and relationship with stakeholder (QSE CSR action plan).

Prof. Li Zhiwu from ICSHP presented the third paper on the Technical Guidelines for the Development of SHP plants – Management. The Management Guidelines provide technical guidance for the management, operation and maintenance, technical renovation and project acceptance of SHP projects. The guideline has four (4) parts, these are:

1. Part 1: Project Construction Management: This part covers nineteen (19) chapters, namely Scope, Normative references, Terms and definitions, Project management organization, Project integration management, Pre-stage planning of project, Project scope management, Project technical management, Project quality management, Project progress management, Project cost management, Procurement management for the project, Project contract management, Project environmental protection and water and soil conservation management, Engineer management, Project communication management, Project information management, Occupational health and safety management for the project, and Project risk management.
2. Part 2: Operation and Maintenance: This part comprises eight (8) chapters and one (1) appendix. The chapters are Scope, Normative references, Terms and definitions, Basic Requirements, Hydraulic structures, Hydro mechanical works, Electro-mechanical equipment, Optimized operation. The appendix is Appendix A (Informative) Grading of the equipment and facilities for the hydropower station.
3. Part 3: Technical Renovation: This part comprises eight (8) chapters, namely Scope, Normative references, Terms and definitions, General, Status analysis and evaluation, Detection and evaluation, Renovation contents and requirements, and Technical performance index.
4. Part 4: Acceptance of Projects: This part comprises seven (7) chapters, namely Scope, Normative references, Terms and definitions, Acceptance before river diversion (closure) of project, Acceptance of reservoir (barrage) impoundment, Acceptance of unit start-up, and Completion acceptance.

He further explained some concepts under Project Construction Management (the first part of management guidelines), these are: supervision, engineering schedule control, engineering quality control, engineering cost control, contract management, information management, and mini case study. He stressed that the factors affecting schedule control are human interference; materials, tools, equipment interference; foundation interference; capital interference; and environmental interference. In engineering quality control, it is important to ascertain key control items and common items, & construction quality control regulations. In addition, information management involves the collection of engineering information, processing, collation, distribution, retrieval and storage. The information management system is a man-machine system which deals with the project information, with the goal to realize information management and provide necessary decision support. The basic functions of information management system should include at least four subsystems: quality control system, cost control, schedule control, and contract management.

13.0 CLOSING

The session concluded with open discussions by all participants and a vote of thanks by the MC, Ms. Joy Asange.

14.0 GENERAL OBSERVATIONS

1. The development of small hydropower in Africa in general is still at small scale;
2. The policies and legal frameworks for SHP are inadequate for mass installations;
3. There are no adequate incentives for investment in SHP in most African regions;
4. There are currently no established standards on SHP in the participated countries but many countries have commenced processes of developing SHP standards;
5. There is lack of technical and human capacity to manufacture SHP equipment;
6. There is inadequate access to finance for SHP projects.

15.0 RECOMMENDATIONS

1. African countries should prioritize the development of Small Hydropower (SHP) in the region;
2. African countries should develop or update relevant policies and plans to promote SHP development;
3. Governments of African countries and sub-regional bodies should provide incentives to encourage investments in SHP;
4. African countries should intensify research and development as well as technology transfer on production of SHP equipment;
5. Governments of African countries and sub-regional bodies should collaborate with global organizations such as UNIDO/GEF and key in to the ongoing efforts to develop standards on SHP.