Public Market Report:

Standards and Technology to Support Benin's Energy Backbone: Energy Storage and Energy Efficiency

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PUBLIC MARKET REPORT

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Azalaï Hôtel de la Plage
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BACKGROUND

Benin has low energy generation and low connectivity rates. Approximately 40 percent of the country has access to electricity (compared to a regional rate of 52 percent), and energy consumption remains low due to limited grid connectivity and interrupted access. Further, due to low levels of power generation, Benin imports between 75-99 percent of its electricity from neighboring nations in the West African Power Pool (WAPP). Despite low availability, demand for electricity has doubled over the past decade and is expected to continue to expand by 6-10 percent annually. Benin has targeted energy independent by 2021, including a goal of 25 percent renewable energy generation in the national energy mix by 2025.[2]

High greenhouse gas emissions, increased demand, and high prices of imported electricity and diesel have compelled Benin to invest in domestic renewable energy sources. These factors have also led Benin to encourage renewable investment through private sector-friendly policies. These policies include both renewable energy feed-in-tariffs (REFIT) and private sector bidding for energy projects. Further supporting private sector investment, the Millennium Challenge Corporation (MCC)'s Benin Power Compact includes planned investments in on-grid solar photovoltaic projects.

While public and private investment in renewable energy generation will increase available energy capacity, the variable nature of renewables limits their commercial viability. However, energy storage and efficiency technologies and strategies, when supported by international standards and good regulatory practices, create space for renewable energy diversification by ensuring more consistent energy flows, helping distributors balance renewable energy inputs in the national grid, and increasing the efficient use of available energy.

Energy storage allows distributors to provide power when it is needed, rather than when it is best generated. If deployed effectively, energy storage can make renewable energy a reliable and cost-effective option for Benin. In addition, if combined to Benin's electricity grids, energy storage will help integrate more renewable energy into its national mix, improve the reliability of the current electrical supply, and defer significant investments from generation to new transmission and distribution capacity. Similarly, standards to support greater availability and proliferation of strategies, technologies, and appliances to increase energy efficiency will help Benin make better use of its limited energy resources.

[2] https://www.se4all-africa.org/seforall-in-africa/country-data/benin/

WORKSHOP SUMMARY

This fifth workshop under the CESP, the "Standards and Technology to Support Benin's Energy Backbone: Energy Storage and Energy Efficiency," created an early dialogue about the standards considerations for energy storage and energy efficiency in Benin, particularly as Benin moves towards a goal of 100 percent domestic electricity generation by 2021. This workshop brought together leading experts from the public and private sectors, featuring presentations by U.S. and Beninois participants on standards–related aspects of energy storage and energy efficiency to facilitate greater proliferation of safe and efficient technologies into the Beninois and greater West African markets. The workshop addressed common approaches to standardization and conformity assessment; technical innovations and developments; and associated case studies to assist in the deployment of safe and effective storage and grid integration systems in Benin.

The two-day workshop attracted more than 100 participants who were able to engage subject matter experts in the fields of energy storage and energy efficiency and included participation from Benin's Minister of Energy, the Honorable Jean-Claude Houssou. Minister Houssou provided opening remarks that demonstrated ministerial-level support for the event and reaffirmed Benin's commitment to energy independence and the integration of renewable energy sources.

The workshop featured 13 experts from the U.S. and Benin. These experts included seven U.S. speakers from General Electric (GE), ICF International, PowerGen Renewable Energy, RIFE International, TansaTech, and Volta Power. Representatives from Benin included Coneils-Etudes-Travaux (CETRA), the Ecole Polytechnique d'Abomey-Calavi (EPAC), ENERDAS SARL, MCA-Benin II, Ministry of Energy, the National Academy of Sciences, Arts and Letters, Société ARESS, and Solariss-ING.

Furthermore, this workshop generated a discussion of standards-related issues that will supplement the Millennium Challenge Corporation (MMC)'s Benin Power Compact. MCC is collaborating with Benin to invest $375 million to modernize Benin's power sector. The five-year compact, which came into force in June 2017, includes four projects for investment in the power sector: policy reform and institutional strengthening, electricity generation (including major investments in solar PV), electricity distribution, and off-grid electricity access.[3] In support of these projects, MCC expressed interest to ANSI in a 2-day workshop addressing support for the national grid and energy storage to increase Benin's capacity in support of energy independence goals and more efficient distribution.

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

Benin is heavily dependent on its neighbors for electricity, importing between 75-99% of its electricity from West African Power Pool (WAPP) countries like Nigeria and Ghana.[4] This dependence coupled with high greenhouse gas emissions, increased demand, and high prices of imported electricity and diesel have compelled Benin to invest in renewable energy sources and to commit to national energy

[3] Millennium Challenge Corporation Factsheet. Retrieved from https://www.mcc.gov/where-we-work/program/benin-power-compact

[4] Millennium Challenge Corporation. Dalberg Global Development Advisors. "Benin Energy Storage Market Assessment." July 2017.

independence by 2021.[5] In an attempt to diversify its energy mix and meet the growing consumer demand, Benin has encouraged renewable investment and expansion through private sector-friendly policies. These policies include both renewable energy feed-in-tariffs (REFIT) and private sector bidding for energy projects.

Despite rapid investments to meet the needs of the nearly 7 million citizens without access to electricity, Benin has been unable to meet its growing electricity demands. Creating further pressure on the government demand is expected to continue to expand at a rate of 6-10% annually. Energy storage and increased efficiency provide two avenues to maximize energy generation and support national energy independence in Benin.

Energy storage promotes an enabling environment for clean energy and transboundary natural resource management. If deployed effectively, energy storage can make the delivery of off-grid energy a reliable and cost-effective option for millions across Benin and West Africa. In addition, if integrated into Benin's electricity grids, energy storage can help integrate more renewable energy into its grid supply, improve the reliability of the current electrical supply, and defer significant investments into new transmission and distribution capacity.

Energy efficiency standards will be an important driver for usage optimization and will lead to cost savings in Benin. Efficiency is a vital component of Benin's push towards energy independence, particularly, as Benin is only beginning to generate its only energy. The nation's energy dependence will require Benin to utilize its limited energy resources in the most efficient manner to maximize countrywide electrification and to optimize grid function.

One example of increasing energy efficiency was achieved through an appliance-labeling program that was coordinated and funded by the Millennium Challenge Corporation (MCC) in nearby Ghana. This program resulted in peak energy savings of over 120 MW and "displaced the need for $105 million (USD) in generation investment and reducing carbon dioxide emissions by over 110,000 tons annually."[6]

Installation codes, standards, and conformity assessment form the foundation for safe, efficient, and interoperable electrical systems. As Beninois utilities, IIPs, and residential property owners consider deployment of energy storage systems and more energy efficient practices, relevant authorities must have the necessary understanding to evaluate these technologies to ensure safety and promote reliability. For this reason, standards are a foundational component to build out Beninois electrical systems, including distributed generation.

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. The WAPP plans to interconnect the most critical borders by 2020, "making it possible for electricity to flow throughout West Africa from countries with cheaper, cleaner and more abundant energy resources to those lacking them." According to the World Bank there is a cost savings benefit of 5-8 billion USD a year

[5] MCC. Factsheet.
[6] https://www.usaid.gov/powerafrica/newsletter/dec2014/smarter-power-in-africa

through regional power sharing. These benefits comes from lower costs of operation and generation costs, which are enhanced by energy storage and efficiency systems.[7]

Additional customers include firms involved in engineering, procurement and construction of electric power facility infrastructure in the region, as well as companies wishing to integrate more energy efficient appliances into their plants. Taking into account the current annual level of U.S. exports of utility equipment to West Africa, one can estimate the addressable market to be at least 156 million USD. Using similar estimates for the West African region, the addressable market is estimated to be at least 35 million USD (YTD) annually. A growing trend of renewable energy uptake in West Africa as demonstrated by megaprojects like the $375 million MCC Compact further support the increasing U.S. market opportunity in Benin and West Africa.

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

[7] World Bank. https://www.worldbank.org/en/news/feature/2018/04/20/regional-power-trade-west-africa-offers-promise-affordable-reliable-electricity

Appendix A. Relevant U.S. Export History to West Africa

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:

HTS number	***Product description***
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
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 the West African Power Pool (WAPP). The table below shows the result of exports over the past five years to countries in the WAPP. 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 by Country Name and FAS Value for WAPP

U.S. Total Exports

Annual + Year-To-Date Data from Jan - Jun

Country	2014	2015	2016	2017	2017 YTD	2018 YTD	Percent Change YTD2017 - YTD2018
			In 1,000 Dollars				
Benin	795	92	4,629	154	88	124	40.7%
Burkina Faso	132	137	288	1,044	124	77	-38.2%
Cape Verde	85	83	23	3	0	7	%

Cote d`Ivoire	2,586	5,650	2,213	2,282	1,239	1,092	-11.8%
Gambia	46	88	24	53	35	0	-100.0%
Ghana	11,663	20,877	21,616	114,454	55,379	5,750	-89.6%
Guinea	459	437	191	439	192	47	-75.3%
Guinea-Bissau	0	20	53	12	0	0	%
Liberia	2,028	5,081	3,264	1,136	566	1,780	214.7%
Mali	231	1,152	3,304	2,537	1,832	711	-61.2%
Niger	427	394	368	1,611	443	470	6.0%
Nigeria	73,972	60,156	43,906	27,082	11,190	17,199	53.7%
Senegal	5,882	3,242	694	2,141	1,227	966	-21.3%
Sierra Leone	252	345	504	381	229	25	-88.9%
Togo	335	17	104	93	14	0	-100.0%
Total	**111,511**	**117,418**	**98,584**	**155,735**	**73,651**	**35,107**	**-52.3%**