SOLAR PHOTOVOLTAIC (PV) IN WEST AFRICA : LEARNINGS FROM BENIN

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About this brief

The brief was authored by Innogence Consulting in collaboration with ARESS.
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Innogence Consulting

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Africa Renewable Energy System & Solution (ARESS) is a leading provider of renewable energy solutions with a focus on solar energy. The company operates in West Africa, with teams in Benin, Togo, Burkina Faso, Mali and Sénégal.

To find out more about ARESS, consult their website: http://www.aress-group.net/

Introduction

Benin has been experiencing a rapid economic growth with a corresponding increase in the demand for energy. Keeping pace with the rising energy needs, to enable economic growth and extend access to modern energy to those lacking, is presently the agenda as well as challenge for policy makers in the country. Trying to solve this while betting on clean energy, well known to be better for the planet and humanity rather than energy derived from fossil fuels, makes it even more challenging.

The Beninese government has a unique opportunity to accelerate sustainable development by putting renewable energy at the heart of its economic development plan. The significant amount of perceived knowledge about the cost and performance of renewable power generation in Benin can be misleading because of the lack of accurate, comparable, reliable and up-to-date data. Like most countries in Sub-Saharan Africa, Benin's energy sector is largely dominated by the use of fossil-based energy and the national grid remains widely unreliable, plagued by wide variations in voltage and frequent power cuts, leaving most of its citizens underserved or unserved by the national grid provided by the Beninese electrical power-company, Société Béninoise d'Energie Electrique (SBEE).

Electricity consumption per capita in Benin is below 110 kWh per year, less than 25% of the continent's average of 483 kWh[1]. According to *Direction Générale des Ressources Énergétiques du Benin*, in its 2018 report, 29.2% of Beninese citizens have access to electricity, with a significant disparity between urban (53.9%) and rural areas (6.5%). The National electrification rate includes every structure that have ever been connected to the national grid and doesn't factor in the consistency of the power supply.

Government has set an electrification target rate of 95% Urban electrification and 65% Rural electrification by 2025. To achieve this goal and given the country's low population density and low purchasing power, especially in rural areas, the government supported the development of decentralised energy production in underserved communities. Benin adopted the Millennium Challenge Corporation (MCC) reform agenda and created the « Off-Grid Clean Energy Facility » (OCEF), which aims to improve access and availability of electricity for use by households.

[1] *World Bank : https://data.worldbank.org/indicator/EG.USE.ELEC.KH.PC?locations=ZF-BJ*

Table 1 : Benin key statistics

Key indicators for 2018	
Total Population	11.5 M
GDP per capita	$901.90
Urbanisation rate	55.3 %
National electrification rate	29.2 %
Urban electrification rate	53.9 %
Rural electrification rate	6.5 %
Number of household without power	1.4 million
Electrification target rate by 2025;	
Urban electrification	95 %
Rural electrification	65 %

Source: Gogla country brief - Benin, INSAE, DGRE Benin

In a bid to promote the uptake of Solar Home Systems (SHS) and solar kits in Benin, the Government agreed to waive the 41% tax (23% on import duty and 18% on sales tax) for all solar products meeting Lighting Global Quality Standards under the « Power out of Poverty Partnership » initiative in 2014. Under the Energising Development (EnDev) Benin Program of 2005-2021, which was created to promote private investments in clean energy, solar products have also been exempted from import duty and sales tax all in a bid to promote renewable energy as well as increase the National electrification rate in Benin. All these different initiatives and efforts by the government to promote the uptake of SHS, helped in accelerating access to clean energy with more and more homes, especially in the rural areas, purchasing solar kits. Between 2016 and 2019 over 250,000 units of solar kits were sold in Benin, and the country was largely dominated by Pay-As-You-Go (PAYGo) sales rather than outright purchases of the solar home systems and much of its sales include kits with basic appliances like radios and TVs.

259,115 portable lanterns, multi-light systems and solar home systems were sold between 2016 and 2019

Source: Gogla off grid solar sales report 2020

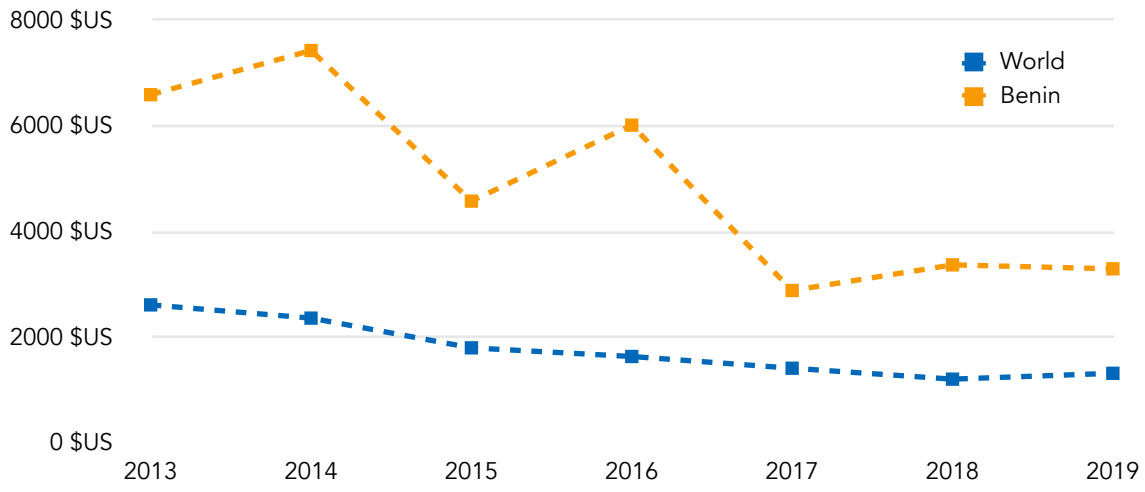
If these kits helped improve energy access in rural areas, their use is limited in urban settings as their power output cannot sustain the energy needs of city dwellers. Most urban homes in Benin need an average of 1kW to fully power their homes, and the energy capacity presently made available to customers via SHS (max of 250W) is not sufficient enough to power home equipments like TV, AC, fridge, etc.

Benin's learning curve

Due to the upfront cost involved in their installation, residential rooftop solar has had a very slow uptake in the Country. Even with its much-needed use for either primary electricity (Off-grid) or for backup power during the brownouts and blackouts that frequently occur in Benin, homeowners who need more energy than what the SHS can supply have still not been able to commit to it. Most individuals have factored in the costs of the heavy equipments like the panels, batteries, inverters etc., as well as the costs for BoS[2] and manpower, and they have tagged solar energy to be more than they can handle although they all agree on its long term benefits in power generation and reliability.

Based on data collected from ARESS (African Renewable Energy Systems & Solutions), one of Benin's top solar PV providers, we can observe a decline in the cost for installed energy capacity, a trend which seems to be similar worldwide as shown in figure 1.

Figure 1 : Global vs Benin average cost of installed kilowatt (kWp)



Source: IRENA, ARESS

Looking at the graph, we can see a rapid decline in the average cost per installed kilowatt, which means that solar energy is getting cheaper and more affordable over the years.

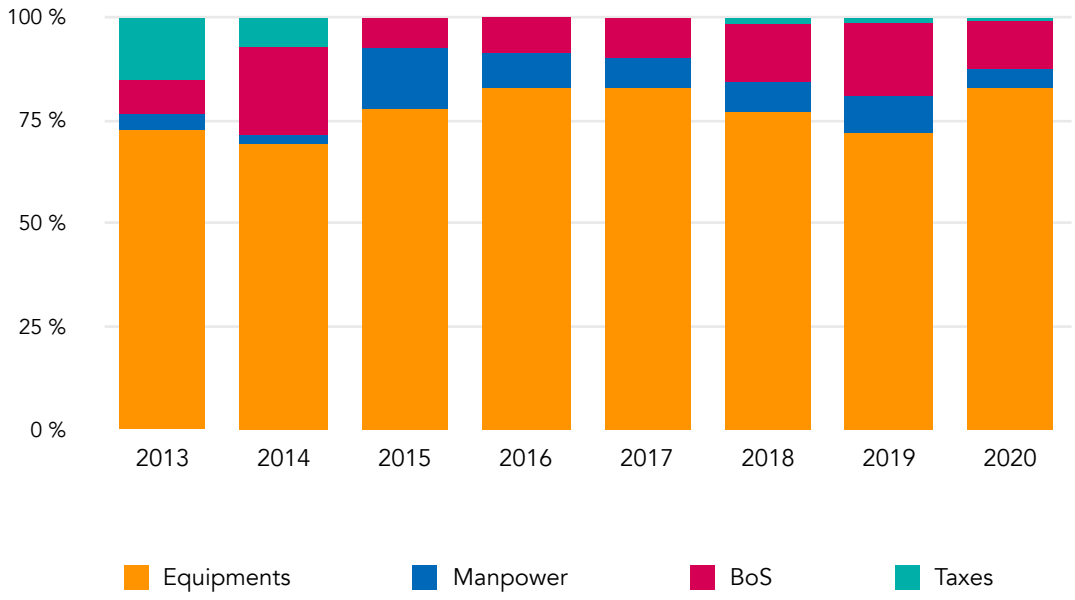
According to ARESS's data, the cost of a kilowatt of installed capacity costed $6,596 in 2013 and as at 2019 the cost dropped by almost 51% to $3,297 per Kilowatt over the course of 6 years. This is consistent, even though rather lower, than the global

[2] *BOS refers to all components of a solar system other than the modules or large equipments. They include cables, frames, installation accessories, etc*

trend which saw a 62% decline in the cost of a unit kilowatt of installed capacity.

When looking at a breakdown of the installation cost as shown in figure 2, we can observe that PV modules, batteries and inverters (named *equipments* in the graph) account for approximately 80% of the total cost. The rest is split between Balance of System (BoS), taxes and manpower.

Figure 2 : Cost segmentation for the installation of a kWp of PV solar in Benin



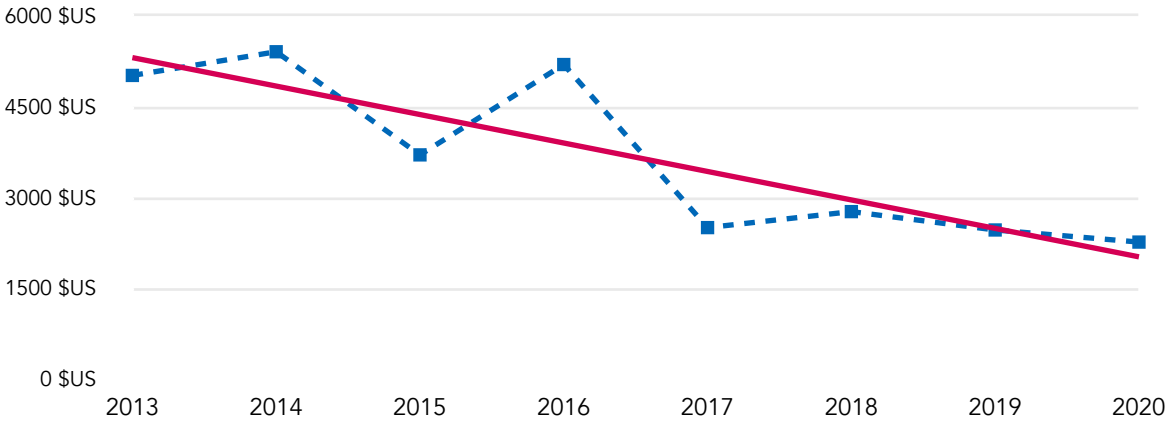
Source: ARESS

Good news is, the expensive *equipments* are increasingly becoming cheaper and more available due to the following reasons:

- Efficiency in solar equipments is mostly driven by technology used in devices like panels, batteries, Inverters, etc., and as science and technology improves, they get cheaper. Technology is constantly advancing and innovations in quantum physics and nanotechnology has increased the effectiveness of solar panels. These advances have helped double, or even triple, the electrical output of solar power systems making them not only cheaper but more efficient.
- Increased manufacturing scale and improved manufacturing processes also led to competitive prices. Competition also helped drive prices down while delivering on more and more efficient equipments.

These global trends also affected the local Beninese market as we could observe a drop of 55% in equipments' prices between 2013 and 2019 as shown in figure 3.

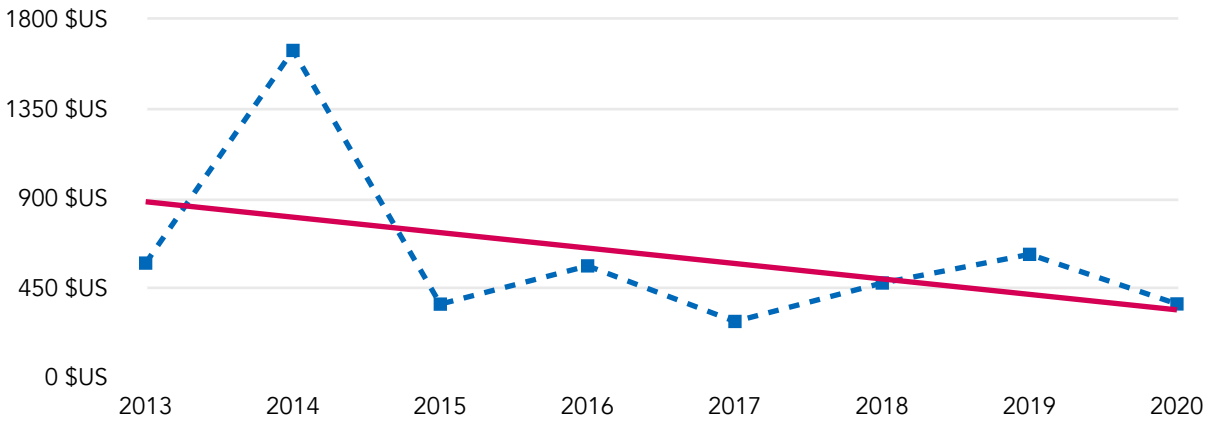
Figure 3 : Average cost of Equipments per installed KiloWatt (kWp) in Benin



Source: ARESS

A Solar Balance of System or BoS refers to the components and equipment that move DC energy produced by solar panels through the conversion system, which in turn produces AC electricity. Like large equipments, improvement in technology and competition have also driven the decline of prices for BoS globally, which impacted Benin as well. However, due to the standards of the solar energy sector regarding the quality of materials, type of installations, and the stable price of copper, the decrease in price has not been as substantial as that of equipments and has remained more or less constant. A price drop of 35% was observed in 7 years as it is shown in figure 4.

Figure 4 : Average cost of BoS per installed KiloWatt (kWp) in Benin

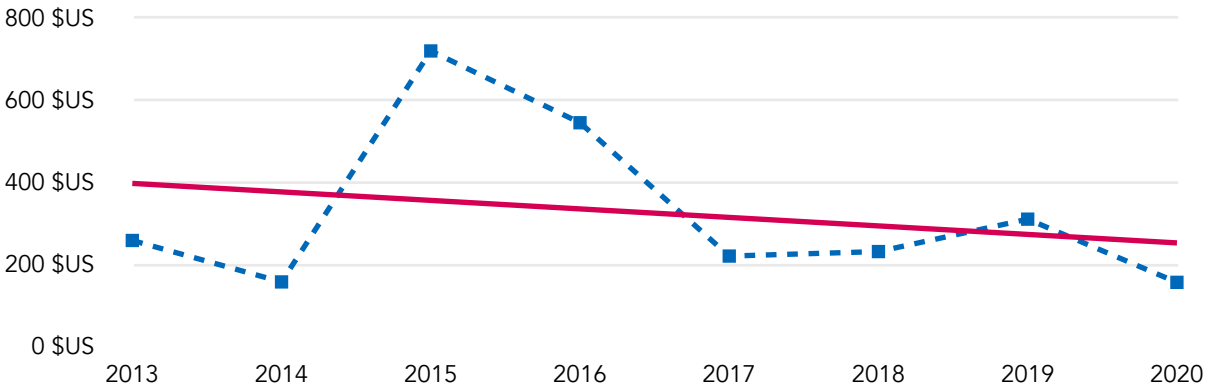


Source: ARESS

Solar energy installations were once considered complicated and skilled manpower was scarce, which led to high installation costs. These costs have now gradually reduced with continued experience. Solar companies, like ARESS, are also investing heavily on in-house training and mentorship programs for their staff to ensure that they are more efficient at their tasks.

This gain in installation efficiency resulting from experience and training brought about a 40% decline in the share of manpower in the installation cost since 2013 as shown in figure 5.

Figure 5 : Average cost of Manpower per installed KiloWatt (kWp) in Benin

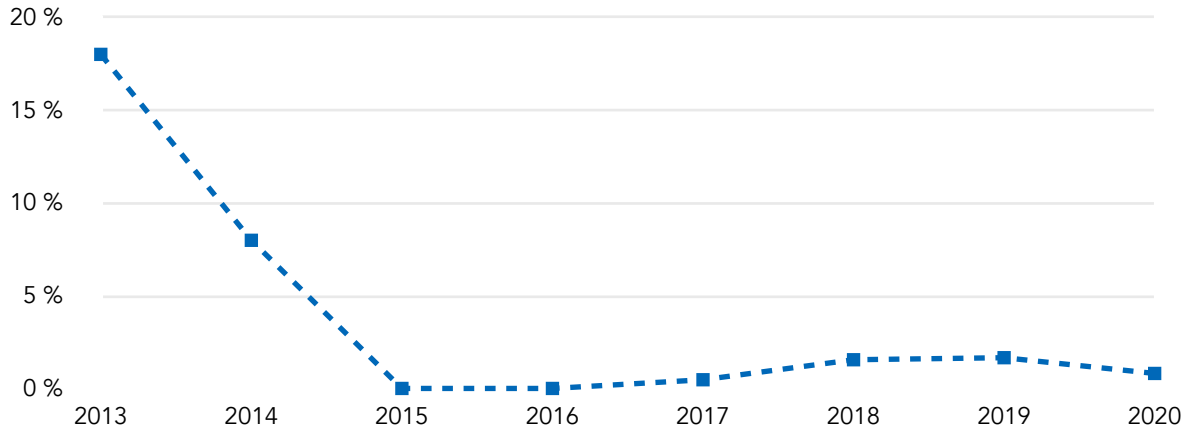


Source: ARESS

One of the leading causes behind the affordability of wind and solar energy is government subsidies. These brought costs down for businesses and residents, hence got more people to buy into solar energy.

In 2014, the government of Benin's renewable energy agency agreed to waive the then 41% import duty for all solar products meeting Lighting Global Quality Standards, for a project under the Power out of Poverty Partnership - which was a public-private initiative led by the Netherlands Development Organisation (SNV) in partnership with MTN Benin, the Government of Benin, local solar power companies and a local micro-finance institution. Under the EnDev Benin program, solar products are currently also exempted from import duty and sales tax. The fall in direct taxes on equipment, as seen on figure 6, has greatly stimulated the competitiveness of the sector, through the development of a quality market. This strong stimulation of activity led not only to a better competitiveness of the sector, but also to a better redistribution of national wealth (more jobs created, more taxes collected, more assertive energy availability).

Figure 6 : Share of taxes per installed kilowatt (kWp) in Benin



Source: ARESS

Recommendations

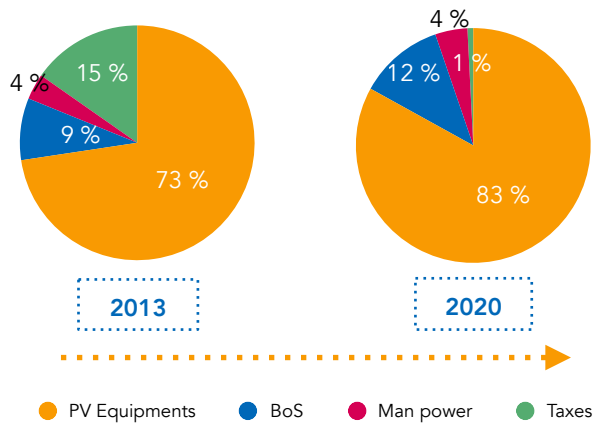
Creating an overall enabling environment for renewable energy in Benin requires finding the right mix of policies, incentives and multi-stakeholder collaboration at country and regional levels. The rewards accruing to countries that meet the challenge will be immense - renewable energy can eliminate power shortages, bring development opportunities to rural areas, spur industrial growth, stimulate entrepreneurship, and support the ongoing lifestyle changes across the continent. At the same time, leveraging renewables would facilitate a cost-effective transformation to a more secure and sustainable power sector. The new electricity code that was adopted in February 2020 by Benin's National Assembly was a great initiative to bring many innovations into the sector as well as open the market to private investors. Following this code, these investors will be able to make investments in the production, transmission, distribution and marketing of electric power, in the same way as the Benin electricity company, (SBEE). Also, the partnership with the International Solar Alliance, to which Benin has now joined, allows things to evolve in the solar field. Nonetheless, the momentum behind past and recent policies and investment plans are not yet enough to meet the energy needs of Benin's population in full, there is a need to consider the following so as to promote the uptake of solar electricity.

Manufacturing plants

In a bid to make solar equipments like panels, inverters, batteries, BoS etc., accessible to the market, purchase and shipments are coming from major production companies in countries like China, Germany, Japan and the United States. Insofar as nothing is produced in Africa, this situation permanently exposes the continent to a high technological dependence on foreign countries and above all a permanent monetary risk.

Also, these equipments currently account for more than 80% of the total expenses for the installation of solar PV as can be seen in figure 7. These funds spent on international markets could go a long way in fostering local economic growth as well as drastically reducing the costs of solar electrification hence improving purchasing power, if the government could spur the creation of local manufacturing plants for solar equipments.

Figure 7 - Cost segmentation of solar installations in Benin from 2013 - 2020



Source: ARESS

Energy Subsidies

Subsidising solar energy simply means that the government pays a portion of the initial costs as an incentive to reduce the end cost of choosing solar energy sources. This will result in a reduced overall economic burden on consumers and encourage more individuals to use more green energy to power their homes and companies.

The main stimulus used by the Beninese government has been to suppress direct taxes, which has always Benin to be at the forefront of policies and measures to support strategic sectors of the economy, including energy. This initiative should be maintained as it directly affects the population's purchasing power, contributing to reduction in solar equipments installation cost.

Training

The share of labor in the total cost of solar installations is a signal on why we must invest in the local development of renewal energy. The low cost of labor remains a comparative advantage, where even more value can be created if the labor force is been provided with adequate professional training.

Such training can be either private sector-led or under public-private partnerships. An example of such a partnership is the *Energie et Applications cluster*, setup between public and private energy stakeholders in Benin and France's Region Haut-de-France. Amongst all of its mandates, training and R&D between both territories standout. One of their objective, is to setup capacity building programs for people working in the energy value chain in Benin.

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Conclusion

Africa's inability to sustain GDP growth is in part due to its failure to provide reliable residential and industrial energy supply. Countries with electrification rates of less than 80 percent consistently suffer from reduced GDP per capita[3]. Fulfilling the economic and social promise of Benin and the continent in general, depends on the ability for governments and investors to develop its renewable electricity capacity.

There is no longer any need to demonstrate that renewable energies have been on the rise for a decade. According to a study carried out within the framework of RECASEB[4], which is a project funded by the European Commission for the capacity building of the energy stakeholders in Africa, the private energy sector, strongly driven by the dynamic off-grid, will reach a market value of around $93 billion by 2035. This, thanks to sustained growth of around 10% per year. As Benin is already favoring investment in the sector, it will therefore continue to benefit from the multiple opportunities offered by climate finance, innovative solutions and globalization of the energy sector, hence maintaining its status as a competitive energy cluster on a regional and continental scale.

In its 2018 Outlook report, the African Development Bank revealed that despite their strong resilience to shocks and certain future growth, African economies remained very dependent on a weak structural transformation, resulting in a low impact on job creation. Imports are strongly driven by consumer goods of all categories, of which we can easily find solar products. In the study, it was observed that more than 80% of the value of energy assets were not produced in Africa. And this is one of the reasons why the virtuous development of renewable energies must be accompanied by a greater share of local activities with high added value. These activities can primarily revolve around the creation of assembly lines, as is already the case with companies like Jirogasy in Madagascar, which import spare parts to assemble and market a series of portable solar-powered computers. Given the impressive volume of products that will be imported in the years to come, capturing a market value linked to semi-industrial units is a geopolitical as well as a social issue. On the other hand, schools and training centers will have to anticipate recruitments in these sectors by setting up more technical and practical training, updating of curricula, and familiarization with project management and innovation. This can be facilitated by strengthening gateway entities such as incubators and clusters.

The above analysis is based on data from Benin's ARESS, covering invoices from 2013 to 2020 for solar installations ranging from 500Wp to 50kWp. To better understand the impact of solar on energy supply, economic development and required policies to be implemented to help boost the sector at a local or regional level, there will be a need to aggregate data from other solar energy companies.

[3] https://www.mckinsey.com/industries/electric-power-and-natural-gas/our-insights/powering-africa#

[4] *Renforcement des Capacités des Acteurs du Secteur de l'Energie au Bénin*

For more information on the content of this publication, please contact :

- **Landry DJIMPE**, Energy Lead at Innogence Consulting

landry.djimpe@innogenceconsulting.com

- **Michael SINSIN**, CEO at ARESS

michael.sinsin@ARESS-group.com

Innogence Consulting

104 avenue de la résistance

93100 Montreuil, France

Tel : +33 (0) 954 335 822

contact@innogenceconsulting.com

www.innogenceconsulting.com

ARESS

N°2980 Cotonou - Vedoko - 10e Arr
BP2572 A/B, Calavi, Bénin

Tel : +229 97 444 646