

THE PENNSYLVANIA STATE UNIVERSITY  
SCHREYER HONORS COLLEGE

DEPARTMENT OF POLITICAL SCIENCE

THE ECONOMIC AND POLITICAL IMPACTS OF RENEWABLE ENERGY

POLICY ON WOMEN IN SUB-SAHARAN AFRICAN NATIONS

CARLEY ANNE PALKON  
SPRING 2024

A thesis  
submitted in partial fulfillment  
of the requirements  
for baccalaureate degrees in International Affairs and African Studies  
with honors in International Affairs

Reviewed and approved\* by the following:

Xun Cao  
Professor of Political Science  
Thesis Supervisor

Giancarlo Visconti  
Assistant Professor of Political Science  
Honors Adviser

\* Electronic approvals are on file.

## ABSTRACT

This thesis expands on why there are different levels of political participation in sub-Saharan Africa. Specifically, I propose that environmental policy, specifically renewable energy policy, impacts gender differently and that those impacts are economic and political and can vary by region and country. To explore this concept, I utilize political, economic, and environmental data collected between 2010 and 2020 within the forty-eight countries of the sub-Saharan African region. I propose that the presence of renewable energy programs contributes to different levels of political participation in sub-Saharan Africa. I hypothesize that the presence of renewable energy programs leads to greater female economic and political participation. Secondly, I argue that greater female economic participation leads to greater political participation. While the models in my analysis do not find statistical evidence for a causal relationship between renewable energy and greater female economic and political participation, a qualitative analysis of Nigeria and Cote d'Ivoire reveals that there are sociocultural factors to women benefitting from renewable energy programs. The study ends with recommendations on future analyses of the relationship between renewable energy and women, and how this may impact domestic and international policies moving forward.

## TABLE OF CONTENTS

LIST OF FIGURES .....	iii
LIST OF TABLES .....	iv
ACKNOWLEDGEMENTS .....	v
Chapter 1 Introduction .....	1
Chapter 2 Literature Review .....	4
Women in Economic and Political Institutions .....	5
Renewable Energy Impacts Within Specific Countries .....	6
Climate Change Impact and Climate Policy .....	11
Conclusion .....	12
Chapter 3 Theoretical Analysis .....	14
Political and Economic Participation Among Women in Developing Nations .....	14
Gender Norms .....	16
Renewable Energy Programs .....	17
Main Argument .....	18
Hypotheses .....	19
Competing Arguments .....	21
Chapter 4 Research Design .....	22
Chapter 5 Results and Discussion .....	32
Discussion .....	42
Nigeria .....	44
Cote D'Ivoire .....	47
Chapter 6: Conclusion .....	50
BIBLIOGRAPHY .....	52

**LIST OF FIGURES**

Figure 1: Map of Nigeria (Gayawan et al. 2014) .....44

Figure 2: Map of Cote d'Ivoire (Elisee et al. 2021) .....47

**LIST OF TABLES**

Table 1: Descriptive Statistics .....	32
Table 2: Univariate, Hypothesis 1.....	35
Table 3: Univariate, Hypothesis 2.....	36
Table 4: Hypothesis 3 (no controls).....	37
Table 5: Multivariate, Hypothesis 1.....	38
Table 6: Multivariate, Hypothesis 2.....	39
Table 7: Multivariate, Hypothesis 3.....	40

## ACKNOWLEDGEMENTS

Throughout my thesis journey, I encountered several individuals who were instrumental in the creation and completion of this thesis, and who made this journey as enriching and fulfilling as it was. I would like to extend special thanks to my thesis advisor, Dr. Xun Cao, for all his expertise and encouragement throughout this process. Without his advice and assistance, much of this thesis would not have come to fruition. Additional thanks to everyone who provided edits or recommendations, including Dr. Clemente Abrokwa, Dr. Maria Hojnacki, and my peers in PLSC 306H. Your insights showed me where details could be improved and edits should be made, transforming the paper into what it is. I would also like to extend a special thanks to my friends and family, as their support made this journey all the more possible. In particular, I would like to thank Kathleen and Christopher Palkon, Kaitlyn, Todd and John Hoffman, and Christopher Palkon, Jr., for all of their love and support.

## **Chapter 1**

### **Introduction**

My thesis asks the primary question: what impacts different rates of political and economic participation among women in sub-Saharan African countries? I seek to explore how female economic and political participation rates among women in sub-Saharan African countries are impacted because of environmental policies, particularly renewable energy policies such as the implementation of solar farms and hydropower farms.

In an era of ongoing research into the impacts of climate change mitigation policies, my thesis topic presents an opportunity to discuss the socioeconomic impacts of climate change policy on women, particularly within formal political and economic institutions. First, there are social challenges within the energy sector as the division of labor along gender roles either hinders or creates access to energy (Ngum et al. 2011, pp. 1-2). This results in women and girls having different energy needs than their male counterparts, adding to their general displacement of access to natural resources such as land, information about formal institutions, and participation in formal political and economic institutions while also failing to meet their energy needs (Ngum 2011, pp. 2-4). Additionally, women are directly impacted by the effects of climate change at rates that are disproportionate to those of men, yet the gendered impacts of climate change on women are not considered as greatly as the impacts of those on men and the field of environmental policy analysis contains a distinct lack of a female perspective (Osman-Elasha 2019; Bendlin 2014, p. 680). International and subnational organizations such as the African Union, the African Development Bank Group, and the Organization for Economic Cooperation

and Development recognize that the potential of renewable energy policies on reducing energy poverty, increasing access to clean cooking methods and improving overall economic development, but little has been done within the economic sphere to ensure that current and future environmental policies do not exacerbate existing inequalities nor create new manifestations of such inequalities (Corfee-Morlot, Parks, Ogunleye and Ayeni 2019, pp. 5-8; “Facts and Figures: Economic Empowerment” 2018; Diffenbaugh and Marshall 2019, p. 9808). This is where this thesis steps in: it seeks to understand how environmental policies, specifically renewable energy policies, impact women’s abilities to participate within their immediate communities and beyond economically and politically.

Additionally, this study is unique in that it discusses both the economic and political effects of renewable energy programs on women in developing nations, while a vast majority of these studies only focus on the economic impacts. While the economic impacts of renewable energy programs are great, there is still a persistent economic gap between men and women in developing nations, the focus of many economic development and energy security compilations (Ferrouki et al. 2018, pp. 26-28). There is also a political participation gap between men and women in developing nations, especially in positions of leadership, stemming from overall attitudes towards female participation in economic and political institutions (“Facts and Figures: Economic Empowerment” 2018; Milazzo and Goldstein 2019, p. 34). The incorporation of an analysis of whether renewable energy programs substantially impact female economic or political participation will help to create a more robust understanding of the socioeconomic impacts of climate policies and how they can be modified to close gender gaps regarding energy poverty, economic development, and female political participation.



I am investigating this question using multiple regression models with time-series data to determine whether the presence of renewable energy programs and their economic outputs impact female political and economic participation. This will be done through data sourced from the World Bank World Development Indicators and UN Gender. These models seek to see if there is a correlation between renewable energy programs and female political and economic participation and whether these correlations are statistically significant in any form. Additionally, there will be case studies focusing on select African countries, namely Nigeria and Cote d'Ivoire, discussing in greater detail the present and future socioeconomic impacts of renewable energy programs and women's relationship to energy and how this affects female political and economic participation. Additionally, as both Nigeria and Cote d'Ivoire are in distinct stages in their renewable energy transition, the case studies attempt to illustrate the current attempts taken by African countries to diversify their energy streams and what such strategies look like.

This analysis reaffirms the idea that environmental policies, such as the implementation of renewable energy, have a socioeconomic and political dimension that must be taken into consideration when gauging effectiveness. Additionally, the analysis asserts that the socioeconomic and political impacts are more individualized than previously thought and should be considered regarding research design moving forward. Overall, the study indicates that there is evidence for renewable energy shifting gender roles that are further confirmed through formal institutions, but more work needs to be done to identify under what conditions this relationship occurs and where.

## Chapter 2

### Literature Review

At present, the literature encompassing the specific topics of renewable energy programs, female political participation, and female economic empowerment are few, with the primary reason being that analysis of environmental policy tends to be centered through an economic lens with a primary focus on how it affects communities with little regard for impacts facing people of minority status, particularly women. However, evidence points towards the gendered impacts of environmental policy and the need for a female perspective within the field of environmental policy (Osman-Elasha 2019; Bendlin 2014, p. 680). Additionally, there is a large amount of literature that touches upon the separate topics of environmental policy and renewable energy impacts, female political participation, and female economic empowerment; there just exists a need to put it all together.

The purpose of this literature review is to incorporate the various thematic concepts that appear through the generalized topics of environmental policy, female political participation, and female economic participation. The literature review will focus on three main thematic concepts to identify current gaps within the current discussions surrounding environmental policy analysis and its socioeconomic impacts as well as thread together key concepts that impact the theoretical basis of the thesis. The three main thematic concepts include women in economic and political institutions, climate change impact and climate policy, and renewable energy program impact.

## **Women in Economic and Political Institutions**

Climate policy specifically favors traditional patriarchal social structures that unequally distribute power in the favor of men, which is both reinforced and created through the arrangement of political institutions (Milazzo and Goldstein 2019, p. 35). The imposition of these power inequalities makes it difficult for women to participate in formal economic and political institutions and also hampers the ability of the social, political, and economic impacts of climate policy (Milazzo and Goldstein 2019, pp. 44-47, p. 55). Current literature states that women in developing countries primarily are often shut out of formal labor markets, instead participating in informal labor markets such as subsistence agriculture and manufacturing (Verick 2014, p. 9). This is supported by Urmee and Md's 2016 study, which states that social and cultural attitudes impact the viability of economic and political policy implementation, highlighting such programs as electrification and renewable energy implementation (Urmee and Md 2016, pg. 159).

Political participation is also supported through cultural norms, political institutions, and economic strength (Bullough 2011, p. 398). When viewed through an issues-based lens, it is even more prevalent that the factors that impact female economic empowerment and participation in formal labor markets and economic institutions, such as cultural norms, political structures, and the strength of economic institutions, still impact political participation (Bullough et al. 2011, pp. 400-402). There is also a relationship between female economic empowerment and political participation, with evidence stating that lower levels of female economic participation subsequently lead to greater female underrepresentation in democratic systems (Iverson and Rosenbluth pp. 486-488). Political and economic systems are impacted by cultural

norms, creating, and reinforcing norms that could push out specific minority communities, such as women, out of formal institutions (Iverson and Rosenbluth 2008, p. 479).

The need to understand the relationship between women and economic and political institutions is vital to identify what pre-existing relationship exists to account for how women interact with the systems because of the imposition of renewable energy programs. Additionally, the understanding of the interactions between women and economic and political institutions introduces the role of cultural norms that impact how women are viewed within their community and how they can participate in formal institutions. The incorporation of this as a major thematic element of the project allows for a broad understanding of the pre-existing circumstances that women in developing countries, specifically women in sub-Saharan African countries, are in politically and economically and can be used to then narrow the scope of analysis to the specific relationship between renewable energy programs and female political and economic empowerment.

### **Renewable Energy Impacts Within Specific Countries**

Another area of focus that ties back into the main argument and theory is the impact of renewable energy programs on individual countries. While these individual case studies focus on specific countries, they use a form of analysis that is essential for understanding the socioeconomic and cultural impacts of renewable energy programs on specific countries and how this can be applied outside.

A major area of focus on renewable energy program impact is India, which contains similar patriarchal norms (especially in rural areas) that can be applied to the majority of sub-

Saharan African countries. At present, researchers have found that renewable energy programs have improved the economic lives of female entrepreneurs, and a government-led push can lead to renewable energy programs yielding net positive economic impacts for women in rural communities (Barauh 2015, pp. 55-56, pp. 67-68). In particular, the paper highlights the strong need for the Indian government to tackle two primary goals: economic development and the incorporation of women into its formal economic sector (Barauh 2015, p. 58). The overall socioeconomic improvements related to the implementation of renewable energy programs and a governmental push to train women, particularly women of lower economic status, led to the expansion of household activities, increasing household quality of life (Barauh 2015, p. 60). However, deteriorations regarding women's subordinate role in the household were noted and call attention to the differences between political empowerment and economic benefits resulting from the implementation of renewable energy programs (Barauh 2015, p. 62).

Another major area of focus is China, particularly the communities of Northwest China. This is primarily due to an overall lack of available energy and the need to turn to renewables to make up for a lack of available biofuels to sustain rural communities. Within China, researchers found that improvements in renewable energy structures and greater participation for women in energy structures improved their available living standards (Ding 2014, pp. 183-184). Additionally, China maintains its position as a leader in the exportation of renewable energy programs globally; if such findings can be replicated elsewhere, there will be increased availability of information on renewable energy programs and their social impacts (Liming 2008, p. 1102-1103; Peidong et al. 2009, p. 439).

Case studies completed in India and China, developing economies with large populations, and outsize interest from the international community regarding development in the renewable

energy sphere, provide a basis for renewable energy programs that can be applied to countries within sub-Saharan Africa. Sub-Saharan African countries have received increased attention in recent years regarding renewable energy programs, particularly in the economic development sphere (Deichmann et al. 2011, p. 215). There are two primary reasons for this; the first is that electrification is a key development challenge for many countries within sub-Saharan Africa and renewable energy programs provide an opportunity for urban and rural communities to have sustainable and efficient access to energy within their household and communities (Deichmann et al. 2011, p. 218). Secondly, renewable energy programs as a form of carbon emission mitigation policy are increasingly popular among development economists within the developing world and are encouraged in development plans, including ones for sub-Saharan African countries (Asongu and Odhiambo 2021, p. 677). As such, there is a growing body of literature focusing on the socioeconomic impacts of renewable energy programs in sub-Saharan African countries to measure the effectiveness of these implemented policies. One case study on renewable energy programs was conducted in Tanzania. While there are clear economic benefits to renewable energy program implementation, including greater available energy sources and international recognition for its ability to complete requirements that align with international energy agreements, there are social costs, such as an overall lack of skilled labor and a lack of available capital to meet the high initial investment costs (Bishoge et al. 2018, pp. 80-82). Additionally, while this specific study did not focus on the gendered impacts, it remains that there are social, political, and economic impacts that are associated with environmental policy and that it is necessary to account for them.

Another case study focused on renewable energy program implementation and development in Ghana. Within Ghana, numerous mechanisms spur development within

renewable technologies, including green bonds, asset-backed securities, and feed-tariffs (De-Graft et al. 2021, p. 322). Many of these mechanisms come from international or national bodies, such as World Bank investors and the Ghanaian national government and lead to disparate outcomes among local communities regarding development (De-Graft et al. 2021, p. 330). Such regulatory costs impact the ability of both rural and urban communities to develop and electrify efficiently, but continued policies such as its “renewable master plan” hope to improve the development of its renewable sector to promote socioeconomic development (Sun et al. 2020). Again, the socioeconomic impacts that are explored are not gendered, but rather urban-rural and Global North/Global South divides, highlighting how minority communities disproportionately lack the economic and social benefits of renewable energy programs at varying scales from the local to the international. As such, the socioeconomic impacts of renewable energy programs contain multitudes of factors that can impact how communities and specific sectors of people are impacted by renewable energy programs, particularly in how renewable energy programs interact with and are impacted by formal economic institutions and political establishments.

A final case study from sub-Saharan Africa that discusses the socioeconomic impacts of renewable energy programs is from Nigeria and focuses on sustainable energy transitions, including the socioeconomic impacts of transitioning from biofuels to renewable energy sources. Dioha and Kumar find that the primary overall energy use is from individual household consumption, particularly in cooking and heating, and that an urban and rural divide exists in terms of types of energy consumed, with biofuels primarily consumed in rural communities and electricity and natural gas consumed in urban communities. With a national and international push towards the implementation of renewable energy programs, the authors find evidence that energy demand in rural communities is reduced, and communities become richer, lessening the

time burden on women and children on resource management and improving their health overall (Dioha and Kumar 2020, p. 10). Additionally, the models created by the authors indicate that there is a shift towards more environmentally friendly forms of energy, including clean energies like solar, that reduce carbon emissions (Dioha and Kumar 2020, p. 11). This case study indicates how the socioeconomic impacts of renewable energy programs can lead to benefits at the local and community levels and improve the economic and human development health of communities. However, this article also spotlights how an urban/rural divide is prevalent within Nigeria (and likely a reflection of the urban/rural divide present within sub-Saharan African countries more generally) and contributes to a difference in the socioeconomic impacts of renewable energy programs.

Case studies such as ones prioritizing Indian and Chinese contexts provide evidence that the socioeconomic impacts of renewable energy programs are a global phenomenon and not restricted to specific regions of the world. They also contribute to a theoretical basis of analysis for renewable energy programs and their impacts in other developing countries, namely sub-Saharan Africa. The conversation about the case studies related to renewable energy implementation in countries with varied political and economic systems but similar cultural backgrounds accentuate how it is the impact of renewable energy programs, not just cultural norms, that leads to differentiated participation among women in formal political and economic institutions.



## Climate Change Impact and Climate Policy

A third and final theme is the impacts of climate change and climate policy. This theme is the most prevalent and most relevant due to a heightened urge for countries to tackle global warming and climate change-related issues, particularly considering new models and data that are released. Studies regarding climate change and climate policy provide a substantial basis for this research question and illustrate a key assumption, which is that climate policy results in gendered impacts. Additionally, the development of specific climate policies, such as renewable energy programs, is tied to economic development through the creation of an environmentally sustainable energy alternative that can be reproduced on a scale that allows for communities to develop.

There is a general need to incorporate female- and rural-led perspectives when it comes to the implementation of climate policy overall, including renewable energy programs. Through such lenses, the progress of climate justice and climate justice research could be furthered and could reduce existing inequalities (Bendlin 2014, p. 684). In particular, this would lead to greater criticisms about the implementation of scale; women often exist at the community and local levels, rarely not being able to participate higher due to societal pressures and social expectations of female roles (Kaygusuz 2010, p. 946; Glazebrook 2011, p. 763). This often leads to international agreements and national policy being difficult to implement on smaller scales as those policies fail to incorporate the vast social and cultural implications that come with their implementation (Glazebrook, pp. 771-775).

Additionally, women are not regarded as key actors when it comes to the implementation of climate change policy, and this will likely be a theme present throughout the data analysis and subsequent models (Riley et al. 2018, p. 317). The failure to consider women as key actors, when

oftentimes they are the ones implementing the policy itself, indicates the need to invest in gender equality programs or incorporate a stronger gender-based lens into the current literature and beyond.

The incorporation of climate policy analysis, specifically the need for analysis that emphasizes the socioeconomic impacts of climate policy on marginalized populations while also reaffirming the need for the use of a varied perspective in approaching climate policy analysis and the application of climate mitigation analysis strategies. This highlights a key gap; that there is climate policy analysis being conducted, with an explicit focus on the socioeconomic impacts on communities, but it fails to consider marginalized communities that exist outside the formal political, economic, and legal institutions. The application of the frameworks discussed in this section is righting a wrong that exists within the examination of environmental policy, which is that marginalized communities face greater harm because of both climate change and climate mitigation policies, as climate mitigation policies often reinforce societal expectations of marginalized communities that often lead to negative political and economic impacts. Additionally, the use of such a framework broadens the general understanding of the varied impacts of climate mitigation policy, specifically as a warming climate and the greater presence of climate change impacts force more debate and application of climate change mitigation programs.

## **Conclusion**

The following three themes explore the wide conceptual area that covers the main research question, which seeks to explain why there are differing levels of political and

economic participation among women in sub-Saharan African countries. The literature review supports the theory that places differences among levels of political and economic participation among women in sub-Saharan African countries as the result of the implementation of renewable energy programs, which fundamentally shifts the relationship between women and their communities and encourages economic and political participation. Within this literature review, a focus on the thematic elements of renewable energy impacts, women and their relationship to economic and political institutions, and climate change policy helps to understand the broad nature of the discussion and the current theses and dialogues surrounding these topics. Additionally, the primary gap within the literature is that there is a lack of insight into the gendered effects of climate change mitigation policies, specifically renewable energy policies, and how that impacts female interaction with formal economic and political institutions. A variety of literature exists within each thematic element of the main research question, but little has been done to examine how these thematic elements work together and how these can be applied to a region that was not a main area of focus within climate change policy. By tackling the various elements of the research and identifying how different frameworks and understandings can be applied to the region of sub-Saharan Africa, we are able to expand the current conceptualization of the socioeconomic impacts of environmental policy and how to tackle its gendered impacts.

## Chapter 3

### Theoretical Analysis

The main question presented within my thesis that I seek to answer is: why are there different levels of female political and economic participation in sub-Saharan African countries? As I argue below, the presence of renewable energy programs explains some of the variation in political and economic participation I observe. The presence, implementation, and use of renewable energy programs are impacted by social factors (primarily gender roles) and institutions (including political and formal economic institutions) that led to direct impacts on female formal economic participation and political participation in developing nations. A special focus on the sub-Sahara African region is employed to test whether the thematic concepts and evidence presented in the literature review are supported within the context of sub-Sahara African countries, if there are additional outcomes relevant to sub-Sahara African countries, and how this ties back to the role of renewable energy at the international and country scales. To begin a discussion on whether renewable energy programs impact female political participation and economic empowerment, I will define concepts that are central to the overall theory.

#### **Political and Economic Participation Among Women in Developing Nations**

Overall, women are not adequately represented in positions of power and formal decision-making, with low levels of representation in positions of power and formal decision-making bodies such as governmental institutions and judicial bodies (“Fact and Figures: Economic Empowerment 2018). A leading explanation for inadequate political participation stems from overall attitudes toward female participation in both economic and political

institutions, with patriarchal norms encouraging women to remain within the sphere of the home rather than the sphere of public life (Milazzo and Goldstein 2019, p. 34). Additionally, women are underrepresented in areas of civic engagement such as policymaking and voting, indicating an overall lower social status among sub-Saharan African countries (Kassa 2015, p. 2). Female economic participation also varies depending on the type of economic institution and framework that women are allowed to participate in; overall, women in developing countries are more likely to participate in informal economic sectors due to a lack of education, gender norms, and other factors (Ramani 2013, p.2).

These statistics highlight the need to be explicit about the concepts put forth within this chapter as a lack of a clear delineation of conceptual values can weaken the argument and findings as it would be difficult to distinguish outcomes observed if the data includes multiple types of institutions or frameworks. For this reason, political participation is defined as focusing on the level of participation in institutions that aid in the design and implementation of policies directly concerning an individual's well-being and behavior (Kassa 2015, p. 3). This includes the ability to act as a representative in formal legislative bodies, such as parliamentary bodies or the executive branch, participating in political parties, and running for political office. There is an added component to political participation that discusses the active involvement of individuals in political processes that contribute to the implementation of policies directly concerning their well-being and behavior but often not their design, such as participating in political parties, engaging in active public dialogue or exerting influence in the news media (Kassa 2015, p. 3). This definition of political participation excludes other measures of civic engagement that can be defined as political, such as union formation.

It is also necessary to strictly define economic participation and engagement in a way that emphasizes participation through formal institutions. While it is known that women in developing countries, including those in sub-Saharan Africa, are more likely to participate in informal economic sectors, it is more compelling to focus on economic participation through formal economic institutions because formal economic institutions emphasize the regularity of payment, payment transparency, taxation of wages and regulated work environments, all of which may or may not exist within informal economies (Corner 2011, pp. 2-4). With a focus on formalized institutions, I can better explore if women can obtain legitimacy through the participation of formal political and economic institutions, whether it can be tied back to renewable energy programs, and how this impacts their social status within the public and private spheres. Additionally, the lack of transparency within informal economic sectors makes it difficult to adequately identify how participation in these sectors impacts female social standing.

### **Gender Norms**

Gender norms represent a vital component to the overall analysis. How women can interact with formal institutions, both political and economic, is highly regulated by social and socioeconomic characteristics (Milazzo and Goldstein 2014, p. 32). Gender norms, also known as gender roles, describe how the dimensions and idea of gender affect individuals at the local scale through their individual behavior and the establishment of household norms and at the national scale through how men, women, and those with other gender presentations are able to participate in codified institutions like a governing body (Alesina et al. 2013, p. 471). A more

succinct definition of gender norms is as follows: “social norms defining acceptable and appropriate actions for women and men in a given society” (Cislaghi and Heise 2019, p. 408).

The attitudes that are influenced by gender norms lead to the creation of patriarchal norms that then trickle down into female political and economic spaces, reducing the ability of women to effectively participate in those spaces, if not shut them out entirely (Coffe and Bolzendahl 2010). Additionally, patriarchal norms spread to traditional roles and duties of women within their communities. Regarding energy consumption and use, women were designated as primary resources and energy controllers of their households and communities, which has persisted into modern economic and political contexts (Lancaster 1976; Oppong 2006, p. 655).

Understanding gender norms is vital as a control for pre-existing conditions that either allow or hinder female participation in political and economic institutions and could potentially influence how renewable energy programs interact with gender norms and formal institutions as a primary or secondary causal mechanism for the explanation. It also describes a pre-existing set of social expectations that may or may not shift because of the presence of renewable energy programs, necessitating the establishment of the current state of gender expectations for women in sub-Saharan African countries.

### **Renewable Energy Programs**

Renewable energy sources are defined as “energy [sources] that are naturally replenishing but flow-limited; renewable resources are virtually inexhaustible in duration but limited in the amount of energy that is available per unit of time” (EIA 2022). Major types of

renewable energy sources include biomasses, such as wood, solid waste, biofuels, hydropower, geothermal energy, wind, and solar (EIA 2022). While not all forms of renewable energy are seen as environmentally friendly, such as biomasses and biofuels, other methods that have been historically used in sub-Saharan Africa, such as hydropower, present environmentally friendly and a low-emissions alternative (Holtz and Golubski 2021; Dutiro 2021). One major form of renewable energy that will be focused on within the thesis is hydropower, a historic form of renewable energy worldwide and within the African continent that is still in use today (Karekezi and Kithyoma 2003, p. 5; IRENA 2022). Other methods, such as solar, are prevalent in the sub-Saharan African region but due to a lack of information on just the rates of solar power usage within the region, hydropower is the sole focus of this study.

The presence of renewable energy programs is indicated by the presence of renewable energy production (specifically hydropower) and the infrastructure to use the produced energy. For almost all countries, renewable energy planning contains both aspects and otherwise, they are not designated as renewable energy programs according to the International Renewable Energy Agency (IRENA 2020).

### **Main Argument**

The primary argument that stems from this contextual framework is that with the implementation and presence of renewable energy programs in sub-Saharan African countries, there will be a shift in female roles regarding energy provision for their households, either as direct participants in this new form of energy collection or as an area undergoes electrification, the creation of a new role altogether. This shift in or creation of new female roles regarding



energy provision for their households and communities is expected to lead to an increase in female economic and political participation. The role of economic and political institutions would be as outlets where women can participate in their communities, enhance their socioeconomic status within their communities and work to advance goals that reduce gender inequality due to their newfound economic and political power.

### Hypotheses

There are three hypotheses that I will evaluate, the first of which is that the presence of renewable energy programs will lead to an increase in women's economic empowerment. The mathematical model that would represent this relationship is:

$$H1: \textit{Female Economic Participation} = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \mu_1$$

$X_1$  represents access to electricity while  $X_2$  represents the amount of electricity generated using hydropower. I believe that there will be a statistically significant positive relationship between female economic participation and access to electricity and the percentage of electricity generated through hydropower because the use of renewable energy will recalibrate women's relationships to resource gathering in sub-Saharan Africa, granting them empowerment, and allowing them to participate economically within their communities.

The second hypothesis I aim to test is whether there is a relationship between female political participation and the presence of renewable energy programs. The mathematical model that would represent this relationship is:

$$H2: \textit{Female Political Participation} = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \mu_1$$

As stated in the first hypothesis,  $X_1$  represents access to electricity while  $X_2$  represents the amount of electricity generated by hydropower. I believe that there will be a statistically significant positive relationship between the independent and dependent variables because, as stated in Hypothesis 1, the presence of renewable energy programs will shift women's relationships to resource gathering and allow them the time and social status to be able to participate politically within their communities.

The third and final hypothesis that I plan on testing is that increased female economic participation leads to increased female political participation. I believe that I would see a statistically significant relationship between female economic participation and female political participation, where an increase in economic participation then leads to an increase in female political participation. The mathematical representation of this relationship is:

$$H3: \text{Female Political Participation} = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \mu_1$$

$X_1$  represents the percentage of women's participation in the labor force, while  $X_2$  represents the level of entrepreneurship opportunities available for women in a country.  $X_3$  represents the access that women must be able to manage their own individual and household assets.

Controls for all three of the hypotheses will include variables that represent women's fertility, their educational attainment levels, and the general perception of women's rights in the country. Other studies demonstrated the impact of these three variables and their relationship to women's political and economic participation in sub-Saharan African countries, making it necessary to include them as controls to ensure that I can limit their impacts on the existing relationship.

## Competing Arguments

There are potential competing answers that I need to be aware of when exploring these hypotheses. The primary one is an overstatement of the role of renewable energy programs on female political participation and economic empowerment and that greater institutional changes or cultural shifts unrelated to the creation and implementation of renewable energy programs are the primary contributing factors toward greater female political and economic participation. However, the purpose of this thesis is related more to policy evaluation, particularly as more countries move towards renewable energy programs as a method to combat emissions and climate change. Understanding how climate mitigation policies impact socioeconomic factors is vital in these exchanges.

A second potential competing answer is that the control variables included in the design have a stronger impact on the relationship than the independent or dependent variables. As will be further explained in the research design chapter, there are strong demonstrated impacts on the relationship between the control variables and the independent variable(s) that firmly reduce the impact of the dependent variables to a negligible amount or counteract the effect entirely. To be able to ensure that the relationship posed in this chapter is plausible, further research might be done to describe the relationship between the control variables and the dependent variables and if they may work together to produce an impact on the independent variable(s). As such, it is important to understand the primary purpose of this study is to take a first look at the socioeconomic impacts of renewable energy. As there is limited done on this topic in the sub-Saharan African region as described throughout this paper, more can and should be done to explore the influences that renewable energy might have.

## Chapter 4

### Research Design

The primary focus of this research is to provide a preliminary answer to this question: why are there distinct levels of female political and economic participation in sub-Saharan African countries? The theory put forth is that socioeconomic impacts resulting from the use of renewable energy led to increased female political and economic participation. To test this hypothesis, I plan on utilizing panel data about female political and economic participation in the formal sector as well as renewable energy use and generation from the years 2010 to 2020 in forty-eight sub-Saharan African countries.

The panel models will be utilizing information on the following countries: Angola, Benin, Botswana, Burkina Faso, Burundi, Cabo Verde, Cameroon, the Central African Republic, Chad, Comoros, the Democratic Republic of the Congo, the Republic of Congo, Cote D'Ivoire, Equatorial Guinea, Eritrea, Eswatini, Ethiopia, Gabon, the Gambia, Ghana, Guinea, Guinea-Bissau, Kenya, Lesotho, Liberia, Madagascar, Malawi, Mali, Mauritania, Mauritius, Mozambique, Namibia, Niger, Nigeria, Rwanda, Sao Tome and Principe, Senegal, Seychelles, Sierra Leone, Somalia, South Africa, South Sudan, Sudan, Tanzania, Togo, Uganda, Zambia, and Zimbabwe. This comprises all countries within the sub-Saharan Africa region, and the primary use of this region is to replicate other analyses conducted within specific countries, such as China, India, and Nigeria, as shown in the literature review. The use of an entire region as opposed to a specific country is to identify whether the trends shown in country-specific literature are apparent across an entire region, especially one that already utilizes renewable energy to a certain extent, and if government entities at the national and supranational levels need to be further incorporating renewable energy into their economic plans for development. An

additional purpose for the use of regional analysis is that the region is an important area for international development agencies and global economic institutions to monitor for advisory purposes. Utilizing a regional approach would allow for the use of this information to inform current and future development policies so that they are more robust. Finally, it should be noted that the term “sub-Saharan Africa” is a geographic, economic, and political term widely used by academics, international non-governmental organizations, and other states. For this study, countries belonging to “sub-Saharan Africa” are designed by being assigned the economic and political descriptor “sub-Saharan Africa” as not all the countries listed contain the Sahara Desert within their borders.

The primary focus of this thesis is to identify socioeconomic impacts resulting from renewable energy policy, particularly as a growing number of countries worldwide are creating widespread climate adaptation policies that include the use of renewable energy. Understanding these impacts can re-frame or readjust development economics and gender equality goals in the short and long term. A secondary focus of this thesis is part of a larger attempt to understand the socioeconomic impacts of development policy, of which renewable energy policy is one small part. The Sustainable Development Goals and its predecessor, the Millennium Development Goals, have played a large part in the creation of the development trajectories of the developing world, such as the special focuses of poverty, education, and health targets (MDGs in sub-Saharan Africa). In recent years, the developing world, including sub-Saharan Africa, has struggled to hit these targets, particularly the economic goals (UNECA 2022). Developing a broader body of information on how the goals relate to each other and the unintentional impacts there may be allows for more robust development policies, more just societies, and further progress on the trajectories set by the Sustainable Development Goals.

The time period of 2010 to 2020 is used due to practical considerations. It is during this period that the most available sets of information on this topic are obtainable as the use of renewable forms of energy is a very recent phenomenon. Specifically, it gained traction through its inclusion after the signing of the 2000 Millennium Development Goals and became more prominent through the adaptation of stronger forms of technology, particularly in the ability to store larger amounts of energy for longer periods that were developed in the late 2000s and 2010s. A major limitation resulting from this period is the short timespan makes it difficult to observe the full effects of renewable energy use and it is highly possible that the total effects of renewable energy use on participation would be shown through a longer period, such as a period of twenty to thirty years.

The use of panel data is employed because it allows for the inclusion of the time element in a way that a cross-sectional analysis would not allow for, particularly in tracking changes that are a result of renewable energy policy. Additionally, it also provides information on individual country behavior, which provides theoretical support for the inclusion of specific countries as case studies and tracks outliers. The inclusion of outliers is likely to be present due to socioeconomic factors, and it is necessary to identify what outliers are there and their impact on the overall relationship. Panel data is a common statistical tool for this kind of analysis. For example, the article *Work and Power: The Connection Between Female Labor Force Participation and Political Representation* utilizes panel data to identify the impacts of trends over time on female labor force participation to supplement their theory. For example, the authors find that there are two key factors found within their data that are highlighted using panel data, those being an increase of women into paid employment and the rise of service employment leading to a rise of women in the workforce overall (Iversen 2008). This

supplements their main theory that this increased participation in the workforce is an entry point into political engagement and would be as clearly identified if panel data had not been employed since they would not have been able to identify increases in female labor participation (Iverson 2008). An additional example of the use of panel data that is more relevant to my thesis is shown in *Inequality, finance and renewable energy consumption in Sub-Saharan Africa* by Asongu and Odhiambo. As stated in their abstract, the authors use quantile regressions utilizing panel data of thirty-nine African countries to identify linkages between financial development, income inequality, and renewable energy consumption to determine causal factors of renewable energy use in sub-Saharan Africa. This demonstrates that not only is this method appropriate for the analysis of the data, but it is also an indication of best practice.

An additional element of the analysis is the use of case studies. The case studies allow for the examination and inclusion of theoretical factors that are difficult to quantify, such as culture, an individual's relationship to governmental structures, a country's history surrounding renewable energy policy, and others. The inclusion of specific case studies (specifically a comparison between two countries) is meant to highlight the potential differences that cannot be quantified adequately but still impact what can be concluded from the quantitative analysis. For example, the case study of Nigeria shown in *Exploring Sustainable Energy Transitions in sub-Saharan Africa Residential Sector: The case of Nigeria* by Dioha and Kumar specifically uses qualitative methodology to explore the motivations behind the uses of specific methods of energy for cooking.

The unit of analysis is country, specifically sub-Saharan African countries: The countries included in the analysis will be Angola, Benin, Botswana, Burkina Faso, Burundi, Cabo Verde, Cameroon, the Central African Republic, Chad, Comoros, the Democratic Republic of the

Congo, the Republic of Congo, Cote D'Ivoire, Equatorial Guinea, Eritrea, Eswatini, Ethiopia, Gabon, the Gambia, Ghana, Guinea, Guinea-Bissau, Kenya, Lesotho, Liberia, Madagascar, Malawi, Mali, Mauritania, Mauritius, Mozambique, Namibia, Niger, Nigeria, Rwanda, Sao Tome and Principe, Senegal, Seychelles, Sierra Leone, Somalia, South Africa, South Sudan, Sudan, Tanzania, Togo, Uganda, Zambia, and Zimbabwe. There are practical considerations behind this choice: it is difficult to obtain data at the household, community, and provincial level for certain countries, particularly those that have weaker bureaucratic institutions or are affected by domestic situations (civil war, severe weather events, etc.) that make record-keeping and statistical analysis difficult unless it is kept by an outside organization. Additionally, statistics about energy are kept at the country level and for theoretical consistency, it is necessary for the unit for analysis to also be at the country level to avoid having to extrapolate data.

The primary dependent variable for hypothesis one is female economic participation, which is operationalized as the labor force participation rate, female (% of female population ages 15+) according to the International Labor Organization (ILO) estimates. The strength of using this variable is that the International Labor Organization data covers all formal industries, which is the primary aim of this thesis. Data reported through the ILO is likely to be more accurate due to stronger reporting mechanisms and the fact that all countries that will be included in the analysis are members and required to submit accurate information on labor trends annually. However, a major weakness that is tied to the use of this variable is that it does not capture the breakdown of women in different sectors of the economy. This information would be useful to understand in what avenues are women participating in the formal economy because participation in different industries comes with disparate wage breakdowns and participation within the economy.



The primary dependent variable for hypotheses two and three is female political participation, which is operationalized as the proportion of seats held by women in national parliaments, illustrated as a percentage. The strength of this variable is that it is a strong representation of women in decision-making bodies at the highest level, as well as being the most robust identifier of women in public decision-making bodies due to gender disparities in federal governments regionally and internationally. However, this presents an additional weakness, which is that this is the most robust variable available, with little to compare to, and that other forms of participation are not addressed, such as voting.

The independent variables that are included in this analysis include energy capacity, which is operationalized as access to electricity, illustrated as a percentage. The main reason for its inclusion is that nearly all major international energy reporting agencies (such as the International Energy Agency [IEA] and the International Renewable Energy Agency [IRENA]) use this variable to make estimations on a country or region's current state of energy capacity, as electrification implies the ability to both generate and store energy appropriately. A major weakness associated with this variable is that it may not be the most accurate measure, as there are major incentives for misreporting and electrification can be dependent on state stability, which might vary. However, the variable still gives insight into the infrastructural capacity of Sub-Saharan African countries to provide energy to their citizens, and theoretical evidence supports that a growing amount of electricity provided comes from renewable sources (International Energy Agency "Africa Energy Outlook" 2022). It should be noted that I am not planning on using energy consumption because as an aggregate, it does not look at the household as variables analyzing consumption often incorporate industry and public uses, making it

difficult to adequately account for scale. In this case, the use of access to electricity allows for more emphasis on a community- or household scale.

An additional independent variable is the amount of energy generated, operationalized as the percentage of total electric generation through hydroelectric sources illustrated as a percentage. This source indicates the presence of renewable energy produced within a country and identifies both the country's willingness to spend and develop renewable energy sources and the use and availability of energy produced from renewable energy sources. The primary source of the data, the International Energy Agency, refers to hydropower as "electrical energy derived from turbines being driven by flowing water in rivers, with or without man-made dams forming reservoirs" (World Bank Group 2024).

Identifiers of female participation in the workforce are operationalized as the Women, Business, and the Law entrepreneurship indicator score (scaled 1-100). Women, Business and the Law is a project group of the World Bank that seeks to collect, analyze, and public data and reports on the legal structures and policy mechanisms to measure the environment for women's economic opportunity, with the primary purpose of identifying whether a country's legal, political and economic structure permits women to achieve economic opportunities in the same way as men do. The entrepreneurship score considers the following variables to weigh their scores and provide a "score" for a country. These variables include if a woman can sign a contract in the same way as a man (1 = yes; 0 = no), if a woman can register a business in the same way as a man (1 = yes; 0 = no), a woman can open a bank account in the same way as a man (1 = yes; 0 = no), and the law prohibits discrimination in access to credit based on gender (1 = yes; 0 = no) (World Bank "Women, Business and the Law" 2024). The closer a country's score to 100 is, the stronger the legal and political protections are for women to participate in that

country's economy. This variable is useful because it reconceptualizes binary variables into a more consistent format for analysis in a panel series in addition to creating a more intuitive model for comparison against countries.

An additional variable that measures women's participation in economic institutions is the Women, Business and the Law assets indicator. The assets score considers the following variables to weigh their responses to provide a "score" for the country, which includes do men and women have equal ownership rights to immovable property (1 = yes; 0 = no), do sons and daughters have equal rights to inherit assets from their parents (1 = yes; 0 = no), do male and female surviving spouses have equal rights to inherit assets (1 = yes; 0 = no), whether male and female surviving spouses have equal rights to inherit assets (1 = yes; 0 = no), and whether the law grants male and female spouses equal administrative authority over assets during marriage (1 = yes; 0 = no) (World Bank Group 2023). As with the entrepreneurship score from the same dataset, the closer a country is to 100, the more access and control a woman in a specific country has over her or her familial assets. The theory behind the inclusion of this indicator is that this score represents the recognition of a woman's ability to participate in formal economic institutions, such as property ownership. Additionally, this is also a create way to conceptualize social attitudes towards women and their participation in economic institutions, including whether there is a widespread belief in a woman's ability to make financial decisions for herself or her family.

The following three variables will be included as controls. The first variable, literacy, will be conceptualized as the literacy rates, adult female (% of females ages 15 and above). Literacy and educational attainment levels are viewed as separate points of comparison, even though literacy has been used as a proxy for educational attainment levels and vice versa (Smith-

Greenway 2015, pp. 1016-1017). However, as new information comes out to suggest that these two variables are not as connected as it seems, literacy is known to be correlated with increased political and economic participation (Amoateng et al. 2014, p. 5898). The use of literacy as a control will allow us to further isolate the relationship to ensure that we can see the relationship between the independent variables and the dependent variable as clearly as possible. An additional control is fertility, operationalized as fertility rate, total (births per woman). There is evidence to suggest that higher fertility rates ultimately shape gender roles in a way that confines women to the sphere of the household, limiting their ability to participate in the public sphere (Mbacke 2017, p. 332). As there is potential for a negative relationship there, it is included as a control variable. Finally, there will be a control for corruption, operationalized as control of corruption on a -2.5 to 2.5 scale. This variable aims to “capture perceptions of the extent to which public power is exercised for private gain, including forms of corruption, as well as “capture” of the state by elites and private interests” (Kaufman and Aart 2023). The greater the perception that a country is corruption, the more negative its score is, while the greater the perception that a country is not corrupt, the more positive its score is. The relationship between corruption and political and economic participation is disputed, with some arguing that it promotes political participation as those who suffer from corruption are more likely to use political institutions to end it (Skolnik 2020, p. 90). Additionally, corruption is also believed to encourage people to behave in ways that are antithetical to economic growth, such as rent-seeking, further demonstrating the potential for a negative relationship (Zhang et al. 2023). Due to the demonstrated presence of a relationship, it is necessary to include this variable as a control.

The data for the variables described were pulled from the following datasets: the World Bank World Development Indicators and World Bank Gender Statistics. Both datasets include

variables from the Worldwide Governance Indicators and the International Energy Agency, but they are incorporated into the Gender Statistics and the World Development Indicators databases.

The methodology for this analysis is two-pronged: the first part of the analysis comprises the utilization of panel data about female political and economic participation in the formal sector as well as renewable energy use and generation from the years 2010 to 2020 in forty-eight sub-Saharan African countries. This panel data will be put into a fixed-effects regression model to identify trends amongst the countries regarding data about African female political participation, female economic participation, and renewable energy use and generation. The second aspect of the analysis comprises case studies, which will be used to compare two countries against each other. These models were created in R, utilizing the ‘plm’ package, which allows for the application of fixed-effects statistical methods on panel data. The case studies will focus on the non-qualitative aspects of female political and economic participation, particularly how culture and political legislation can impact how women interact with both energy and economic and political institutions. This will be done through the continued analysis of the panel data as well as the addition of information from case studies conducted within these two countries.

## Chapter 5

### Results and Discussion

For this project, there will be several statistical techniques employed to understand the shape of the data, the potential relationship between the independent and dependent variables, and if so, what is the strength of such a relationship, and the impacts that control variables may have on the relationship. Additionally, there will be two case studies, that of Nigeria and Cote d'Ivoire, to expound on potential gaps in the qualitative data and to identify what the future of renewable energy programs in different countries may look like.

The following are the descriptive statistics of the independent and dependent variables. Descriptive statistics are meant to give insight into the size and shape of the data, which allows for a more robust analysis. Table 1 describes the descriptive statistics of all nine variables.

**Table 1: Descriptive Statistics**

	Minimum	1 <sup>st</sup> Quartile	Median	Mean	3 <sup>rd</sup> Quartile	Maximum
Labor Force Participation (%)	20.59	49.19	57.00	56.90	67.11	83.90
Women in Parliament (%)	3.03	10.96	17.96	20.83	27.79	63.75
Access to Electricity (%)	1.50	21.05	42.41	43.73	60.93	100.00

Electricity Generated by Hydropower (%)	0.000	3.98	48.870	45.02	74.23	99.89
Women, Business, and Law Entrepreneurship Score (1 – 100)	0.00	75.00	75.00	70.69	100.00	100.00
Women, Business, and Law Assets Score (1 – 100)	0.00	60.00	80.00	70.68	100.00	100.00
Literacy Rates, adult female (%)	12.19	34.09	61.97	59.18	82.45	96.70
Fertility Rates (births per woman)	1.36	4.05	4.70	4.63	5.29	7.49
Control of Corruption, Estimate Score (-2.5 – 2.5)	-1.94	-1.19	-0.76	-0.67	-0.26	1.39

It is important to note that for some of the variables, data was not available, particularly for the amount of electricity generated by hydropower (370 NAs) and adult female literacy variables (431 NAs). This does not necessarily indicate that the reported data is automatically

zero, but rather that the data was not captured and reported. In the assigned year. However, as some data is incomplete, the results of the panel regression models will also be incomplete. Regarding women's political participation and labor force participation, the average country in the sample averages about 20.8% and 56.9%, respectively. The average country in the sample sees about 43.7% of its population having access to electricity. For countries that had the data, the average saw about 45% of its electricity generated through hydropower. On average, the samples in the dataset scored 70.7 for both the Entrepreneurship and Asset scores. The average country (of those that reported data) had about 59.2% of its adult female population attaining literacy while the average woman from the set gave birth 4.6 times. Finally, the average country in the sample saw a corruption score of -0.67, indicating the perception of a somewhat corrupt state. Overall, the spread of the data indicates the presence of some countries having an outsized impact on the data, as many of the variables are negatively skewed, as shown through the means of the variables being smaller than the median. As this points to the direction of outliers being on the left side of the dataset, it is possible to affect the trendlines and overall shape of the relationship between the independent and dependent variables.

Next, univariate and multivariate regressive methods are employed for each year, 2010-2020. The purpose of the examination of the univariate relationship is to explore, in its plainest terms, the possibility of a relationship between the independent and dependent variables. The use of multivariate regression allows for the addition of the control variables, which might reveal the true nature of the relationship. As discussed earlier, the univariate and multivariate models will be using panel regression models. This is done for all three hypotheses.



**Table 2: Univariate, Hypothesis 1**

	<b>Estimate</b>	<b>Std. error</b>	<b>t-value</b>	<b>Pr (&gt; t )</b>
Access.Electric	0.137168	0.102160	1.3427	0.18181
Elec.Hydro	-0.149438	0.096391	-1.7298	0.08614
Total Sum of Squares	2250.3			
Residual Sum of Squares	2163.1			
R-Squared	0.038762			
Adj. R-Squared	-0.16118			
F-Statistic	2.5203 on 2 and 125 DF, p-value: 0.084516			

As illustrated in Table 2, there is a mild positive relationship between access to electricity and female economic participation, which shows that for every one-unit increase in access to electricity, there is a 0.137 unit increase in female economic participation. For the percentage of electricity generated from hydropower and female economic participation, for every one-unit increase in electricity generated from hydropower, there is a -0.149 unit decrease in female economic participation. This is not a statistically significant relationship due to p-values of 0.181 and 0.086, respectively. Additionally, the univariate analysis reveals that this regression model is not a good fit due to an adjusted R-squared value of -0.16.

**Table 3: Univariate, Hypothesis 2**

	Estimate	Std.Error	t-value	Pr (> t )
Access.Elec	-0.00513	0.030731	-0.1669	0.8677
Elec.Hydro	0.033598	0.0259925	1.2926	0.1984
Total Sum of Squares	229.89			
Residual Sum of Squares	226.85			
R-Squared	0.013241			
Adj. R-Squared	-0.1826			
F-Statistic	0.878942 on 2 and 313 DF, p-value: 0.41766			

Table 3 outlines the univariate regression model between female political participation and access to electricity and electricity generated from hydropower. As shown in the table, for every one-unit increase in access to electricity, there is a -0.005 unit decrease in female political participation. For every one-unit increase in electricity generated from hydropower, there is a 0.034 unit increase in female political participation. There are very weak relationships for both independent variables as neither variable is statistically significant, with p-values of 0.868 and 0.198. Additionally, the fit of this regression model is not adequate due to a low adjusted R-squared value of -0.183.

**Table 4: Hypothesis 3 (no controls)**

	Estimate	Std. Dev	t-value	Pr (> t )
Labor.Force.Participation	0.012055			0.9096
		0.10607	0.1137	
Entrepreneurship	0.007541	0.007541		0.7327
			0.3417	
Assets	0.013167	0.0366341		0.7194
			0.3594	
Total Sum of Squares	6382.3			
Residual Sum of Squares	6378.8			
R-Squared	0.0005555			
Adj. R-Squared	-0.10876			
F-Statistic	0.0829983 on 3 and 448 DF, p-value: 0.96928			

Table 4 displays the regression model for female political participation and the other main independent variables for this hypothesis, female labor force participation, levels of entrepreneurship for women, and the ability of women to access and maintain their own assets. In this model, the control variables are excluded to gain preliminary insight into whether there is a statistically significant relationship. Every one-unit increase in female labor force participation yields a 0.012 unit increase in female political participation, while every one-unit increase in a country's entrepreneurship score yields a 0.007 unit increase in female political participation. Additionally, every one-unit increase in the assets score for a country yields a 0.013 unit increase

in female political participation. All three relationships in the regression model are not statistically significant as shown through p-values of 0.910, 0.733, and 0.719. The adjusted R-squared value also indicates a poor fit with a score of -0.109.

**Table 5: Multivariate, Hypothesis 1**

	Estimate	Std. Error	t-value	Pr (> t )
Access.Electric	-0.77150	0.54300	-1.4208	0.18907
Elec.Hydro	-0.10675	0.75791	-0.1408	0.89110
Literacy.Fem	-0.43431	0.65223	-0.6659	0.52218
Fertility	-17.2680	22.98534	-0.7513	0.47168
Control.of.Corruption.Est	22.34602	11.52089	1.9396	0.08436
Total Sum of Squares	433.41			
Residual Sum of Squares	243.03			
R-Squared	0.43926			
Adj. R-Squared	-1.056			
F-Statistic	1.41005 on 5 and 9 DF, p-value: 0.030775			

Table 5 illustrates a multivariate regression model between the dependent variable ‘female economic participation’ and the independent variables ‘access to electricity’ and ‘electricity generated by hydropower. Additionally, the control variables ‘adult female literacy’, ‘fertility’, and ‘control of corruption estimate’ are also included. All five variables, including the controls, are not statistically significant but do show varying levels of impact on the dependent variable. For example, for every one-unit increase in the ‘control of corruption’ estimate variable, there is a 22.346 unit increase in female political participation, which adheres to the

theory described in Chapter 4. However, for every one-unit increase in the ‘fertility’ variable, there is a -17.268-unit decrease in female political participation. For the two main independent variables, for every one-unit increase in access to electricity and electricity generated by hydropower, female political participation decreases by 0.771 and 0.106 units, respectively. It should be noted that the variables included in this model are not a good fit, as shown through the adjusted R-squared value of -1.056. With further analysis, this model is not statistically significant in any of the countries in the sample. However, the F-statistic is significantly significant with a p-value of 0.031, indicating that the collection of these variables are statistically significant, rather than their significance being independent of each other.

**Table 6: Multivariate, Hypothesis 2**

	Estimate	Std. Dev	t-value	Pr (> t )
Access.Elec	-0.06184	0.097556	-0.6339	0.540388
Elec.Hydro*	0.270134	0.095564	2.8267	0.017952
Literacy.Fem	-0.02908	0.116137	-0.2504	0.807343
Fertility**	-14.5011	3.899994	-2.7182	0.003987
Control.Corruption.Est	-1.83444	1.841591	-0.9961	0.342686
Total Sum of Squares	26.115			
Residual Sum of Squares	9.2029			
R-Squared	0.6476			
Adj. R-Squared	-0.19815			
F-Statistic	3.67542 on 5 and 10 DF, p-value: 0.03793			

Table 6 displays the multivariate regression model for the dependent variable ‘female political participation’ and the independent variables ‘access to electricity’ and ‘electricity generated by hydropower’. The control variables described in Table 5 are also included. In this model, the variable ‘electricity generated by hydropower’ is statistically significant with a p-value of 0.017. As a result, for every one-unit increase in ‘electricity generated by hydropower’, there is a 0.270 unit increase in female political participation. The control variable ‘fertility’ is also statistically significant with a p-value of 0.004, indicating that this variable affects the regression to some degree. For this model, for every one-unit increase in ‘fertility’, there is a decrease of 14.501 units in female political participation. As with the other models, this is a poor fit with an adjusted R-squared value of -0.198. However, the F-statistic is statistically significant, with a p-value of 0.038, indicating that the group of variables in this model is jointly significant. Like with the model in Table 6, none of the countries within the sample are statistically significant independently.

**Table 7: Multivariate, Hypothesis 3**

	Estimate	Std. Dev	t-value	Pr (> t )
Labor.Force.Participation	-0.564741	0.306509	-1.8425	0.07264
Entrepreneurship	-0.127920	0.128456	-0.9958	0.32517
Assets	-0.018656	0.086699	-0.2152	0.83070
Fertility*	-8.009776	3.224226	-2.4842	0.01716
Literacy.Fem	-0.047129	0.117379	-0.4023	0.68957
Control.Corruption.Est*	12.188921	5.291657	2.3034	0.02640
Total Sum of Squares	1117.00			

Residual Sum of Squares	793.79
R-Squared	0.28935
Adj. R-Squared	-0.5773
F-Statistic	2.78226 on 6 and 41 DF, p-value: 0.023093

Table 8 displays the multivariate regression model between the dependent variable ‘female political participation’ and the independent variables ‘female labor force participation’, ‘female entrepreneurship scores’, and ‘women’s access to assets’. Additionally, the controls are the same as shown in Tables 6 and 7. For this model, the only two statistically significant variables are the control variable ‘fertility’ and the control variable ‘control of corruption’ with p-values of 0.017 and 0.026, respectively. While they are both controls, this demonstrates that these two variables have an impact on the main dependent variable for this model. For ‘fertility’, for every one-unit increase in ‘fertility’, there is a decrease of 8.010 units in female political participation. This is consistent with the relationship between fertility and female political participation shown in Table 7. For ‘control of corruption’, every one-unit increase in the score yields an increase in female political participation by 12.189 units. As with the other multivariate models, the adjusted R-squared value is -0.577, indicating a poor fit. Additionally, the F-statistic is significant with a p-value of 0.023, indicating that the group of variables within the model is statistically significant. For this model, the only statistically significant country is Eswatini.

## Discussion

For all three hypotheses, I fail to reject the null hypothesis due to a lack of a statistically significant relationship. For Hypothesis 2, there is partial evidence as demonstrated through the multivariate regression model displayed in Table 6, where the independent variable ‘electricity generated through hydropower’ is statistically significant. However, as the other independent variable ‘access to electricity’ is not statistically significant, it does not meet the requirements necessary to reject the null hypothesis for Hypothesis 2, which is that an increase in access to electricity and electricity generated by hydropower leads to an increase in female political participation. In a future analysis, I would like to further explore the relationship between ‘electricity generated through hydropower’ and female political participation to determine if this is a consistent relationship or if it is limited to this analysis only.

While the main independent variables are all statistically insignificant, some of the control variables proved to be significant, such as ‘fertility’ and ‘control of corruption estimate’. This is consistent with the background for the inclusion of the variables as controls, described in Chapter 4. However, as both ‘fertility’ and ‘electricity generated by hydropower’ are statistically significant in the multivariate model for the second hypothesis, if further testing is to be done, it would be beneficial to include ‘fertility’ as a control to see the range of its effects.

As shown throughout the three multivariate models, the F-statistic remained significant. This demonstrates that while the independent and control variables do not demonstrate a causal relationship, the variables help to explain the unexplained variance in the independent variables ‘female political participation’ and ‘female economic participation’. However, it should be noted



that the models demonstrated poor fit overall, so the F-statistic being significant may not be relevant in future studies.

Several implications arise from the outcomes of this analysis. First, the lack of responses in some variables, as stated earlier in this section, and the outliers in the sample may be affecting the relationship in some way. For example, the descriptive statistics indicate that there are strong negative skews in the data, as some countries within sub-Saharan Africa are lower on certain aspects of political and economic development than others. Additionally, conditions within the region may prevent adequate data collection, resulting in incomplete data for some variables, as shown in Table 1. Before we can rule out a relationship entirely, better and more complete sourcing of data would be useful in addition to utilizing statistical methods that would reduce the impact of the different socioeconomic and political conditions of different countries within the region. Second, it is possible that, in its current state, the impacts of renewable energy are too individualized to be able to adequately capture using a regional panel data regression model. For example, the range of the data for 'electricity generated through hydropower' contains a significant amount of missing data or zeroes, indicating that it might be useful to utilize other forms of renewable energy in a future study. Additionally, as stated previously, the countries in sub-Saharan Africa are incredibly diverse and various sociocultural aspects, such as the varying forms of gender roles, can be difficult to adequately quantify. While some of this can be solved through the use of qualitative data, as utilized below, it would be beneficial for future analyses to be able to test causality using sociocultural indicators. Different uses and application of statistical analysis and data collection would be beneficial in this regard.

To further examine the role of renewable energy in female economic and political participation, I will turn to two case studies to further examine the trends outlined in the models.

The purpose will be to further expand upon the quantitative data outlined here but also provide an alternative view of the relationship between renewable energy programs and female political and economic participation.



**Figure 1: Map of Nigeria (Gayawan et al. 2014)**

One of the most diverse countries on the African continent, Nigeria is located on the western coast and is centered between Benin to the west and Cameroon to the southeast. The country, before its colonization in 1914, was ruled by several different Islamic kingdoms representing a variety of different languages and cultural traditions, including the Borno, Kano, and Sokoto caliphates and the Benin and Oyo Empires (“Nigeria” 2024). The post-colonial

period, beginning in 1960 after Nigeria's break from the British, marked the start of an ethnically inflamed and politically tense period in Nigerian history. The Nigerian Civil War (1967-1970), while marking the creation of a stronger central government through the establishment of military rule, created the conditions of ethnic tensions that continue to this day. Presently, Nigeria faces instability due to a lack of democratization, a legacy of corruption, and increased terrorism and successionist violence within the nation ("Nigeria" 2024). However, it is the largest economy on the African continent, with a real GDP of \$1.05 trillion ("Nigeria" 2024). The size of its economy, combined with its abundant natural resources, makes the use of renewable energy a necessity as energy demand grows due to industrial and manufacturing growth.

Nigeria already has a strong renewable energy infrastructure due to its use of hydropower as a supplement to meet current domestic energy demand. However, the share of energy needs met coming from renewables, based on current forecasts, is likely to increase to a 47% share by 2030 and a 57% share by 2050 (International Renewable Energy Agency 2023). As Nigeria energy needs continue to grow and are met by renewable energy, the greater the potential for future socioeconomic and political impacts to occur.

As demonstrated through the multivariate analyses, Nigeria did not appear as a statistically significant country regarding the socioeconomic and political impacts of renewable energy. However, other studies, utilizing qualitative analysis such as interviews, government documents, and others, give an insight into the current state of renewable energy within the country and its impacts on female political and economic participation. Overall, women have a lower awareness and understanding of renewable technology and its role in preventing greenhouse gas emissions, even when accounting for levels of education (Wojoula and Alant

2019, p. 1367). Additionally, women do not appear to participate in renewable energy themselves, despite Nigeria's strong push towards the incorporation of renewable energy technology into their electric supply (Wojoula and Alant 2019, p. 1368). This indicates that any relationship between female economic and political participation is likely to be indirect.

However, it is possible that increased access to renewable energy, particularly for women in rural areas, will lead to increased productivity gains in agriculture and industry, allowing women to increase their access to healthcare and education, thus expanding their economic and political opportunities. Folarin et al., in their paper *Access to Healthcare through Renewable Energy on Female Agricultural Productivity in Nigeria*, find that increased productivity gains, such as those made with the use of renewable energy, allowed women's access to improved healthcare. Through improved healthcare and other indicators of development such as increased access to education, female farmers can increase their productivity and their profits, increasing their social standing within their communities as well as allowing their families to access education and healthcare, promoting development gains throughout a community (Folarin et al. 2022, p. 8).

Other organizations, such as Solar Sister, allow women to establish entrepreneurial networks with renewable energy (Heuer 2017). Renewable energy, specifically solar, can be enacted at smaller scales, allowing for rural communities to mitigate the costs of energy and establish entrepreneurial enterprises, such as agricultural or artisanal ventures that require energy inputs (Heuer 2017, p. 117). The use of these technologies allows women to gain expertise in both renewable energy technology and entrepreneurial skills, decreasing gender gaps in economic participation (Heuer, 2017, p. 118; Atahau et al. 2021).

Little has been done to examine this relationship over the long-term and much of the current analyses available are conducted at a local level, likely due to the locations of renewable energy infrastructure and to better gauge the outcomes resulting from renewable energy programs. However, as Nigeria is deeply embedded in renewables and looks to keep expanding, future analyses would benefit from long-term studies.

### Cote D'Ivoire



Figure 2: Map of Cote d'Ivoire (Elisee et al. 2021)

Before the establishment of the French colony of Cote d'Ivoire in 1844, various kingdoms ruled the territory starting in the 15<sup>th</sup> century. Many of these kingdoms, such as the Sanwi kingdom, sought to maintain independence from the French colonial government through secession but failed to do so ("Cote d'Ivoire" 2024). Cote d'Ivoire declared itself independent in 1960 but continued to have strong economic ties with France, such as through the cocoa trade ("Cote d'Ivoire" 2024). While it is one of the most prosperous states in Western Africa, the early 21<sup>st</sup> century saw a period of extreme political instability through the establishment of a military junta and its subsequent removal by Laurent Gbagbo ("Cote d'Ivoire" 2024). Several years of civil war followed until an agreement was signed in 2007, where the leader of the rebel faction, Guillaume Soro, joined the Gbagbo administration. In November 2010, Alassane Dramane Ouattara won the popular elections but Gbagbo refused to hand over power, resulting in a violent conflict until Gbagbo was ousted in 2011. Since then, Ouattara has remained in power, despite there being a two-term presidential limit, with the next elections coming up in 2025 ("Cote d'Ivoire" 2024).

Despite the ongoing political instability, Cote d'Ivoire is one of the most stable and booming economies within West Africa ("Cote d'Ivoire" 2024). There is an increasingly diversifying economy, with strong strides made in the construction and industrial sectors, but most Ivorians work in agriculture ("Cote d'Ivoire" 2024). Like with Nigeria, energy demand and consumption is going to increase as the Ivorian economy continues to grow, and the government and private sector are turning towards renewable energy as a supplement. At present, the country is heavily dependent on local oil and gas production while renewables make up about 24% of total power generation overall (Enerdata 2023; International Energy Agency "Cote d'Ivoire"

2023). As the country is at the beginning stages of strongly implementing renewable energy, its impacts are going to look different than those of Nigeria.

Little is written on the specific relationship between female economic and political participation and renewable energy in Cote d'Ivoire, as much of the current literature focuses on the overall impacts of energy access and where renewable energy options can close the gap between urban and rural populations (Diallo and Moussa 2020). However, there is a growing recognition of how energy access contributes to increased economic opportunities for women, as they can automate processes in the household, like cooking, to free up more time for them to provide for their families (Diallo and Moussa 2020). While there is limited knowledge of the specific relationship that Ivorian women might experience due to the increased implementation of renewable energy, it is important to note that the government is aware of the general trend between development and increased access to electricity. As a result, it is possible that during discussions about how to equitably distribute the positive effects of renewable energy, women will be at the forefront.

Like with Nigeria, future studies must be done to continue to examine this relationship to ensure that there is equitable access to energy, particularly renewable energy.

## **Chapter 6: Conclusion**

This paper was an initial attempt to explore the socioeconomic and political outcomes of renewable energy use, particularly as policies with a focus on environmental protection become more commonplace throughout areas that are likely to be affected by climate change, such as sub-Saharan Africa. While there is limited statistical evidence to support a causal relationship between renewable energy and increased female economic and political participation, the case studies and much of the literature comprising the base of this paper indicate that there are positive impacts from renewable energy for women. As there is growing support among the countries in the sub-Saharan African region on the implementation and use of renewable energy, renewable energy and its socioeconomic and political impacts will be at the forefront to ensure that renewable energy is implemented justly as well as providing the economic and political benefits that are commonly touted.

This paper, and more broadly this area of study, presents many benefits for policymakers as it identifies what adjusted in the wake of a climate change-induced slowdown of economic growth and potential adverse political outcomes as a result. This area of study clearly outlines how development is related to environmental policy, in addition to when and how it should be executed to ensure the enjoyment of its benefits. Through the incorporation of both qualitative and quantitative analysis, policymakers will understand the complexity of this topic and aim for continued future research in this area.

For future analysis, it is recommended that a longer time horizon be used to fully explore the shape and strength of a potential relationship between female economic and political



participation and the implementation of renewable energy. Additionally, different variables reflecting measures of human development, such as access to healthcare, would be useful to explore. Finally, the continued use of both quantitative and qualitative analyses would be the most beneficial to policymakers and stakeholders in this topic, as they can recognize the impacts of people at varying levels of implementation in addition to the replicability of quantitative analyses.

As the energy transition begins and renewable energy becomes more and more attractive, the exploration of how it shapes political and economic institutions as well as individuals becomes more pertinent. It is with the hope of I and other researchers that there is continued support for this area of study to ensure an equitable and just future and that all individuals are able to reap the benefits from this new form of technology.

## BIBLIOGRAPHY

- “Facts and Figures: Economic Empowerment.” 2018. *UN Women*.  
<https://www.unwomen.org/en/what-we-do/economic-empowerment/facts-and-figures>  
 (October 13, 2021).
- Ahmed, A., & Cleeve, E. (2004). Tracking the millennium development goals in sub-saharan Africa. *International Journal of Social Economics*, 31(1/2), 12–29.  
<https://doi.org/10.1108/03068290410515394>
- Amoateng, A. Y., Heaton, T. B., & Kalule-Sabiti, I. (2014). Gender and Changing Patterns of Political Participation in Sub-Saharan Africa: Evidence from Five Waves of the Afrobarometer Surveys. *Gender & Behaviour*, 12(3), 5897-5910.  
<https://ezaccess.libraries.psu.edu/login?url=https://www.proquest.com/scholarly-journals/gender-changing-patterns-political-participation/docview/1657549169/se-2>.
- Asongu, S. A., & Odhiambo, N. M. (2021). Inequality, finance and renewable energy consumption in Sub-Saharan africa. *Renewable Energy*, 165, 678–688.  
<https://doi.org/10.1016/j.renene.2020.11.062>
- Atahau, A. D., Sakti, I. M., Huruta, A. D., & Kim, M.-S. (2021). Gender and renewable energy integration: The mediating role of Green-Microfinance. *Journal of Cleaner Production*, 318, 128536. <https://doi.org/10.1016/j.jclepro.2021.128536>.
- Baruah, B. (2015). Creating opportunities for women in the Renewable Energy Sector: Findings from India. *Feminist Economics*, 21(2), 53–76.  
<https://doi.org/10.1080/13545701.2014.990912>
- Bendlin, Lena. 2014. “Women's Human Rights in a Changing Climate: Highlighting the Distributive Effects of Climate Policies.” *Cambridge Review of International Affairs* 27(4): 680–98. doi: 10.1080/09557571.2014.960507 (September 7, 2021).
- Bishoge, Obadia, et al. “The Potential of Renewable Energy for Sustainable Development in Tanzania: A Review.” *Clean Technologies*, vol. 1, no. 1, 30 July 2018, pp. 70–88.,  
<https://doi.org/10.3390/cleantechnol1010006>.
- Bullough, Amanda, et al. “Women's Political Leadership Participation around the World: An Institutional Analysis.” *The Leadership Quarterly*, vol. 23, no. 3, 11 Oct. 2011, pp. 398–411., <https://doi.org/10.1016/j.leaqua.2011.09.010>.
- Central Intelligence Agency. (2024a). *Cote d’Ivoire*. Central Intelligence Agency.  
<https://www.cia.gov/the-world-factbook/countries/cote-divoire/>
- Commissions Sector, UNECA. (2022, February 28). *Africa's progress towards achieving the sdgs and targets needs strategic acceleration – 2020 africa sustainable development report*. 2020 Africa Sustainable Development Report. Retrieved April 3, 2023, from <https://www.uneca.org/stories/africa%E2%80%99s-progress-towards-achieving-the-sdgs-and-targets-needs-strategic-acceleration-%E2%80%93-2020>
- Corfee-Morlot, J., Parks, P., Ogunleye, J., & Ayeni, F. (2019, January). *Case study: Achieving clean energy access in sub-saharan africa - OECD*. OECD Environment; Climate Futures. Retrieved December 5, 2022, from <https://www.oecd.org/environment/cc/climate-futures/case-study-achieving-clean-energy-access-in-sub-saharan-africa.pdf>

- Deichmann, U., Meisner, C., Murray, S., & Wheeler, D. (2011). The economics of renewable energy expansion in rural Sub-Saharan Africa. *Energy Policy*, 39(1), 215–227. <https://doi.org/10.1016/j.enpol.2010.09.034>
- Diallo, A., & Moussa, R. K. (2020, March 1). *The effects of solar home system on welfare in off-grid areas: Evidence from Côte d'Ivoire*. ScienceDirect | Energy. <https://doi.org/10.1016/j.energy.2019.116835>.
- Diffenbaugh, Noah S., and Marshall Burke. “Global Warming Has Increased Global Economic Inequality.” *Proceedings of the National Academy of Sciences*, vol. 116, no. 20, 22 Aug. 2019, pp. 9808–9813., <https://doi.org/10.1073/pnas.1816020116>.
- Ding, W., Wang, L., Chen, B., Xu, L., & Li, H. (2014). Impacts of renewable energy on gender in rural communities of North-West China. *Renewable Energy*, 69, 180–189. <https://doi.org/10.1016/j.renene.2014.03.027>
- Dioha, M. O., & Kumar, A. (2020). Exploring sustainable energy transitions in sub-saharan Africa residential sector: The case of Nigeria. *Renewable and Sustainable Energy Reviews*, 117. <https://doi.org/10.1016/j.rser.2019.109510>
- Elisee, G. N., Bachir, S. M., & Desire, K. K. (2021). Contribution of a Websig to a study of the distribution of education staff for vocational training in Cote D'Ivoire. *Intelligent Information Management*, 13(02), 141–155. <https://doi.org/10.4236/iim.2021.132007>.
- Enerdata. (2023, July 1). *Côte d'Ivoire Energy Report*. Enerdata | Reports. <https://www.enerdata.net/estore/country-profiles/cote-divoire.html#:~:text=C%C3%B4te%20d'Ivoire%20aims%20for,with%20a%20share%20of%2059%25>.
- Ferroukhi, R., Renner, M., Nagpal, D., & Garcia-Baños, C. (2019, January 1). *Renewable energy: A gender perspective*. IRENA: Renewable Energy: A Gender Perspective. Retrieved December 5, 2022, from <https://www.irena.org/publications/2019/Jan/Renewable-Energy-A-Gender-Perspective>
- Folarin, E. M., Osabuohien, E. S., Okodua, H., & Okafor, V. (2022). Access to healthcare through renewable energy on female agricultural productivity in Nigeria. *IOP Conference Series: Earth and Environmental Science*, 1054(1), 012040. <https://doi.org/10.1088/1755-1315/1054/1/012040>.
- Gayawan, E., et al. “Possible determinants and spatial patterns of anaemia among young children in Nigeria: A Bayesian semi-parametric modelling.” *International Health*, vol. 6, no. 1, 31 Jan. 2014, pp. 35–45, <https://doi.org/10.1093/inthealth/iht034>.
- Glazebrook, Trish. “Women and Climate Change: A Case-Study from Northeast Ghana.” *Hypatia*, vol. 26, no. 4, 2011, pp. 762–782., <https://doi.org/10.1111/j.1527-2001.2011.01212.x>.
- Heuër, A. (2017). Women-to-women entrepreneurial energy networks: A pathway to green energy uptake at the base of Pyramid. *Sustainable Energy Technologies and Assessments*, 22, 116–123. <https://doi.org/10.1016/j.seta.2017.02.020>.
- International Energy Agency. (2022). *Africa Energy Outlook*. IEA | Reports. <https://www.iea.org/reports/africa-energy-outlook-2022/key-findings>.
- International Energy Agency. (2023). *Cote d'Ivoire - countries & regions*. IEA. <https://www.iea.org/countries/cote-divoire>

- International Renewable Energy Agency. (2023, January 1). *Renewable energy roadmap: Nigeria*. IRENA. <https://www.irena.org/Publications/2023/Jan/Renewable-Energy-Roadmap-Nigeria>.
- Iversen, Torben, and Frances Rosenbluth. “Work and Power: The Connection between Female Labor Force Participation and Female Political Representation.” *Annual Review of Political Science*, vol. 11, no. 1, 2008, pp. 479–495., <https://doi.org/10.1146/annurev.polisci.11.053106.151342>.
- Kaufman, D., & Kraay, A. (2023). *Home: Worldwide governance indicators*. World Bank Worldwide Governance Indicators. <https://www.worldbank.org/en/publication/worldwide-governance-indicators>.
- Kaygusuz, K. (2010). Energy Services and Energy Poverty for Sustainable Rural Development. *Renewable and Sustainable Energy Reviews*, 15(2), 936–947. <https://doi.org/10.1016/j.rser.2010.11.003>
- Liming, H. (2008). Financing rural renewable energy: A comparison between China and India. *Renewable and Sustainable Energy Reviews*, 13(5), 1096–1103. <https://doi.org/10.1016/j.rser.2008.03.002>
- Mbacké, C. (2017). The Persistence of High Fertility in sub-Saharan Africa: A Comment. *Population and Development Review*, 43, 330–337. <http://www.jstor.org/stable/26622885>
- Milazzo, A., & Goldstein, M. (2019). Governance and women's economic and political participation: Power inequalities, formal constraints and norms. *The World Bank Research Observer*, 34(1), 34–64. <https://doi.org/10.1093/wbro/lky006>
- “Nigeria.” *Central Intelligence Agency*, Central Intelligence Agency, 18 Mar. 2024, [www.cia.gov/the-world-factbook/countries/nigeria/](http://www.cia.gov/the-world-factbook/countries/nigeria/).
- Ngum, S. A., Gregorio, E., & Turner, J. (2011). *Empowering women in Africa through access to sustainable energy: a desk review of gender-focused approaches in the renewable energy sector*. African Development Bank Group; Documents. Retrieved December 5, 2022, from [https://www.afdb.org/fileadmin/uploads/afdb/Documents/Publications/AfDB-Gender\\_and\\_Energy\\_Desk\\_Review-EN-2016.pdf](https://www.afdb.org/fileadmin/uploads/afdb/Documents/Publications/AfDB-Gender_and_Energy_Desk_Review-EN-2016.pdf)
- Osman-Elasha, Balgis. “Women...in the Shadow of Climate Change.” *United Nations*, United Nations, 2019, <https://www.un.org/en/chronicle/article/women-in-shadow-climate-change>
- Owusu-Manu, D.-G., Mankata, L. M., Debrah, C., Edwards, D. J., & Martek, I. (2021). Mechanisms and challenges in financing renewable energy projects in sub-Saharan africa: A Ghanaian perspective. *Journal of Financial Management of Property and Construction*, 26(3), 319–336. <https://doi.org/10.1108/jfmpc-03-2020-0014>
- Peidong, Z., Yanli, Y., jin, S., Yonghong, Z., Lisheng, W., & Xinrong, L. (2009). Opportunities and challenges for renewable energy policy in China. *Renewable and Sustainable Energy Reviews*, 13(2), 439–449. <https://doi.org/10.1016/j.rser.2007.11.005>
- Školník, M. (2020). Corruption and political participation: A Review. *Sociální Studia / Social Studies*, 17(1), 89–105. <https://doi.org/10.5817/soc2020-1-89>.
- Smith-Greenaway, E. (2015). Educational attainment and adult literacy. *Demographic Research*, 33, 1015–1034. <https://doi.org/10.4054/demres.2015.33.35>.
- Urmee, T., & Md, A. (2016). Social, cultural and political dimensions of off-grid renewable energy programs in developing countries. *Renewable Energy*, 93, 159–167. <https://doi.org/10.1016/j.renene.2016.02.040>

- Verick, S. (2014, September 1). *Female labor force participation in developing countries*. IZA World of Labor. Retrieved April 3, 2023, from <https://wol.iza.org/articles/female-labor-force-participation-in-developing-countries/long>
- Wojuola, R. N., & Alant, B. P. (2019). Sustainable Development and Energy Education in Nigeria. *Renewable Energy*, 139, 1366–1374.  
<https://doi.org/10.1016/j.renene.2019.03.010>.
- World Bank Group. (2024, February 21). DataBank | World Bank Group. DataBank | Meta Data Glossary | Electricity production from hydroelectric sources (% of total).  
<https://databank.worldbank.org/metadataglossary/world-development-indicators/series/EG.ELC.HYRO.ZS>.
- World Bank. (2023). Data notes - women, business and the law. WBL World Bank | Content. <https://wbl.worldbank.org/content/dam/sites/wbl/documents/2023/Data%20Notes.pdf>.
- World Bank. (2024, February 24). Women, business and the law: Entrepreneurship indicator score (scale 1-100). World Bank Gender Data Portal.  
<https://genderdata.worldbank.org/indicators/sg-law-indx-en/>
- Winther, T., Matinga, M. N., Ulsrud, K., & Standal, K. (2017). Women’s empowerment through Electricity Access: Scoping Study and proposal for a framework of analysis. *Journal of Development Effectiveness*, 9(3), 389–417.  
<https://doi.org/10.1080/19439342.2017.1343368>
- Zhang, M., Zhang, H., Zhang, L., Peng, X., Zhu, J., Liu, D., & You, S. (2023). Corruption, anti-corruption, and Economic Development. *Humanities and Social Sciences Communications*, 10(1). <https://doi.org/10.1057/s41599-023-01930-5>.

## Data Sources

- World Bank Group. (2024a). *Gender statistics*. DataBank.  
<https://databank.worldbank.org/source/gender-statistics>.
- World Bank Group. (2024). *World development indicators*. DataBank.  
<https://databank.worldbank.org/source/world-development-indicators>.