Toward More Energy Justice: The Case of Guinea (draft)

Laurent Jodoin

ABSTRACT

The need to encompass energy decisions within a broader perspective of ethical concerns has recently been advocated (Sovacool et al. 2016). This article subscribes to this view and adopts a normative framework founded on the capability approach to assess the data of an electricity access survey of 3,680 households in Guinea based on the ESMAP Multi-Tier Framework (ESMAP 2015). This paper has thus three main goals: (1) to provide yet unpublished data on electricity access in Guinea; (2) to discuss what this country could do to move closer to energy justice further; and (3) further the discussion on energy justice, how it can be operationalized. It ends with recommendations for fostering energy justice in Guinea.

Keywords: energy justice, Guinea, operationalization; capabilities; energy survey; multi-tier

1. Introduction

The importance of energy for life, society and development is undisputable. Many recent studies have emphasized the importance of energy for not only reaching a certain level of quality of life with indicators such as education, incomes and health (Pasten and Santamarina 2012; Bridge et al. 2016) and for well-being and capabilities (Day et al. 2016), but also for addressing broad social concerns (Sovacool et al. 2016; 2017). Nevertheless, over a billion people still don't have access to clean, modern energy (IEA 2019) and they are basically still using the energy systems that were available 500 years ago. Energy resources and services are distributed very unevenly among the countries, regions, households and even among members within households. Energy extraction and production can have many immediate and remote consequences, making energy more like a burden than a good. These justice concerns related to energy systems are nowhere more pressing than in Sub-Saharan Africa (SSA).

In that region, around 150 million people are estimated to have gained electricity access only since 2000, but this lags population growth, resulting in a worsening picture overall (IEA 2015). Per-capita energy consumption in Africa remains about half of China's, which is about half of the Unites Sates' (IEA 2015). Also, the SSA's average Human Development Index (HDI) is the lowest in the world (UNDP 2016). As a country of this region, Guinea is striving toward human development and broadening energy access. With a population of 12.6 million recovering from the Ebola virus epidemic, Guinea's HDI is one of the lowest (ranked 183) among 188 surveyed countries (UNDP 2016). The urbanization rate is estimated at 37% (UNDP 2016), and the national and the rural electrification rates were, respectively, about 35% and 9% in 2017 (ESMAP 2019). Most of the energy supply in Guinea comes from biomass and most of the electricity supply comes from imported petroleum-based production operated by a state-owned vertically integrated utility called *Electricité de Guinée* (EDG). How, then, can we ensure that an SSA country like Guinea attain a sufficient level of development and well-being through its energy sector?

In this paper, the energy-development nexus will be assessed by drawing on an extensive 2015 World Bank electricity survey undertaken with 3,680 Guinean households and based on the ESMAP Multi-Tier Framework (MTF), which assigns households to one of five tiers according to their ability to attain different levels of energy services. Although the survey was restricted to electricity access, the discussion, as mentioned, expands the perspective on the energy issues within the broader, energy justice framework (EJF) and adresses potential solutions for assessing as well as addressing energy justice. Indeed, the energy justice decision-making framework is complex and (to our knowledge) has never been operationalized or empirically assessed. That is why we propose building on the results obtained in Guinea to further the discussion on how energy justice can be assessed and measured in general and how it could benefit this country in particular.

This article starts with a presentation of the EJF and how it is linked to the capability approach and quality of life. This normative framework does not promote energy access *per se* but rather promotes access to energy services with high-quality energy. Then, the ESMAP survey methodology and results are presented and analyzed in Section 3. Building on these results, Section 4 presents some suggestions for operationalizing the EJF, which is used in Section 5 to assess the current level of energy justice in Guinea and provides some recommendations.

2. Energy Justice, Quality of Life, and Capabilities

The importance of energy services for modern life makes the case for their relevance for matters of development, quality of life, capabilities, and justice. In effect, in many situations, energy services are necessary for satisfying basic needs or for pursuing a life that many people value. Despite the complexity of the quality of life concept, which encompasses several subcategories such as life satisfaction, well-being, happiness, meaning, and wealth, it is acknowledged that access to modern energy like electricity can significantly improve the quality of life, especially for poor people, both at the national and individual levels (Pasten & Santamarina 2012; Kanagawa & Nakata 2008). Also, just as with income, different people have different opportunities for converting energy access into "characteristics of good living and into the kind of freedom valued in human life" (Sen 2009: 254), and so people have different capabilities as regard to energy systems, which can be understood as different causes and effects of social inequalities (Day, Simcock & walker 2016).

Both concepts of quality of life and capabilities are recognized as complex and multidimensional (Nussbaum & Sen 1993). In that vein, the multifaceted concept of *energy justice* has been recently proposed by building on the idea of global justice for a better understanding of these issues as well as more adequate and fairer energy interventions (Jones *et al.* 2015; Sovacool & Dworkin 2015; Sovacool *et al.* 2016). This concept thereby relies on different aspects of justice such as distributive, procedural, recognition and cosmopolitan. It can be broadly defined as "a global energy system that fairly disseminates both the benefits and costs of energy services, and one that has representative and impartial energy decision-making" (Sovacool & Dworkin 2015: 436). It does so within the capability approach, which insists on people's freedom (Sen & Nussbaum 1993; Sen 1999; Sen 2009). Capabilities are a person's real freedoms or opportunities to achieve functionings, i.e. various states of human beings and activities that a person can undertake. Consequently, what is sought is not energy *per se* but rather the services *and* the global opportunities energy can provide for persons. The energy justice framework (EJF), which includes ten principles or criteria, is presented in Table 1. Their bearing on the more restricted but operationalized framework from ESMAP will be discussed in Sections 5 and 6 along with application (*ex post*) and implementation (*ex ante*) in Guinea.

Table 1 : Energy Justice Principles (from Sovacool *et al.* 2017)

Principe	Description
Availability	People deserve sufficient energy resources of high quality.
Affordability	The provision of energy services should not become a financial burden for consumers, especially the poor
Due process	Countries should respect due process and human rights in their production and use of energy.
Transparency and accountability.[1]	All people should have access to high-quality information about energy and the environment, and fair, transparent and accountable forms of energy decision-making.
Sustainability	Energy resources should not be depleted too quickly.
Intragenerational equity	All people have a right to fairly access energy services.
Intergenerational equity	Future generations have a right to enjoy a good life undisturbed by the damage that our energy systems inflict on the world today.
Responsibility	All nations have a responsibility to protect the natural environment and reduce energy-related environmental threats.
Resistance	Energy injustice must be actively, deliberately opposed
Intersectionality	Expanding the idea of recognitional justice to encapsulate new and evolving identities in modern societies, as well as acknowledging how the realization of energy justice is linked to other forms of justice e.g. socio-economic, political and environmental

Critiques are still few granted the novelty of the concept. Day, Simcock & Walker (2016), for instance, complain that it is too wide in scope and its rationale "too abstract". The matter of its legitimacy notwithstanding (see, e.g., Jones et al. 2015), two major problems hamper this concept as a "conceptual, analytical and decision-making tool" (Sovacool & Dworkin 2015). While some advocates of this concept somewhat acknowledge these problems (e.g. Sovacool et al. 2017), it is important to address them because it remains a valuable concept nonetheless and even more so once these problems are solved, even partially. Also, the solutions to these problems are often context-specific so that the case of Guinea can be enlightening in that regard.

First, the EJF obviously intertwines "many notions of justice" (Sovacool & Dworkin 2015: 440) and refers to various ethical concepts. In effect, it relies "on a range of modern philosophical theories, predominantly social justice and environmental justice," (Jones *et al.* 2015: 146) which are interpreted by the concept of human capabilities, while calling for the involvement of "non-human-centered notions of ethics and justice" (Sovacool *et al.* 2017), and finally refers explicitly to the notion of right (see Table 1). Although it can make the case for framing energy decisions as ethical concerns, its multidimensionality can leave us astray when trade-offs are necessary. This can partially explain why economics generally dominate policy formulation (Heffron, McCauley & de Rubens 2018). The topical example of climate change exemplifies this difficulty because fostering intragenerational equity by increasing energy consumption in developing countries can sabotage efforts for more intergenerational equity. Furthermore, although this is not necessarily an insurmountable problem for the EFJ, it makes the task of implementing the EJF in practice even more difficult.

Second, as of yet, there is no operationalization (metrics and indicators) and no empirical evidence (i.e. it has not been measured) for this concept. And this is indeed related to the first problem. Operationalization could tell us which institutions, nations or even technologies are able to foster

[1] Sovacool & Dworkin (2015) label this principle as 'good governance."

energy justice (Sovacool & Dworkin 2015), and it can exert a significant influence on policymaking because it helps set the policy agenda and measure policy success or failure (Hammond et al. 1995). The lack of operationalization is also related to the fact that the EJF is based upon the capability approach (Jones et al. 2015). However, there are no general agreement on the set of relevant capabilities, which then needs to be established through some kind of deliberation, and it is almost always easier to observe and measure functionings than capabilities (Sen 1992: 52–3).[2]

Both of these problems will be discussed in light of our survey in Guinea. But it is already evident that, though justified, the assessment of the applications of these principles can be quite difficult and requires interdisciplinary and multilevel analyses. Although our analysis is primarily based on the ESMAP access to electricity survey and focuses on criteria (or principles) such as availability, affordability, intergenerational equity, and sustainability, the discussion goes beyond because it can serve as a first step toward the operationalization of the EJF. Additionally, an analysis of the results of the survey can be helpful in identifying the challenges and potential solutions for this operationalization.

3. Access to Electricity Survey in Guinea

In 2015, the World Bank funded a project that aimed at designing and implementing a monitoring and evaluation system for the energy sector in Guinea. The household energy survey served to establish a baseline[3]. As mentioned, the energy sector in the Republic of Guinea remains underdeveloped and characterized by a low access rate to electricity, estimated at less than 31% overall and less than 3% in rural areas in 2015 (World Bank 2018b). The following subsections present the methodology and the main results of the survey, followed by a discussion on the findings.

4.1 Methodology

The survey was conducted in the prefectures of six of the eight administrative regions: the prefectures of Nzérékoré, Faranah, Kankan, Labé, Kindia, and the City of Conakry. These prefectures were chosen based on an analysis of 2014 census data for the entire country. The National Institute of Statistics (NSI) contributed greatly to defining the sample. Its expertise also made it possible to correctly carry out sampling. Data collection took place in both urban and rural areas and followed a cross-sectional sampling by clusters. A sample of 1,840 households was selected and interviewed from each area type, urban and rural, for a total of 3,680 households.

The survey was rolled out in two phases, a pilot phase, and a final phase. The pilot phase allowed interviewers to test the reliability, comprehension and actual duration of the survey questionnaire by administering it to a smaller sample of households. The findings of this pilot phase made it possible, among other things, to optimize the questionnaire, improve the training of interviewers, and better understand the approach to be used to contact households.

To ensure the reliability of the survey data, a household eligibility process was first developed. Then, a profile approach was developed, i.e. a household had to meet three criteria for the questionnaire to be administered; these three criteria were ideally embodied by one and the same person:

[2] Osmani (2016) writes: "…as far as the basic capabilities are concerned, actual achievements (functionings) can be used as good proxies for the richness of the capability set because in these cases people would, on the whole, choose better functioning if better opportunities became available. This is especially when it relates to the average picture of communities as a whole rather than a particular individual (some of whom may happen to behave in idiosyncratic ways). Functioning in these cases may be seen as a valid proxy for capability."

[3] The firm Econoler managed the whole project and the survey was coordinated by the firm StatView International (the firm Hatch also participated).

- The head of the household has to work in a formal or informal activity at a small company (fewer than 20 employees) or in their own company.
- The household must include a person responsible for the energy supply.
- The household must include a person in charge of cooking.

If nobody in the households could match all three criteria, the household was discarded. If the second household was still not eligible, the interviewer moved to a third household and administered the questionnaire to the household, whether they met all the criteria or not. Experience teaches that one person is unlikely to fulfill the three above criteria. Thus, in many cases, more than one person participated in completing the household questionnaire. The ratio of unanswered questions was negligible. Table 1 and Figure 1 below present the sample breakdown.

Table 1: Breakdown of Households in the Sample

Sample Distribution of Households				Total Population[4]	
Region	Zone		Total	Households	Population
	Rural	Urban			
Conakry	0	700	700	238,134	1,667,864
Faranah	360	200	560	34,707	280,511
Kindia	340	280	620	62,612	438,315
Labé	440	120	560	56,910	318,633
Nzérékoré	260	300	560	62,095	396,118
Siguiri	420	240	660	63,850	695,449
Total	**1,840**	**1,840**	**3,680**	**518,308**	**3,796,890**

These criteria were adopted for simplicity sake, given the high number of surveyed households. A more comprehensive or broader study, as an assessment of energy justice would require, should lessen those criteria.

[4] From the National Institute of Statistics of Guinea (2015).

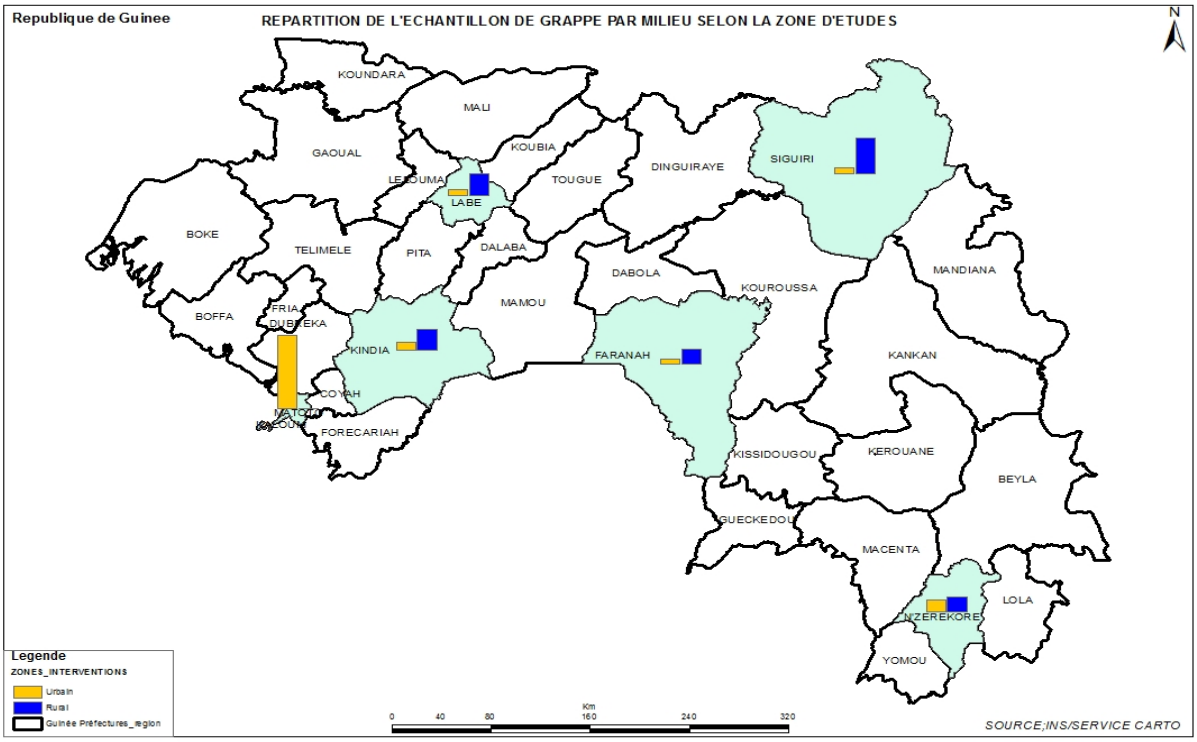

Figure 1: Sample Distribution by Sector (Urban and Rural) for Survey Areas

The questionnaire was elaborated to fit within the ESMAP *Multi-Tier Framework* (MTF) which serves to collect information on seven attributes of electricity services including capacity, service hours, reliability or service interruptions, quality or voltage fluctuations, affordability, legality, and safety (ESMAP 2015). Based on these seven attributes, the MTF assigns any given household to one of five tiers according to its ability to attain different levels of energy services. Since improving energy access is not a single-step transition from lack of access to the availability of access, the basis of a multi-tier conceptualization of energy access is to reflect a continuum of increasing levels of energy attributes versus a binary conceptualization. Although the study focused on access to household electricity, the ESMAP MTF covers a wide range of access types such as access to cooking solutions, space heating, and streetlighting.

4.2 Results and Discussion

Overall, 7,839 persons answered the household survey: 3,907 in rural areas, 50.4% of whom were men and 49.6% women, and 3,932 in urban areas, 45.3% of whom were men and 54.7% women. These percentages, however, refers to the designated main respondent only since in many cases both women and men answered the questions. The average age of respondents was 41, while 25.2% had a university degree in urban areas and 7.3% in rural areas.

Since the study was based on the ESMAP MTF, results are indeed bound to a large extent to ESMAP criteria. Its aggregated approach is thereby presented at the end of this section. However, pursuant to the broader perspective of the capability approach, the following discussion is divided according to the principles or criteria of "energy justice" (Sovacool *et al.* 2016) with those of availability,

sustainability, intragenerational equity and affordability, which overlap, and those of due process, transparency and accountability, intergenerational equity, responsibility, resistance, and intersectionality which do not, or only partially. When the later is the case, solutions for assessing and addressing those criteria are discussed in Section 5.

Availability. The EJF's definition of this principle covers a wide range of meanings. The sufficiency sub-criterion (as in 'sufficient energy resources'; see Table 1) can be interpreted simply as access to energy (i.e. connection) as a threshold of energy consumption per person (UN AGECC 2010), as the number of energy services accessed (Nussbaumer et al. 2012), or as the amount of energy necessary to attain a certain HDI (Mirza and Szirmai 2010) or to realise essential capabilities (Day et al. 2016). The quality sub-criterion can refer to optionality (as discussed in Section 3), reliability (e.g. the number of outages), and safety (number of accidents). It thus entails a multi-dimensional concept and is assessed through indicators such as the type of energy and devices used, maximum power, as well as the number of outages and accidents. Within the ESMAP MTF, availability is restricted to electricity and broadly understood as the ability to draw energy when needed for use of energy services and is measured with the capacity, time and duration of electricity supply.

As expected, almost all households in the capital Conakry were connected to the national grid, as were the majority (66%) of urban households nationwide. Consequently, they have the maximal capacity. Conversely, the majority (69%) of rural households nationwide have no access to energy, except through non-rechargeable batteries, thus representing the lowest capacity (see Tables 2 and 8). Again, we see (e.g. Aglina *et al.* 2016) wide gaps in energy access between rural and urban areas (discussed later). The local mini-grid (including generators) represents 11% (399) and solar PV is marginal with only 3% (126) of all surveyed households, with little difference, in that particular case, between urban and rural areas.

Table 2: Main Energy Sources Used in Households

		nb	National Grid (EDG)		Local Grid		Solar (domestic)		Battery (rechargeable)		Battery (non-rechargeable)		Other	
			n	%	n	%	N	%	N	%	n	%	n	%
Prefecture	Conakry	700	699	100	1	0	0	0	0	0	0	0	0	0
	Faranah	560	118	21	27	5	12	2	1	0	384	69	18	3
	Kindia	620	270	44	7	1	6	1	0	0	268	43	69	11
	Labé	560	69	12	4	1	35	6	1	0	321	57	130	23
	Nzérékoré	560	114	20	61	11	9	2	1	0	318	57	57	10
	Siguiri	680	5	1	299	44	64	9	4	1	284	42	24	4
Area	Rural	1,840	58	3	187	10	85	5	3	0	1,272	69	235	13
	Urban	1,840	1,217	66	212	12	41	2	4	0	303	17	63	4
Total		**3,680**	**1,275**	**35**	**399**	**11**	**126**	**3**	**7**	**1**	**1,575**	**43**	**298**	**8**

For both rural and urban areas, the electrification rates are accompanied by a rather low penetration rate for electric end-use devices or appliances. In effect, the penetration rate of most appliances is well below 20%, and the rate drops further if we consider only grid-connected households. Higher

penetration rates were observed for color televisions with 1,658 (45%) and electric ventilators with 816 (22%). In terms of the rate of frequent use of electric appliances, only 46 households (1.2%) regularly use a refrigerator, 534 (14.5%) a freezer, 81 (2.2%) an air conditioner, and none uses an electric cooker (see 3 below) or a dishwasher. Only 54.8% of all surveyed households use some kind of electric lighting (e.g. incandescent, fluocompact, LED), but nearly three-quarters possess a cell phone charger.

Table 3 below presents the types of cooker used in the 12 months prior to administering the household survey. In both rural and urban areas, the quasi-totally of households (99.9%) uses either homemade cookers fired by solid fuel or manufactured cookers fired by either solid or liquid fuel. The high proportion of households (59,3%) with homemade cooker shows that too many of them still cook with inefficient and/or polluting cookstove. Indeed, three billion people still remain without clean cooking solutions, mostly in Africa in terms of proportion of the population (2019 IEA, IRENA, UNSD, WB, WHO 2019). While this situation reveals a lack of attention from policy-makers, the problem is neither the availability or the affordability of more efficient biomass cookstoves, despite a lack of availability and affordability of clean fuel. In effect, surprisingly, not even one household uses an electric cooker, even though 23 households (0.6%) possess one. In addition, the quasi-totally of respondents said they use wood (solid or ripped), charcoal, leaves, or straws for cooking, and 20 households use coal. Obviously, similarly as Bacon et al. (2010) found, access to electricity does not entail that households use electric appliances in general or electric cookers in particular.

Table 3: Types of Cookers Used in the 12 Months Prior to Survey

Type of Equipment	Nb	%
Homemade cooker with solid fuel	2,180	59.3%
Manufactured cooker with solid or liquid fuel	1,494	40.6%
Butane cooker	4	0.1%
Propane cooker	1	0.0%
Electric cooker	0	0.0%
Total	**3,679**	**100%**

The sub-criterion of quality can be further divided into duration, reliability, safety, and overall appreciation. For these sub-criteria, households that mainly use batteries were excluded so that the main energy source was either the national grid, a local grid, or solar PV. The results reveal that energy availability was not reliable because during the period of the year when energy supply duration is the worst, the main source of energy (i.e. electricity) of households is available for an average daily duration of 6.3 hours per day and 2.8 hours between 6 pm and 10 pm. Moreover, the average number of outages was estimated at more than six per week. A thin majority (53%) indicated having experienced a voltage drop that hindered the proper functioning of an appliance. Finally, none reported a fatal accident or serious injury related to electricity sources. In sum, the main household *electricity* source was not always available, and though unreliable, it was safe.

However, this focus on electricity leaves aside other aspects of quality that are associated with other energy sources, especially those for cooking. Then, the *Multi-tier Matrix for Measuring Access to Cooking Solutions* also from ESMAP can complement the approach and move toward the EJF. While the safety indicator (i.e. number of accidents) as with the electricity access, can be used, the indicator of indoor

air quality, which is notoriously difficult to obtain because it depends on the emission performance of the cooking device but also on the size and ventilation of the cooking area, as well as the quality of fuel used (ESMAP 2015). It can be measured with the WHO indicators. Also, the heterogeneity of the energy sources is a challenge for a synthetic criterion of availability. Indeed, whereas availability of grid electricity is assessed through the power capacity rate (in W), availability of biomass energy should be measured through energy consumption indicators (in kJ).

Table 4: Distribution of Households with Renewable and Non-Renewable Energy Source

Prefecture/Area		Total nb	Renewable		Non-Renewable		No Energy	
			nb	%	nb	%	nb	%
Prefecture	Conakry	700	0	0%	700	100%	0	0%
	Faranah	560	13	2%	529	95%	18	3%
	Kindia	620	6	1%	545	88%	69	11%
	Labé	560	36	6%	395	71%	129	23%
	Nzérékoré	560	10	2%	506	90%	44	8%
	Siguiri	680	68	10%	589	87%	23	3%
Area	Rural	1,840	88	5%	1,531	83%	221	12%
	Urban	1,840	45	2%	1,733	94%	62	3%
Total		**3,680**	**133**	**4%**	**3,264**	**89%**	**283**	**8%**

Sustainability. The sustainability criterion should be assessed through a (more) comprehensive study that tracks the way energy is produced, distributed and consumed, but our survey offers interesting results nonetheless. Table 4 contrasts energy use groupings with renewable and non-renewable sources: the renewable energy category includes the choices "home solar system," "solar lantern," and "rechargeable battery system". The non-renewable category includes 'national grid,' 'local grid,' and 'non-rechargeable battery'. The vast majority of households mainly uses a non-renewable energy source (Table 4). This can be explained by the fact that the majority of *urban* households is connected to the national or local grid (both are considered as non-renewable) and that the majority of *rural* households uses non-rechargeable batteries (also considered as non-renewable). Also, the majority of urban households (78%) uses an electric primary source of energy (i.e. they are connected either to the national grid, a local grid or a generator), whereas the majority of rural households (87%) has a non-electric primary source (i.e. they use batteries, domestic solar PVs, or other sources). In the case of the capital, Conakry, all surveyed households have access to electricity and are connected to the national grid with the main distributor, EDG.

In Guinea, electricity is generated mainly from petroleum and marginally from hydroelectricity. Although this does not entirely qualify as sustainable, the low intensity of consumption is correlated with an overall low rate of CO_2 emissions per capita of only 0.2 metric tons (World Bank 2018b). However, as discussed earlier, the use of biomass such as wood and dung for cooking has many harmful

consequences other than CO_2 emissions. People, mostly women and children, spend many hours gathering these fuels, which in turn reduces the time they devote to more productive activities such as farming and education (Birol 2007; Aglina *et al.* 2016; Energia 2017). Also, collecting firewood leads to deforestation, resulting in severe damage to ecosystems (Birol 2007; Sovacool 2013) and negative impacts on water quality (World Bank 2017). During the time period of 2000-2010, the amount of Guineans residing in remote degrading agricultural areas with limited market access increased by 25%, reaching 375,000 people, and the annual cost of land degradation in Guinea is estimated at 512 million USD, equivalent to 12% of its GDP (Global Mechanism of the UNCCD). Globally, this land degradation has further environmental impacts because it decreases resilience by reducing ecosystem services and increasing the runoff coefficient, thereby reducing aquifer recharge rates, which might eventually be exacerbated by a potential decrease in rainfall (UNEP 2014).

Affordability. On average, surveyed households spend a little more than USD 12 per month on energy costs. What was surprising is the huge, threefold difference between the average monthly spending of rural households (USD 28) and urban households (USD 8). The average price of electricity is considerably high for the region of Siguiri where it is three times the national average (see Table 6 below). There are several factors that account for this. In some regions, households are generally not connected to the national grid but rather to a local grid or they own a generator, in which cases energy expenses vary considerably. Some household members, for example, indicated the price of the generator itself and some said that they did not have to pay at all for electricity. These survey results show the disparity between rural and urban household energy expenses, and the large variability of prices in rural area. Also, the results show that 644 out of 1821 (35%) households allocate more than the ESMAP's threshold established at 5% of their income to energy supply, and 65% allocates less than 5%. Finally, the average electricity consumption per household income presents no pattern, except for a larger consumption for the highest incomes bracket (as expected) but also (more surprisingly) for the second lowest incomes bracket.

Table 6: Average Monthly Energy Expenditure of Households and Appreciation of Energy Supply

Prefecture/Area		Total nb	Monthly energy expenses (Guinean Francs/USD)		Total nb	Global Note Attributed to Energy Services
Prefecture	Conakry	664	72,031	7.95	700	3.8
	Faranah	137	81,614	9.00	155	5.3
	Kindia	269	37,992	4.19	280	4.0
	Labé	61	26,628	2.94	84	4.1
	Nzérékoré	130	100,909	11.13	150	3.3
	Siguiri	201	346,124	38.18	367	6.3
Area	Rural	234	254,702	28.10	305	6.4
	Urban	1,228	76,501	8.44	1,431	4.0
Total		**1,462**	**105,023**	**11.59**	**1,736**	**4.5**

Intragenerational Equity. Intragenerational equity is mainly assessed by the differences in energy availability and affordability between regions and countries. While data show that energy access in Guinea is around 35% compared to 100% in Western countries, the survey results also reveal huge differences between urban and the rural areas. Whereas urban households are connected to the national electricity grid at 66% (Table 1) and pay an average USD 8 per month for energy (Table 4), rural households have a connectivity rate of only 3% and average monthly energy expenses of USD 28. The rural-urban gap in energy access is the widest in Sub-Saharian Africa (IEA 2017; ESMAP 2019). Furthermore, households from any region and any income bracket use either homemade solid-fueled cookers or manufactured solid- or liquid-fueled cookers (Table 3). Many studies have demonstrated a strong correlation between energy access and health as measured by life expectancy (e.g. WHO 2006; Aglina et al. 2016). Collecting biofuels is time costly and dangerous, and burning biofuels indoors is one of the greatest health concerns the developing world faces (Sagar 2005).

The survey was not specifically designed to obtain gender-disaggregated data, but it nonetheless yielded some useful and interesting results. Among the 3,680 surveyed households, only 112 women were the main survey participant (sometimes more than one person answered the questions). Among these 112 women, 100 identified themselves as the head of the household and 31 answered having ever been to school (none to university). It thus suggests that gender equity in energy decision is far from optimal. Moreover, identifying the gender-differentiated benefits of energy access *and* electric appliances is not straightforward. First, energy interventions are likely to impact women and men differently. For instance, "availability of electric light during the evening hours may improve the quality of life for some household members, by allowing reading and entertainment, education and information from radios and televisions, while for other members it may simply extend the working day." (Energia 2017: 13) More time for education and extra-household activities is not necessarily the result of improved female empowerment since "existing structural impediments to gender equality translate into additional investment barriers as well as increased likelihood of occurrence and severity of the financial impact of generic investment risk" (Glemarec et al. 2016: 136). Simply put, time opportunities (e.g. more free time outside of households) do not necessarily translate into empowerment opportunities such as entrepreneurship activities.

Gender-differentiated data, which are actually lacking for the energy sector (Energia 2017), would of course require an even broader, interdisciplinary and multi-level survey. In effect, surveys that require direct answers from more than one member of the household are quite demanding, especially in some African rural area where there are many polygamous households. Focus groups and individual interviews, which are not part of the ESMAP MTF, might thus be necessary. Also, assessing the real opportunities for women beyond the households demands information on the communities, organizations and institutions through which equity and women empowerment can be achieved. Finally, both energy policy with gender mainstreaming and the population's perception should be assessed. These considerations and challenges apply to most of the criteria that do not overlap with the ESMAP framework, and they are discussed below.

Due process. The ESMAP MTF provides one indicator that contributes to the assessment of the due process criterion, which is legality. ESMAP 's legality of the household energy situation concerns only those households connected to a grid (thus excluding those using mainly batteries) and is determined by the fact that the household was able to show that the utility bill was paid to a prepaid card seller or an authorized representative. Only 67% of the surveyed households were able to prove it and were thus considered as 'legally connected'. Among those who were not able to prove it there are households that indicated that there was no need to pay for energy (10%); this includes family arrangements where many households are connected to one generator.

Multi-Tier Approach. The results of the ESMAP MTF-based survey are outlined in Table 8 further below. Each Tier is defined by thresholds or brackets for each of the seven criteria among the following: capacity, duration, reliability, quality, affordability, legality, health, and safety. The lowest Tier of the seven Tiers attributed to the seven criteria for a given household determines the Tier ascribed to this household. For example, a household categorized in Tier 5 for all criteria except for affordability for which it is in Tier 2 will thus be categorized in Tier 2.

As expected, the vast majority (98.8%) of the surveyed population was categorized in the three lowest tiers. Thus, being connected to the national grid does not guarantee a Tier 5 categorization. This shows a situation of energy poverty in Guinea. Also, the previous discussion showed hints of a lack of energy justice as defined by Sovacool *et al.* (2016). The disparity between rural and urban households is even more obvious as shown by the Multi-Tier approach in Fig. 2.

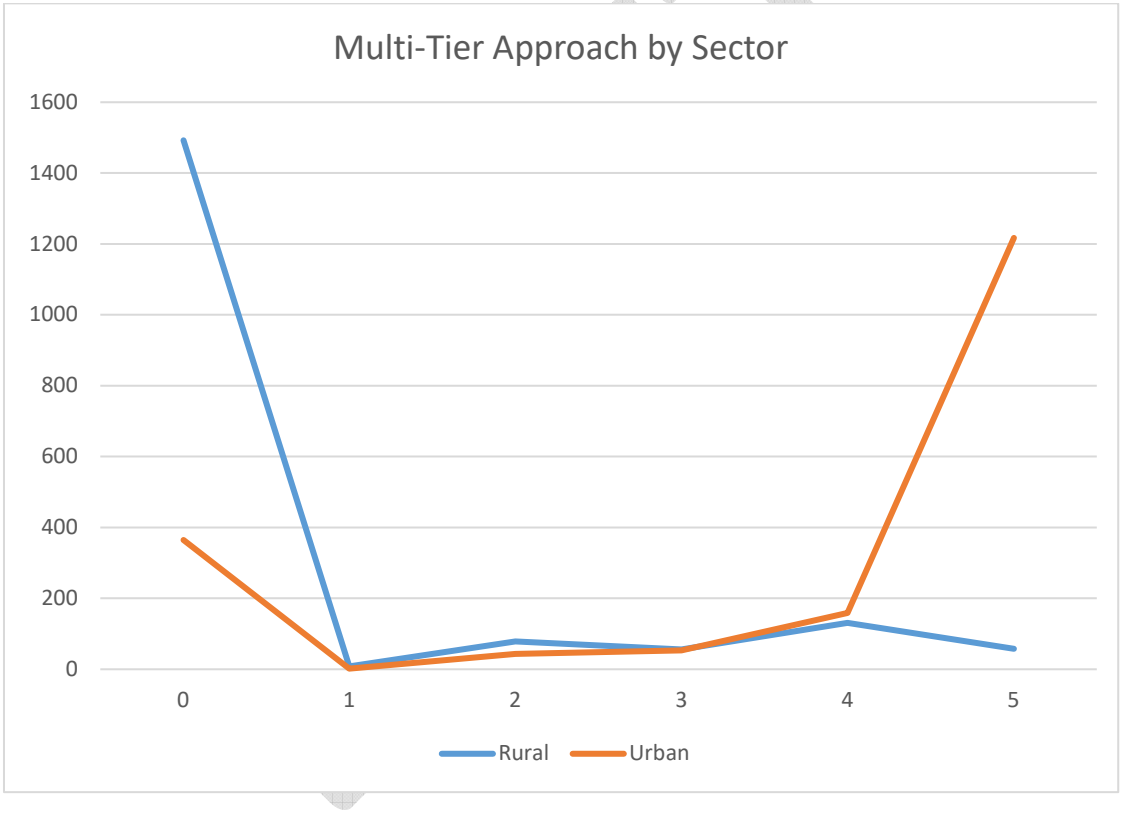

Figure 2: Multi-Tier Approach by Sector – Number of Households in Each Tier

Table 8: ESMAP's Multi-Tier Framework Definitions and Results

Criteria	Definition	Tier 0	Tier 1	Tier 2	Tier 3	Tier 4	Tier 5
Capacity	Amount of energy required to support different levels of power load.	< 3 W/no electricity **(1,858 or 50%)**	Min 3 W Min 12 Wh **(11 or 0.3%)**	3 to 50 W Min 200 Wh **(122 or 3.3%)**	50 to 200 W Min 1 kWh **(109 or 3%)**	200 to 800 W Min 3.4 kWh **(290 or 7.9%)**	> 2 kW Min 8.2 kWh **(1,275 or 34.6%)**
Duration	(i) Total hours of supply.	< 4h **(305)**	4h ≤ total supply < 8h **(1,082)**		8h ≤total supply < 16h **(266)**	16h ≤total supply < 23h **(53)**	≥ 23h **(30)**
	(ii) Hours of evening supply.	Evening supply < 1h **(136)**	1h < = evening supply < 2h **(180)**	2h < = evening supply < 3h **(362)**	3h < = evening supply < 4h **(242)**		Evening supply > = 4h **(816)**
Reliability	Disruptions per week (h) and duration of disruptions.	Disruptions > 14h **(152)**		14h < = Disruptions < 3h **(564)**		Disruptions < = 3h and disruption < 2h per week **(161)**	
Quality	Drops or fluctuations in voltage are only minor and rare with little or no impact on electricity operations.	Poor quality of energy supply/ voltage problems affect use of desired appliances **(927)**			Good quality of energy supply/ voltage problems do not prevent the use of desired appliances **(809)**		
Affordability	Ratio of monthly expense for a specified electricity consumption to monthly household income.	Consumption > 5% of HH income **(644)**				Consumption < 5% of HH income (**1,177**)	
Legality	Electricity supply is obtained through legal means.	Illegal energy supply **(161)**			Legal energy supply/bill is paid to utility, prepaid card seller or authorized representative **(1,447)**		
Health and Safety	The energy system has not caused and is unlikely to cause harm, such as by burning, injury, electrocution, air pollution, or drudgery.	Unhealthy and unsafe energy system **(2)**			Healthy and safe energy system/ absence of past accidents and electrocution **(1,734)**		
Energy Access		**2,195 (60%)**	**99 (3%)**	**1,158 (31%)**	**199 (5%)**	**20 (1%)**	**9 (0.2%)**

4. Moving Toward More Energy Justice

As discussed, the criteria or principles of the due process, transparency and accountability, intergenerational equity, responsibility, resistance, and intersectoriality are not assessed by ESMAP's MTF. Social dimensions are notoriously more difficult to measure. That is why, for instance, it was acknowledged as under-represented in the set of sustainability indicators of Kemmler and Spreng (2017). This section discusses these criteria, proposes some indicators (Table 9) for those criteria that have not yet been addressed and makes adjustments, where pertinent, for those criteria already discussed.

Availability and affordability.. The lack of access to electricity and the prevalence of biomass for cooking in developing countries necessitate the consideration of thermal indicators. ESMAP (2015) proposed "a comprehensive approach for defining and measuring household access to cooking." However, "the performance of cooking solutions varies widely based on several parameters, making the categorization of such solutions challenging." (ESMAP 2015: 104). Actually, wood calorific power depends on the species, relative humidity and the energy services provided. Undesirable effects, such as indoor air pollution, depend on the technology used. Both have an impact on the sustainability of harvesting and the burden of fuel collection. The indicators (see Table 9) proposed by ESMAP (2015) are based on the WHO's guidelines, among other sources. Finally, one area of research that should be further explored is related to the quality of energy in terms entropy and exergy.

It can be misleading to think that the operationalization of affordability involves establishing a certain percentage of a household's income. Indeed, any threshold (e.g. 10% of total income) is not easily justified because it should change from one country to another, even from one region to another, and the quality of energy (as discussed above) is also a relevant factor. ESMAP's framework focuses on low-income and middle-income countries and sets it at 5% (as mentioned), but it does not include the opportunity costs because the time and energy spent to collect biomass like wood is not considered, still less its quality. This is especially relevant in developing countries like Guinea, where poverty is crippling and forces people to satisfy their needs by free-of-charge means. A person should thus be considered energy-poor if she spends a lot of time and effort getting access to energy, even though he or she does not spend a certain amount of money on energy. In other words, if the price of energy hinders her capabilities because the time spent on collecting fuel is not spent on basic capabilities such as child-caring, schooling, or undertaking paid employment. Toman and Bluffstone (2017) also propose a holistic definition of the full social costs of cooking energy options and this definition includes not only the opportunity costs of self-collected fuels but also the externalities such as effects on human health and GHG emissions. Therefore, though the externalities addressed by these authors are arguably included in other criteria, the affordability principle's scope should be broadened by taking into account the level of effort (e.g., the amount of time spent and the distance travelled) in collecting energy.

Due process, good governance, transparency and accountability, and resistance. These criteria are a matter of procedural justice. This kind of justice is intended to ensure that people who will be affected by energy policies are represented in policy-making deliberations in a manner roughly proportionate to the importance of the matter at stake and the irrevocability (irreversibility) of the decisions. It applies to both people in their communities and countries in international negotiations. It thus requires a multi-level assessment approach. These criteria are examples of the extensive, interdisciplinary investigation required to fully assess an energy justice situation. It is also representative of the difficult trade-offs that complex decision-making frameworks, such as the EJF, have to make. Let me present two cases. Firstly, complex energy systems are generally governed and operated far from any public deliberation and rather by technical as well as politic experts. As with the IPCC consultations that leave aside the

indigenous people, representativeness is often traded off for effectiveness. Secondly, human rights can conflict and sometimes some of them can be overridden to serve a community's common good. Then, one must distinguish the classes of rights with one class of rights that cannot be so overridden. Sometimes, such a distinction seems obvious, as with the cases of energy companies making use of rape, murder and slavery (see Sovacool 2013: chap, 4), but in other cases, it is not so obvious (though justified), as with the case of lack of procedural justice (despite a Supreme Court ruling) for the construction of a pipeline in Canada (Hunsberger and Awâsis 2019). Human Rights Watch, which reports on human rights abuses in countries (and Guinea is one of them), could be one tool to assess the criterion of due process.

By and large, the reason behind the need to have transparency and accountability is the same reason why there is so much talk about governance in general: the diverse and complex power relations beyond the sphere of formal democracy. The WB's Worldwide Governance Indicators offer a good way to assess this criterion by measuring six dimensions of governance (Table): voice and accountability, political stability and absence of violence/terrorism, government effectiveness, regulatory quality, rule of law, and control of corruption. However, governance and procedural justice is also a matter of multi-level analysis as factors influencing its realization can be within small communities and households. Unfortunately, as Pachauri and Rao (2013) acknowledge, "issues related to intra-household decision-making and how these influence energy choices and behaviours are largely unexplored in the literature." Many factors influence women's intra-household bargaining power, such as income and employment, asset ownership, education, but also bride price and dowry (Doss 2011). Since, decision-making within the household follows from the social – e.g. women have in general less influence over decisions and exercise less control over their own lives and resources than men at both the household and community levels (Energia 2017) – the EJF should find a way to assess this dimension.

Intergenerational equity. Perhaps the most pressing question is whether matters of intragenerational equity for an energy-poor country such as Guinea should override matters of intergenerational equity. In other words, should energy-poor countries be granted the right to pollute in order to increase their capabilities and quality of life while compromising the right of future generations to enjoy a good life undisturbed by the damage caused by today's energy systems? A diachronic lecture of Rawls's difference principle (Rawls 1971) would suggest that they should be granted this right but only as long as it does not impact negatively the future generations even more than the present generation. To a large extent, this criterion is mediated by the ecosystems and the atmosphere's level of degradation and depreciation. It can thus be assessed by the existence and enforcement of low-carbon and environmental policies, but also by the choice of a certain value for a discount rate, which should be low enough to assign a sufficient importance to future generations in cost-benefit analysis (Stern 2014).

Responsibility and intersectionality. Responsibility, which is "perhaps the most controversial and complex, as it blends together four somewhat different notions of responsibility (Sovacool and Dworkin 2015: 440), can be directed at the environment, non-human species, at communities endangered by climate change, at future generations, and so on. As far as climate change is involved, it is generally focused on states and realized through mitigation or adaptation (Hayward 2012). Responsibility in this context should mainly be understood as forward looking collective responsibility. Accordingly, the adoption of international treaties (on biodiversity conservation or climate change mitigation) by a state can be one indicator, but it might also require to assess various incommensurable dimensions of individual contributions, including degrees of initiative, importance of assigned task, levels of authority, etc. Finally, intersectionality is arguably constantly evolving and is a reminder that societies are as well.

Table 9: Energy Justice Framework (Partial) Operationalization

Principle	Sub-criteria	Indicators
Availability (electricity)	Capacity (electricity)	Installed kW. (ESMAP MTF for electricity).
	Reliability	The number of disruptions per week and duration of disruptions (hours).
	Quality	Drops or fluctuations in voltage are only minor and rare with little or no impact on electricity operations.
	Health and Safety (electricity)	The number of accidents (harm, such as by burning, injury, electrocution, air pollution, or drudgery).
	Efficiency	Entropy production/kWh
Availability (thermal)	Efficiency (thermal)	High power thermal efficiency. Low power specific consumption. (ESMAP 2015, Table 8.5)
	Health and Safety (thermal)	The number of diseases (ischemic heart disease, stroke, chronic obstructive pulmonary disease, lung cancer, acute lower respiratory infection). Quantity of pollutants (particulate matter, carbon monoxide, etc.) (WHO guidelines; Iowa Protocol)
Affordability	Financial capacity	% of income allocated to energy services.
	Level of effort	Opportunity costs: time spent and distance travelled
Due process	Respect of Human Rights	The HRW Index
	Legality	Electricity bills
Transparency and accountability	Gender mainstreaming	Are there equitable opportunities for influencing the design and location of the project in order to avoid or minimize negative impacts?
	Voice and accountability	The extent to which a country's citizens are able to participate in selecting their government, confidence in honesty of the elections, accountability of public officials, freedom of expression, freedom of association (a precondition for resistance), and free media (contributing to politically independent and high-quality information).
	Government effectiveness	Perceptions of the quality of public services, the quality of the civil service and the degree of its independence from political pressures, the quality of energy policy formulation and implementation, and the credibility of the government's commitment to such policies.

Principle	Sub-criteria	Indicators
	Regulatory quality	Perceptions of the ability of the government to formulate and implement sound policies and regulations that enable and promote private sector development.
	Rule of law	Perceptions of the extent to which agents have confidence in and abide by the rules of society (e.g., property rights, the police, and the courts); all of it contributes to due process and resistance.
	Control of corruption	Perceptions of the extent to which public power is exercised for private gain, including both petty and grand forms of corruption, as well as the capture of the state by elites and private interests. Corruption among public officials, public trust in politicians, diversion of public funds.
	Intra-household dynamics	Is the decision-making process fair and gender-sensitive?
Sustainability	Resources depletion	Tep/%GDP
	Fossil fuel consumption or energy intensity	% of RE in the national energy mix.
	Woodland	Forest area, deforestation/afforestation, wood volume. Sustainable forest management and policy.
Intragenerational equity	International equity	Disparities among the countries.
	Gender equity	Disparities between men and women.
	Social equity	Disparities between rural areas and urban areas.
		Are there compensation and resettlement plans that recognize and address social, gender inequalities and the social impacts caused by construction?
Intergenerational equity	Low-carbon policy	Existence and promotion of sustainability or environmental or green bonds.
	Environmental protection policy	Existence and promotion of sustainability or environmental or green bonds.
	Cost-benefit analysis	Low discount rate.
Responsibility	Global environmental governance	Adhesion to international convention on climate change, biodiversity, and so on.
Resistance	Recognition	Is there a recognition of the energy injustice by (*a*) the government, (*b*) the energy policy, (*c*) the NGOs, (*d*) the private sector, (*e*) the media (*f*) the citizens?

Principle	Sub-criteria	Indicators
	Activism	Presence of activist organizations.
Intersectionality	N/A	Evolving indicators

5. Toward More Energy Justice in Guinea

As expected, although the empirical evidence obtained from the ESMAP survey does not entirely fit the bill of the EJF, it is fair to say that Guinea is not an energy-just country. Actually, half of the surveyed households were in Tier 0, meaning that they lacked modern, reliable and affordable energy. Moreover, evidence shows that huge inequalities exist not only between this country and developed countries, but also between regions (urban and rural) within this country. There are compelling reasons to believe that Guinea does not meet the due process and transparency criteria. Fortunately, the country is making progress and there are solutions to achieve energy justice.

The low availability of modern energy in the Republic of Guinea is mainly due to an underdeveloped energy sector, a chronic lack of investment in the sector and the widespread poverty among its population. This situation is similar to that in many SSA countries (Aglina *et al.* 2016; UN 2019; WEC 2019). The electrical installations are controlled and operated by the main operator in the electricity sector, namely the state-owned EDG, which has the following: (1) an interconnected network powering the largest concentration of electricity consumers in the western part, including the capital Conakry; (2) a second interconnected network in the centre; (3) 13 isolated ones scattered throughout the rest of the country. As discussed, there are huge disparities between urban areas and rural areas. Both urban areas and rural areas receive poor energy services since the average daily duration of electricity is 6.3 hours and only 3% of the rural households are connected to EDG. The national government launched in the past an initiative to privatize the operations of EDG, but this initiative failed. So, the government then hired a private partner to manage EDG for four years to improve its performance and to help implement a recovery plan of 1.44 billion euros mainly financed by development institutions, including the World Bank. The goal was to ensure that the operator of the electricity grid in Guinea becomes a solvent player.

The Republic of Guinea, like other SSA countries, has recently improved its energy policy. For instance, seven laws related to energy were adopted in the 2016 - 2017 period compared to none in the 2014 - 2015 period, according to the National Institute of Statistics. Also, since 1992, the Government of Guinea has been developing an energy development policy, entitled *Lettre de politique de développement du secteur de l'énergie* (The Energy Sector Development Policy or LPDSE for short) with the explicit aim to show that the development of the energy sector has been a long-standing government priority and undergoes periodic updates. Currently, electricity is mainly produced by thermal plants and the Government of Guinea intends to tap in its large hydroelectric potential, which is expected to supply 70% of the national grid production by 2025. By then, the solar PV production of the national grid is expected to reach 11%. However, decentralized and renewable solutions and a holistic vision for their implementation (PPEO 2016) still remain largely ignored in the government planning.

Since access to electricity is the worst in rural areas and electricity in rural areas is generally supplied by off-grid (e.g., solar home systems and SHS), mini or local grid installations, policy measures should help remove the barriers to expanding these decentralized grids. For instance, meeting the energy demand of higher tiers, such as Tier 4 and Tier 5, is possible with an approach based on bottom-up, interconnected SHS-based microgrid as opposed to stand-alone SHS (Narayan et al. 2019). This solution might therefore help overcome the limited penetration rate that can be observed in certain African rural areas (Azimoh et al. 2016). Thanks to decentralized solutions' lower implementation

costs, reliability, and low level of pollution at the production and the consumption stages, they can help rural areas climb the energy ladder. Therefore, these solutions can help reach the goals of the EJF, such as availability, affordability, and sustainability. Furthermore, in addition to the benefits that electricity access offers to women in general (e.g., more security from street lighting and more income opportunities), decentralized solutions can empower women by including women in the energy decision-making process.

Mitigation measures may include the following: (1) filling the gaps in the policy and regulatory framework; (2) dealing with specific issues related to electricity rates that are not cost-effective for developers; (3) overcoming the lack of market data and linkage; (4) providing the right information on state-owned grid expansion plans, i.e., on "how mini-grids will be integrated into the grid and how mini-grid owners will be compensated if the grid arrives" (ADB 2016: 7). Also, the approach to electricity expansion should match the demand characteristics of different types of populations because off-grid electricity supply such as solar PV is generally more cost-effective for isolated villages with low-household density. Therefore, the Government of Guinea should make a strong effort to collect up-to-date, clear and precise information and provide it to developers.

This is not to say, however, that large-scale power plants should be abandoned, but rather that it should be planned along with decentralized solutions. Another difficult trade-off that the EJF must face is the one between those solutions that can maximize energy access or availability at a certain financial cost (e.g., fossil-fuel-fired power plants) and those solutions that yield less energy access at the same cost but offer benefits such as less GHG emission (fostering sustainability and intergenerational equity) and more decentralized decision-making processes (fostering procedural justice). Whatever this trade-off could be, our survey indicates (as discussed) that more access to electricity will not necessarily be accompanied by a reduction of wood consumption, and correlatively by a reduction of health problems caused by indoor air pollution. Since more efficient cookstoves are both available and affordable in Guinea, our survey suggests that information campaigns would be needed to increase their penetration rate. For such campaigns to be effective, attention should be paid to gender issues. Actually, how households use finances, who makes the decisions, whose preferences are prioritized and how those decisions are influenced (e.g., value of women's labour), particularly in terms of intra-household negotiation, are key determinants in the uptake of modern energy fuels and technologies (Clancy *et al.* 2012). However, the 2012 LPDSE indicates that the objective of promoting gender equality was not likely to be achieved.

Finally, interventions by the Government of Guinea are unlikely to happen and/or to benefit the population in general if these interventions remain far from procedural justice. In other words, if the government cannot ensure effective recourse through judicial and administrative remedies and forms of redress, it should establish a comprehensive participatory framework and a genuine community consultation as well as neutral arbitration structure to handle grievances. The assessment of legality in the ESMAP MTF indicates a lack of information about who is illegally connected to the EDG and thus governance issues. Also, in 2015, the Government of Guinea requested a private firm to serve as a strategic partner so as to make EDG profitable within four years. While this objective seems *prima facie* legitimate, this kind of agreement often results in a lack of transparency. Our experience suggests that, most often than not, government ministries and agencies are understaffed and unstable, thus giving rise to these shortcomings in procedural justice. This is something that international agencies should seriously consider when designing development programs.

6. Conclusion

The issue of energy is better addressed from a broader ethical perspective and the capability approach offers an adequate normative framework since it helps conceptualize the real opportunities that the wide diversity of energy services can offer. Based on this approach, the results of a household energy survey in Guinea show intragenerational inequity between rural areas and urban areas (as it is the case in many other countries with a similar context); the results also show that, when accessible, household electricity was neither always available nor reliable, but safe.

The poor quality of energy negatively impacts the capabilities and quality of life of Guineans. Therefore, the energy policy and the sustainable development effort must give due consideration to the need to improve electricity access in rural areas and target a higher penetration rate of more efficient, clean cooking devices to reduce indoor pollution and deforestation, even in regions with access to electricity. Additionally, social-policy measures, such as better education, need to be implemented concurrently with energy-policy measures. Although further research will be needed in order to fully operationalize the EJF, our proposal is one step further in that direction. Because whatever the normative framework there is to be followed, the indicators and data will provide us with the insights on what to do and whether or not we have chosen to go in the right direction.

References

2 Agency), I. I. E. Wolrd Enery Outlook. (International Energy Agency, Internet, 2010).

3 Angelou, N. (ed ESMAP).

4 Bacon, S., Bhattacharya, S. & Kojima, M. Expenditure of Low-Income Households on Energy. Evidence from Africa and Asia. Extractive Industries for Development., (World Bank, Washington DC, 2010).

5 Banerjee, S. G., Moreno, A., Sinton, J., Primiani, T. & Seong, J. Regulatory Indicators for Sustainable Energy: A Global Scorecard for Policy Makers. (World Bank, http://documents.worldbank.org/curated/en/538181487106403375/Regulatory-indicators-for-sustainable-energy-a-global-scorecard-for-policy-makers, 2017).

9 Bridge, B. A., Adhikari, D. & Fontenla, M. Electricity, income, and quality of life. The Social Science Journal 53, 33-39 (2016).

10 Deutscher, G. The Entropy Crisis. (World Scientific Publishing Co. Pte. Ltd., 2008).

11 Diaz-Mendez, S. E., Rodriguez-Lelis, J. M. & Hernandez-Guerrero, A. A general exergy-based environmental impact index. Journal of Mechanical Science and Technology 25, 1979-1985 (2011).

12 Dincer, I. & Cengel, Y. A. Energy, Entropy and Exergy Concepts and Their Roles in Thermal Engineering. Entropy 3 (2001).

13 Energia. Energy access and gender equality: What we know so far and knowledge gaps. (Gender-Energy Programme, 2017).

14 ESMAP. Beyond Connections: Redefining Energy Access. (http://www.worldbank.org, 2015).

15 Geels, F. W., Berkhout, F. & Vuuren, D. P. v. Bridging analytical approaches for low-carbon transitions. Nature Climate Change 6, 576-583 (2016).

16 Group), A. A. D. B. Green Mini-Grids in Sub-Saharan Africa: Analysis of Barriers to Growth and the Potential Role of the African Development Bank in Supporting the Sector. (African Development Bank Group, https://www.energy4impact.org/file/1818/download?token=j67HKZEy, 2016).

17 Hayward, T. Climate change and ethics. Nature Climate Change (2012).

18 Heffron, R. J. & McCauley, D. The concept of energy justice across the disciplines Energy Policy 105 (2017).

19 Hunsberger, C. & Awâsis, S. Energy Justice and Canada's National Energy Board: A Critical Analysis of the Line 9 Pipeline Decision. Sustainability 11 (2019).

20 IEA. World Energy Outlook. (International Energy Agency, Paris, 2015).

21 IEA, I., UNSD, WB, WHO. Tracking SDG7: The Energy Progress Report 2019. (International Bank for Reconstruction and Development / The World Bank Washington, DC, 2019).

22 Köhlin, G., Sills, E. O., Pattanayak, S. K. & Wilfong, C. Energy, Gender and Development: What are the Linkages? Where is the Evidence? , (The World Bank, https://elibrary.worldbank.org/doi/abs/10.1596/1813-9450-5800, 2011).

23 Moran, M. J. & Shapiro, H. N. Fundamentals of Engineering Thermodynamics. (John Wiley & Sons Ltd,, 2006).

24 Organization, W. H. Fuel for Life: Household Energy and Health. (Geneva, 2006).

25 Osmani, S. R. The Capability Approach and Human Development: Some Reflection. (UNDP, 2016).

26 Pasten, C. & Santamarina, J. C. Energy and quality of life. Energy Policy 49 (2012).

27 Pfaff, A., Lima, J. R. E., Sandoval, C. & Herrera, L. D. Governance, Location and Avoided Deforestation from Protected Areas: Greater Restrictions Can Have Lower Impact, Due to Differences in Location. World Development 55, 7-20 (2014).

28 Programme), U. U. N. E. Assessment of Transboundary Freshwater Vulnerability in Africa to Climate Change. (UNEP and Water Research Commission, http://wedocs.unep.org, 2014).

29 Saito, M. Amartya Sen's Capability approach to Education: A critical exploration. Journal of Philosophy of Education 37 (2003).

30 Sen, A. Development as freedom. (Knopf, 1999).

31 Sen, A. The idea of justice. (Allen Lane, 2009).

32 Sovacool, B. K., Burkec, M., Bakerb, L., Kotikalapudib, C. K. & Wloka, H. New frontiers and conceptual frameworks for energy justice. Energy Policy 105, 677-691 (2017).

33 Sovacool, B. K., Heffron, R. J., McCauley, D. & Goldthau, A. Energy decisions reframed as justice and ethical concerns. Nature Energy 1, 16024, doi:10.1038/nenergy.2016.24 (2016).

34 Tanner, A. M. & Johnston, A. L. The impact of rural electric access on deforestation rates. World Development 94, 174-185 (2017).

35 Toman, M. & Bluffstone, R. Challenges in Assessing the Costs of Household Cooking Energy in Lower-Income Countries. (World Bank Group, 2017).

36 UNCCD, G. M. o. t. Country Profile: Guinea. Investing in Land Degradation Neutrality: Making the Case, An Overview of Indicators and Assessments. (United Nations Conservation to Combat Desertification, Bonn, Germany, 2018).

37 UNDP. Human Development Report 2016. (United Nations Development Programme http://hdr.undp.org/sites/default/files/2016_human_development_report.pdf, 2016).

World Bank 2017. Climate Resilience in Africa: The Role of Cooperation around Transboundary Waters. (International Bank for Reconstruction and Development, https://openknowledge.worldbank.org/handle/10986/29388, 2017).

---. Tracking SDG7: The energy progress report 2018. (2018).

---. in https://data.worldbank.org (https://data.worldbank.org, 2018).