17 Demand-side Flexibility to Address Household Energy Poverty in Sub-Saharan Africa

The Case of Burkina Faso and Madagascar

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17.1 Introduction

The European concept of energy poverty, which primarily concerns a household's inability to heat its living space, is largely unsuitable for Africa due to its hot and humid climate, where temperatures frequently fall between 22°C and 30°C. Instead, energy poverty on the continent is linked to the fact that people have little or no access to modern energy sources and services, such as electricity. On November 15, 2022, the world's population reached 8 billion people. With over 950 million people, Sub-Saharan Africa is the most electricity-poor region in the world[1]. In 2020, 568 million people had no access to electricity (out of 733 million globally), while one billion people relied on traditional biomass as their main source of energy for cooking (IEA et al., 2022). Less than half of the population has access to electricity, mainly in rural areas. Despite committed efforts, energy poverty persists and remains a severe problem.

Access to modern energy is at the core of the UN Sustainable Development Goals (SDGs), adopted in 2015. In particular, Goal 7 focuses on "Clean and affordable energy". It considers energy to be at the heart of all current and future social and economic challenges and opportunities. It suggests that access to modern energy is a fundamental human right, enabling other rights to be fulfilled such as health, well-being, education, social inclusion, and empowerment (Hesselman et al., 2021). It is critical to advance gender equity by helping women fulfil their professional and personal aspirations (e.g., storing food for eating and selling, recharging their phones, and watching television).

Based on the case of two Sub-Saharan African countries (Burkina Faso and Madagascar), this chapter examines the meaning and challenges of energy poverty and the responses provided by electrification programmes in these countries. It critically examines the relevant policies and programmes developed in these countries. The aim is to answer the question of *how to do better with the limited infrastructure available on the continent?* Better still, *can innovative tools like electricity-as-a-service and energy demand flexibility address household energy poverty?* Direct consumer participation is at the heart of the reflection, whether through energy-as-a-service or demand-side flexibility, that is, when a consumer (prosumer) adapts their consumption to production, price signals, or market incentives. Those tools aim to improve the existing access to electricity rather than add new layers.

This chapter focuses on provoking a conversation beyond the challenge of lacking access to electricity, raising the question of reliability and quality of supply in the African context. Given the extremely high prices and supply security issues in Europe, the experience of African countries, built on scarcity together with resilience logic and adaptation to economic and social constraints, makes it all the more relevant.

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The discussion will make four stops. After methodological and conceptual clarifications, a brief presentation of the energy situation in Burkina Faso and Madagascar will be given. The challenges of energy poverty in these two countries and the responses provided by electrification programmes linked to digitalisation will then be analysed in the third portion. Finally, the fourth and last will attempt to show how the experience of African countries can be a source of inspiration for European countries facing increasing difficulties in accessing energy.

17.2 Methodological and conceptual clarifications

17.2.1 Methodological clarifications

This chapter is based on field and documentary data collected within the framework of the EU-funded EURICA project (project WP 15 – LEAP-RE EU Grant Agreement 963530). The LEAP-RE programme seeks to create a long-term partnership between African and European stakeholders in a quadruple helix approach involving government (programme owners and funding agencies), research and academia, the private sector, and civil society. It is organised into three pillars: external research funding and capacity-building activities; eight key projects; and management, coordination, monitoring, and evaluation.

EURICA is one of the key projects of the second pillar. To rapidly develop access to electricity services for African populations, EURICA mostly works on the backbone: existing infrastructure and networks. These must be reliable, decarbonised, decentralised, and intelligent (in the sense of "digital"). EURICA combines a top-down and bottom-up strategy to bring together individual electrification practices and support the development of transmission networks. This will address immediate and long-term challenges, such as maintenance and expansion.

The bottom-up approach, set up in Ambanja, Madagascar, interconnects existing small microgrids called "nanogrids". It aims to improve the quality of service and achieve a higher level of electricity access. It relies on an "electricity-as-a-service" model. The top-down approach in Ouagadougou, Burkina Faso, aims to improve the service in locations connected to the grid and make the area more resilient by promoting Distributed Energy Resources (DER). DER provides digital tools to facilitate their insertion into the grid and create a local flexibility market to reduce congestion problems with limited impact on the population. The project supports the take-off of data-driven methodology rather than time-consuming and costly physical network expansion. It enables local community engagement and creates local energy markets. This leads to flexibility management and improves mini-grid stability and supply reliability. All in all, it maximises local, sustainable, and cost-effective energy resource management and use.

For the project to gain insights into the views and experiences of specific populations, the authors conducted 67 in-person and remote interviews across Burkina Faso, Madagascar, and Cameroon[2] in the winter and spring of 2022. They used qualitative methods such as in-depth user and expert interviews, as well as participatory observation. The participants were selected according to their profiles and availability at the agreed times (e.g., availability had to match the travel schedules to Madagascar and Ouagadougou). The interviewees belonged to the direct and indirect networks of the project partners (contact persons). The authors' analysis aimed to uncover the underlying logic of interviewees and communities, focusing on induction from facts to ideas. The author used qualitative data analysis software and coding interview transcripts for coherent interpretation. While the authors' sample is not statistically representative, it aims to highlight and explain social realities linked to electricity consumption, integrating diverse stakeholders.

Table 17.1 List of interviewee categories

Categories of interviewees	*Cameroon*	*Burkina Faso*	*Madagascar*
Academia	2	2	
Agriculture/other businesses	3		
Business/Economic Interests (solar sector)		8	6
Consumers and end-users	9	3	6
Government Officials	4		1
International donors		4	1
Illegal distributors	3		
Local NGOs		1	2
Regulators	1		
Utilities/Distributors	4	5	
Other		1	1
Total	26	24	17

Source: The authors.

17.2.2 Conceptual clarifications

Given the context, the authors provide definitions to clarify what the debate is about.

17.2.2.1 "Flexibility" and decarbonising the energy sector

Today, the energy sector is responsible for roughly three-quarters of the greenhouse gases that cause climate change (heat, electricity, and transport) (Ritchie & Roser, n.d.). Therefore, it is essential to decarbonise this sector, that is for it to no longer rely on the combustion of fossil fuels, such as oil, gas, and coal. On the contrary, decarbonisation depends on using more energy from renewable sources, such as electricity produced by photovoltaic solar panels or wind turbines. However, electricity remains difficult to store, so it must be consumed when it is available in abundance. All around the world, grids and networks are the energy systems' backbones. They need to become more resilient to make space for renewables, absorb structural shocks, and implement energy efficiency much faster.

Thus, to allow renewable energies to reach their full potential and for networks to function correctly, three other Ds accompany decarbonisation: digitalisation, decentralisation, and democratisation of networks and production (Soutar, 2021).

Decentralisation is essential to developing renewable energies and corresponds to the situation where production is as close as possible to the final user. It avoids transporting electricity over very long distances, with all the associated costs and risks of loss. Transmission and distribution system operators are key players in enabling this. They are the entities responsible for transporting, distributing, and managing energy from the generation sources to the final user. They must constantly engage with regulators, policymakers, suppliers, and energy service providers (Brisbois, 2020). Digitalisation enables the monitoring of the flows and production of renewable energies and allows industries and energy-consuming appliances to adapt the time of consumption to the time of production. This is what is called demand-side management or flexibility.

Flexibility can be implemented automatically (in industry or with aggregators) or manually (i.e., by starting a washing machine or charging an electric vehicle when the solar panels are working at full capacity). Demand flexibility refers to the fact that consumers can also participate in the balance of the power system by intentionally changing their consumption (Herc et al., 2022). Therefore, the correlate is the direct participation of citizens – a phenomenon summarised as the “democratisation” of the energy sector, especially when the electricity they produce is shared with other users (Wahlund & Palm, 2022). It can increase the capacity for individual action, especially for those belonging to traditionally marginalised groups, such as women, indigenous communities, and vulnerable communities (Stephens, 2019).

17.2.2.2 Electricity-as-service

Energy-as-a-service (EaaS) is a business concept in which clients pay for an energy service without making any upfront capital commitment. EaaS models often take the form of a subscription for electrical equipment held by a service firm or energy use management to supply the required energy service.

The consumer benefits from avoiding direct power payments, costly updates for electrical equipment or software, or device administration while still enjoying the benefits of the gadget. EaaS, like other service models, may make better technology (such as energy devices and software) more available, benefiting customers, service companies, and the electrical grid (Cleary & Palmer, 2019).

17.2.2.3 Energy poverty

Energy poverty in Europe is defined as the lack of thermal comfort for households that cannot afford associated energy costs due to insufficient thermal quality (Bouzarovski et al., 2021). However, defining energy poverty in Africa is more complex due to varying socio-economic, urban, and climatic contexts. The lack of access to reliable, affordable, and sustainable energy services hinders development and makes Africa vulnerable to shocks. Cities are generally connected, whereas rural areas remain in the dark. Some areas of Sub-Saharan Africa do not need heating at all, while the need for cooling is much more urgent. Women, children, minorities, and indigenous groups are the most vulnerable (IEA et al., 2022). As a result, individual solutions such as diesel-powered generators or individual solar kits are proliferating.

The multi-tiered framework (MTF) has been developed to ensure access to quality and affordable energy services for development (Bhatia & Angelou, 2015; ESMAP, n.d.). Therefore, energy poverty in Africa refers to all situations where access to adequate, affordable, reliable, quality, safe, and sustainable energy services for development is not assured. This definition emphasises the importance of electricity quality, supply continuity (vs. untimely outages), and affordability (Anuga & Njenga, 2022).

Although initially European concepts, energy flexibility, decarbonisation, and energy poverty are crucial for Africa’s human and economic development.

17.2.3 Energy situation and prospects in Burkina Faso and Madagascar

17.2.3.1 Energy situation and prospects in Sub-Saharan Africa

Regarding population growth, Sub-Saharan Africa now has over 800 million people. It is rising at more than 5 per cent annually (2.4 per cent in Madagascar, 2.7 per cent in Burkina Faso). By 2050, the African population might double (SEforALL Africa Hub, 2023; World Bank, n.d.). Fossil fuel costs are rising, subsidies are decreasing, and deforestation is increasing the cost of biomass. As a result, the cost of conventional alternatives to electricity (wood, candles, paraffin lamps, etc.) is rising even if the demands are mostly unchanged. This confluence of causes will likely increase already widespread poverty (IEA et al., 2022).

In parallel, the quick adoption of Western energy consumption norms (without most of the energy efficiency regulations), the adoption of the digital economy, and the accompanying appliances are driving the use of electricity for personal needs (from domestic appliances to smartphones, computers, servers, televisions, DVD players, radios, and Hifi). Innovative energy service models offered by private and public stakeholders are proliferating. For example, many African users still lack access to domestic energy while relying on their phones for everyday tasks. The growing popularity of electricity-as-a-service decentralised mobile phone charging stations illustrates such a phenomenon (Eun Hee et al., 2022; Victron Energy, n.d.).

As a result, embracing clean, modern energy sources is already a reality for many Africans. The continent could leapfrog from a situation of no energy access to abundant, emission-free sources, with the potential to be a springboard for society. However, as stated in SDG 7, social justice, particularly gender equality, must be prioritised in policies and activities. This will guarantee that communities' potential is fully realised and everyone benefits from higher living standards (Colantoni et al., 2021; SE4All, n.d.).

17.2.3.2 Energy poverty and access in Burkina Faso

Burkina Faso is one of the poorest and least electrified countries globally, as less than 20 per cent of the population receives access to electricity. Access to electricity is uneven and depends strongly on where people live; around 65 per cent of urban households are electrified compared to less than 5 per cent of rural households. Therefore, the national figure of 18.6 per cent hardly reflects reality and progress on the ground, despite some progress in the past decades. In 2010, the actual access rate to electricity was barely 13 per cent.

The country's energy demand is growing, driven by industrial consumption, transport needs, population growth, and urban domestic demand. Currently, the energy system overly relies on solid fuels, such as biomass. Non-solid fuels' access only reaches around 8 per cent nationally (SEforALL Africa Hub, 2023). Despite having tremendous solar potential and recent investments in these technologies, most electricity remains produced by fossil fuels (90 per cent in 2020), especially in diesel-fuelled power plants. Hydroelectricity accounts for only 10 per cent of production. Therefore, the country's population and economy are particularly vulnerable to variations in oil prices. Hence, the government heavily subsidises the electricity sector to limit the adverse effects of rising oil prices on electricity production (Alliance Sahel, 2020).

Pushed by international donors, Burkina Faso's government sets ambitious electrification targets regularly. The most recent objective is to achieve 95 per cent electricity access in urban areas in 2030 (SEforALL Africa Hub, 2023), with a threshold of 75 per cent by 2025 (Coulibaly, 2021). Access to clean cooking should also be extended to cover 100 per cent access in urban areas against 65 per cent in rural areas by 2030.

17.2.3.3 Energy poverty and access in Madagascar

Madagascar also experiences endemic poverty, and people are 42 per cent poorer today than in 1960, the year of Madagascar's independence (World Bank, 2018). Concerning energy specifically, the Malagasy population heavily relies on biomass. About 80 per cent of the island's energy consumption comes from plant and animal sources[3]. Madagascar's electrification level is among the lowest in Africa and the world. About 16.5 million people did not have electricity in 2019, with huge disparities. 80 per cent of the urban population had access, compared to 23.1 per cent of the rural population (IEA et al., 2022; World Bank, n.d.). The actual – or usable – levels might be lower. According to SE4All, at the end of 2018, 21 per cent of households in Madagascar had Tier 1 equivalent or higher electricity access per the MTF. Level 1 is the most basic level of access to electricity. It corresponds to task lighting and phone charging for at least four hours during the daytime and at least one hour in the evening.

Based on the social, cultural, economic, and energy situations in Burkina Faso and Madagascar and the challenges and significance of fuel poverty, we examine the electrification programmes in these countries and present proposed solutions from the EURICA project.

17.2.4 Innovative models to serve local needs: examples from Madagascar and Burkina Faso

17.2.4.1 Madagascar (Ambanja): serving local needs through a flexible "energy-as-a-service" model

Due to territorial complexity and the distance between large cities and remote hamlets from distribution lines, many rural Malagasy areas are completely excluded from national electrification plans. Private and non-profit organisations are stepping in, seeking solutions to enable households to benefit from minimal access to electricity. Solar kits and diesel generators are widespread but often insufficient, and their quality and durability are often questionable. Above all, these measures seem to do little to fill the gaps in electrification needs.

According to field workers interviewed by the authors in March 2022, one of the recurring problems is that many NGOs that seek to provide access to electricity aim to "dictate" their funding conditions to the donors' agenda (general public, government funding), especially what the donors think is needed. Local needs tend to be overlooked. For example, many donors will seek to electrify schools even though the pupils only attend during daylight. Meanwhile, they find it "inappropriate" for families to watch television at home in the evening, even though that is what they actually want.

Many users are gradually becoming dependent on those low-value solutions, which may be cheap to buy but need to be replaced often, leading to a waste of resources and money. For example, low-quality solar kits running on poorly efficient batteries may need to be changed often, and batteries may not be recycled. Another emblematic case is leasing solar kits (where people pay in instalments with loans at 20 per cent per year), which amounts to indebting people who already have very little. Besides, these solutions generally do not provide any social or long-term value such as training and employment that are essential to meet other development needs (Kinally et al., 2022). Furthermore, improper recycling processes expose people to health problems, such as lead poisoning (Gottesfeld et al., 2018). In short, even though they fulfil the immediate needs and demands of populations, these solutions are often socially and ecologically unsustainable.

Building on extensive empirical research and evidence, Nanoé, a partner in the EURICA project, follows the opposite logic. Local and international energy experts founded this Franco-Malagasy SME. It wants to sell a solution, not "sell a dream to someone financing a solution to a problem they do not understand". In the words of its cofounder, they "manage to sell something more specific and more useful in the long term" (interview with Nanoé's cofounder, 28 March 2022).

Nanoé has developed a "nanogrid" system, combining the pooling of solar panels and efficient batteries to interconnect houses and relying on an intelligent management system for electrical flows. The innovation, defined as a process of progressive expansion of the grid, or "lateral" in their terms, is based on linking these tiny networks to form a larger one, better able to support productive uses (such as water pumps or small machines) (Fondation Tuck et al., 2018).

But innovation is also about business practices. Rather than offering to supply a certain volume of kilowatt-hours at a certain price, Nanoé sells different packages of electricity services, fulfilling the power needs of the appliances that users are equipped with (such as light bulbs, mobile phone charging, TVs, or even fridges). This business model, known as "energy-as-a-service", was inspired by what exists in other sectors, such as telecommunication or video streaming.

This service-based business model provides customers with affordable, quality products daily. Tariffs and packages are made very simple and flexible for users; rather than talking about power, they are explained in terms of equipment (see Figure 17.1). For example, the "economy" package connects two bulbs. Installation costs MGA 10–30,000 (EUR 2.1 to 6.3)[4], and the daily rate is MGA 650 per day (EUR 0.14) or MGA 4,000 (EUR 0.84) per week. Households have to buy the two bulbs and the cable to connect them for MGA 60–80,000 (EUR 12.6 to 16.8), but Nanoé provides a discount of MGA 50,000 (EUR 10.5). This discount is applicable regardless of the initial package. If, for example, a household chooses the "multimedia +" or "premium" packages, which include the power to connect a

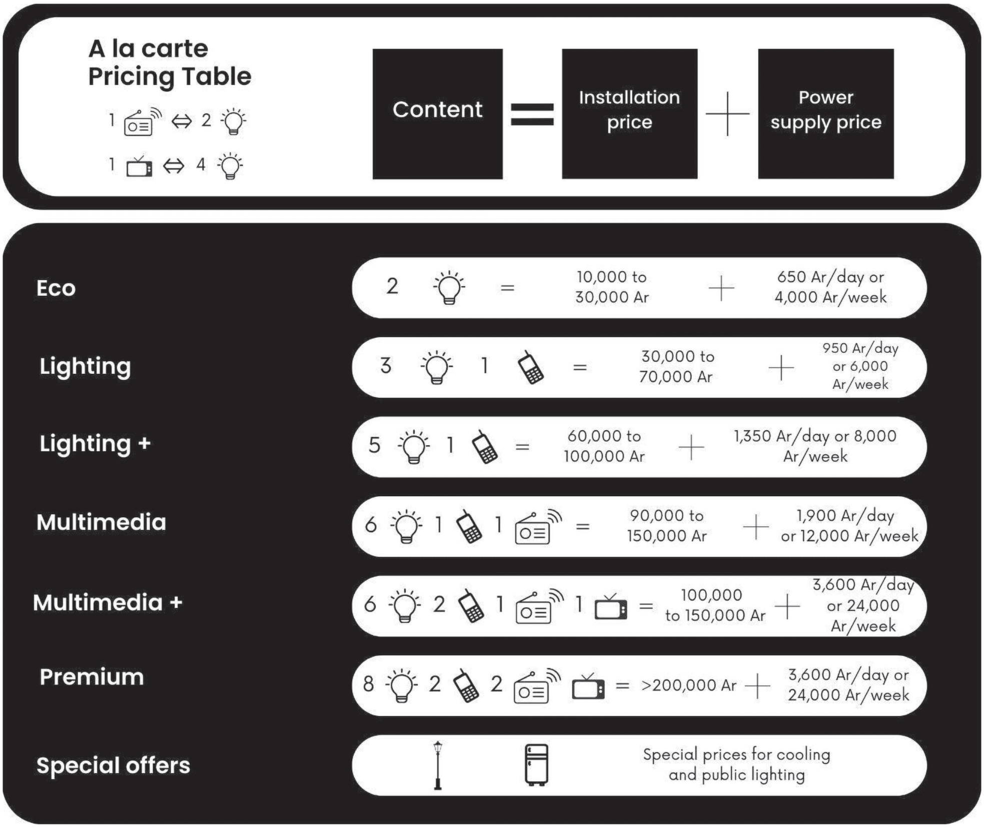

Figure 17.1 Nanoé's various offers and fixed fees.

Source: EURICA team (2022).

12V television set (MGA 300,000 (EUR 63.02) for a 19″ model and 650,000 (EUR 136.54) for a 32″ model), families will also benefit from a MGA 50,000 discount. In the latter case, the installation costs more than 200,000 MGA (EUR 42), and the weekly fee is 24,000 MGA (EUR 5.04). Nanoé guarantees a maximum daily performance of 5 hours and takes care of the maintenance of networks and equipment.

As a social enterprise, Nanoé reinvests all its profits in community development. It relies on a network of nanoentrepreneurs, that is, local young people trained as technicians and sales representatives selling, installing, and managing the nanogrids.

Nanoé's solution meets technical requirements for sustainable electricity supply thoroughly monitoring the material and technology sourcing, delivery, and recycling chains. It addresses economic and social needs through job creation, training, and affordable pricing. All in all, by pooling costs and promoting community collaboration, Nanoé enables more households to access greater comfort and maximises the impact of electrification efforts.

17.2.4.2 Demand-side flexibility to overcome power outages in Burkina Faso

As the multi-tier framework emphasises, the quality of electricity matters as much as its availability – and the absence of blackouts is one of the benchmarks (Padam et al., 2018). In Burkina Faso, the weak grid presents a fundamental challenge to better and broader access to electricity and makes it difficult to adopt energy from renewable sources. Even though the study area receives electricity from the main grid, the quality is not sufficient – but digital flexibility solutions could provide a sustainable solution to improve the quality of electricity.

This example follows the case of the Azimmo 2000 neighbourhood in the heart of Ouagadougou, the capital of Burkina Faso. In this residential area, mainly composed of individual houses, most dwellings are connected to the national grid (managed by the vertically integrated utility SONABEL), but suffer from recurrent power outages. Those outages are caused by the high level of demand, particularly in the summer, the low availability of supply, and the overall instability of the grid. Indeed, the Burkinabè electricity network and infrastructure have not been sized to handle this substantial energy increase and the fast pace of new grid connections (new customers).

Those overloads reduce the grid lifetime's expectancy and the customer's supply quality due to out-of-range voltages. SONABEL, like most Distribution System Operators (DSOs), mostly relies on one approach to solving such problems: investing in the electricity grid, which is highly capital-intensive. In parallel, many customers have been investing in their own electricity generation capacity, either from solar panels or diesel generators.

To answer this challenge, the EURICA project organised "Azimmo Ouaga 2000" as a local energy community. It has introduced demand-side flexibility into the local electricity environment to optimise available resources.

This solution is based on several technologies that allow physical devices to "communicate" through smart meters, the Internet of Things (IoT) digitisation and electronic observation of the local electricity network. These tools automate the power distribution that the grid can effectively provide during the day and between consumers according to their needs and means. The network observability system monitors the status of these constraints to detect them, forecast them, and request the activation of the necessary flexibility to mitigate them. By fulfilling the conditions, the project creates an intelligent and flexible local network, which allows for a better distribution of uses and avoids untimely outages by adjusting the network to the constraints in real-time (see Figure 17.2).

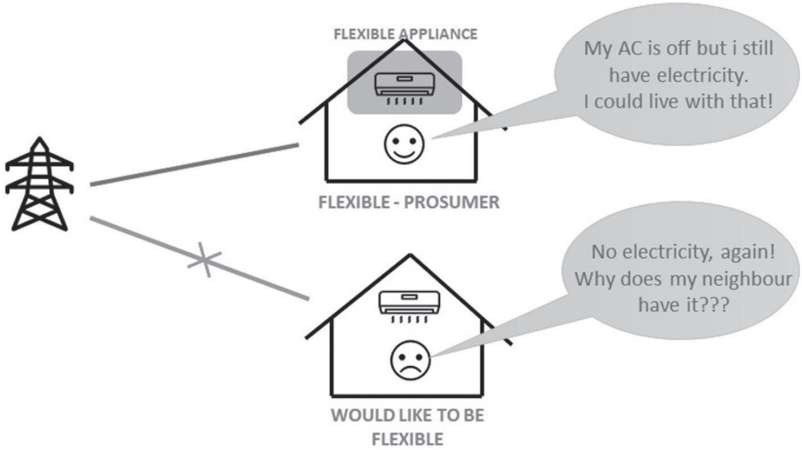

Figure 17.2 Flexible user. Small changes in individual and local communities' behaviour can help flatten the local demand to reduce peak loads and congestion of low-voltage assets and avoid outages linked to this issue.

Source: EURICA (2023).

The cases of Madagascar and Burkina Faso show that it is possible to optimise electrical energy consumption by mobilising intelligent strategies thanks to innovative business models such as electricity-as-a-service and flexibility (or demand-side response) mechanisms.

17.2.5 Doing more with less: build on flexibility and energy-as-a-service experiences in Africa for European countries

17.2.5.1 Historical context

It is difficult, if not impossible, to explain specific energy consumption logic (energy waste, energy resilience, or energy flexibility) without trying to understand the history of consumption in the world, which is primarily influenced by Western consumption logic. Consumption is an "analyser of society" (Desjeux, 2006). It illustrates the way of thinking about the world, the power relations between social groups, and the relationship between the people and their environment. It is also a marker of social belonging and differentiation (class, gender, generation, and culture) and, therefore, of social distinctions. Therefore, it is a "total social fact" to use Marcel Mauss' formula insofar as it allows us to grasp the world in its entirety (Olivier, 2008).

Concisely, consumption has gone from a craft mode where people consumed out of necessity, that is, to satisfy their basic needs, to a compulsive way of consumption-oriented, in addition to necessity, towards pleasure and luxury. With the development of salaried employment, urbanisation, and its artefacts, we no longer necessarily produce and consume to satisfy basic needs but also increasingly satisfy contemporary desires for luxury. Conspicuous consumption and wastefulness gradually come to give meaning to everyday consumption and become a way of life – the way of life of the modern ("developed") person.

The behaviours of the actors illustrate the consequence of socialisation and habits acquired by the populations progressively in the course of history, encouraged in this by the structuring of Western societies where mechanisation (and thus energy consumption) has become indispensable. Energy consumption is sustained by a desire for ever greater comfort. Over the decades in Europe, electricity consumption has grown exponentially, even if it has stabilised or even fallen due to gains in energy efficiency in recent years[5]. In such a context, changing the energy consumption patterns of populations that equate their well-being with a form of consumption focused on material comfort becomes difficult. It is necessary to consider this reality because it is a question of moving away from a set of mechanisms, some of which are cyclical and most of which are structural, and integrating others more oriented towards sufficiency.

17.2.5.2 How to do better with less in Europe: the experience of flexibility and electricity-as-a-service in African countries

The brief analysis above allows us to distinguish between Western and African (Sub-Saharan Africa) logics of electrical energy consumption. While it is established that consumption patterns in Africa are changing and increasingly adapting to those of European countries, it should be noted that African societies have long been structured by precariousness and uncertainty in all areas. Resilience is more of the population's existential necessity than a voluntary choice. "Doing better with less" thus appears to be a survival strategy adapted to the structural reality of the environment and the various economic situations.

Based on the cases of Burkina Faso and Madagascar, the experiences of service-based electricity and flexibility in certain African countries could contribute to promoting a more sustainable consumption logic of electrical energy in Europe. The main idea is to move away from the traditional consumption logic (always more) to an "intelligent" consumption logic based on resource sharing. However, the latter is strongly correlated with the development of digital technologies. Therefore, this approach is part of the quadruple helix of the "four Ds of the energy transition": decarbonisation, digitalisation, decentralisation, and democratisation of energy.

One of the strengths of flexibility and its corollary, smart grids, which could be of interest to Western countries, is the ability to activate or deactivate devices depending on the situation. In the context of the EURICA project, flexibility is defined as the ability to activate or deactivate a device at the right time to be helpful for the consumer and the energy network to offset peaks in supply or demand. The principle for the flexibility providers is to shift prosumers' electricity consumption depending on its availability when demand is forecast one day ahead by the Grid Observability system. It enables us to do more with less by improving the network while allowing users to pay less for a better-quality service. In Madagascar's case, energy availability is guaranteed for a certain number of hours. While this limiting prospect is unlikely in a European context where people have become accustomed to an unlimited supply of quality electricity, it does show that the rationale is, primarily, to address specific needs that serve the people.

17.3 Conclusion

The various energy supply crises that have shaken the world in recent years have finally established the need for a change of course regarding energy consumption habits. This chapter aimed to show the importance of service-based consumption patterns and system flexibility. Based on case studies, we have shown that these measures allow for a better distribution of resources by focusing on specific needs and for the grid to adapt to a lack of production, surplus consumption, etc. Smart grids, that is, the digitalisation and modernisation of electricity networks, are a means of achieving this objective. This encourages electricity consumers (individuals or professionals) to become increasingly involved and adapt their consumption patterns to the actual electricity production. The cases studied in Burkina Faso and Madagascar reveal the benefits of intelligent systems.

Notes

1 Africa's total population is 1.4 billion, or 18 per cent of the world's population (United Nations Department of Economic and Social Affairs, 2022).
2 At this stage, the project will not roll-out a technological solution in Cameroon, but the study of the local situation serves as a benchmark for Burkina Faso and Madagascar. Institut Supérieur Dale Kietzman in Douala, Cameroon, is a partner of the project.
3 in particular, firewood accounts to 68 per cent of the share, charcoal 10 per cent and other biomass 2 per cent), 17 per cent on petrol (transport), 2 per cent on electricity (hydropower and diesel power plants) and 1 per cent on coal (energypedia, n.d.).
4 MGA 1.00 = EUR 0.00021 (7 April 2023).
5 In 2020, the EU's primary energy consumption was 1 236 megatons of oil equivalent (Mtoe), a sharp drop from 1 353 Mtoe in 2019. Mainly due to the COVID-19 crisis, this drop allowed the EU to surpass its 2020 target (1 312 Mtoe). Primary energy consumption has thus fallen in all Member States between 2019 and 2020. The average decrease in the EU amounts to 8.7 per cent. Large falls were recorded in Spain (−12.5 per cent) and France (−11.4 per cent). In comparison, Lithuania showed a slight decrease of 1.6 per cent (European Environment Agency, 2022).

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