Observatoire Europe-Afrique 2030

Case Study

Promoting manufacturing of third generation minigrids in sub-Saharan Africa

Case Study #18

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Summary

It is estimated that between 100,000 and 150,000 additional mini-grids will be needed in Sub-Saharan Africa by 2030 to meet the "access to electricity for all" scenario. However, no country in Sub-Saharan Africa has an industrial tool capable of manufacturing mini-grids locally. As a result, by 2030, the acquisition of several tens of thousands of installations will force the African states concerned to import most of the $100 billion worth of equipment and services needed. The impact on the debt and trade balance of these countries will be very heavy. One solution is to develop integrated African clusters for the design and manufacture of third generation mini-grids, in one or more Sub-Saharan African countries, based on a co-production approach between European and African manufacturers. Because of its high-tech characteristics, this project appears to be at odds with the strategies usually advocated for developing the manufacturing sector in Sub-Saharan Africa, which are based on "traditional" sectors.

Table

1. Context

In many parts of Africa, the electricity distributed by third generation mini-grids[i] (hybrid solar) is already competitive with the kWh delivered by centralized networks. The technological progress made over the last 15 years has made it possible to significantly reduce the cost of electricity produced by these mini-grids. This cost is expected to be cut in half over the next decade, from $0.41/kWh in 2020 to $0.20/kWh in 2030[ii].

The development of third generation mini-grids would allow 81 million additional consumers[iii] in Sub-Saharan Africa to have access to electricity[iv], including industrial consumers. Moreover, this would significantly reduce greenhouse gas emissions[v] through the gradual replacement of diesel generators currently used on a large scale in urban[vi] and rural[vii] areas.

Many African governments, including Ethiopia, Kenya and Nigeria, are making mini-grids a pillar of their national electrification plans, complementing grid extensions and solar home systems. For their part, European, Japanese and American companies that have the know-how are multiplying their initiatives.

Structures are being put in place to support this development. Recently, a partnership between the African Mini-grid Developers Association (Amda) and the Common Market for Eastern and Southern Africa (COMESA - a sub-regional organization of 21 countries) was created to facilitate the installation of mini-grids in rural areas in Africa. The partnership includes improving the quality of data collection and dissemination on the mini-grid sector within COMESA member countries, as well as improving the availability of financial instruments[viii].

It is estimated that between 100,000 and 150,000 additional mini-grids would be needed in Sub-Saharan Africa by 2030 to meet the "electricity access for all" scenario[ix]. However, to date, only 2160 mini-grids are operational, 63% of which are based on solar or solar hybrid power.

However, there is still a significant gap in the description above, as no country in Sub-Saharan Africa has an industrial tool capable of manufacturing mini-grids locally. As a result, by 2030, the acquisition of several tens of thousands of installations will force the African states concerned to import most of the $100 billion worth of equipment and services required. The impact on the debt and trade balance of these countries will be very heavy.

2. Objective

A solution would greatly reduce this financial burden. There is a unique opportunity for African and European governments and entrepreneurs to demonstrate that it is possible to develop an integrated African industry for the design and manufacture of third generation mini-grids in Sub-Saharan Africa. This sector would be based on a logic of co-production between European and African manufacturers.

Because of its high-tech characteristics, this project is a break with the strategies usually recommended to develop the manufacturing sector in Sub-Saharan Africa, which rely on "traditional" sectors such as leather or textiles/clothing.

The rationale for such a sector is the very nature of the mini-grids market:

- As the size of the potential African mini-grid market is considerable, the industry could develop in the form of large-capacity industrial units, thus maximizing economies of scale. This is a much more favorable context, for example, than for local auto assembly lines, which are not economically justified in most of Sub-Saharan Africa due to the small size of domestic new vehicle markets.

- With the world market for mini-grids growing rapidly, mini-grid manufacturing units located in Africa could easily be added to existing capacity worldwide. Again, the context is favorable when compared, for example, with other high-tech markets such as cell phones, which have reached maturity and for which the entry ticket is very high.

- For European designers/manufacturers of solar hybrid mini-grid equipment, co-production is an opportunity not to be missed in order to optimize their value chains and remain competitive in the long term on African markets, in the face of competition, particularly from China.

3. « Multi-country » scenario vs. « National » scenario

The institutional context in which the mini-grid industry could develop will depend very much on the pace of implementation of the AfCFTA over the next five to ten years. Two scenarios are possible.

3.1 "Multi-country" Scenario

This scenario is fully justified economically if the AfCFTA develops as planned. The industry is built around a sub-region encompassing the Sub-Saharan African countries that represent the highest potential demand for mini-grids: Nigeria, Democratic Republic of Congo, Ethiopia, Tanzania, Uganda. It consists of creating a network of industrial clusters, located in Special Economic Zones and distributed among these different countries.

3.2 "National" scenario

This scenario is based on the assumption that the implementation of the AfCFTA will be slower than expected. It consists of concentrating co-production in one Sub-Saharan African country, chosen for its large market potential. As in the previous scenario, the industrial cluster(s) would be located in special economic zone(s).

4. Business model

Two profiles of European companies have the required technological know-how to accompany African companies in a co-production process:
- Designers of solar hybrid mini-grids (Engie, Power Corner...)
- Inverter manufacturers (Schneider Electric, Kostal Solar, Fronius, SMA Solar....).

A company will only agree to play the role of "locomotive" in this type of project if it is accompanied, in the long term and in a concerted manner, by the public authorities of the member state(s), the European Union and the African countries concerned. The proposed mechanism for this assistance has been described in detail in a previous case study[x]. It is based on a combination of two complementary grants, given directly to the companies carrying a project:
- Start-up aid, provided that the proposed host country is eligible, i.e. that it has made a sufficient commitment to structural reforms.
- One or more targeted complementary aids, if the geographical area concerned by the investment proves to have handicaps in specific areas such as the low qualification of the workforce or the inadequacy of access infrastructures to the area.

African states should fully play the cooperation and transparency card, by committing to a stable institutional framework over time[xi]:
- Tax exemption on the exchange of services, parts and manufactured sub-assemblies between the African production sites
- Tax exemption on imports from European partner companies (parts and sub-assemblies imported for assembly on the African production sites)
- Guarantee the safety of personnel
- Guarantee the quality of the access infrastructures to the production site(s).

Eventually, African production sites should be operated and managed almost entirely by local staff, in order to avoid production cost drift. The "training" component is therefore essential in the development plan for the sector.

5. A fully-fledged industry

The industrial tool will consist in manufacturing clusters made up of a galaxy of subcontractors and co-contractors, which will gradually be grafted around a core joint venture, in order to achieve a maximum local integration rate after five years of activity.

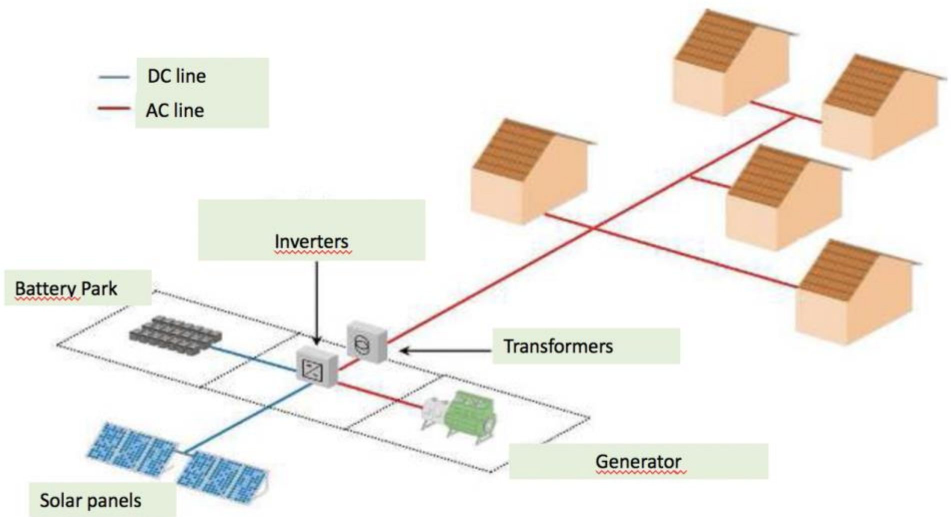
Maximizing the local integration rate is a key issue.

5.1 What is a solar hybrid mini-grid?

Before defining in more detail the means that would allow to maximize the local integration rate, it is necessary to recall what a solar hybrid mini-grid is.

The diagram below illustrates the general structure of the system.

Diagram of a solar hybrid system for rural electrification



The **solar inverter** is the central equipment of the system. It transforms and optimizes the electric current produced by the solar panels into alternating current. To do this, it constantly analyzes the direct current emitted by the solar panels, which changes continuously depending on various factors, such as sunshine. The latest generation of inverters, called "hybrid", is able to determine whether the electricity produced should be used immediately, stored in a battery, or fed into the grid.

The inverter includes power switches (transistors) which are high-tech components. Manufacturers have mainly developed the power range from 1 kW to 20 kW. Modular products, which combine multi-functional inverters with PV inverters or charge controllers, can reach output powers of 300 kW.

The inverter represents about 20% of the investment cost of the installation. Its relative share tends to increase[xii].

Solar panels are manufactured in two steps:
- Photovoltaic cell manufacturing: extraction and processing of silicon, then encapsulation of the cells with a polymer. The connections are made of copper or silver.
- Manufacture of the modules, each module comprising several photovoltaic cells (60 in most cases), frames and conductive metal plates at the back. Finally, a glass plate is added on top.

The set of "solar panels + supports" represents about 30% of the investment cost of the installation. Their share in the total investment is tending to decrease due to the decreasing production cost of the panels.

The **generator,** powered by diesel, develops a power of 30 to 200 kVA. It represents about 10 to 15% of the investment cost of the installation.

The **battery park** allows to store the produced electricity. The technology currently best suited to hybrid systems for rural electrification consists of lead-acid tubular plate batteries. Li-ion batteries can also be used. The cost of the battery park represents about 20% of the total investment of the installation.

The **"other services and equipment"** item represents 15 to 20% of the investment. It includes, among other things, design services, civil engineering work and start-up operations. As far as design services are concerned, mini-grids are characterized by their complexity. Design software is essential for simulating the operation and optimizing the sizing of the systems, not only from a technical point of view but also from an economic and financial point of view.

Access to **maintenance** and spare parts is critical for the electronic equipment of the installation (inverters, controllers...). The sustainability of maintenance services over the long term is essential.

5.2 Maximise the rate of local integration

The rate of local integration in African production sites will gradually increase, as more and more subcontractors and co-contractors are set up on the industrial sites.

The goal is to achieve near autonomy in engineering services, component procurement, manufacturing of most critical equipment (solar panels, batteries, etc.), on-site work (civil engineering, assembly), start-up and maintenance operations.

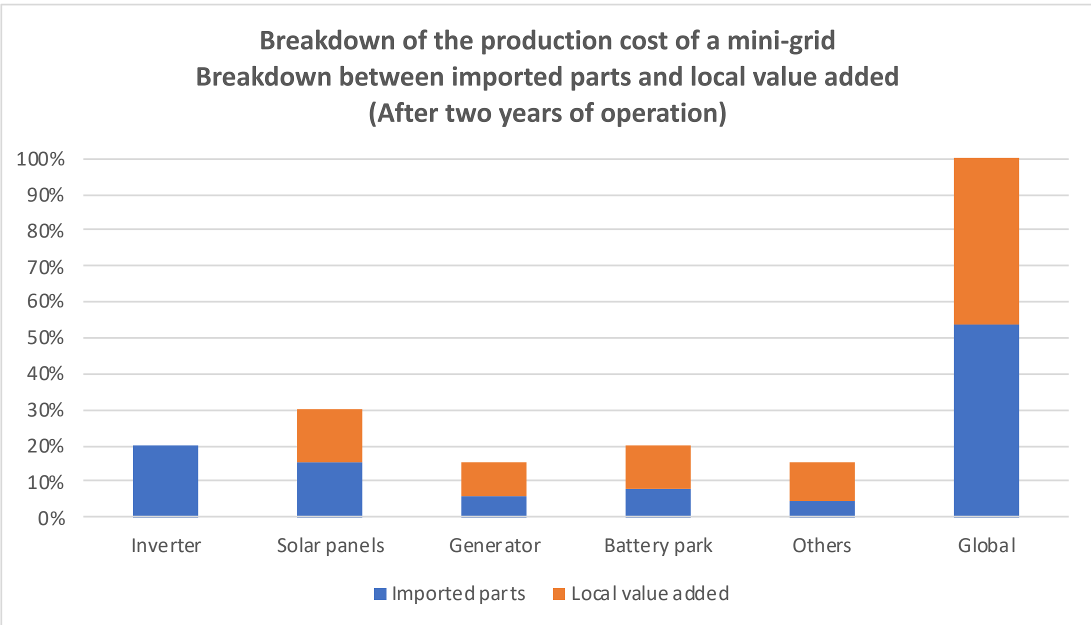
During the first two years, the “leading” European company will share its technological know-how with its African partners and train the workforce.
- The equipment with high technological content (inverters) will first be imported, then in a second phase, manufactured under license in the African sites.

- Equipment with moderate technological content (transformers, solar panels) will be manufactured locally under license.
- Equipment and services with low technological content (armatures, civil engineering) will be produced locally.

The estimated share of local value added in each equipment from the first year of production of the mini-grids is mentioned in the table below. By weighting the value of the different modules according to the share of local value added in each module, it appears that the overall share of local integration would be slightly above 45%.

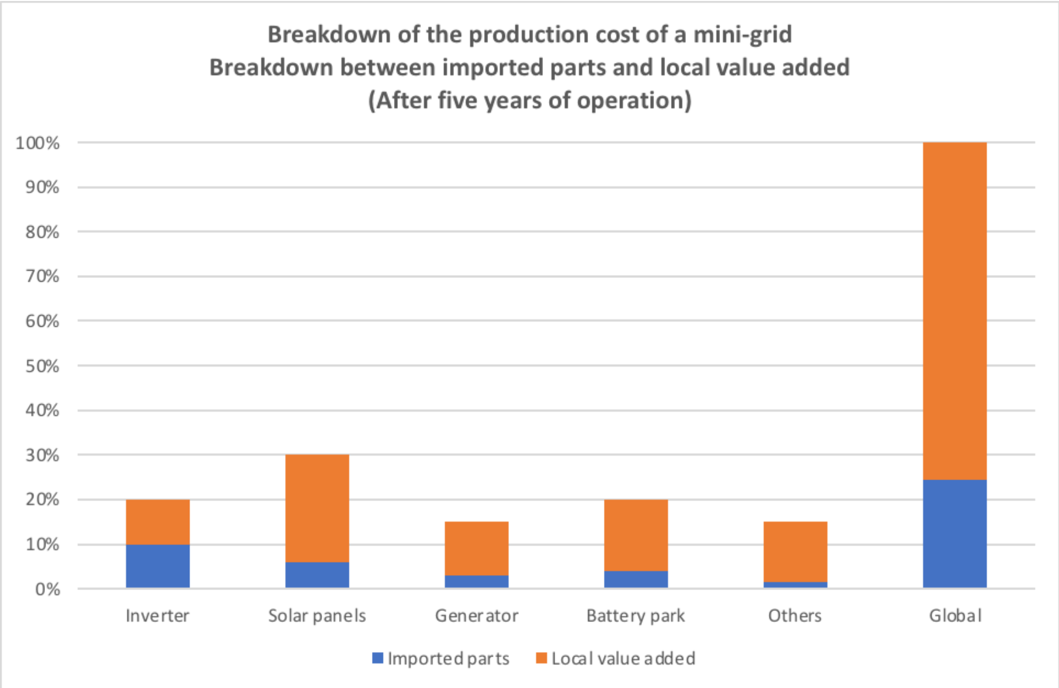
	Inverter	Solar panels	Generator	Battery park	Others	Global
Share of the equipment in the total cost of the mini-grid	20%	30%	15%	20%	15%	100%
Share of local value added in the cost of each equipment	0%	50%	60%	60%	70%	46,5%

Source : Estimation of the author



In the medium term (three to five years), the share of local value added in each equipment would increase in the proportions indicated below. In this hypothesis, the weighted share of local integration could reach 75%.

	Inverter	Solar panels	Generator	Battery park	Others	Global
Share of the equipment in the total cost of the mini-grid	20%	30%	15%	20%	15%	100%
Share of local value added in the cost of each equipment	50%	80%	80%	80%	90%	75,5%



6. Conclusion

The project of a "sub-Saharan" manufacturing sector of hybrid solar mini-grids is not a utopian idea. It would be a strong signal of voluntarism in terms of concerted industrial cooperation.

The operational implementation of the ZLeCAf would give it additional assets, within the framework of a "multi-country" sector.

It would enable the African states concerned to curb their spiraling debts and the deterioration of their trade balance.

It would give African companies the opportunity to acquire know-how in a strategic sector.

It would allow European companies, through an innovative co-production strategy, to remain competitive with Asian competition, particularly Chinese.

The success of this industrial project would serve as an example and could be applied to other "green" sectors such as wind farms or biogas plants, helping to break the current logic of "bottom-up" development of manufacturing sectors in sub-Saharan Africa.

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[i] A mini-grid is an electricity delivery system with a generating capacity of between 1 kW and 10 MW (IRENA) that can operate in isolation from the main utility power grid. It includes at least one power generation unit and a local distribution system and provides electricity to more than one consumer (source: "Guidelines Summary - USAid Scaling up Renewable Energy Program" - February 2021.

[ii] Source: "State of the Global Mini-grid Markets - Report 2020" - MGP/Bloomberg NEF/Sustainable Energy for All".

[iii] Households, industries.....

[iv] This figure corresponds to the share of third generation mini-grids in the scenario that would allow all populations to access electricity (source: ibid.)

[v] In Nigeria, the cumulative capacity of diesel generators, mainly used by households, is eight times the effective peak capacity of the entire national grid. Nigerians spend at least $12 billion annually on the purchase and operation of gasoline generators (source: ibid.).

[vi] This market is for businesses or institutions (hospitals....) that need a reliable supply of electricity to grow. It has two components: the replacement of existing generators and a "first equipment" component, for example for SMEs not equipped with generators.

[vii] This market includes a substitution component for fuelwood and diesel generators, as well as a "first equipment" component, for example for new agri-food facilities in a rural area or for domestic fireplaces using fuelwood.

[viii] Source: Energies Media - 20/12/2021.

[ix] Estimate obtained by cross-checking the work of the World Bank ("Mini-grids for half a billion people - ESMAP - June 2019) and Bloomberg SEF (ibid.).

[x] The reader may refer to the following document produced by the Europe-Africa 2030 Observatory: "Case Study n°7: Promoting the development of export-oriented manufacturing clusters in Sub-Saharan Africa: Proposal for a new financial incentive tool - Europe-Africa 2030 Observatory - (November 2018)".

[xi] Key factors in the development of the mini-grid market are not addressed in this case study. Although essential, they are outside the scope. The most frequently cited key factors in fostering the development of mini-grid demand are: Clear medium-term electricity pricing policies, ending diesel subsidies, clear definition of how mini-grid users will be economically protected if the grid comes in, obtaining permits, lack of local currency financing at affordable rates and with long maturities.

[xii] Source: GIZ, IED. The breakdown shown is for the case of Senegal. It does not include costs related to the MV or LV distribution network.

For eight years, **Christian Delavelle** was cost-control engineer and then project engineer in two Oil & Gas engineering companies. Then, manager at the consulting department of Taylor Nelson Sofres Group, he conducted numerous strategic studies in sectors as mechanical equipment, steel making, textiles, energy, electronics, automotive, aerospace and green technologies. He worked in a dozen African countries on missions for the World Bank, the UNIDO and the European Commission. In 2003, he created AJI-Europe, company specializing in strategic consulting for “clean transportation”. He created the Observatory in 2016.