SUSTAINABILITY, INCLUSIVENESS AND GOVERNANCE OF MINI-GRIDS IN AFRICA (SIGMA) RESEARCH PROJECT

CHALLENGES TO LOCAL MANUFACTURING IN SENEGAL'S OFF-GRID SOLAR SECTOR: EXPERIENCES OF A FORERUNNER ENTERPRISE

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ABSTRACT

In this paper I explore the complex institutional challenges faced by small and medium enterprises (SMEs) in Senegal for the local manufacturing and assembly of small-scale, off-grid solar systems.

With many years of professional experience in the solar PV industry on three continents, and as CEO of a Senegalese off-grid solar company called Nadji.Bi Sénégal, I share my understanding of the slow pace of solar industrialisation in my country. This, despite Senegal's significant solar potential, which could have a transformative impact on the country's agricultural and industrial development, as well as on the living conditions of much of the population.

First, I situate solar manufacturing in Senegal in a historical context, starting with the local research and development of solar water pumps in the mid-1950s at the University of Dakar and the development of the first industrial solar motor called 'Nadje' in the 1960s. I go on to discuss initiatives for the local assembly of solar water pumps and solar water heaters in the 1970s, which were supported by the Senegalese government and international partners. I then look at developments in the 2010s and the serious challenges to the local assembly of solar PV modules at that time, amid a global surplus of solar PV cells and panels and their main raw material, polysilicon.

I also examine the historical national and regional complexity of various supportive measures to develop a national solar industry in response to the global oil crises of the 1970s, notably, the inclusion of solar energy in the Senegalese public procurement regulation in 1978; the first tax advantages introduced in Senegalese law in 1981; and the declaration of eight West African heads of state in 1984 to follow a common strategy to develop renewable energy manufacturing capacity in West Africa. I then go on to explore the failed implementation of this strategy and the subsequent counterproductive introduction of several customs and VAT exemptions at the national and regional levels between 1992 to 2022. As I discuss, such exemptions undermined the chances of success of local manufacturing and assembly in the solar sector.

With this context established, the second half of the paper describes the specific experience of my company, Nadji. Bi Sénégal, starting with the challenges we faced in accessing global quality verification for our solar home systems. I then go on to explore our successes in developing local technical and financial innovations in solar milling and solar water pumps and providing vocational training and local solar entrepreneurship. This, despite the various obstacles that we have faced in implementing our activities, including: a persistent lack of supportive national policies for local supply chain development in the off- grid solar sector; the lack of institutional resources within various government departments and a lack of awareness of the technologies; poorly designed tax and customs regimes; the absence of appropriately targeted public subsidies; and the failure of development

finance institutions to recognise the value of supporting SMEs operating in this challenging space.

In conclusion I argue that local off-grid manufacturing and assembly is more critical than ever for the sustainable development of Senegal and that of other countries in the region, but that this can only achieved through strategic and long-term commitment from national and international stakeholders.

CONTENTS

List of acronyms

ACF TAF	Africa Clean Energy Technical Assistance Facility
AfDB	African Development Bank
ANER	Agence Nationale d'Energie Renouvelables (ministry for renewable energy)
ASER	Agence Nationale d'Electrification Rurale (Senegalese Rural Electrification Agency)
CEDEAO	Communauté Economique des États de l'Afrique de l'Ouest (see ECOWAS)
CERER	Centre d'Études et de Recherches sur les Énergies Renouvelables
CET	Common External Tariff
DFI	Development finance institution
ECOWAS	Economic Community of West African States
ECREEE	ECOWAS Centre for Renewable Energy and Energy Efficiency
FCFA	West African Franc
GOGLA	Global Off-Grid Lighting Association
IoT	Internet of Things
IPM	Institute of Meteorological Physics
MW	Mega Watt
MWp	Mega Watt Peak
OPEC	Organisation of Petroleum Exporting Countries
PAYGo	Pay-As-You-Go
PUDC	Plan d'Urgence de Développement Communautaire (Emergency Community Development Plan)
SHS	Solar home system
UCAD	Université Cheikh Anta Diop de Dakar
R&D	Research and Development
SME	Small and medium enterprise
SOFRETES	Societé Française d'Etudes Thermique et d'Energie Solaire
UCAD	Université Cheikh Anta Diop
UEMOA	l'Union Économique et Monétaire Ouest Africaine (see WAEMU)
UNIDO	United Nations Industrial Development Organisation
VAT	Value added tax
WAEC	West African Economic Community
WAEMU	West African Economic and Monetary Union

1. INTRODUCTION

In this paper I explore the complex institutional challenges to local manufacturing and assembly in off-grid, small-scale solar systems faced by small and medium enterprises (SMEs) in Senegal. In writing it, I draw from my long-term professional experience of working in the solar PV industry on three continents and as the CEO of a Senegalese solar company called Nadji.Bi Sénégal since 2014. I also draw from an extensive grey and academic literature relating to solar and renewable energy policy in Senegal and elsewhere. Nadji.Bi undertakes local manufacturing and the deployment of innovative off-grid solar solutions throughout the country, including solar milling machines and solar water pumps, as well as the training of local technicians in off-grid solar technologies. In 2016, Nadji.Bi developed a solar home system (SHS) which was awarded verification from the World Bank's Lighting Global Programme.

As I discuss in this paper, the key challenges to the local manufacturing and assembly of off-grid solar in Senegal, including those faced by Nadji.Bi, relate to the lack of a supportive national policy for the development of a local supply chain; the lack of institutional resources and a misunderstanding of the technologies within various government departments; poorly designed tax and customs arrangements, which have severely discouraged local assembly and manufacturing, and served a far greater benefit to international suppliers; the lack of a targeted public subsidy and private sector interest for small-scale players in the industry; as well as the failure of development finance institutions (DFIs) and donors to recognise the value of supporting SMEs working in this challenging space. This, in addition to increasing competition coming from well-financed global players.

My motivation for working in the Senegalese solar industry, and for writing this study originates from my firsthand experience acquired in the early 2000s of living without modern energy services in the village of Ndiaganiao in the region of Thiès. As in many rural African communities then and now, the lack of access to electricity is intrinsically linked to other forms of poverty and vulnerability. It was this experience that ultimately led me, a decade later, to establish the Nadji.Bi Sénégal Foundation of which I am now CEO.

While I was living in Ndiaganiao, significant international developments were afoot which have shaped the global and national solar sector in profound ways. First, Germany introduced the first effective feed-in tariff for solar-generated electricity under its 2000 'Renewable Energy Act' (EEG) and subsequent amendment in 2004. Such regulation and the developments that followed contributed significantly to the expansion of the solar industry worldwide[1]. Then, in the wake of the launch of Germany's EEG, China positioned itself as a future leader of the global solar industry, acceding to the World Trade Organisation (WTO) in 2001 and implementing the "Renewable Energy Law of the People's Republic of China" on

[1] https://www.futurepolicy.org/climate-stability/renewable-energies/the-german-feed-in-tariff/

28 February 2005[2]. The introduction of this law coincided with the scale up of the production of crystalline silicon cells and modules by major solar PV manufacturers to meet increased global demand. This resulted in major initial public offerings (IPOs) for various China-based panel manufacturers, notably Suntech Power Holdings; Yingli Green Energy; Solarfun Power Holdings; Canadian Solar; and Trina Solar, all of which were listed on the NASDAQ or New York Stock Exchange (NYSE) and received U.S.-backed financing.

I charted my own professional path through the evolution of the global solar sector. After my studies, I worked in polysilicon trading in China where I witnessed the impacts of the 2008 global financial crisis on the polysilicon market resulting in a dramatic price crash. I subsequently worked for a US logistics company in Shanghai, serving the solar PV industry among others and saw how the solar PV market was boosted by the introduction of feed-in tariffs and later renewable energy auctions in France, Canada, the Netherlands, several US states and latterly, Brazil, South Africa and Mexico at the end of 2009.

In December 2009 I started working for JinkoSolar Holding Co., Ltd., a silicon ingot and wafer manufacturer, which had just acquired a solar cell and module manufacturer called Zhejiang Sun Valley Energy Application Technology Co., Ltd. Having launched one of the first fully automated PV module production lines in China (using NPC technology from Japan), Jinko was preparing its expansion plan in Europe as well as its IPO on the New York Stock Exchange.

I then went on to work in collaboration with electronics specialists, contributing to the design of solar lanterns and SHSs at the same time as exploring rural and urban markets in Senegal. To that end, I officially registered the first Nadji.Bi company in 2013 and then returned to the country to begin the implementation of our first assembly line of SHSs.

Senegal has one of the largest solar potentials in the world, which could have a transformative impact on the country's agricultural and industrial development as well as the living conditions of much of its population. For instance, currently only 30 per cent of Senegal's irrigable land is in use, and the potential for future agricultural development assisted by solar technology (as well as by green hydrogen and green ammonia) is huge. Yet the country's solar resources have yet to be fully exploited, reflected in the low rural electrification rate of around 43.4 per cent in 2022[3], the almost non-existent residential solar market, and the weak development of the commercial and industrial solar sector.

While the size of Senegal's solar market remains small compared to many developed countries, it is nevertheless one of the most advanced in the region especially for ground-mounted grid-connected PV power plants. And while many laws and regulations have been implemented in the country to boost solar demand and investment at the utility-scale, far fewer have been implemented to assist with local content and local manufacturing which remains a key challenge for the development of the industry.

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[2] https://policy.asiapacificenergy.org/node/43
[3] https://data.worldbank.org/

Yet there are many advantages to the local assembly and manufacturing of small-scale, off-grid solar systems including: cost competitiveness; improved cash flow; the development of local capacity in research and development (R&D) and innovation; quality control; the ready availability of spare parts; and effective warranty and after-sales service. This, in addition to the development of partnerships with local training and innovation centres, including universities and engineering schools, as well as easier brand awareness. Another strong argument is that the off-grid industry is labour intensive at the level of assembly and quality verification and there is plenty of available human capital in Senegal's growing and youthful population.

However, as this paper explores there are many significant challenges to the local assembly and manufacture of small scale off-grid solar systems, particularly for an SME such as Nadji.Bi. In exploring these challenges, the paper identifies a key tension that exists in the off-grid solar sector in various countries: between the priorities of local economic development, including employment, geographically appropriate technologies and the creation of local innovative capabilities on the one hand; and the standard orthodoxy of importing technological components at the least cost on the other.

The structure of this paper is the following. Section 2 puts Senegalese solar manufacturing in a historical context, charting its evolution from the mid-1950s until 2013, including various supportive measures to develop a solar industry in response to the global oil crises, and the subsequent undermining of these measures by trade and customs arrangements and a lack of government support. This section also considers global challenges to local solar manufacturing in the country and how despite the promotion of off-grid solar for electrification and productive use in agriculture, this has rarely encouraged national efforts at innovation; Section 3 puts these developments in context by consider the specific case of Nadji.Bi; and Section 4 concludes, finding that local off-grid manufacturing and assembly is more critical than ever to Senegal's sustainable development.

2. SENEGALESE SOLAR MANUFACTURING IN A HISTORICAL CONTEXT

Measures to promote solar energy in Senegal began in 1955, five years before independence, when Dakar University (now UCAD) established an institute of meteorological physics (IPM) in its Science Faculty. IPM was later named the Henri Masson Institute, in honour of the first dean of the University's Science Faculty who was a pioneer in solar energy research and particularly solar water pumps and published the ground-breaking article titled 'Solar motors in arid regions' in 1957. In 1985, the Institute was said to

have become "…one of the country's leading research bodies, and its reputation spread beyond Senegal's frontiers."[4]

In 1966, the first industrial solar motor model called 'Nadje' was developed, followed by that of a more efficient motor called 'Segal' with the support of the French company SOFRETES (Societé Française d'Etudes Thermique et d'Energie Solaire). SOFRETES was founded in 1973 by French engineer and research physicist Jean-Pierre Girardier who had himself undertaken ten years of research and development on solar water pumps in Senegal under the supervision of Henri Masson.

In March 1976, the IUT - Institut Universitaire de Technologie de Dakar (now ESP - École Supérieure Polytechnique) manufactured and tested a solar water heater. This was followed by the commissioning of five solar water pumps by UNIDO (United Nations Industrial Development Organisation) and support from the then French development agency Fonds d'Aide et de Coopération.

In 1978, between both major global oil crises, Senegal included solar energy in its regulation for the public procurement of energy for the first time, prior to which, solar had not been considered a potential energy source in public tenders[5]. In 1980, the Henri Masson Institute, became a fully-fledged university institute and renamed the Renewable Energy Study and Research Centre (Centre d'Études et de Recherches sur les Énergies Renouvelables (CERER)), which still exists today.[6] That same year the Senegalese government launched the Energy Redeployment programme (Programme de Redéploiement Energétique du Sénégal), which aimed to halve the country's import of petroleum products by 1990, and support the development of technical expertise and the promotion of a new industrial manufacturing ecosystem[7].

In 1981, the first tax advantages for the use of solar energy were introduced in Senegalese law.[8] This was followed in 1984 by the Declaration of the Heads of State of the West African Economic Community (WAEC) on the Regional Solar Energy Centre, signed by Thomas Sankara of Burkina Faso, Félix Houphouët-Boigny of Côte d'Ivoire, Moussa Traoré of Mali, and Abdou Diouf of Sénégal, among eight others[9]. This declaration, which sought to follow a common strategy to develop renewable energy manufacturing capacity in West Africa, stated: "we recommend that the national administrations of member states strengthen or

[4] Renewable Energy Research Drive Reported, The Kenya Times, Amadou Dieng, 1985
[5] Circulaire primatoriale n°10226/PM/SGG/EC5 du 21 décembre 1978
[6] Décret n° 80-402, Sénégal, 1980
[7] Communication initiale du Sénégal à la Convention-Cadre des Nations-Unies sur le Changement Climatiques (CCNUCC), Ministère Sénégalais de la Protection de la Nature, 1997
[8] Law 81-22, Sénégal, 1981
[9] http://www.ecowrex.org/pt-pt/system/files/repository/adf-bd-if-99-178-en-mali-regional-solar-energy-centre-of-the-west-african-economic-community.pdf

create… the industrial capacities required for the partial or total production of equipment using renewable energies…".[10]

Some years later in 1992, Senegal introduced the first customs and VAT tax exemptions for the import of solar components[11], followed in 1999, by the establishment of a quality control laboratory for solar PV components within CERER[12]. However, these progressive gains to promote the manufacturing/ assembly of solar energy were somewhat undermined in 2000 by the full implementation of the Common External Tariff (CET) of the West African Economic and Monetary Union (WAEMU) (see Box 1). This new regional customs tariff framework reintroduced VAT on all imported solar components except for solar PV modules, on which VAT was kept at zero per cent. Such a move essentially undermined any potential local manufacturing initiatives for solar PV modules and established an advantage for imported products.

Box 1: West African regional economic governance in context
The influence of regional institutions over national economic and monetary policy (including tax, trade, customs and currency) in Senegal and neighbouring countries in West Africa is significant and has inevitable consequences for many sectors, to which solar is no exception. As briefly described below, there are various overlapping institutions of relevance, with a complex historical, political and economic context and of which the mandates of which have shifted somewhat over the decades. The Economic Community of West African States (ECOWAS; in French CEDEAO) was established in 1975 and is headquartered in Abuja, Nigeria. ECOWAS had 15 member countries until early 2024 when Burkina Faso, Mali and Niger expressed their will to leave the organisation, creating the Alliance of Sahelian States. The remaining members are Benin, Cape Verde, Côte d'Ivoire, the Gambia, Ghana, Guinea, Guinea-Bissau, Liberia, Nigeria, Senegal, Sierra Leone, Togo. In the run up to the formalisation of ECOWAS, the West African Economic Community (WAEC; in French CEAO) was established with French support in 1970 partly in response to the economic dominance of anglophone countries within ECOWAS, particularly Nigeria. WAEC is of particular relevance to the solar industry because it called for the establishment of a regional solar centre in the wake of the global oil crises of 1973 and 1979. The West African Economic and Monetary Union (WAEMU; in French UEMOA) was established in 1994 by the seven former French colonies of ECOWAS and subsequently joined in 1997 by Guinea-Bissau, a former Portuguese colony. Created in the interests of regional integration, WAEMU members share a customs union and a currency union, all

[10] The Declaration of the Heads of State of the West African Economic Community (CEAO) on the Regional Solar Energy Center (RSEC), Bamako, Mali, 1984
[11] Note de décision n° 0706/DGD/DERD/BE des Douanes, Sénégal, 1992
[12] Arrêté n°29/MEMI du Ministre de l'Énergie, des Mines et de l'Industrie, Sénégal, 1999

using the West African CFA franc, which is pegged to the euro at a fixed exchange rate that is guaranteed by the French Treasury. WAEMU created a free trade area in 1996 and introduced a common external tariff (CET) in 2000 to reduce tariff rates. This CET was replaced by the ECOWAS CET in 2015.

In 2015 the WAEMU CET was replaced by the ECOWAS CET (see Box 1), a move that expanded the shared customs union to all ECOWAS countries, eliminating tariffs on imported goods from within ECOWAS, but increasing tariffs on imports from the rest of the world. However, the arrangements for imported solar components remained the same as under the WAEMU CET. This meant that the zero per cent customs tariff on solar PV cells imported from outside of ECOWAS was upheld, regardless of whether these cells had been assembled into modules. By comparison, and as discussed below, a lot has changed for other solar components since the introduction of this tariff structure, which have had their customs tariff increased by 20 per cent compared to the pre-1992 Senegalese customs tariffs.[13]

Indeed, many goods and sectors were prioritised in the WAEMU CET and the subsequent ECOWAS CET to benefit from preferential customs tariffs when assembled locally, but this did not extend to solar energy. To that end several harmonised system (HS) codes were created to distinguish between "goods in a completely disassembled or unassembled state imported for the assembly industry" and goods in 'other' states which are already fully assembled, and therefore enable importers to benefit from preferential customs tariffs[14]. In every subsequent version of the CET, including the most recent in 2022, additional HS codes have been created to promote local assembly in various sectors, including radio and televisions; motorcycles; bags and luggage, shoes; fridges and freezers; and cars, trucks and busses[15]. But not in solar energy.

While various national regulations have been introduced to promote the use of renewable energy, these have not included measures to support local assembly and manufacturing. Notably, in 2004, a new system of income tax reductions for "investment made in the use of solar or wind energy" in the new Senegalese General Tax Code (Code Général des Impôts)[16] was introduced. This was followed by other significant initiatives in the energy sector, notably the 2008 Energy Development Policy Letter, which included a target for 15 per cent of renewable energy generation by 2020[17]; the creation in 2010 of a ministry in charge of renewable energy, and in the same year, an accompanying renewable energy policy law[18].

[13] Du soleil pour tous : L'énergie solaire au Sénégal : un droit, des droits, une histoire, Frédéric Caille, Babacar Sarr, 2018
[14] TEC UEMOA 2002, UEMOA, 2002
[15] See footnote 16
[16] Loi n°2004-12, modifiant le Code Général des Impôts, Sénégal, 2004
[17] Lettre de Politique de Développement du Secteur de l'Énergie (LPDSE) 2008-2012, Sénégal, 2008
[18] Loi n°2010-21, portant loi d'orientation sur les énergies renouvelables, Sénégal, 2010

In 2011, a feed-in-tariff for the purchase of renewable energy generation was introduced[19] and in 2013, the creation of the National Renewable Energy Agency (ANER)[20].

In 2013, the Additional Act A/SA.3/7/13 on ECOWAS renewable energy policy was signed during the forty-third ordinary session of the conference of heads of state and government of ECOWAS. Among other decisions, targets were fixed for the regional manufacture of renewable energy equipment by sector, with a target of seven per cent of renewable energy equipment installed in 2020 to be manufactured regionally, rising to 20 per cent by 2030.[21]

However, such a potentially progressive step was not followed by action at the national level and was further undermined in 2020 by an interministerial decree that established a list of components for the generation of renewable electricity to be exempt from VAT. This decree was followed by a guide to the import of off-grid solar products and systems to be exempt from VAT in Senegal. While the order included a VAT exemption process for local *manufacturers* it made no mention of VAT exemptions for *components* being used in the manufacturing process[22]. It also had a heavier tax declaration process for the local manufacturer as compared to the importer[23]. As discussed below this development had a significantly detrimental impact on our manufacturing and assembly activities.

Based on my understanding, since WAEC's declaration of 1984 and ECOWAS' declaration of 2013, there has been no national strategy to develop national industrial capabilities for the production of renewable energy technologies, or to reach the seven per cent indicator of equipment installed by 2020. That said, some encouraging measures have very recently been proposed in the new national development plan 'Senegal 2050: National Transformation Agenda'[24] issued by the new Senegalese government in October 2024. This plan aims *inter alia* to: reach 100% electrification rate in 2034, develop a local renewable energy production industry (solar, biogas, biomass, etc.) will help to achieve environmental sovereignty, set-up manufacturing and assembly industry. It is therefore something that we will be watching closely.

2.1 Solar water heaters: the case of SINAES-DAGUERRE

The rise and eventual demise of the Franco-Senegalese company, SINAES-DAGUERRE is significant because most of the regulations introduced in Senegal from the 1970s and the 1980s in support of renewable energies were put in place because of the political will at the time to promote the activities of this company[25]. However, as this section explores, despite

[19] Décret n°2011-2013, Sénégal, 2011
[20] Décret n°2013-684, Sénégal, 2013
[21] Additional Act A/SA.3/7/13 on ECOWAS, ECOWAS, 2013
[22] Arrêté interministériel n°010158, Sénégal, 2020
[23] Arrêté interministériel n°010158, Sénégal, 2020
[24] Sénégal 2025 : Agenda National de Transformation, 2024
[25] Etude sur les aspects techniques, économiques et financiers du cadre réglementaire pour la production d'électricité à partir des énergies renouvelables, MVV Decon, Jean-Pierre Abrassart, 2010

the company's initial successes, it was eventually undermined by various internal and external factors.

In 1972, the Prime Minister of Senegal recommended that all government buildings and certain types of houses built by the two main state-owned real estate development companies, SICAP and OHLM, should be equipped with solar water heaters when needed.[26] In 1976, with support from a French government programme called "Sahel énergie nouvelle"[27], SOFRETES and the government of Senegal founded the company SINAES-DAGUERRE (Société Industrielle des Applications Solaires). The company's shareholders were made up of: a Renault-SOFRETES consortium with 35 per cent; the government of Senegal with 30 per cent; the French pump manufacturer Briau SA with 11 per cent; various shareholders with nine per cent; and the French government's Caisse de Cooperation Économique (which became AFD in 1998) and a French SOFEE consortium including Elf-Aquitaine with 7.5 per cent each.[28]

The objective of SINAES-DAGUERRE, based in Thies, was to manufacture and assemble solar water heaters and solar water pumps by importing components from French companies: from SOFEE for the solar water heaters and from SOFRETES and Briau SA for the pumps. The company was also to be responsible for the development of and upkeep and maintenance of new and existing solar industrial installations[29],[30]. SINAES-DAGUERRE benefitted from customs and VAT exemptions, as well as from financing of 500,000 units of account (a basket of European currencies used prior to the European Currency Unit, which eventually became the Euro in 1999) from the European Investment Bank in 1979.[31] By 1984, the company had created a pilot project for solar water heaters for 125 houses, estimating that it could install up to 1,000 per year, with a customer payback period of three years.[32]
Less than two years after the inception of SINAES-DAGUERRE, in 1977 UNIDO carried out a study called 'Research programme on solar energy applications in Senegal, Mali and Niger'. The study's objectives were to provide "assistance in preparing national programmes with an emphasis on the local manufacture of solar equipment". It recommended that Senegal "develop local manufacturing of solar water heaters"[33]. However, the study also argued that the establishment of factories manufacturing exclusively solar equipment was not justified

[26] Circulaire n°10.226 PM/SGG/ECT, Sénégal, 1972
[27] Le départ raté de l'énergie solaire en Afrique de l'Ouest, 1960-1987, Journal of Energy History #7, Jean Gecit, 2022
[28] Programme de recherches relatif aux applications de l'énergie solaire au Sénégal, au Mali et au Niger, Assad Takla et Carlo Mustacchi, ONUDI, 1977
[29] Senegal: Issues and Options in the Energy Sector., UNDP/World Bank, 1983
[30] Renewable Energy Activities in Senegal, ENSUT Dakar, Pierre Viaud, 1985
[31] Stratégies de contrôle des filières technologiques solaires et rapports Nord-Sud, Cahiers du CREAD, Smaïl Khennas, 1984
[32] Activity completion report n°025/84, Energy Sector Management Assistance Programme, UNDP/World Bank, 1984
[33] Programme de recherches relatif aux applications de l'énergie solaire au Sénégal, au Mali et au Niger, Assad Takla et Carlo Mustacchi, ONUDI, 1977 pp16-18 [available at : https://downloads.unido.org/ot/46/90/4690223/00001-10000_08175F.pdf]

because of the limited market. It therefore recommended a form of Pay-As-You-Go mechanism to tackle the end-user financing challenge, and that "the governments of the three countries set up credit-sales systems for these products. Payments should not be proportional to the buyer's income, but rather to the monthly energy costs avoided by purchasing the solar equipment." [34]

Despite its initial milestones, the progress of SINAES-DAGUERRE soon started to flounder. Various reasons have been attributed to its ultimate decline, the main one being that the company's supporting company, SOFRETES, never reached profitability. Indeed, in March 1978 SOFRETES' main development partner, Renault, which had acquired a stake in the company in June 1975 withdrew, to be replaced by the French CEA - Atomic Energy Commission. SOFRETES then suffered from low levels of investment and facing difficulties in financial recovery following a 'white elephant' project in Diré, Mali, was absorbed by the CEA in 1983 and disbanded[35]. A subsequent partnership developed between SINAES-DAGUERRE and GIORDANO, the leading French manufacturer of solar water heaters, which as of 1980 had 80 per cent of its capital controlled by the SINAES indirect-shareholder CFP Compagnie Française des Pétroles, now TotalEnergie[36].

Additional causes attributed to the failure of SINAES included high costs, the lack of suitable financing mechanisms which slowed the development of the company [37,] and low demand stimulation. As Abrassart stated, "the regulation was only interested in encouraging the private sector to use solar or wind power", with the previously-mentioned tax exemption (Law 81-22, Sénégal, 1981)[38], and that "it should have focussed more on users who were going to invest in the acquisition of renewable energy equipment… In that case, they may only be interested in an equipment subsidy (cost reduction), but not in a tax reduction" [39]. The lack of a strategy for after-sales to support the solar water heater diffusion policy[40] was also given as a reason for the company's failure, with one study stating that "most of these installations have either not been maintained or have been abandoned due to a lack of maintenance"[41].

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[34] Programme de recherches relatif aux applications de l'énergie solaire au Sénégal, au Mali et au Niger, Rapport Final, Assad Takla et Carlo Mustacchi, ONUDI, 1978
[35] Le départ raté de l'énergie solaire en Afrique de l'Ouest, 1960-1987, Journal of Energy History #7, Jean Gecit, 2022
[36] Stratégies de contrôle des filières technologiques solaires et rapports Nord-Sud, Cahiers du CREAD, Smaïl Khennas, 1984
[37] Plan d'Actions National des Energies Renouvelables (PANER), Ministère de l'Energie et du Développement des Energies Renouvelables du Sénégal, 2015
[38] Law 81-22, Sénégal, 1981, see footnote 8
[39] Etude sur les aspects techniques, économiques et financiers du cadre réglementaire pour la production d'électricité à partir des énergies renouvelables, MVV Decon, Jean-Pierre Abrassart, 2010
[40] See footnote 37
[41] Rapport de l'étude de marché du solaire thermique : production d'eau chaude et séchage des produits agricoles au Sénégal, Dr Ababacar THIAM, SOLTrain – CEDEAO, 2015

Moreover, it has been argued that as a quasi-public corporation, SINAES never became a profitable private company[42], never moved beyond the pilot phase and never transformed its "agreement with the state-owned real estate development companies (SICAP and OHLM)"[43]. Finally, the over-indebtedness of the 1980s and the subsequent structural adjustment programmes of the World Bank and the International Monetary Fund undermined national solar projects such as SINAES-DAGUERRE, despite the government support it received. This, in addition to a series of business mistakes, the OPEC policy changes to increase oil supplies in 1985 and the subsequent oil price collapse[44]. The company eventual closed in 1991.

2.2 Solar PV Modules: the case of SPEC SOLAR

After a failed initiative by Sénélec to launch a new PV module assembly factory called IPSOL in the late 1990s[45], a new company was launched in 2009 called the Sustainable Electric Power Company (SPEC). SPEC was registered in Dakar, with an official investment of FCFA 3 billion (around EUR 4,5 million)[46], and debt financing from the Bank of Africa and Banque Internationale pour le Commerce et l'Industrie du Sénégal (BICIS) covered by a loan guarantee from Agence Française de Développement (AFD)[47]. In 2011 SPEC's solar PV module assembly line was inaugurated and successfully launched [48], with a nameplate production capacity of 16MWp expandable to 25MWp. According to an interview of the managing director published in 2013, thanks to their IEC certification delivered by TÜV Rheinland, SPEC aimed to produce further PV module types of between 50Wp and 300Wp, and to serve various market segments such as rural electrification, commercial and industrial projects and solar ground-mounted generation plants.[49]

However, various factors ultimately undermined the success of this initiative in a way that those unfamiliar with rapidly evolving dynamics the global solar PV market could not have anticipated. While price stability in the average sales price of solar PV modules between

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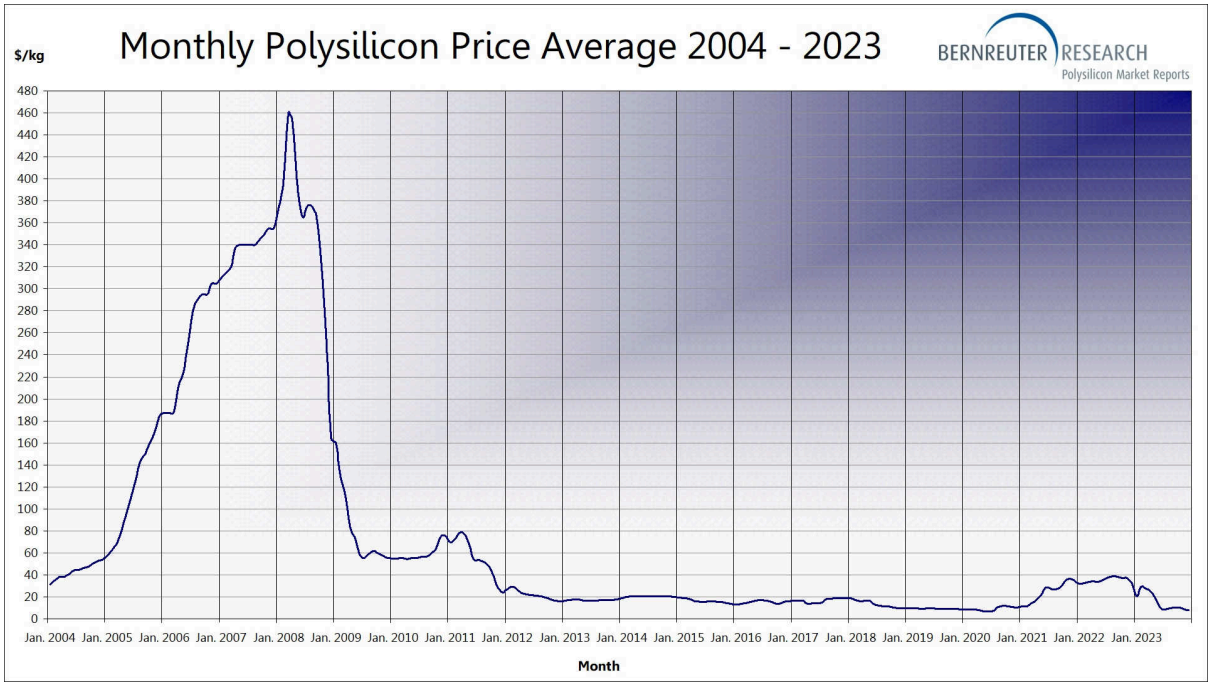
[42] Quels instruments politiques et financiers pour le développement des PME en énergie durable ?, Bocar Sada Sy, Atelier PNUD, 2008
[43] Évaluation des besoins en technologies (EBT) et plans d'action technologiques (PAT) aux fins d'atténuation aux effets du changement climatique, Ministère de l'Environnement et du Développement Durable du Sénégal, 2012
[44] The Great Plunge in Oil Prices: Causes, Consequences, and Policy Responses, Baffes, Kose, Ohnsorge, Stocker, World Bank, 2015
[45] Quels instruments politiques et financiers pour le développement des PME en énergie durable ?, Bocar Sada Sy, Atelier PNUD, 2008
[46] Sénégal : Inauguration d'une usine de panneaux solaires, Infrastructure Consortium for Africa (ICA), 2011
[47] SPEC SOLAR : Ndiégne Fall et Malamine Tandian Ndiaye Gérant de SPEC SOLAR paient 700 millions aux banques, leral.net, 2014
[48] Sénégal : Inauguration d'une usine de panneaux solaires, Infrastructure Consortium for Africa (ICA), 2011
[49] Liaison énergies francophone n°93 : La transition énergétique ou les énergies que nous aurons, IFDD, 2013

2005 and 2008 suggested a viable opportunity for PV module manufacturing in Senegal, such a picture was misleading. This price stability was in part due to growing global demand encouraged by the introduction of feed-in tariffs in Spain and Germany[50] as well as shortages in polysilicon, the main raw material and most expensive component in PV cells and panels. These shortages provoked an increase in polysilicon spot prices (see Figure 1), an increase in the cost of solar PV modules, and in turn contributed to perceptions of a profitable opportunity for potential manufacturers in Senegal.

Events in 2008 then marked a turning point for the global PV industry. First the crash of Lehman Brothers and the global financial crisis reduced solar demand and led to the scrapping of feed-in tariffs for PV systems in Spain. In response, annual global market demand shrunk by 75 per cent, resulting in market oversupply, despite an increase of global PV installations of 25 per cent in 2009.[51] Second, and coupled with the subsequent glut in polysilicon, the average selling price of PV modules fell dramatically after 2008 (see Figure 2). Swanson's law[52], which contends that the price of PV modules drops by 20 per cent for every doubling of cumulative shipped volume, held true throughout the 2008-2012 period. Prices continue to fall to this day (see Figures 1 and 2).

Figure 1: Monthly polysilicon price average 2004-2023[53]



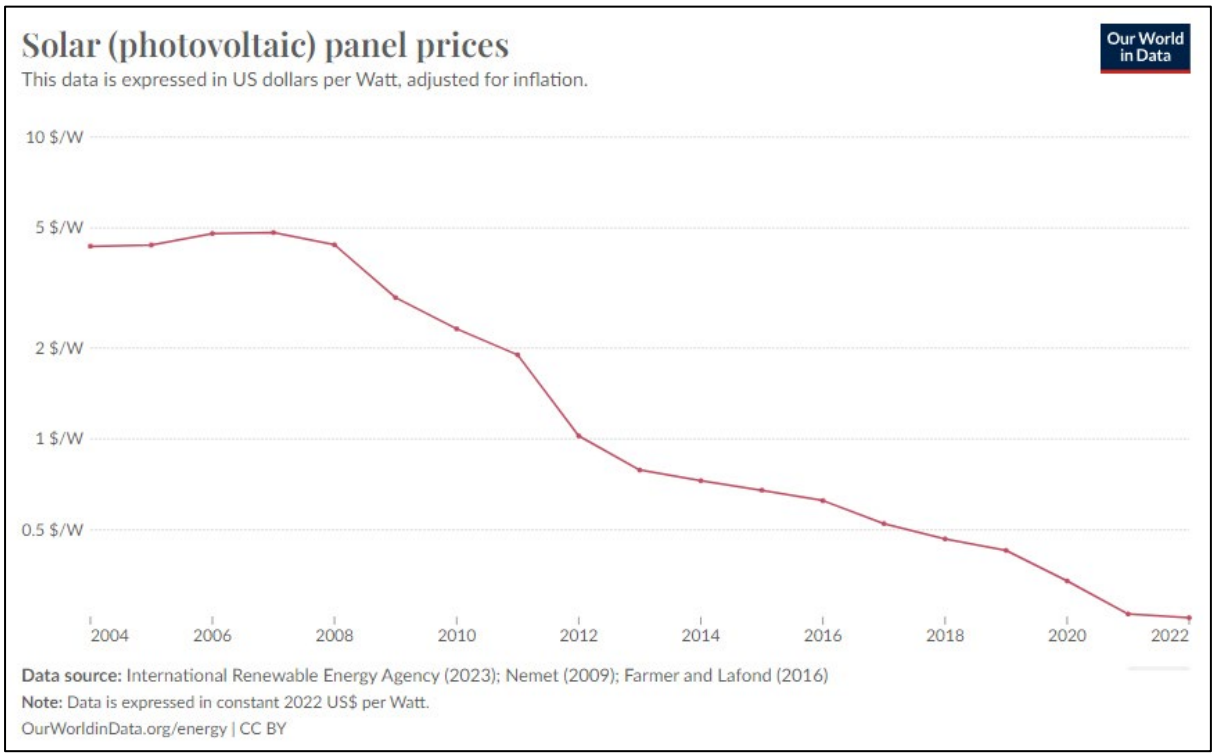
[50] Hajdukovic, I. (2022), "The impact of international trade on the price of solar photovoltaic modules: empirical evidence", EconomiA, Vol. 23 No. 1, pp. 88-104. https://doi.org/10.1108/ECON-05-2022-0007

[51] https://www.bernreuter.com/polysilicon/price-trend/

[52] https://www.economist.com/news/2012/11/21/sunny-uplands

[53] Data sources: UBS/BNEF/PVinsights (2004 - 2010), EnergyTrend (2011 - 2023); Chart: Bernreuter Research, https://www.bernreuter.com/polysilicon/price-trend/#chart-monthly-polysilicon-spot-price-average-from-2004-through-2023

Figure 2: solar PV panel prices[54]



Local Senegalese entrepreneurs and their advisors unfamiliar with the global PV module manufacturing market may also have been unaware of the strong growth of the Chinese industry and nameplate capacity which continued in the 2010s driven by the 12th Five-Year Plan for the Solar Photovoltaic Industry of 2011[55].

As the managing director of SPEC stated in an interview in 2013, “On the commercial front, 2011 was marked by an unexpected development on the world market, with the end of subsidies in most European countries, due to the acute financial crisis that these countries experienced in 2010. This led to the collapse of the European market, the world's leading market, and the bankruptcy of some of the biggest names in the European solar industry. This situation led to a collapse in prices, both for raw materials and finished products. Many manufacturers in Europe and Asia found themselves with large stocks of unsold products, which led to an unstoppable fall in prices, aided by the emergence of Asian behemoths who, in the space of a few years, have considerably increased their production capacities to several gigawatts per year. Against this backdrop, SPEC's arrival on the market, with the start of production in July 2011, came at a time when the market was going through a real tumultuous period. SPEC's strategy was not to focus on panel sales alone, but to develop

[54] Source: OurWorldInData: https://ourworldindata.org/grapher/solar-pv-prices?time=2004..latest

[55] 太阳能光伏产业“十二五”发展规划 (12th Five-Year Plan for the Solar Photovoltaic Industry), The government of the People’s Republic of China, 2011

projects. Even so, this situation has considerably slowed the company's development and, consequently, the achievement of its short-term objectives."[56]

Second, unlike the experience of SINAES-DAGUERRE, where the government put some initial regulations in place to support the company, SPEC lacked this kind of support and coordination. As discussed above, no incentives had been put in place within the customs tariff framework of the WAEMU CET to promote local assembly of PV modules. As a result, modules and the solar PV cells destined to be assembled into PV modules that were imported from outside the area were subject to a zero per cent customs tariff rate.

In addition, at the time, all the other imported components needed to assemble a PV module (such as aluminium frames, tempered glass, backsheets, EVAs, junction boxes, connectors, cables), were facing heavy customs tariffs. As the managing director of SPEC lamented in a 2013 interview: "From an institutional point of view, there are currently no other photovoltaic panel production units in West Africa, and as a result, SPEC's products have to compete with those from abroad, which are tax-exempt in the WAEMU region. At the same time, imported inputs for module manufacture are heavily taxed. If this situation is not resolved quickly, it could wipe out any ambition to develop the photovoltaic industry locally. In our opinion, it's no longer smart to continue with tax-free imported modules when, with SPEC, the bulk of photovoltaic panel needs can be met locally"[57].

While the Senegalese government could have introduced regulations to overcome this situation, or to ensure the preferred position of locally assembled solar PV modules within the national tenders, no such strategy was put in place. This, in comparison to South Africa's 2011 Renewable Energy Independent Power Producers Procurement Programme which included local content requirements for solar modules, inverters and metal structures[58].

Ultimately, SPEC failed to reach its targets for several years after launch and the company ended in financial turmoil with legal complaints against it[59].

2.3. Global challenges to local manufacturing in Senegal's off-grid industry

Local content is a common topic in daily discussions in Senegal and notable examples exist of how the successful protection of domestic industries has been enabled by appropriate regulation. For instance, the banning of imports of uncooked poultry meat and the

[56] Liaison énergies francophone n°93 : La transition énergétique ou les énergies que nous aurons, IFDD, 2013
[57] See footnote 58
[58] Local Content Requirements and the Manufacture of Solar Photovoltaic Components in South Africa, Mandlesizwe Kuswayo, 2018
[59] SPEC SOLAR : Ndiégne Fall et Malamine Tandian Ndiaye Gérant de SPEC SOLAR paient 700 millions aux banques, leral.net, 2014

development of a local poultry supply chain[60], and measures to successfully encourage the local production of onions and potatoes since 2003[61],[62],[63].

In another example, following the recent discovery of oil and gas reserves in Senegal, the government instituted a law in 2019[64] which aimed to: increase local content and job creation through the use of local expertise, goods and services; develop and encourage national skills and capacity through education, training, technological transfer and research and development; promote the national and international competitiveness of Senegalese companies; and establish a transparent and reliable mechanism for monitoring and evaluating local content obligations in accordance with national public policy. While such measures hold promise for the oil and gas industry, thus far nothing comparable has been introduced for off-grid solar, though the 'Senegal 2050 : National Transformation Agenda', discussed above may hold promise.

Over the last 10 to 15 years there have been various initiatives to develop the solar off-grid market in Senegal and elsewhere, which has received grants, debt and technical assistance from international DFIs, as well as venture capital investment particularly through Pay-As-You-Go (PAYGo) companies[65]. As part of this, the World Bank's International Finance Corporation funded the launch of the Global Off-Grid Lighting Association (GOGLA) in 2012[66], which encouraged manufacturers and distributors of off-grid solutions to come together and has since become the global industry lobbying association. Yet despite such support, neither the electrification programmes taking place in Senegal or GOGLA have prioritised a strategy for local content and manufacturing, instead encouraging the import of equipment manufactured in China.

Moreover, from 2016 the Lighting Global Initiative's testing labs were located in China, which provided competitive advantages to Chinese manufacturers. While all documentation related to certification was translated into both English and Chinese, none of it was translated into other major African official languages such as French, Arabic, and Portuguese. A lot of lobbying was done by GOGLA to exempt solar products from tariffs to facilitate imports from China, instead of promoting infant industries at even a minimum of local assembly.

During the 2015 GOGLA General Assembly in Amsterdam, Nadji.Bi Sénégal, as the only African member of the organisation at the time, expressed its concerns during a vote on the

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60 https://apps.fas.usda.gov/newgainapi/api/Report/DownloadReportByFileName?fileName=Food+and+Agricultural+Import+Regulations+and+Standards+Export+Certificate+Report_Dakar_Senegal_SG2022-0002.pdf

61 https://www.rvo.nl/sites/default/files/2021/02/Senegal-Value-Chain-Study-Onions.pdf

62 https://www.journalijar.com/uploads/80_IJAR-27895.pdf

63 https://www.fao.org/faostat/

64 Law 2019-04, Sénégal, 2019

65 Baker, L. (2022). New frontiers of electricity capital: energy access in sub-Saharan Africa. *New Political Economy*, *28*(2), 206–222 4

66 https://www.gogla.org/

GOGLA position on VAT and import tariffs, as stated in the summary of the General Assembly: "The position advocates for VAT and tariff exemption for solar lighting and home systems as well as their spare parts. It was recommended to explicitly include batteries when communicating the position as it is challenging to import it without VAT/ tariff levies. A comment was further made that VAT and duties are different issues and should be distinguished. Duties can protect the local manufacturing which should be captured in the position. The AGM however came to the conclusion that the industry as a whole benefit more from tariff exemptions."[67] The position was adopted with one abstention.

In 2020 an initiative for VAT exemption on the import of off-grid solar products and systems was led by the Africa Clean Energy Technical Assistance Facility (ACF TAF), the Tony Blair Institute, Tetra Tech and UKAID all of whom collectively supported the Senegalese Ministry of Energy in its implementation[68],[69]. Prior to its original release on 11 August 2020, the Senegalese Ministry of Energy organised some local stakeholder consultations and shared its draft "Guide to the import and VAT exemption for off-grid solar products and systems in Senegal". The draft made no mention of local manufacturing or assembly, in response to which Nadji.Bi Senegal raised concerns that without clarification of the exemption process, the initiative could affect any current or future attempts at local manufacturing and assembly. While the final version of the guide, which was presented to stakeholders in November 2020, does now mention local manufacturing and the VAT exemption processes[70] its application in practice has made little difference.

Another challenge has been the lack of investor interest in local manufacturing and assembly in addition to the frequent use of shell companies located elsewhere. Such a set up has enabled distribution companies of PAYGo SHSs to avoid taxes in the countries where products are sold. Notable examples in the case of Senegal, include first, the import of D.Light products from China (mainly from the Total Solar off-grid distribution initiative), with packaging mentioning D.Light Energy company's Cayman Island registration and Chinese phone contacts[71]. Second, Oolu Solar, a local Senegalese company which has used companies located in Mauritius and its first and second holding companies both located in Delaware, United States[72] which has enabled the company to reduce its corporate tax to three per cent instead of 30 per cent when a Senegalese company was owned by a holding company located in Mauritius (this double taxation agreement between Mauritius and Senegal was finally terminated in 2020)[73]. Third, PEG Africa (taken over by BBOXX in early

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[67] GOGLA: Summary Annual General Meeting 2015 16th of June 2015, Amsterdam
[68] https://ace-taf.org/kb/guide-dlmportation-et-dexoneration-de-la-taxe-sur-la-valeur-ajoutee-sur-des-produits-et-systemes-solaires-hors-reseau-au-senegal/
[69] https://www.institute.global/insights/climate-and-energy/power-africa-success-story-expanding-renewable-energy-electrify-senegal
[70] GUIDE D'IMPORTATION EXON. FINAL DU 12-11-2020 rev ND
[71] https://lh3.googleusercontent.com/-GSlSlOxpmZs/VUi2YjdpNoI/AAAAAAAAABE/4rh9Ugtzez0/s1600/IMG_0037.JPG
[72] Energise Africa – Oolu Solar Issue 1, Lendahand, 2018
[73] https://www.mra.mu/taxes-duties/international-taxation/double-taxation-agreements

2023), located in Mauritius alongside PEG International. Finally, BBOXX has used Hong-Kong based BBOXX Asia to locate most of its declared income in its UK-based parent company[74].

Such institutional and financial arrangements allow profits to be positioned in a tax haven or jurisdiction with comparable systems, by applying different prices to goods purchased in China and goods sold in Africa. Such arrangements do not work as easily when distributed goods are manufactured or purchased locally, because no profit retention or tax optimisation can take place.

3. NADJI.BI SÉNÉGAL CASE STUDY

3.1 Of Lighting Global and the complex institutional challenges to SHS assembly in Senegal

In 2016, Nadji.Bi's solar home system (SHS) was awarded verification from the World Bank's Lighting Global Programme. While such a prestigious acknowledgement, a strong market demand and a competitive positioning should have enabled the successful national distribution of our product, we faced numerous institutional and financial challenges. Despite meeting with the relevant national entities involved in solar energy in Senegal, offering our services and support to plans and programmes that would help develop our market on a sustainable basis, the lack of support and/or interest from most local entities brought us to a point where we had to stop our SHS assembly line.

Our first SHS pilot had to be designed to meet the IEC 62257-9-5 standard (the quality test method for stand-alone renewable energy products for rural electrification). Once we were sure we had met this level of quality, and that our market study and business development gave us clear evidence of market maturity, as well as being cost-competitive with imported SHSs, we invested approximately Euros 100,000 to set up Nadji.Bi Senegal's first SHS assembly line in 2015, with a capacity of 3,000 units per month.

As this is a capital-intensive business for manufacturers, we were looking for investors to drive our sales operations and secure a long-term inventory of components. A few years earlier in 2012, the IFC-World Bank Lighting Africa initiative had announced in Dakar[75] the launch of its quality verification programme called Lighting Global, to promote the diffusion of solar lanterns and SHSs as a pre-electrification solution in southern countries.[76] This programme, now called Verasol, based its quality verification on the aforementioned IEC 62257-9-5 standard, and was strongly promoted as a key to developing the off-grid market.

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[74] Bboxx Limited_Group_Companies_Accounts_2022

[75] 3rd International Off-Grid Lighting Conference and Trade Fair November 13-15, 2012, Dakar, Senegal, Conference Proceedings, 2013

[76] Lighting Global quality verification programme: founded as Lighting Africa in 2007, Lighting Global quality assurance framework for off-grid energy products was launched in 2012, and then changed its name in 2020 for VeraSol, which is now managed by CLASP in collaboration with the Schatz Energy Research Center at Humboldt State University (USA).

Every manufacturer who wanted to be eligible for programmes, and every distributor who wanted to make sure they were distributing quality products was encouraged to choose Lighting Global quality verified solar products.

We therefore applied to this programme in order to certify our products and to attract interest from potential distributors in both Senegal and neighbouring countries. We were initially asked to send our samples for testing in a newly accredited laboratory in China given that the European accredited laboratory had closed, but we eventually had to send them to a laboratory in the USA given that express shipping for SHS with lithium batteries between Senegal and China was not available at the time. Indeed, there were no testing incentives for African manufacturers, and at approximately $11,000 (of which $8,000 for testing services, $2000 for the sales value of 18 samples which would be destroyed after testing, and courier fees of about $1,000) the testing came at a high cost for us a small company.

Nadji.Bi Sénégal finally received the Lighting Global product testing verification letter for our locally manufactured SHS in May 2016 and we were subsequently invited to become an associate of the Lighting Global programme. Such an accolade should have allowed our company to benefit from various services provided by IFC, including business development, networking assistance, and country-specific advice such as consumer education, market intelligence and facilitation of access to finance. Unfortunately, none of these services were forthcoming despite our requests and we were not visited by local IFC staff.

Our original plan was to start by sourcing low-cost components from local and international sources and undertake local mechanical assembly for SHSs with an aim of gradually increasing sales and investing in manufacturing capacity, machinery and personnel. Our proposed business model was to sell our products for cash to international and national distributors who would then sell on our products using Pay-As-You-Go (PAYGo) systems, among others. However, we soon realised that despite the stated commitments of such companies to the realisation of Sustainable Development Goal 7 and to local economic development, most PAYGo distributors were operating on business models that did not include buying equipment from a local manufacturer and would only work if their margins could be positioned abroad rather than in local market countries. Therefore, despite our best efforts, none of these companies wanted to use our products, even if their local staff and local distributors may have been keen to do so.

As discussed below, we then tried to sell through local development initiatives and the microfinance institution Caurie MF, as well as to establish distribution plans through national organisations and large local companies. However, this plan was wholly undermined by the inter-ministerial decree of 2020 (discussed in Section 2) which exempted further technological components for the generation of renewable energy from VAT. In the wake of this decree, the international distributors did not reduce their selling price and benefitted from this VAT exemption in terms of cash flow improvement and an increase in profits. This new regulation, coupled with the lack of motivation and commitment of the

organisation with which we had set up plans, eventually forced us to shelve local assembly at our facility.

We also struggled to secure any state or DFI support, particularly for the startup phase of our SHS manufacturing. This, despite presenting our company, our Lighting Global quality verified Made in Senegal SHS, and our industrialisation plan to numerous government institutions and programmes involved in industrial development, innovation, energy and finance. As I now describe, we discovered none of these were appropriate for small-scale, off-grid SMEs such as Nadji.Bi.

3.1.1 Industrial development and innovation

Our original plan was to grow in Senegal first and then to export given the demand of distributors in neighbouring countries for our products. To that end, following the "Standard application for approval under ECOWAS trade liberalisation scheme", we aimed to apply for a certificate that would allow us to freely export our Made in Senegal SHS to other ECOWAS markets.[77] However, we were unable to a sustainable agreement with the players in question because they were unable to find financial support to buy stocks and develop distribution so we decided not to apply for the certificate.

We further discovered that the Senegalese Ministry of Industry lacked the strategy, the development plans, and the implementing agencies to promote local industrial development in general. Moreover, support for local industrial production for the local market falls outside the scope of APIX, the agency charged with promoting private sector investment and supporting the development of major infrastructure in Senegal[78]. Not only have solar and electronics industries not been identified by APIX as target sectors but also, only companies that can demonstrate their ability to export qualify for support from the agency.

In addition, while the operational office for the monitoring of the national development plan (Bureau Opérationnel de Suivi du Plan Sénégal Émergent) mentioned several objectives that we could help achieve, including 'Integrated Industrial Platforms' and 'Universal energy service', there was no programme or specific schemes to support local industrial start-ups or develop solar electrification markets with small-scale local companies. Other smaller agencies involved in industrial development, including the Agency for Economic Development and Supervision of Small and Medium Enterprises (ADEPME), the Senegalese Agency for Export Promotion (ASEPEX), the Private Sector Promotion Bureau (BMN) were also unable to either provide any support to high-tech industrial companies like ours, or to promote us in neighbouring countries. Finally, the Senegalese Standards Association (ASN)

[77] https://www.etls.ecowas.int/wp-content/uploads/2011/08/Application-form-french.pdf
[78] L'Agence Nationale chargée de la Promotion de l'Investissement et des Grands Travaux (APIX-S.A.): www.investinsenegal.sn

was not able to support our request for ISO certification and directed us to consulting services from France, which was beyond our budget at the time of the request.

While there are few national institutions in Senegal explicitly tasked with innovation, the Senegalese Agency for Industrial Property and Technological Innovation (ASPIT) has various missions to promote innovation and invention, to create synergies between SMEs and universities, and to contribute to the development of local industry[79]. However, as we found it acts only as a focal point for the African Intellectual Property Organisation and was therefore unable to support us.

3.1.2 Energy and electrification

Our attempts to gain support from the various government institutions involved in electrification were largely unsuccessful. While the Ministry of Energy, through its Directorate of Electricity, welcomed our initiative, connected us with all its agencies and institutions and invited us to all the events organised by international organisations working in the field of rural electrification, this enthusiasm did not translate into further action.

The state-owned electricity utility Sénélec was also interested in expanding its electrification activities through the PAYGo schemes for SHSs and welcomed our approach. While Sénélec representatives even visited some villages benefiting from our Made in Senegal SHSs, they offered terms that would have seriously compromised our autonomy, as a result of which no agreement was could be reached. Alongside these discussions, in 2017, we met with the then President of Senegal, Maky Sall, and presented our solution to him[80], but received no follow-up from his cabinet.

The Senegalese Rural Electrification Agency (ASER) was another possibility, but it has no electrification programmes of its own and instead oversees several programmes initiated by donors, of which local content requirements generally do not form part. While ASER runs a programme for 500 villages that will not be electrified by other means and which could be served by SHSs, no funding was available. While we offered to establish a public-private partnership with ASER, and to explore various credit and financing options, notably World Bank carbon finance available to subsidise SHS credit sales of approximately FCFA 5 billion[81], none of our proposals were followed by actions.

Another potential area for the distribution of our SHSs was with Senegal's electricity concessions, companies that hold the monopoly in individual or multiple Senegalese regions

[79] Décret n°2012-115 portant création et fixant les règles d'organisation et de fonctionnement de l'Agence sénégalaise pour la Propriété industrielle et l'Innovation technologique, 2012
[80] https://www.youtube.com/watch?v=CMJw66BdctU
[81] https://www.seneplus.com/economie/la-banque-mondiale-accorde-5-milliards-fcfa-laser-0

to carry out rural electrification through grid extension, mini-grids or SHSs[82]. Of note is that several years after the concession contracts were signed with the Ministry of Energy, there were significant delays in implementation[83] and while SHSs were to be distributed by all of them, only two, the companies ERA and Comasel, have done so[84]. An important factor is that the criteria defined by ASER's tenders for the concessions were very strict in terms of technological requirements and selling prices. The SHSs to be distributed by the concessionaires were not adapted to market demand, the pricing system was based on monthly fees and not adapted to the market and PAYGo technology was not anticipated. In this regard, we were unable to reach a cooperation agreement with the concessionaires.

In 2015, the Emergency Community Development Plan (Plan d'Urgence de Développement Communautaire, PUDC) was launched to partially implement the National Rural Electrification Emergency Programme during the period 2015-2017, with the support of United Nations Development Programme. However, the electrification efforts deployed by the PUDC included neither local content requirements, nor SHSs. Finally, while the National Agency for Renewable Energies (ANER) does not have a mission to stimulate or support local production or local content in its activities, we were nonetheless offered a partnership agreement with this agency. However, after some negotiation it was not possible to finalise such an agreement and benefit from their support because the agency did not follow on our proposal.

3.1.3 National financial institutions

Local banks in Senegal lend at around 10 to 14 per cent of annual interest rates. While this is an acceptable rate for small industrial SMEs like ours, the banks generally require a guaranteed deposit of 10 to 50 per cent, something we struggled to access without the support of early-stage investors. We therefore considered various other national institutions.

First, the Guarantee Fund for Priority Investments (Fonds de Garantie des Investissements Prioritaires, (FONGIP)) was created in 2013 to provide a solution for SMEs that cannot access bank financing[85]. Unfortunately, FONGIP was focused on programmes and initiatives initiated by the government and international donors, with a high political orientation, rather than small-scale private sector such as our company.

Second, the Sovereign Strategic Investment Fund (Fonds Souverain d'Investissements Stratégiques), FONSIS, a private company also created in July 2013 with the aim of creating national champions and substituting domestic production for imports in order to

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[82] ASER : Concession d'électrification rurale, The Africa Electrification Initiative (AEI) Workshop, Papa Momar NGOM, 2009
[83] Accès universel et durable à l'électricité au Sénégal, Ahmadou Saïd Ba,2018
[84] See footnote 69
[85] Décret n°2013-691 du 17 mai 2013 portant création et fixant les règles d'organisation et de fonctionnement du Fonds de Garantie des Investissements Prioritaires, 2013

consolidate national sovereignty in key sectors, while preserving the country's environmental capital[86]. However, in practice, FONSIS invests only in energy infrastructure projects in state-owned companies or in companies supported and/or initiated by international donors. We therefore did not qualify.

A third institution of potential interest was the General Delegation for Rapid Entrepreneurship of Women and Youth (Délégation générale à l'Entreprenariat Rapide des Femmes et des Jeunes (DER/FJ)), created in 2018 with the aim of promoting self-employment for women, young people and groups, mobilising resources and financing business creation projects and income-generating activities[87]. However, as we soon discovered, DER S/J at the time was not focused on industrialisation or renewable energy and seemed to have been used to attract political support during the pre-election period, which did not reassure us.

We then met with most of Senegal's microfinance institutions, of which there are many. Even if they lend at very high interest rates of between 18 to 24 per cent per year, reach the households targeted by the bottom-of-the-pyramid SHSs. We nevetheless realised the lack of willingness of these companies to innovate and invest in new financial products, despite the fact that an international microcredit institution called Microcred, had created a spin-off company called Baobab+, which started to sell SHSs on credit.

We eventually reached an agreement with the company Caurie Microfinance, through an international initiative launched with some subsidy. Unfortunately, the business model, which had been imposed by the donor with assistance from an international consultant, was based on flawed socio-economic assumptions and was inappropriate to the local context. Despite the distribution of hundreds of solutions, the initiative did not survive without subsidies. Nadji.Bi Sénégal and another company Bonergie partnered with Caurie-MF in 2016 through a programme supervised by the Participatory Microfinance Group for Africa (PAMIGA)[88]. The programme selected a small number of local suppliers who sell Lighting Global-verified solar products (SHSs and solar freezers), and who could support the sale and installation of these solar products. The programme did not require local content but was more inclined to work with local partners who could demonstrate technical expertise. The programme, which could have been a major milestone in local financing or solar products, was unsuccessful because it required that local informal women's groups carry out the solar installation but with such a small margin that was insufficient to cover their logistics costs. Without greater subsidy or a more efficient distribution model, the programme inevitably stopped.

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[86] Loi 2012-34 du 31 décembre 2012 autorisant la création d'un Fonds souverain d'investissements stratégiques (FONSIS), 2012

[87] Décret 2017-2123 du 15 novembre 2017 portant création et fixant les règles d'organisation et de fonctionnement de la Délégation générale à l'Entrepreneuriat des Femmes et des Jeunes, 2017

[88] CAURIE MICROFINANCE Rapport d'activités 2017

A leading partially state-owned microfinance institution, Crédit Mutuel du Sénégal (CMS), which holds 35 to 40 per cent of the Senegalese microfinance market, initiated a partnership with a solar distributor called Suntaeg Energy in 2018[89] to promote the sale of solar products on credit. However, heavily subsidised and the victim of repeated internal fraud and embezzlement, CMS hasn't been able to evolve as a commercial entity capable of leveraging its leadership position to develop an appropriate solar offering for its 1.3 million customers.

In 2012, the Senegalese Housing Bank (Banque de l'Habitat du Sénégal, BHS) signed an agreement with the Senegalese Ministry of Energy and Mines to facilitate the purchase of 15,000 solar PV kits for Senegalese households. This FCFA 10 billion (€15 million) credit line was to be used for residential solar installations at a preferential interest rate of 6.5per cent[90]. However, no reference to local content was made in this agreement, and the initiative has not become operational.

In 2014, the French Development Agency (AFD) launched a project called Sustainable Use of Natural Resources and Energy Finance (SUNREF), which aimed to support local banks in financing energy efficiency and solar installations for commercial and industrial use. The programme, with a budget of €50 million, covered several West African countries (including Bénin, Ivory Coast, Togo and Senegal). In Senegal, two banks partnered with the project, SGBS and Orabank Senegal[91]. The project offered credit lines at preferential rates to these banks, and asked local businesses interested in exploring solar solutions to optimise electricity costs to seek assistance from subsidised French engineering firms for sizing their solar systems (€15 million of the programme budget). However, the preferential tariffs were not transferred to local companies, local content was not included, and even the engineering had to be outsourced to French companies. To my knowledge, only one solar pumping project through SGBS was implemented by a French company In Senegal.

3.1.4 Regional organisations and DFIs

We have also sought support from various regional organisations and DFIs involved in solar energy programmes, though thus far without success. First, from the ECOWAS Centre for Renewable Energy and Energy Efficiency (ECREEE) whose functions include energy efficiency, renewable energy development and capacity building in the region, alongside research, technology transfer, programme development and resource mobilisation. However, despite several requests for support, ECREEE could not offer any solution suited to local private companies focussed on developing local manufacturing in off-grid solar.

[89] https://www.suntaegenergy.com/fr/suntaeg-et-le-credit-mutuel-du-senegal/
[90] https://www.mediaterre.org/commerce/exportactu,20130104155418,1.html
[91] Améliorer_la_compétitivité_des_PME_et_favoriser_la_création_d'emplois-7814, 2020

Second, a programme called Regional Off-Grid Electricity Access Project (ROGEAP), designed by the World Bank and Lighting Global in 2017[92],[93] became effective in 2021 under the management of ECREEE. However, at the time of writing in 2024 the programme had not provided any support to local private companies, despite its stated provision of seed funding to local startup entrepreneurs, and incentives to attract impact investors by providing matching grants[94].

The African Development Bank (AfDB) launched an ambitious African Renewable Energy Initiative (AREI) in 2015. Yet despite the many solar energy and rural electrification projects financed by the Bank[95], and that the industrialisation of Africa is among the Bank's top five goals, solar local manufacturing has never been its priority, and it has no dedicated financing vehicles or grants for local solar manufacturing companies.

The West African Development Bank also plays an important role in financing solar rural electrification projects, particularly in Senegal, where it co-financed the "FP138 ASER Solar Rural Electrification Project"[96] with the Green Climate Fund, KfW-IPEX and the Senegalese government. However, this project and its accompanying Strategic Environmental and Social Assessment Report did not include local content requirements for the equipment procured[97]. Since the successful launch of this programme in 2022[98], we understand that manufacturing or assembly activities that could easily be located in Senegal are being carried out abroad, for example the assembly of containerised mini-grid solutions in Germany.[99]

In an older example, in December 2016 the World Bank, approved $8.47 million in financing to ASER for a programme called 'The Senegalese Rural Electrification Programme'[100]. The objective of the programme was to increase access to electricity and reduce global greenhouse gas emissions by introducing a range of solutions, including grid extension, solar/diesel mini-grids, solar home systems and solar lanterns in rural areas of Senegal. The programme aimed to use a carbon-linked, results-based payment scheme to support the implementation of the government's plan to expand and accelerate the pace of rural electrification through private concessionaires and other project operators. However, this

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[92] Regional Off-Grid Electricity Access Project (ROGEAP) presentation, World Bank, 2021
[93] https://projects.worldbank.org/en/projects-operations/project-detail/P160708
[94] See footnote 82
[95] https://www.afdb.org/en/the-high-5
[96] https://www.boad.org/fr/nos-secteurs-dintervention/environnement-finance-climat/finance-climat/partenaires-techniques-et-financiers/le-fonds-vert-pour-le-climat/
[97] Rapport d'Evaluation Environnementale Stratégique et Sociale, ASER, Pyramide Environnemental Consultants, 2020
[98] https://www.greenclimate.fund/project/fp138
[99] https://www.youtube.com/watch?v=POJ6LwT5cV4
[100] https://documents.banquemondiale.org/fr/publication/documents-reports/documentdetail/515181563201649629/disclosable-version-of-the-isr-senegal-rural-electrification-programme-p158709-sequence-no-01

programme did not include local content requirements for the equipment procured, as this is not mentioned in the new joint World Bank/AfDB M300 initiative of 2024.[101]

We at Nadji.Bi Senegal made a proposal to ASER to use this grant to offer a comprehensive digital system to properly track subsidies and carbon, develop our manufacturing capacity, and distribute SHSs with local communities. We received little response, and the programme was eventually cancelled by the World Bank, mainly because of the complexity of the programme, and ASER's failure to meet key requirements under the emission reductions purchase agreement, and to address key operational obstacles[102].

Tellingly, the AfDB, together with the World Bank/IFC, the US Power Africa initiative, and the UN Sustainable Energy for All, funded a guide for African governments published by GOGLA in 2019[103], in which Section 3.5 claims that local manufacturing and tariffs on imports could likely reduce job creation, and that the economies of scale brought about by almost all manufacturing capacity being located in China were good for the competitiveness of the off-grid industry. Based on the sources included in this guide, such a claim arguably lacks sufficient evidence to back up such a perspective.

Such a perspective was challenged in the publication of several reports, including the 2021 'Assessment of local manufacturing of off-grid solar in sub-Saharan-Africa', by the ACF TAF[104], which focussed on Nigeria, Ethiopia, Zambia, Tanzania and Rwanda and concluded that "The relatively large off-grid population in the five countries, and the ambitious universal energy access goals indicated by their governments, results in an important market for off-grid products and the opportunity to achieve greater impacts through the local assembly and manufacture of solar products. The market for these products is further evidenced by the growing demands in different segments such as productive use and commercial and industrial applications."

Another report from the Powering Renewable Energy Opportunities (PREO) programme titled, 'Made in Africa: impact of local manufacturing on profits, people and products'[105] and published in October 2023 identified the top three drivers of increased profitability as the avoidance of import duties and taxes, avoidance of supplier margins, and avoidance of shipping costs. The report also highlighted the various benefits of local manufacturing in

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[101] https://www.worldbank.org/en/news/press-release/2024/04/17/new-partnership-aims-to-connect-300-million-to-electricity-by-2030

[102] https://documents1.worldbank.org/curated/en/099805008032284504/pdf/BOSIB079ed10b701a088f30c99046171b27.pdf

[103] Providing Energy Access through Off-Grid Solar: Guidance for Governments, GOGLA, 2019 [available at: https://www.gogla.org/wp-content/uploads/2022/12/energy_access_through_off-grid_solar_-_guidance_for_govts.pdf]

[104] Assessment-of-Local-Manufacturing-of-Off-Grid-Solar-in-Sub-Saharan-Africa-1, 2021, Africa Clean Energy, Tetra Tech, UKAID

[105] https://www.preo.org/wp-content/uploads/2023/10/Made-in-Africa-Impact-of-local-manufacturing-on-profits-people-and-products.pdf

SSA, including increases in profitability ranging from as low as 12 per cent to as high as 38 per cent in five different case studies.

3.2 Solar Milling machines

Despite the challenges to the manufacturing of our SHS, a second and more successful initiative that we have developed is that of solar-generated hulling and milling machines used to process millet grain into flour, and the impactful Walalma service centres for women developed around these machines.[106] Through our business development and partnerships with NGOs and local women's organisations, we realised the significant difference that such machines could make to the lives and livelihoods of women and girls in rural areas.

The nature of millet grain is such that it cannot be processed through a standard milling machine, least of all one that has not taken the Senegalese rural context to mind. The machine also requires a specific mechanical design to work without consuming a lot of energy. With this in mind, we designed a solar-generated millet milling machine with a much better yield and lower energy consumption than many standard machines. One of the features of our grain-processing solar machines is that they are digitally connected thanks to their connected internet of things (IoT) electronic card, thus enabling digital payment and smart monitoring.

As a local company, our R&D capacity, mechanical manufacturing capacity, electronic design, electrical assembly, software and digital solution development, and after-sales services cannot be easily replicated by manufacturers from other continents. We therefore anticipate that both national and international organisations will rely on companies like ours to manufacture and diffuse solar productive use solutions locally.

3.3 Solar Water Pumps

A third and also more positive initiative relates to our efforts in solar productive use by developing solar water pumps and IoT electronic cards, which allow real-time monitoring and control of our pumps. After conducting a market study in the Northwest region of Senegal, where most of the country’s vegetables are produced, we realised that not only was the market demand for solar water pumps very important, but also that there were many barriers to its development.

A key advantage was our ability to design and assemble most of the features of our solar water pumps locally. This was also possible due to the average size of solar water pump required by the market, which is of relatively small power demand but requires the system

[106] www.walalma.com

to be customised to the specific needs of each farm. Such factors prevent the import of plug and play solutions which cannibalise local know-how and industrialisation.

Our project is funded by La Banque Agricole (formerly CNCAS) which capitalised on a previous a failed experience launched in 2017, when it had signed a multi-party agreement with ANER, the Niayes Market Gardeners Association, the company E3C, The Priority Investment Guarantee Fund (FONGIP) and the Niayes Economic Development Programme of Canadian Cooperation as part of the pilot phase for the installation of solar pumps for the benefit of market gardeners in the Niayes region. According to the Bank, the project's technical partner, the customer's crop was not properly assessed before the pumps were distributed, and the amount of water available often failed to match the farmer's needs. It also raised concerns about the availability of after-sales service and the lack of customer follow-up after installation.

Nadji.Bi's Sénégal IoT electronic card, which allows full control of the solar water pump in the off-grid area, provided the opportunity to develop a brand new programme together with La Banque Agricole with the support of the USAID - West Africa Trade & Investment Hub initiative. This programme, called Woomal Mbay, has allowed La Banque Agricole to offer its customer a technical-financial package that included:

- A free on-site study to offer the customer the right pump;
- An on-site installation;
- An Android application to monitor and control the pump remotely;
- A three-year warranty;
- A complete after-sales service;
- a three-year insurance policy provided by CNAAS (Senegal National Agricultural Insurance Company); and
- the financing of the pump against a deposit of 10 per cent of the customer and some fees, consisting of a credit of 7.5 per cent annual interest rates over three years, with three payments to be made each year on the pump installation anniversary date.

This programme could only start with the provision of a first loss guarantee deposit from USAID to La Banque Agricole to cover farmers risks and unlock financing.

Nadji.Bi Senegal, manufactures and assembles all mechanical and electrical parts of the solar water pumps locally, in addition to developing our own web and Android application and electronic cards and programmes, including local content by default in this project. Despite the many challenges we have faced, this programme has been a success, and we plan to expand it in the coming years without USAID support.

3.4 Training solar technicians

A key obstacle to the development of the solar market in Senegal and the West African market more generally relates to a skills deficit and the lack of availability of well-trained technicians. While there are a high number of solar training programmes in Senegal,

thousands of technicians are certified each year without knowing how to identify quality solar components or how to carry out a proper solar installation. Many training programmes are not run by experienced professionals, but rather trainers with no field experience. In many training programmes there is also a lack of equipment and poor material purchasing processes and habits. As a result, very poorly-trained technicians end up working in the solar market and increasing the proliferation of poor-quality components and installations. This in turn discourages customers from choosing solar.

Faced with the problem of having to retrain solar engineers and technicians at our own expense, we proposed to the AfDB to set up a training and incubation programme to enable skilled professionals to provide adequate training for solar technicians and support young solar entrepreneurs to set up in business. This programme, called QualiSolaire Sénégal, is the first public-private partnership of the AfDB in the field of vocational training[107]. However, since September 2020 we have been able to train almost 300 solar entrepreneurs of which almost 100 women. Nine months after being trained, more than 75 per cent of our trainees have found employment, including some who have taken on responsible roles within Nadji.Bi Sénégal and others who have started their own businesses.

3.5 End of life and recycling

In Senegal, there is no regulation for recycling and end-of-life management of solar products or indeed many products. Consequently, we have tried to draw the attention of international organisations to our need for support for our deposit refund system, especially lithium batteries and solar PV modules. We have also offered to participate in the coordination of recycling efforts in the solar industry by ASER, ANER and Sénélec even though none of our proposals have been followed up.

We have identified several initiatives to support recycling opportunities in Senegal, including Power Africa's 2018 solar e-waste and battery technology research and award programme[108] and the solar e-waste challenge project global leap awards[109] of which no Senegalese companies have so far been selected as grantees. We also note the proposed organisational strategy for the solar waste management sector in Senegal report by GIZ and Dalberg in 2021[110], which did not mention local companies including us.

[107] https://www.qualisolaire-sn.com/
[108] Solar E-Waste and Battery Technology Research and Award Programme, Power Africa, 2018
[109] Solar E-Waste Challenge Project Spotlights, round 2 Global Leap Awards, 2020
[110] Proposition d'une stratégie d'organisation pour la filière de gestion des déchets solaires au Sénégal, Dalberg, GIZ, 2021

4. CONCLUSION

In this paper, I have examined the development history and current status of local manufacturing and assembly for off-grid solar PV in Senegal. From the early research of the Henri Masson Institute and the developments of SINAES-DAGUERRE to the establishment of IPSOL and SPEC Solar, local manufacturing and technological capabilities for solar in general have had a long but challenged history in the country. Meanwhile, various internal and global factors, as well as unpredictable market crises at various points in history, have undermined the ability to create a sustainable national sector of manufacturing and assembly for off-grid solar systems including SHSs, solar pumps and solar-generated hulling and milling machines. However, as this paper has argued, the potential exists to develop such a sector, with local technological and industrial capabilities at its core.

As the oil and gas industry prepares for the start of oil and gas production, we will soon start to see the impact of this local content regulation initiative. Key learnings from this initiative are that local content development in strategic industries, such as energy in general and renewable energy manufacturing and assembly, is dependent on political will, and that the development of renewable energy, driven by electrification and decarbonisation of electricity, can play a major role in the industrialisation of Senegal and have a significant positive impact on many related industries.

Among its main missions, our Senegalese government and its ministries and agencies, such as ANER, ASER, ASPIT and ASN, should contribute, as required by their prerogatives[111], to improving R&D and promoting the technological innovations related to renewable energies. This includes promoting the emergence and development of local manufacturers of renewable energy solutions and encouraging investment, especially local investment, in this strategic sector. The Senegalese government has the challenge of leading ECOWAS and the entire West African region on a new path of development in order to achieve ambitious and realistic Sustainable Development Goals based on its own roadmap.

The Asian continent and its companies have shown that with sufficient will, many things are possible in countries with growing populations, including the development of first-class industries that serve not only local but also international markets. Nothing is impossible but the situation is complex and if our national policy makers and those individuals and institutions in positions of power are unable to take full account of this complexity, it will be hard to bring about the change needed.

Drawing on the lessons learned from previous attempts and benefitting from a promising legal and regulatory framework, if Senegal can introduce and enforce local content requirements in the development of its various solar projects as compared to imported products, it now has a unique opportunity to become a leading industrial player in the region, and at least capable of exporting to neighbouring markets with a less proactive

[111] Décret n°2013-684 portant création, organisation et fonctionnement de l'Agence Nationale pour les Energies Renouvelables (ANER), 2013

industrial policy. The creation of these national champions will be able to leave their profits in the country, while benefiting as much as possible from the direct impact of their activities. Despite being located in one of the poorest and least developed countries in the world, Nadji.Bi Sénégal has demonstrated its ability to break barriers and rethink the position of SMEs in the electrification landscape of SSA, demonstrating its ability to innovate and to develop unique, disruptive and resilient business models that are well-adapted to the local context.

With its state-of-the-art networked solar water pump, solar milling machines and Walalma service centres for women, as well as its innovative vocational school and incubation centre for solar entrepreneurs, Nadji.Bi is charting a path of endogenous development, a path that provides an example of how to address some the major problems facing Senegal, such as poverty, agricultural underdevelopment, lack of innovation and high-tech industry, as well as gender inequality, vocational training, entrepreneurship and the digitalisation of the economy.

Our story demonstrates the power of following evidenced-based knowledge and local experience rather than accepting preconceived ideas and dogma; of allowing local entrepreneurship, creativity and unlimited talent reservoirs to express themselves rather than unquestioningly accepting the lessons and templates of orthodox economic principles that have failed for so many years to improve the situation in countries of the global South. Senegal has a unique opportunity to be at the forefront of a sub-Saharan industrial revolution, with knowledge, technology and sustainable industry as its flagships. As we say in Senegal, "Il vaut mieux un petit chez soi qu'un grand chez les autres": “it's better to have a small house for yourself than to live in a big house of others”. And Nadji.Bi Sénégal is no exception to this quote, preferring to follow what seems right, logical and proven in business, rather than the inefficient suggestions of short-term consultants with no responsibility or accountability, who have argued in many reports that Africa can develop and electrify itself without developing local industrial and technological know-how and a local industry capable of developing products adapted to local markets.

Nadji.Bi Sénégal's ambition is to inspire entrepreneurs and other businesses in the country and elsewhere on the continent, to open the box of knowledge and overcome the inferiority complex that is still very much present in the minds of sub-Saharan Africans. At the end of the day, involved national and international stakeholders have no choice but to support companies like ours to manufacture and diffuse solar productive use solutions locally if they want our countries to reach a sustainable development.

The progress we have made in the last decade, with substantial achievements like Qualisolaire, our Woomal Mbay smart solar water pumps, and Walalma women's service centres with solar milling machines, has allowed Nadji.Bi to better understand the dynamics of the off-grid ecosystem. This, despite all the challenges and the failure to keep our SHS assembly off the ground. We can now build on this to make further gains towards poverty reduction and sustainable development in Senegal.

It is estimated that the population of Senegal will reach 32.5 million in 2050, compared to the current 18 million today, and could reach 62 million in 2100. The demographic factor, when it appears in a stable environment, remains the best guarantor of economic growth, and this human capital remains and will remain an undeniable asset for Senegal in the coming century.