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Article

Significance and Directions of Energy Development in African Countries

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Abstract: The development of energy networks and electrification is a major challenge in many African countries, which can contribute to reducing social inequalities. Energy, and above all electricity, is a decisive factor influencing the functioning of national governments. The power of governments in individual countries depends on the energy sector. Therefore, it is worth noting that during the presidential elections, candidates make many promises related to the improvement of the energy supply. The article shows, using the examples of Guinea, Ethiopia and Egypt, how politicians in the pre-election period use slogans related to the energy and development of the country. The innovative side of this article looks at how politicians keep their promises by using the energy sector and how they secure victory in the next election. The article linked the objective needs for the development of the energy sector resulting from the growing demand for energy with the motives of the decisions makers who want to maintain power through the implementation of new investments in the energy sector. The paper presents the results of research on the development of the energy sector and the motives for this development, explains how energy investments are realized, and discusses the environmental and social problems that arise when building huge hydropower stations.

Keywords: energy; energy policy; energy poverty; society; government policy; management of enterprises

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1. Introduction

Energy is one of the major driving forces of any economy. Access to energy and other natural resources is a key issue in economic, social, technical and institutional terms [1,2]. The economic development of states depends on access to energy [3–5], especially electricity. Energy plays an important role as a factor that significantly influences productivity growth and plays a key role in economic development [6,7]. In addition, the impact of the energy sector on the social aspect and human well-being can be seen [8], although some say that there is no research that would clearly and faultlessly show the relationship between the economic aspect expressed by economic growth and the energy production defined as energy supply [9]. The relationship which occurs between energy consumption and observed economic development is considered by some researchers as an asymmetric relationship [10,11] although other researchers show that taking into consideration asymmetry does not affect the relationship between energy and economic growth [12]. In industrialized countries, the key to economic development is the proper functioning of the electricity sector, while in developing countries energy is a scarce resource, delivered with interruptions related to, e.g., old infrastructure [13] or system failure. The total installed electricity generation capacity is insufficient, leaving millions of people without access to electricity in Africa [14,15]; therefore, the enlargement of the energy sector, the development and growth of which could potentially contribute to the economy's transition to a higher level of economic development in the future, is essential [14]. Energy is therefore not only the basis for the development of modern civilization, but also a social good [16], whose price should not be an access barrier for the lowest-income social groups. All economic processes, industry and technical services are based on energy, as well as consumption and transport, which makes it a "public good", which means that it becomes a determinant of the functioning of enterprises, organizations and governments [17]. Energy production should take into account its impact on the environment and humans [7] and strive for the lowest possible harmful impact by looking for innovative technical and technological solutions. The research concerning the mentioned subject carried out so far has considered the occurrence of populism in Western democracies [18,19] and African countries—sub-Saharan Africa—as separate issues [20]. In many studies carried out so far, much attention has been devoted to the issue of energy and its importance for the functioning of societies in individual, selected countries [21,22], which can be described as point photography of the situation, although the first attempts to look from a wider perspective have already appeared [23]. A new approach to the subject is a consideration from different research perspectives in the field of energy and societies, i.e., simultaneous research in several African countries, which can be described as panoramic photography. The idea of the research is to find (if any exist) the mechanisms common to most countries, regardless of the degree of economic development and geopolitical situation. The idea of conducting this research appeared during my stays in several African countries, when I personally experienced energy poverty, while the governments of these countries promoted information about the energy strength of these countries. I observed deficiencies in access to electricity and the resulting problems for businesses and citizens and, at the same time, banners and advertising by the government about the energy power of those countries. The article analyzes issues related to the energy sector in African countries, the impact of politics on the development of the sector and its technical and technological innovation. The research was carried out as hypothetical-deductive research with hypotheses and as inductive research with observations and interviews. Research questions were asked concerning whether similar mechanisms exist in most countries, determinants between stability and maintenance of state power and the energy situation, and whether there are differences in the type of promises, concerning energy, made by governments. This research is an attempt to answer the above questions and at the same time find similar or different motives that are followed by leaders in individual countries. The research was carried out in several African countries to analyze the mechanisms functioning in countries where energy poverty occurs (Guinea, Ethiopia) and in Egypt—a country that will have problems with energy production at the Aswan power plant situated on the Nile and problems with access to water when Ethiopia also builds and opens a hydroelectric power plant on the Nile. The sources of the Nile are in Ethiopia and heavy rains in Ethiopia have an influence on water level on the Nile River. The construction of another water dam on the Nile will cause a decrease in the water level and contribute to problems at the Aswan power plant. Completed research shows how the functioning of governments in selected countries depends on the production of and universal access to energy [24].

The main problem that is the starting point for this research is to show the relationship between the development of the energy sector and government policy in African countries. The research takes into account the impact of population growth, increased energy demand and the political situation in the countries under consideration. Thanks to this approach, it is possible to link the motives of the rulers with the objective effects of their actions. It is an innovative approach to the development of energy in Africa.

2. Materials and Methods

The induction model and a hypothetical-deductive model were used in order to carry out this research. The induction model allowed conducting qualitative research, including observations and interviews, while the hypothetical-deductive model allowed the author to carry out quantitative research, including the statistical evaluation of the occurring phenomena what have been illustrated in Figure 1. By applying a so-called mixed methods approach to scientific research (the simultaneous use of qualitative and quantitative methods), scientists expect that the combination of these methods will reduce or eliminate errors that characterize individual methods. Moreover, the use of mixed methods in the conducted research will allow the supplementing of the partial results obtained at individual stages of the research process.

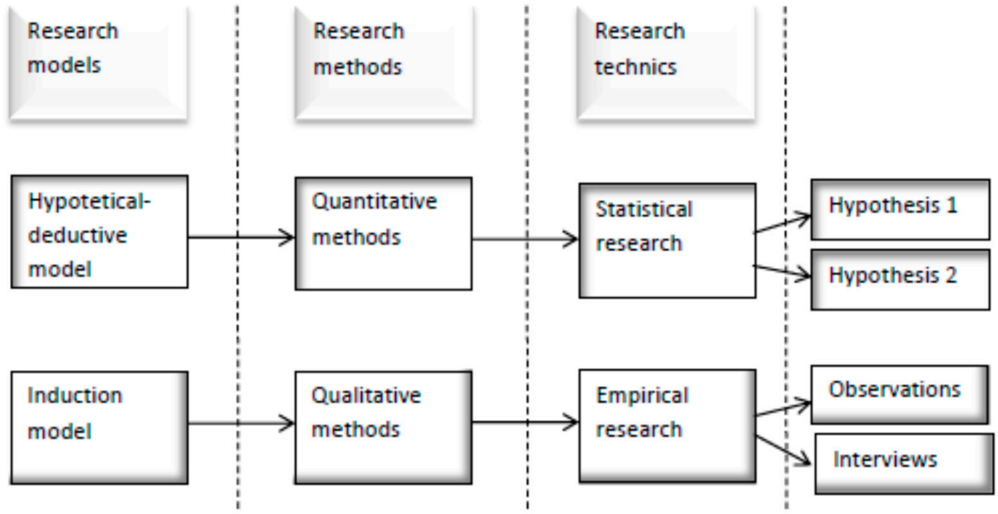

Figure 1. Conceptual framework for conducting research.

In quantitative research based on the hypothetical-deductive model, which is the core of this type of method, the first step is to familiarize yourself with and analyze the theoretical foundations [25]. The theoretical foundations in the hypothetical-deductive model are built on the basis of a review of the available global literature and after conducting its critical analysis. This stage is carried out in order to define the conceptual framework of the research by precisely defining the existing and used terms. Qualitative research is characterized by using the induction model [26]. In the inductive model, research questions are asked and the research goes from detailed to general. The results are not assumed a priori, i.e., the image of reality is not built, but some patterns and rules are found, which are then transformed into generalizations on the basis of empirical research. Qualitative methods make it possible obtain empirical and experimental data (as a result of realized experiments), and based on these results it is possible to conduct an interpretation process and make generalizations, primarily in social sciences and management. In qualitative methods, source data are obtained through observation and conducted interviews. Qualitative methods offer basically unlimited resources for the possibility of obtaining source information, which is then used to articulate the truth about the phenomena that occur. As the facts are expanded, the accuracy of inference increases [27]. Qualitative research is most often found in the interpretative trend and is used in the context of research problems that are not well known.

In this research I will use both mentioned methods. The use of two research methods will allow a more thorough analysis of phenomena. Scientific methodology is constantly developing and changing, and mixed methods are another step forward; they are more and more widely accepted because they use the advantages of both qualitative and quantitative research. Mixed methods have become widely used in the social sciences and management sciences, and they are finding more and more supporters of their use in realized research. Mixed methods allow researchers to obtain different types of evidence that refer to different sensibilities; in addition, they allow researchers to look at the occurring phenomena from a broader perspective, giving the possibility of a more thorough and more in-depth assessment of the situation [28,29]. The use of mixed methods gives a wide range of possibilities, allows for greater flexibility, but at the same time guarantees greater accuracy of results in the conducted research thanks to the generation of arguments that are based on research data obtained using two methods [30,31]. This allows researchers to eliminate any errors related to individual methods. This can be called a double verification of the results [32,33].

3. Results

In research on the environment and political aspects of energy, it is worth analyzing the connections and relationships that occur between social development and sustainable development. Social development can be described by means of selected elements, such as life expectancy, income per capita, education and health care. The used indicators allow us to classify, rank and organize nations and describe them via the Human Development Index (HDI) to show the level of development of the individual countries. By contrast, sustainable development is growth that meets the current needs of today's society, without prejudice to the ability of future generations to meet their future needs, and can be described by environmental, economic and social factors. The economic factors included in the HDI describe, inter alia, the level of development of the country, which may translate into energy consumption [34] and the possibility of financing the development of a modern energy sector.

3.1. Quantitative Research According to Hypotetical-Deduction Modelubsection

The first stage of the designed research was to analyze the relationship between social development and the factors classified as sustainable development (environmental, economic and social factors). The studies were carried out as secondary studies and the relationships were determined using Pearson's correlation. An independent variable and dependent variables have been defined. Independent variable: level of social development. Dependent variables: percentage share of older people in the working group; use (consumption) of natural resources; use of renewable energy sources; CO_2 emissions were presented in Table 1.

Table 1. Independent and Dependent Variables.

HDI Rank	Country	Old-Age Dependency Ratio	Natural Resource Depletion	Renewable Energy Consumption	Carbon Dioxide Emissions
36	Poland	36.3	0.7	11.1	9.1
71	Turkey	18.0	0.3	12.8	5.2
111	Egipt	10.5	6.4	5.5	2.4
174	Ethiopia	6.6	11.2	93.5	0.1
183	Guinea	6.1	19.2	76.3	0.3

Source: own elaboration based on [35]. HDI—Human Development Index. Old-age dependency ratio—the percentage ratio of people over 65 years of age to people of working age, i.e., in the age range of 15–64. Natural resource depletion—percentage share of natural resource depletion (mineral, energy, forest and air exhaustion), expressed in monetary form, relative to Gross National Income. Renewable energy consumption—amount of renewable energy in total final energy consumption. Carbon dioxide emissions—human-originated carbon dioxide emissions stemming from gas flaring, the burning of fossil fuels, and the production of cement, divided by the population in the middle of the year.

3.1.1. Pearson Correlation

In order to check the relations between the dependent variables and the independent variable, the Pearson correlation was used [36]. Correlation is a typical statistical analysis based on bivariate that measures the force a relationship and coupling between two different variables and the trend among these relationships. The value of the correlation coefficient can range from +1 to −1. Extreme values, i.e., ±1, indicate that there is a maximum degree of connection between the pairs of variables; the pairs of variables are very strongly related to each other. When the correlation coefficient is around ±0.5, the correlation is still quite strong, while when the coefficient approaches 0, it can be said that the relationship between these two variables is very weak or entirely absent. The sign of the coefficient indicates the course and trend of the association; a plus sign (+) means that there is a positive relationship and a minus sign (−) indicates that there is a negative relationship between variables. Pearson r correlation is the most popular and widely utilized correlation statistic to measure the grade of the relationship between linearly tied variables [37]. In our case we were able to use Pearson correlation because two or more continuous variables were presented, as well as cases which had non-missing values on both variables and a linear relationship between the variables existed. Pearson's correlation coefficient can be calculated using the function appearing in Excel spreadsheets, while in the presented article it was calculated according to the following equation to show the principle of calculating this coefficient (1) [38].

$$r_{xy} = \frac{\sum(x_i - \overline{x}) \sum(y_i - \overline{y})}{\sqrt{\sum(x_i - \overline{x})^2} \sqrt{(y_i - \overline{y})^2}} \quad (1)$$

where r—correlation coefficient of x and y;

$\overline{x} = \frac{1}{n} \sum_{i=1}^{n} x_i$ denotes the mean of x;

$\overline{y} = \frac{1}{n} \sum_{i=1}^{n} y_i$ denotes the mean of y.

In our case, the results of Pearson correlation are presented in Table 2.

Table 2. Pearson Correlation.

		Dependent Variables			
		Old-Age Dependency Ratio	**Natural Resource Depletion**	**Renewable Energy Consumption**	**Carbon Dioxide Emissions**
Independent Variable	HDI Rank (level of country development)	−0.90	0.93	0.87	−0.96

The results of the research concerning environmental (natural resource depletion, renewable energy consumption, carbon dioxide emissions) and social (old-age dependency ratio) variables showed that there is a very strong negative correlation between the country's development and the level of CO_2 emissions (−0.96), which means that the more developed the country (i.e., the better a country's position in the HDI rankings), the greater its carbon dioxide pollution. This is a negative effect of industrialization in countries with high social development. Urban development and population growth, as well as industrialization, have a significant impact on increasing energy demand and, at the same time, increasing CO_2 emissions, but many studies show that these relationships vary depending on the level of economic development, including industrialization and income earned [39–41]. Developed countries have noticed the high threats resulting from excessive CO_2 emissions and the use of fossil fuels for energy production and are starting to implement a zero-emission economy based largely on RES and alternative fuels [42,43]

Based on this stage of study, the hypothesis H1 can be put forward.

Hypothesis 1 (H1). *In highly developed countries, governments will strive to reduce CO_2 emissions and improve air quality by implementing innovative solutions in the energy sector.*

However, in countries with a low level of social development (occupying a weak position in the HDI rankings) there is a strong positive correlation between the low level of development of the country and the use and depletion of natural resources (0.93). The less developed the country, the more natural resources are exploited and the level of depletion of natural resources increases. The developing countries are now largely responsible for the excessive use of resources, which is manifested in the clearly visible depletion and use of natural resources. It seems obvious that a significant proportion of the economic growth measures implemented by poor governments cause a significant depletion of resources. In addition, developing countries remain heavily dependent on exports of natural resources (diamonds, gold, silver, uranium) to generate economic dividends [44,45]. Therefore, if the resource is depleted over time, consumption growth is reduced [46].

Hypothesis 2 (H2). *In less developed countries there is a phenomenon of exploitation of natural resources to increase the supply of electricity.*

There is also a strong negative correlation between the country's social development and the participation of older people in society (−0.9). The less developed the country, the lower the percentage of economically active people aged over 65. It is therefore important to ask whether, indeed, the participation of older people in society has a positive impact on economic development. Most studies show a positive correlation between population aging and economic growth [47,48]. Population aging according to the share of the elderly (or the dependency ratio of the elderly) may have a negative effect on economic growth under the condition that it reaches a certain high level and its negative impacts intensify with the increase in the aging population. Aging has slowed down economic growth in recent years, especially in most developed countries, where the proportion of older people is very high [48,49].

3.1.2. Elements of Sustainable Development

The ecological environment plays an important role in energy management and energy enterprises management and influences the decisions taken by national governments. Various elements of the ecological environment can be used by governments to shape economic development and influence society and social progress [50]. National governments take environmental requirements into account to a greater or lesser extent and make decisions that affect the country's economy (e.g., subsidies for ecological activities), but that also have an influence on society (e.g., energy subsidies, grants for replacing boilers in homes). Currently, the ecological environment is playing an increasingly important role and the pursuit of sustainable development in the economy is clearly visible. The approach to sustainable development is based on an understanding of ecology issue by decision-makers at higher and medium levels of management and a focus on social problems [51]. The ecological environment is influenced by legal issues, legislation, legal acts, directives, ordinances and regulations which, due to their variability and complexity, may often cause new conflicts and inconsistencies on the national or international level in the field of sustainable development [52,53]. The aforementioned uncertainty, the volatility and complexity of regulations translates into an increase in the level of business risk in the energy market [54]. Enterprises operating on the market, including enterprises belonging to the energy sector, strongly feel the influence of the legal environment characterized by new directives and regulations related to ecology, e.g., limiting harmful emissions, such CO_2 emissions and greenhouses emissions, thus reducing the negative impact on the environment [55]. In energy sector enterprises, an important element of the undertaken actions is the reduction of harmful emissions in the field of energy installations. In addition to technical changes, technological changes are also undertaken, as well as changes in the materials used for combustion. The combustion of petroleum fuels gives a more favorable exhaust composition than when using coal (even with additives), but the emission of such air pollutants as NOx and particulate matter—PM 10 and PM 2.5—is still far higher many regions of the world than the level required by international standards [56,57]. One of the effective ways to improve the situation is the introduction of alternative fuels (e.g., clean coal briquettes or biochar from agricultural wastes) or the use of innovative solutions related to the reduction of emissions in transport fuels or the development of electromobility [58–61]. The ecological environment forces enterprises to undertake activities in the field of developing and implementing new technical and technological solutions that will meet the challenge resulting from strict environmental criteria. Technologies are constantly evolving and their impact on the environment is changing. Emissions of SO_2 and other harmful dusts related to coal combustion are much lower than a dozen or so years ago, while CO_2 emissions are steadily increasing. According to the Global Carbon Atlas, CO_2

emissions over the twenty years between 1998 and 2018 are as shown in Tables 3 and 4. Table 3 shows CO_2 emissions and growth dynamics while Table 4 shows the amount of emissions per capita and growth dynamics.

Table 3. CO_2 Emission and Dynamic of Emission Growth.

	[$MtCO_2$]			Dynamics
	1998	**2008**	**2018**	**2018/1998**
Guinea	1.4	2.0	3.2	2.28
Egypt	122	195	239	1.95
Ethiopia	3.1	6.4	15	4.84
Turkey	212	309	428	2.01
Poland	339	329	344	1.01
World total	24,150	31,994	36,573	1.51

Source: own calculation based on [62].

Table 4. Amount of CO_2 Emission and Dynamic of Growth.

	[tCO_2/Person]			Dynamics
	1998	**2008**	**2018**	**2018/1998**
Guinea	0.2	0.2	0.3	1.5
Egypt	1.8	2.5	2.4	1.33
Ethiopia	0.1	0.1	0.1	1.00
Turkey	3.5	4.4	5.2	1.49
Poland	8.8	8.6	9.1	1.03
World average	4.0	4.7	4.8	1.20

Source: own calculation based on [62].

The presented data shows that in Ethiopia, emissions increased by more than 1.8 times while per capita remained unchanged, which indicates a large increase in population. In the remaining analyzed countries, the trend is increasing both in quantitative and per capita terms.

The combustion of fossil fuels containing many chemical elements causes significant environmental pollution and at the same time, through these negative effects of combustion, contributes to its systematic degradation. Coal is a fossil fuel that usually contains a lot of sulfur in its chemical composition, which is released into the atmosphere in the form of sulfur dioxide during combustion [61]. SO_2 has a negative impact on forest areas that die from acid rain. SO_2 also acidifies the environment and contributes to increasing the acidity of water and soil [63]. The systematic reduction of SO_2 emissions is mainly due to the increasing rate of desulfurization, LNB (Low NOx Burners) converters, denitration and dust removal equipment [64]. The producers of harmful substances install devices and installations that are meant to ensure the effective desulfurization of all the exhaust gases generated during the energy production process. Mostly, the wet lime method is used. Apart from the aforementioned harmful effects of SO_2, the absorber also absorbs other pollutants such as hydrogen chloride HCl, hydrogen fluoride HF, mercury Hg and ash [65]. Another negative phenomenon faced by energy producers is the production of deleterious nitrogen oxides as a result of the coal combustion process being carried out too quickly at high temperatures. Power plants and combined heat stations in the energy production process emit nitrogen oxides, popular known in the literature as NOx, into the atmosphere in addition to CO_2. In order to reduce harmful emissions into the atmosphere, in accordance with the regulations in force in the field of environmental protection and energy production, combined heat and power plants are gradually building up catalytic denitrification systems—Selective Catalytic Reduction (SCR) [66,67]. This method is based on the reduction of nitrogen oxides to atmospheric nitrogen using a substance containing ammonia. The chemical reaction described above takes place on the surface of the catalyst. Burning coal is associated with another side effect, which is the formation of large amounts of fly ash in the furnace and sending to the atmosphere. An adequate level of exhaust gas dedusting is maintained due to proper operation process and the gradual replacement of the elements responsible for the cleaning of pollutants, i.e., electrostatic precipitators. Highly developed countries can invest in new, innovative solutions and national governments can support these solutions. High-efficiency electrostatic precipitators used by energy companies for dedusting (two-stage dedusting) cooperate with flue gas desulfurization installations, thanks to which high efficiency is achieved. Fly ash has a negative impact not only as an element of environmental pollution, but also on heating systems, as the gradual deterioration of transmission devices is perceived. Various mineral particles contained in the ash, which are residues of the combustion process, pass through the steel boiler tubes, destroying the surface by abrasion and mechanical damage. These particles rubbing the pipe walls contribute to the increase in production costs, because they caused attrition that forces the replacement of entire installations. The composition of fine coal that is formed in the combustion process depends on the quality of the input material, which is coal of various types; therefore, each CHP (Combined heat and power) plant installs pipes which are made of different types of steel, the composition of which depends, among other things, on the types of coal burned. Reducing pollution emissions is also associated with increased costs associated with the implementation and installation of innovative solutions. Increasingly, power plants recover fly dust, which can then be used in various industries, e.g., road construction, embankments, building materials and cement production. Worldwide, considerable amounts of fly ash and coal ash are produced, but less than 30% of the ash produced is reused [68,69]. The costs incurred for innovative solutions can be financed through emissions trading. Solutions for emissions trading on a global scale may face legal, technical or systemic barriers [70]; however, they may bring the intended benefits at national level [71]. People who support the implementation and operation of the emissions trading system show that such a mechanism that punishes environmental polluters and promotes environmental initiatives may favor the search for more effective technologies for reducing pollution, as energy companies will strive to reduce costs. If the company is considering modernizing their installations, then the possibility of the Emissions Trading Scheme will allow the company to sell its emission allowances and will act as a financial incentive to innovate [72]. It is forecast that by 2050 the world economy will grow at an average rate of 2.8–3% per year, which means almost doubling by 2037 and almost tripling by 2050 [73]. Given the projected steady increase in efficiency in electricity generation, the growth of the global energy sector will be 1.1% per year. The importance of conventional sources is expected to decrease (e.g., electricity generated from coal and oil is expected to increase by only 0.4% per year), with a simultaneous increase in the share of renewable sources (such as water, wind, solar and geothermal energy are predicted to increase by 7.4% annually). The development of energy based on renewable sources should contribute to achieving a 37% share in energy production in 2040. (According to the WEO 2016 [74], in 2040 renewable energy will have a 37% share in energy production). The increase in the share of renewable energy is also associated with problems regarding the variability of production (e.g., variability of wind power, variability of solar radiation intensity), which leads to an increased demand for services such as reliability, regulation, transmission restrictions and energy storage. Energy storage is considered a viable solution and can alleviate several problems [75]. As African countries are rapidly expanding their cities, so these countries need to develop an energy sector to meet the rapidly growing energy demand. The exponential growth in energy demand requires building new, innovative, efficient energy companies and extending modern digital energy services on a larger number of local community groups, while being mindful of improving people's health conditions and and at the same time paying attention to ensuring long-term systematic sustainable development. Increased access to modern forms of energy will contribute to the transformation of agriculture-based economies into industrial-based economies in African countries. Modern forms of energy play a key role in industrialization and economic development.

From the first stage of research (quantitative methods) mentioned above, it can be summarized that the high level of carbon dioxide emissions in countries with a high level of social development and the depletion of natural resources in poor countries give national governments the right justification for offering new energy solutions. In developed countries, the emphasis will be on ecological aspects, on reducing CO_2 and other harmful substances, while in poor countries the main premise will be to increase access to electricity and reduce energy poverty. Access to clean and affordable energy sources is essential to improve living conditions in developing countries.

3.2. Qualitative Research Carried out According to the Induction Model/Qualitative Research Based According to Induction Model

The second part of the research consisted of analyzing texts, conducting interviews and observations in the field of ecological, social and legal environment in Guinea, Ethiopia, and Egypt. Interviews were carried out by two methods. The first method was interviews conducted on the spot in individual countries in the form of direct interviews with respondents; the second method was interviews with individual respondents via web applications. Observations were carried out in all analyzed countries according to a harmonized system so that comparable results could be obtained.

3.2.1. Overall Observations Related to Electrification in Africa

Research conducted according to the induction model is characterized by the use of research methods in the form of observations and interviews. The results of observations carried out in African countries combined with a review of the literature in this field are presented in the following paragraph.

The analysis of the texts published in many scientific journals shows that, across sub-Saharan Africa, there is a similar political strategy, characterized by populism, backed by strong, charismatic leaders. Such a charismatic leader claims at the outset that he has no political affiliation and does not come from the established political class. Thanks to these assurances, he is often elected in free elections and, after winning elections, tries to present the development of the energy sector as a remedy for social problems. In many African countries, according to Fraune and Knodt, leaders are able to describe their achievements in a convincing and promising way and convince the public in a rhetorical style about the successes in the field of activities aimed at the electrification of the country. If the citizens see and find out the words are just empty, banal promises that have no real action, they will start protests or even want to take matters into their own hands, starting bottom-up activities instead of waiting for the government to deliver on its promises and provide them with electricity [18,76]. According to Trotter and Maconachie, the government's promises regarding energy can be verified directly by the public because they can determine whether their homes have access to energy and whether energy is being supplied on a continuous basis. In the case of other government promises, e.g., on improving national economic development, healthcare or the quality of education, it is quite difficult to state unequivocally whether the promises have been fulfilled [20]. Given the high level of energy poverty in sub-Saharan Africa, [14,15,77], African governments are strongly motivated to convince the public of their electricity supply capabilities. Change can only be made by political willingness on the part of the government and the right climate for change from the highest levels of government. Governments must recognize this as one of their most important responsibilities [14]. Since 2000 there has been systematic economic growth in Africa, which translates into a systematic increase in energy consumption, which increased by 45% in relation to 2000 [78]. The energy sector in sub-Saharan Africa faces major challenges such as the current rapid population growth, which means that 590–600 million people now belong to the group characterized by energy poverty (i.e., without access to electricity) and it is expected that by 2030 there will still be no access to energy 530 million people. Moreover, the challenge for the energy sector is the development of the sector where the total installed capacity is currently less than 100 GW. Rapid economic growth and, at the same time, population growth on the African continent, especially in fast-growing cities, will have profound repercussions for the energy sector, both regionally and globally [79]. Population growth is unevenly distributed between large, densely populated urban areas and vast rural areas, but significant population growth is expected to continue in both fast-growing urban agglomerations and rural areas [78]. Africa needs a significant increase in investment in the electricity sector in generation and networks, which, according to data, rank Africa as the continent with the lowest level of investment in energy. Although the African continent is inhabited by 17% of the world's population, investments in energy are negligible. If you compare investments in Africa with global investments, unfortunately the comparison is against Africa, where only 4% of global investments are realized. This opens up broad investment perspectives that require financial outlays to the future. In order to achieve energy security, as expressed by reliable electricity supply, by 2040, it needs to increase by almost four times, to around USD 120 billion. Investments in energy at this financial level require mobilization that can be achieved if economic, political, legislative and regulatory solutions are implemented to improve the finances and operational efficiency of energy enterprises. It is also important to facilitate the effective use of public funds, which will also activate private capital investment. The analysis shows that there is no one-size-fits-all solution: decision-makers must not only develop and implement an appropriate energy policy, but also create an investment climate to mobilize domestic and foreign capital and innovation [15]. According to Chidebell-Emordi, high levels of energy poverty in Africa are, therefore, the driving force behind African governance. The level of energy poverty, its measurement and impact on African societies was also the subject of [80] Nussbamer's research (2012). Energy poverty and the percentage of electrification for the African countries surveyed—Ethiopia, Guinea, Egypt—are presented in Table 5.

Table 5. Energy poverty in Guinea, Ethiopia and Egypt.

	Intensity of Energy Poverty	**Electrification [%]**
Guinea	0.85 (high energy powerty)	20.9 (low)
Ethiopia	0.93 (acute energy poverty)	12.2 (notably low)
Egypt	0.48 (moderate energy poerty)	99.4 (high)

Source: own elaboration based on [80].

The electricity system should operate in such a way as to ensure that energy producers are able to independently generate energy that will sufficiently meet the actual demand. In a properly functioning system, the price structure should reflect the demand for energy, and production should be profitable for investors and at the same time affordable for a wide range of consumers [77]. Energy poverty also causes many social inequalities [81].

Observations Research in Analyzed Countries

Having presented a general analysis of the situation in African countries, I will now describe the detailed observations and interviews carried out in Guinea, Ethiopia and Egypt.

Guinea

Guinea is an example of a country that has problems with the supply of electricity. For decades, this potential has not been exploited adequately. Guinea has huge energy potential but the power generation capacity is still insufficient to meet national consumption needs and favor accelerated growth objectives. Throughout Guinea's history, hydroelectric dams have been used by politicians to run an election campaign. For example, the first research of barrage sites at Konkouré dates back to 1948. When Sékou Touré came to power first as Prime Minister and then as President (1958–1984), he began implementing the Konkouré dam project and worked on it for 26 years and exercised power thanks to the promises of constructing the Konkouré dam and making it the key to Guinea's industrialization. His successors followed his example, betting on Guinea's fascination with dams on the

Konkouré River to promise Guineans a better tomorrow. Lansana Conté (1984–2008) and Alpha Condé (since 2010) have made hydrodams the focal point of their campaign promises to secure their next term and even amend the Constitution to be able to run for the third term. To reduce electricity deficits, Guinea has recently started building four dams with hydroelectric power plants. With a river network exceeding 6250 km, Guinea could have a hydroelectric capacity of 7000 MW installed, of which only slightly more than 5% is currently used. After winning the presidential election in 2010, President Alpha Condé began several projects with the government on the Konkouré River in Kaléta, Souapiti, Amaria and Koukoutamba [82]. New hydropower projects were created to reduce the electricity deficit affecting the country and subregion, and to produce clean and cheap energy. Re-elected on October 2020 for a third term, Alpha Condé continues to prioritize the development of the energy sector. Figure 2 shows the energy initiatives taken by the president and the years in which the presidential election was held.

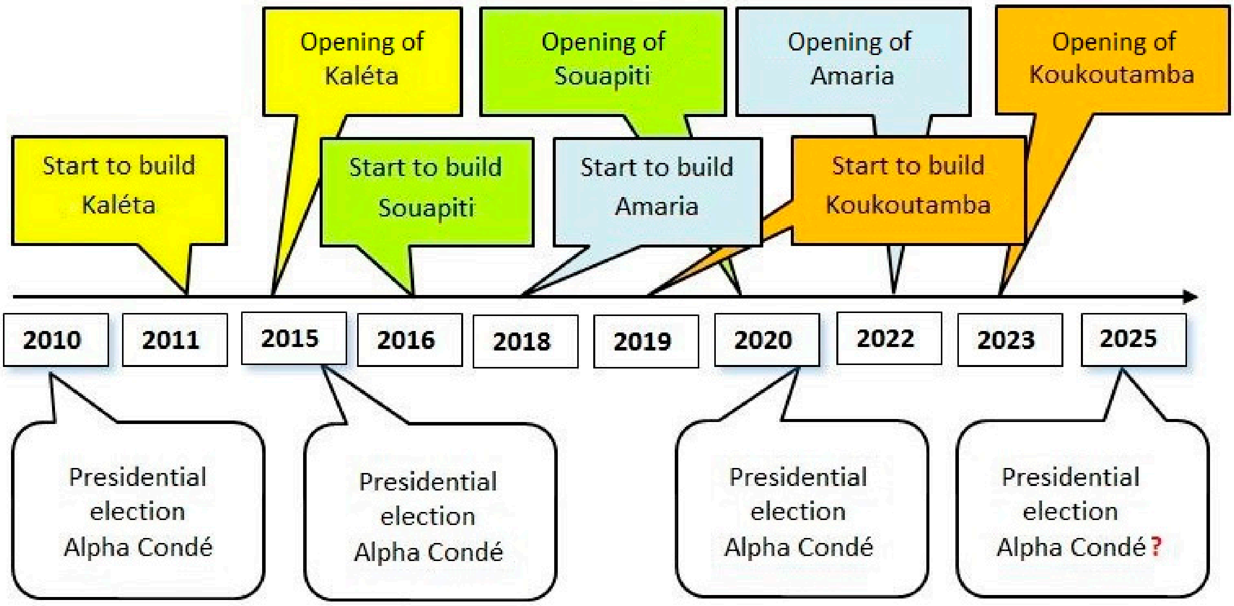

Figure 2. Presidential elections and hydroelectric plant program development.

During the last ten years, electricity production increased by 13% and the distribution network was developed, which improved the service of 26 cities and 36 cities in central and coastal Guinea, respectively, including Conakry. In Guinea, the average rate of access to energy services is 18.1%; 47.8% in urban areas and 2% in rural areas, respectively. Energy consumption is concentrated in urban areas while it is almost unavailable in rural households. Breaks in the supply of electricity are still a problem for the people, so very often small enterprises use man power to drive their businesses (e.g., factories producing clothes use sewing machines driven by foot pedals) and very often go to the airport to read and study at the evenings under the lights of the lamps installed in the airport parking area. In Guinea, only 2% of the rural population has access to electricity. Not much has changed in the ten years of Alpha Condé's presidency [76]. However, it should be emphasized that, these projects concerning hydrodams, which for the population are populistically presented as electrification to improve living standards, are mainly motivated by the development of the very energy-consuming bauxite mines in Kindia and Boké. These mines also affect environmental pollution levels. The bauxite industry uses a variety of harmful chemicals including calcium oxides (CaO) and caustic soda (NaOH). The environment is also polluted by other harmful subsidies such as mercury, unregulated combustion, and gas pollution [83] as well as electronic waste (called e-waste) [84]. In addition, the construction of the hydropower plant in Koukoukambe is associated with destructive interference in the natural environment. The infrastructure of the Koukoutamba hydroelectric project will be built in the Bafing River Valley in the Middle-Bafing National Park, which is one of the last remaining conservation areas for West African chimps, an endangered primate species. If a dam is built, it will have a destructive effect on the chimpanzee population. In the construction of the Koukoutamba hydroelectric power plant continues, up to 1500 western chimpanzees—one-twelfth of the country's population—will die. Species numbers have fallen by 80 percent over the past two decades and they are now listed by the International Union for the Conservation of Nature as "critically endangered." People also have to leave their property and move to other places, leaving behind their possessions. Compensation for abandoned property is symbolic, so the social costs of building new hydropower plants are enormous [85].

Ethiopia

Ethiopia is a country with significant energy poverty which currently faces double challenges related to limited access to modern energy and at the same time being strongly dependent on traditional sources of energy production from biomass. In recent years (according to official government statistics) the country has recorded very high economic growth, and maintaining this growth in the future will require a huge expansion of the energy supply. The government of Ethiopia, in accordance with the adopted national growth and transformation plan, is taking steps aimed at universal electrification. In order to achieve the set goal, it is developing and implementing large-scale hydroelectric projects [86]. The Ethiopian Electric Power Corporation (EEPC) expects an increase in domestic energy demand and plans to integrate alternative energy sources, such as solar, wind, geothermal, oil and gas, to meet the anticipated growing demand. In the future, the EEPC expects that the export of energy to neighboring countries will also increase. Ethiopia has started building a hydroelectric power plant on the Nile, which is intended to improve the energy situation. The Grand Ethiopian Renaissance Dam, worth nearly USD 5 billion, whose construction started in 2011 and which is largely financed by citizens' contributions, is meant to make the country a power giant instead of leaving it struggling with an unstable electricity supply, but it should also be emphasized that it caused conflict with Sudan and especially with Egypt concerning the level of water in the Nile. The heart of the project is the largest hydropower plant on the continent. The hydroelectric power plant will generate over 6000 MW of capacity, more than twice the current capacity of all Ethiopian power plants combined. This is a great financial burden for citizens, where GDP per capita is USD 570. The results of the research, conducted in the form of interviews and as the author's own observations, show that the problem perceived by the society is the lack of expected and promised effects (e.g., there are still frequent power outages), so in every home there are small cookers for coal used in periods of blackout, and people indicated that the financial outlays and costs associated with the construction outweigh the obtained results. The rate of access to electricity in Ethiopia is currently 45%; 11% of the population already has access through decentralized solutions [87]. Data showing the current situation and predicted until 2040 are presented in the Table 6.

Table 6. Development of Electrification in Ethiopia.

	2000	2018	2030	2040
Population (mln)	67	108	143	173
With electricity access (%)	5	45	100	100
With access to clean cooking (%)	1	7	34	56
CO_2 emission ($MtCO_2$)	3	14	29	46

Source: own elaboration based on [87].

In Ethiopia, the government's strong commitment to achieving full access before 2030 can be seen; however, interviews conducted among respondents show dissatisfaction with the progress of work. The need for energy imports could be reduced by resolutely pursuing the country's vast water resources and accelerating electrification, and by investing in and supporting the development of limited natural gas resources. However, Ethiopia lacks political advice based on comprehensive analysis of the energy sector to improve access to electricity and diversifying the energy supply sources to develop a sustainable energy sector. Therefore, many activities are underlined, highlighted and implemented in the pre-election period [88].

Egypt

Politics and power in Egypt in the last decade were associated with changes resulting from the "Arab Spring". In Egypt, the situation has been very dynamic for a decade, and governments have changed hands as a result of revolutionary action. As a result of social unrest in 2014, President Sisi took power. In this revolutionary period, young Egyptians, who desired democracy and freedom for Egypt, played an important role [89]. They expected full democracy and impatiently waited for a better time. The Egyptian President started to look for allies and their old resentment towards Russia reappeared. In 2015 an agreement was prepared for Russia to build Egypt's first nuclear power plant. Moreover, following the US ceasefire of certain arms deliveries, Moscow saw opportunities to strengthen its position in the Egyptian military market. Since Washington began to criticize "Egypt's democratic going bad", it opened the door for Putin, who secured an invitation to Egypt. This gave President Putin another opportunity to re-enter the Egyptian market and gain influence at the expense of US interests. Russia uses its energy capabilities and experiences as a way to gain influence and impact on the economy and politics through non-traditional and non-transparent mechanisms. The basis of Russia's international policy and its position in world markets is its enormous energy resources. Prestige in the international arena is derived not only from military strength, but also from political strength and energy resources. These resources can be a source of economic attractiveness for neighbors and partners and are an important factor in bilateral relations with countries cooperating with Russia, as well as constituting the basis of trade, thanks to which political and economic benefits are obtained [90]. In Egypt, the energy market has been in private hands since its inception in 1893. Private energy companies controlled the energy market until 1962, when the sector was nationalized and the government took over the operating companies. Thus, the market model became a state monopoly, characterized by the problems of a monopoly. For decades, electricity prices in Egypt were subsidized by the state, where prices were below true marginal costs, which meant a stiff domestic electricity price. This resulted in bad consequences, mainly related to increased energy demand and the improper use of electricity, and also burdened the state budget, especially since Egypt's electricity production depends on non-renewable resources (mainly natural gas) with high marginal costs, which means that the production of an additional unit of energy is very expensive in comparison to renewable resources (wind and solar energy). In the renewable energy sector the fixed costs are high but the marginal costs are almost zero [91]. Subsidies for electricity also included direct and indirect energy-related activities. The direct actions consisted of providing subsidized electricity to consumers, and the indirect actions were related to subsidies for the extraction of the crude oil and natural gas used for the production of electricity [92]. Egypt has recognized the shortcomings of such a structure and is now striving to achieve high and sustainable economic growth. When shaping the policy of sustainable development while maintaining a high tempo of economic growth, one should remember the constantly growing demand for energy and its impact on the environment.

However, the energy situation after the 2011 revolution was quite complicated and Egypt experienced frequent power outages and a serious shortage of the energy supply. Ensuring energy security involving, inter alia, a sustainable and reliable energy supply remains one of the key challenges facing the current Egyptian government. There are many factors that have exacerbated Egypt's energy problems in the last decade. These factors include the growing demand for energy resulting from population growth and economic development, emerging problems with uninterrupted natural gas supplies, aging generation and transmission infrastructure that requires systematic repairs, and the ongoing stagnation in energy investments. Developing appropriate solutions requires understanding the essence of the problems that occur. The energy sector in Egypt is facing, above all, challenges in the form of new investments. It is also important to renovate the existing, but constantly aging infrastructure that requires constant repair and modernization. In addition, proper management of the energy demand is extremely important. The abovementioned aspects should form the basis of any energy reform policy in Egypt. To meet the high and steadily growing demand for energy, the Egyptian government introduced several political reforms. The government has responded to the energy problem by reducing energy subsidies for heavy industry and reducing household electricity consumption. Energy subsidies accounted for a significant share of government spending. In addition, the government plans to introduce a system of smart cards that will allow for a controlled flow of financial resources in the form of subsidies to the most needy and poorest people in order to increase the functional efficiency of this system. Expanding energy produced from renewable sources, especially wind and sun, can also be a promising solution. The Egyptian government seems to be trying to adopt an energy saving policy to offset energy consumption and remedy the energy supply deficit. Energy is the lifeblood of any economic activity, so there is concern that problems related to reduced supply and, at the same time, energy consumption could undermine the growth potential of the Egyptian economy. There are also studies on the relationship between energy consumption and economic development which show that the application of energy saving policies does not adversely affect development and the economy in the long term [93].

Energy security is currently one of the priorities of government agencies, especially in the case of fast-growing economies. There is often a discrepancy between the perception of the development of the energy sector by industry and government [53]. The energy sector will change because it has to adapt to the requirements of the legal and regulatory environment that appears along with the ecological approach based on the policy of decarbonization in the energy sector. Therefore, the energy sector in Egypt should focus its activities on strengthening innovative solutions used in the energy sector, such as electromobility, energy storage and energy management. The energy sectors of less developed countries should observe the dynamics of activities related to technical and technological progress and development, try to transfer knowledge and experience from advanced regions of the world and implement large-scale investments in the R&D sphere [94,95] as well as digitization of the sector [96]. Collected knowledge and organizational learning should be used in the companies from the energy sector because innovative culture significantly moderates between organizational learning and the firm's market position and sustainability [97]. Moreover, the social and ecological aspects, as well as innovation and digital transformation, play an important role in business models in the energy sector [98]. The challenges facing the energy sector include increasing the efficiency of power plants and increasing the share of natural gas and renewable energy, including wind, solar and biomass energy [59,99,100].

4. Discussion

Africa is a continent that is considered to underutilize its water potential [101]. Large hydropower plants can be built on many rivers, which on the one hand will reduce energy poverty, but on the other hand will affect the surrounding environment and relations in local communities. The construction of large hydroelectric power plants is associated with the displacement of indigenous peoples, flooding bustling cities and towns in order to dam up areas and create huge water reservoirs [102]. The aforementioned problem of large energy projects is a problem faced by the governments of many African countries. However, the problem of growing energy demand resulting from population growth and host development can be offset by the supply of energy produced in small hydropower plants [103] or photovoltaic installations. However, such projects are not as spectacular as large investments in hydroelectric plants. By 2050, the population of Africa is expected to double to 2.5 billion [104]. Economic growth is positively correlated with energy consumption [105]; therefore, new energy projects are a challenge for African countries. When expanding the energy sector, it is also important to pay attention to the safety of employees working on energy installations [106]. The development of the energy sector is closely related to national and international politics. For those in power, energy is a topic that allows them to shape not only the country's energy policy, but also its economic and social policy, and its international policy. The strengthening of the partnership with Africa, which is one of the priorities of the European Commission, is clearly visible now. Africa's high position in EU politics results from the importance of the continent for the EU's security, economic and migration interests [104]. Thus, energy is a highly political topic and must be considered not only through the prism of supply and demand, but also through the prism of domestic and international politics.

5. Conclusions

The energy sector is a strategic sector in all countries and is a bargaining chip in parliamentary and presidential elections. From the conducted research it can be clearly concluded that governments use the energy sector to strengthen their positions and legitimize power in subsequent terms, promising development and prosperity to voters, but at the same time in democratic countries, the energy sector, during the term of office and especially in pre-election periods, can influence decisions and impact the directions of government activities. In addition, the hypotheses put forward in the research have been positively verified. Rich countries are looking for innovative solutions, providing better environmental and social conditions, while in developing countries, natural sources and the environment are overexploited to increase energy production. The following conclusions can be drawn from the research on the relationship between the energy sector and governments in individual countries:

1. The energy sector is a sensitive sector of the economy and plays a key role in the exercise of power by those in power. These relations are of a different nature, but one guiding motive can be seen, namely the activities of the authorities in the energy sector are carried out for several terms of government (the power of the president).
2. Thanks to the involvement of the authorities in activities related to the energy sector in African countries, power can be maintained for several terms.
3. The authorities support new technologies and try to finance the huge energies projects. Such actions by the authorities result from their will to maintain power and fulfill international obligations.

The energy industry in African countries is facing the prospect of long-term development and will require large domestic and international financial resources. International investments in individual countries depend on the political situation and international capital, so foreign investors will monitor whether entering the local market is a safe investment. The considerations and research results presented in the article will allow decision-makers to pay attention to the problems related to the energy market in Africa.

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