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The False Start of Solar Energy in West Africa, 1960-1987

Abstract

From 1960 onward, solar energy developed in a context of innovation and structured scientific policy in Senegal, Mali, and Niger. The crises of the early 1970s brought new actors to the region, as well as technological competition between thermodynamic and photovoltaic solar energy. In the early 1980s, dependence on foreign products led African countries to work toward the continent's endogenous and industrial development. However, these policies were hampered by economic difficulties that prevented the solar industrialization of the region's countries, and weakened a regional solar project that could not withstand the oil counter-shock.

Plan of the article

INTRODUCTION

1 The use of solar energy in West African countries is a matter of independence, development, and—in many instances—one of survival for the population. Solar energy has raised questions from the independence of 1960 up through the present. Would it reduce rampant deforestation? Would it foster greater energy independence? Would it be a lever for increasing the standard of living? These questions have recurred over the decades, and make this subject intensely topical.

2 The interest of West African countries in solar energy is in keeping with a very rich international context dating back to the early 1950s. From 1951 onward, the United Nations Educational, Scientific, and Cultural Organization (UNESCO) was behind major efforts in arid zones.[1] These efforts were punctuated by a Symposium on Wind and Solar Energy held in New Delhi in 1955, and a Symposium on the Problems of the Arid Zone in Paris in 1960.[2]

3 The development of research on solar energy in the 1960s produced early achievements, and raised the crucial and central question of the sector's possible industrialization. This industrialization would lower production costs; give local populations access to solar devices that would improve standard of living by providing hot water and better conservation of agricultural products; and provide solar water pumps for direct use by the local population, livestock, and for agricultural irrigation purposes.

4 For the historian, writing this history faces the challenge of assembling African sources that support this. The absence of documentation in Africa for this history requires the historian to use complementary sources. United Nations (UN) archives—especially those of Bertrand Châtel[3]—have proven invaluable. They compensate for the meager documentation available for these specific issues. A few authors have worked on the history of solar energy in West Africa, including Sophie Pehlivanian[4] and Frederic Caille,[5] who have explored these questions via the French Company for Thermal and Solar Energy Studies (SOFRETES). They have both crafted a history of thermodynamic solar energy in the region. These important contributions are sometimes limited to a single actor, and are therefore incomplete for the purposes of writing a more general history.

The brief history of solar energy in West Africa I will present here focuses on sciences and technology in Africa, development, and African institutions. It is a major contribution by virtue of its many cross-cutting issues. This history gives careful consideration to the international context, thereby integrating events within a broader international and African history. At the same time, careful attention is given to West African scientific policies, the establishment of new technologies in the region such as photovoltaic solar energy, and emphasis on issues relating to dependence and development. 5

This history begins in 1960, a time marked by the independence of multiple countries in West Africa, and ends in 1987 in the aftermath of the oil counter-shock that saw a sharp drop in the price of black gold. This was a key moment, in which the solar industrialization dreams of West African countries came to an end. 6

This history explores how the emergence of solar institutes in the 1960s led to dreams 7

1 UNESCO, *Arid Zone Programme: report of the second session of the Advisory Committee on Arid Zone Research, 3-5 September 1951* (Paris: UNESCO, 1951), 6.

2 UNESCO, *The Problems of the arid zone: proceedings of the Paris Symposium* (Paris: UNESCO, 1962).

3 Bertrand Châtel (1920 – 2013) was the director of scientific and technological applications between 1968 and 1979 at the Office for Science and Technology, an Office of the United Nations Secretariat.

4 Sophie Pehlivanian, *Histoire de l'énergie solaire en France, Science, technologies et patrimoine d'une filière d'avenir* (Ph.D. dissertation, Université de Grenoble, 2014).

5 Frédéric Caille, « L'énergie solaire thermodynamique en Afrique. La Société française d'études thermiques et d'énergie solaire, ou Sofretes (1973-1983) », *Afrique contemporaine*, n°1-2, 2017, 65-84.

Figure 1: Map of Western Africa

of regional solar industrialization in the 1980s. What were the limits of these industrial projects? Why did this industrialization fail?

8 The emergence of West African solar institutes during the 1960s was a first step that fostered future achievements as well as the arrival of new international actors in the 1970s. It led to the establishment of solar industrial projects by West African countries in the 1980s.

1. EARLY SOLAR ACTIVITY IN WEST AFRICA (1960-1973)

9 The first steps of solar development in West Africa occurred within a context of scientific conferences, which connect this African history with broader international issues. In addition to UNESCO's arid zone research cited above, the United Nations Economic and Social Council (ECOSOC) brought together scientists from around the world for the UN Conference on New Sources of Energy held in Rome in 1961. This conference helped raise international awareness regarding the potential future of solar, wind, and geothermal energy.

The 1960s were also characterized by the adoption of scientific policies by developing countries, initially as part of the UN Conference on the Application of Science and Technology for the Benefit of the Less Developed Areas (1963), and later of the Lagos Conference (1964). The former explored the use of innovation to accelerate development and reduce the technological gap between countries, while the latter asked each African state to create the institutions required to plan their scientific policy. 10

The development of solar energy in West Africa is thus at the intersection of a broader history, and is related to various issues such as a desire for national economic development, a reduction in the technological gap between countries, a desire for energy independence, the international development of solar energy, and the construction of scientific policy in each African state. 11

Meeting of Scientists at the IPM in Dakar (Senegal)

12 In Senegal, the development of solar energy was not driven by the state, but rather by members of the scientific community. Senegal is an exception thanks to its early development of solar power as well as the extent of the activity. The solar adventure in Senegal began in the 1960s, through the research conducted on solar energy in the late 1950s by the French scientist Henri Masson. He was the Dean of the Dakar Faculty of Science in 1958, where he created the Institute for Meteorological Physics (IPM) on February 25, 1960.[6]

13 The following year, Professor Masson met Jean-Pierre Girardier of France, a student at the Polytechnic School in Zurich, who began his military service in 1961 at the age of 27, in the middle of the Algerian War. Girardier traveled to Dakar as soon as he had an opportunity, and met Masson, who asked him to extract cold water from the Sahelian subsoil by using the sun's heat to create a mechanism producing energy based on Carnot's principle.

> "I have a little job for you. It is quite simple. You see, there is a ton of solar in the country. It's what I call the hot source. The number one need of these countries is water, and there is a lot of it in the subsoil. We can see this as a cold source. According to Carnot's second principle, we should be able to install a mechanism between them that can produce energy. We need to develop a machine that really works in the sun based on Carnot's principle."[7]

14 Girardier wrote his doctoral dissertation on this topic, and in 1962 built the world's first thermodynamic solar pump, named Secra.[8] He defended his dissertation the following year at the University of Dakar, and began to build a new enhanced pump in 1964.

That same year, Girardier also completed his military service. He returned to France and continued his research remotely with Masson; he ultimately joined the Pierre Mengin family factory, which produced hydraulic pumps, where he made the Ittec solar collector using the factory's equipment and 11 million old francs in financing from the French National Center for Scientific Research (CNRS). 15

Girardier then began constructing a new experimental pump named Nadje at the IPM in 1968 (Figure 2). The pump has a 12 m² collector and an output of 1,200 liters per hour for 5-6 hours.[9] 16

A lack of financing and the high price of motors prompted him to build his own motor, which he incorporated into his pumps. This motor was called the M.G.S 2000, in reference to Masson, Girardier, and Segal in 1968. 17

The French Ministry of Cooperation ordered two pumps. One was called Segal, and was the first to include this new motor; it was put into service at the IPM in 1969. It is pictured below (Figure 3), and has an 88 m² collector, an imposing structure that operates 5-6 hours per day, and yields 6 m³ of water per hour. The other was named ONERSOL after the Nigerien solar laboratory to which it was sent. Girardier's team shipped a number of pumps abroad, especially to the Upper Volta (Burkina Faso), where the pump Ouaga was installed at the Inter-state School of Rural Equipment Engineers (EIER) in Ouagadougou in 1971. 18

Another pump was installed in Mauritania. The management of the Mauritania Iron Mining Company (MIFERMA) travelled to Dakar, and wanted to offer a gift to the Senegalese government. The management was won over by the Segal pump and placed another order for a pump, which it installed in the city of Chinguetti 19

6 Henri Masson, « Institut de physique météorologique de la Faculté des sciences de Dakar », *Bulletin COMPLES, Coopération méditerranéenne pour l'énergie solaire*, n°2, 1962, 7.

7 Jean-Pierre Girardier, *L'homme qui croit au soleil, un pionnier de l'énergie solaire* (Paris : Les éditions du Cerf, 1979), 15.

8 *Ibid.*, 29.

9 Henri Masson, *Rapport sur l'utilisation de l'énergie solaire pour le pompage de l'eau en zones arides*, 1973, 8.

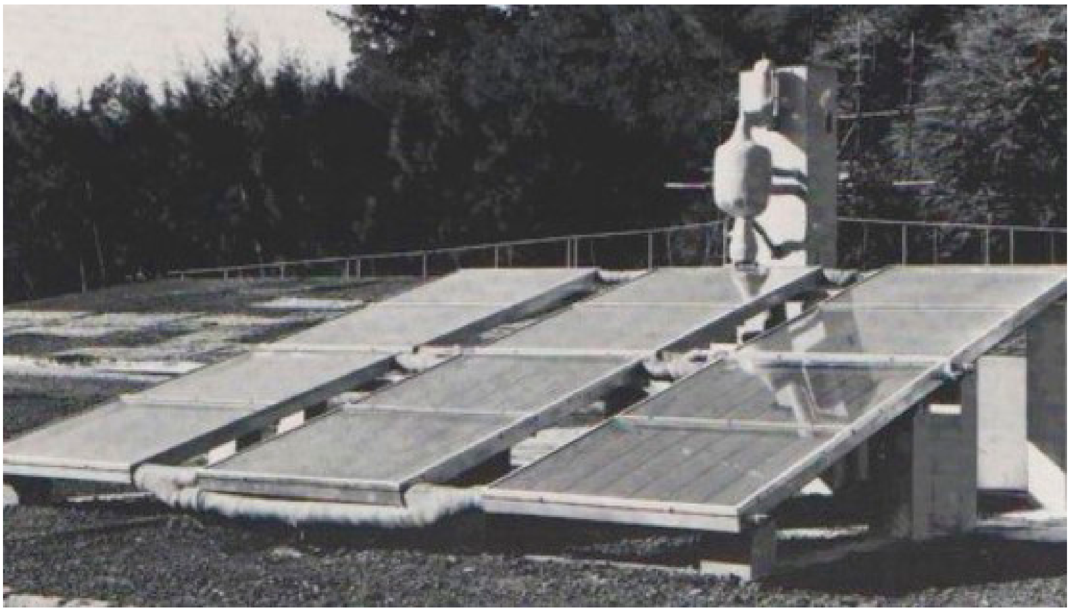

Figure 2: Photograph of the Nadje pump. Source: Private archives of Bertrand Châtel, Chief of Scientific and Technical Applications, Office of Science and Technology, United Nations General Secretariat (1968-1979).

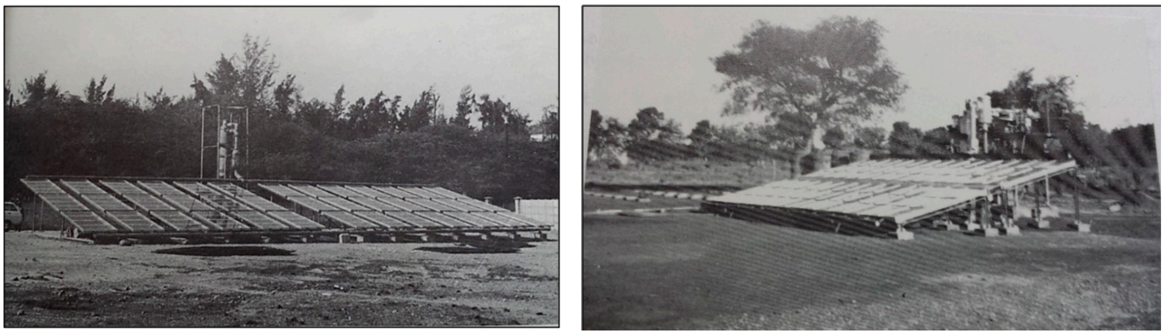

Figure 3: Photographs of the Segal (left) and Ouaga (right) pumps. Source: Private archives of Bertrand Châtel.

(Mauritania) in 1973.[10] What was distinctive about this solar pump (Figure 4) is that it was installed in a school. The solar collectors placed on the roof provided natural air conditioning for classrooms. The decision to build it on top of a school was not inconsequential, as it demonstrated the change in lifestyle brought about by the installation of a solar pump in a village. The pump profoundly changed the population's habits, provided easy access to water near homes, and did away with the drudgery of walking kilometers each day to reach a water source. This change lightened the physical burden on inhabitants, shifted places of socialization, and enabled considerable time savings, thereby allowing women to work (agriculture, commerce), while children attended school.

Solar energy thus contributed to the develop- 20
ment of countries in the region in the 1960s. The Chinguetti pump was expected to supply 2,000 homes and operate 5 to 6 hours per day, but poor projections and a lack of water in the subsoil only permitted it to operate 30 minutes to 1h per day.[11]

10 Jean-Pierre Girardier, *L'homme qui croit au soleil, un pionnier de l'énergie solaire*, *op. cit.*, 30.

11 CEA, *Sommaire des activités et des réalisations en matière d'utilisation de l'énergie solaire en Afrique*, Niamey, 20 December 1978, 16.

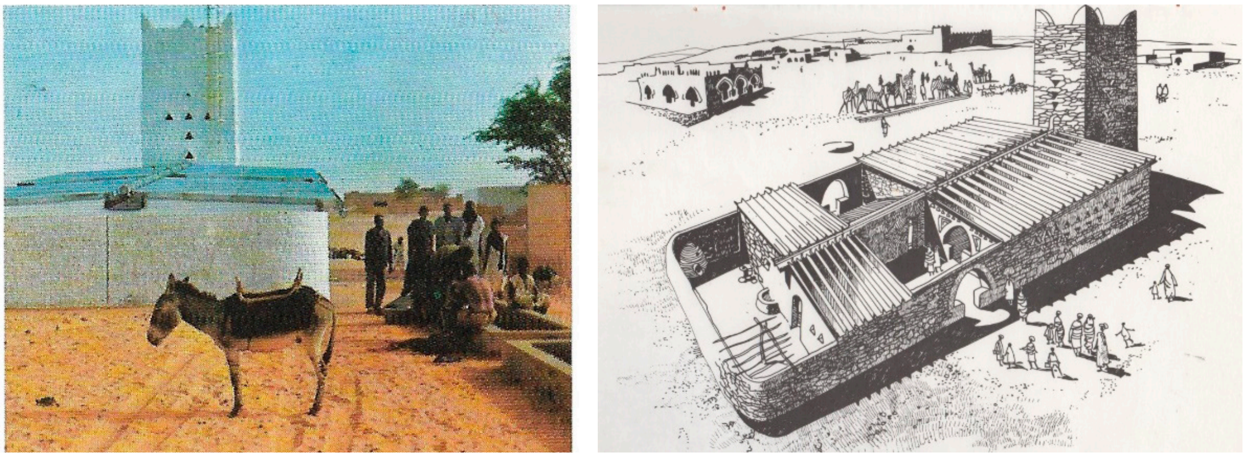

Figure 4: Drawing and photograph of the solar pump in Chinguetti. Source: Private archives of Bertrand Châtel.

21 The development of solar energy in Senegal was driven by the scientific community, and was based primarily on the construction of thermodynamic solar pumps. The Senegalese case is an exception in West Africa, for while other countries in the region were interested in solar energy, its development was now a choice made by heads of state, who established a scientific policy in keeping with the Lagos conference in 1964.

LESO Created as Part of Malian Scientific Policy

22 The development of solar energy in Mali began under the impetus of President Modibo Keita, who in 1963 created the Solar Energy Laboratory (LESO) in Bamako[12] as part of a Malian scientific policy, in which the LESO was part of the National Laboratory for Public Works upon its creation. The latter was managed by a French contract worker who tried, with limited means, to produce a number of solar demonstration prototypes, in an effort to raise awareness among the population regarding the importance of solar energy.

23 The following year, in 1964, LESO became an independent organization. It had its own building: a hangar and two offices located at the courtyard entrance of the Central Garage for Military Engineering in Dar-Salam, a neighborhood in the north of Bamako. The institution was managed by Abdou Moumouni Dioffo of Niger, a professor and holder of an *agrégation* in physics, who became LESO's first director. The physicist's dynamism and perseverance helped make the hangar into a general mechanics workshop equipped with machine tools bought with grants from the Malian government. The laboratory also received financial assistance from Israel[13] that allowed it to launch an initial phase of activity and studies for various devices between 1964 and 1967.

24 The laboratory's independence does not mean that it was not part of a larger national scientific blueprint. It became an entity in its own right within the context of a scientific policy coordinated by the National Scientific and Technological Research Council (CNRST). LESO thus developed as part of the organization and planning of a Malian scientific policy. It was then placed under the administrative supervision of the State Secretariat for Energy and Industry around 1967, when a trace of this organization appears in a UNESCO document.[14]

12 Ministère des Mines, de l'Energie et de l'Eau du Mali, *Répertoire énergétique du Mali, Dans le cadre du projet PPP : Etablissement d'un cadre de dialogue pour la promotion du partenariat public-privé dans le secteur de l'énergie*, European Union Energy Initiative, 2006, 14.

13 Jean-Claude Woillet, Maise Allal, International Labour Office, *Répertoire des Instituts africains de technologie* (Geneva: International Labour Organization, 1984), 16.

14 UNESCO, *Rapport de consultation sur la politique scientifique au Mali* (Paris: UNESCO, 1968), 12.

25 The year 1968 marked the beginning of a period of reorganization through which the laboratory obtained the infrastructure needed to conduct experiments. The following year there were only two people working in the laboratory,[15] and in March Dioffo was called back to Niger to lead the Solar Energy Office of Niger (ONERSOL), as we will see below. The atomic and thermophysics engineer Cheickna Traoré subsequently took the helm at LESO.

26 LESO focused on the application and diffusion of knowledge for both direct and indirect solar energy. It concentrated its research on the country's important solar resources, as well as developing prototypes for water heaters, ovens, and solar cookers, with their production leading to fundamental applications for the country.

27 Let us consider the example of distilled water. Mali cruelly lacks it and has a substantial need for it for car batteries, pharmaceuticals, and other health products. What's more, if distilled water is accompanied by chemical processing, it can make polluted and brackish water potable. In 1970, LESO began to supply military engineering units, the Malian Railway Company, the administrative garage, and some private garages as well.[16]

28 The laboratory also sought to develop solar drying for agricultural products, which is more hygienic that drying on the ground. The solar process enables better conservation, reduces loss, and increases agricultural production. LESO provided solar dryers to the Malian Fruit Conserve Company (SOCOMA); to Opération pêche for drying fish; to the Malian Livestock, Hide, and Leather Company (SOMBEPEC) and the Malian Livestock and Meat Office (OMBEVI) for drying meat; to the Malian Tannery for hides to produce shoes; and to the Briqueterie for the production of bricks.

29 Dioffo's departure for Niger does not seem to have affected LESO's research and production, although it underscores the connections, communications, and exchanges that existed between West African countries, challenging the notion that each country developed independently. The connection between Mali and Niger does not stop there, as solar development in Niger and the creation of ONERSOL also grew out of state efforts,[17] which simultaneously enjoyed UN support.

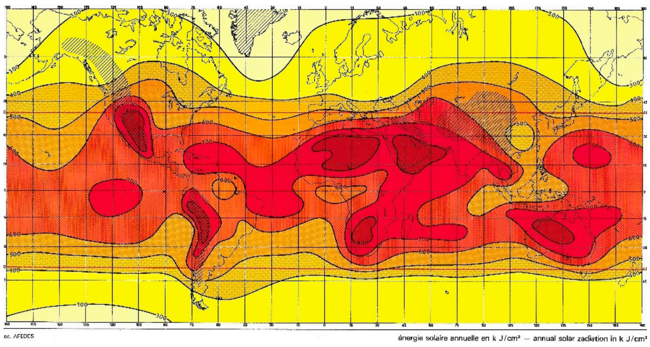

Figure 5: Map of the world's sunshine. Source: Brochure RTC La Radiotechnique-Compelec, Cellules solaires (Paris: 2e trimestre 1979), 33.

ONERSOL, A Solar Laboratory in Niger with a Regional Dimension

The United Nations Economic Commission for Africa (UNECA) creased ONERSOL in Niger by adopting Resolution 113 (VI) on March 2, 1964,[18] emphasizing West Africa's climactic predisposition for solar energy, and thereby helping to combat deforestation (Figure 5). 30

In particular, the resolution recommended creating "an experimental solar energy center [in Niamey] tasked with developing various prototypes of solar devices and diffusing the results of experiments."[19] A resolution approved on August 14, 1964 by ECOSOC soon established Niamey as the African center for solar development. 31

15 CEA, *Sommaire des activités et des réalisations en matière d'utilisation de l'énergie solaire en Afrique*, *op. cit.*, 24.
16 *Idem.*

17 Présentation du Centre national de l'énergie solaire (CNES) au Niger – Historique du CNES : **URL : http://www.cnes.ne/index.php/presentation-fr/85-cnes-niger**
18 Economic Commission for Africa, *Utilization of solar energy, Resolution 113 (VI) adopted by the Commission at its 113th plenary meeting on 2 March 1964*, Addis-Ababa, 1964, 1.
19 *Idem.*

32 The center's "regional"[20] dimension was confirmed by the Nigerien government in the bill dated May 5, 1965 passed ten days later by the Nigerien National Assembly, officially creating the Office of Solar Energy (law no. 65.033).[21] The law established the objectives for the new organization, and asked ONERSOL to create an experimental solar energy center, conduct solar energy measurements, study solar prototypes, and develop applied research. ONERSOL became an industrial and commercial public institution under the administrative supervision of the Head of State and the Ministry of Public Works, working closely with the Water Committee of the Commissariat for Development.

33 ONERSOL'S first director was Bernard Bazabas of France,[22] an engineer from Martinique who held this post from 1966 to 1969. He received assistance from two experts: the first was from Australia, a specialist in measuring solar radiation, who stayed in Niamey from December 13, 1966 to May 29, 1967; the second was from France, and stayed in Niamey from April 1 to June 30, 1968.

34 The first ONERSOL administration, which lasted from 1966-1968, saw a few tests and prototypes for solar cookers, ovens, and water heaters.[23] The organization's funding was divided into two categories: national and foreign. The former included funding from the Nigerien government, and the latter from the French Fund for Aid and Collaboration (FAC), Libyan aid, the United Nations Development Programme (UNDP), and UNESCO.

35 ONERSOL grew in scope in 1969 with the arrival of Dioffo. At the same time, the FAC granted 32 million CFA francs to ONERSOL—more than double the 1967 budget—to purchase equipment and provide the laboratory with more resources. Then came the arrival of the solar thermodynamic pump Onersol (Figure 6), with a 60 m² collector and an output of 6-7 m³ of water per hour for 5-6 hours.[24]

Figure 6: Photograph of the Onersol pump. Source: private archives Bertrand Châtel.

Experimentation with solar devices (water heaters and solar distillers) led to the first installations in private homes in 1971, as well as in high schools and public buildings. The sale of ten solar distillers paved the way for making this product more widely available. 36

At the same time, in 1966 Niamey launched the Niger School Television (TVSN) program to improve the level of primary school education in rural areas. Two years later, the technical services of TVSN and ONERSOL installed an experimental photovoltaic solar panel to power a television for educational purposes in Gondel, a village near Niamey. This panel (Figure 7) could power a television set for 30 hours per week from October to June.[25] After an application study by the French National Radio-Television Office (ORTF), six other installations followed in 1972; twenty-two classes were equipped in 1973, allowing 800 students 37

20 Résolution 1033 B (XXXVII) – E/RES/1033(XXXVII), Conseil économique et social des Nations Unies, *Nouvelles sources d'énergies*, 1350e séance plénière, 1964, 8-9.
21 CEA, *Sommaire des activités et des réalisations en matière d'utilisation de l'énergie solaire en Afrique*, *op. cit.*, 32
22 Abdou Mahaman Dangon, *A guide to sustainable energy in West Africa* (Cambridge Scholars Publishing, 2020), 67.
23 ONUDI (UNIDO), Niger, *Rapport technique : La situation et les perspectives d'évolution de l'Office national de l'énergie solaire* (Vienna: ONUDI, 1991), 12.
24 Henri Masson, *Rapport sur l'utilisation de l'énergie solaire pour le pompage de l'eau en zones arides*, 1973, 9.
25 National Academy of Science, *Renewable Resources and Alternative Technologies for Developing Countries* (Washington D. C.: Agency for International Development, Office for Science and Technology, 1976), 104-105.

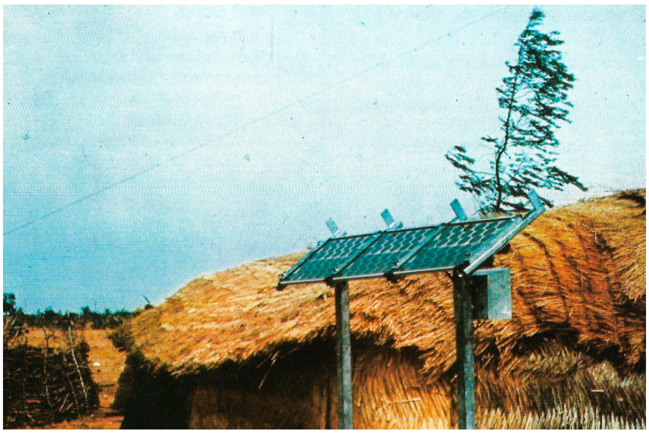

Figure 7: Photograph of the solar panel of a school television in Niger in 1968. Source: RTC La Radiotechnique-Compelec, Cellules solaires, op. cit. 25.

to take advantage of this medium. The government sought to extend this success to 80% of the population by 1985.

38 It should be noted that IPM, LESO, and ONERSOL were not the only ones in West Africa developing solar energy. While they were the most important bodies in this field in the 1960s, there were also some voltaic experiments in Ghana, Guinea, and Ivory Coast.

39 It is increasingly clear that each country did not develop solar energy independently, for there were links between organizations, as suggested by Dioffo's move from LESO to ONERSOL. These links began to take shape in the 1970s, when countries combined their efforts as part of numerous institutional, industrial, and solar projects.

2. EXPANDING SOLAR PROJECTS AND ACTORS (1973-1979)

40 The early 1970s were a time of change in West Africa, one that saw a succession of economic, energy-related, and environmental crises that led to the creation of new institutions and solar efforts in the region.

41 From an institutional point of view, new economic organizations were created in the area: the Mano River Union (MRU) in 1973 and the Economic Community of West African States (ECOWAS) in 1975. These institutions emerged from a broader vision that grew out of the first Pan-African Conference held in Addis Ababa, Ethiopia in 1963, which saw the creation of the Organization of African Unity (OAU).[26] One of the OAU's goals was to foster economic ties between states, especially in the form of customs and monetary unions, as well as to encourage shared exploitation of wealth, rivers, etc.

This period of institutional creation went hand in hand with Nigeria's emergence in West African spheres of influence. The end of the Nigerian Civil War in 1970 allowed Nigeria to become an unquestionable regional and continental power owing to its many natural resources, its population of 80 million inhabitants, and the educational opportunities created by its many universities. The country thus enjoyed unparalleled influence in the region. 42

Creation of the Regional Center for Solar Energy (CRES)

In response to Nigeria's rising power, Francophone states[27] met on June 3, 1972[28] in Bamako as part of a new organization, the West African Economic Community (WAEC). The community was a trade zone involving various areas such as agriculture, industry, transport, and communications, along with solar energy after the signing of ten additional protocols in Abidjan in 1973.[29] 43

Member states of the WAEC and the Permanent Interstate Committee for Drought Control in the Sahel (CILSS) were soon targeted by a UN interagency mission[30] from April 16 to May 3, 1975. The mission, which was organized by the UNDP, 44

26 E. Kane, *Problèmes juridiques et économique de la CEAO* (Master's thesis, Académie économique de Poznań, 1988), 6.
27 Ivory Coast, Dahomey (modern-day Benin), Upper Volta, Mali, Mauritania, Niger, and Senegal.
28 E. Kane, *Problèmes juridiques et économique de la CEAO*, *op. cit.*, 9.
29 CEAO (WAEC), *Rapport sur le colloque énergie solaire et development*, Bamako, 28 September-2 October 1976, 1.
30 The mission consisted of a UNDP representative, who was joined by representatives from UNESCO, the United Nations Industrial Development Organization (UNIDO), and the Office of Technical Cooperation (OTC).

travelled to Senegal, Gambia, Mauritania, Mali, Upper Volta, and Niger in an effort to identify and learn more about research institutions studying solar energy.

45 The mission concluded that Mali and Niger had centralized research policies for solar energy (LESO and ONERSOL), while other countries had multiple organizations. For instance, the EIER, Ministry of Rural Development and Hydraulic and Rural Equipment, and Ouagadougou High School all coexisted in the Upper Volta; the same was true of the General Delegation for Scientific and Technical Research (DGRST), the IPM, and the University Institute of Technology (IUT) in Senegal.

46 Each of these countries studied—at very different levels—how to use solar energy to pump, heat, and distill water, or to dry food for conservation purposes. When the mission was complete, the experts recommended the creation of a Regional Centre for Solar Energy.

47 One year later, WAEC member states met in Bamako from September 28 to October 2, 1976[31] as part of the Solar Energy and Development conference. The gathering provided an opportunity to present the energy-related difficulties faced by countries, as well as to emphasize their energy dependence, the high price of oil, the excessive use of firewood, and their desire to preserve the environment. Solar energy thus held potential for these countries, which called for the creation of a "regional center for solar energy research and development."[32] The project raised great hopes.

48 However, it took two years before the center was officially created during the Fourth Conference of WAEC Heads of State, held in Bamako in October 1978. WAEC heads of state had great hopes for this center, and produced a document entitled *Major Community Projects,* which touched on various issues including the creation of CRES in Bamako.

Following this decision, WAEC member states asked UNESCO to prepare a feasibility report for CRES, which was presented to the economic community a few months later on June 23, 1979. UNESCO called the creation of CRES a "necessity,"[33] and believed that a regional organization would centralize funding, produce photovoltaic solar devices for a large market, create economies of scale that could make solar devices more accessible, and generate profits. 49

The WAEC signed a number of cooperation agreements with CILSS in 1979, in addition to economic partnerships with the Organization of Petroleum Exporting Countries (OPEC), the African Development Bank (ADB), the European Economic Community (EEC), and notably FAC. CRES thus received aid from the international community thanks to the signing of numerous cooperation agreements, and at the same time took advantage of the growth of solar energy research in the region. 50

Intensifying Regional Research on Solar Energy

All of the region's countries developed solar energy on their territory. Niger, Mali, and Senegal were the most advanced in the field, especially with respect to research on solar water heaters. The interest in these devices spread to other countries, with an experimental solar water heater being installed on the roof of the Faculty of Sciences building in Sierra Leone, and on the roof of the villa belonging to the Ivory Coast's minister of tourism. 51

These countries' interest in solar energy is reflected in the existence of no less than twenty-five institutes focusing on this field in the region. In addition to the institutions cited above, there were numerous efforts in various countries, including those of the Department 52

31 CEAO, *Rapport sur le colloque énergie solaire et development, op. cit.*, 1.

32 Anonymous, « Le Colloque de Bamako », *Agecop Liaison, Bulletin de l'Agence de coopération culturelle et technique*, n°32, 1977, 5-6.

33 UNESCO, « Le centre solaire régional de Bamako, Mali. Une étude de l'Unesco », *Le Courrier de l'UNESCO*, 34e année, 1981, 29.

of Non-Conventional Energy of the Ministry of Rural Development in Cape Verde, the University of Abidjan in the Ivory Coast, Kumasi University in Ghana, the University of Conakry in Guinea, five research organizations in Senegal, and those belonging to the University of Sierra Leone in Freetown.

53 In the 1970s, Nigeria alone had ten organizations working in this field. With the exception of the Projects Development Institute in Enugu and the Nigerian Stored Products Research Institute in Lagos, these research organizations were part of universities. The Universities of Calabar, Ife, Jos, and Maiduguri took an interest in these solar subjects. More precisely, Amadou Bello University in Zaria and the University of Ibadan tested Guinard solar pumps in their laboratories, while the University of Nigeria in Nsukka worked on solar refrigeration, and the University of Lagos on the production of solar water heaters.

54 The example of Niger stands out from other countries in that its research contributed to the industrialization of its sector. In fact, Niger's head start in solar research was such that ONERSOL established an industrial production factory for solar devices, the first of its kind in West Africa. A study by the International Labour Office (ILO) in 1975 endorsed this project, with construction lasting from September 1975 to July 1976 in the industrial zone of Niamey. The buildings were paid, to the tune of 75 million CFA francs, by the Nigerien government, while the purchase of equipment was funded by UNESCO's Aid Fund of Saudi Arabia to Sahel Countries.[34] ONERSOL's activities were divided in two: a Research Department, and a Production and Sales Department to expand the production of devices as well as industrial-scale manufacturing of solar water heaters and flat-plate collectors.[35]

The development of solar energy in West Africa cannot be reduced to the work of these research institutes, as it was also inscribed on an international scale, with France playing an active role. 55

France Develops Photovoltaic Solar Energy in the Region

Numerous French companies exported their know-how to West Africa, including SOFRETES, which was created on October 10, 1973[36] by Girardier following UNESCO's international congress entitled The Sun in the Service of Mankind. In 1975, SOFRETES, which specialized in thermodynamic solar energy, secured prestigious funding from the French Atomic Energy Commission (CEA) and the French Petroleum Company (today TotalEnergies), which it used to create the Prométhée economic interest group. This funding helped increase thermodynamic solar activity in West Africa and Mexico in particular. 56

The year 1976 marked a turning point as well as the beginning of a partnership in the solar industry between France and the United States; the latter had previously limited itself to its domestic market, unlike France, which was an export market. This partnership lowered the cost of solar photovoltaic technology, increased production, and gave French companies access to photovoltaic technology, while providing American companies with access to French-speaking markets, and hence those in West Africa.[37] 57

In 1976, the French Petroleum Company—a SOFRETES partner—invested in photovoltaic solar technology by purchasing 51% of the shares of Photon-Power. It then joined forces with the American glass producer Libbey Ford, and secured the Baldwin group's patents in the photovoltaic industry.[38] 58

34 CEA, *Sommaire des activités et des réalisations en matière d'utilisation de l'énergie solaire en Afrique*, *op. cit.*, 32.

35 UNIDO, *Niger, Rapport technique : La situation et les perspectives d'évolution de l'Office national de l'énergie solaire*, *op. cit.*, 12.

36 Sophie Pehlivanian, *Histoire de l'énergie solaire en France, Science, technologies et patrimoine d'une filière d'avenir* (Ph.d. dissertation, Université de Grenoble, 2014), 473-474.

37 Éric Didier, « Les différents accords conclus pour l'utilisation de l'énergie solaire », *Revue Juridique de l'Environnement*, n°4, 1979, 339-348.

38 *Idem.*

59 At the same time, the Leroy-Somer company, which was in the electrical motor industry and had owned Pompes Guinard since 1972, installed the first photovoltaic pump in 1975 in Propriano, Corsica. The following year, Leroy-Somer united with the Société nationale Elf Aquitaine (SNEA) and Piles Wonder to create the GEW economic interest group,[39] in order to produce photovoltaic solar pumping stations in isolated areas and develop solar television, lighting, telephony, radio relays, etc. However, Leroy-Somer had a minority stake in GEW, and in 1977 decided to approach the American company Solarex Corp., the world leader in photo-batteries. Together they created the France-Photon subsidiary,[40] which enabled Leroy-Somer to produce solar panels at lower cost, and in particular to jointly produce the components for its photovoltaic solar pumps, while giving the American company access to West African markets.

60 The year 1976 was decisive for photovoltaic solar energy, especially with the launch of France's New Energy for the Sahel program. This three-year program (1976-1979) created by the Ministry of Cooperation as part of French-African relations would provide funds for French companies seeking to export solar devices, and would also fund projects in West Africa.[41] The goal of the New Energy for the Sahel program was to respond to the urgent issue of access to water. It was behind a number of projects, which bear witness to a technological revolution in West Africa, as well as the transition from thermodynamic to photovoltaic solar energy.

61 This technological revolution in West Africa can be traced through a single person, Father Bernard Verspieren.[42] Faced with the drought that struck the region in 1973, Verspieren created the Mali Aqua Viva association in 1974 to increase hydraulic drilling in Mali, and in 1975 created two drilling workshops in the diocese of the city of San. Hand- or foot-operated manual pumps were initially installed, but their durability was challenged by intensive use and the difficulty of performing maintenance.

In 1976 Father Verspieren travelled to Propriano, Corsica, where he discovered the first photovoltaic solar pump. It had been created in 1975 by Pompes Guinard, and required no motion, thereby reducing use and maintenance compared to manual pumps. Verspieren decided to adapt a new technique for his drilling in Mali by including the population in the effort (doing the groundwork, building walls to protect the pump from livestock, contributing funding for the pump, appointing a pump watchman, etc.) 62

The first photovoltaic solar pumps proved their worth in Africa, competing with thermodynamic solar pumps and eventually outshining them. Let us consider a few figures. There were 42 solar stations in Upper Volta, Mali, and Senegal between 1969 and 1979. The number of installations clearly shows the evolution underway. Between 1969 and 1976, there were 23 solar stations in these three states, 22 of which were thermodynamic solar pumps belonging to SOFRETES, with only one photovoltaic solar pump (Dakar, 1976). However, between 1977 and 1979, there were 26 solar stations: nine were thermodynamic solar pumps belonging to SOFRETES, but 17 were photovoltaic solar stations. 63

In other terms, before the end of the SOFRETES monopoly in the late 1970s, there came an end to the monopoly of the thermodynamic technology embodied by SOFRETES, in favor of photovoltaic solar energy fostered by New Energy for the Sahel program. 64

39 Solar Energy Research Institute (SERI), *Characterization and Assessment of Potential European and Japanese Competition in Photovoltaics*, (McLean, Virginia: SERI, 1979), 3-7.
40 Philippe Barbet, *Les énergies nouvelles* (Paris: Editions La Découverte/Maspero, 1983), 102.
41 Willeke Palz, *Photovoltaic Solar Energy Conference, Proceedings of the International Conference, held at Cannes, France, 27-31 October 1980* (Dordrecht: Reidel Publishing Company, 1980), 136.
42 Bernard Verspieren (1924-2003) was born in northern France to a family of industrialists from Roubaix. He attended the Jesuit Agricultural School in Purpant at the age of 16. Three years later, he joined the Missionaries of Africa (called the White Fathers), and was ordained as a priest in Carthage in June 1950 at the age of 26.

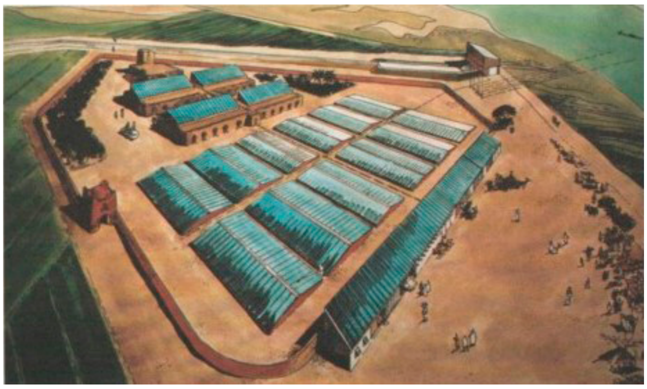

Figure 8: Sofretes' illustration of the Diré project in Mali (1978). Source: Bertrand Châtel's private archives - Sofretes brochure.

65 Amid this rise in the number of photovoltaic solar projects, on November 26, 1979 SOFRETES launched, as a last hope, the world's first solar thermodynamic power plant in Diré, near Timbuktu. This colossal agricultural and tourism project (Figure 8), had a power of 75 kW. It produced enough solar energy to pump water as well as provide electricity, lighting, and air conditioning.

66 The Diré plant was an ambitious project. It cost over 8.5 million CFA francs[43] (approximately 5.1 million euros in 2020),[44] and aimed to eventually irrigate over 3,000 hectares of crops. These characteristics stand in contrast to the installation's short period of activity of less than four years; it quickly became a "white elephant," the first of its kind in the West African solar industry.

67 The project faced numerous challenges. It was located on the edge of the desert far from the capital, with poor accessibility and no infrastructure (no equipped port, no roads, etc.). It could only be reached by boat four months per year. Moreover, during its inauguration, the plant was not connected to the city of Diré, and high-quality potable water was directly poured into the fields. Maintenance staff was kept on site, but none of the inhabitants worked in these new fertile fields, which explains why the local population was not part of the project's implementation.

These combined factors—overly ambitious, difficult to access, costly, and imposed on local populations—led to the abandonment of the colossal project, which in retrospect was economically inefficient, far-fetched, and irrational. This abandonment left a white elephant behind in Diré, and prompted the collapse of SOFRETES, which was wound down in 1983.[45] This presaged the many failures that would come during the 1980s. 68

3. THE FAILED INDUSTRIALIZATION OF THE SOLAR SECTOR (1979-1987)

The international context in the late 1970s was challenging in many respects. The Iranian Revolution (January 7, 1978-February 11, 1979) sparked a new oil shock and economic crisis that hit Africa with full force, just as West Africa was preparing for a new period of drought. This provided an opportunity for countries to refocus on the African continent. 69

The Lagos Plan of Action: Toward the Industrialization of the African Solar Energy Sector

Faced with these difficulties, OAU heads of state met in Lagos (Nigeria) in April 1980 to discuss the continent's economic difficulties and promote endogenous development, in an effort to foster self-sufficient and self-sustained economic growth. They developed the Lagos Plan of Action, a development strategy based on food self-sufficiency and African commerce through the elimination of commercial and customs barriers, limited use of foreign currencies, the industrialization and transformation of local raw materials, and the creation of a single African market. In other words, it amounted to creating an African Economic Community by the year 2000.[46] 70

43 Private archives of Bertrand Châtel – Technical Presentation of the "DIRE" project, undertaken by SOFRETES on June 8, 1977. Prométhée project (study and development of solar energy).

44 Result obtain using the franc-euro converter of the French National Institute of Statistics and Economic Studies (INSEE):
URL: https://www.insee.fr/fr/information/2417794

45 Sophie Pehlivanian, *Histoire de l'énergie solaire en France, Science, technologies et patrimoine d'une filière d'avenir*, *op. cit.*, 478.

46 Adebayo Adedeji, « La situation économique de l'Afrique : vers une reprise ? », *Politique étrangère*, n°3, 1988, 621-638.

71 The Lagos Plan of Action also sought to remedy technological dependence on industrialized countries by using inexpensive technologies to improve the standard of living of rural populations. At the same time, the plan gave importance to environmental issues, as well as to the struggle against deforestation and desertification. It made solar energy one of the objectives and priorities of African policies.[47]

72 The development of solar energy in West Africa was not just regional, as it expanded to include a continental space. The Lagos Plan of Action promoted the development of a pan-African solar industry; this took concrete form with the African Regional Center for Solar Energy (ARCES),[48] which encouraged African scientific research and cooperation on solar energy, the local manufacturing of devices, and industrial production.[49] This project was facilitated by the creation of the Solar Energy Society of Africa (SESA) to facilitate information exchange between countries.[50] The society was created in 1982[51] following the African Regional Solar Energy Conference organized by UNESCO in Nairobi, Kenya. The previous year, in August 1981, the city had hosted the UN Conference on New and Renewable Sources of Energy.

73 Implementation of the Lagos Plan of Action took shape with the launch of the Industrial Development Decade for Africa (1981-1990), which was adopted in October 1981 during the Sixth Conference of African Ministers of Industry. It established a strategy for self-sufficiency in agriculture, electricity, and energy. Industrialization was planned according to two phases: an initial preparatory phase (1982-1984) in which African countries would present their industrialization programs, followed by a second phase (1985-1990) in which the projects would be carried out.

In this favorable context for solar development, two phenomena stand out in the West African region. First, solar research began in multiple countries that had not previously shown interest in the field: Liberia with the research conducted by the Faulkner College of Science and Technology at the University of Liberia; and Togo, where the University of Benin established a Solar Energy Laboratory (SEL) and sought to develop solar water heaters and dryers.[52] In Benin, the Enerdas company undertook research much later, in 1986. Guinea-Bissau was the only country not to take an interest in solar energy during the three decades under study. 74

Beginning in 1980 there was also structural activity in a number of countries, as well as the start of industrial production of solar dryers and water heaters, confirming the efforts made by certain states during the 1970s. This was true of the Center for Study and Research in Renewable Energy (CERER) founded in Senegal in April 1980 with help from the Industrial Society for Solar Energy Applications (SINAES) created a few years earlier. Together they worked from 1982 onward as part of Senegal's Sixth National Development Plan (1981-1986), which sought to reduce the country's oil bill by using solar energy.[53] 75

In Nigeria, the Project Development Agency (PRODA) created the Solar Energy Society of Nigeria (SESN) in March 1980 to produce devices. 76

47 Organisation de l'Unité Africaine, *Plan d'Action de Lagos pour le development économique de l'Afrique 1980-2000* (Geneva: Institut international d'études sociales, 1981), 111.
48 The idea of creating CRAES was proposed in 1976 and adopted on May 13, 1982 at the OAU Conference of Ministers via resolution 337 (XIV). The disputes caused by the center's location brought the project to a standstill, which was ultimately established in Bujumbura, Burundi in 1986, although member states did not pay their contributions, with the center's activity suffering considerably as a result.
49 Commission économique pour l'Afrique, *Rapport du séminaire régional sur l'énergie solaire en Afrique*, Niamey, 12 February 1979, 35.
50 Commission économique pour l'Afrique, *Projet d'acte constitutif de la société africaine de l'énergie solaire*, Niamey, 14 November 1978, 8.
51 Félix Malu Wa Kalenga, *Science et technologie en Afrique (Histoire, leçons et perspectives)* (Brussels: Académie royale des sciences d'Outre-mer, 1992), 135.
52 PNUD, *Togo : Problèmes et choix énergétiques*, Rapport n°5221-TO, Report by the joint UNDP/World Bank program to promote energy choice management, June 1985, 91.
53 ECREEE, *Ecole supérieur polytechnique de l'Université Cheikh Anta Diop de Dakar, Senegal, Rapport de l'étude de marché du solaire thermique : production d'eau chaude et séchage de produits agricoles* (Dakar: ECREEE, 2015), 23.

This did not prevent the Agricultural Engineering Department of Ahmadu Bello University in Zaria to work on the production of solar dryers, or the National Electric Power Authority to produce solar water heaters for hotels, hospitals, private residences, and the country's important complexes.

77 In Burkina Faso, solar energy had been synonymous with national independence since the coup d'état of November 1980. The Burkina Energy Institute (IBE)[54] and the Solar and Appropriate Technology Workshop of the Albert Schweitzer Ecological Center produced solar devices. There was an increase in the number of solar pumps installed, as well as experiments in telecommunications.

Structural Adjustment Plans Hamper Solar Industrial Development

78 In the early 1980s, the economic situation of West African states deteriorated considerably. The Iranian Revolution and the Iran-Iraq War raised the price of oil, while industrialized countries lowered their imports, leading to a fall in the price of Africa's primary export products (coffee, copper, cocoa, bananas, vegetable oil, tea). The continent's countries lost considerable income, leading to mounting over-indebtedness: the population's income decreased, even as demographic growth continued. Furthermore, in 1982 a new dry spell struck the region, leading to malnutrition and disease. Water shortages decimated herds and shrank grain production; import needs were considerable, with the already-substantial debt ultimately exploding.[55]

79 Faced with the difficulties of states to repay their debts, the International Monetary Fund (IMF) and the World Bank offered loans to African countries, who accepted to proceed with large-scale structural reforms of their economies. The goal was to redefine the very role of the state—deemed corrupt and inefficient—by liberalizing economic activity through massive privatizations designed to reduce the weight of companies on public accounts. The state was called upon to refocus on its regalian functions, such as law enforcement, information, healthcare, research, and education.[56] The structural plans of the Bretton Woods institutions sought to promote agricultural development for export—to generate cash to reimburse the debt and restore the trade balance—rather than for industrialization. These adjustments brought an end to the Lagos Plan of Action, and subjected states to greater dependence on foreign aid.[57] These difficulties had a direct impact on the industrialization of the solar sector in multiple states (Ivory Coast, Gambia, Guinea, Mali, Mauritania, and Niger).

As each country cannot be discussed in its entirety here, I will focus on the example of Niger, which is no doubt the most compelling case. 80

It is important to recall that on May 15, 1975, ONERSOL was a pioneer in the field, and was divided into two entities: a research department, and a production-sales department. The ILO recommended the production of 400 water heaters and 2000 m² of flat-plate collectors per year for the project to be economically viable. However, between 1976 and 1990, ONERSOL only produced 600 solar water heaters and 1750 m² of flat-plate collectors. What happened? 81

The production of solar devices took a nosedive. ONERSOL produced solar cookers, water heaters, flat-plate collectors, and dryers. However, solar cookers were not accepted by the population on the ground: distilled water was considered a luxury product, as were solar dryers, which were prohibitively expensive. Only solar water heaters enjoyed a certain measure of success, although the targets were very far from being met. 82

54 UNECA, *L'influence des politiques économiques et de development sur la science et la technologie en Afrique*, Section de la science et technologie au service du development en Afrique, March 1994, 50.

55 Adebayo Adedeji, « La situation économique de l'Afrique : vers une reprise ? », *op.cit.*, 621-638.

56 Olivier Lafourcade, Michèle Guerard, « Banque Mondiale et ajustement structurel *», Revue d'économie financière*, Hors-série 4, 1994, 355-367.

57 BAD (ADB), *Rapport économique sur l'Afrique : 1985* (Addis Abeba : BAD, 1985), 19.

83 Aside from orders for solar water heaters (46 units) and flat-plate collectors (590 m²), during 1981-1982 and 1982-1983 respectively, the sale of solar devices was very low each year (approximately 15 water heaters).[58] Was this the result of poor publicity?

84 In 1981, a number of water heaters were ordered to equip Hotel Gaweye, with inconclusive results; a new order was placed the following year to add flat-plate collectors and increase the power of the water heaters, although this proved ineffective, for the addition of 10% of conventional heating proved necessary as a supplement. This generated bad publicity for ONERSOL, as hot water was needed early in the morning and at night, two times that were not favorable to the optimal functioning of solar devices.

85 ONERSOL ran deficits each year. On October 7, 1983, its production department became an independent *société d'économie mixte* (semi-public corporation) named the New Energies Company of Niger (SONIEN), which tried to open up its capital to a number of Nigerien companies. However, in 1984, the Structural Adjustment Program of the IMF and World Bank reorganized the Nigerien state's spending, and required state companies to have total financial autonomy. With no aid, SONIEN considerably raised the price of the rare products it was able to sell: the price of a solar water heater rose from 182,000 to 350,000 CFA francs. This untenable situation led to the liquidation of the recently-formed SONIEN in December 1984.[59] Only ONERSOL's research department remained.

The Industrial Collapse of CRES and the Private Sector's Monopoly over Solar Production

86 The story of SONIEN is representative of a phenomenon affecting a large number of countries in West Africa during this period, and at the time demonstrated the need to implement a larger-scale solar project in the form of CRES. This regional center included a broader scope—supported by the Lagos Plan of Action—and was framed by the creation of continental institutions such as ARCES and SESA.

Following UNESCO'S feasibility study for the CRES project in 1979, a second study was conducted in 1981 to include WAEC and CILSS member states. It provided for the implementation of a Regional Program for Solar Education and Training (PREFAS) for the 1981-1984 period, which would allow eleven states[60] to train qualified personnel at the center, finish building the CRES building in Bamako, and study an industrial strategy for producing solar devices. 87

CRES led an ambitious program beginning in 1982, with an annual production of 1,000 drilling sites, 700 photovoltaic solar pumps, 300 windmills, 100 refrigerators, 3,300 lighting systems, 300,000 cookers, 2,000 water heaters, and 10,000 m² of flat-plate collectors, for a total cost of $82.5 million per year, with 90% of support coming from West African public funds.[61] The project involved the creation, in every WAEC/CILSS member state, of a solar industry directly connected to CRES in Bamako. The European Development Fund (EDF), UNDP, the US Agency for International Development (USAID), France, the Federal Republic of Germany (FRG), and the African Development Fund (ADF) financed the implementation of CRES (training, equipment, buildings). 88

During an assessment mission in May 1983, the African Development Bank considerably reduced the project's scope, notably by cutting staff from 207 to 83 individuals, and by reducing the center's cost to $57.1 million: OPEC, the ADF, and WAEC countries would fund the center's construction, while the FRG, France, EDF, and WAEC would pay for equipment. 89

The official construction of CRES began in 1984, a decisive year that saw a project that had been in the planning stages for nearly six years finally 90

58 ONUDI, *Rapport technique : La situation et les perspectives d'évolution de l'Office national de l'énergie solaire* (Vienne : ONUDI, 1991), 28-29.
59 *Ibid.*, p. 14.

60 Benin, Burkina Faso, Cape Verde, Ivory Coast, Gambia, Guinea-Bissau, Mali, Mauritania, Niger, Senegal, and Chad.
61 CEAO/CILSS, *Séminaires CRES – Documents de discussions juin-juillet 1982* (Bamako: CRES, 1982), 34.

take form. This would be the year to "create production capacity within the region [...] [and to] create an equipment production company on the level of CRES"[62] during the 1985-1987 period. In October 1985, a meeting of experts from WAEC and CILSS member states was held to create a Production Unit for Renewable Energy Systems (UPS) in Bamako to produce photovoltaic solar panels and solar water heaters.[63] This was confirmed and adopted in March 1986 during the first CRES Board of Directors meeting in Bamako.

91 It would be fruitful at this point to explore the synchronism between the collapse of solar industries in a number of states (Niger in 1984, Ivory Coast and Gambia in 1985 in particular) and the establishment of a regional solar industry in Bamako between 1984-1986. Was it a simple coincidence or a reaction to the failures of national solar industries? While there is no document to confirm it, the dates and context bear mentioning.

92 In a major surprise, during the 25th session of the Council of Ministers in Ouagadougou in May 1988, we learn that the backers (EDF, France, FRG) had withdrawn from their financing agreements for CRES the previous year (1987).[64] This sudden withdrawal brought CRES to a standstill. The delay, absence of equipment, and lack of funding froze its activity while awaiting new backers, only in vain.

93 The withdrawal of European backers was justified by the solar organization's undue size, the overlap between the activities of national institutes and the regional institute, and by the low participation of WAEC member states in financing for CRES. This decision sparked a strong reaction from the other backers (WAEC, ADF, and OPEC). The ADF questioned the truthfulness of statements by European backers. "These reasons are more pretexts than solid justifications."[65] The African backer believed that the criticisms of European funds were technical issues that could be resolved, and that the FRG, France, and the EDF were impervious to the solutions offered. The ADF was indignant, and asked whether the interest of European sponsors was quite simply located elsewhere:

> "The economic issue is clear: CRES as envisioned by WAEC could prove to be a formidable competitor to European companies specializing in solar energy, which would be unacceptable to European backers. Despite their clearly stated commitment to help finance the project based on defined amounts, European partners (EDF, France, FRG) unexpectedly ended their participation in the project, even as the operation had been launched and was in need of their support as planned."[66]

It would only provide a partial picture to limit oneself to the ADB's point of view, for it is also important to consider the global economic and energy context that took advantage of the consequences of the oil counter-shock, with the price of a barrel of oil falling from \$30 to \$14 between 1985 and 1986. In France, the CEA's solar subsidiary was experiencing difficulty, and lacked both resources and staff. Moreover, as 70% of French electricity was produced from nuclear energy, interest in solar energy diminished considerably. The political cohabitation that began in France in March 1986 prompted the Chirac government to deeply disengage from solar energy. Similarly, the missions of the French Agency for Energy Management (AFME) were also reoriented, with solar energy being placed at a disadvantage in relation to other renewable energies.[67] One could therefore suppose that a change in policy in France would lead to the 94

62 *Ibid.*, p. 40.

63 CEAO/CILSS, *Rapport Final, Réunion des Experts des Pays Membres du CRES sur le Programme Régional d'Equipements en Energies Renouvelables et l'Etude de Stratégie Industrielle pour la Production de Systèmes* (Bamako : CRES, 1985), 6.

64 ADF, *Rapport d'achèvement de projet, Centre régional d'énergie solaire de la Communauté économique de l'Afrique de l'Ouest (CEAO)*, Report drafted by M.T.P Seya (Mission Director) and Ms. R. Coffi Berte (Architect) for the ADF, March 1995, 7.

65 *Idem.*

66 *Idem.*

67 Sophie Pehlivanian, « Histoire de l'énergie solaire en France, Science, technologies et patrimoine d'une filière d'avenir », *op. cit.*, 484-485.

cancellation of the commitment made to CRES, although this does not explain the simultaneity of the three withdrawals.

During the same period, the Heads of State of CILSS member states met in Praia, Cape Verde in October 1986 to develop a strategy to combat drought in the region and promote develop-
95 ment in the Sahel beginning in 1988 thanks to financing from the EDF.[68] One of the components of this strategy was the Projet énergie (Energy Project) of May 1987, which was limited to promoting the use of butane gas. This limitation was quickly rectified, for the following year (1988) CILSS and the EEC published the *Regional Solar Programme (RSP). Sahel: Solar Energy for Tomorrow?*,[69] a publication that modified the Projet énergie and ultimately reserved a central role for solar energy.

96 The RSP provides photovoltaic solar equipment on a large scale for rural areas in the Sahel, in an effort to improve standard of living, ensure food security, and protect the environment (electrification, cold production, water pumping). Thanks to the production of hundreds of solar devices, the RSP and the Western private sector secured a monopoly over solar projects in West Africa.

CONCLUSION

97 This brief history of solar energy in West Africa shows the transition from solar development managed by states in the 1960s, to the one led by the private sector in the late 1980s, which still holds true today. The interest of states in solar energy translated into a desire to use an abundantly-available resource, thereby limiting imports and the deforestation that was accelerating desertification in the region. In other words, it involved producing energy by using a technology well-adapted to the West African environment.

Solar energy was also a response to the var- 98
ious crises experienced by the West African region. Independence, the first drought (1968-1974), the first oil crisis with the ensuing energy and economic crises, the second oil crisis, the global recession, the second drought (1982-1984), and the debt crisis all had direct and indirect impacts on the development of solar energy.

This history emphasizes two complementary 99
and fundamental notions for every West African state: development and (in)dependence.

With regard to development, it went hand in 100
hand with major conferences—during a time of major scientific innovation—seeking to increase exchange among scientists, present advances, and promote solar research. Development was also reflected in increased activity, as well as the vision of the Lagos Plan of Action to promote endogenous and self-sufficient growth, and to industrialize the continent so that it could achieve independence.

The political independence of the early 1960s was 101
followed by economic and energy independence, which proved to be an on-going battle through the creation of WAEC and CRES. Solar technology provided energy that was available on-site, with no need for transportation or import, thereby contributing to independence. On the contrary, foreign companies from outside of Africa had more advanced technologies as well as the financing to help establish solar energy on the continent. The line between dependence and independence was thus very fine when a village had to import foreign technology in order to gain energy independence. Finally, the drive for independence was expressed through the drive of states to industrialize their solar industry, despite struggling to obtain the expected results.

The failure of industrialization is all the more 102
striking given the solar potential of West African states, leaving aside the fact that the West African solar industry could have contributed to the EEC's Regional Solar Programme (RSP) in 1988.

68 CILSS, *Compte rendu de la 22ème session du Conseil des ministres* (Ouagadougou: CILSS, 28-29 January 1987), 4.
69 Jean-Paul Minvielle, *La question énergétique au Sahel* (Paris: Karthala, IRD, 1999), 160.

103 For that matter, researchers generally begin the history of solar energy in the region with the RSP. However, this history—which could also be called a protohistory in light of these elements—actually began with the independence of 1960. This forgotten history has emphasized the evolutions observed over three decades, and has presented a globalizing and liberalizing West African economy. This history is a vital key for understanding the foundation on which solar development in the region is based today.

Bibliography

Adedeji Adebayo
« La situation économique de l'Afrique : vers une reprise ? », *Politique étrangère*, n°3, 1988, 621-638.

Banque africaine de développement (BAD)
Rapport économique sur l'Afrique : 1985 (Addis Abeba : BAD, 1985).

Barbet Philippe
Les énergies nouvelles (Paris : La Découverte/Maspero, 1983).

Caille Frédéric
« L'énergie solaire thermodynamique en Afrique. La Société française d'études thermiques et d'énergie solaire, ou Sofretes (1973-1983) », *Afrique contemporaine*, n°1-2, 2017, 65-84.

Centre pour les énergies renouvelables et l'efficacité énergétique de la CEDEAO (ECREEE)
Ecole supérieur polytechnique de l'Université Cheikh Anta Diop de Dakar, Sénégal, Rapport de l'étude de marché du solaire thermique : production d'eau chaude et séchage de produits agricoles (Dakar : ECREEE, 2015).

Comité inter-État de lutte contre la sécheresse au Sahel (CILSS)
Compte rendu de la 22ème session du Conseil des ministres (Ouagadougou : CILSS, 28-29 janvier 1987).

Communauté économique d'Afrique de l'Ouest (CEAO)
Rapport sur le colloque énergie solaire et développement, Bamako, 28 septembre-2 octobre 1976.

Communauté économique d'Afrique de l'Ouest (CEAO), Comité inter-État de lutte contre la sécheresse au Sahel (CILSS)
Séminaires CRES – Documents de discussions juin-juillet 1982, (Bamako : CRES, 1982).

Communauté économique d'Afrique de l'Ouest (CEAO), Comité inter-État de lutte contre la sécheresse au Sahel (CILSS)
Rapport Final, Réunion des Experts des Pays Membres du CRES sur le Programme Régional d'Equipements en Energies Renouvelables et l'Etude de Stratégie Industrielle pour la Production de Systèmes (Bamako : CRES, 1985).

Dangon Abdou Mahaman
A guide to sustainable energy in West Africa (Cambridge Scholars Publishing, 2020).

Didier Éric
« Les différents accords conclus pour l'utilisation de l'énergie solaire », *Revue Juridique de l'Environnement*, n°4, 1979, 339-348.

Economic Commission for Africa
Utilization of solar energy, Resolution 113 (VI) adopted by the Commission at its 113th plenary meeting on 2 March 1964, Addis-Ababa, 1964.

Economic Commission for Africa
Sommaire des activités et des réalisations en matière d'utilisation de l'énergie solaire en Afrique, Niamey, 20 décembre 1978.

Economic Commission for Africa
Rapport du séminaire régional sur l'énergie solaire en Afrique, Niamey, 12 février 1979.

Economic Commission for Africa
L'influence des politiques économiques et de développement sur la science et la technologie en Afrique, Section de la science et technologie au service du développement en Afrique, Mars 1994.

Fonds africain de développement (FAD)
Rapport d'achèvement de projet, Centre régional d'énergie solaire de la Communauté économique de l'Afrique de l'Ouest (CEAO), Rapport rédigé par M.T.P Seya (Chef de mission et Mme R. Coffi Berte (Architecte) pour le FAD, Mars 1995.

Gecit Jean
Les énergies nouvelles en Afrique de l'Ouest. Des recherches scientifiques aux défis industriels (1960-1987) (Thèse de doctorat en histoire, Sorbonne Université, 2020).

Girardier Jean-Pierre
L'homme qui croit au soleil, un pionnier de l'énergie solaire (Paris : Les éditions du Cerf, 1979).

Kane E.
Problèmes juridiques et économique de la CEAO (Thèse de maitrise, Académie économique de Poznań, 1988).

Lafourcade Olivier, Guerard Michèle
« Banque Mondiale et ajustement structurel », *Revue d'économie financière*, Hors-série 4, 1994, 355-367.

Malu Wa Kalenga Félix
Science et technologie en Afrique (Histoire, leçons et perspectives), (Bruxelles : Académie royale des sciences d'Outre-mer, 1992).

Masson Henri
« Institut de physique météorologique de la Faculté des sciences de Dakar », *Bulletin COMPLES, Coopération méditerranéenne pour l'énergie solaire*, n°2, 1962, 7.

Minvielle Jean-Paul
La question énergétique au Sahel (Paris : Karthala, IRD, 1999).

National Academy of Science
Renewable Resources and Alternative Technologies for Developing Countries (Washington D. C.: Agency for international development, Office for Science and Technology, 1976).

Organisation de l'Unité Africaine (OUA)
Plan d'Action de Lagos pour le développement économique de l'Afrique 1980-2000 (Genève : Institut international d'études sociales, 1981).

Organisation des Nations Unies pour l'éducation, la science et la culture (UNESCO)
Arid Zone Programme: report of the second session of the Advisory Committee on Arid Zone Research, 3-5 September 1951 (Paris: UNESCO, 1951).

Organisation des Nations Unies pour l'éducation, la science et la culture (UNESCO)
The Problems of the arid zone: proceedings of the Paris Symposium, (Paris: UNESCO, 1962).

Organisation des Nations Unies pour l'éducation, la science et la culture (UNESCO)
Rapport de consultation sur la politique scientifique au Mali (Paris : UNESCO, 1968).

Organisation des Nations Unies pour l'éducation, la science et la culture (UNESCO)
« Le centre solaire régional de Bamako, Mali. Une étude de l'Unesco », *Le Courrier de l'UNESCO*, 34e année, 1981.

Organisation des Nations Unies pour le développement industriel (ONUDI), Niger
Rapport technique : La situation et les perspectives d'évolution de l'Office national de l'énergie solaire (Vienne : ONUDI, 1991).

Palz Willeke
Photovoltaic Solar Energy Conference: Proceedings of the International Conference, held at Cannes, France, 27-31 October 1980 (London: Reidel Publishing Company, 1980).

Pehlivanian Sophie
Histoire de l'énergie solaire en France, Science, technologies et patrimoine d'une filière d'avenir (Thèse de doctorat, Université de Grenoble, 2014).

Programme des Nations Unies pour le développement (PNUD)
Togo : Problèmes et choix énergétiques, Rapport n°5221-TO, Rapport du programme conjoint PNUD/Banque Mondiale pour favoriser la maitrise des choix énergétiques, juin 1985

Solar Energy Research Institute (SERI)
Characterization and Assessment of Potential European and Japanese Competition in Photovoltaics, (Mc Lean (Virginia): SERI, 1979).-Woillet Jean-Claude, Allal Maise, *Répertoire des Instituts africains de technologie*, (Genève, Organisation internationale du travail, 1984).

[Auteur inconnu]
« Le Colloque de Bamako », *Agecop Liaison, Bulletin de l'Agence de coopération culturelle et technique*, n°32, 1977, 5-6.