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# Challenges connected with the energy choice and transition in bakeries of Abidjan, Côte d'Ivoire

Salimata Berte<sup>1,3\*</sup>  and Djané Dit Fatogoma Adou<sup>1,2</sup>

## Abstract

**Background** The great dependence on fuelwood due to demographic factors, logging, agricultural expansion and the repercussions of political instability, is presented for Côte d'Ivoire, as a contributor to forest degradation and deforestation. Faced with this situation, the country has been trying for many years, through the promotion of alternative energy sources to firewood, to put in place a policy to protect the environment. However, the findings from the urban bakery industry question the social logic behind the choice of energy used. The bakery industry is considered as one of the main contributors to the erosion of the country's main forest due to its propensity to use firewood for cooking. Despite the recommendation of the Ivorian government to use butane and the promotion of "clean" energies, firewood is still the most used energy source in Abidjan. Against this background, the social determinants of the continued use of firewood in those bakeries should be critically assessed.

**Methods** The study relied on a qualitative approach using semi-structured interviews and direct observation for data collection. Interviews were conducted with state and non-state actors selected using a "snowball" sampling method. Data collected were subject to thematic content analysis.

**Results** The energy transition in the bakery sub-sector in Abidjan is hampered by the plurality of actors and the lack of clarity in energy management. It has led to a higher consumption of firewood and other sources of energy in the production of bread.

**Conclusion** Three elements shape the adoption of clean energies in bakeries in Abidjan. These are the politics of the government, its bilateral and multilateral partners, the immediate social pressure linked to wood resources and the availability of infrastructure.

**Keywords** Energy transition, Governance, Cooking energy, Environment, Bakery, Côte d'Ivoire

## Background

Issues related to energy sources are at the forefront of several events and at the heart of development policies since the beginning of the twenty-first century. Indeed, recognizing the crucial role that energy plays in sustainable development, the United Nations General Assembly proclaimed 2012 the International Year of Sustainable Energy for All [1–3]. The goals set at that occasion intended to improve, on the one hand, access to modern energy services and, on the other hand, energy efficiency in all sectors of economic activity and

\*Correspondence:

Salimata Berte  
sali.berte@csrs.ci

<sup>1</sup> Centre Suisse de Recherches Scientifiques en Côte d'Ivoire (CSRS),  
Abidjan, Côte d'Ivoire

<sup>2</sup> Institut National de Santé Publique (INSP), Abidjan, Côte d'Ivoire

<sup>3</sup> Centre de Recherche en Ecologie (CRE)/Université Nangui Abrogoua  
(UNA), Abidjan, Côte d'Ivoire



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to further develop the use of renewable energies [4]. The majority of the population in developing countries derive their energy from wood resources [5].

The issue of energy has given rise to reflection at the international, regional, and national levels. It concerns across social sciences in general and sociology. It is materialized by the organization of conferences on this problem such as the first and second international days of Sociology of Energy [6, 7]. Previously, a multidisciplinary conference in Nantes has been organized by the Society of Human Ecology in August 2007 on the theme "Energy and society: science, governance and uses" [8]. The African Development Bank (AfDB) and its partners organized an Energy Week from Monday 14 to Friday 18 September 2015 in Abidjan [9]. On the agenda, there were presentations and brainstorming sessions regarding the development of the energy sector in Africa, namely lighting, electricity supply and the development of the enormous energy potential of the continent that were at the center of the discussions. At the ECOWAS-GFSE High Level Energy Forum held in October 2012 in Accra, Ghana [10], the Energy Ministers of the Economic Community of West African States (ECOWAS) adopted two regional policies on renewable energies and energy efficiency and the ECOWAS bioenergy strategic framework. These policies and strategies provide the framework for actions to promote efficiency in the operation and use of modern cooking fuels. The objective is to make "safe" fuels available to the populations of the ECOWAS region by 2030. This objective was at the heart of the regional workshop of the West African Clean Cooking Alliance (WACCA) held in Ouagadougou in 2013 [11] with proposals such as the use of modern biofuels like ethanol, biogas and briquettes, and the supply of energy for safe, sustainable, and affordable cooking. Likewise, the study of the Renewable Energies, Environment and Solidarity Group (GERES) conducted by StovePlus in Côte d'Ivoire provides another contribution to express the challenge of clean cooking energy [12]. The Energy Progress Report shows that while progress has been made in expanding access to electricity, using renewable energy for power generation, and improving efficiency, there is still a long way to go. The progress of Renewable energy for power generation and improved energy efficiency is uneven across regions and energy efficiency as well as across regions and sectors. Access to clean cooking solutions continues to lag far behind [13–16]. The majority of households in sub-Saharan Africa, some 700 million people, rely on traditional biomass for cooking, and while in other regions, biomass use is decreasing, in Africa it continues to rise [17–19]. In sub-Saharan African countries, the energy supply of households, artisanal structures and, more

generally, processing units promoting economic development, is based on biomass and remains unsecured in the medium term, of low quality, intended for polluting and inefficient equipment [18–20, 20]. Most households have no choice but to burn biomass fuels (mostly firewood and charcoal) on open fires or in inefficient stoves [17].

Deforestation accounts for about 20% of global CO<sub>2</sub> emissions. Indeed, forests, especially when trees are growing, can constitute "carbon sinks" eliminating CO<sub>2</sub> from the atmosphere. Their degradation or deforestation contributes to the reduction of carbon storage while sustainable management, planting and rehabilitation of forests promotes carbon sequestration [5]. Côte d'Ivoire is not exempted from this dynamic, with its forest capital declining at an accelerated pace since its independence in 1960. Thus, from 16 million hectares at the beginning of the last century, dense rainforest decreased to 9 million hectares in 1965 and 3 million hectares in 1991. This evolution in dense forest shows the extent of deforestation in Côte d'Ivoire where nearly 84% of the forest cover of the 1960s was lost in 2000. Of the 16 million hectares of forest inventoried in 1960, only 2.1 million remain, i.e., 8% of the total area [21]. This translates into a deforestation rate of 250,000 hectares per year, with reforestation estimated at 5000 hectares per year. In fact, more than 600,000 tons of the Ivorian wood resource are consumed annually as firewood, 50% of which is consumed by the city of Abidjan alone [12]. Households use it for cooking with traditional inefficient stoves and access to energy for productive uses remains limited. According to a study conducted by StovePlus in 2015, final energy consumption shows a predominance of biomass with 73%, followed by petroleum products 21%, electricity 5.3% and gas 1.7% [12]. Previous studies have addressed the issue of energy at the household level and do not shed enough light on the logics of the different actors. Particularly, there is a paucity of studies on bakeries, which are major consumers of wood energy.

Thus, research on combustible energies is justified by their importance and by the news of the phenomenon in Côte d'Ivoire where the question of the environment is acutely raised by the degradation of the state of the Ivorian forest cover. This study is part of an exploration of the energy question in general and the determinants of the choice of baking energy, mainly in the so-called modern bakeries in Abidjan. It focusses on interests of the various players involved, their practices and their representations. Such an approach to the study finds all of its relevance in the very fact that the environment is a social issue to better understand environmental problems implies their analysis, as social problems [22]. The previous studies have addressed the issue of energy at the

household level and do not sufficiently highlight the logics of the different actors. In particular, there is no mention of bakeries, which are major consumers of energy. This article fills this gap in the research on the explanatory factors of the choice of cooking energy in bakeries.

### Study-specific introduction

With regard to the increased deforestation, the Ivorian government has initiated a policy of promoting butane gas to substitute wood energy for consumers of combustible energy in urban areas, particularly in Abidjan in 1993. This policy of "butanization" has been intensified since 1993 by the National Oil Company of Côte d'Ivoire (PETROCI) and targeted all actors using wood energy in their various activities. The objective of this policy is to gradually replace wood and charcoal with butane gas and to improve the use of clean cooking techniques. Thus, research on fuel energy is justified by its impact on the country's forest degradation. This study aims at exploring the energy issue in general and the determinants of the choice of energy used in baking industries in Abidjan. To this end, the first observation is linked to the use of fuelwood as the main source of combustible energy in the city of Abidjan despite the initiatives of the State on the risk faced by the forest. In 2010, FAO pointed out that bakeries consume a significant amount of firewood for baking bread, with a daily average of 157 kg of firewood per bakery [5].

Although policies were made to reduce the pressure on the forest cover by encouraging the use of alternative energy, it appears that many bakeries continue to use firewood for baking bread. Thus, out of 271 bakeries identified in four municipalities, 145 use firewood, 73 use gas and 53 use diesel. The resulting research question is what factors determine the choice of energy used in the baking industry of Abidjan? The main objective is to investigate the determinant of the choice of energy used in the baking industry in Abidjan. For counting in the city of Abidjan, four municipalities were selected in this study, as shown in Table 1. This table shows a predominance of fuelwood use in these bakeries.

**Table 1** Results of census of bakeries in four municipalities

Kind of fuel used by Municipalities	Wood	Gas	Diesel	Electricity	Total
Abobo	59	17	11	00	87
Cocody	12	06	11	00	29
Yopougon	41	31	07	00	79
Koumassi	33	19	24	00	76
Total	145	73	53	00	271

The study mobilizes social practices theory, Reckwitz [23], as an approach, which instead of placing behavior as a trait of individual conduct and decision-making at the center of the analysis, instead focuses on how, at any given time, a larger set of collective practices are established to achieve everyday goals. Practices are seen as the central starting point for understanding the social system [24, 25]. Practice theory makes an important shift in the perspective by placing practices at the heart of the analysis of consumer behavior. A practice involves skills, i.e., knowledge, know-how, understanding or the ability to evaluate a performance. The objects it requires to manipulate include infrastructures, tools, sometimes digital devices and the human body itself. These elements are linked to the general concept of routine characteristics of practice theory, which passes "practice" as a type of routinized behavior that consists of several interconnected elements: forms of bodily activities, forms of mental activities, "things" and their use, basic knowledge consisting of understanding, know-how, emotional states and motivations [23, 26]. It also carries meanings, i.e., meaning [27], which are translated into mental activities, emotions, and motivations [28]. From this perspective, it is the existence of the practice that allows us to understand the origin of expectations, needs, skills and value judgments, as they emanate from it [29, 30]. The system is evolutionary and iterative, any practice is likely to change and each new experience potentially feeds a looping system.

The theory of practices allows us to account for the evolution of daily practices over time. These practices often take the form of routines that do not involve questioning, as long as the action seems to be appropriate [30]. The theory of social practices is based on Bourdieu's work on practices and habitus and on Giddens' theory of structuring [26], notably by taking up the key role of routines in the structuring of societies. We generally speak of theories of social practices, in the plural. Taking practices as a means of analysis, as Reckwitz [23] suggests, means understanding consumption through the prism of everyday practices. Most practices require and result in consumption. Literature [29] defines consumption as a process by which agents engage in credit, whether for utilitarian, expressive, or contemplative purposes, goods, services, performances, information, or ambience, whether purchased or not, over which the agent has some degree of discretion. Consumption is not in itself a practice, but rather is a moment in almost every practice that the most commonly cited authors in the practice theory literature are [23, 27, 31, 32].

Indeed, much empirical research that builds on this theoretical framework focuses on practices that require energy consumption, such as that of daily mobility [29,

33, 34] or several practices that have a lesser effect on the environment [35–37], whereby [38] also used social practice theories in her participant observation study of pro-environmental change in a company.

This theory, which puts practice first, suggests that it is from the practice of this or that activity that comes from individuals' ability to act (and thus also generates needs and desires), and not from the individuals themselves that thus take a back seat. Consequently, consumer types are not sufficient to account for the social identity that lies at the heart of the analysis of practices, unless the contours and determinants of each type are clearly explained and determined. This theoretical balancing act thus aims to understand the stabilization of practices, their diffusion, or even their transformation, and is therefore particularly consistent with the study of energy consumption practices in housing in the context of the energy transition we are currently undergoing. It insists, in this case, on the inertia of social practices, questioning their strong dependence on entities that are material devices, knowledge or skills, meanings and behaviors or activities. Their regulation therefore seems impossible from the outside.

In [39] the role of routinization and reflexivity processes is studied in relation to consumption practices, concluding that the change of practices occurs when new habits become routines, after a process of conscious and motivated reflection on the part of the consumer. Concerning the conceptualization of each practice, these practices being most of the time very interconnected, and their limits being very porous, it insists on the importance of including the technologies on which they take shape as well as these interconnections in the empirical analysis. Practice theory is still in its infancy, as evidenced by [40] discussing theoretical and methodological considerations for applying practice theory to the study of consumption, which seeks to define what it means to analyze a practice. It seems crucial for the authors to focus the analysis on the material environment as well as on the tacit and formulated knowledge that practitioners incorporate, and finally on their role in the process of creating interactions, continuity and reality. This point of view therefore assumes that the researcher must in fact collect the discourses of the respondents, without which he or she loses the entire system of meanings relating to the practices.

Regarding [31], a practice is either a performance or an ordered entity, i.e., "a temporally unfolding and spatially dispersed connection of doings and sayings "with" key components of this connection identified by Schatzki that link doings and sayings for the purpose of constituting a practice" [41, 42]. Schatzki [31] in his studies identifies three key components of this "connection of doings and sayings" which are knowledge (know-how) and

routines, institutionalized rules and teleoaffective structures, which Schatzki defines as "ends, projects, tasks, objectives, beliefs, emotions and moods". The nature and number of these key components are debated. Indeed, several authors have stressed the relevance of integrating another key component of this "connection of doings and sayings", namely the material structure, the available products and the technical arrangements. This technical component seems especially relevant in studies of the sociology of energy.

In this study, two key components of a practice will be considered, namely routines, institutionalized rules and material structures. As many of these empirical studies are related to the theme of sustainable development, foremost of the theories of social practices is the study of the processes of change of practices, in energy consumption, for example. Warde [29] notes that "the main implication of a theory of practice is that the sources of behavioral change lie in the development of the practices themselves.

Thus, the focus is no longer on the individual's decision-making, but on the "performance" of various social practices and the discrete consumption that is integral to many practices [41]. As a result, individuals become the "carriers" of social practices rather than the focus of attention [23].

## Methods

### Study area

The survey was conducted in Abidjan (Côte d'Ivoire) using qualitative methods. In this section, it is important to indicate and describe the location where the empirical survey was conducted and the reasons for this choice. The geographical area chosen for this study is the city of Abidjan [43]. Considered to be the cultural crossroads of West Africa, or even Africa, the city of Abidjan is experiencing perpetual growth, characterized by strong industrialization and rapid urbanization. This choice is justified on the one hand by the proliferation [44] of bakeries in the city since the signing of the decree on the liberalization of the bakery sector decree n°96–211 of March 9, 1996 [45]. On the other hand, by an empirical observation during the exploration of the field, which was found that some of these modern bakeries use firewood in the urban environment.

The economic capital of Côte d'Ivoire, the city of Abidjan is located in the south of the country on the Gulf of Guinea, on the Atlantic Ocean, precisely on the banks of the Ebrié<sup>1</sup> Lagoon. The agglomeration of the city of Abidjan covers an area of 57,735 ha. It is made up of ten municipalities,

<sup>1</sup> Ethnic group in Abidjan city.

namely Plateau, Abobo, Attécoubé, Adjamé, Cocody, Koumassi, Marcory, Port-Bouët, Treichville and Yopougon [46]. All of the different town halls were run by a central town hall. In 2001, the city of Abidjan was established as a district where the governor is appointed by the head of state. The population is estimated at 4,707,404 [47], or 20 percent of the country's total population. The economic boom of Côte d'Ivoire in the 1960s-1980s, earned it the "title" of the economic hub of West Africa and the crossroads of migration, thanks to the export of raw materials including coffee and cocoa [46].

The housing in the city of Abidjan is of high, medium or low standard, depending on the architecture of the materials used for construction. It is made up of modern individual houses, housing on common courtyards, apartment buildings, collective housing built by real estate operations of State companies (SICOGI, SOGEFIHA) or of a private type (SOPIM, SCI LES ROSIERS, LAURIERS, etc.). However, the modern constructions contrast with pockets of precarious housing built with banco and/or recycled materials. The precarious neighborhoods are found in all the communes of Abidjan. These neighborhoods generally lack basic socio-economic infrastructure because they are difficult to access due to their location in non-buildable areas. The neighborhoods of the District's communes generally benefit from modern subdivision plans. However, there are also areas where village subdivisions have not yet been approved and precarious neighborhoods that are poorly developed or not developed at all and therefore difficult to access [48].

Four municipalities out of 13 were selected for counting in the city of Abidjan for this study as presented in Fig. 2. The municipality of Yopougon covers an area of 153.06 km<sup>2</sup> [48], a plateau favorable to mass urbanization. It is in the west of the city of Abidjan. It is the largest and most populated municipality with 1,071,543 inhabitants [47]. This municipality is characterized by a contrasting urban fabric, with high, medium, and low standard neighborhoods. It is made up of precarious housing since it is home to major industrial zones. The municipality of Abobo is located on the northern outskirts of the city of Abidjan, and has a high human density. It covers an area of 90 km<sup>2</sup> with a population of 1,030,658 inhabitants. It is the second most populated municipality of Abidjan after Yopougon. In terms of spatial organization, Abobo is mostly made up of traditional, popular, and precarious housing. Compared to Yopougon and Abobo, Cocody has a lower density of 447,055 inhabitants [47] and better socio-economic infrastructure. It is constituted of several residential areas among which some are of a very high standing. Additionally, Cocody, a residential district, is known for the wealth of its inhabitants and the architecture of its houses, many of which are built in a colonial style. In the popular imagination, it is considered

the commune of the "rich" [48]. The wealthiest classes of Ivorian society, as well as most expatriates and diplomats make it their residence of choice. Finally, Koumassi located south of Abidjan is located at equal distance from Abidjan International Airport, the Autonomous Port and the Plateau business center. The population of Koumassi is estimated to reach over 300,000 inhabitants [47].

Local economic development is primarily based upon promoting employment through the creation and development of new jobs and employment through the creation and development of formal and informal businesses in the city's territory. The labor market in Côte d'Ivoire, particularly in Abidjan, has been strongly affected by the political crisis [46].

After counting the bakeries, the municipalities of Yopougon and Abobo were chosen for the survey as mentioned in Fig. 2.

### Characteristics of the participants

The main data collection techniques used are semi-structured interviews and direct observation. Documentary research was of great importance in this study as it allowed for the indexing of reports and policies on energies both nationally and internationally. Thus, secondary data were mainly derived from analysis and review of relevant articles and books, national journals that repeatedly raised the issues of deforestation and cooking energy, study reports and previous reports on the activities of the ministries (laws, decrees, and orders).

The various interview guides were addressed to two types of actors. These are state actors, namely the Ministry of Trade, the Ministry of Water and Forests, the Ministry of Mines and Energy, SODEFOR (*Société de développement des forêts*) and the municipal authorities. These different choices were motivated by the place and role that each institution has played or continues to play in public energy policies and in the choice of fuels in baking.

The Ministry of Commerce, Crafts and SME Promotion was chosen because the bakery sector is part of the SME sector. To this end, the sector is organized and supervised by this ministry. It is this ministry which drafts the various texts concerning the sector.

The Ministry of Water and Forests was chosen because it supervises everything relating to the preservation of forest cover and the issuance of authorizations for the exploitation of forest products. The authorization to use secondary forest products is issued by its department in charge of secondary products. It is the Energy Department, which deals with energy in general and fuels that is the subject of this study.

As for SODEFOR, its role is to enrich and enhance the national forest heritage, develop forest production, enhance forest products, and safeguard forest areas and their ecosystems. It is also in charge of the marketing of

secondary products including fuelwood which is one of the fuels used for baking bread in bakeries. For the Town Hall, the choice of the Hygiene and Environment Service is linked to its role of controlling the bakeries in the town. The questions posed to the state actors were around their missions concerning compliance with energy and environmental standards, perceptions related to the use of different types of energy in bakeries and their relationship to the environment, regulations in force concerning the cooking energy used in bakeries, etc. The questions posed to the state actors were around their missions concerning compliance with energy and environmental standards, perceptions related to the use of different types of energy in bakeries and their relationship to the environment, regulations in force concerning the cooking energy used in bakeries, etc. Non-state actors made up of bakers, bakery managers and bakery workers. This category is made up of three sub-groups which are the bakers' union, the bakers, and the bakery chain. The first subgroup is the bakers' unions.

The second subgroup is made up of the bakers themselves. At this level, there are bakers, bakery owners, bakery managers and bakery clerks. The third is the bakery chain. As for the non-state actors, the questions asked were related to the procedure for setting up a bakery, issues related to baking energies, characteristics of bakers' practices in using fuel energies for baking bread (bread baking practices in the bakery, the choice of energies used and the equipment used), fuel energies in bakeries and the environment, social relationships between bakers, unions, the state, wood sellers and customers (relationship systems), regulations in force concerning the baking energies used in bakeries. As for the non-state actors, the questions asked were related to the procedure for setting up a bakery, issues related to baking energies in the bakery, characteristics of bakers' practices in using fuel energies for baking bread (bread baking practices in the bakery, the choice of energies used and the equipment used), fuel energies in bakeries and the environment, social relationships between bakers, unions, the state, wood sellers and customers (relationship systems), regulations in force concerning the baking energies used in bakeries.

#### **Participants selection criteria**

The sample of state actors was determined using the "snowball" technique, which is based on reasoned choice. Snowball sampling is a non-probability sampling method in which one first selects a (specific) person, then—through that person—one obtains a list of people with the same characteristics as the people initially selected, and so on. Respondent-based sampling uses a modified snowball sampling method to recruit participants [49]. Interviews were carried out either

with the direct managers of the bakeries, or with people designated by the managers. Entry into these establishments was through academic letters (letters signed by the research director). The advantage of the snowball sample is that it makes it possible to determine the first level of contacts which then makes it possible to reveal and to follow other actors. Often reserved for specific populations composed of experts, more generally individuals whose identification is difficult and/or who have particularly rare characteristics, i.e., often small populations, specialized engineers or craftsmen. This method consists of having the sample constructed by the individuals themselves. It suffices to identify a small number to whom we ask to bring other individuals having the same knowledge and/or characteristics as themselves. On the union side, the first leaders were questioned. They were the presidents of the two unions. As for the bakery sector, the person in charge of energy and baking quality was the appropriate actor to answer the various questions. With the technique of single-case sampling, social micro-units were used for bakers.

For the purposes of this study, the appropriate sampling is the "one-off" case. This is the construction of the sample from a geographic or institutional framework. This type of sampling method is best suited for this research. Thus, the environmental, geographic, or institutional sample was selected. An "environment" was chosen as the working universe for the constitution of the empirical corpus, for example: a district of the city [50], a psychiatric hospital, a suburb, etc. The working environment presents itself to the analyst in a manner that is not divided and as susceptible to apprehension. The medium sample does not necessarily require that all observations be made in one location, but simply that they be treated as related to the same medium as a whole [51]. The chosen universe is the city of Abidjan. The bakeries visited are all modern bakeries in the various municipalities of Abidjan. Thus, bakers, employees and bakery managers were the most interviewed because they are best placed to provide information on the mechanisms of use of baking energy in bakeries, the perceptions of the activity and the meaning given to the use of these fuels. Twenty-five bakers were interviewed for this study. The data collected during the interviews were transcribed verbatim. The purpose of the transcription is to make Côte d'Ivoire understandable what was said in the interview. In addition, content analysis was used to parallel similar ideas contained in the speech of individuals in the separate interviews. The content analysis deals with different kinds of messages studied systematically according to quite precise rules of analysis and interpretation of texts. A fundamental problem in content analysis is that of having to reduce the multitude of words in a text to a few analytical categories.

**Table 2** Proportion of fuel energy used by bakers in four districts of Abidjan

Energy	Number of bakery	Frequency %
Electricity	0	0
Firewood	98	49
Gas	89	45.5
Diesel fuel	13	6.5
Total	200	100

## Results

### Governance of energy in Côte d'Ivoire: a fragmented regulatory space

Côte d'Ivoire is working to cope with global and local standards in energy management. International initiatives give impetus to the deployment of national governance. The initiative to scale up renewable energies in West Africa is an example [52].

Public energy policies are anchored in various regulatory frameworks, in particular forestry, climate and environmental policies. Each policy is driven by groups of actors with different objectives. For example, formal energy governance in Côte d'Ivoire involves six ministries. These ministries are directly or indirectly involved in the management of biomass, the promotion of energy and renewable energies.

There is also the Ministry of Petroleum, Energy and Renewable Energies and its separate procedures. This Ministry is responsible for the implementation and monitoring of the Government's policy on mining, petroleum and energy. This ministry implements the government policy of energy saving and promotion of renewable energies in conjunction with the Minister for the Environment and the Minister for Water and Forests.

In addition, there are four types of energy fuels for bakery ovens, namely fuelwood, gas, diesel and electricity as presented in Table 2. But the different sources of energy used in bakeries in Côte d'Ivoire are fuelwood, gas and diesel. None of the bakeries visited use electric ovens as shown in the following table.

The Minister of Commerce is responsible for the implementation and monitoring of the Government's trade policy with commercial logics and integration. The bakery sector is regulated by the Ministry of Commerce. The decree N ° 619/MCAPME/MSLS/MINESUDD of the December 17, 2014, declaration required the opening, the installation and the extension of bakeries. Here are some provisions of this decree:

*Article 1: The installation, opening and extension of bakeries in Côte d'Ivoire are subject to prior declaration to the Ministry of Commerce.*

*Article 2: The provisions of this decree apply to artisanal bakeries and modern bakeries in Côte d'Ivoire.*

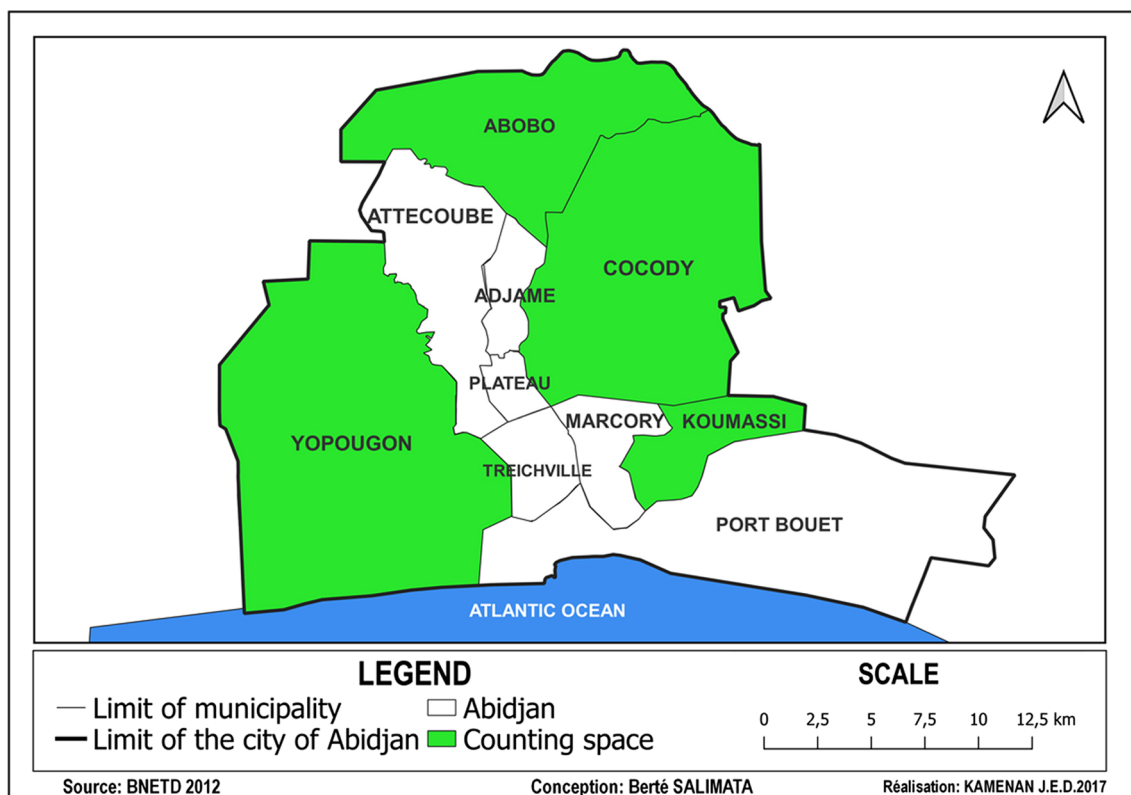
In the process of opening the bakery, the acquisition of an authorization is realized through two phases. According to the head of the bakery sector of the Ministry of Commerce: "For the setup of a bakery, there are two phases. The first phase is the installation request. The distance between two bakeries should not be less than 200 m, and the environment is taken into account. One cannot install a bakery next to the gutters. After that, the applicant should fill an application form requesting an opening authorization. After all, we send agents to look at the hygiene conditions, all equipment, toilets and medical certificates for workers as they will be in contact with the bread. For required equipment, modern bakeries should not use firewood. These are part of the installation criteria of a bakery. Then our agents do regular checks in collaboration with the district of Abidjan and municipal agents".

According to the classification of the Ministry of Commerce, there are three types of bakeries in Côte d'Ivoire. The modern bakery, which is any unit whose main purpose is the production of bread, from wheat flour, types 55, and other flour. This unit must have as production equipment at least one kneader, a scale, a modern oven, and a divider. The artisan bakery, which is any unit run by a qualified craftsman, who use flour to make bread dough, mechanically kneaded to make breads of all kinds and cooked in a traditional oven, sometimes over a wood fire and ensuring selling directly to the consumer. Finally, the specialized bakery that is any unit of bread production starting from wheat flour of types 55 or any other type for the confection of specific dishes (Lebanese shawarma, American hamburger, etc.) and having adequate equipment.

The Ministry of Health carries out health inspections, draws up guidelines and standards for nutritional issues. The purpose of this service is to control the working environment of bakeries.

*"Our job is to check the working environment of bakers. Agents go regularly to see if the work equipment is clean, if there is no dirty water running in or around bakeries, are workers clean if there is 'interview...'".* (The head of the Hygiene Department of Abobo).

The Ministry of Agriculture controls part of the wood and charcoal sector. In addition, the Agricultural Water Control and Farm Modernization Department plays a role in the management of agricultural residues. The institutional framework related to the environment in general and energy issues in Côte d'Ivoire is characterized by a multiplicity of stakeholders and by frequent restructuring. This situation causes overlap, skills gaps and confusion of roles and responsibilities. Recurrent



**Fig. 1** Map of municipalities affected by bakeries census

restructuring of institutions reduces the effectiveness of actions and prevents program monitoring.

Besides state institutions, there are civil society organizations working on energy issues and the preservation of the environment. The Ivorian Association of Renewable Energies (AIENIR) created in April 2013, is responsible for promoting and developing renewable energies and energy efficiency in Côte d'Ivoire, and contribute to mitigate climate change. To this end, AIENR raises awareness, informs, advises, and assists professionals and project developers. AIENR currently has 24 companies as members and collaborates with organizations such as the Regional Center for Renewable Energy and Energy Efficiency of ECOWAS. Of all these initiatives, none really put specific emphasis on cooking energies to push for a transition as intended by official policy.

**Social representations related to the choice of cooking energies**

The results show that there is a selection of wood that can be used in the oven for baking bread. For this purpose, two types of wood are identified including "red" and "white" wood.<sup>2</sup> All woods are not used for baking bread in

<sup>2</sup> A classification of wood by bakers.

bakeries, with a preference for "red" wood considered to be harder and stronger. For this purpose, the most popular wood used by these bakers to produce bread is commonly called "red wood". Thermally, this type of wood provides more heat than others and it lasts much longer during combustion and produces less smoke.

*"You have to use good wood to avoid smoke. And then there is a chimney through which the smoke comes out. The wood that is usually used is commonly called red wood. When the wood makes a lot of smoke, it not only clogs the chimney, and then it dirties the oven and every time we have to maintain the oven"* (A bakery manager at Yopougon).

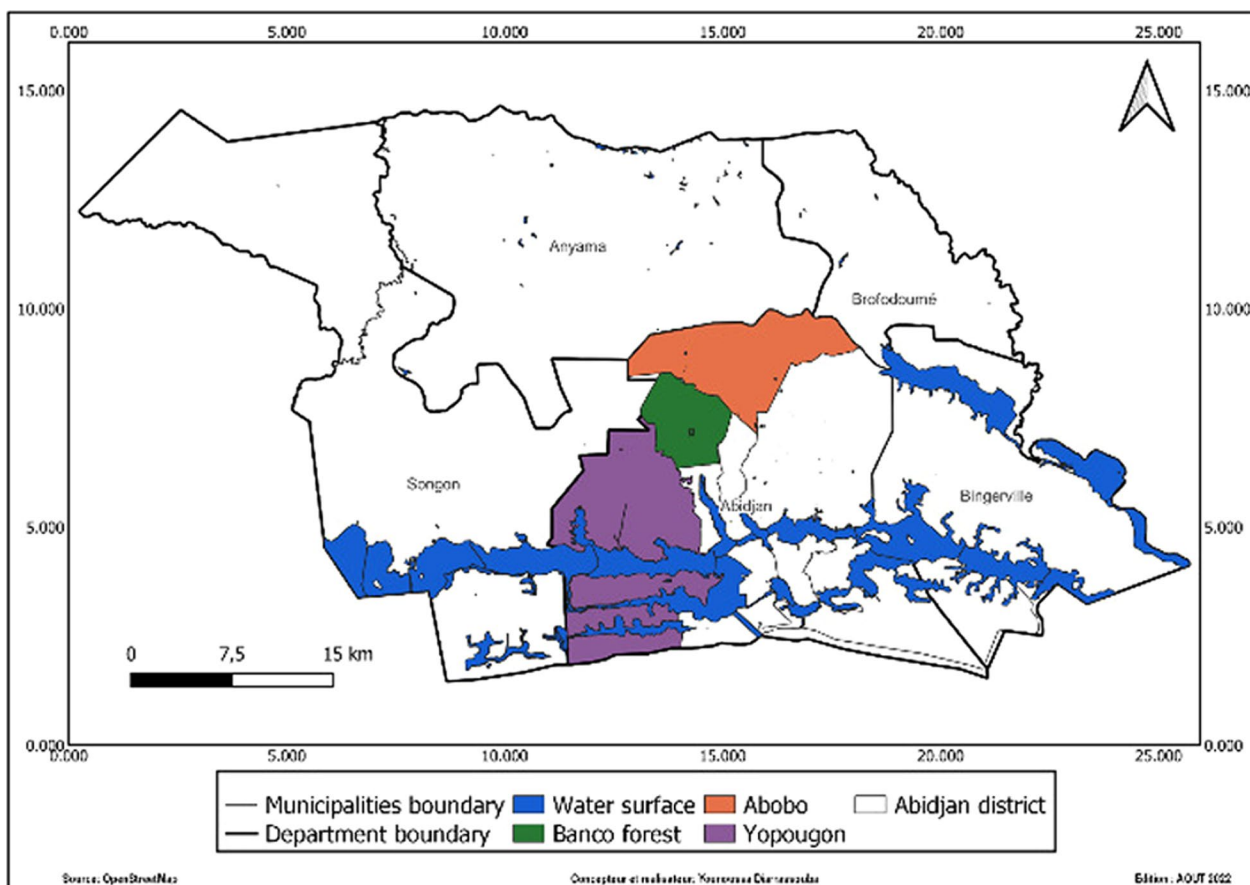
The species most often used for fueling the oven are "Manan, Bété,<sup>3</sup> Makore,<sup>4</sup> Teck<sup>5</sup>". Moreover, the amount of fire, heat and sparks very often depend on the type of

<sup>3</sup> Yellowish brown to dark gray wood with violet hues, apparent veining. From the family of MALVACEAE (angiosperm) whose scientific name is *Mansonia altissima*, also called *Mansonia* from Africa (Côte d'Ivoire, Nigeria, Congo, Ghana).

<sup>4</sup> Dark brown to dark reddish-brown with sometimes purplish reflections and / or slightly indistinct pale veins. Often moire. From the SAPOTACEAE family (angiosperm), whose scientific name is *Tieghemella heckelii*.

<sup>5</sup> Dense and noble wood—yellow brown color with sometimes black veins. Scientific name *Tectona grandis*.





**Fig. 2** Map of municipalities involved in data collection

wood used. These woods are most often red in color as shown in Fig. 1. For the interviewed bakers, the heavier the wood and better the quality, the more heat it provides.

In Fig. 2, a stock of white wood that is not much appreciated by the bakers. According to them, this type of wood is not of good quality.

**Choice of fuel energies and economic constraints**

The price of fuels is one of the determinants guiding the choice of cooking energies. The economic conditions of access to "modern" combustible energies lead these bakers to turn to firewood. In fact, these bakeries are very often confronted with an increase in energy prices that affect their profitability. Per month, the average energy expenditure of a bakery is about 200,000 FCFA for those who use firewood, while those using modern energy are around 900,000 FCFA. *"The average expenditure per month of a bakery is about 200 000FCFA if it consumes wood. This same bakery, if it consumes gas or diesel, could end up with more than 900,000 CFA francs a month."* (A manager of a chain of bakeries).

The structuring of the firewood trade around these bakeries is based on a network of actors ranging from villagers who own the wood cutting areas, loggers, wholesalers, and retailers of timber sales. In fact, bakers who use firewood get their supplies from wholesalers. Interviewed bakers using firewood reported that they always buy on credit.

*"There are bakeries who buy their wood in cash, but they are not many. In any case, all those with whom I collaborate buy the wood on credit. When I started, I bought cash two or three times. After we negotiate and I take it on credit"* (A baker in Yopougon).

**The infrastructures used for cooking energies in bakeries in Abidjan**

The fuel gas is provided in two forms, including butane conditioning and butane bulk. The butane conditioning is intended for domestic use and comes in the form of gas cylinders of 6 kg (B6), 12.5 kg (B12) and 28 kg (B28). As for bulk butane gas, it is intended for industries, services and public institutions with tanks. At bakeries, gas is conserved in a bottle outside the bakery. It should not

be installed inside the bakery and must be protected to prevent leaks.

*"You see how the bottle is placed; it should not be in the bakery. You need a specific place to store the gas. So, you see that if the bakery does not have a good space, it is difficult to use the gas. It's not like wood that can be dropped anywhere."* (A bakery manager in Yopougon).

Domestic diesel is intended for hospitals, supermarkets, bakeries, and heating industries. In bakeries, it is stored in a tank for gas oil. Diesel in bakeries is most often stored in barrels.

As for wood, the storage does not require any specific location. A storage area can be found either inside or outside the bakery. As shown in Fig. 3 (gas) and Fig. 4 (diesel), in bakeries using gas or gas oil for baking bread, there is a special device depending on the fuel. It is stored either in front of the bakery or inside the bakery depending on the availability of space in the bakery. Wood is very often preferred to butane or gas oil because it does not require the installation of sophisticated equipment other than the oven.

*"You see in front of the bakery, that's where the wood is stored when the truck arrives. Often even one can keep up to three truckloads. With wood, you only need a place to keep the wood. It's not a problem. But if it's gas we cannot put it outside like that."* (A bakery manager in Yopougon).

#### Competences constraints and coping strategies

Modern furnaces require skills and availability of bakeries materials. For this purpose, it assumes that the bakery activity requires theoretical and practical training. Without these skills, the bakers prefer using wood. They adapt the oven to use wood instead of gas or gas oil. The operation of the equipment for the use of conventional energies carries risks according to the bakers. For example, Fig. 5 presents a normal gas oven, whereas Fig. 6



**Fig. 3** Stock of red wood in front of a bakery



**Fig. 4** Stock of white wood in front of a bakery

shows a gas oven that has been adapted to use wood. Figure 7 shows a gas oven installed at the time of the bakery installation. A few months later, this oven was converted for the use of firewood as shown in Figure 8. This work was done by technicians.



**Fig. 5** Gas bottle of a bakery with a capacity of 1t 360 kg



**Fig. 6** Barrel of diesel



**Fig. 7** Gas burner



**Fig. 8** Wood fireplace

*"The gas connection must be done by a qualified expert who will ensure the proper gas supply and a good adjustment of burner combustion. These installation operations that you see there, are very delicate and essential for the oven to work without too much trouble." (A baker in Koumassi).*

## Discussion

The results of the present study reinforce certain presuppositions of the sociology of energy. Indeed, the energy choice practices that emerge from Abidjan experience are related to a set of action logics, i.e., acts linked to motivations that individuals try to pursue but which are related to the constraints of daily life. These constraints are related to habitat, income levels, life stages, available technologies, incentives and opportunities (energy prices, existence of tariff offers, etc.). As [53] shows, there are many factors, and part of the work of sociological analysis is to derive trends or categories of actors from them. Here, the analysis reveals several pre-existing logics of action involved in these experiences. According to [54], the solutions advocated in the energy sector are characterized by an almost total lack of interaction between them. Indeed, they are often implemented separately from their own data and methodologies [55]. This is echoed by the public that refer to a multiplicity of actors with multiple interests [55]. In [52], it is shown that environmental regulations in Côte d'Ivoire are well developed. However, their implementation poses serious problems. Environmental law faces real difficulties in application. These studies confirm our findings that show a plurality of actors working separately for the same objectives. The shortage of so-called modern energies is an obstacle to their use in bakeries. According to [12], many retailers (depots or service stations) mention supply difficulties. These include frequent stock-outs, the administrative slowness of suppliers to process orders and other requests, delays in deliveries and partial supplies (which suppliers justify by the lack of trucks) and the failure to respect the filling volume of gas cylinders (quite rare). The results of this work reinforce certain presuppositions of the sociology of energy. Indeed, the energy choice practices that emerge from the Abidjan experience are consistent with a set of action logics. These actions constitute the main motivations that individuals try to pursue. They are linked to housing constraints, income, life stages, technological conveniences, incentives and opportunities (energy prices, existence of tariff offers, etc.). Any fuel switching is context-specific and depends on the complex set of factors that define the energy economy. In a context of rising energy prices, reducing the energy budget, whether one is an individual in one's home or a business owner, it is an important concern with multiple benefits. It is present but in a minority way in the two experiments. This can be seen among the bakers in Abidjan, most of whom cite economic reasons for choosing fuel energy for bread production. In

a context of rising energy prices, reducing the energy budget of an individual or a company is a major concern. From a study on energy sobriety [56], Subrémon et al. 2013, state that if the question of energy is legitimate to question situations of vulnerability, the ways of doing things, the logics of action and the meaning given to this question are extremely diverse. It is present but in a minority way in both experiences. The economic conditions of access to "modern" fuel energies lead these bakers to turn to firewood. The results of this research support those described in [57], according to whom the financial logic is very strong in the discourses and in the practices. Studies [56, 57] revealed that economic constraint, well-being and comfort in the home are much more structuring than ecological sensitivity, but without questioning the possibility of a spatial constraint that influences the "energy balance" skills developed by the bakeries. [56, 58] have clearly demonstrated the expression of a specific living knowledge that she calls "energy intelligence", but without necessarily linking it or measuring the influence of the living space on this knowledge. The physical accessibility of the different energy sources is a determining factor in the choice of bakers. The increase in wood consumption in bakeries is also due to the lower price of wood compared to gas or oil.

According to [59], technology plays a central role in the construction of social heating practices. Whatever the logic or motivation for action, practices are carried out in socio-technical spaces that determine the conditions of their realization. At this level, the results have shown that the installation of gas and diesel boilers requires a heavy investment to avoid energy leakage. This aspect is decisive in the choice of wood-fired ovens that do not require connection. According to [58], technology plays a central role in the construction of social heating practices. In these experiences whatever the logic or the motives for action, practices are carried out in socio-technical spaces that determine the conditions in which they are carried out. This is evident from a cognitive point of view, as we have seen, but also from a strictly material point of view. The technique can resist regulation when, badly or poorly maintained, the radiators leak, the taps are blocked, the windows close badly, the thermal insulation is poor. At this level, the results showed that the installation of gas and diesel ovens requires a large investment to avoid energy leaks. This aspect is a factor in the choice of wood-fired ovens, which do not require connection. Study [59] analyzed daily routines and energy-consuming appliances, developing a theory that emphasizes the importance of the development and growth of consumption taken for granted. It emphasizes the influence of the built environment, housing, and equipment as carriers of "scripts" that determine conventions, norms,

and current values that thus inhibit behavior change. These results show that behavior and choice of energy for baking vary according to the municipality in which the bakery is located. Literature [58] analyzed the daily routines and energy-using appliances, thereby developing a theory that emphasizes the importance of the development and growth of conspicuous consumption. It emphasizes the influence of the built environment, housing, and equipment as carriers of the "scripts" that determine the current conventions, norms, and values that prevent behavioral change. The results show that bakers' behavior and choice of cooking energy vary according to the municipality in which the bakery is located. In fact, gas is the energy most used in modern bakeries in the commune of Cocody. However, when we look at the other communes, we find that most of these modern bakeries use firewood. The results are confirmed by those presented in [60] when analyzing the damage of electricity cuts in Abomey-Calavi in Benin. Thus, it lists two types of power outages. These are planned outages and unplanned outages. The planned outage is a scheduled outage. In this case, the company responsible for the distribution of electrical energy announces in advance the period of the outage and informs consumers of the reasons for the outage. An unplanned outage is one that comes as a surprise and for which no announcement is made to consumers in advance. As traditional fuels, firewood is generally considered by these bakers to be easy to use. Those who are not familiar with the equipment of other ovens in the bakery will be trusted to use it without fear of accident or waste. Despite its advantages, gas is often considered too dangerous or too valuable to be left in the hands of anyone [20]. In reality, energy consumption, and therefore energy performance, is a combination of technological and socio-cultural factors. Energy consumption results from the convergence of norms, practices and technological developments that contribute to building a socially accepted definition of normality in terms of comfort at home or at work [37].

## Conclusion

The choice of energy used for cooking in the bakeries in Abidjan was analyzed using the theory of social practices. In this context, three elements seem to structure the adoption of clean energy by the bakeries in Abidjan. The first element concerns the will of the State and its bilateral and multilateral partners. It draws the attention and issues of international, sub-regional and national governance to local practices of shared forest resource preservation and energy efficiency. Thus, several ministries and departments are involved in the management of biomass and cooking energy in Côte d'Ivoire. However, energy transition and energy

management are facing difficulties. These difficulties are related to the juxtaposition of roles distributed by the ministries and institutions, the lack of monitoring and the inadequate regulation of the use of cooking energy by these bakeries. The second element is the immediate social pressure related to wood resources. The third element is the availability of infrastructure. This includes guaranteed access to alternative energies and their installation on the public domain. Some practices are developed around the use of fuel energy in bakeries. The activity of bakers being a profit-making activity, the actors present in this activity mobilize strategies to obtain profits. This can be seen in some of the practices of these bakers. And this activity is marked by the formation of a certain type of network to which one must belong in order to benefit from certain privileges. And so, as a result, there are forms of alliance that are created in reference to membership in the existential social network. These forms of alliance rely on the network to function. The method of payment used by the majority of bakers who use wood is payment on credit. Following this study, it would be useful to study the strategies for the diffusion of renewable energy in Côte d'Ivoire, the representations that the populations have of renewable energy and their factors of acceptability.

#### Abbreviations

ADB	African Development Bank (ADB)
ECOWAS	Economic Community of West African States
IEA	International Energy Agency
NGOs	Non-government organizations
SODEFOR	Société de développement des forêts
WACCA	West African Clean Cooking Alliance

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#### Author contributions

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