



U.S.-AFRICA CLEAN ENERGY STANDARDS PROGRAM

Public Market Report: Standards to Promote Interoperability: Interconnection Code Compliance & Corrective Actions

Phase II Workshop No. 3 USTDA Activity No. (2015-11008A) and Contract No. (CO201511061)

Produced through cooperation between
the **American National Standards Institute (ANSI)** and **Power Africa**
under sponsorship of the **United States Trade and Development Agency (USTDA)**

October 2018

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PUBLIC MARKET REPORT

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Standards to Promote Interoperability: Interconnection Code Compliance & Corrective Actions

October 1, 2018

**Kigali Convention Centre, Radisson Blu Hotel
Kigali, Rwanda**

BACKGROUND

This workshop addressed standards and technical regulations to bolster the reliability of the transmission grid and day-to-day operations of the power system within Rwanda and the Eastern African Power Pool (EAPP). The workshop built upon existing gaps and corrective actions, identified by a Power Africa study and gap analysis, to allow Rwanda to comply with the EAPP interconnection code. This activity covered both an overview of current challenges as well as viable solutions to meet technical requirements under the EAPP interconnection code. This information supported the flexibility and reliability of the Rwandan and EAPP grid systems as well as promoted a more stable business environment for the export of U.S. products that will aid in grid operation and management.

Among the more pressing challenges identified by the Rwanda Energy Group (REG) for Rwanda's energy grid are voltage control and the pending 220kV high voltage (HV) interconnection with Uganda. This workshop provided an opportunity for U.S. private sector representatives to describe potential solutions to mitigate foreseeable issues as Rwanda interconnects with EAPP neighbors. Solutions discussed were firmly rooted in international standards and best practices, which support the import of safe and reliable technology.

Speakers emphasized how maintenance and harmonization standards for energy transmission improves grid resilience and reduces system operation costs. These benefits are particularly important in Rwanda and the East Africa region, where energy deficiencies are profound. In Rwanda, where slightly more than 40 percent of the population has access to electricity, improving the operational efficiency of the national grid will help to augment energy supplies to allow energy to seamlessly travel from the generation source to the end user.¹ As national utilities and government bodies develop on-grid solutions to address gaps in energy access, the need for harmonized standards and regulations to promote energy system interoperability will be essential.

Well-developed standards pave the way for robust and reliable energy flows across the national grid and international borders. While the EAPP has developed a regional interconnection code, many East African nations do not have the technical standards, equipment, or institutional knowledge to support the operation of their domestic grid systems to EAPP specifications. This limitation has contributed to less than 22 percent electricity access across East Africa compared, as opposed to the sub Saharan African (SSA) average of 33.5 percent access.² The government of Rwanda has recognized these challenges and is emphasizing electricity access as a critical element of Rwanda Vision 2020 and the National Energy Strategy. To address the national energy deficiency, Rwanda has set an ambitious target of nationwide electrification by 2024.³

¹ Rwandan Development Board. (August 2017). Retrieved from <http://www.rdb.rw/rdb/energy.html>

² UNIDO. (2016). "2016 East African Community Renewable Energy and Energy Efficiency Regional Status Report."

³ Rwandan Development Board. (August 2017). Retrieved from <http://www.rdb.rw/rdb/energy.html>

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To meet its goals, Rwanda's government will need to invest in a variety of energy equipment to support grid operations. Based on estimates following the Power Africa gap analysis, the implementation of the identified mitigation plans in Rwanda alone could result in one to three years of effort with a value of up to \$10-15 million in equipment. Further, based on previous export trends for electrical equipment to the EAPP region, one could further estimate the EAPP-wide addressable market to be at least \$128 million annually. Existing shortfalls provide a valuable market opportunity for experienced power engineers and operators to share best practices in support of the Rwandan's power system management.

WORKSHOP SUMMARY

As the sixth workshop under the CESP, the "Standards to Promote Interoperability: Interconnection Code Compliance and Corrective Actions," continued an important dialogue regarding the value of harmonizing standards and practices for regional transmission systems and incorporating high quality products to support transmission system operation. This is particularly true as the EAPP and its members continue to expand regional interconnections and start to interconnect with other African power pools.⁴

This activity assembled leading experts from the public and private sectors, featuring presentations by U.S. and Rwandan participants on standards-related aspects of transmission system integration and interoperability to facilitate greater proliferation of safe and efficient technologies into Rwandan and East African markets. The workshop addressed existing gaps and corrective actions to allow Rwanda to comply with the EAPP interconnection code and provided an overview of viable technological solutions to meet technical requirements under the EAPP interconnection code.

The one-day workshop attracted 99 participants from 16 countries including participants from Cote d'Ivoire, Democratic Republic of the Congo, Egypt, Ghana, Guinea, Kenya, Malawi, Namibia, Nigeria, Rwanda, Senegal, South Africa, Uganda, Zambia, and Zimbabwe. Participants engaged subject matter experts and technology providers for interconnected transmission systems. Participants also included members of the African Electrotechnical Standardisation Commission (AFSEC) who serve on national, continental, and international technical committees for the development of standards.

The workshop featured nine experts from the U.S. and Rwanda. These experts included eight U.S. speakers and one Rwandan organization from Eaton, Electric Reliability Council of Texas (ERCOT), General Electric (GE), IEEE, Motorola, Nexant, REG, and Schweitzer Engineering Laboratory (SEL).

This activity furthered the discussion and exchange of standards-related issues related to previous work done by Power Africa and the EAPP to support interconnection code compliance. Bolstering the ongoing efforts of REG, this workshop highlighted U.S. company solutions to fill the existing gaps in Rwanda's transmission system. Additionally, US experts were able to highlight US-manufactured, technological solutions to meet Rwandan and East African system needs for system operation.

Links to a flyer, photos, the final agenda and presentations from the workshop are available for on the U.S.-Africa CESP web site: www.StandardsPortal.org/us-africacesp

MARKET OPPORTUNITY

⁴ AFCC2/RI-3A Tanzania-Zambia Transmission Interconnector (June, 2018). Retrieved from <http://projects.worldbank.org/P163752?lang=en>

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Energy is pivotal to many of the challenges the world faces today. Whether maintaining national stability, economic growth, protecting ecosystems, or promoting social equity each hinges on access to secure and sustainable energy. Because energy access plays a vital role in accelerating economic development by improving health and promoting a strengthened service sector, the Government of Rwanda has emphasized electricity access as a key priority. For this reason, Rwanda has made significant investments in the area of energy proliferation. Since 2000, access to electricity has risen from 2 percent to 40.5 percent in 2017.⁵

Despite substantial progress, major challenges and shortfalls exist. Rwanda is a landlocked country with no port access and limited natural resources. Rugged topography and high population growth rates impose major strains on the country's limited natural resources, evidenced by high levels of land and wetland degradation, deforestation, and loss of bio-diversity. These limitations, lead to increased energy costs, transferred on to high costs of doing business and impeded economic development. The government of Rwanda is supporting policies to promote service-lead growth, this strategy for economic development and the resulting industrialization and urbanization will increase demand for further energy and transport investments.⁶

Reducing infrastructure-related costs of doing business, especially the high cost of electricity and low level of energy production, will relieve constraints on the Rwandan economy. With an electricity generation capacity of 210.9 MW for a population of nearly 12 million, the government of Rwanda has emphasized the need for a significant rise in energy investment led by the private sector to meet national targets for increased manufacturing, industrialization, and the creation of a robust service sector.⁷ As the private sector becomes more involved in energy generation, transmission, and distribution the importance of standards and technical regulations to support and harmonize energy access will also grow.

Across Africa, regional power pools are being deployed to integrate power systems and create more robust power grids. The integration of electricity systems facilitates the transfer of electricity across micro-grids, national grids, and across national borders, and is becoming increasingly important. This integration relies on the harmonization and consistent use of international standards for technologies and operating practices across the power pool. In order for Rwanda to rapidly scale up electricity access, it will need to meet the standards and technical requirements outlined in the Eastern Africa Power Pool (EAPP) interconnection code and international best practices.⁸ As the country continues to scale up, a plan for connection or integration will need to be in place to ensure current and new systems do not hinder grid stability.

Standards and regulations supporting these connections are either nascent or non-existent in Africa, reducing investment appeal for the private sector, which is necessary for the expansion of energy access. Further complications exist due to the complex nature of operating an efficient interconnection, which requires proper planning and design along with a large number of components to allow the system to operate in a synchronized manner.

⁵ Republic of Rwanda. (2012). Rwanda Vision 2020. Retrieved from http://www.minecofin.gov.rw/fileadmin/templates/documents/NDPR/Vision_2020_.pdf

⁶ African Development Bank. (2013). Rwanda Energy Sector Review and Action Plan. Retrieved from http://www.afdb.org/fileadmin/uploads/afdb/Documents/Project-and-Operations/Rwanda_-_Energy_Sector_Review_and_Action_Plan.pdf

⁷ Republic of Rwanda. (2012). Rwanda Vision 2020. Retrieved from http://www.minecofin.gov.rw/fileadmin/templates/documents/NDPR/Vision_2020_.pdf

⁸ Rwandan Ministry of Infrastructure. (June 2016). Rural Electrification Strategy. Retrieved from http://www.mininfra.gov.rw/fileadmin/user_upload/aircraft/Rural_Electrification_Strategy.pdf

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As Rwanda and EAPP countries increase their technical capacity to meet international standards, markets in Africa will expand for U.S. manufacturers and service providers. Cooperation between U.S. energy companies and Rwandan public sector will ensure regulatory policy provides access to Rwandan markets while supporting domestic energy needs. Policy conducive to the uptake of quality technologies will also help to facilitate continental energy solutions and decrease energy prices across Africa.

For U.S. companies, the primary customers should be electrical generation, transmission, and distribution utilities located across Africa. As those utilities and national governments continue to plan and deploy electrical systems, including to transmit electricity across borders and to connect millions of households and businesses to sources of electricity, quality and safe products are paramount. Additional customers include firms involved in engineering, procurement and construction of electric power facility infrastructure in the region. Taking into account the current annual level of U.S. exports of utility equipment to the EAPP, one can estimate the “addressable market” to be at least USD 128 million annually.

*A complete breakdown of the U.S. electrical exports by EAPP member is included in Appendix B.

U.S. business responses regarding their perceived commercial benefits and opportunities are included below.

*A complete breakdown of the U.S. electrical exports by EAPP member is included in *Appendix A*.

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Appendix A. Relevant U.S. Export History to EAPP Members

The range of electrical products needed for safe and reliable transmission, distribution and use of electrical energy is extensive. Years of experience has shown that at least the following list of products is included:

<i>HTS number</i>	<i>Product description</i>
7306.30	Non-insulated metallic conduit
7326.9085	Rods for electrical grounding
8501.61	AC generators (alternators): Of an output not exceeding 75 KVA
8501.62	AC generators (alternators): Of an output exceeding 75 kVA but not exceeding 375 kVA
8501.63	AC generators (alternators): Of an output exceeding 375 kVA but not exceeding 750 kVA
8501.64	AC generators (alternators): Of an output exceeding 750 kVA
8503.00	Commutators: Stators and rotors for motors and generators
8504.21	Liquid dielectric transformers: Having a power handling capacity not exceeding 650 kVA
8504.22	Liquid dielectric transformers: Having a power handling capacity exceeding 650 kVA but not exceeding 10,000 kVA
8504.23	Liquid dielectric transformers: Having a power handling capacity exceeding 10,000 kVA
8504.31	Other transformers: Having a power handling capacity not exceeding 1kVA
8504.32	Other transformers: Having a power handling capacity exceeding 1 kVA but not exceeding 16 kVA
8504.33	Other transformers: Having a power handling capacity exceeding 16 kVA but not exceeding 500 kVA
8504.34	Other transformers: Having a power handling capacity exceeding 500 kVA
8504.40	Static converters
8504.50	Other inductors
8504.90	Parts
8532.10	Fixed capacitors used in 50/60 Hz circuits, w/reactive power capacity of not < .5 kvar
8535.10	Electrical apparatus for switching or protecting electrical circuits, voltage > 1,000 V: Fuses for a voltage > 1,000 V
8535.21	Automatic circuit breakers for a voltage > 1kV but < 72.5 kV
8535.29	Other circuit breakers for a voltage > 72.5 kV
8535.30	Isolating switches and make-and-break switches
8535.40	Lightning arresters, voltage limiters and surge suppressors
8535.90	Other electrical apparatus for switching or protecting electrical circuits above 1000 V
8536.10	Fuses
8536.20	Automatic circuit breakers
8536.30	Other apparatus for protecting electrical circuits
8536.41	Relays, for a voltage not > 60 v

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8536.49	Relays, 60 to 1000 V
8536.50	Switches
8536.61	Lamp holders
8536.69	Electrical connectors
8536.90	Boxes, raceway, terminals and others
8537.10	Panel boards, voltage not > 1,000 V
8537.20	Switchgear and assemblies for a voltage > 1,000 V
8538.10	Boards, Panels, consoles, desks, etc. for goods of 8537 w/out their apparatus
8538.90	Molded and other parts for 8536 and 8537
8544.41	Electric conductors, fitted with connectors for voltage not > 80 V
8544.49	Electric conductors, fitted with connectors for voltage not > 80 V: Other, without connectors
8544.51	Electric conductors, fitted with connectors, voltage > 80 V but < 1,000 V
8544.59	Electric conductors, fitted with connectors, voltage > 80 V but < 1,000 V: Other, without connectors, of copper; other, not of copper
8544.60	Electric conductors, fitted with connectors, voltage > 1,000 V: Not fitted with connectors and of copper; Not fitted with connectors and not of copper
8544.70	Optical fiber cables
8546.10	Electrical insulators of glass
8546.20	Electrical insulators of ceramics
8546.90	Electrical insulators of other material
8547.90	Insulated metallic conduit
9028.30	Electricity meters
9028.90	Parts and accessories

The U.S. International Trade Commission Interactive Tariff and Trade Database provides direct access to trade data and allows users to create customized reports from queries created under "advanced searching" from a defined list of products. Using the list above a query was developed to determine the export of these products to countries in sub-Saharan Africa using the AGOA 2016 defined list of countries. The table below shows the result of exports over the past three years to members of the Eastern African Power Pool, excluding the Democratic Republic of the Congo due to a lack of available data. These data represent all of the products from the list above aggregated. It is possible to disaggregate the data into specific tariff lines if necessary for further analysis.

FAS Value for East Africa

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U.S. Domestic Exports
Data from 2014-2017

Country	2014	2015	2016	2017	Percent Change 2016 - 2017
	<i>In 1,000 Dollars</i>				
Burundi	17	42	10	49	377.7%
Egypt	67,223	75,087	88,110	106,739	21.1%
Ethiopia	18,438	4,135	13,609	5,097	-62.5%
Kenya	3,741	3,848	6,380	7,157	12.2%
Libya	72,206	2,186	1,089	5,929	444.5%
Rwanda	135	86	189	200	5.9%
Sudan	40	0	27	44	62.2%
Tanzania	8,320	1,431	1,470	1,788	21.7%
Uganda	1,063	938	756	1,171	54.8%
Total	171,183	87,754	111,641	128,175	14.8%