NATHAN YEAWONYEE BELLEPEA

ANALYZING THE RELATIONSHIP BETWEEN ENERGY POVERTY AND GENDER INEQUALITY: A COMPARATIVE STUDY OF SOUTHERN ASIAN, SUB-SAHARAN AFRICAN, AND EUROPEAN UNION COUNTRIES WITH A FOCUS ON WOMEN'SEMPOWERMENT.

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Declaration

I at this moment affirm that the information, documents, analysis, and findings contained within this thesis have been diligently collected and presented in strict adherence to the academic regulations and ethical guidelines set forth by the Institute of Graduate Studies at Near East University. Furthermore, I declare that following these guidelines and principles, all non-original information and data utilized in this study have been appropriately cited and referenced.

NATHAN YEAWONYEE BELLEPEA

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Abstract

ANALYZING THE RELATIONSHIP BETWEEN ENERGY POVERTY AND GENDER INEQUALITY: A COMPARATIVE STUDY OF SOUTHERN ASIAN, SUB-SAHARAN AFRICAN, AND EUROPEAN UNION COUNTRIES WITH A FOCUS ON WOMEN'S EMPOWERMENT

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This study conducted from 2000 to 2020 across Southern Asian, Sub-Saharan African, and European Union countries, seeks to understand the connection between gender inequality, energy poverty, and women's empowerment. Utilizing the Panel Mean Group (PMG) method, the research uncovers a significant positive correlation between gender inequality and energy poverty in Southeast Asian and Sub-Saharan African countries, even when considering various influential factors. These findings emphasize the disproportionate impact of energy poverty on women, primarily due to their reliance on traditional cooking methods. Additionally, the study provides insights into the relationships between these variables in the context of the European Union countries through the analysis of estimated coefficients derived from the PMG. Notably, the study reveals that gender inequality (LGIQ) demonstrates a positive and statistically significant coefficient of 14.72119, suggesting that an increase in gender inequality is linked to a substantial rise in energy poverty. Conversely, both RGDP and QGDP exhibit negative coefficients of -9.222453 and 0.656907, respectively, indicating a reverse relationship with energy poverty. These findings underscore the ongoing importance of addressing gender inequality as a strategy to alleviate energy poverty within these regions. Importantly, the study's timeframe, spanning from 2000 to 2020, enables a comprehensive understanding of the long-term trends and dynamics of gender inequality, energy poverty, and women's empowerment. This temporal

scope facilitates the analysis of potential shifts and developments in these relationships over the two-decade period, offering valuable insights into the evolving nature of these issues over time.

Keywords: Energy poverty, gender inequality, women's empowerment, energy access, gender gaps.

Soyuz

ENERJİ YOKSULLUĞU VE CİNSİYET EŞİTSİZLİĞİ ARASINDAKİ İLİŞKİNİN ANALİZİ: KADINLARIN GÜÇLENDİRİLMESİ ODAKLI GÜNEY ASYA, SAHRA ALTI AFRİKA VE AVRUPA BİRLİĞİ ÜLKELERİ ÜZERİNE KARŞILAŞTIRMALI BİR İNCELEME

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2000'den 2020'ye kadar Güney Asya, Sahra Altı Afrika ve Avrupa Birliği ülkelerinde yürütülen bu çalışma, cinsiyet eşitsizliği, enerji yoksulluğu ve kadınların güçlendirilmesi arasındaki bağlantıyı anlamayı amaçlamaktadır. Panel Ortalama Grup (PMG) yöntemini kullanan araştırma, çeşitli etkili faktörler göz önüne alındığında bile, Güneydoğu Asya ve Sahra Altı Afrika ülkelerinde cinsiyet eşitsizliği ile enerji yoksulluğu arasında anlamlı bir pozitif korelasyon olduğunu ortaya koyuyor. Bu bulgular, enerji yoksulluğunun, öncelikle geleneksel pişirme yöntemlerine güvenmeleri nedeniyle kadınlar üzerindeki orantısız etkisini vurgulamaktadır. Ek olarak, çalışma, PMG'den elde edilen tahmini katsayıların analizi yoluyla Avrupa Birliği ülkeleri bağlamında bu değişkenler arasındaki ilişkilere dair fikir vermektedir. Özellikle, çalışma, cinsiyet eşitsizliğinin (LGIQ) 14.72119'luk pozitif ve istatistiksel olarak anlamlı bir katsayı gösterdiğini ortaya koymaktadır, bu da cinsiyet eşitsizliğindeki artışın enerji yoksulluğundaki önemli bir artışla bağlantılı olduğunu düşündürmektedir. Tersine, hem RGDP hem de QGDP, sırasıyla -9.222453 ve 0.656907'lik negatif katsayılar sergiliyor ve bu da enerji yoksulluğu ile ters bir ilişkiye işaret ediyor. Bu bulgular, bu bölgelerdeki enerji yoksulluğunu hafifletmek için bir strateji olarak cinsiyet eşitsizliğini ele almanın devam eden öneminin altını çiziyor. Importantly, the study's timeframe, spanning from 2000 to 2020, enables a comprehensive

understanding of the long-term trends and dynamics of gender inequality, energy poverty, and women's empowerment. This temporal scope facilitates the analysis of potential shifts and developments in these relationships over the two-decade period, offering valuable insights into the evolving nature of these issues over time.

Anahtar Kelimeler: Enerji yoksulluğu, toplumsal cinsiyet eşitsizliği, kadınların güçlendirilmesi, enerjiye erişim, toplumsal cinsiyet uçurumları.

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Chapter I

Introduction

1.1.1. Introduction

Energy poverty and gender inequality are two central concerns for inquiry and policy discourse across the countries of Southern Asia and Sub-Saharan Africa. The mutual relationship between these phenomena has been extensively stressed by researchers, underscoring the socio-economic development and human well-being, besides gender equity, as deeply impacted. However, despite the generated knowledge from analyses in these regions, a significant gap remains in the understanding of energy poverty dynamics coupled with gender inequalities while incorporating an inclusive global context. Such being the case, extending this comparison to include the countries in the European Union (EU), is a valuable step towards better illumination of these complex issues. This sets forth energy poverty and gender inequality as critical challenges in any given nation, especially so due to the direct impact it has on the socio-economic development of nations.

Understanding this inter-relationship among the problems would enable appropriate addressing of these multidimensional barriers faced by the vulnerable populations, especially women from Southern Asian and Sub-Saharan African and European Union countries who have different cultures in these regions. Hence, research has highlighted the detrimental effects of energy poverty on gender equality. For instance, Smith et al. (2019) and Johnson and García (2020) found from their studies that limited access to reliable and affordable energy in turn discriminates against women, hindering their economic empowerment, and sustaining sexist patterns. Besides, Reddy and Pachauri's (2019), research has majorly delved into thenexus between energy poverty and women's health whereby they rallied that the provision of energy access should be entrenched with adequate gender interventions to ensure substantive equality. On the other hand, Mulugetta et al. (2021), emphasized the importance of sustainable energy sources as a basis to promote gender equality and socialdevelopment. In their study, they demonstrated that improved energy access and gender-sensitive approaches can increase women's economic opportunities, education, as well as general well-being in the countries of

Southern Asia, Sub-Saharan Africa, and European Union Countries. A comparative study will be conducted in these areas to analyze the association between energy poverty and gender inequity. Energy poverty is defined as theabsence of access to modern, reliable energy services that are necessary to support basic human needs and other development objectives.

The idea includes access to energy sources as well as affordability of energy services. Energy poverty affects various humanlife issues including health, education, income generation, and general well-being. According to the International Energy Agency (IEA), about 770 million people across theworld are without access to electricity, with a larger percentage of this population residingin Sub-Saharan Africa as well as Southern Asia. This keeps women disproportionately from reaping the benefits of education, economic empowerment, and overall quality of life gains. In addition, normally energy poverty leads to the need for the use of traditionalbiomass raw materials such as wood, and dung both for cooking purposes as well as alsoto a greater extent fuel purposes - that have adverse impacts on health and the environment. Gender inequality can refer to such unequal treatment of people of a particular gender, as well as providing a person of a given gender with poorer opportunities or resources based on their sex. It cuts across the many social, economic, and political gaps existing between men and women.

Gender inequality is deeply rooted within social norms, cultural practices as well and institutional structures that aid in the propagation of such discrimination as well as the limitation of the agency of women and their participation in society to a large extent. Regarding the comparative study centeringon women empowerment in the Southern Asian, Sub-Saharan African, and European Union countries, it is salient to understand how energy poverty fuels gender inequalities.Breaking down the dynamics in these areas on an individual basis helps to shed light on the challenges faced by women and how far their empowerment is envisaged. One particular aspect to note from the impact of energy poverty on gender inequality is the disproportionate weight imposed on women, especially on issues surrounding the collection of firewood and traditional fuel sources. Often the responsibility is misplaced towards the women leaving them to have little time as well as energy and resources. The process of collecting these fuels is rather tough, tiresome, and

time-consuming than simple. Besides affecting the physical healthy environment for women, it also hampers other development issues. Time and effort are being spent collecting fuel rather than on investment activities for earning an income, or in education or community development issues. This way, women miss out on economic opportunities followed by gender disparities and limited empowerment. The use of traditional energy sources like fuels forcooking and heating also has major health implications, especially targeting women and children. Major health risks related to this problem, besides a deteriorated quality of life, are respiratory diseases and other complications that come due to indoor air pollution resulting from the use of biomass fuels. Such health risks mostly affect women who usually spend most time indoors. The resulting health consequences further function to reinforce gender inequality by undermining women's productivity, limiting their contributions to their families and communities, and perpetuating a cycle of disempowering.

Apart from impacts on health and economics, energy poverty leads women to an increased likelihood of violence and harassment. The vulnerability and riskincrease when women leave their homes to collect firewood or to access communal facilities after dark. Insufficient lighting and security in energy-poor communities enhancethe risk of gender-based violence. As such safety concerns limit the freedom of women tomove and provide them a chance to attend schools and engage in regular normal employment or public participation. With the profound implications that energy povertyhas in women's lives both within Southern Asian countries and some parts of the EuropeanUnion countries, no doubt mentioning the relationship of energy poverty with gender inequalities comes out timely and necessary.

These initiatives can well contribute to transformative change, sustainable development as well as enhanced welfare among the marginalized communities in Southern Asia, Sub-Saharan Africa, and European Union countries among others through promoting gender equality and women's empowerment inthe context of energy access. It also seeks to identify the possible strategies supported byexisting literature in multiple disciplines that can effectively promote gender equality andsustainable development Ramos et al., (2020). Gender disparity refers to unequal treatment of a person based on gender on various

grounds including employment, society,and cultural roles EIGE, (2020). In most writings on gender inequality is further promotedby institutional and social factors such as religion Cooray & Potrafke, (2016); Seguino, (2016) and the legal system Harbers, (2020). Despite evidence compelling as it relates tothe existence of gender disparity in work settings and other societal domains Njoh et al., (2018), strides toward solving this problem still are imperative. In recent times, significant advances have been made in tackling the gender disparity. However, amid the ongoing COVID-19 pandemic, progress to gender parity has received a major blow and the existing gender gap has also worsened due to it. This therefore makes it a matter of urgency to inquire into the adverse impacts on gender equality in southern Asian and eastern Africancountries that are caused by insufficient access to affordable energy sources. The lack of access to affordable energy services is a pervasive challenge among many developing countries as evidenced in various studies such as Awaworyi Churchill et al. (2020). Moreover, the research conducted by Gonzalez-Eguino et. al. (2020), concerning Bouzarovski et. al. (2018), further enriches our knowledge about this critical issue.

However, within economic circles, the dominant view is that the primary problem lies in people's lack of fulfillment of basic energy needs, which is regarded as the foremost ultimate cause. The study conducted by Thompson et al. (2019), serves to further elucidate this point. Accordingly, according to Gonzalez-Eguino (2015), in a situation where accessing other secondary forms of energy is very difficult, traditional biomass remains a perfect solution for use by many low-income people as their primary source of thermal endowments. Chevalier and Ouédraogo (2009), argue that people in sub-Saharan Africa spend a significant amount of time collecting fuels like wood and dung from the forest and distance locations towards the satisfaction of their basic energy needs. The impact of the energy crisis has been, in essence, very disastrous for women as the negative impacts are channeled via them whose major tasks at a residence are cooking and cleaning. Recent studies on gender inequality cite affordable electricity as one of the reasons that promote it.

Robinson (2019), in his research, associate’s energy insecurity in the United Kingdom with economic productivity as well as the general standard of living of the country. Aristondo and Onaindia (2023), argue that gender differences exist between how men and

women react towards poverty for the reason of lacking affordable energy. They link these to a shortage of cheap power sources. Besides, as it has been shown by the study of Moniruzzaman and Day (2020), men and women both may experience certain difficulties with energy poverty. The study adds to the understanding of gender inequality in the existing four key respects. As such, healthy workplaces, education, as well as sociopolitical and economic rights. The researchers applied experimental analysis procedures to determine the effects of energy poverty alleviation on developing countries across the world from a representative sample to accomplish the objective. Many of these countries are commonly classified as third-world nations. In this view, the research investigates the effect of poverty alleviation in developing countries and thereby provides a comprehension of plausible mechanisms whereby gender inequality might be reduced for subsequently bolstering human development.

Their study focused on the workplace, where women often have to face such problems as an opportunity for promotion and paydifferentials. Moreover, it tries to investigate its impact on the stature of women in termsof health due to energy poverty and a relationship with inadequate access to medical carefacilities and an increased pace of vulnerability associated with distinct critical diseases. Furthermore, the study looks at how energy poverty may hamper women from accessingand achieving educational empowerment as well as the numbers and positions of womenin political processes and decision-making. This study is significant to the gender-energynexus literature since it uses a relatively more improved experimental analysis method applied by most of the previous researchers. Since the mainstreaming of gender considerations in economic literature back in the 2000s Radovi-Markovi (2011), much emphasis has been on highlighting the issue of gender inequality within economic literature and a lot of progress has been achieved in identifying this issue.

However, the acknowledgment of this pressing concern is a recent phenomenon amongst economists inthe field of energy. Gender inequality has hitherto been partially linked to energy povertyto a certain extent, but there cannot be any specific studies undertaken hitherto to address such interrelated issues alone. Thus, recognition of this intricate relationship between energy poverty and gender inequality is important for progressively advancing our understanding of the multidimensional nature of these phenomena. Energy poverty and limited access to reliable sources of energy continue to bolster gender

disparities manifestin economic opportunities, health outcomes, education, and political representation. Therefore, through a comprehensive evaluation of the nexus between energy poverty andgender inequality, researchers can shed light on how energy poverty reinforces prevailing differences. Many advances have been made in the fight against gender inequality in economic livelihoods, yet research on energy presents virtually uncharted territory when it comes to understanding its impact on gender dynamics. Accordingly, there is a need tocarry out strict and narrowed researches that explicitly focus on the nexus of energy poverty and gender inequality. It can help provide empirical evidence and insights required to inform interventions in policy and initiatives aimed at the effective tackling ofenergy poverty and challenges relating to gender inequality.

Linking energy research to gender studies will enable scholars and policymakers to deepen the level of their comprehension of the sophisticated interaction between both phenomena. Through well- focused research centered on areas of great interest to energy poverty as well as gender equality, it can increase our knowledge-based existing interventions and engender innovation towards addressing both vis-à-vis the global spheres. The reduction of energypoverty is part and parcel of sustainable development Sovacool, (2012). This recognitionis derived from the significant implications it exerts on diverse interlinked areas like economic growth, health, happiness, inequality, and preservation of the natural environment Awaworyi Churchill et al., (2020). Energy poverty provides the cornerstone of sustainable development, as a holistic endeavor, as reinforced by Chevalier.

Research in underdeveloped countries is highly important for several reasons and one of the most eminent factors is shaping public policy. Studies on developing nations like countries of Africa - The Gambia and Sierra Leone - by China Tang & Liao, (2014), Bangladesh Barnes et al., (2011), and China serve to shed light on the imperative nature relative to insufficient access to electricity. Their research contributes to raising awareness about themagnitude of the issue and underscores its significance. An important facet highlighted by Munro and Schiffer (2019) after extensive research on the matter. In the research of Klasen et.al. (2021), it was widely defined that gender inequality is more pronounced in poor nations compared to developed ones. The same was discovered through the researchof Klasen et.al. (2021). On the opposite side, most of the developed

economies do not experience any drastic influence of energy poverty, which makes policymakers indifferent to this problem. However, it has to be emphasized that the problem of energy poverty remains pressing today on a global scale, and above all in developing countries where people's access to modern energy services is extremely poor. The study provides a detailed and persuasive analysis of the complex linkage between gender inequality and energy poverty from different dimensions. The evidence presented in this study is indispensable to further research and offering adequate information for policy-making purposes. This research will thus significantly contribute to improving the understandingof this complex challenge and the urgent need for action to address energy poverty.

According to the European Institute for Gender Equality (EIGE), gender inequality is a situation characterized by disparities that exist in terms of the rights and respect accorded to people concerning gender Khan, A., & Tidman, M. M. (2023). These manifest in various aspects such as legal frameworks Harbers (2020), the structure of institutions, and social circumstances Njoh et al., (2022). These factors have been identified and studied through multiple sources with advanced research also being carried out by Reczek et al. (2020) as well. However, the concern of what causes gender inequality remains discussed and open for debate. There are a lot many issues where gender inequalities prevail – at the workplace, in receiving an education, health problems, and legal safeguards. The pursuit of gender equality stands as a paramount objective within the United Nations' Sustainable Development Goals UN, Feenstra, M., & Clancy, J. (2020), specifically emphasized in Objective 5.

This objective holds particular significance in developing nations, where addressing gender disparities is crucial for achieving sustainable development and promoting inclusive societies. The majority of economists, on the other hand, believe thatit is because individuals do not have access to affordable energy sources for their homes.That is, people who live in energy poverty have to spend a large amount of time each daygathering local energy supplies like wood and dung to satisfy their most basic energy requirements Chevalier & Ouédraogo, (2009). This is necessary for them to meet their most basic energy requirements. As a result, the following conclusion must be reached: energy poverty is inextricably linked to economic, social, and health issues. This is especially true

for women, who bear a disproportionate share of the responsibility for performing domestic duties such as cooking and cleaning. Recent studies suggest that gender inequality may be connected to a lack of access to energy resources.

Poverty is an imperative concern that demands immediate attention and concerted efforts. It serves as a cornerstone for a significant portion of international development policies Sarkar (2010), and its alleviation should be given the utmost priority. A significant fraction of countries, mostly those located in South Asia and Sub-Saharan Africa, live in absolute poverty, and even with little if any hope that addressing any single dimension will relieve the impact on others. Notable poverty is seen among rural communities, indigenous South Asians, and select immigrant groups. A multifarious strategy has to be implemented to overcome this major issue and the welfare of women and children. Poverty determines the significant negative impact on the prospects and opportunities of the life chances of women and children. Indeed, children, because of their extremely susceptible and dependent nature concerning other people, make them the most suffering parties whenever poverty is experienced by a household. It is quite unfortunate since in such a scenario it can jeopardize their entire future by depriving them of those vital chances which are needed for honing themselves to perfection.

This is done through measuring poverty which can be affected by several ways and different approaches that have their share of merits and demerits. In most cases, it refers to measuring poverty concerning a poverty line which is an income threshold that is defined and revised from time to time. It should, however, be noted that different methods of measurement and various approaches adopted in estimation and updates can lead to slightly varying results. In this regard, the individual measure must be critically looked into to reflect the actual reality regarding the poverty situation. Further in the examination of family incomes, taking into consideration the distribution of assets or wealth. This consideration becomes significantly valuable in safeguarding against potential income crises such as sudden unemployment or prolonged illness. While analyzing the result distribution of assets, there exists some kind of protection and resilience for individuals and families while dealing with unforeseen financial challenges.

Understanding the relationship between these elements and developing holistic

approaches are essential for sustainable improvement and betterment of poverty-ridden communities. It is said that in their indoor settings, women and their children are exposed to very high levels of pollution for up to six hours a day. Indeed, it is alarming to know that almost half of the global households and up to 90 percent in developing countries still use biomass fuels. In India, for example, up to 75 percent of households rely on biofuels for cooking needs Bagdi, et.al. (2023). However, biofuels are traditionally burnt indoors in open fires and inefficient stoves hence causing very high amounts of indoor air pollution. The impact of indoor air pollution due to the use of biofuel can be severe

problem that would need immediate attention from policymakers in gender, energy, environment, and health. However, it should be noted that the highest concentrations are recorded in rural indoor environments where biofuels have extensively been used for cooking Pansera, M., & Sarkar, S. (2016). Thus, it calls for a holistic approach to deal with this burning issue as well as safeguard the interests of individuals and communities affected by this harmful practice.

This trend of moving away from the use of biofuels to petroleum products (for instance, kerosene and LPG) and electricity is consistently noticedin most developed countries. However, biomass fuels often continue to be applied by householders even cleaner and more advanced fuel options exist especially in developingcountries Ogwumike, F. O., & Ozughalu, U. M. (2016). Although the decline in the globalshare of energy from biofuels is large, this trend implies increased dependence on biofuelsby the poor. One of the major obstacles to the development of a viable market for cleanerfuels is poverty. As the development is slow, for many years to come people in many countries have to depend on biofuel for their energy requirements.

This is going to put people in poverty into deplorable situations. Moreover, it is important to realize that this transformation towards cleaner fuels involves holistic planning, incorporating economic,social, and environmental aspects, and assuring that no one will be left out of their accessto sustainable energy. Access to modern energy services is poor and forms a constraint that impacts significantly on the ability of people to escape from poverty and therefore severely limits their possibility of improving living conditions. People who lack such modern energy sources are forced to spend a huge amount of time and physical effort in simple survival, hence leaving them with very limited opportunity

for pursuing education,and income-generating activities. Energy poverty affects women disproportionately especially those who live within rural areas. Rural women suffer most from lack of accessto adequate energy.

When they get engaged in any income-generating activities, it is usually under the informal sector, hence not well captured or reflected through any national accounting systems that exist. This is because the work women constantly do falls under the economic value. This lack of formal recognition is the cause of a cycle of economic disadvantage for women that continues to deny them access to resources, financial independence, and opportunities for upward mobility. The solution to this gender inequity challenge forces a complex set of approaches. This includes the recognition and appreciation of women's remunerated labor in the form of caregiving, subsistence agriculture, and household work.

The essential requirement of contemporary, dependable, and sustainable energy resources for human development is catered towards the United Nations' sustainable development goals. Energy poverty and its related problems are multi-dimensional as witnessed from a pool of researchers such as Listo, R. (2018). If the energy supply is inadequate, societies are likely to be marked by a myriad of challenges ranging from gender issues and poverty-related problems together with poor access to the Groh. et. al. (2018); Sovacool, et. Al. (2016); Zaman et al., (2021). Consequently, reliable and sustainable access to energy services is pertinent not only in achieving the development goals but also in serving the broader socioeconomic mandate of marginalized communities.

Access to modern and clean energy resources has the potential of transformative impact on human lives throughmultiple channels, which include a significant improvement in health outcomes as well asthe adoption of LPG for cooking, which shows that it saves women's lives Andadari et al.,(2014); Bouzarovski et al., (2018); Pachauri et al., (2018); Sadath and Acharya, (2017); Sagar, et al. al. (2005). Additionally, the provision of uninterrupted electricity to hospitalsnot only improves the delivery of healthcare services but also increases the general qualityof life that their clientele gets Sovacool, (2013). Importantly, the vital point should be thatwomen should not be made to traverse long distances to collect firewood for domestic cooking for want of clean fuel. Unfortunately, women's access to education, health, and security rights is fundamentally challenged by

their lack of access to clean energy and basic services Toro, et. al. (2023); Urpelainen, et. al. (2018). Overcoming such energy- related challenges, and ensuring universal access to cleaner energy resources in the social,economic, as well as environmental realms will empower women, improve public health,and foster greater societal equity and security.

Energy is a paramount party in human beings' daily lives as it forms a most important tool for cooking food, enabling lighting in households, and even being a source for business operations Rasool et al., (2020). However, it is notable that by the year 2014, a very big percentage of the world's population approximately 1.1 billion people did not have access to electricity with the inhabitants of the rural developing parts of Asia and Africa being the most affected by the phenomenon International Energy Agency & Longe, (2021). However, what is important to note is that a mega milestone was reached, in developing Asia as the United Nations Agba et al., (2017).

By 2016, approximately 870 million peoplein the region had gained access to electricity, a significant jump in energy access. These statistics underscore the urgent necessity of joint efforts to bridge the gap in energy accessand to ensure that all persons can access energy services, especially electricity available in the world. It is a way of fostering socio-economic development, improving the qualityof life, and being an enabler in making communities better if we can heed energy povertyand both access and availability of energy infrastructure. Through the year 2017, Bangladesh had impressively achieved high access to electricity and with that rate, almost83% of the entire population was now able to enjoy the essential energy source. For this success, the concentration of the population in urban areas where electricity infrastructureis accessible easily makes a big contribution World Bank, (2018). Meanwhile, India showed a similar development as when in 2015, 88% of the population had access to electricity.

However, the multiple energy crises experienced in the country as well as poor power supply led to it dwindling to 81% in 2017 making it even more unreliable World Bank, 2018. Nepal and Sri Lanka exhibited excellent performance having increased access to power in both rural and urban areas in 2017. Nepal recorded a rate of 94% while a slightly higher rate of 97% was recorded by Sri Lanka World Bank, (2018). Another outstanding performance is demonstrated by Pakistan, Bhutan, and Maldives. In this respect, many

countries were able to not only increase electricity coverage for their populations but able to do it quite fast and even surpass their respective targets toward better lives and socio-economic growth World Bank, 2018. The successes outlined above show the essence of placing access to electricity as a focal point and employing strategic policies and development plans. The empowerment of citizens with electricity access in countries would add impetus for economic growth, and improvement in the general well-being of populations. Nonetheless, a lot more needs to be done to bridge the observed gaps by ensuring universal access to reliable and sustainable energy services. Economic development is one of the main major concerns in the literature, Cheng, et. al. (2021) and Raghutla, C., & Chittedi, K. R. (2022) contend.

It is a complex concept crocheted with several micro and macro issues such as inflation, income, education, health, and environment. Consequently, several empirical studies were aimed to unveil the factors that possess a substantial impact in driving economic development. Raghutla, & Chittedi, K. R. (2022) revolved around labor and capital as central to economic improvement determinants. From these findings, one cannot help but underscore the importance of knowledge and good, particularly towards these factors in fostering economic growth anddevelopment. One grievous challenge crippling most of the low-income countries across South and Southeast Asia, and in Africa, too, is lack of access to electricity, gas, and otherclean energy sources.

There are many surrounding bigger problems for the victims. For example, approximately 840 million people lived without electricity in the year 2019 alone while around 3 billion people used general fuels such as firewood for making meals.Besides that, these living conditions offer drastic health consequences as well. Millions ofpeople all across the globe, especially women and children suffer regular exposure to indoor air pollution. This is due to open cooking fires that traditionally fuel emitting substances that are responsible for indoor air pollutants causing an alarming death toll every year amounting to about 2.6 million people. These shocking statistics underline the dire need to deal with the inaccessibility to clean energy coupled with attendant health risks occasioned in these regions. Dealing with energy poverty is a matter that requires collective attention at national and international levels. It requires sustainable and inclusive policy frameworks that will foster the development and deployment of clean energy technologies besides

adequate infrastructures, which will guarantee equal access. Moreover, awareness creation on the need for energy efficiency and cleaner energy alternatives can help to stop or reduce the use of traditional fuels that pose a risk to humanhealth and the environment. This social order seeks to exercise control over women in multiple and interrelated ways involving sanctions, violence, and human rights violations.The gendered social order in these regions works as a mechanism to keep intact the existing power structures norms and expectations of the society. They insist on a range ofpractices, both subtle and overt, that restrict women's agency, limit their access to resources and opportunities, and perpetuate gender inequalities.

By addressing the underlying causes of gender inequality and favoring a more inclusive and equitable society, the South Asian, Sub-Saharan African countries and the European Union region would be able to create an environment wherein each individual, with no regard to his or her gender, would be able to fully enjoy his or her rights and contribute towards the overall development and wellbeing of the people of these regions. Conversely, in his work, Mammo (1999) submits that the concept of 'hierarchical opposition' is what properly describes gender dynamics. For example, as noted by Natarajan et. al. (2020), under this philosophy the male/female pairs are not intrinsically superior or inferior to one another but coexist harmoniously. There was stratification of gender in the early societies within the subcontinent, but collective contributions were made by both of them to work and equal rights to resources.

They constructed male and female gender subjectivities within the socio-economic, theological, and political discourses that were formed with thestates and class structures at that time. They propagated conservative notions of female sexuality and femininity. Again, centuries of invasions and the colonial past have affected the cultural landscape significantly towards developing a parochial mindset contrasting with them. These women, therefore, overcame prevailing prejudices and barriers, ultimately impacting qualitative changes within the social fabrics of their period Kar et. al (2019). This considerable body of literature on gender in South Asia, Sub-Saharan Africa, and European Union countries overdraws women's history under enormous historical phenomena as well as experiences. Further, this literature is going to explore the intersections of gender with other social factors like caste, ethnicity, culture, and religion to bring a broader understanding of these interlinked practices of gender relationships

within those contexts. In the field of gender studies, one witnesses growing attempts to explore the local, comparative, and transnational contexts. Such explorations are provided into the rich experiences and meanings of interdisciplinarity and intersectionality.

Gender equality ranks among the 17 Sustainable Development Goals (SDGs) declared during the United Nations Sustainable Development Summit held on September 25, 2015. It however remains an elusive goal cherished for all of humanity. Tourism, therefore, is truly such a powerful economic and cultural global force as it cuts across various dimensions of economies, societies, and environments in its effects have been felt the world over. Higgins-Desbiolles (2021) argues that there is a strong argument for the role tourism plays in achieving the 17 Sustainable Development Goals (SDGs). Furthermore, the tourism industry can be positively influenced by gender equality. As such, the area of tourism and its association with gender equality has become the subject of several researches. Some of the important ones in this regard are Wilkinson and Pratiwi (2017), Figueroa-Domecq, Pritchard, Segovia-Pérez, Morgan, and Villace-Molinero (2021), Ferguson (2016), Cole, et. al. (2020), and Alrwajfah, Almeida-García, and Cortés-Macías (2023). Over the past three decades, 'gender' has emerged as one of the most important aspects of development theory and practice.

The above catchphrases emphasize the lasting impact gender-focused approaches have made within development thinking and practice. They are continuous reminders of ongoing processes intended to systematically include gender concerns in development policy, program, and strategy formulation toward achieving gender equality and empowerment. Recent years, nevertheless, have seen governmental and nongovernmental actors alike, in conjunction with international development organizations and donor agencies, active in rolling out a wide variety of initiatives to address women-specific development challenges. These have included dedicated development projects' launching, specialized gender sensitization programs, and incorporation of gender towards existing development endeavors. This joint undertaking mirrors the growing recognition by stakeholders of the necessity not only to first position gender equality but also to take action in measuring, monitoring, and evaluating the outcomes of these interventions. An emphasis is here put on what is generally referred to as 'gender evaluation', aimed at evaluating the impacts of these projects and programs in effecting real changes in women's

lived experiences and transformations in gender dynamics. With the use of strict evaluation methodologies, different actors attempt to measure the effect of these programs in fulfilling their objectives and providing positive and sustainable results. The focus on gender evaluation emphasizes a commitment to evidence-based practice and ongoing intervention design aiming at promoting gender equality and empowerment of women. It represents how poverty dynamics are transformed within the community and the social structure is an essential mechanism of overall well-being and the utmost function to pursue valued lives of the people Pachauri, et. al. (2013). Therefore, numerous studies on well-being and development drew attention to the contextuality of their well-being and freedom perceptions of individuals and communities. It emerges that these perceptions are significantly influenced by social norms and expectations including those related to socioeconomic status, and gender among other markers of social identity Batz and Tay, (2023); Graham and Chattopadhyay, 2013).

However, as pointed out by Dolan et. al. (2013), well-being andfreedom have no fixed meanings but are influenced by several factors including those social norms and expectations. Further, in one of the most recent scholarly works on the issue, it is underlined that well-being and liberty are usually interpreted as referring to thesocial context of the individual. For example, well-being and freedom descriptions do notonly depend on the socioeconomic position of individuals but also their gender and other mediating social markers Batz and Tay, (2023); Graham and Chattopadhyay, (2013). The social markers could either facilitate or constrain the opportunities and choices for the people thereby affecting their overall well-being. Additionally, the poverty dynamics of a given community and crucial dimensions of social arrangements and opportunities contributing to the poverty dynamics are important dimensions for well-being and freedom. Recognizing the context-dependent nature of well-being and freedom man, it is apparent that social norms and expectations such as towards socio-economic position, gender, and social identity play important roles in forming people's views of their own well-being and freedom Batz and Tay, (2023); Graham and Chattopadhyay, (2013).

In 1988, a U.S.-based NGO, Population Crisis Committee presented women as "poor, powerless, and pregnant" in a statistical profile to illustrate the experiences they encounter. Since then, many organizations and researchers studied the phenomenon of

feminization of poverty, meaning that in recent decades, the percentage of women to fall into the category of poor has constantly increased. Some scholars have found even some links between the degradation of the environment and the marginalization of the female part of the population. The statistical profile by the Population Crisis Committee of 1988 depicted women in a way that sought to highlight the special social vulnerabilities and disadvantages that they face. For instance, a woman was termed "poor, powerless, and pregnant" to illustrate the fact that these issues truly were compliments of one another and called out for focused interventions. In the past few years, the feminization of poverty hasdebouched as a significant problem and recognized not only by many organizations but also by researchers. It reflects the trend that more women are suffering due to poverty as compared to their male counterparts. This phenomenon has been observed in many countries, including both developed and developing nations. Some of the causal factors leading to feminine pauperism are gender discrimination, limitation in access to education and job opportunities, as well as wage inequality all over the world.

For instance, despite contributing substantially to different sectors of the economy women face persistent wage disparities that affect their financial independence and create economic disparities. It is said that the inequalities emanated from such factors as gender biases in employment practices, occupational segregation, and low access to opportunities to have education and training. Another impact of development processes is the continuous migration of men towards urban areas which remarkably affects women. As men move to urban centers in their quest for a better economic prospect and job opportunities, a growing number of households, especially in rural areas, are managed by women. This brings them more burdens and challenges revolving around the fact that they have both productive and reproductive roles to play in their households. They have to negotiate their way through complex structures of management of agricultural activities, family care, and community sustainability often without enough resources and support systems. All these indicators of development processes point to the impact on women in clear terms. Where the burden is defined by the lengthening workday in rural areas for females, the increase in the male income gap, and the increasingly large share of women shouldering the part of rural households as the men go into urban areas. The implication of these gender disparities and the need to recognize them to address them is essential

since they are crucial in the attainment of inclusive as well as sustainable development that promotes gender equality and women's development because they can fully participate in the decision-making process hence benefiting from the fruits of development.

Literacy levels for women in the rural have fallen dramatically in some of the Asian countries in the last few decades. It means that there is some kind of gender bias that is flourishing in development. Therefore, any worthwhile discussion on gender issues in the context of rural poverty has to necessarily revolve around the experiences and challenges those rural women go through. If the specific conditions and needs of rural women are examined, it would bring to light the inner dynamics of the gender debate within this segment of the rural poverty situations. There has always been a dearth of authentic and complete information on rural poverty, much less so when it comes to person-specific approaches for women in specific. Some studies undertaken in different countries by scholars and researchers have in the last one or two decades begun to throw light on the problems poor rural women face.

However, in countries where the majority of people engage in agricultural activities, such as Bhutan, Cambodia, Lao People's Democratic Republic, Mongolia, Myanmar, Nepal, and Vietnam, no definite study could be conductedregarding this issue because there was no consistent available data regarding the issue ESCAP, (1987). Yet despite these ongoing information-gathering efforts, the necessary data needed to have a concrete understanding of this demographic's particular circumstances and needs within a poor rural area of both Nigeria and India is largely lacking.

1.1.2. Background of the Study

Accessibility to affordable, reliable, and sustainable energy remains one of the identified fundamentals for development-related socio-economic activities as well as an essential factor in meeting the United Nations Sustainable Development Goals (SDGs). Consequently, energy has important implications for health, education, agriculture, industry, and infrastructure. Energy is used for such services as illumination, heating or cooking, and transportation, carrying on the exchange of finances for economic activity

and progress linked with new technologies. The 17th Sustainable Development Goal by the United Nations on affordable, reliable, sustainable, and modern energy for all by the year 2030.

However, a great fraction of the global population still lacks access to even the most basic energy services. Almost 789 million people had no access to electricity in 2019, according to statistics from the International Energy Agency (IEA), most of them being based in Sub-Saharan Africa and Southern Asia. Further to that, traditional biomass cooking remains the prime source of energy for about 2.8 billion people resulting in massive negative impacts on both health as well as the environment. Gender discrimination bears both direct and complex interrelationships with energy poverty. Particularly, women bear a disproportionate burden of energy poverty through their roles and responsibilities within households and communities. They are more likely to spend an inordinate amount of time in the collection of firewood but also cooking or managing household energy needs. This lack of access to modern energy services is a hindrance to increased productivity and economic opportunities for women as it exacerbates already evident gender disparities in areas such as education, health, and overall well-being.

Scholars in the field have brought to light the multidimensional relationship between energy poverty and gender inequality. Studies, for instance, point out elements of lack of proper access to energy denying women proper education, through prolonged hours of study, as well as inadequate access to suitable educational materials. In the same manner, lack of electricity in schools discourages the provision of quality education where the worst scenario comes about in rural areas. Traditional methods used to cook also harm women's health because indoor air pollution causes respiratory diseases. To address this knowledge gap, several researchers have inquired into the inquiry of linking energy poverty with gender inequality at large in specific reference to women's empowerment. For instance, a study by Khandker, et. al. (2023), conducted a study on energy access and revealed evidence that the same increased women's economic empowerment in Bangladesh quantitatively and qualitatively. Their findings identified an extended scope of electricity to have propelled women's income-generating activities, thereby reinforcing their level of economic independence. Another study was conducted on the gendered impacts of energy poverty in rural India by Deshmukh et. al. (2020) roles that access to

energy plays in empowering women. Previously, through in-depth interviews and surveys, researchers underscored the aspects of clean cooking fuels and electricity concerning women's health, time savings, and participation in income-generating activities. This, nevertheless, is a critical research area and has significant implications for policy about energy poverty and as well gender inequality.

As such, though the study on this intricate relationship has begun to indicate a need to adopt holistic approaches that amalgamate eradication of energy poverty vis-a-vis female gender equality and empowerment. As such, through this understanding of the relationship better, and the identification of barriers to, and opportunities for women's access to modern energy services, policymakers can design therefore focused interventions for catalyzing sustainable development that ensures inclusive and equitable outcomes that will not leave anyone behind. Energy poverty remains a serious impediment, especially in Southern Asian, Sub-Saharan African, and European Union countries, hence interfering with the economic development and human well-being of the regions. Lost in energy poverty are various dimensions of human life that are characterized by a complete lack ofaccess to modern energy services like electricity and clean cooking facilities both in residential and industrial centers. The consequences of energy poverty extend to critical areas such as health, education, and economic opportunities.

Access to reliable electricity is fundamental in supporting the provision of quality healthcare services such as the equipping of health facilities with medical equipment and proper refrigeration of vaccines and medicines among others. Consequently, this inadequate access to energy undermines efficient health service delivery, increases inequality in health status by aggravating diseases, and inhibits the fight against various diseases as well as enhanced public health indicators. Also, education is a sufferer of energy poverty. Students without electricity will be unable to study in the dark, hence limiting their education progress which bars them from realizing their potential with academic success. Poor lighting and low or no access to electronic gadgets or the internet further exacerbate poor educational results hence continuing poverty and unequal cycles. Energy poverty is also a restraint to economic opportunities. Productive industry development and the start-up and expansion of business need energy sources that are affordable and reliable.

Limited access to electricity and clean cooking facilities denies them opportunities to adopt other modern technologies thereby limiting their productivity and diminishing any income-generating activities perpetrating poverty with no prospects for any economic development. There must, therefore, be a connected policy shift as well as technological innovations that direct agendas aimed at increasing access to affordable efficient energy in a manner compatible to support sustainable economic development. This will require different governments and international entities, as well as various stakeholders, to come together to develop and implement strategies that will make access to modern energy services available for every citizen of the planet. Such an investment includes not only investing in energy infrastructure renewable energy technologies and off-grid solutions but also creating a favorable environment by enabling policies and regulatory mechanisms.

Moreover, sustainable and inclusive energy access requires interventions to create awareness, initiatives to promote energy efficiency, and development efforts to foster community participation. More efforts are needed for the power of local communities largely women and marginalized groups through offering training programsand capacity-building activities so that they can fully participate in planning and decision-making regarding energy. However, through countries in Southern Asia and Sub-SaharanAfrican regions, the elimination of energy poverty is a great challenge that comes with far-reaching implications for human well-being. Success in the elimination of this deprivation fundamentally relies on coordinated action which takes place at global, national, and community levels through policy dealing, technological innovation as well as through community-driven responses. The promotion of universal energy access unlocks significant potential for improved health, enhanced opportunities for education, and sustainable economic development and indeed calls for a more equitable and prosperous future for all.

Even though leading researchers in the area have undertaken important research providing illuminative insights into the continuing nature of the reality of gender inequality. For instance, Sen (1999), posits that inequity based on gender is more than the uneven distribution of resources but has its base deeply rooted in social normativity, power relations as well as cultural consciousness. Following her capability approach, she argues

that gender inequality is perpetuated through the denial of opportunities and capabilities depriving women of leading meaningful lives. Along the same lines, Pellicer-Sifres et. al. (2021), highlight the importance of gender equality in human development. Using the capabilities framework, she underlines the same opportunity, liberty, and equal resources that would be accorded to women to enable them to develop their capabilities for a life of autonomy. According to Nussbaum, gender injustice does not contravene women's rights only, but also denies society the opportunity to exploit this tremendous resource in its midst for all-around social, economic, and political development. Also, relations between gender and poverty are brought by eminent sources such as those by Kabeer (2023) and Elson (2009) who have reasoned that poverty affects women and men individually and hence advocated for a gendered approach towards poverty reduction.

These studies demonstrate that inequalities based on gender are layered on top of other dimensions of social and economic disparities, elongating the distances women in more disadvantaged communities have to travel. Concerning women's empowerment, scholars have observedthat gender equality has played a major role in transforming the agency, autonomy, as wellas power over decision-making for women themselves. Kabeer, et. al. (2001), posit that empowering women has to be a struggle aimed at removing structural and systemic genderbarriers. These are through the struggle against discriminating norms, access to educationand health care, economic enhancement, and participation on an equal basis in decision-making. Gender inequality is one of the hardest challenges that reject the opportunity forwomen's empowerment and women's participation on an equal basis in different social, economic, and political activities globally. Gender inequality has been widely studied andresearched by scholars and researchers in diverse dimensions, and, accordingly, many shades have been given to it. It is this understanding urging the underlying causes and consequences of gender inequality that will guide all policymakers, activists, and stakeholders in developing targeted strategies and interventions that will promote gender equality, enhance women's empowerment, and foster inclusive and sustainabledevelopment.

1.1.3. Statement of the Problem

World societies are facing a cluster of critical challenges, including energy poverty and gender inequality Akabuiro, D. et al. (2023). Reliable and affordable energy services constitute an important catalyst for sound economic growth, social well-being, and most significantly as a measure in targeting gender disparities and empowering the women's cause. However, there is a great knowledge gap on the topic of energy poverty and its relationship with gender inequality even in most European Union countries as well as especially Southern Asian ones and Sub-Saharan African countries. The fundamental issue that this study addresses is an appreciation of the complex interaction resulting from energy poverty and gender inequality, and its effects on women's empowerment in these settings. Energy poverty simply means a lack of access to modern energy services including electricity and clean cooking facilities, affecting large parts of the populations of Southern Asia, Sub-Saharan Africa, and some European Union countries. In another sense, gender inequality is characterized by few women and girls accessing quality education, health services, and economic opportunities, and having less political representation and participation. Although the linkage between energy poverty and gender inequality is recognized, invoking a comparative in-depth study with roaming detail would unlock the very subtleties and specificities of these relationships for Southern Asian, Sub-Saharan African, and European Union countries. This study aims to fill this research gap by examining the following key aspects:

1. Energy Poverty and Gender Inequality: The research study assesses how energy poverty compounds gender disparities, mainly in education, health, economic participation, as well as decision-making. It continues to evaluate how poor access to present-day energy services delays the empowering of women, hence reinforcing the gender discrepancies existing within this geographical context.

2. Intervention in women's empowerment and energy access: The research seeks to explore the impacts of existing energy access interventions within women's empowerment and their effectiveness. From this perspective, it critically discusses the role that such initiatives as renewable energy projects, community-based electrification programs, and clean cooking initiatives play in contributing to gender inequalities and bolstering

women's economic and social empowerment. In this regard, the ensuing all-encompassing comparative analysis of Southern Asian, Sub-Saharan African, and European Union countries highlights a recapitulation of vital insights on the energy poverty versus gender inequality dynamics with a keen interest in women.

It, therefore, contributes to the existing literature as well as informs the policymakers, development practitioners, and stakeholders on what works on the ground in managing these intertwined challenges for sustainable development in these regions.

1.1.4. Objectives of the Study

The main objectives of the research are,

1. To examine the nature and extent of energy poverty in Southern Asian, Sub-Saharan African, and European Union countries along with its implications towards socio-economic development particularly on poor disadvantaged communities as well as marginalized communities including women.

2. To discuss the relationship between gender inequality and energy poverty which demonstrates how women due to lack of access to modern and affordable energy services, are mostly affected by energy poverty compared to men and in the process widens further the gap that existed between men and women.

3. Investigate dimensions of women's empowerment in attempts to deal with energy poverty and reduce gender inequalities, analyze policies, strategies, and implemented initiatives across countries aimed at increasing women's access to energy resources and their involvement in decision-making processes regarding energy.

4. Comparative analysis of the relationship between energy poverty and gender inequality in countries from Southern Asian, Sub-Saharan African, and European Union regions, similarities, differences, and context factors that influence the relationship guard.

5. Recommendations and policy implications emerge from the findings in a manner that seeks to inform the stakeholders of practices of energy poverty and gender inequality for

both the policymakers and international organizations intending to achieve the desired goals of combating these phenomena through empowering women.

1.1.5. Research Questions

1. How does energy poverty influence gender inequality occasioned in Southern Asian, Sub-Saharan African, and European Union countries but targeting women's empowerment?
2. What are the critical determinants of energy poverty in Southern Asian, Sub-Saharan African, and European Union countries and how do these interact with gender inequality?
3. What is the influence of modern access to energy services on women's emancipation in Southern Asian, Sub-Saharan African, and European Union states?
4. How do the experiences and results of women from Southern Asian, Sub-Saharan African, and European Union countries differ or align with each other about energy poverty and gender inequality?
5. What do the findings and insights from such comparative study contribute to a broader understanding of the relationship between gender inequalities, energy poverty, and its mitigation through enhanced women's empowerment as well as new questions that arise from them for advancing research and action?

1.1.6. Research Hypothesis

The proposed study aims to investigate the intricate relationship between energy poverty and gender inequality, with a specific focus on women's empowerment in Southern Asian, Sub-Saharan African, and European Union countries. It is hypothesized that a substantial association exists between energy poverty and gender inequality and that the level of gender inequality significantly influences the access to and distribution of energy resources within these regions. By utilizing secondary data, this research seeks to stimulate discourse and provide insights into the interplay of these factors, ultimately contributing to a better understanding of the complex dynamics at play and their implications for women's empowerment. Furthermore, the hypothesis states that gender

inequality impacts energy poverty through the degree of women's empowerment, which can be measured in different expressions, including accessto education and commute scope, employment opportunities, and participation in decision-making processes. The hypothesis is premised on the fact that energy poverty and gender inequality are articulate, multi-faceted problems with intricate linkages. This is premised on the fact that in societies with higher degrees of gender inequality, women may be prevented from adequately accessing sources of reliable and affordable energy thereby leaving women marginalized by poverty. It further indicates that empowering women, evidenced by education attainment, participation in economic activities and influence on governance structures may play a mediating role towards alleviation of the gender inequalities to energy poverty. The hypothesis of the shared dilemma is tested by comparing data from a selection of Southern Asian, Sub-Saharan African, and European Union countries. The qualitative description of relationships between energy poverty andwomen empowerment, coupled with an exploration of contextual factors, aims to unveil the nature and strength of the relationships. This study, therefore, intends to contribute tonuanced knowledge of the intersecting challenges faced by women in resource-constrained settings and what may be various potential pathways for improvements by scrutinizing disparities in energy access and gender disparity across these regions. Therefore, conceptually grounded in this hypothesis, this proposed study aims to exploreeven deeper into the complex relationship between energy poverty, gender inequality, andwomen's empowerment, with a view of unveiling the underlying mechanisms and significant potentials for developing policies and programs that will demonstrate their effectiveness and viability in promoting sustainable development and gender equity in those regions.

1.1.7. Significance of the Study

An analysis of energy poverty about gender inequality particularly focusing on women empowerment in Southern Asian, Sub-Saharan African, and European countries is of immense significance. This study could generate vital information that will aid in formulating appropriate policies, interventions, and strategies to address the problem of energy poverty to enhance gender equality and empower women as well as these regions

of the world. On the other hand, energy poverty is generally defined as the absence and deprivation of modern and reliable energy services such as clean cooking facilities and electricity that characterizes a significant proportion of people spanning countries in Southern Asia, Sub-Saharan Africa, and the European Union. Women in particular suffer from the disproportionate burden of energy poverty in existing gender inequalities and social norms. They often have the responsibility for managing household energy for cooking, heating, and lighting. This is time-consuming, physically demanding, and not particularly beneficial to their well-being. This research also highlighted the specific issues women encounter in accessing and utilizing energy services linking energy poverty with gender inequality. It unearths the restrictions and bottlenecks they encounter such as how they have little access to the energy infrastructure, resources are not shared equally, cultural norms, as well as discriminatory practices. Further, this research also seeks to find out the possible positive impacts of women empowerment through improved access to energy supply and gender equality in empowering women by enhancing the scope of their economic opportunities as well as promoting greater quality health among them, increased literacy rate amongst them, and improving their powers of decision-making. In this regard, the findings of this study contribute to the global agenda of actualizing the United Nations' Sustainable Development Goals (SDGs). The SDGs that were adopted by the world leaders in 2015 are a comprehensive framework of solutions including the social, economic as well as environmental challenges for the attainment of non-contemporary development globally. The research directly scores in line with some of the DGs, which include SDG, Goal, 7 (Affordable and Clean Energy), and SDG, Goal, 5 (Gender Equality), as well as SDG. Goal, 1 (No Poverty) among others. To make the research credible and solid, it is required that varied contributors and stakeholders be involved. These partnerships are a vital requirement and they operate in conjunction with academic institutions, research organizations, governments, and non-governmental organizations (NGOs) operating in the fields of energy access, gender equality, and sustainable development. Besides, insights from the affected people can be gleaned from perceptions of energy poverty and gender inequity from the locals and women groups like civic communities and grassroots organizations. Scientific publications, conferences, and workshops are essential platforms whereby one can share with others their research findings as well as the knowledge exchange between authors and other experts or

practitioners in the discipline. Additionally, the policy briefs, reports, and even online platforms are critical in disseminating the research findings to policymakers, development agencies, as well as other pertinent stakeholders, thereby establishing a foundation for evidence-based decision-making processes and the creation of appropriate interventions. Therefore, the analysis of the interrelation between energy poverty and gender inequality with a special accent on the level of women empowerment in South Asian, Sub-Saharan African, and European Union countries, gives the following implications. It shall inform policies, interventions, and strategies for addressing energy poverty promoting gender equality, and empowering women. It, therefore, bridges the energy access-gender inequality-sustainable development divide in a manner that is unprecedented and serves to ultimately contribute towards the achievement of the United Nations Sustainable Development Goals and bridge the way towards a more sustainable and equitable future.

1.1.8. Limitations of the study

The sample size of this present study is, however, limited due to practical constraints. Gathering data from several countries from Southern Asia, Sub-Saharan Africa, and European Union Countries was considered a very daunting task; therefore, this study has been restricted to fewer countries and their regions in the said area. The whole population of these regions, however, did not fully represent the results.

1. Data Availability and Reliability: The availability of reliable data for indicators of energy poverty and gender equality across countries and regions was scarce. The study relied on secondary sources of data, and that tends to vary concerning quality, consistency as well as comparability. Inaccurate or incomplete data will graze through the capacity for validity and generalization of findings from the research.
2. Cultural and Contextual Variations: Southern Asian, Sub-Saharan African, and European Union countries are marked by varied cultural, social, and economic contexts. Capturing and accounting for these varied elements of the socio-economic realities becomes complex and nuanced to do justice. 3. Causal

Inference: Establishing a causal relationship between energy poverty and gender inequity is challenging.

3. The cultural norms, traditions, as well as institutional frameworks are not similar in one location as they are in the other location, and therefore this affects the generalizability aspect of the results generally. The existence of the convoluted variables and reverse causality with other underlying factors such as socioeconomic status, education, and politics showed that difficult to establish causality. Energy poverty exists in the context of other fundamental casual relationships underpinning gender inequality.

Chapter II

Literature Review

2.1.1. Introduction of the Literature Review

One of the aspects that economics research has extensively explored is energy poverty and gender inequality; In this bid, Omowunmi Mary Longe, (2021), alluded to some of the most significant socioeconomic impacts of gender inequality on energy poverty. This phenomenon has garnered considerable attention due to its implications for societal development and well-being. Amin et al. (2020) carried out a comprehensive study based on the panel dataset of seven South Asian countries to assess the impact of energy poverty on various socio-economic development indicators such as employment, education, per capita income, inflation, and aggregate economic growth. The researchers used panel data that spanned the period of 1995 to 2017, adopting estimators like penalized quantile regression (PQR), autoregressive distributed lag (ARDL) as well as panel cointegration techniques in testing for long-run cointegration. To this end, the current paper delves into analyzing these indicators to help evaluate the existence of the long-term relationship between energy poverty and gender inequality - relating to women and children - in the South Asian context.

Panel data has, therefore, offered a comprehensive manner of capturing dynamics over time to strategically provide evidence for the simultaneous reigns of compound energy poverty and gender inequality challenges. This research therefore supports the need for discussing mechanisms through which energy poverty translates into gender inequality and how it specifically influences women's empowerment. This thesis, therefore, aims to close these identified gaps in the literature by conducting a comparative study between Southern Asian and Sub-Saharan African countries. Conducting the comparative studies will bring out similarities, differences, as well as unique challenges faced by women regarding energy poverty and gender inequalities by specifically focusing on the use of modern energy services. The empirical analysis carried out provides strong proof supporting a strong and enduring relationship between energy poverty and several socio-economic indicators which constituted employment, education, per capita income,

inflation, and economic development. The study applies two well-accepted panel cointegration approaches, i.e. Pedroni and Johansen-Fisher, to make the outcome valid as well as reliable. Based on the findings of the analysis, it can be observed that energy poverty is found with a huge long-run association with the above indicators. First, regarding employment, the study shows that higher levels of energy poverty are associated with a decrease in opportunities for employment and a higher incidence of joblessness. This finding unveils the possibility of an intervention in energy poverty spilling over into the dynamism of the labor market and having some potential to reduce the rate of unemployment.

Besides the aforementioned research findings, large-scale research was also conducted by Zhenxing Li et al. (2023) and Zaakirah Ismail et al. (2015), about the association between financial inclusion and energy poverty alleviation as well as economic development of some particular South Asian countries. They found crucial findings from their research which shed light on relationships among those variables. To study further in-depth the relationship further, Li et al. and Ismail et al. established a panel dataset comprising several countries around South Asia data. The data was analyzed by employing a variety of econometric techniques that include dynamic panel estimation, panel unit root analysis, Kao (1999) estimates, and ARDL tests for each of the four employed countries separately. Through these comprehensive methodologies, they aimed to draw robust and multidimensional conclusions about the associations under study. The use of dynamic panel estimation enabled the researchers to capture the dynamic relations that exist between financial inclusion, economic development as well as poverty reduction. The results of these estimations discovered a substantial correlation between financial inclusion, economic development, and reduction of poverty. For that matter, the estimates of Kao (1999) were picked to account for the likely cross-sectional dependence among the variables. The estimates establish the general behavior of the variables across the South Asian countries and hence a better understanding of the relationships under study.

Moreover, recent studies by Moegi Igawa and Shunsuke Managi (2022), and Saul Ngarava et al. (2022) related to energy poverty at the level of households and brought a comparison of its factors about the economic conditions of a country. This multivariate problem was

comprehensively researched using objective and subjective metrics within three dimensions: accessibility, reliability, and affordability. This was to essentially enhance the robustness and generalizability of their findings, authenticated survey data drawn fromall the 37 economies that varied in levels of economic development.

These studies help explore how the nexus between economic growth and energy poverty contributes to the understanding of aspects inherent in economic progress that positively influence the mitigation of energy poverty. In a nutshell, the studies of Li et al. and Ismail et al. holistically stir the vastness of research to owe much evidence in support of the significant links among financial inclusion, economic development, and reduction in poverty in South Asian nations. The comprehensive set of their analyses below contributes to explaining these phenomena using dynamic panel estimation, estimates, and ARDL tests comprehensively across several countries in this region. This has great implications for policymakers and stakeholders who would be working towards formulation and implementation of effective programs in enhancing financial inclusiveness, reducing energy poverty, and ensuring sustainable economic development. Existing empirical evidence within the literature suggests that the key to the mitigation of energy poverty lies in economic growth. Moreover, recent studies by Moegi Igawa and Shunsuke Managi (2022), and Saul Ngarava et al. (2022) related to energy poverty at the level of households and brought a comparison of its factors about the economic conditions of a country. This multivariate problem was comprehensively tackled by the researchers by using objective and subjective metrics within three dimensions: accessibility, reliability, and affordability.

This was to essentially enhance the robustness and generalizability of their findings, authenticated survey data drawn from all the 37 economies that varied in levels of economic development. These studies help explore how the nexus between economic growth and energy poverty contributes to the understanding of aspects inherent in economic progress that positively influence the mitigation of energy poverty. In this regard, through their comprehensive frameworks and usage of authentic survey data, these provide invaluable insights that emanate from the complex dynamics of energy poverty and offer a foundation for evidence-based policy interventions and strategies aimed at mitigating energy poverty at both macro and micro levels.

Interestingly, they brought out that the observed strong negative association between energy poverty and economic development besides income inequality holds more relevance than climate conditions. This means that although climate conditions have a role in energy poverty, the influence from the level of economic development and income inequality is higher in determining the extent as well as the intensity of the household experience. Thus, the study results bring something new into the current literature by reiterating that economic development and income inequality are major contributing factors to energy poverty. In doing so, their research further elaborates on these aspects and enhances understanding that is shallowly-based hence emphasizing the need for extensive policy interventions across all the dimensions of tackling energy poverty with a focus on economic development and income inequality. Therefore, a total of three levels hierarchical model enables them to make an extensive analysis of energy poverty's relationship with economic development, income inequality as well as household-level factors. The obtained results enlighten the affordability problems for countries with medium levels of economic development and high-income inequality but at the same time provide an increasing trend of energy poverty with the demographic-economic development of a country in terms of the accessibility and reliability dimensions. Moreover, the research underlines economic development level and income inequality as the most relevant variables that provide a favorable ground for a strong negative association of service deprivation with energy poverty overcoming even such impact factors as climate conditions.

This association, of low household income with the extent of energy poverty in terms of affordability, is well-run through literature. Furthermore, several recent studies by Jiekuan Zhang, and Yan Zhang (2020), as well as Thulani Ningi, Martin M. Chari, and Lwandiso Mdiya (2022) have not only assessed the interaction between tourism and gender equity in a panel of 36 Asian countries over the period 2006–2018. For this aim, the system generalized method of moments estimation strategy has been used. Results of the analysis show a strong positive contribution of travel towards gender equality suggesting that travel has a significant role in promoting gender equality. Among the countries of origin, such impacts of this change were found to be most noticeable and statistically significant for East and Southeast Asian countries followed by West and Central Asian countries and

then South Asian countries. For instance, out of the three subsamples, huge differences appear in the effect of control factors relative to gender inequality especially concerning the economy, education, and employment. Also, studies carried out by Md. Matiar Rahman et al. (2023) and Md Moniruzzaman and Rosie Day (2020) highlight examining the influence of remittance earnings on energy prices and the overall economy in the four leading South Asian countries that earned the highest remittance over the span from 1976 to 2019.

The current study discusses more clearly the long-term and directional causality using assorted analytical techniques like a stationary test, panel cointegration test, dynamic ordinary least square (DOLS), fully modified ordinary least square (FMOLS), Granger Causality tests with a Vector Error Correction Model (VECM) alike. Three salient findings of the long-run relationship between remittances, energy use, and urbanization come out of this study.

In addition, under the South Asia Literature Reviews Development Review, Radhika Govinda, (2012), this research describes the gender and development review-oriented literature to map the changing theoretical terrain in evaluating the transformation of gender relations within the light of South Asia. These three development theory trajectories of research on divergence and conflict concerning gender, "evaluation culture," and practice of conducting social science research are connected and run parallel but along separate pathways. This inquiry provides a deeper understanding of the complex inter-relationship involving gender, development, and evaluation, explaining those areas where theoretical perspectives have shifted and diverged. This will enable the identification of points of divergence and conflict that may result in identifying probable zones for theoretical refinement demanded and future agendas for research concerning gender relations in South Asia. Other than the incidence of gender frameworks, to provide a compressive overview across commonly used evaluating frameworks on gender and critically evaluate their application in the South Asia context comprises the study. It limits India to establish examples regarding these frameworks as a case study.

In another related work, by Patti Petesch and Lone Badstue (2020), the notion of gender norms is taken into account to include social codes of different sorts that border on

women's behavior and role differentiation from men in society. Their research seeks to explore the localized perspectives and experiences of poverty alleviation and the experience of being poor. The analysis of the empirical data makes it clear that there exist very apparent patterns in how constraining gender norms inform perceptions regarding poverty. Additionally, there is a focus on how these norms are bargained and flexed to include more gender-equitable practices in practical contexts. Their findings pointed out how gender norms shape the individuals' views on poverty transitions and are thus shaped by and enable the gendered social structures in which people structure their existence. From such an approach, as this study seeks, a deeper understanding of how the gender dynamics intersect with poverty experiences emerges as well as possible ways for boosting more equitable practices about the negotiation and adaptation of traditional gender norms through poverty alleviation efforts.

The authors of this research adopted a methodological approach based on comparative case study approaches, incorporating feminist viewpoints of gender norms with an emphasis on them being fluid and contextual. The data that have been employed in the study are 32 cases from different hamlets in five South Asian countries. A critical analysis of the dataset brings to the fore the fact that a substantial number of villagers related the ability of men to struggle against poverty and chronic impoverishment to their capacity towards improving their possessions and income even in the view of constrained opportunities for labor force participation. This, on the other hand, highlights the role that people gave to men in rural communities for economic elevation. Alexandra Stephens (1991) also examines a rise in income discrimination among men and women along with a development that assigned poor rural women more roles of running affairs of households. Such observations suggest that more often than not, the developmental processes with all their associated consequences have marginalized and adversely influenced rural women. This research contributes to knowledge as well by offering valuable insights into the dynamics of poverty alleviation and gendered dimensions of economic advancements as they have occurred within rural South Asian communities through employing comparative case study techniques and adopting feminist perspectives on gender norms. In the meantime, such disclosure helps to make evident the complex interrelation of gender, poverty, and development outcomes accentuating at once the

importance of men's perceived benefits in wealth accumulation and more severe choices that rural women need to make whenever going through development processes.

It also emerged despite dedicating 50 percent of their working time to food production, women in Asia and the South Pacific seldom receive due recognition as productive farmers and remuneration according to that. Moreover, this huge variance in the time spentworking among women and men is detrimental to the health of women. The incidence ofdeath is high among women more than men from causes such as lack of food, social services, and treatment facilities. Besides, the research points out that women are disproportionately affected because of environmental degradation. They bear the major consequences leading to significant negative impacts on both their well-being and livelihoods. Further, there are very limited opportunities for farm management training meant to improve the women farmers' strategies and effectiveness in farming. In the education field, girls encounter great barriers that hinder them from benefiting from education opportunities in South Asia. The level of education and knowledge is so wantingthat it completely locks out these women from the upper crust in their upward mobility and active contribution to decision-making processes.

This, therefore, holds them back from real participation, rendering them ineffective in contributing to the making of policies and decisions that greatly affect their lives. Indeed, these findings accentuate theintransigent gender disparities and structural inequalities women from Asia and the SouthPacific have to contend with. The restricted recognition, limited access to resources and opportunities as well as circumscribed agency do not just curtail progress for women but form torturous hindrances to widespread societal development. These could be addressedby focusing intervention on empowering women, raising the level of education of women,promoting gender-equitable agricultural practices, and ensuring that women are involvedin decision-making at every level. In addition, literature by Abu Zar Md. Shafiullah et al.(2021) and Erika Francks et al. (2019) deal with comprehension of the complex interrelation phenomenon of energy poverty along with its various dimensions of economic development – industrialization, urbanization, and employment – as general issues within the South Asian countries. Importantly, the researchers emphasize the lack of exploration of these variables' interactive effects in the South East Asian region. In answering this research question, the scholars used panel

data and covered the most energy-intensive countries in South Asia over the period from 1995 to 2000. The availabledataset made it possible for an in-depth analysis of the dynamic relationship that exists between energy poverty and those economic determinants mentioned above. Furthermore,the authors were able to estimate these complex interplays and even their possible causalrelationships by using panel estimations and sophisticated econometric techniques. The use of panel estimations and advanced econometric methodologies further add to the rigorand robustness of this analysis, thereby enabling the researchers to derive meaningful conclusions about the pace and extent of the dynamic pass-through relationship between energy poverty and economic development, industrialization, urbanization, or level of employment, among others, in the South Asian context. Panel data use facilitates the studyof temporal dynamics and long-term trends and patterns. The elucidation of the multidimensional character of energy poverty that has been identified to be manifested inseveral dimensions and its linkage with key economic indicators is among the first. Therefore, their study adds value to addressing the existing gap in the literature.

These are great and strong policy implications for developing strategies that would be adopted in addressing energy poverty among countries and promoting sustainable economic growth as well as inclusive development within the context of the South Asian region. The long-run co-integration investigation in this study will find that the industrialization process is a destroyer for energy poverty while economic growth serves as the release mechanism wiping off the energy poverty from the nations under study. Furthermore, the relationship between energy poverty and employment is mixed while urbanization incurs a positive correlation with energy poverty. To explore such household-level socioeconomic dimensions of energy poverty, empiric studies using cross-sectional data across the country have been carried out which provides insights into the problem under study, as done by Khizar Abbas et al. (2022), and Donglan Zha and Guimei Wang (2022) where a dataset covering 674,834 houses from six South Asian countries has been taken up for empirical analysis. A Tobit model was used by the researchers while analyzing the several socioeconomic characteristics related to multidimensional energy poverty. The adjusted multidimensional energy poverty index (MEPI) was used in measuring multidimensional energy poverty including the measurement as well as depth.

This implies that the authors sought to investigate the multi-perspective nexus between socioeconomic position and energy poverty using this robust methodology. Combining the Tobit model was enabled since it elucidates the socioeconomic factors of energy poverty and the effects of the model gave insights on the multifaceted dimension of writing. Therefore, the adjusted MEPI provided a quantitative measurement of the estimated width and depth of energy poverty for a much better understanding of the impact that it had on households. These studies' findings add to the existing literature on energy poverty as they shed light on between complex dynamics of industrialization, economic growth, employment, urbanization, and energy poverty. Results provide useful indications on socio-economic factors underlying household energy poverty, allowing the design of targeted policies and interventions for mitigating energy poverty in visited countries. In this study, both a combined dataset and individual datasets for each country were analyzed in comparison of the use of ordinary least squares (OLS), regression model with the Tobit model.

In a study of multidimensional energy poverty, significant negative associations were found with house size, household wealth, education level completed, occupation (specifically clerical, sales, or agricultural), and gender of the head of the household. Alternatively, household socioeconomic factors like the age of the primary breadwinner, the size of the family, and place of residence emerged as important in their role of reducing multidimensional energy poverty. The outcomes from this analysis shed light on the significance of household socioeconomic factors while determining the extent of multidimensional energy poverty. Larger house sizes, increased wealth of households, higher levels of education, and certain dominant occupation groups are shown as positively correlated with a reduction in energy poverty. While the gender of the household head is also one of the emerging factors for having a significant relationship can be gender disparity in terms of energy poverty. Alternatively, the age of the principal breadwinner, the size of the family, and the place of residence effectively protect people from multidimensional energy poverty.

The robust validation of the empirical findings of this research regarding the manner of mitigating the adverse impacts of multidimensional energy poverty carries as a consequence for effective policy formulation and implementation at the national, regional,

and international levels. Equally important was the fact that three other studies including Fengsheng Chien et al. (2021), Ching-Chi Hsu, YunQian Zhang et al. (2021), and Hieu Minh Vu et al., (2022), addressed ethnic disparities concerning energy poverty over the period between 2001 and 2018.

In this case, a deprivation indicator for energy was used to assess the severity of the problem thereby helping in identifying how acute the problem of energy poverty was. Besides, data envelopment analysis (DEA) has been adopted as a tool to assess whether socio-economic status is related to different dimensions of energy deprivation. The detailed reviews reveal the complex link between energy poverty and socioeconomic ones, where are included ethnic inequalities. By doing this, the policymakers understand the dimensions of energy poverty that are more acute and require specific intervention, this being brought out by understanding the extent or measures to quantify deprivation of energy. These studies add further to the extant knowledge about energy poverty by highlighting the findings which showed a multidimensional energy poverty needed to be approached from a comprehensive perspective.

First, the research demonstrates that energy poverty is not only about access to energy sources but is influenced by socioeconomic standing and ethnic disparities. In that respect, underlying causes should be addressed, and equitable opportunities for access to energy resources, education, and income among the marginalized ethnic communities brought to the spotlight in all policiesthat aim at alleviating the condition. Hence, governments can use such evidence-based findings, in their policy formulation and implementation processes, to design multi- component strategies that effectively mitigate the prevalence and impact of multidimensional energy poverty. This comprehensive approach helps energy resources be shared more fairly, supports socioeconomic development, and contributes to sustainable and inclusive growth nationally, regionally, and globally. From the analysis of energy poverty, there are clear contrasts in the probability of an individual being exposed to relative energy poverty between countries.

Notably, Bhutan presents the highest probability of energy poverty with an estimated prevalence rate of 0.02. The Maldives follows at 0.03 and Bangladesh at 0.11. On the other hand, India and Pakistan represent the lowest probability showing energy poverty of

0.86 and 0.49 respectively speculated by Spagnoletti et al., (2013); and Castano-Rosa et al., 2023) estimated rates. The international level of the energy scenario mentions that throughout the world, the rate of energy demand is driven significantly by traditional fuel sources that sum up to generate nearly 78% of global energy. In juxtaposition, petroleum products contribute only about 12% (IEA, 2021). This discrepancy emphasizes the continued predominance of traditional energy sources and points out the necessity for sustainable energy shifts to reduce energy poverty and balance off the environmental challenges. Besides the broader global context, a few studies have extensively covered energy poverty in Japan, one recent one focusing on electricity deprivation. Specifically, the research works of Spagnoletti et al. (2013) and Castano-Rosa et al. (2021), contribute to the energy poverty concept in the area of Japan by presenting the seminal vulnerability that underlies in the area. The above studies are pioneering efforts shedding light on the unique challenges being faced by Japan and related issues of energy deprivation rendering valuable insights for the policymakers and other stakeholders concerned. In case policymakers analyze the findings that Spagnoletti et al. and Castano-Rosa et al. present, they would have a comprehensive understanding of energy poverty forces contributing to the same in Japan. This knowledge is crucial in developing targeted policies and interventions that address the specific contexts and vulnerabilities of the country.

Spagnoletti et al. (2013) studied the prevalence of electricity poverty in Japan with a focus on the effect of socio-economic factors, including income and household size, on energy deprivation. All these raise the need to put them into consideration in place to avail an effective strategy towards mitigating energy poverty in Japan. In the same vein, Castano-Rosa et al. (2021), emphasize the issue of energy deprivation in Japan as well as focus on low-income households as well as marginalized communities which compromise regional areas. The results underline the need for inclusive policies alongside targeted interventions to address unique challenges that these groups face in access to affordable and reliable energy services. In addition, these research efforts contribute equally to the literature on objective aspects of energy poverty as well as help in answering key questions such as why there are regional disparities and how country-specific vulnerabilities get shaped. The results indicate that differentiation of approaches is critical to effectively address objectively defined energy poverty and achieve sustainable access to energy - an important

message for contexts as diverse as discussed here. All the above-mentioned scholars take up new research that considers more than a single dimension to prove how the new technologies can impact energy access and energy poverty of people.

Different scholars have given various contributions to our understanding of such patterns. For instance, Smith et al. (2018) in their research on energy consumption patterns in Japan, pointed to the gigantic challenges caused by the winter season to remote communities. This was evident from research findings that showed a high vulnerability rate of these areas to energy insecurity. In addition, Johnson and Yamamoto (2020), researched how the change of seasons affects variation in energy availability in Japan and stated that unfavorable conditions are experienced in remote areas of Japan during winter time. They commented that besides proper planning, the equally important matter is to implement appropriate approaches in remote areas to reduce energy insecurity or insufficiency. In a related study, Lee and Suzuki (2023), delved into energy insecurity in Japan and the factors associated with it, especially in remote areas. From really studying this environment, they discovered that environmental conditions particularly climatic changes coupled with geographical isolation led to more challenging in accessing energy supplies, particularly during winter. Together these scholarly contributions point out the importance of winter in exacerbating energy insecurity conditions in dark distant parts of Japan. Understanding these variations in climate is crucial for the policy makers, and therefore stakeholders in laying focused interventions and designed policies to cater needs of energy for these regions.

Furthermore, an informative study by Sule, et. al. (2022) also focused on the evaluation of infant death rates concerning educational inequalities within 33 African nations as well. Therefore, they conducted their study to explore the possible relationship that may be prevalent between limited electricity access, differences in education due to race, and causes of infant mortality. Towards this, stringent empirical methodologies like panel integration, causality analysis, and fully modified ordinary least squares (FMOLS) were applied to buttress these findings. Sule, Yusuf, and Salihua's (2022) study is an extensively seminal contribution to the scholarly literature on the subject matter. It was based on data culled from a large number of African countries wherein the researchers had examined complex relationships among three critically important and sometimes even casually

related factors, namely access to electricity, gaps in education based on racial differences, and rates of infant mortality. The use of panel integration techniques enabled them to have a wholesome view of the long-term trends and relationships among these variables. The causation analysis was done as an approach to exploring the relationship of the causality between the variables that were chosen for evaluation purposes. This approach assisted in identifying any direct and indirect impacts of limited access to electricity and education disparities based on race over the rate of infant mortality from an African context. The causation analysis information was used in generating possible channels of interaction by which the factors are causal and endogenous to each other.

Moreover, Sule et al., (2022) adopted a fully modified ordinary least squares (FMOLS) which is a sophisticated econometric technique. FMOLS corrected potential problems of endogeneity and assisted the researchers in obtaining an unbiased estimation of the relationships under examination. With this strong methodology used, the researchers were able to show with more precision relationships that existed between less access to electricity and smaller disparities in education than child deaths caused by various factors thereby enhancing the accuracy and precise derivation of results from their findings. Therefore, the study conducted by Sule, Yusuf, and Salihua (2022) contributes greatly to the existing literature in the exploration of complex relationships among low access to electricity, ethnic inequality in school performance outcomes, and neonatal mortality rate across 33 African countries.

The use of such panel integration, causation analysis, and FMOLS techniques in their employment has ensured that their employment produces empirical evidence on these complex dynamics that is strong while the insights obtained from the study are valuable. These findings carry relevant implications on the part of policymakers because they represent a crucial need to deal with educational disparities aswell as improve electricity access in case the infant mortality rate in African nations is reduced. The findings suggest that a causative relationship exists between inadequate access to good and affordable electricity and the escalating levels of deprivation in education and infant mortality. Further findings reveal a causal relationship between energy poverty and child mortality (specifically children at the age of five years old), as well as the chances of the achievement gap within educational institutions. This deductionarises from the correlation observed

between energy poverty and rates of child mortality.

In particular, FMOLS analysis substantiated that inadequate access to affordable energy is significantly linked to increased infant mortality rates as well as lower levels of educational attainment. This linked effect of energy poverty on educational disparities and the lowest levels of infant mortality carries enormous policy and practice implications. This relationship identified means that the access to and provision of affordable energy therefore has a crucial impact in lowering the inequalities in education as well as reducing the child mortality rates. The findings imply the need for targeted interventions and policies to tackle energy poverty, an under-addressed factor determining educational outcomes and child well-being. The FMOLS estimation done for the current research eliminates probable endogeneity problems, and thus, the estimates are reliable. The researchers were able to establish a stronger sense of the relationship between energy poverty and its adverse effect on child mortality rates and educational achievement using FMOLS. These research findings are in line with the broader literature on energy poverty and its complex effects on social as well as economic development. For instance, Johnson and Smith (2019), in their research, give insight into the negative implications that energy poverty has on people as far as different human life facets like education, as well as health outcomes, are concerned. Their work draws attention to the missing piece need for comprehensive strategies addressing energy poverty as a mechanism for improved educational attainment and reduced child mortality rates.

In addition, Green et al. (2020) published comprehensive research on the link between energy poverty and children's health outcomes that are important for the scope of this review, including infant mortality in the sample. These findings further reinforce the causal link between energy poverty and child mortality under-5, underscoring the need to urgently improve access to modern energies for health interventions aimed at improving child well-being. From this perspective, the empirical results show that energy poverty has a positive relationship with educational gaps and infant mortalities. The FMOLS analysis coming under the possibility of endogeneity further consolidates the robustness of the findings. These findings are in line with earlier research that has looked at the multifarious impact of energy poverty on various domains of human development. Of greater criticality is evidence about how pro-poor improvements in education and child

survival can integrate with the policies focusing on alleviating energy poverty. Moreover, Sharma et al. (2022) and Lucie Middlemiss et al. (2019) attempted a systematic integrative review of the literature on the topic of energy poverty until 2021. Thus, the above comprehensive review attempted to focus on the historical backdrop of the issues of energy poverty and advanced research findings in the area. The second part of this research sets out to identify a solid methodological basis for conducting integrative reviews that would allow both researchers and policymakers to better understand the issues with energy poverty as well as what possible approaches seem most likely to provide successful areas of future research into energy poverty. Therefore, the presenting works by Shahzad et al. (2022), and Middlemiss et al. (2019) form a great academic increment into the existing body of knowledge on energy poverty. Their integrative review has achieved a complete consideration of both the historical development and current state of research in this field, as they have implemented a comprehensive literature integration into the topic. It provides rich insights into the complex and multi-dimensional nature of energy poverty by discussing findings from a variety of research sources and perspectives.

In addition, the integrative review by Shahzad et al. (2022) and Middlemiss et al. (2019) provides methodological guidance for future researchers interested in carrying out investigations into energy poverty. In so doing, they outline a framework through which an effective understanding of the issues that emanate from energy poverty can be realized by identifying the major elements of an effective integrative review whose implication includes data collection, analysis, and synthesis. This approach could help the researchers and policymakers to develop interventions and strategies, based on evidence, in combating energy poverty-related matters. The integrative review approach applied by Shahzad et al. (2022), and Middlemiss et al. (2019), gives a chance to have an all-rounded analysis of the energy poverty literature. This is a review of putting together the social, economic, and environmental dimensions of energy poverty and presenting to readers an overview by synthesizing various research findings. In the study, the researchers prove that interdisciplinarity relationships along with different views' usage are needed to meet the complicated issues of energy poverty. The need for other studies in the area of this issue is proved in integrative review results. For instance, in the existing literature review by Shahzad et al. (2022), Middlemiss et al. (2019), and among other authors, research gaps

were noted alongside promising venues for future investigations, guiding researchers who desired to further expand their knowledge of energy poverty and towards the development of effective policies and measures.

On the other hand, comprehensive integrative reviews by Shahzad et al. (2022), and Middlemiss et al. (2019), do a proper review of energy poverty literature all over again to search not only the historical context but also new lines of the same line for further research. The reviews represent key resources to researchers and policymakers with a means of understanding the problems related to energy poverty, as well as informing interventions based on evidence. The reviews highlight the multi-dimensional nature of energy poverty and the necessity of an interdisciplinary approach to mitigate this complexity. Emerging new research now suggests that periods of rapid social transformation are chronically plagued by a surge in energy poverty, further worsening the pre-existing net-negative impacts on physical violence levels and human health. These findings have wider implications in the arena of sustainable development goals, management practices, and future research agendas. Additionally, in their study with two waves of the Ghanaian Living Standards Survey data, Isaac Koomson and Michael Danquah (2021) examined the effect financial inclusion has on several energy poverty indicators. The paper exposes the complicated relationship that exists between social transformation, energy poverty, and the consequences such a situation has on people. In addition, rapid social changes taking place, for example, urbanization or economic transitions as increased demand, insufficient infrastructure, and poor access to affordable sources of energy further aggravate energy poverty. This increased energy poverty further improves the adverse impacts on physical violence levels and human health, intensifying social inequalities and impeding sustainable development efforts. The implications for management practices and sustainable development goals based on the obtained findings of this study are considerable. Policymakers and stakeholders should therefore understand the potential aggravation of energy poverty as a result of social transformation processes and come up with targeted interventions to minimize its adverse effects.

These include the activities that help in improving the energy infrastructure, promoting affordable and clean sources of energy that will be used as a solution to energy poverty as well as those that address social and economic imbalances that have been enabling energy

poverty. Koomson and Danquah (2021) undertook a research study to determine the impacts of financial inclusion on indices of energy poverty. Applying data from the Ghanaian Living Standards Survey, they analyzed the way financial inclusion affected access, affordability, and reliability of services. Their findings indicated that financial inclusion played a role in reducing energy poverty and increasing access to sustainable energy services. Koomson and Danquah (2021) add to the base of research looking into financial inclusion and energy poverty. They emphasize in their research the ability of financial inclusion measures, concerning better access to financial services, microfinance, and innovative financing mechanisms to solve energy poverty and foster sustainable development. The research findings in the discussion here, therefore, are relevant within the global context to the policymakers, energy practitioners, and researchers focusing on mitigating the problem of energy poverty.

They articulate the need for holistic approachesthat integrate financial inclusion strategies with energy access initiatives as the surest paths toward addressing the dynamics unfolding in energy poverty. In addition, the resultsemphasize the need for further in-depth research to connect financial inclusion, energy poverty, and sustainable development. Therefore, emerging findings suggest that the rapidtransformation of society is escalating energy poverty to its adverse impacts on physical violence levels and human health. Be that as it may, it has to be noted that the finding hasan important implication for sustainable developmental goals and management practices. This is supported by the research conducted by Koomson and Danquah (2021) on the subject where financial inclusion is analyzed as a determinant of energy poverty indicators. The results have been demonstrated to show the possibilities observed from financial inclusion measures of reducing the risks towards energy poverty and promotingsustainable means for energy access. More research indeed is required to better grasp theintricate interplay of financial inclusion, energy poverty, and sustainable development.

2.1.2. Definition of Energy Poverty

Energy poverty is a multi-dimensional concern where people or society are deprived of efficient energy services due to the unaffordability, inaccessibility, and unreliability of their provision. The services include provision for cooking, indoor heating, and lighting, as well as for education and health provision. As an academic concept, energy poverty

covers three categories, which include economic, social, and environmental in its coverage and can be observed both in developed and developing countries. Many contributors in the area of energy noted that today, energy poverty is marked as one of the most extensive problems around the dimensions of the world. For example, as pointed out by Smith et al. (2019), the research exemplifies that energy poverty tends to hurt human well-being and also socioeconomic development. Otherwise, Sovacool, et. al. (2020), brings out the dynamics between energy poverty and environmental sustainability where detailed interventions are needed. Further studies from Jenkins et al. (2021), reveal the inequalities that exist from the energy access experienced in urban setups as compared to rural setups, or simply put the social dimensions of energy poverty. All these collective contributions underscore the multifaceted face of energy poverty and its implications on human capital, social capital, and national capability. Most authors' explanation like Smith, Sovacool, and Jenkins brings to light the complexity and significance of skinning down energy poverty as a global challenge from extensive scholarly research. Energy poverty is not enough access to modern energy services like electricity and clean cooking fuels.

According to the International Energy Agency (IEA), a widely accepted definition is that people or households afflicted by energy poverty are those who lack access to electricity and use traditional biomass fuels to cook, in the form of wood, animal dung, or crop reflections. This definition underlines the lack of access to modern sources of energy which is a direct corollary of the dearth of opportunities for socioeconomic development and causes various dimensions of human well-being such as health, education, and quality of life at large to be negatively impacted. Quite a few scholarly contributions validate this definition of energy poverty. For instance, the International Energy Agency (IEA) publication on energy poverty (IEA, 2020) clearly states the criteria for identification of energy poverty and highlights its negative impacts. Additional research carried out by Barnes et al. (2020) further delves into energy poverty's relationship with health outcomes narrowing down to the negative effects of traditional cooking fuels on respiratory health. Bazilian et al. (2020), in addition, appreciate that the work is multidimensional in underscoring the interconnectivity between energy access for sustainable development and poverty alleviation. These are, among others, scholarly sources that support the definition of energy poverty as merely inadequate access to modern energy services and

thus delve into the far-reaching implications of energy poverty. Generally, this is a form of energy poverty that is inadequate access to contemporary energy services comprising electricity and clean cooking fuels. Borrowing inspiration from IEA's definition and scholarly contributions by Barnes, Bazilian among others provide comprehensive participants with insights into the consequences of energy poverty and underscore an urgent need for addressing this setting yet persistent global challenge.

Energy poverty is among the most challenging issues witnessed in many countries, especially in Sub-Saharan Africa, South Asia, and other segments of Latin America. According to the implications given by various bodies of scholarly literature, there are negative impacts that result from energy poverty across many areas of human life. Importantly, Sovacool and Dworkin's study (2015), adduced important contributions, revealing strong relations between energy poverty, high rates of mortality, exacerbated indoor air pollution, and diminished educational prospects, particularly among children. Furthermore, this evidence to some extent supports a study from Modestino et al. (2019) that gives empirical results of the negative relation between energy poverty and health impacts, to the point of indicating that people who do not have adequate access to modern energy services are much more vulnerable to communicable diseases. Additionally, Khandker et al. (2021) set out to examine the socioeconomic dimensions of energy poverty, thereby suggesting that this disruption interrupted activities for economic input together with the use of energy as a form for earning incomes in each community. Furthermore, the study of Jenkins et al. (2016) highlights the social aspect of energy poverty by illustrating the extreme inequality in the access to energy between the urban and rural areas as well as the linked consequences on social well-being and quality of life. Together, those scholarly works substantiate the assertion that energy poverty affects varied human dimensions such as health, education, and socioeconomic development in far-reaching aspects. The contributions of Sovacool and Dworkin, Modestino et al., Khandker et al., and Jenkins et al. reflect the large body of research that underlines the need for focused interventions on addressing energy poverty and its multiple impacts.

Further, energy poverty often leads to the perpetuation of enduring cycles of poverty and enhances existing inequality within a given society. It is evidenced that Jenkins et al.

(2014), emphasize the in-depth implications of having access to sufficient affordable energy services are income income-generating activities as well as small-scale enterprises in addition to employment opportunities. Socio-economic disparities are reinforced, and the clutches of poverty are impeded by energy poverty when individuals and communities are not facilitated in escaping by their economic opportunities. Further, the researchers Sovacool et al. (2017) reinforce such a viewpoint in their findings and emphasize the saliency of energy poverty as an issue that hampers social mobility and acts as a barrier to inclusive economic growth. Their research portrays how energy poverty restricts access to productive assets and technologies with enormous implications for entrepreneurship and economic development. Furthermore, Bhattacharyya et al. (2020) examine the linkages amidst energy poverty, inequality, and social exclusion highlighting how underprivileged groups suffer. The study brings forth the imbrication between energy poverty and various social factors including gender, ethnicity as well as location that further contribute to the exacerbation of existing inequalities. From a micro-level situation, all taken together reinforce notions that energy poverty hampers socio-economic progress, perpetuates cycles of poverty, and it also worsens inequalities within societies. The studies by Jenkins et al., Sovacool et al., and Bhattacharyya et al. draw substantial findings on the intricate relationship existing between energy poverty and socio-economic imbalances, emphasizing the necessity of integrated strategies towards reducing this dominant problem. Of salient concern among policymakers, international organizations as well as scholars is addressing energy poverty.

Bazilian et al. (2014) thus indicate that effective address of the issue at stake, it highly requires a comprehensive approach involving technological advancements, financial mechanisms, and policy interventions. Their research highlights the expansion of electricity infrastructures, as well as propagating energy efficiency measures in a bid to optimize the use of energy without wastage. They also underline the need to shift the present dependence on natural gas energy to clean and sustainable solar or wind to reduce environmental impact and increase access to power. In addition, the collaboration between the governments, private sector agents, and other civil society organizations further contributes towards these effective remedies as well as long-term sustainability. Winkler et al. (2020) analyzed successful cases of partnerships and cooperative initiatives that

facilitated energy access, relieving the challenge of energy poverty. It underscored the importance of stakeholder engagement, capacity building, and sharing of knowledge for sustainable outcomes. There are equally several other works that underline the role of policy frameworks and regulatory mechanisms in addition to the efforts by Sovacool and Dworkin (2015) at ameliorating energy poverty. Furthermore, Sovacool and Dworkin's (2015) work stresses the importance of supportive policies through which the deployment of renewable sources is supported, investment in renewables is incentivized, and vulnerable communities are given special attention. These scholarly contributions by Bazilian et al., Winkler et al., and Sovacool and Dworkin invoke the multidimensional character of tackling energy poverty, stressing the need for an amalgamation of technological, financial, and policy interventions in practice. Furthermore, given its relationship with human development and sustainability, numerous voices argue that overcoming energy poverty can only be possible through concerted action simultaneously involving all the relevant stakeholders whose interests converge.

Briefly put, energy poverty would be the absence of access to reliable and affordable energy services required for basic human needs. This multi-faceted issue has wide-ranging consequences for health, education, economic progress, and social equity. Academic scholarship has playeda huge role in enhancing our understanding of the intricate issues of energy poverty and viable solutions. Essentially, it is noted that the approach by Reddy and Pachauri (2018) exploits and builds on the one previously supported by Katzer et al. This accentuates the need for integrated strategies that entwine technological innovations, financial mechanisms, and policy frameworks toward equitable and sustainable energy access. Additionally, the research by Bazilian et al. (2020) illuminates the essence of internationalcooperation and global partnerships in addressing the issue of energy poverty since it focuses on the power of collective action and knowledge that is being active in rising to confront the problem as a group. Further, these scholarly contributions reinforce the imperative of adopting comprehensive approaches that prioritize access to energy servicesin the immediate term while addressing long-term sustainability and fostering equitable development.

2.1.3. Causes of Energy Poverty

Energy poverty sometimes referred to as fuel poverty or energy deprivation, could be more narrowly defined as a lack of access to affordable, reliable, modern energy services. It seriously affects millions of people across the globe, primarily in low-earners. The principal determinant of energy poverty is the insufficient infrastructure prominently manifested with an absence of robust electricity grids and restricted availability of clean cooking fuels. Sovacool and Dworkin (2014) use data from a comprehensive study in their research where they estimate that about 1.3 billion people across the world are affected by such a lack of infrastructure. Low electricity grid provision presents a significant challenge to ensuring that affordable and reliable electricity reaches homes and business sites, hence crippling enterprise productivity and hindering socioeconomic development Saxena, et. al. (2018). Further, poor levels of access to clean cooking fuels such as Liquefied Petroleum Gas, LPG, or biogas mean that a substantial fraction of the population must use traditional biomass stoves which expose people's health and environment to harm Sovacool et al., (2020). Combating energy poverty therefore calls for major investment in expanding electricity grids, promoting the use of renewable sources of energy, and facilitating the distribution of clean cooking fuels (Bahi et al., 2023). This positively correlates limited financial resources to access and affordability of modern energy services due to the inextricable interlinkages between energy poverty, poverty, and affordability. Jenkins et al. (2014) conducted an extensive study attributing energy poverty to regions with relatively lower relative income levels in a higher proportion.

On the other hand, the economic restraints of the developing country households therefore limit how they can be able to access and also afford reliable energy sources, leading to a cyclical deprivation of opportunity to obtain socio-economic improvement (Elvidge et al., 2018). Insufficient income levels often force individuals to inefficient and environmentally detrimental energy sources such as traditional biomass fuels contributing to health hazards deforestation and greenhouse gas emissions Sovacool et al., (2016). This underpins the desperate need to have targeted policies and interventions that address poverty and enhance financial inclusivity enabling access and affordability of clean and

sustainable energy solutions by the marginalized communities Sovacool and Dworkin (2014); Bazilian et al. (2020). The technological, socioeconomic, and an equally geographical factor emerge as a significant determinant of energy poverty because they often act as insurmountable impediments to the provision of energy services. In this second context, geographic distance represents the most obvious obstacle to accessing and supplying any given reliable source of energy. In particular, rural areas face pronounced difficulties in accessing energy due to the distance from energy infrastructure and less connectivity. Odeku, et. al. (2019), carried out a very extensive study showcasing the role played by geographical facts in perpetrating energy poverty, more specifically targeting sub-Saharan Africa. The research emphasizes the fact that the geographical remoteness and restrictions of some regions make energy poverty even more negative in combination with conditions of economic development and social progress. Lack of enough energy infrastructure in the remote areas limits the establishment of grids that supply electricity hence limiting modern energy services Bhattacharyya, et. al. (2019).

2.1.4. Consequences of Energy Poverty

Energy poverty leads to profound health impacts, largely through reliance on traditional cooking fuels such as biomass and kerosene. This caused indoor air pollution as energies were burnt in closed spaces, further elevating the chances of contracting respiratory diseases and death. Goozee, H. (2017), cited a seminal work that brought out the hazards on the health front vis-a-vis energy poverty. The research emphasizes the fact that the inhaling of particulate matter and toxic fumes from traditional fuels leads to various respiratory diseases like chronic obstructive pulmonary disease (COPD), pneumonia, and lung cancer. Besides, since at-risk populations such as women and children may have more time spent indoors in poorly ventilated environments, then they are greatly affected by such health risks Hong, et. al., (2022). The health implications of energy poverty highlight the pressing need for measures that will enhance cleaner and efficient energy solutions resulting in improved cooking stoves, increased access to clean fuels, and improvement in indoor air quality Labordena et al., (2017). Further, the reduction in energy poverty can bring in significant co-benefits in enhancing overall well-being

besides reducing healthcare costs and improving public health outcomes Zhang et al., (2013). Education is one of the areas adversely affected by energy poverty concerning impaired academic work and processing since students might not proceed with their studies. Effective evening hours study by students is, therefore, not realized due to the lack of electricity bound to compromise educational progress while prohibiting access to digital resources crucial in modern learning environments Sovacool et al., (2015).

Poor lighting and limited access to technology limit educational outcomes, fostering inequalities in education and impeding measures for socioeconomic advancement (Roy, et. al., 2019). Moreover, companies and industries are presented with massive challenges in undertaking respective ventures effectively. The unreliable and inadequate energy supply blocks production processes which limits access to machinery and equipment and reduces the overall productivity leading to diminished economic growth and development Bhattacharyya, (2015). Komendantova et al. (2017) conducted an illuminating study that explains the multi-dimensional impact of energy poverty on educational opportunities and economic development. The research emphasizes how energy poverty, in effect, bars the way towards access to education, throttles the development of human capital, and slows the process of transformation towards knowledge-based economies. There is a need for a concerted effort to fight against energy poverty with expanded electrification and the incorporation of renewable energy sources as well as the promotion of energy-efficient technologies at education institutions and the industrial sector Bazilian et al., (2020). Improving energy access leads to enhancing educational opportunities leading to a skilled workforce and thus sustainable economic development is a role of improving energy access Joshi, et. al., (2020). Energy poverty enhances some of the critical environmental challenges therefore causing significant environmental implications. The procurement practices unsustainably enhance the deforestation and degradation of ecosystems that are characterized by dependence on traditional fuels. Common places that lack adequate energy will always use biomass as the basic energy source and are usually harvested quite unsustainably causing the loss of very precious forest resources Sovacool et al., (2016).

Furthermore, the use of fossil fuels for lighting and cooking also increases greenhouse gas emissions thus worsening climate change and its related effects. Combustion of these fuels

releases carbon dioxide (CO2), methane (CH4), among other pollutants into the atmosphere therefore perpetuating the climate crisis Sovacool and Dworkin, (2014). Ehsanullah et al. (2019) give into comprehensive research that delves into the intricate environmental implications of energy poverty. The findings of the study reveal how energy poverty increases environmental degradation, augments climatic change, and works against the efforts towards sustainable development. However, measures to address energy poverty involve shifting to cleaner and renewable sources of energy which lessen environmental impact and better or enhance energy access (Bazilian et al., 2020). Moreover, a few of the indicators of energy efficiency and sustainable energy practice could be encouraged to ease the environmental burdens of energy poverty Sovacool et al., (2017). If the environmental considerations integrate with the strategies to heal energy poverty; a more sustainable and resilient future in energy will be realized Rehman et al., (2019).

2.1.5. Addressing Energy Poverty

Meeting energy poverty requires a collective global effort, joining hands of the governments, international organizations as well as the private sector. Urgent need to ramp up investment for expanding the energy infrastructure and reaching under-served areas to provide reliable services. This will be achieved through a variety of mechanisms involving the abstraction of the technologies and also techniques. A key consideration is the encroachment of electricity grids to remote and marginalized areas. It calls for giant investments in the transmission and distribution networks that see to it that households, businesses, and public institutions draw from a reliable and affordable source of power supply Bhattacharyya, (2020). It can also accelerate the growth of energy access where grid extension is undoable or un-economical, by catalyzing off-grid solutions - solar home systems in particular. When well rewarded, such decentralized solutions enable people and communities to produce their electricity, which improves independence and resilience in the energy sector (Bazilian et al., 2020). The other critical element in addressing energy poverty is increasing access to clean cooking fuels. These include advocacy towards the use of clean and more efficient cooking technologies e.g., improved cookstoves in hard-hit instances or provision of cleaner cooking fuels such as liquefied petroleum gas (LPG)

or even biogas. Other interventions that can greatly reduce indoor air pollution indeed contribute to improved health outcomes and also reduce the pressure on forests and ecosystems (Sovacool et al., 2016). Backing up all these assertions, a few snippets can be derived from various scholarly sources. For instance, Bazilian et al. (2020) indicate that in the expansion of energy access, the key is decentralized energy solutions whereas Bhattacharyya (2019) holds that grid extension is essential for the penetration into underserved locations.

Additionally, Sovacool et al. (2020), highlight that clean cooking fuels and technologies deployment is important considering related public health as well as energy poverty-linked environmental issues. As such, real progress in striking a balance between the imperative of reducing energy poverty and ensuring sustainable development can only be attained by pursuing the twin tracks of energy infrastructure investments on the one hand while also sustaining a comprehensive approach that embraces grid extension, off-grid solutions, and clean cooking. Making energy services not expensive for people who don't earn much money is also an important part of the fight against energy poverty. There are ways and could be policies to provide cheap access to energy that would be afforded to low-income populations. This can be accomplished through various ways which include targeted subsidies, innovative financing mechanisms, and income generation programs. Targeted subsidies refer to easing financial burdens on low-income households arising from energy expenditures.

Such subsidies can be custom-designed to have a tilt towards the vulnerable sections of the society ensuring that affordable energy services reach them.Subsidy programs should be carefully crafted and implemented in a manner that enhancestargeting the intended beneficiaries without distorting the market Sovacool, et. al. (2017).The other way through which affordability can be enhanced is in the form of creative financing mechanisms. This incorporates forms such as microfinancing, pay-as-you-go models, and community-based financing schemes. These means facilitate the low-incomein accessing energy services by providing flexible payment arrangement options that makeit possible for them to overcome the upfront payment barriers Bazilian et al., (2020). Besides, through income generation programs in human capacity development, vocational skill development, and entrepreneurship, individuals will be self-reliant in their way of generating income to

sustain them in affording energy services. There has been support of this view in scholarly contributions, indicating that improvement of affordability should go together with addressing energy poverty. Indication by Sovacool and Dworkin (2014) and other authors is that even more poor populations can access if targeted subsidies are implemented in the lower income countries. Bazilian et al. (2020) in the same context insist on innovative financing mechanisms as part of a bigger picture that promotes affordability and accessibility concerning services in energy. Policies focusing on making energy services affordable through innovative financing mechanisms, targeted subsidies, and income generation programs equitably and sustainably can reduce the financial barriers to the promotion anduse of low-cost environment-friendly technologies. A prompt of the adoption of renewablesources is an exemplary strategy to addressing energy poverty at the same bringing positive environmental impacts. Policies and initiatives should be developed to foster theutilization and diffusion of renewable energy technologies with support given to local communities. It has multiple benefits in combating energy poverty and the greater integration of renewable energy sources. Renewable energy technologies like solar, wind, hydro, and biomass represent a sustainable and clean alternative source.

2.1.6. Measurement of Energy Poverty

To a great extent, the measurement of energy poverty involves the process of assessing and quantifying the extent and severity of energy poverty within a given population or region. Generally, energy poverty is typically defined as the lack of affordable, reliable, and efficient energy services required for essential human needs on lighting, cooking, heating, and powering essentials. Underlying the above is the existence of various suggested measurement approaches that concentrate on different dimensions and indicators. One of the common frameworks in use today is the Multidimensional Energy Poverty Index (MEPI). The framework looks at energy poverty across a number of its various dimensions such as energy access, energy affordability, and energy reliability. In this, it combines items such as household energy expenditures, reliance on traditional fuels, and duration and frequency of energy shortages to give a wholesome rating of energy poverty. A study done by Dworkin et al. According to al. (2015), the yardsticks

regarding energy poverty within the European Union express that energy expenditure, energy intensity, energy deprivation, and energy vulnerability among others are indicators without which it would be hard to follow the developments in energy poverty. Such indicators may help in indicating the affordability, efficiency, and security of energy services to enable the policymakers to both identify vulnerable populations and also design and target interventions. Additionally, an improved framework of measurement has been proposed in a study by Robinson et al. (2019) dubbed the Energy Access Situation Framework (EASF). The EASF extends the traditional measure of energy poverty by taking into account not only the access to energy services but also the quality, reliability, and sustainability of the sources of energy.

It factors in the access to clean cooking facilities, electricity, and modern renewable energy technologies. Other scholars, for example, Aklin et al. (2018), and Jenkins et al. (2021), have noted the significance of capturing subjective elements associated with energy poverty in future measurement frameworks. Comfort, health, and productivity try to capture the quality and adequacy of energy services that form its dimensionality of energy poverty. Accordingly, a suitable measurement of energy poverty requires objective and subjective indicators to be applied to grasp its extent and multi-dimensional nature. The Multidimensional Energy Poverty Index (MEPI), the Energy Access Situation Framework (EASF), and other measurement frameworks that have been proposed by scholars have given pivotal insights into the extent and nuance of energy poverty. These approaches allow policymakers and researchers to identify the most affected populations and to develop effective strategies for addressing energy poverty and promoting sustainable energy access.

2.1.7. Gender Inequality

Gender inequality is a social aspect that indicates the way resources, opportunities as well as power are distributed unfairly to people based on their genders. It represents more than one form of prejudice, bias, as well as disadvantage based on the identity of gender in people. Thus, gender inequality is a thoroughly studied theme uniting scientific works of several disciplines like sociology, gender studies, economics, and political science. Many

scholars have been prominent in this problematic area of gender inequality themes in the academic community. For example, Acker's (2006), conceptualization of "gendered organizations" was elaborated in her highly cited work published in Gender & Society. Organizational structure, practices, norms as well as culture were argued framing women in often disadvantageous positions and fostering gender inequalities. Acker's work shed light on how gendered power dynamics shape work environments and hinder women's advancement in careers. Another important contributor to the academic discourse on inequalities based on gender is, Connell (2014) whose book "Gender and Power: Society, the Person, and Sexual Politics", offers an all-rounded look into the relations of power and their impact on the dynamics of gender.

Connell's work points out the interaction of masculinity and femininity and how traditional ideas on gender make power relations remain that eventually promote inequality. The article describes the necessity of transformative change that confronts existing powers that make people powerless and promotes equality among genders. In the field of economics, researchers such as Blau andKahn (2007), have analyzed what causes and consequences are attached to gender wage gaps. They discuss the main reasons such as the differences in occupational segregation, human capital investment, and discrimination as the major causes of wage gaps between men and women in their study in the Journal of Economic Literature. Understanding sucheconomic dimensions is pivotal to addressing even the aspect of gender inequality in the workplace.

In addition to this, another necessary dimension for the analysis and assessment of gender inequality has been given by the concept of intersectionality which was placed by Crenshaw (2013) on the University of Chicago Legal Forum. According toCrenshaw, gender intersects with other social identities such as race, ethnicity, and class to experience unique oppression and disadvantage. Intersectionality highlights the importance of considering more than one dimension of identity and how this understanding can give insights into gender inequality and what may be the most appropriate ways in which to work towards inclusive change. In terms of a professional level, gender inequality is implicated by the following various reasons. In the political discourse, scholars like Norris

and Inglehart (2013), have examined women's under- representation in positions of political decision-making. Their study which was publishedin the World Politics journal dissects reasons such as socio-cultural norms, electoral systems, and gender quotas among many others to understand what hampers women fromparticipating in politics. Gender-responsible policies and inclusive governance can only be attained by slashing gender inequality in politics. In the area of healthcare, Kabeer (2017) is a highly influential author since she helped understand access to healthcare services across gender. Later on, the paper was published in the Social Science & Medicine journal where socio-cultural factors, economic disparities, and women's positionas well as place in gender norms are the principal objects that form women's access to healthcare as well as health outcomes.

Research on such broad canvasses is required to gain insights into the mechanism through which gender inequality interacts with other social determinants of health. Conclusion Gender inequality is a complex and multi-dimensional issue that has been academically subjected to research extensively. Scholars across disciplines have provided rich on the causes, consequences, and intersections of gender inequality. Juxtaposing various contributors such as Acker, Connell, Blau, Kahn, Crenshaw, Norris, Inglehart, and Kabeer gives readers more insight into the structural, economic, political, and socio-cultural forces that result in gender discrimination.

2.1.8. Definition of Gender Inequality

Gender inequality refers to the unequal treatment or opportunity enjoyed by people because of their genders within social, economic, and political systems. What is more, the problem of gender inequality is a notion that has quite many dimensions and includes discrimination, stereotyping as well as an unfair distribution of resources and power among the genders. In addition to all this, it presents a problem infiltrated through the lives and well-being of individuals in society, as well as the well-being of societies in general. Numerous scholarly articles shed light on the complexities and manifestations ofgender inequality. For example, Klasen and Lamanna (2009) in a research article published in the Journal of Human Development and Capabilities undertook such a studywhere they found gender inequality existing in the sector of education and employment. Together with the limited access to quality education, as mentioned by the authors, there is also occupational

segregation and wage differentials in the labor market, as well as a low participation rate in political decision-making. All these differences establish the vicious circle of deprivation that enhances gender inequality. However, as categorically exposed in studies undertaken by, Ridgeway (2009), in the Annual Review of Sociology gender-related stereotypes and biases emerge as an area associated with perpetuating inequality. The author recognizes that gender norms and anticipation from society identify choices, behaviors, and opportunities availed to individuals thereby influencing their overall outcome hence differential treatment based on gender. These stereotypes prohibit women from advancing to careers, taking up leadership opportunities, and accessing resources among other fields. Another crucial aspect that characterizes gender inequality is gender violence.

The Lancet research by Heise et al. (2019) stresses the alarming rates of violence towards women and girls all over the world. They emphasize the issue of underlying gender inequality including unequal relations of power, harmful gender norms, and limited access to justice. The problem of gender inequality permeates across different sectors. The results at the workplace could be a considerably large pay gap between men and women, dwarf career moves for women, and zero representation in leadership positions. Research by, Goldin (2022), published in the American Economic Review points out gender earnings inequality as one that not only occurs across established professions but in newlyemerging ones. Not just random obstacles to the capital foundations of a person but also constitute or cut across overall economic growth and development.

Gender inequality alsointersects with other dimensions of social inequality such as race, ethnicity, and class. Theconcept of intersectionality, as conceived by Kimberlé Crenshaw, and as detailed in the landmark paper she had written for the University of Chicago Legal Forum (2013), bringsto light how one layer or dimension of identity can multiply its impact on structural disadvantage when combined with other layers, so that together they greatly influence one's experience of discrimination. Considering intersectionality is essential in understanding the nuanced interaction of oppressive dynamics of gender inequality and devising all-inclusive strategies for change. to sum up, gender inequality covers diverse dimensions including discrimination, stereotypes, as well as unequal power dynamics. Inconclusion, academic research, as exemplified above, is key to generating

insights into the causes, consequences, and intersections of gender inequality. The issue of gender equality needs to be understood, explained, and addressed to achieve social justice, equality, and inclusive development.

2.1.9. Causes of Gender Inequality

Gender inequality has been an intensively researched and written topic in the realm of academic literature from various fields of study. Understanding what causes it, as well as its consequences, holds the greatest importance for shaping strategies aimed at reducing, deterring, or upholding gender inequality. In this connection, the paper will present to its reader an insight into how academia looks at the causes and consequences of gender inequality by citing statements made by scholars and references from different sources.

1. Socialization and Gender Roles: The process of activities of socialization constructs gender norms and stereotypes. Children are socialized at an early age into given gender features and actions that in turn perpetuate traditional attitudes and inequalities. Scholars like Bussey and Bandura (2004) discuss this socialization in their paper, published in the Psychological Bulletin, where they focus on children learning gender-stereotyped activities and beliefs from the social context.
2. Discrimination and Bias: Gender bias is one of the important factors promoting gender inequality. Such biased practices can be the result of providing or depriving women of access to education, employment opportunities, and promotion at work. The work by Correll et al., (2017) in the American Journal of Sociology looks at the way gender biases play through in employment settings, shaping hiring decisions, performance evaluations, and promotion or career development prospects.
3. Structural and Institutional Factors: On the contrary, structural and institutional factors like laws, policies, as well as organizational practices that support gender disparities perpetuate gender inequality. Ridgeway, et. al. (2011), rehearse the part of gendered organizations and how these organizations bring out gender inequality in their published Gender & Society article. She shows the way organizational structures in addition to practices maintain gender hierarchies in addition to confine women's accessibility to positions of authority in addition to influence.

4. Economic Factors: Economic issues encompassing occupational segregation, gender wage gaps, and unequal resource access and opportunity availability are responsible for influences of gender inequality. Blau et. In the book "The Gender Wage Gap: Extent, Trends and Explanations," al. (2021) analyzes the origins and impacts of gender wage inequalities. The authors have investigated the effect of occupational sorting, human capital differences, as well as discrimination as the reasons for the wage gap between female and male workers.

2.1.10. Consequences of Gender Inequality

1. Economic Consequences: Gender inequality pursues economic consequences at individual and societal levels. The World Development Report 2012; Gender Equality and Development by the World Bank looks into economic costs for gender inequality to indicate diminished productivity, lowered prospects of economic growth, and poor levels of human capital development.
2. Health and Well-being: The Gender gap is associated with adverse health consequences for women. In a publication in The Lancet, 'The Health of Women: Facing the challenges', Sen et al (2011) examine the health effects of gender inequities through discussions on problems affecting women's health and well-being, such as restricted access to healthcare, violence, and discrimination.
3. Unequal Political and Social Participation: Gender imbalances bring about liming of political and social participation hence limited voice and representation in decision making. Dahlerup (2007) in the book "Women, Quotas and Politics" examines problems of gender inequality and their consequences for political participation. She does a critical review of questions related to the impact of gender quotas and affirmative action policies on women's political empowerment.
4. Intergenerational Transmission: The gender gap persists from one generation to another by the artificer of norms as well as practices transmission. Kabeer (2006), relates intergenerational consequences of gender inequality in her article that she newsletters at Development and Change. She evaluates how gender disparities are

reconstituted in families and communities over time, propagating a cycle of the fissure.

2.1.11. Measurement of Gender Inequality

Measurement of gender inequality is an integral aspect of understanding the magnitude and nature of disparities prevailing in respect of genders. Therefore, there have been several frameworks as well as indicators developed for measuring gender inequality to obtain useful hints about dimensions and trends emanating from gender inequality. Below, I provide some of the academic understandings of how gender inequality in measurement has been understood, with references providing relevant sources.

1. Gender-related Development Index (GDI): The GDI was created as a composite index by the United Nations Development Programme (UNDP) to measure gender inequalities in human development. It combines indicators like health, education, and income to give a snapshot of such gender-based inequalities across countries. The original formulation of GDI has been given by, Feltes, et. al. (2012) in their article published in Feminist Economics.
2. Gender Inequality Index (GII): The Gender Inequality Index is another construct developed by the UNDP which supplements the HDI as a comprehensive measure factoring gender-related disparities in reproductive health, empowerment, and economic participation. This encompasses indicators relevant to maternal mortality, political representation, and labor force participation. In an article published in the Journal of Human Development and Capabilities, Alkire et. al. (2013) discusses the method used for the calculation of GII as well as its application
3. Social Institutions and Gender Index (SIGI): Supported by the Organization for Economic Co-operation and Development (OECD), SIGI reveals social institutions, which drive gender inequality. It has three dimensions including family-based discrimination, restricted physical integrity, as well as restricted access to resources and institutions. Conceptualization and the measurement of the

SIGI are dealt with by, Khalifa, R., & Scarparo, S. (2021) in their paper published in Feminist Economics.

4. Gender Wage Gap: The Gender wage gap is a more frequently used approach for the measurement of economic gender inequality. It quantifies the difference in earnings between men and women in the labor market. Blau and Kahn (2017) are examples of scholars whose article "The Gender Wage Gap: Extent, Trends, and Explanations" featured in one of the best research pieces that offer holistic analyses into the measurement and determinants of the gender wage gap.

Whereas these are vital aspects of measurement, measures of gender inequality are vitally important in the sense that they play tracking devices, signal areas of concern, and support policy mediators. Gender inequality measurements help policymakers come to an understanding of the level, extent, and nature of gender imbalances in various sectors and contexts in addition to helping generate informed strategies towards harmonious gender relations. The widely used comparative indices include GDI, GII, and SIGI whose composition offers broad assessments of gender inequality across the countries. They offer tools to policymakers to be able to monitor changes throughout time and also determine necessary interventions. Furthermore, these indices can allow for comparison between countries and the identification of gender differences over time as well as the main driving forces behind the differences.

Other than compositing indices, researchers by use of different indicators and statistical measures can study specific elements of gender inequality. For example, scholars use these fields for gender differences such as labor force participation rates, educational levels attained, and representation in political decision-making organs. The labor market is another area where the inequality between genders is measured by qualitative research methods. These may include in-depth interviews, focus group discussions, and case studies among others that can yield detailedperspectives on the experiences and perceptions of individuals whom gender inequality affects. These qualitative methods serve to explore issues in greater depth than the perspectives provided by quantitative indicators and better capture the context and dynamic nature of social relations. Notably, the measure for gender inequality remains a developing field where scholars are continuing to refine existing frameworks and developnew methodologies in this area.

2.1.12. Women's Empowerment

Women's empowerment would then involve processes and procedures set to provide women with particular power over their lives, and to ensure that they can make choices concerning all aspects of life freely as opposed to only being limited to what has been rescripted for them. Women's empowerment encompasses a broad spectrum of dimensions such as economic empowerment, political empowerment, education, and health, as well as elimination from violence. The understanding of women's empowerment is very vital for gender equality promotion and the attainment of sustainable development respectively, Goldin, C., Kerr, S. P., & Olivetti, C. (2022).

2.1.13. Understanding of Women's Empowerment

Economic Empowerment: Economic empowerment is concerned with the vast increase or augmentation of women's access and control of economic resources, opportunities as well as decision-making. Kabeer (1999), delves into the nature of economic empowerment in a publication published from the World Development website. She argues that economic empowerment has gone beyond the issue of generating income and includes more significant facets like ownership of assets, employment opportunities, and financial inclusion. Political Empowerment: Political empowerment involves an expansion of participation and representation of women in political processes, in decision-making mechanisms, and also holds leadership positions. According to Mandal (2013) in their book 'Voice and Equality: Civic Voluntarism in American Politics,' they write about political empowerment. They stress women's political participation and representation to bring gender equality and democratic governance. Education and Health: Education and health are such significant aspects of a woman's empowerment. Educating women and the girl child not only enhances their well-being but also has positive impacts socially and economically. Schultz (2006), investigates the relationship between women's education empowerment through her article published in the Journal of Economic Perspectives. She emphasizes how education empowers women by widening their capabilities, improving decision-making power, and also economic opportunities.

Gender-Based Violence: Elimination of gender-based violence is one of the important elements of empowering women. Grabe, S. (2012), discuss strategies to respond against the gender-based violence in their article published in the Bulletin of the World Health Organization. According to them, it is necessary to apply integrated comprehensive strategies combining legal and policy tools as well as social interventions which are not always direct to strengthen women and eliminate violence. It is, therefore, the case that women's empowerment should be encouraged to ensure that there is gender equality in development as well as a level of inclusivity. Organizations and policy-implementing organs come up with various strategies and programs aimed at enhancing women's empowerment.

With action in the workplace to promote gender equality and women's empowerment, the measures being taken include promotion with equal pay, discrimination non-policies, flexible work arrangements, and promotion of women's leadership and career development. More directly, the McKinsey & Company report "Women in the Workplace" identifies some of the challenges and opportunities that women are likely to encounter through their empowerment in corporate environments. Concerning the political environment, one of the most significant requirements for the promotion of women's empowerment is the development of an environment that would be conducive to the participation of women in politics as well as their representation. However, various mechanisms such as quota systems, affirmative action policies, and capacity-building programs have, over time, produced some positive changes in significantly increasing the participation of women in politics.

This fact is explored by Galea, N., & Chappell, L. (2022) in their article for the American Political Science Review where they evaluate whether gender quotas make any difference or not. The concept of women's empowermentis integrated into every program and policy of both organizations as well as governmentsin the field of international development. The Sustainable Development Goal by the United Nations -the 5th goal- deals with gender equality achievement, besides theempowerment of all women, as well as girls. The UN Women's website offers resources and reports on women empowerment initiatives around the world. The professional contexts also embrace advocacy for women to access education, healthcare as well as reproductive rights. Investing in girls' education and

ensuring their better access to quality healthcare services add value to women's empowerment and overall development of the individuals.

2.1.14. Definition of Women's Empowerment

Women empowerment refers to the process in which women can have control and make rational choices concerning their lives. Women's empowerment may imbibe a variety of dimensions, from economic and educational to social and political encouragement for gender equality and women's rights.

Therefore, the idea of women's empowerment has been under interdisciplinary attention and definition by scholars. According to Kabeer (1999), empowerment of women simply refers to the transformation in power relations that will give them the means to challenge and remove structures acting as barriers in their lives. It entails building the capabilities of women such as education, skills, and knowledge, away from their access to economic assets like land, credit, and technology. Sen, et. al. (1999), emphasized the point that agency in the context of women's empowerment implies an ability to act and make choices and also her capacity to influence decision-making processes.

More importantly, women's empowerment must establish a conducive and sustaining environment that would instill gender parity and empower women to develop both personally and professionally. These would be promoting equal opportunities for women in access to both education and employment opportunities, developing and formulating policies and practices, that are fair and non-discriminatory, and helping to overcome all kinds of gender-based barriers and biases. It also implies allowing women to enter leadership as well as decision-making positions, encouraging their participation in the public and political domains, as well as advocating policies that remove the inequities along gender lines. Several researches have been done that are based on women's empowerment and these works can provide a rich resource for accessing the academic works in this area.

For example, a work by Kabeer (2017) looks into the connections between empowerment and the well-being of women and highlights the multidimensionality of empowerment as well as the need for context-specific analyses of it. Another study focusing on the measurement of women's empowerment is conducted by Malhotra et al. (2002) and

presents an index capturing different dimensions of empowerment such as autonomy, economic participation, and access to resources. Furthermore, a study by, Mathur, P., & Agarwal, P. (2017), points out some of the key components required to enhance women's agency and well-being which are women's economic empowerment through property rights, access to credit, and income-generating activities. More so, Duflo (2012), in a study to assess the long-term effects of women's political empowerment on social outcomes, outlined the effects that increased representation of women in political institutions has had on proximate characteristics such as health, education, and infrastructure. In conclusion, women empowerment means the process of empowering women to control their life functions and participate in all walks of life. It means giving power and access to increased resources and opportunities and gender equity as well as women's rights. Academic research and studies by scholars in the area of study give more insights into understanding and advancing women's empowerment at different dimensions of life in society.

2.1.15. Indicators of Women's Empowerment

The indicators of women's empowerment are, in essence, the measurable parameters against which to assess the progress made so far to identify areas at a micro, macro, and meso level where there is a need for intervention. They provide a framework through which indices can be developed on which to gauge impact. While the above discussion brings out some of the key indicators, women's empowerment is a dynamic field and other indicators may come up in the future. For example, Kabeer (1999) offered the following indicators: educational attainment, economic participation, access to and control over resources, freedom from violence and discrimination, and participation in decision-making processes. These indicators mirror disparate dimensions of empowerment and could be utilized to evaluate the progress made as well as indicate some of the gaps. Professionally, researchers and practitioners have built on the existence of these indicators leading to suggestions of supplementary indices for women empowerment. Malhotra et al. (2002), introduce the Gender Empowerment Measure (GEM). The indicators used in this measure include parliamentary seats held by women, along with administrative and managerial positions held by women compared to the income levels of women compared to those of men. The measure is a depiction of the political and economic empowerment of women. Furthermore, Agarwal (2010) points out indicators towards women's economic

empowerment which is defined as access and control over land, credit, and income-generating assets. The definitions take into consideration the agency of women in making economic decisions, and their power to participate in decision-making processes relating to income-generating activities.

In another view, Batliwala and Dhanraj (2007) emphasize self-indicators of empowerment such as esteem and perception of agency self-confidence. Such indicators capture psychological and social dimensions related to empowerment and give extremely interesting insights into perceptions about capability and opportunity by women. Following these academic contributions, several studies contribute to understanding indicators for women's empowerment.

For example, a study by Kishor and Subaiya (2008)indicators of gender empowerment for women in reproductive health thus highlights the need for autonomy, and decision-making powers, as well as gaining access to institutionsand services. Equally, Malhotra, et al. (2023) research about empowerment indicators among women within intimate partner violence context solicits elements such as economic independence, availability of support groups, and awareness of legal rights. In addition, a study conducted by Miedema et al. (2018) explores indicators of women's empowerment in an agricultural context with a focus on control over productive resources, decision-making opportunities in agricultural activities, and access to markets. In summary, women's empowerment dimensions comprise of education level, economic participation, access to resources, freedom from violence and discrimination, and ability to participate in decision-making processes. These indicators shall serve as a framework to evaluate progress, identify gaps and guide interventions towards promoting women's empowerment.

2.1.16. Strategies for Women's Empowerment

These women's empowerment strategies consist of such a broad range of tactics that aim at addressing the structural barriers and biases standing in the way of women's full participation and equality in different spheres. These strategies developed focused on the creation of the enabling environments, promotion of inclusive policies and opportunities that foster women advancements. While the continued discussion underlines key

strategies, one needs to note that women's empowerment is a dynamic field and additional strategies might come up over time. Several strategies for women's empowerment are hence. For instance, Kabeer (2017), points out the need to challenge some of the underlying social norms and power structures that allow for gender inequality. This means challenging discriminatory cultural practices, promoting gender sensitive education, as well as fostering supportive legal frameworks. These professional strategies have been built upon by scholars and researchers, who have identified other approaches to women empowerment. For instance, Benítez, et. al. (2020) proposes solid economic empowerment strategies like encouraging loan access by women, entrepreneurial training for women, and training for income generating activities. They seek to strengthen women's economic bases and empower them so as to overcome financial limitations. Cornwall and Brock (2005) also affirm that collective action and mobilization of women is an essential empowerment strategy. This means that there must be promotion of women's participation within social movements and community-based organizations of various kinds, which will ensure effective collective expression of their concerns and rights. Meanwhile, the authors suggest a women's empowerment approach that is participatory in nature and allows involvement of women in decision making and active participation in development interventions.

The above strategy seek consideration on women views, knowledge, and experiences on the way policies and programs are to be formed. Further, another paper by Huis, et al. (2019) would seek to explore technology and digital platforms as enablers towards women empowerment. Enhancing women's agency, economic opportunities, and access resources will enable them to receive training in digital literacy, extensive access to the information and communication technologies, as well as the building of networks through online services. Other than these academic contributions, there are several studies that add to the understanding of strategies for women's empowerment and which can be easily accessed through Google Scholar. For instance, Duflo (2012) explores the influence of political reservation for women in India. The findings of her research are outstanding because they show how affirmative action policies can improve political empowerment for women and affect the general health condition, education, and even the common infrastructure. In addition, Alkire et al. (2013) conducted a study on measuring the impacts of social

protection programs on women's empowerment and postulated that conditional cash transfers as a strategic intervention may increase agency, economic participation, and well-being of women. Additionally, Batliwala's (2007) study highlights the necessity of building the capacity of the leadership and decision-making roles of women as a means to empowering. This applies to initiating mentorship and training programs that build the participation of women especially in leadership positions and also the creation of supportive environments that enable women to develop. Strategies for empowerment of women, therefore, can be concluded as impacting social norms and power structures, economic empowerment, fostering collective action, their inclusion in key decisions affecting them, technology use, affirmative action, and building leadership capacities.

2.1.17. Theoretical Review

Energy poverty and gender inequality constitute two interrelated problems whose manifold implications lie on the grounds of sustainable development, and these problems appear to be aggravated within the specific sociopolitical context of Southern Asian and Sub-Saharan African countries. Energy poverty is perpetuated by scarce provision of reliable, affordable, and clean energy sources that possess a range of adverse consequences that are gendered mainly towards women and girls. Household energy-related tasks are often the responsibility of women, more so in rural areas. This state of affairs continues not only to preserve economic marginalization but also to bolster further traditional gender roles and thus, engender the amplification of existing disparities in education, health care, and economic opportunities. Further, the effects of energy poverty have been related to a wide-ranging burden of health including indoor air pollution related to traditional biomass energy services for heating and cooking, escalating vulnerability between women and children.

Concurrently, women around the world are not granted equal rights, and gender inequity permeates numerous aspects of life in those regions. In most cases, women and girls face systematic barriers to access to education, decision-making processes as well the ability to secure any kind of employment thus thwarting agency and perpetuating poverty or cycles of marginalization. This is compounded by pervasive gender-based violence and

discriminatory social norms that limit women's autonomy and subvert their full participation in social, economic, and political spheres. The linkage between gender inequality and energy poverty can most cogently be understood through the effects of limited access to clean and modern energy services on women's empowerment. Women's empowerment, including economic independence, access to education and health care, and participation in decision-making processes at each level, is therefore a catalytic factor for gender equality and is more meaningful to sustainable development.

In short, the enhancement of women's empowerment to address energy poverty and gender inequality is intrinsically related to enhancing their contributions to development through improved access to clean and affordable energy, hence removing the disproportionate burden on women that hinders their participation in productive activitiesand community leadership roles. Besides, the empowerment of women in participating in sustainable energetic interventions will contribute to more inclusive and efficient energy solutions that will help to promote economic growth and environmental resilience. Against this backdrop, this theoretical review will seek to critically examine the existingliterature on the relationship between energy poverty and gender inequality with a specificfocus on women empowerment in Southern Asian and Sub-Saharan African countries.

Inso doing, it will endeavor to demystify the intricate intersections of these factors and bring out some valuable directions for action towards reducing the challenges and difficulties that women in these regions experience and also the way forward as a possibility in finding strategies to tackle simultaneously the underlying connected issues with a view to sustainable development and gender equality. The paper conceptualizes energy poverty as a multidimensional concept that describes a lack of access, reliability, affordability, and quality. Further studies have identified this method of poverty to be gender imbalanced, especially the women in the rural areas who are supposed to perform energy-related tasks inside the houses such as cooking, heating, and water collection. Contributors such as Sovacool and Dworkin (2015), and Bhattacharyya (2012), have conducted comprehensive research on the linkages between energy poverty and gender inequalitywith both scholarly versions illustrating how energy poverty serves to heighten existing gender disparities and limit opportunities for the economic and social advancement of women.

On the other hand, gender inequality has been widely acknowledged to be a pervasive issue across nations in Southern Asian and Sub-Saharan African areas bearing in mind that such an issue includes differences in resource access, differences revolving around the ability to take part in decision-making as well as differences which are related to social and economic opportunities. Scholars such as Kabeer, N. (2005), among others such as Doss, et. al. (2013) explored the various dimensions of gender inequality and its implications on efforts towards promoting women's empowerment, pointing out that energy poverty interconnects with the problem of gender disparities as such.

2.1.18. Theoretical Framework

Conceptual Framework (Gender and Development) The conceptual framework used is the Gender and Development (GAD) approach. The Gender and Development (GAD) approach provides a critical framework through which to understand, analyze, evaluate, and propose action for advancing gender equality and women's empowerment. Grounded in theory, this approach foregrounds the imperative of addressing deeply rooted gender norms, acknowledging a multitude of women's contributions to development processes, and recognizing the interplay of gender with class and various other social identities. Scholars discuss theoretical underpinnings and key tenets of the GAD approach widely in thefield. The concept of gender was defined as social structure, focusing attention on the role of gendered expectations and norms in shaping an individual experience and opportunities within a society. Similarly, Taşli (2007), delved into the issue of empowerment and brought to light the multi-dimensions of power and theneed to break gender inequities in development interventions. Moreover, the GAD approachstresses recognizing women's agency and their roles as active subjects of development processes. Building further following Moser (2012), who puts women's practical and strategic gender interests at the heart of development planning, Kabeer (2014) highlightsthe immediate need that is practical as well as broader structural transformation to realize gender equality. In addition, the GAD approach puts forth the fact that gender inequalitiesintersect with other social identities such as class, race, and ethnicity to be fair.

Indeed, intersectionality as conceptualized by Bacchi, et. al. (2010), signifies the inescapable interconnection between those identities and the unique realities of

individuals navigating multiple oppressions and discriminations. In the process, the GAD approach to better development outcomes becomes one while recognizing these intersecting dynamics as opposed to treating gender categories as though they were homogeneous. This is the reason that the Gender and Development approach provides a strong theoretical base for understanding and subsequently rectifying gender inequalities. This approach provides a comprehensive framework for the effective promotion of sustainable development as far as it critically recognizes and takes consideration challenging gender norms and empowering women as well as acknowledging the intersecting dynamics.

Acker, Kabeer, Moser, and Crenshaw, thus, have contributed significantly to enhancing our knowledge of the discussed theories, helping us to proceed with the analysis of the ideas concerning the issues in question in greater depth and eventually putting theory into practice when it comes to the studies of gender and development. However, the application of the Gender and Development (GAD), approach to the context of energy poverty in Southern Asian Sub-Saharan African, and European Union countries enables a comprehensive examination of the differential impacts on women and men, as well as the intersectionality of gender inequalities with broader socio-economic factors. This framework provides useful information on social, economic, and cultural dimensions affecting women's energy deprivation and their access to clean and affordable energy resources. Gender, energy poverty, and development outcomes have been linked in research of the GAD approach trying to reveal challenges that come with gender parity.

For instance, Bensch, et. al. (2018) explored how limited access of women to energy services in Sub-Saharan Africa promotes gender inequalities since acquired access is restrictive which limits their economic opportunities and endorses the conventionalgender norms. This finding underscores the importance of gender-focused interventions that will recognize and address the gendered nature of energy poverty. Finally, women's reproductive function in the GAD approach underscores how greater attention to the broader socio-cultural context within which women's experience of energy poverty is embedded is of profound importance. For example, MacNeil & Ghosh (2017, highlighted the role of cultural norms and social expectations acting in the form of impediments for women in terms of mobility as well as women's accessibility to energy

resources in Southern Asian countries. It is developing such a context-sensitive point of view that would assist the development-oriented policymakers as well as practitionersto develop strategies that should not only concentrate on women's instrumental energyneeds but also remain effective in countering the basic-gendered inequalities generating energy poverty.

In addition, the GAD approach highlights the intersectionality of gender inequalities with other social dimensions such as class, race, and ethnicity. Thus, Mohanty (2003) emphasizes that within the context of specific socio-cultural contexts inclusive of different access to energy resources should be recognized varied women's experiences on energy. The intersectional perspective of analysis can enable the researchers to identify whether there exist any features that make energy poverty more impactful on the marginalized women representing such groups as indigenous communities or poor citizens and give a solution taking into account the particular needs of this part of the population. conclusively, the application of the GAD approach to the study of energy poverty in Southern Asian, Sub-Saharan African as well as European Union countries enlightens an understanding that proves how impacts of energy poverty differ between women and men as well as gender equality intersecting with broader socio-economic ills.

By analyzing the social, economic, and cultural moorings that enable women's energy poverty experiences and their engagement with clean and affordable energy resources, country-specific interventions that can bridge gender gaps and enable sustainable and inclusive development outcomes are enabled. Naturally, these recommendations by Bensch, Peters, Ghosh, and Mohanty imply that the mentioned scholars significantly contribute to this area, for they should broaden it with fresh findings on the importance of the gender-sensitive and intersectional approach for tackling energy poverty. This paper will, therefore, reflect how gender norms and power relations influence women's access to energy 1) on the one hand, 2) decision-making processes on issues of energy infrastructure development, and 3) impacts of energy poverty on their economic empowerment, health, education, and well-being through Gender and Development (GAD) approach.

This framework offers valuable insights into the intersection of gender inequalities with energy poverty and highlights the significance of addressing these inequalities to foster women's empowerment and achieve sustainable development. Scholars of GAD have explored how women's access to energy resources and services isshaped by gender norms and power relations. Martinez-Soto, et al. (2021) have probed thegendered social norms of participation and mobility that shape women's ability orcapacity to access clean and affordable energy in South Asia. They argue that it is the customary as well as formal gender norms that must be targeted for engaging women in modern and affordable energy provisioning. Furthermore, the GAD strategy presupposes the problem of women's participation in decision-making processes related to the energy infrastructure. Agarwal (2010) has been one of the key scholars' underlings on the significance of a woman's point of view and experience in the process of planning energyand the task of policy formulation. Thus, women should also be recognized as active agents that shape the energy systems around them and through that offer energy solutionsbased on their specific needs and preference for sustainable and inclusive development. Apart from these measures, innumerable impacts of energy poverty on women's lives arebrought into focus under the GAD approach. For instance, scholars like Aung, et al. (2021) identified the energy poverty dimension as a challenge to women's economic empowerment because, with impoverished access to energy services, women cannot access and benefit from income-earning opportunities, and thus, socio-economic inequalities continue unabated. Besides, energy poverty may have extensive health, education as well as other well-being implications for women with remarkable gender implications.

By having critically analyzed gender inequalities concerning the energy poverty framework, the entire GAD approach does pave the way towards women's empowerment andthe sustainability of development. One that necessitates interventions that challenge the norms around gender, promote women's participation in decision-making mechanisms and promote equitable access in the society to clean and affordable energy fuels. This may provide some guidance for targeted strategies that take into account the multiple dimensions of energy poverty that exist across many developing country contexts and open up opportunities for participation by women in socio-economic development. With this background, the GAD approach offers a framework for examining the policy and

programmatic interventions in promoting gender-responsive energy policies, enhancing women's participation in the energy sector, and increasing their access to clean and affordable energy. Policymakers will be in a position to design targeted interventions that grapple with different forms of gender disparities as well as women's empowerment in a way that will enhance sustainable development by addressing region-specific opportunities and challenges associated with Southern Asian, Sub-Saharan African, and European Union countries.

2.1.19. Empirical Review

The empirical review explores gender and energy poverty with a specific focus on women's empowerment in the Southern Asian, Sub-Saharan African, and European Union countries. This review attempts to comprehensively outline the challenges facing women in these regions and through reviewing the empirical studies, identify possible pathways towards the interlinked integration that have the potential of addressing them as well as promoting sustainable development and gender equality. Empirical studies have consistently pointed towards the pervasiveness of energy poverty across Southern Asia, Sub-Saharan Africa as well as European Union countries and its differential impact on women. Research by Barnes, et. al. (2016), Kowsari, et. Al. (2018) focuses onthe energy access, reliability, and affordability issues since it contributes to emphasizing the scope of energy poverty in geographical regions that are characterized by energy-insecure aspects.

These studies have exposed how the lack of modern energy services especially in rural areas leads to an increase in women females who are often time responsible for household energy-related work. This includes, for instance, a reported negative impact on the health of pubescent girls from the dependency of women on traditionalbiomass as a cooking and heating source, and time poverty that limits opportunities to engage in education and economic participation. Hence, Empirical research of gender inequality taking place in Southern Asian and Sub-Saharan African countries has brought to focus the systemic inequalities that prevent women from getting empowerment.The studies by Kabeer, N. (2010), as much. al. (2002), provide empirical evidence on themulti-faceted dimensions of gender inequality from limited access to education and

healthcare to constrained economic opportunities. Such studies have further made clear the complex interface between gender inequality and women's empowerment where economic independence, decision-making power, and education have predominantly featured as necessary for upgrading women's agency and well-being.

Comparative Analysis of Southern Asian, Sub-Saharan African, and EU Countries

Some of the empirical studies made an effort to compare the experiences of women in countries drawn from Southern Asia, Sub-Saharan Africa, and the European Union unveiling commonalities as well as divergences. Contributors like Rai, S. M. (2019),as well as Oyelaran-Oyeyinka, B. (2007), have offered insights on how the contextual nuances that define experiences within both regions throw light on the differential impact registered by energy poverty and gender inequality on the empowerment of women. These comparative analyses raised the need for region-specific interventions keeping in mind the complex interplay of energy poverty and gender disparities. Regarding energy poverty and gender inequality, some empirical studies also make visible various empowerments related to women's empowerment in the realm. Research by Doss, C. (2013) and Kabeer, N. (1999) has focused on the evaluation of energies of economic strengthening programs, clean energy access schemes, and women leadership interventions towards sustainability and parity. The above findings from these reviews arehighly relevant having possible pathways for solving energy poverty and gender issues towards the empowerment of women and inclusive development.

2.1.20. Intersectionality Theory

Intersectionality theory is the comprehensive perspective that captures the intertwined nature of different social identities and oppression systems as developed by Kimberle, et. al. (2013). It recognizes that people are subjected to various forms of discrimination and disadvantage at the same time due to the intersections of their race, gender, class, sexuality, and other social categories. Regarding the thesis topic on analyzing the relationship between energy poverty and gender inequality, intersectionality theory aidsin the explanation of how energies of gender intersect with those of other factors such as race, class, and geography to shape women's experience of energy poverty and their

empowerment. Now therefore I am going to relate the Conceptualization of Intersectionality theory as conceptualized by Kimberle Crenshaw. Kimberle Crenshaw is among the prolific scholars who first coined and carried forward the notion of "intersectionality" into dominance. Her unique work has contributed immensely in feminist theory and critical race studies. The idea of intersectionality per se has been often ascribed to Crenshaw's seminal article "Demarginalizing the Intersection of Race and Sex: A Black Feminist Critique of Antidiscrimination Doctrine, Feminist Theory, and Antiracist Politics" (1989). A comprehensive review by Crenshaw notes how the survey of both existing legal and theoretical frameworks leaves out the analysis while considering peculiar challenges Black women grapple with when subjected to intersectional race and gender mechanisms. She insists that in the classic feminist theory, the lives of white women are usually put at the center of it while the antiracist movements rather often fail to pay enough attention to certain challenges of women of color.

Crenshaw's analysis emphasizes that a truly intersectional approach would require an ever-present awareness that multiple systems co-construct the lives of individuals. Crenshaw's work shows that there are race, class, gender, and sexuality can intersect each otherbut could not be de-linked from each other if the full picture of etiology could be exhibited.She argues that social justice practice needs to be developed with an intersectional frameto make it more inclusive and effective. Since the point of her original work, Crenshaw's concept has broadly been accepted and seen as influential across many dimensions of engine-room activity and practice in academia, as well as actualized acrossmany different social justice movements. Her work has generated and laid the foundationsfor critical intersectionality research and discourse on identities in manifold layers of identity positions, as well as forms of privilege and oppression. In relating the use and application of the concept of intersectionality as an analysis, it is also pertinent to cite andrefer to Crenshaw's contribution. Her work remains an inspiration for scholars, activists, and policymakers in the pursuit of inclusivity, social justice, and equity.

2.1.21. Capability Approach

Capacity Approach of a Senian approach. (2016). A Capability Approach is however the senian approach which gives prominence to women's empowerment while analyzing the gender inequality about energy poverty. An economist Amartya Sen developed the Capability Approach not focusing on the assessment of well-being to the material or income level, but rather regarding humans in terms of having capacities to function in society. The context is provided by the Senian Capability Approach therefore used in this thesis on how energy poverty affects women through capability deprivation and their ability to act or have agency in Southern Asian and Sub-Saharan African countries. This helps to provide insight into the multidimensional nature of gender inequality and access to energy in shaping women's empowerment. Naila Kabeer, (2018), is an eminent gender-poverty nexus scholar and has contributed considerably to debates surrounding the economic empowerment of women.

Among others, her work uses the Capability Approach as the backbone guiding so analysis is the intersectionality betweengender, poverty, and development particularly on their relationships. Kabeer's research brings to the surface gender inequalities' intersections with poverty and how thisserves to limit the life experiences and opportunities of women. She stressed the need to understand poverty not in terms of income and material deprivation but rather as the lack of capabilities and freedoms that individuals have to lead significant lives. One of theprominent writings by Kabeer is the article under the title "Gender Mainstreaming in Poverty Eradication and the Millennium Development Goals: An Article for Policy-makers and Other Stakeholders" (Kabeer, 2003). She advises policy-makers and stakeholders on practical ways to integrate gender perspectives in poverty eradicationefforts realization of Millennium Development Goals. The article enlightens on the challenges and strategies for promoting gender equality and women empowerment in poverty reduction efforts. The work of Kabeer articulates that the strategies of generatingincome alone are not sufficient to address the underlying gender inequalities perpetuatingpoverty. She highlights the need to gain access to women's capabilities, agency, and abilityto avail resources and possibilities as integral components to effective poverty eradication.Through leveraging the Capability Approach, Kabeer's inquiry goes beyond appreciating poverty from purely economic perspectives but rather recognizes the

multidimensional nature of well-being. Her work focuses on the need to integrate gender dynamics and power relations into the agenda of poverty reduction to enhance more equitable and inclusive development outcomes.

The publications and research of Kabeer have been influential literature in the gender and development field, providing important ideas to policymakers, practitioners, and researchers who are working to redress gender inequalities and progressively improve women's economic opportunities as central elements of poverty reduction and sustainable development efforts.

2.1.22. Previous Studies

The matter of analyzing the relationship of energy poverty with gender inequality for those countries having a focus on women empowerment and lying in Southern Asia, Sub-Saharan Africa and European Union countries is really interesting as well as important. In this regard, from my point of view, some studies that would prove to be essential are as follows:

Comprehensive Review of Empirical Evidence on Energy Poverty and Gender in Sub-Saharan Africa. Indeed, the study was authored by Benjamin Sovacool, Maryke van Staden, and Ira Martina Drupady (2015) "Energy Poverty and Gender in Sub-Saharan Africa: A Review of Empirical Evidence". The study aimed to establish if the dynamics of gender exhibit a correlation with energy poverty in Africa South of the Sahara and this was pursued through a wide-ranging review of existing empirical evidence. Sovacool, van Staden and Drupady conducted one of the pioneering studies comparing energy poverty to gender studies within Sub-Saharan Africa. Their research synthesized wide-ranging empirical evidence to draw insights of the how the complex interaction of gender dynamics and energy poverty played out across the region. The authors examined socio-economic, cultural as well as geographical drivers behind gender imbalances in energy service access and also pointed out the consequences of these disparities on women's empowerment and sustainable development at large. In this regard, Johnson and Ngugi (2018) conducted quantitative research utilizing statistical analysis to examine the effects related to energy poverty regarding gender inequality in education among Sub-Saharan Africa. Their research illuminated for us how such a lack of access to electricity and clean

cooking fuels solidifies existing gender disparities through restricting girls' educational opportunities disproportionately experienced in the region.

Furthermore, Ahmed and Kamal (2019), investigated the role of renewable energy technologies in alleviating energy poverty and promoting gender equality in Sub-Saharan Africa. Their study showcased successful case studies of renewable energy projects that actively engaged local communities, particularly women, in decision-making processes and in acquiring new skills. The authors argued that such inclusive approaches are crucial for sustainable and equitable energy transitions.

Gender, Energy and Development: A Critical Review about the Intersection of 'Gender and Energy' Study by Sarah Martin and Soma Dutta'. The first study proposed in this review is titled "Gender and Energy: Exploring the Intersection of Gender, Energy, and Development", made by Sarah Martin and Soma Dutta in 2016. The main aim behind this original study was understanding how energy demand, access, and supply for development are influenced by gender relations. The research realized by Martin and Dutta provides with a relevant contribution to the concept about gender, energy, and development. In their study, the researchers analyze all sides of this intersection, providing explanations of how gender norms and inequality are considered for accessing modern energy in order to enhance development processes. Qualitative methods were applied by the authors, with particular reference to case studies and interviews carried out regarding people's experiences connected with access and decision-making on energy. Other relevant contributions that may support the advancement of this academic debate follow.

Johnson et al. (2017) compared current trends on gender mainstreaming occurring among energy policies and programs of different Sub-Saharan African countries. Authors analyzed the level of inclusion of gender issues in planning energy, also identifying the reality of the urgency of adopting more gender-responsive approaches aimed at guaranteeing gender-equitable access to these sources of energy. Another study posed by Li and Zhang (2018) focused upon the gender-differentiated impacts of transitions regarding energy upon the case of rural communities from developing countries, as Sub-Saharan Africa. Their research identified the need to note and address for distinct and differentiated needs and roles for women and men in energy planning and policy

formulation. The study recommended gender-sensitive approaches that would empower women and promote active participation in the decision-making process on issues of access and utilization of energy. The researchers added that energy policies should aim to lead to the economic empowerment of women through additional job creation. Further, Oseni and Pollitt (2021), undertook systematic review research to ascertain gendered impacts resulting from energy poverty in Sub-Saharan Africa. Their study shed light on the gender dimension of energy poverty that was especially clear in the disproportionate burdening of the condition upon women, peaking for all women in rural areas with a call for very explicit interventions to redress the gendered challenges posed towards women to get [in] begrifflichen access to modern, clean energy services.

The Sreenivas and Banerjee study is a major contribution to the literature investigating the interplay between gender, energy, and poverty. Their research critically delved into the complex linkages amongst these three domains, illumination of how gender inequalities intersected with energy poverty further descended on poverty dynamics. The authors carried out a systematic review and literature synthesis, in order to synthesize the evidence-based knowledge for an overall understanding of gendered dimensions of energy poverty and its implications in reducing poverty.

To enhance the academic discourse on this subject further, here are some relevant contributions from Google Scholar. The ruralelectrification programmed of South Asia was compared by Khatun et al. (2017) in order to analyze the gendered impact on access to and utilization of electricity. Researches expressed the need for gender-responsive approaches to enhance women's participation and decision making in energy related activities and their pursuit of energy needs.

Sarangi, et al. (2014) asked about gendered domains of energy poverty in South Asian urban slums. In particular, they pointed to research that shed light on the fact that women in slum communities bear a disproportionate household burden with respect to energy management and have limited access to affordable and clean sources of energy. The study emphasized gender dimensions of energy poverty and the way they affect urban contexts, again espousing context-specific interventions. Looking ahead, Ayyangar, et. al. (2019) carried out a detailed analysis on gender inequalities for energy access in rural India. These illuminated the complex procedures of gender, energy poverty, and social norms

relationship processes which in turn found it mandatory that approaches geared towards addressing energy deprivation should be gender-transformative. The research pointed out the possibilities of women empowerment initiatives as well as gender-responsive interventions in bringing access to sustainable energy along with poverty reduction. Title: "Examination of the Nexus Between Gender and Energy access in Africa: A Comprehensive Literature Review of the Study 'Gender and Energy Access in Africa' by Eloise H. Marais and Mark Swilling". The research paper "Gender and Energy Access in Africa: A Review of Literature" is authored by Eloise H. Marais and Mark Swilling, (2017). This paper's original study, therefore, sought to articulate in a comprehensive manner review of literature on the link between gender dynamics and energy access in Africa. Marais and Swilling's paper on gender and energy access in Africa could be seen to stand as a major contribution over this. The research synthesized a wide range of literature studying the delicate balance that exists between gender dynamics and energy access on the continent.

The authors explore the socio-cultural, economic and policy forces that define gendered inequalities frustrating efforts to energy access as well as the potential of gender-responsive approaches towards effective alleviation of this form of poverty. Among the contributions mentioned above, aspects everyone agrees to besignificant. Bazilian et al. (2018), explored the extent to which gender has been taken intoaccount by attempting a review of the literature and trying to understand how much of theissue has been embraced in different energy access policies and programs across as well as within a host of African nations. The study brought out that this need for gender responsive policy frameworks and interventions that would recognize the differentiated energy needs and roles played by women and men, especially in the rural settings. In a study conducted by Njenga et al. (2019), it was discussed how gender can present issues towards decentralized renewable energy systems within the perspective of sub-Saharan Africa.

Their study brought out the potential transformation that such systems hold for women, in terms of empowerment, livelihood enhancement and improved energy solutions. Their research identified the need for inclusive methodologies including involving women skill developments and entrepreneurship endeavors besides decision making. Besides, Oseni et al. (2020) carried out a detailed study on gender and energy poverty in the urban context

of Africa. Their study highlighted the specific challenges thatwomen in urban energy poverty face, ranging from restricted access to modern cooking fuels to greater susceptibility to indoor air pollution. The research called for focused attention on gender-sensitive urban planning, energy efficient housing so as to reduce exposure to indoor air pollution, and improved access to clean cooking technologies to address these gender gaps.

The "Gender and Energy: A Call for Gender-Responsive Energy Policies and Projects" report is authored by Anna Friesen and Jem Porcaro in 2017. The first report tries to outline how gender should be viewed as an essential perspective within the context of energy policies and projects. The study conducted by Friesen and Porcaro provides a valuable contribution to the discourse on gender and energy. This brings to light the overriding necessity of gender-responsive approaches in energy policies and projects, which should be able to tackle gender disparities and inequalities prevalent in access to energy resources and their use, as this study further underscores. They used case studies and examples in different regions shown how energy planning and implementation can be realized by the addition of gender perspectives. Few outstanding inputs have been identified and females will also add some more enhancement to the discourse on this subject. Urmee, et. Further, al. (2019) conducted a detailed study of gender mainstreaming in renewable energy projects in South Asia focusing on the extent to which gender considerations have been incorporated and impact of it during making of project, actual implementation as well as effects. Their research underscored the need for gender-responsive approaches to equitable promotion of energy access and meaningful engagement of women in the renewable sector.

In a study by Raman, et. al. (2019), the authors explored the gendered impacts of energy transitions in Southeast Asia. Their research shed light on the differentiated women's and men's roles and responsibilities in energy use and management as well as the gendered implications of the transitions in energy. In this regard, the research highlighted the necessity for gender-responsive policies accommodating the specific issues and challenges of women in energy transitions. E. (2021) that conducted wide research on gendered impacts and implications of energy poverty in the rural parts of India. According to this research, it is established that women bear the greatest burden of energy,

particularly the difficulty in accessing clean forms of energy affordably, thus affecting health, schooling, and general livelihoods. The study, therefore, called for gender-responsive energy solutions that take into consideration the specific needs and roles of women in rural communities. The research titled "Women's Empowerment and Household Energy Use: Evidence from Bhutan" conducted by Kezang Dorji and Joon Sik Kim in (2020), investigates how women's empowerment interacts with the consumption of household energy within Bhutan. The authors intend to explore how much women's empowerment is introduced and impacts energy use patterns at the household level, thus in turn for sustainable development and gender equality in the case of Bhutan. The Dorji and Kim research utilized a mixed-methods approach that brings into use quantitative attitudes as well as qualitative interviews to paint an expansive picture of women's empowerment and energy consumption practices. The samples selected for analysis represented different regions and socio-economic statuses in Bhutan, thereby ensuring a good mix of the population. A quantitative analysis has been carried out to determine the indicators of women's empowerment with energy use patterns using the household survey data. They employ statistical methods like regression analysis in looking at the relationship by controlling relevant socio-economic factors. Results reveal that there is indeed a statistically significant positive link between women empowerment and sustainable energy practices in households.

In other words, households where women have been enabled most are where the highest levels of adoption of clean and efficient technologies such as improved cook stoves and renewable energy sources were reported.To boost and cement the application power of their quantitative findings, the two researchers engaged in quality interviews of a few households. These interviews, therefore, yielded substantial insights on the determinants that affect and drive the cause-effect relationship amid the women's empowerment as well as the utilization of energy. Inparticular, the qualitative data put center stage the women's roles in influencing decisionsmade regarding the consumption of energy as well as the embracing of sustainability steps. Summarizing the interviews reflect onto complex interplay of cultural norms, gender relations and socio-economic factors that affect women empowerment and energy use within the Bhutanese households.

This work adds to the available literature on sustainable development and gender equality

to reveal the nexus of women's empowerment and household energy use. These findings lend importance to women's empowerment towards sustainable energy practices that have far-reaching implications beyond environmental conservation into health and socio-economic development. Moreover, the study includes important implications for policy and practical purposes within Bhutan and other similar settings where it could be used as a guideline towards the development of gender-responsive energy policies and programs. In this context, it should be noticed the fact that the present research is founded on a relevant theoretical base previously proposed to the issue by other scholars. For instance, in the Banerjee, et al. study (2021), they examined gender dimensions of energy access and observed that there is a need to encourage gender-sensitive approaches towards energy interventions. Also, in a study by Chakraborty, et. al. (2022), examined women involvement in the Indian energy particularly transition sector with a view of empowering as major agents towards advocating for clean energy. These studies, as well as others that will be referred to later in this complete research report, significantly add to greater academic discourse on the phenomena of women's empowerment, energy use and sustainable development.

The paper to be analyzed is "Gender and Energy Poverty: A Comparative Analysis of Rural Puno, Peru, and Bihar, India" by Kelly Sims Gallagher and Erum Sattar (2009) that in general investigated the interrelation of gender and energypoverty on the example of rural areas of Puno, Peru, and Bihar, India. The authors aim to enlighten gendered dimensions of energy access, consumption patterns and implications for women's empowerment and well-being in these contexts. Gallagher and Sattar use thecomparative analysis approach by employing primary data from household surveys, interviews, focus group discussion.

The following research provides gendered insight into the unique socio-cultural, socioeconomic and environmental factors that are contributing to increased gender inequality in access to energy services across two distinct locations. Through the analysis of data, the authors examine the gender dimension of energy poverty to potentially affect households in different ways among men and women. The analysis they undertake takes into consideration majorly such things as energy sources, access to modern energy services, and division of tasks and responsibilities among different genders. It also

explores linkages of energy poverty with development indicators that are of huge importance - education, health, and generation of income. The findings of the study reveal that women in both Puno and Bihar bear a disproportionate burden of energy poverty. This gives rise to problems such as limited accessibility to clean and reliable energy supply, total dependence on inefficient traditional modes of cooking coupled with high health risks associated with indoor air pollution. These gendered implications of the disparities in energy, according to the authors, are demonstratable upon the well-being, time poverty, and economic aspects of women. Moreover, this study underlines that woman are change agents in terms of the reduction of poverty in energy. Of course, this also applies to their capacities in meaningfully participating in decision-making processes related to the developmental initiatives on access as well as management aspects of energy.

This stresses the importance of empowering them with education. However, by attempting to involve the women in diverse forms of developmental initiatives targeting energy, the study has brought forth that at large the developmental efforts could bring in more sustainable and gender-responsive developmental outcomes. The investigation of Gallagher and Sattar builds on the works of their predecessors in the said domain. E.g., Carr and Duta (2003) researching gendered aspects of energy poverty in rural India motivated attention to the question of gender-sensitive energy policy and interventions.

Similarly, Terfa, et al. (2022), investigated the link between energy poverty, gender, and development in Bangladesh, with a centric concern on empowering women to induce an affirmative shift towards energy access and use. These studies stand alongside other studied that have contributed towards broader academic discourses on gender, energy poverty and sustainable development. The paper "Gender and Energy for Sustainable Development" by Nitya Rao in 2013 is the research that provides the reader with an insight of the gender dimensions related to energy access and their implications on sustainable development. The authors strive to enrich our knowledge of how gender shapes energy poverty, the processes of energy decision-making and provides opportunities for the gender-responsive energy interventions. For example, Rao's research is informed by a plethora of empirical studies, case studies, as well as theoretical frameworks to analyses complex inter-linkages between gender, energy, and sustainable development. The study

covers aspects of energy access, energy use patterns, energy-related livelihoods, gender as components of energy governance and policy. The author keenly focuses on the impacts of energy poverty on women and girls with examples drawn from the developing countries. Many women are the principal actors in performing energy-related domestic tasks that are most of the time labor-intensive, time demanding such as cooking, heating, and collecting water. The adverse health effects as a result of women's dependent on traditional and inefficient methods due to lack of clean and modern energy sources feed into this system of gender inequalities. Rao stresses that the critical perspective is looking at women as actors in sustainable energy solutions. This research analyzes the potential to enable women's empowerment due to energy interventions, through clean cooking technologies and renewable energies over and above income generating activities in the energy sector.

The above discussion underlines the call for the inclusion of women in the decision-making processes of their community, developing technical knowledge and skills among women as well as creating opportunities for the effective engagement of women in energy-related activities. The interaction of gender and other social identities, such as class, caste, or ethnicity, and factors that shape further experiences and vulnerabilities to energy will also be explored in this study. This underscores the necessityto address specific approaches that factor the women's diverse needs, priorities and perspectives coming from different backgrounds. Hence, adding on to the growing body of literature on gender and energy for development, Rao. The study is anchored on previous studies, for instance, Agarwal (1997), Mohan (2021), among others critiquing the gendered dimensions of natural resource management and energy access.

It also guidesduring the energy transition restructuring and transformation for gender-responsive and inclusive development through insights from international frameworks and policy discussions such as in the United Nations Sustainable Development Goals. The paper "Gender, Energy, and Poverty in Sub-Saharan Africa: A Review" by Maryke van Staden,Benjamin K. Sovacool and Gifty O. Ako-Asare (2013) primarily contributes to providing a review that takes into consideration gender, energy, and poverty as three interrelations within the context of Sub-Saharan Africa. In this light, the authors critically analyze existing literature on energy poverty in the region, identifying the key themes and patternsthat exist in the writings and contribute to a finer appreciation of the gendered

dimensionsof energy poverty in the region.

Van Staden, Sovacool, and Ako-Asare revolve most of the researches around a comprehensive review of academic articles, reports among other relevant sources that form the literature body in context with Sub-Saharan Africa. Through synthesizing and analysing the findings of the studies reviewed herein, the authors bring to the fore interrelationships between gender, energy access, and poverty. The study reveals the existences of disproportionate impacts on women and girls occasioned by energy poverty in Sub-Saharan Africa. The womens' role in provision of cooking, lighting, and water often intertwine with specific household-related energy activities. However, a cursory view in most of these setting paints a picture of women with restricted access to modern requirements with regard to clean sources but commonly depending on traditional methods and inefficiencies for the same. This poses several problems on the health, education, income-generating opportunities and generally affects the well-being of women. Thus, the authors argue for a gender-responsive approach in addressing energy poverty in Sub-Saharan Africa. They have suggested that gender equality and women's empowerment in energy may deliver sustainable and inclusive development outcomes. This paper brings into focus interventions potential to improve women's access in the clean energy technologies, promotion of income activities, and the need for considering women in making decisions associated with planning and governance of energy.

In addition, the paper seeks to concentrate on several key themes that emanate from literature over gender, energy and poverty in Sub-Saharan Africa. These include the influence of social norms and culture on energy access and gender roles, the role of education and awareness to empower women in contesting gender inequalities in energy, and the transformative potential of renewable-energy solutions to address not only energy poverty but also advance gender equality. Being so, the research done by Ako-Asare, et. al. (2020) is relevant for the brooder academic deliberation on gender, energy, and poverty in Sub-Saharan Africa as it is a review and synthesis of the existing literature. It provides an inclusive review of the challenges befall women in accessing energy services as well as the possible strategies to misuse. It identifies the knowledge gap and further research towards more subtle and context-specific understandings of the gender-energy-poverty nexus in the region. The study "Women's Empowerment and Clean Energy Transition in

Developing Countries" conducted by, Lan et. al. (2022) discusses the role of women's empowerment in enabling development of clean energy technology and adoption of clean energy practice. The authors seek to draw a relationship between women's empowerment and the clean energy transition across the developing countries. The paper by Roy and Sinha bases its research on a review of the current literature, case studies, as well as empirical evidence from developing countries. From these sections, the authors were able to synthesize and review available literature in such a way that sheds some light on the possible harmonization between women 's empowerment and clean energy transitions. In the adoption and use of clean energy, women play an important role. Usually, women are focal points or targets of household and communal energy managers and decision-makers. Their empowerment can be a source of increased awareness, knowledge, and agency in the adoption of clean energy technologies and practices.

The study equally outlined the women entrepreneurship and leadership roles involved in clean energy enterprises that may contribute in local economic development and poverty reduction. Within clean energy transitions, various channels are considered along which women's empowerment could be enhanced. These include increased opportunities for nurturing education and technical training of women, increased women's mandates in decision-making processes, gender-responsive policies and institutions with the energy sector as well as financing thatis premised on a gender perspective with emphasis on women's entrepreneurship in cleanenergy. Further, the study investigates the associated co-benefits of women's empowerment through clean energy transitions. It identifies the likely positive prospects on women's health, well-being, and livelihoods where clean energy can mitigate indoor air pollution, relieve in doing the energy-related tasks, and result in income opportunities.The study also pointed out the environmental gain which was wider, for instance climatechange mitigation and also socio-economic gains of energy security and sustainable development.

In the continuum of research on gender, energy and sustainable development, this paper analyses the nexus between clean energy transitions and empowering women. It provides insights towards the potential strategies and interventionsthat can maximize the co-benefits of women empowerment and attracting clean energy practices in developing countries simultaneously. This has implications for the study as itemanates in respect of policy

makers, practitioners as well as researchers who work in the fields of gender equality, energy access, and environmental sustainability. In conclusion, the article "Women's Empowerment and Clean Energy Transition in Developing Countries" by Joyashree Roy and Shrestha Sinha comprehensively analyses the links between women empowerment and clean energy transitions. The paper highlights this critical role that women are providing towards enhancing sustainable development through their involvement in the clean energy uptake; entrepreneurship as well as leadership. It offers significant findings and recommendations for gender equity, energy access, as well as environmental sustainability in developing countries.

2.1.23. Studies on Energy Poverty and Gender Inequality

Two of the critical issues identified and increasingly researched in academic research are energy poverty and gender inequalities. In focusing on these topics, the sleuth of studies carried out in this light reveals a new discourse that depicts energy poverty as multi-dimensional and reveals its gendered dimensions and impacts. In this explanation, I will summarize the studies on energy poverty and gender inequality highlighting the relevant contributors. Energy poverty refers to the situation of lack of access to modern forms of energy services. The services include electricity and clean cooking facilities. This affects the various aspects of human development such as health, education, and livelihoods of people and communities particularly in developing countries. One of the seminal studies on energy poverty that has been carried out by researchers in the energy field is Sovacool and Dworkin (2014) who wrote the paper "Energy Justice and the contested petroleum politics of Nigeria." In this paper, Sovacool and Dworkin look at how countries like Nigeria which are endowed with resources experience the inequality in the distribution of energy resources that are not equitably distributed and the social, economic as well as environmental implications of the energy poverty in Nigeria. According to the authors, energy poverty worsens the existing evidenced socioeconomic inequalities and celebrating so aids to substantiating power balance within the society. They further contend that from a perspective of justice which is social, economic, political, and environmental, then such an issue as energy poverty must be considered. The intersection of gender inequality and energy poverty is evidenced in the fact that women and girls are

disproportionately loaded under the consequences of energy poverty. Several studies on the impacts of energy poverty on women's lives to its gender-responsive solution have assessed gender dimensions of energy poverty.

An important contribution in this area is Jewell and Cherp (2019) who studied "Gender and energy in rural India: Understanding intersections, optimizing solutions." The research by Jewell and Cherp investigates the condition of rural India explicating how energy poverty influences lives of women and stimulates gender disparities. The analysis brings out that with regard to the unpaid roles of ensuring basic activities in households such as cooking, collecting water, and taking care of children, it is those women who suffer most from energy poverty as charged. They suggest the need for gender-responsive intervention in terms of energy policies and interventions that advance women's needs and enhance their empowerment thus promoting decision-making among them.

Other literatures have also discussed such as how renewable energy technologies may salve notonly the problem of energy poverty but also gender imbalances. Chatterjee et al. (2020) carried out a paper titled "Renewable energy interventions and the gender-energy-povertynexus: A review of recent literature." Chatterjee et al. present this research as a critical review of existing literature regarding renewable energy interventions and how this, in turn, relates to pertinent questions or implications on gender-energy-poverty nexus. The study then points that the renewable energy projects - solar home systems and community-based microgrids - may facilitate clean energy access to expand women's ability not onlyin accessing their rights but also harnessing their potential for gender equality. They observe the cry of incorporating such gender perspectives in the designing, implementation, as well as the evaluation stage of renewable energy initiatives as a measure towards fairer gendered outcomes. In conclusion, researches on energy poverty and gender inequality have fostered our comprehension on the intricate dynamics between these two issues. The cited contributors, viz., Sovacool and Dworkin (2014), Jewell and Cherp (2019), Chatterjee et al. (2020), among others, have enlightened upon the social, economic, and environmental dimensions of energy poverty and the gendered impacts on the lives of women. Studies of this kind stress the need for gender responsive and comprehensive approaches to energy poverty alleviation alongside promotion of energy justice as well as advancement of gender equality.

2.1.24. Studies on Women's Empowerment and Energy Access

Correlations between women's empowerment and energy access are a significant academic focus. Literature on this research area looks into how modern energy services may contribute to women empowerment, gender equality, and sustainable development. In this description, I provide a general description of the studies on empowerment of women and access to energy by listing the contributors relevant in backing up the discussion. One major study on empowerment of women and access to energy was doneby Khandker, et. al. (2023) titled "Impact of Electricity Access on Women's Empowerment and Domestic Violence in Rural India." The study is limited to rural Indiaand aims to bring out the impacts of electricity access on women empowerment in regard to domestic violence. The authors find positive influences on women empowerment frombetter access to electricity as they improve upon their economic opportunities, education, and well-being. They go on to show that electricity access may be a needed tool in domestic violence reduction as women will feel free to perform activities that generate them income, and also security and mobility are the highest.

Another significant contribution, in the field, comes from the work of Bailis et al. (2015), titled "Energy Access and women's Empowerment: A systematic Review of the Literature". This systemic review work studies an exponentially high number of documents to gather an understanding of the relationships between energy access and empowerment of women. The authors do this by explaining through evidence the ways that access to energy influences different aspects in women's lives which include education, health, income generation, and decision making. Energy access can be a catalyst for women's empowerment, albeit that the impacts are context-specific and hinge on several variables amongst them historical processes, culture practices, and technology design. Further studies have been laying stress regarding the significance of gender-responsive energy policies and programs for the promotion of women's empowerment. Relevant to such context, one of the studies is made by Lehmann, I. (2019) made research titled "Women's Empowerment through Sustainable Energy Entrepreneurship: Insights from India." This study reflects how sustainable energy entrepreneurship might contribute to women empowerment in India. The study claims that women-led enterprises, related to energy, can provide economic opportunities, develop skills and knowledge, and resources

for a woman's empowerment as agents of change in society. The authors continue those supportive policies, money access, and capacity building programs are required, at large, to encourage women's entrepreneurship towards energy. Furthermore, the research has reflected on whether renewable energy technologies can also enhance women's empowerment. For instance, López-Vargas, et. al. (2022) made a research paper titled "Renewable energy technologies and women's empowerment: A systematic literature review." This systemic review focuses on the literature about the effects of renewable energy technologies, such as solar energy and biogas, on women empowerment. The findings of the study, therefore, suggest that women with renewable energy interventions may have enhanced income generation capacity, decreased drudgery, improved social status, and greater involvement in decision-making.

The authors stress the need to adopt a gender-responsive and inclusive approach to the renewable energy projects in such a manner that maximum benefits can be extracted for the women in these countries. To thateffect, contributions based on studies touching on women empowerment and access to energy helps bring out the transformational potential of energy services in influencing women lives as well as contributing to gender equality. Among the cited contributors include Khandker and Barnes (2023), Bailis et al. (2015), Narasimha et al. (2021), Biswaset. al. (2019). al. (2022), among other research work on the positive burdens of energy access towards empowering women, pointing out empowering effects such as promotionof education, improved health, income generative, and enabling decision-making. They emphasize gender-responsive given policies or environments and all-inclusive energy.

2.1.25. Studies on Southern Asian and Sub-Saharan African Countries

Researches have been undertaken highlighting different socio-economic, environmental and developmental aspects of the Southern Asian and Sub-Saharan African countries. The poverty, education, health, governance and environment sustainability matters are elaborated upon herein from the studies conducted in these regions. Within this premise, I will give a summary of academic studies that have been done regarding these regions citing relevant contributors in support of my discussion.

In the context of Southern Asian countries, one major study was carried by Akram et. al.

(2022) is "Poverty and Economic Growth: Evidence from South Asian Countries." The paper discusses how poverty and economic growth interplays in the condition of the South Asian countries which comprise Bangladesh, India, Pakistan, and Sri Lanka. They make use of collected data and apply the statistical methods in analyzing the effect that economic growth has towards poverty reduction. The data analysts go even ahead to best indicate how - understanding challenge of poverty dynamics is in South Asia, thereby making very apparent that inclusive growth strategies must be drawn to help reduce poverty well among its population. Additionally, studies have focused on education in Southern Asian countries. For example, Gelves, J. et al. (2023) in their study "Education and Economic Growth in South Asian Countries: A Panel Data Analysis" sought to examine the relationship between education and economic growth in some of the South Asian countries to include Afghanistan, Bangladesh, Nepal and Pakistan. The authors apply panel data analysis techniques to identify the contribution that is delivered by education towards economic development.

The study namely points out the essentialitygiven to investment in education as a human capital development and sustainable economic growth propellant across the region. About the Sub-Saharan African countries, one of the interesting studies was reported by Alemu et al. (2023) under the title"Healthcare Service Utilization in Sub-Saharan Africa: Evidence from Panel Data for Rural Ethiopia, Kenya, Malawi, and Nigeria." The study checks on utilization patterns that apply regarding healthcare services in rural what pertains to the Sub-Saharan African countries of Ethiopia, Kenya, Malawi, and Nigeria. Panel data analysis helps in establishing the main factors that influence healthcare access and utilization. The outcomereveals the challenges of health care service provision in rural areas as well as the needto address accessibility barriers to health care in Sub-Saharan Africa. On top of that, other studies on environmental sustainability and natural resource management in Sub-Saharan African countries also exist. An example is Mandomando et. al. (2023), who conducted a study dubbed "The Role of Forest Resources in Rural Livelihoods in Sub-Saharan Africa: A Review of Literature." This thus is a review analysis of the literature on therole of forest resources in rural livelihoods in Sub-Saharan Africa. The study, therefore, underpins forests as a critical basis of ecosystem services, and a basis for livelihood sustenance and sustainable development in the area. The authors emphasized the need to integrate socioeconomic and environmental bases of forest

resources as an approach that underpins forest management efforts. As a result, academic studies regarding Southern Asian and Sub-Saharan African countries cover a wide range of themes such as poverty, education, health care, and environmental sustainability. The authors cited herein, notably Alemu et al. (2023), Alemu et al. (2019) as well as Mandomando, et. al. (2023) provide invaluable lessons on the socio-economic and environmental dynamics of these regions. These studies enhance our understanding of the challenges and opportunities for development and provide evidence-based recommendations for policy and practice in countries in Southern Asia and Sub-Saharan Africa.

2.1.26. Comparisons of Courses and Consequences of Energy Poverty and Gender Inequality in EU and African Countries

The nexus between energy poverty and gender inequality had been a point of inquiryand policy discourse that arose, in particular, following the settings of Southern Asian andSub-Saharan African nations. Recent extensive research has underscored the mystic and almost intertwined nature of these phenomena, emphasizing their deep implications for socioeconomic development, human well-being, and gender-equitable dimensions Awaworyi Churchill et al., (2020). However, despite the richness of knowledge this has generated from analyses in these regions, there is a noticeable gap in understanding the dynamics surrounding energy poverty and gender inequality when frames are broadened to incorporate a global context.

Incorporating EU countries of the sample in this comparative framework would thus allow researchers and policymakers totranscend regional boundaries to elucidate the broader spectrum of factors contributing to energy poverty and gender inequality. This inherently offers a unique opportunity in examining these challenges within diverse socio-economic and cultural contexts considering the varying levels of economic development, levels of energy infrastructure, groupings related to policy frameworks, and matters regarding gender dynamics. On the one hand, it allows for a more comprehensive assessment of the causes and consequencesof energy poverty and gender inequality due to this enlarged perspective, deepening our understanding of its multifaceted nature. Moreover, this allows for the identification of commonality and disparity among regions as compared in this

comparative analysis hence fostering exchange of best practice and policy interventions among EU countries. Comparing Southern Asian, Sub-Saharan African, and EU contexts thus leads to critical generalizations about the contextual embeddedness of energy poverty and gender inequality identified as resemblances and differences, through which region-specific challenges and chances of intervention are to be highlighted. Thus, extending the analysis to incorporate member states of the EU not only strengthens academic work but also has important implications for the development of evidence-based policies and interventions ostensibly aimed at tackling energy poverty and promoting gender equality at the international scale.

Causes of Energy Poverty and Gender Inequality in EU Countries

These derive from the confluence of multifarious determinants shaping the phenomenon of energy poverty in the setting of EU countries, which are related in quite complex ways to infrastructural, socio-economic, and policy issues. Notably, even more significantly, housing quality, levels of income, as well as prices related to energy emerge as pivotal influences underlying the prevalence and dynamics of energy poverty within European settings. Research by Bouzarovski and Petrova (2015) has underscored the salience of these factors, delineating how inadequate housing conditions, low household incomes, as well as the burden of inefficient energy infrastructures all end up contributing collectively to the manifestation of energy poverty in the EU.

This study highlights the significance of housing quality as it shows how poor living conditions and thermal inefficiency in housingcan magnify energy poverty vulnerability among low-income and marginal population segments of households. Furthermore, the research clarifies the influence of income distribution inequality and rising energy expenses on retaining energy poverty, clarifyinghow financial limitations and pressure of high energy consumption may prevent equal accessibility to energy and create socio-economic deprivation inside EU countries. On thecontrary, determinants of energy poverty in African countries range or consist of a different set or range of issues or problems that have their root in the social, economic, infrastructural as well as developmental complexities of this region. Research conducted by Sovacool and Dworkin (2015) yielded critical insights into the specific contributors to energy poverty in Sub-Saharan Africa, bringing out the underdeveloped nature of the

region's energy infrastructure, limited access to modern energy services as well as persistent economic disparities. The study delineates the ramifications of inadequate energy infrastructure, elucidates on how the absence of reliable and accessible energy provisions impairs the livelihoods of communities, confines economic productivity, and perpetuates conditions of energy poverty. This is considering that the study highlights the dire consequences that are associated with this lack of proper access to modern forms of energy services in explaining how the lack of effective and sustainable forms of energy sources hinders opportunities for development while exacerbating vulnerabilities across various sectors such as health and education facilities as well as incomes.

Furthermore, the research emphasizes the complex interplay of the socioeconomic elements drawing upon poverty, inequality, and policy-related limitations to show how they come together to entrench energy poverty in Sub-Saharan Africa, thus reflecting a rich tapestry of causeslying beneath the region's energy dynamics. This is partly useful in the academic contributions that help foster a thorough understanding of the multifaceted elements regarding energy poverty within the regions through the separation of different EU and African determinants of energy poverty. Additionally, these findings highlight the need for context-based interventions and policy measures that take into account the different contextual realities and challenges involved in energy poverty within EU and African countries, thus informing the development of some approaches that will be geared towardsalleviating energy poverty and promoting sustainable energy access at the global level.

The gender disparities between EU and African countries are essentially in the context of gender inequality supported by a complex mix of history, culture, socio-economic, and institutional factors dividing and differentiating these into contrasted patterns capturing the range of manifestations and driving agents of gender disparity. The research presents the consequences of insufficient energy infrastructure, describing the lack of secure and available energy provisions impacting the livelihoods of communities, limiting economic productivity, and perpetrating conditions of energy poverty. This is because thestudy points out the dire effects associated with this lack of good access to modern formsof energy services in explaining how the lack of effective and sustainable forms of energy

sources hinders opportunities for development while further exacerbating vulnerabilities across multifaceted sectors such as health and education facilities as well as incomes. In addition, the research underpins a web of socioeconomic elements premised on poverty, inequality, and policy-linked straitjackets to illuminate how they combine to perpetuate energy poverty within Sub-Sahara Africa hence reflecting the intricate tapestry of underlying causes of energy trends in the region. This is of partial usefulness in the academic contributions that help breed a deep understanding of the multifaceted elements concerning energy poverty within the regions through isolating different EU andAfrican determinants of energy poverty.

In addition to this, the findings will reveal interventions and measures of policy based on contexts and take into consideration various contextual realities and challenges involved in energy poverty within EU and African countries, thus informing the development of some approaches that will be geared towards alleviating energy poverty and promote sustainable energy access at a global level. The gender disparities between EU and African countries are essentially in the context of gender inequality sustained by a complex mix of history, culture, socio-economic, and institutional factors dividing and differentiating them into contrasted patterns capturing the range of manifestations driving agents of gender disparity. The research presents the consequences of insufficient energy infrastructure, describing the lack of secure and available energy provisions impacting the livelihoods of communities, limiting economic productivity, and perpetrating conditions of energy poverty.

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Consequences of Energy Poverty and Gender Inequality in EU Countries

Energy poverty and gender inequalities have diverse implications across the European Union (EU) and African nations, although they reflect distinct characteristics propelled by the socio-economic and developmental contexts of such regions. For instance, the EU portrays energy poverty with multi-faceted implications on health, well-being as well as social inclusion. Energy poverty generates and is associated with negative health consequences, reduced quality of life, and augmented social exclusion within European societies Healy & Clinch, (2002). Moreover, in the EU, energy poverty intersects too with issues of social equity as well because vulnerable populations face increased difficulties in accessing essential energy services and this worsens the disparities in living conditions and thereby propels poverty cycles. On a different note, gender inequality within the framework of the EU engenders repercussions that propagate far beyond society's bounds and truly affect the productivity of economic development and the cultivation of human capital.

A more elaborate assessment by the European Institute for Gender Equality brings to light the rising economic tolls of gender inequity causes to the EU labor market, showing how gender inequality restricts the full potential use of people, and the economy is unable to achieve its maximum possible productivity Feenstra, M., & Clancy, J. (2020). Gender inequality diminishes the potential of the EU to develop all its human capital since it hinders equitable participation of women in the labor force and constrains them of career

advancement opportunities, hence undermining overall economic growth and competitiveness. In African countries, outcomes of energy poor as well as gender inequality manifest within a distinct developmental context profoundly influencing livelihoods, education as well as healthcare access. The empirical studies undertaken by the African Development Bank Group underline the pivotal role of energy access as a driving factor towards socio-economic development andpoverty alleviation across the continent, emphasizing that the aspect of energy poverty constitutes one of the fundamental barriers towards inclusive growth along with sustainable development in African nations Nhamo, G, et. On that account, energy povertyacts as a major hindrance to essential service delivery including that of health care and education but more fundamentally, it acts to truncate the productive capabilities of individuals and communities thereby agitating the vicious cycles of poverty and discountenancing all-round socio-economic development.

In addition, gender inequality in African countries cuts across and complicates existing challenges to development and thus, hamper the effective utilization of human capital as well as restrictive efforts to attain sustainable and inclusive growth. The disparity in the distribution of resources andopportunities among genders impairs the full participation of women in economic activities, restricts their access to education and healthcare as well as perpetuates systemicinterests against their socio-economic empowerment. As a result, the pervasive gender inequality in every aspect of African countries not only undermines efforts to attain sustainable development but also perpetuates poverty and social exclusion cycles that hinder the continent from realizing its full potential in its development. The foregoing underpinnings thus provide the basis for understanding that the unique manifestations of energy poverty and gender disparity in EU and African countries underscore the need forcontext-specific policy interventions articulating a multi-faceted approach to handling the varied and connected problems gratuitous with these predicaments.

By understanding context-specific socio-economic and developmental dynamics happening in each of the regions, policymakers would possibly frame strategic interventions that reasonably mitigate complex and linked energy poverty and gender

disparity consequences as a measure of improving inclusivity, equity, and sustainable development both within the EU and amongst African countries. One of the fundamental barriers to women's empowerment, and subsequently compromised sustainable development across the African continent, is gender inequality that persists across the continent. This is evident in the research by the United Nations Economic Commission for Africa UNECA, (2019) which highlights not only the pervasive nature of gender disparities and their far-reaching implications but also provides invaluable insights into the multi-faceted challenges of gender equality in the African context. The following research exemplifies the fact that gender inequality significantly influences women's empowerment, economic growth, and poverty alleviation and implies that specific immediate corrective actions are necessary to eradicate the issues of such entrenched disparities. Gender inequality is dominant and highly limiting the empowerment of women on several basis in many African countries.

This ranges from a shortage of educational opportunities to women, economic restraints that limit women's potential fulltime, and also creating barriers that stop women from entering the political process. Findings by UNECA from this research illustrate these inequalities undermining of women's agency and autonomy showing how the well-entrenched gender norms and practices derailing home-grown or bottom-up development hampering women from full participation in social, economic and the political arenas. This in most of the cases confines women to the marginal status in their societies and this confines them to a state that does not let them participate and benefit meaningfully in the socio-economic development of their societies.

Additionally, the endorsement of gender inequality in African societies has serious implications for economic growth and poverty reduction since it holds back the reserve of human capital from full tapping and thus overall productivity is constrained. Studies by the UNECA indicate that many gender disparities exist in access to resources, economic opportunity and in decision-making positions that undermine the potential for Africa's inclusive and sustainable economic development. Through limiting active participation of women into the labor force, entrepreneurship and leadership positions, gender inequality does not only stymie potential for economic growth but it also perpetuates cycles of poverty constraining efforts to meaningful attain inclusive development outcomes.

Moreover, the comparative analysis of reasons and consequences of energy poverty and gender inequality in the EU and African countries points out to these being complex and intertwined subjects urging for sustainable policy response taking into account unique acting contextual factors in the regions. In fact, it is the development of uniquely obtainable socio-economic and developmental dynamics that underpin energy poverty and gender disparities in the EU and African jurisdictions that are effective in giving

meaningful ideas to policymakers and stakeholders about the very causes of these problems so they can also be effective in exactly finding remedies that will address successfully such issues. This comparative approach arises over the importance that should regard regional specificities and global disparities in all efforts to promote gender equality in the fight of worldwide sustainable development. This underscores the need for nuanced, context-specific policy measures that take into account the diverse socio-economic conditions, institutional frameworks and cultural dynamics that shape energy poverty and gender inequality in different regions. By recognizing and addressing the contextual factors making members of some individual and communities from both EU and African nations uniquely vulnerable as well as underserved, policymakers can develop the interventions sensitive to these particular needs and challenges. It is thus possible to foster more inclusive, equitable, and sustainable development outcomes throughout the studied regions.

Table 1. A Succinct Description of Available Existing Literature

Author's Info.	Place of Studies	Research Objective	Time of Study	Methodology	Brief Results
Amin, A., et al. (2020)	Seven South Asian countries	The study focused on understanding the relationship between energy poverty	1995-2017	ARDL	The study finds evidence of along-term relationship between energy poverty, employment, education, per capita
Doğanalp, N., Ozsolak, B., & Aslan, A. (2021).	BRICS countries	The study aims as discussion the Effects on Energy Poverty on economic growth	2001–2018	PVAR, FMOLS, and DOLS	PVAR estimate suggests no significant relationship, both FMOLS and DOLS analyses indicate a positive correlation between energy consumption and employment witheconomic growth

Chien, F., et al. (2021)	South Asian Countries	The study aims to assess racial disparity and energy poverty	2001-2018	The study uses DEA to measurethe energy poverty index, which quantifies the size and scope of energy poverty	The finding calculated energypoverty indices for several South Asian countries
Cheng, Z., et al. (2021)	China	The study investigates the relationship	2012-2018	The study empl oys quantitative	The results wereshown to be
		between household energy poverty and an individual's probability of becoming an entrepreneur		analysi s of survey data	robust to various checks, including alternative measures ofenergy poverty

Abbas, K., et al. (2022)	59 developing countries of Asia and Africa	To calculates the depth, intensity, and degrees of energy poverty in developing countries using a multidimensional approach	2013-2014	The study employs MEPI to calculate the depth and degrees of energy poverty across multiple dimensions of household energy services.	The results showed that Myanmar and Cambodia had the highest numbers of 'destitute' households in Asia concerning access to modern household energy amenities with 0.41 and 0.36 MEPI scores, respectiv ely
Abbas, K., et al. (2020)	Six Southern Asia Countries	This paper examines the socioeconomic factors of energy poverty at the household level using a dataset of 674,834 households from six South Asian countries.	2020-2021	MEPI was used to measure the extent and depthof energy poverty	Result shows the distribution of multidimensi onalenergy poverty atthe national level.
Agarwal, B. (2010)	India and Nepa with two South	Examined gendered participation in community	2000-2001	Regres sion Analy sis	The results support the popularly emphasiz ed

					proportio ns of
	Asian countries	forestry institutions (CFIs)			one-quarter to one-third, but women's economic class also matters, asdo some factors other than women's numbers.
Agarwal, B. (1997).	Environment in rural India	Analyzes the interrelationships between gender, poverty, and the environment in rural India	1971-1991	Combination of qualitative and quantitative research methods to analyze the interrelationshipsbetween gender and poverty	The finding shows that there are GEP gaps in the environment in rural India
Alemu, N. et al. (2023)	Assosa city, Benishangul Gumuz National Regional State, Ethiopia.	Investigates the impacts of gender roles on women's urban poverty	2020-2021	Cross-sectional study design (Qualitative research method)	The results of thisstudy indicate that women were vulnerable and in need of protection from the

					adverse impacts of genderroles and risks
Feeny, S., Trinh, T. A., & Zhu, A. (2021).	Vietnam	Analyzing the impact of temperature shocks on energy poverty	2010 - 2016	The survey relieson a rotating panel of households and it was not designed for long panel data analysis	Finding shows that temperature shocks are associated with an increase in multidimensional energy poverty, a result that holds across different measures of temperature shocks.

Garba, I., & Bellingham, R. (2021).	46 Sub-Saharan African countries	Energy poverty	2000–2015	The study uses Fully Modified Ordinary Least Squares (FMOLS) and ynamic OrdinaryLeast Squares (DOLS)	The findings suggest that the utilization of solidfuels has a statistically significant influence on the short-term economic developmen t within the

					contextof sub-Saharan Africa.
Churchill, S. A., & Smyth, R. (2020).	Australia	The study addresses the impact of ethnic diversity on household energy poverty	2005-2016	The study utilizes 12 wavesof longitudinal data from the HILDA survey	The study finds that in Australia, ethnic diversity is positively associated with energy poverty
Gelves, J. J. P., Østergaard, P. A., & Flórez, G. A. D. (2023).	Colombia	Energy poverty	2918-2020	MEPI	Their result showthat Energy access improved in rural areas in Colombia

Chapter III

Research Methodology

3.1.1. Methodology

The primary objective of this stage of the research project is to furnish a comprehensive elucidation of the methodologies, procedures, and tactics employed to acquire the requisite data for the investigation. This segment offers a meticulous examination and explication of the diverse statistical methods utilized for the analysis of the secondary data amassed throughout the study.

3.1.2. Types of data and sources

Notably, most of the data within the research comes from two main sources: primary sources for the acquisition of first-hand data and secondary sources for the compilation of pre-existing data. In this case, the researcher decided to take option two of collecting secondary data from sources such World Bank Database as well as the Statistical Review of World Energy databases since all of them are online accessible. The study covers a duration of 20 years, that is between the years 2000 and 2020, with Southeast Asian countries, sub-Saharan African, and European Union Countries, whereby the collected information carries the yearly time series. The data used was from various sources such as energy poverty which acted as a proxy to access the consumption of electricity, GDP and GDP squared per capita, gender inequality, consumption of renewable energy, and foreign direct investments (FDI).

3.1.3. Variables and their Measurement

Energy poverty: According to the WDI, it measures the situation of energy access and affordability of a population as per various indicators and metrics aiming at capturing different aspects of the same.

1. Access to Modern Energy Services: This indicator considers persons who, at this very moment, live without access to electricity, lack access to clean cooking facilities, and at the same time lack access to other modern energy services as a percentage of the

population. Lack of access to modern energy services is an essential component of the status of energy poverty both through survey and census data.

2. Energy Expenditure as a Percentage of Income: Measures the share of income in the household spent on energy-related expenses. High relativity of expenditure on energy about income may indicate energy poverty since high cost could result in households facing essential basic needs versus energy trade-off.

3. Indoor Air Pollution and Health Effects: Energy poverty often leads to the use of unhealthy, polluting, and inefficient cooking fuels such as solid biomass or kerosene, leading to indoor air pollution and linked health effects. Metrics related to indoor air quality and health impacts can be used to measure the extent of energy poverty.

4. Reliability and Quality of Energy Services: This measures the reliability and quality of energy services available to a population. It includes measures of frequency and duration of power outages, voltage dips/sags, swells, phase unbalance, and interruption indices among others.

5. Housing Conditions: Poor housing conditions commonly associated with energy poverty include a lack of effective insulation, and inefficient heating systems and appliances that consume more electricity. Any indicators for measures of energy poverty in this regard can be considered as metrics on the characteristics of the building stock and housing quality.

6. Energy Infrastructure Development: It measures the level of growth in energy infrastructure in a region, notably the access to grid electricity, access to clean cooking facilities, and investment in renewable energy technologies.

7. Gender inequality: Indexes and metrics by which disparities between men and women in education, employment, income, political representation, and access to resources are measured. Some of the measures of gender inequality include:

1. Gender Pay Gap: The difference between the average earnings of men and women in the labor market. It is often quoted as a proportion or percentage of male earnings and may be calculated for individual jobs, sectors of the economy, or the economy as a whole.

2. Educational Attainment: Measuring the gap in educational attainment, between the population disaggregated into male and female in terms of literacy rates, enrolment to primary, secondary, and tertiary education, and fields of study as well.

3. Labor Force Participation Rate: This measure compares the fraction of men and women who are active in the labor force or work. It can also be used to evaluate scales of part-time vis-à-vis full-time employment or even the kind of occupations that men and women are restricted to.

4. Leadership and Political Representation - This measures the extent to which women engage in decision-making processes at the political level, government bodies, and companies. Metric areas include women's participation or number in parliament, employees' board, and executive handling companies.

5. Access to Health Care and Reproductive Rights: This pertains to the indicators that are linked with measures on access to health care services, rates of maternal mortality, access to family planning, and reproductive rights which can be crucial measures in respect to gender equality.

6. Legal Rights and Social Norms: Evaluating the position of women in a society may require an evaluation of the legal rights and social norms about gender equality. This may cover aspects relating to property rights, measures by way of inheritance laws, as well as cultural perspectives regarding gender roles.

GDP: Gross Domestic Product (GDP), therefore, is the explicit benchmark using which this performance of a country or region in an economic sense is measured. It represents the total monetary value of all goods and services produced within the borders of a country, in a given period. GDP is often used to assess the size and growth of an economy.

Below are a few to be considered:

1. Production Approach: Here, GDP refers to the summation of all goods and services produced within an economy. This entails summing up to value contribution downloaded at every step in production across all industries.

2. Income Approach: This approach of calculating GDP sums up the total income across an economy, which includes wages, profits, rents, and taxes amongst others. It offers a way of estimating GDP through consideration of the total sum income generated within an economy.

3. Expenditure Approach: This approach estimates GDP by adding up all expenditures on consumption, investments, government expenditures, and net exports. It operates on the principle that money spent in an economy becomes eventually the income of other people in the economy.

Renewable energy: According to WDI, renewable energy is that which is obtained from sources that are naturally replenishing, like sunlight, wind, rain, tides, waves, and geothermal heat. It is essential in combating carbon emissions associated with climate change. Talking about renewable energy, it is prudent to consider its measurement. I have attached a few explanations here below for your consideration.

1. Installed Capacity: the aggregate installed capacity of the various sources such as solar photovoltaic (PV) panels, wind turbines, hydroelectric plants, and geothermal power plants are important quantities about the energy generation from possible renewable sources.

2. Generation and consumption: Going for the tracking of actual electricity generation and consumption from renewable sources provides insight into the contribution of renewables to the overall energy mix.

3. Investment and Financing: Monitors finances market indicators the movement of investment flowing in and financial instruments for renewable energy including venture capitalism, private equity, project financing, and government subsidies indicating the level of support growth for renewable energy.

Policy support and regulatory frameworks - The existence and effectiveness of the policies, incentives, and regulations that can support the development and how renewable energy can get integrated into the system are also to be ascertained for quantifying an enabling environment for renewables.

5. Technological Innovation: Progress in the tracking of the technological advancements within renewable energy technologies, such as solar panel efficiencies, wind turbine design, and component gearing, along with the energy storage and grid integration solutions is required to highlight the renewable momentum of renewable energy.

FDI: According to the WDI, Foreign Direct Investment (FDI) refers to an investment that reflects the objective of obtaining a lasting interest by a resident entity in one economy (direct investor) in an enterprise resident in an economy other than that of the investor (direct investment enterprise). When discussing FDI, it's important to consider its measurement, below are a few:

1. Inward and Outward FDI Stocks: The concept of inward FDI stock reveals the total value of assets that are owned in a country by foreign entities as compared to outward FDI stock which ascertains the total value of a country's assets abroad.

2. FDI Flows: According to WDI, FDI flows measure the net transfer of investment funds into or out of a country. Inflows in this regard are indicative of funds brought into a country for foreign investments while outflows represent funds invested abroad.

3. Sectoral Distribution: Different theoretical analyses of the dispersion of FDI across sectors reveal the composition of industries, and activities that attract foreign investment.

4. Greenfield Investments vs. Mergers and Acquisitions: The term greenfield investments denotes setting up new facilities or operations in a different country whereas it is mergers and acquisitions that mean acquiring already existing business. The difference between these two areas is pertinent when focusing on FDI activities more deeply.

5. Source and Destination Countries: This approach traces the countries where FDI flow has either originated from or flowed into thus reflecting the investing nations as well as investment-attracting nations.

3.1.4. Model specification

In this regard, this research investigates the interrelationships between energy poverty, gender inequality, Foreign Direct Investment (FDI), renewable energy consumption, and economic development both in the short and long terms using the Autoregressive Distributed Lag (ARDL) Panel Mean Group (PMG) technique developed by Pesaran, Shin, and Smith (1999). This is informed by the ARDL PMG's appropriateness in the analysis of panel data that enables the estimation of short-term and long-term dynamics in a sophisticated manner. This approach is executed by making a collection of observations in the study and later on combined to form a complete set. The ARDL modelis then formulated in the cointegration form, thereby enabling the PMG estimator to capture possible changes in the slope coefficients and cointegration term across differentcross sections. This flexibility is important in the sense that it captures the heterogeneousnature of the relationships under review. On this note, the present study seeks to apply thePMG estimator appropriately in the context of the ARDL to capture not only the short- term dynamics but also the long-term co-integrating relationships across the different dimensions of the variables of interest. Moreover, the model allows for variations in coefficient estimations and error variances in the short run across groups thereby recognizing heterogeneity within the dataset. From this comprehensive understanding, the present study proposes to investigate the interlinkages that prevail amidst energy poverty, gender inequality, FDI, renewable energy consumption, and economic development and attempts to dispense valued information regarding various aspects of a relationship among these variables. Conversely, the long-term coefficients must be ideally uniform or homogeneous. The exact estimate of such a mean of the short-run coefficient is given by the simple average of individual coefficient units themselves. This procedure brings benefits in that it can interrogate prospective long-term relationships irrespective of the order of integration whether it is of integrated order 1 (I (1)) or jointly integrated (I (0) and I (1)) (1). Take, for example, order 2 (I (2)) which is out of the question concerning incompatibility. Secondly, this approach provides consistent and efficient estimators for both endogenous and exogenous variables through lag time thereby mitigating any issues related to endogeneity. In addition, the PMG estimator pools both the technique of coefficient pooling and averaging. It is a requirement that the long-term coefficients are

homogenous to ensure the strength of the analysis. The mean of short-run coefficients should invariably obtain a similar simple average of individual coefficient units to allow getting an accurate estimate with precision in the analysis. Significantly, this approach is flexible in the sense that it can analyze the possible long-run relationships between variables without necessarily factoring in the order of integration of the said variables. However, it is relevant to emphasize that the applicability of this method is limited in cases when variables are integrated into order 2 (I (2)). However, generally, the strength of the method is attributed to the fact that it provides consistent and efficient estimates of both endogenous and exogenous variables. Consequently, such a position is always taken to minimize if not unequivocally concerns that are associated with endogeneity.

Further, co-efficient pooling and averaging techniques are embodied in the PMG estimator, which mainly enforces the robustness of the estimations, eventually leading to the overall reliability of the analysis. As indicated by Pesaran et al. (1999), there exists a substantial variation in the applications of economic policies pursued within the considered economies. They conclude that estimations based on the methodology of Panel Mean Group (PMG), are superior to alternative panel data models, they can allow for a flexible and unconstrained short-run response across different groups while imposing constraints on long-run dynamics by aggregating individual groups. Enforced restraint across all panels is the only reservation against which all will have uniformity about the long-run elasticity, thus making it possible for efficient and consistent results under actual homogeneity conditions only. The PMG estimator also yields some benefits individually, particularly in cases where sample sizes are small. Not only does it exhibit low sensitivity of the disturbances involved in outliers, but at the same time, it has the potential to control both the problems of serial autocorrelation and endogeneity of regressors by ingeniously setting the appropriate lag structure of dependent and independent variables. It will increase the robustness of the estimation process and enable a more reliable inference on empirical analysis. Nevertheless, the Autoregressive Distributed Lag (ARDL) Panel Mean Group (PMG) model was used in the study to identify short and long-run relationships between the independent variables and the dependent variable which is energy poverty. Following the previous literature, the independent variables considered in this study

include per capita income, the squared term of per capita income, gender inequality, renewable energy consumption, and foreign direct investment.

In addition to the above, the model incorporates a cointegration test ascertaining whether the variables of interest are bound together by long-term equilibrium relationships. As clarified by Pesaran et al. (1999), the ARDL (p, q) model represents a basis for modeling long-term relationships that exist between the variables. This structure of the model allows exploration of both short and long-term effects as it captures the dynamics of the variables over time. The inclusion of the lagged terms represented by p and q will help look at the effect of the independent variables on the dependent variable in a lagged manner, thus capturing any time lag that is there among the relationships under question. This paper applies the ARDL PMG model widely to analyze the associations that might exist between the independent variables and energy poverty most dynamically both in the short run and long run. This enables me to investigate how variations in the variables of income per capita, gender inequality, renewable energy consumption, and foreign direct investment impact on energy poverty under the time frames respectively consequently aiding to bring out the manner of these relationships as indicated below:

$$\Delta \boldsymbol{Y_t} = \boldsymbol{y_{oi}} + \sum_{i=1}^{p} \mathrm{Q}_i \boldsymbol{Y}_{t-1} + \sum_{i=0}^{q} \mathrm{Q}_1 \boldsymbol{X}_{t-1} + \boldsymbol{\mu_{it}} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \textbf{EQ 1}$$

In this equation, denoted by Y_t and X_t, the vector Y_t contains the dependent variables, and variables in X_t contain a mixture of I(0), I(1), or cointegrated variables. In this framework, I and _1 become slope coefficients while y represents a constant term. Further, i=1 to p and q represent optimal lag orders for the dependent and independent variables respectively. The vector _it is to represents the error terms that make up an unobservable white noise zero-mean vector process characterized by independent or serially uncorrelated components. Here, the symbol "p" denotes a lag value of the dependent variable i.e. previous values of the dependent variable could have a temporal influence on its present value. Conversely, "q" represents the lag value of the regressors expressing the number of past observations of the independent explicit variables that are accounted for in the model. This temporal dimension is necessarily essential in capturing any eventual lags of time and related impacts on the interrelation under analysis. This model structure

allows detailed scrutiny regarding the dynamics exposed among variables over time, which takes into account the possible combination of integrated and cointegrated series. This model, thus, with the inclusion of the lagged terms, takes into account the comprehensive temporal dynamics analysis and lagged effects within the system under study or in the respective phenomenon while at the same time accounting for the specific lag orders for both dependent and independent variables. Hence, to account for the unobserved stochastic behavior as well and increase para the robustness of the estimation process, the error terms have been incorporated within the model as a zero-mean white noise vector process. Since the variable also has lagged effects, checking both current and lagged values of an exogenous variable within the model will help us in doing so. Hence, in a Vector Autoregressive (VAR) model, the lag orders p and q do not have to be equal. The symbol Δ further depicts the difference operator which portrays the first difference of the variable while μ_it stands for the random disturbance error term. And yet, when energy poverty takes up the designation of the dependent variable, formulation of the Panel Autoregressive Distributed Lag (ARDL) equation specific to this variable can best be expressed as follows:

$$lnEP_{it} = \beta_0 + \beta_1 lnGIQ_{it} + \beta_2 GDP_{it} + \beta_3 GDPSQ_{it} + \beta_4 FDI_{it} + \beta_5 REN_{it} + \varepsilon_t \quad \text{--------}$$

EQ 2

On the other hand, lnEP_it is used to denote a natural logarithm of a given indicator or an index associated with energy poverty at some specific period (t) within the region under study. Coefficients β_0 to β_5 represent the slope coefficients in the equation reflecting the estimated difference in the level of energy poverty (lnEP_it) for each of the independent variables while controlling for the effect of other factors included in the model. Moreover, lnGIQ_it is the Gender Inequality, measured by the natural logarithm, regarding a times-specific random variable on gender inequality at a given time (t) within the region. The magnitude of energy poverty at a particular point in time within a defined geographical area is represented by lnEP_it, the natural logarithm of the energy poverty indicator. The inclusion of slope coefficients β_0 to β_5 enables measurement of the effect exerted by each of the independent variables on that dependent variable interesting to

know how much income, gender inequality, and renewable energy consumption contribute to energy poverty incidence. Second, the natural logarithm of the gender inequality variable is a measure of the level of discrepancy between the two sexes in an area at some point in time and will help one to investigate the relationship between gender inequality and energy poverty. While the variable GDP_it denotes the Gross Domestic Product as a measure of the economic output by countries under study at a given time (t). A squared value of GDP, GPD_sq_it, is included to capture the possibility of a non-linear relationship between GDP and energy poverty in the analysis. This makes it possible that a curvilinear relationship between economic output and energy poverty does exist, thereby bringing an insight better grained into the relationship between them. Besides, FDI_it denotes foreign direct net inflows across the countries being analyzed at the time (t). This variable is only a hint at the flow of foreign investment in the researched economies, thus raising the possibility of researching its impact on the energy poverty of the foreign capital flows. In addition, it denotes Renewable Energy Consumption, by indicating the ratio or the amount of energy from renewable sources in time t in the context of the respective country under study. The incorporation of this variable assesses the role that renewable energy may have in addressing energy poverty and is therefore likely to highlight the possible influence that sustainable energy sources might have towards mitigating energy poverty levels. Lastly, ε_t represents the error term, which could consist of certain unobserved elements that always interfere with relations relating during that particular time under consideration. The model takes into account this stochastic component to acknowledge the influence of unmeasured factors to guarantee that the estimation process is robust.

3.1.5. The importance of the ARDL Model

If there exists a single cointegrating vector already, then the method of cointegration as introduced by Johansen and Juselius in 1990 is not appropriate. It hence becomes imperative to consider other methods like that of the Autoregressive Distributed Lag (ARDL), methodology for cointegration or the bound procedural approach, of establishing long-run relationships advocated by Pesaran and Shin in 1995, and Pesaran et al. (1996), independent from whether the variables of interest are stationary (I(0)), non-stationary (I(1)) or a mixture of both. Both of these approaches were first proposed by Pesaran and Shin (1995). Apprising timing of ARDL to analyze cointegration is expected to be fair and practical estimates based on some conditions. It is for this reason that these alternative approaches in cointegration should be considered when the traditional Johansen and Juselius techniques may not apply. On the other hand, unlike the 1990 cointegration technique by Johansen and Juselius, the Autoregressive Distributed Lag (ARDL) approach to cointegration avails the cointegrating vector(s). Each underlying variable could be conceptualized fundamentally as an individual connection equation operating over time. Once a single cointegrating vector, also referred to as the underlying equation, is found the ARDL model of the cointegrating vector can be re-expressed in terms of an Error Correction Model (ECM). Thus, the ARDL approach offers a good alternative to the Johansen and Juselius approach by identifying cointegrating vector(s) when traditional techniques are inapplicable. Since each of the variables may present behavior over time, this last approach allows a better understanding about which is the relationship among the variables. In addition, testing for a single cointegrating vector would reformulate the ARDL model of the cointegrating vector into an ECM hence giving a dynamic representation of the long-run relationship among the variables at hand. Accordingly, the ARDL approach represents an excellent analysis tool for cointegration while understanding how the underlying economic or statistical processes change to unobserved long-run equilibrium. The reparametrized result thus allows acquiring both that is the 'short run' of the variables simultaneously within a unified model commonly referred to as the traditional Autoregressive Distributed Lag (ARDL) model and the long-term relationships. Reparameterization is possible because the ARDL model assumes the form of a dynamic single equation sharing the same structure as the Error Correction Model

(ECM) due to the structural resemblance between the two. A distributed lag is, therefore, that place an unlimited lag of the regressors forms a part of the regression function such that fundamentally this characterizes the distributed lag model. The reason is that this way of the analysis for cointegration provides required specific insights to find out whether an underlying variable of the model is cointegrated provided the endogenous variable is accounted for properly. The benefit of the reparametrized outcome is that it enables one to capture both short-term dynamic interplays and also long-run equilibrium relationships in a combined manner. Owing to this reason, better use of the reparametrized outcome will be used since at whichever angle, it will portray how the variables do interact at different time horizons.

The structural similarity between the ARDL model and the ECM also makes it possible to smoothly interact with approaches to extract long-term relationships from the ARDL framework. Including distributed lags into the regression function of the model ensures that dynamic relations between the variables have been taken into account and accordingly that many of the economic processes could be well represented by this model. This comprehensive approach to cointegration analysis gives valuable insights into the underlying relationships amongst variables, in the end assuming a gainful more penitent understanding of the economic or statistical phenomena being sought. On the other hand, since many cointegrating vectors do not support the ARDL method of cointegration, then it cannot be applicable in such cases. For such scenarios, the methodology introduced by Johansen and Juselius in 1990 can be considered as a possible alternative. The sections that follow will then outline the necessary requisites for using this technique and elaborate on the steps to be taken procedurally to use it. The constraint offered by the ARDL approach is one of limited applicability when one is faced with several cointegrating vectors and forces the researcher to explore other methodologies like that suggested by Johansen and Juselius. Enterprising scholars would seek to comprehend the salient conditions surrounding the use of this alternative approach would gain an all-encompassing comprehension of its scope and suitability in various empirical contexts. In addition, procedural steps to use this alternative approach are explained to direct the researchers on how to practice cointegration analysis in real-world contexts for effective deployment in empirical.

3.1.6. Stationary test

Characteristics of stationary series may be like the constant mean and persistence of autocorrelation over variations in the period over which the series is observed. This is opposed to changes in the mean and autocorrelation in non-stationary series which depend on shifts in the period of observation. It is by examination of the statistical properties of a series to ascertain the presence of stationary characteristics that it leads to an assessment of whether the same is stationary and hence, mobility becomes a distinguishing feature of stationary cumulative series (Gujarati and Porter, 2010, p.775). A theory of stationary series is one of the attractive methods in time series analysis, econometrics, and other related fields. Stationary time series begets constant statistical properties over time giving rise to a number of the analytical methods known in the literature. On the other hand, the non-stationary series turns out to be challenging most of the time where it varies in statistical properties hence making it unattainable to apply methods of analysis and interpretation across. Before delving deeper into the analysis of a time series process, it is inevitable to observe stationarity in the series since this determines how relevant results from the analytical techniques applied can be translated for the practical problem at hand. So a series must be examined for stationarity by using rigorous statistical analysis to validate the acceptability as well as the usability of any further analysis or interpretation. In simple words, we can consider that the given series is non-stationary if the variable under consideration exhibits different features of non-stationarity. Conversely, if the mean, variance, covariance, and all other statistical properties of a series remain constant over time, an extrapolation method to some future point can be inferred from that series being stationary.

This characteristic presents a critical stationarity prerequisite over time. In essence, the series is not changed by time such that it has statistically retained its attributes regardless of temporal changes over time. Even after adjusting, the dynamic nature of a stationary series persists, which shows its characteristic stability. Notably, descriptions such as "unit root," "non-stationary," and others of similar connotation terms are used interchangeably hence they have distinct meanings in the time series analysis. It is, therefore, necessary to establish the properties of a stationary and non-stationary series in varied lines of work

such as econometrics, finance, and time series analysis. For this reason, also, there is the demonstration of the stationary series stability and hence most of the statistical techniques apply to the analysis and modeling of these series making their use in empirical research very extensive. On the other hand, the dynamic nature of nonstationary series requires specialized analytical approaches that account for changes in their statistical properties. There is thus the need to identify whether a series is stationary or non-stationary as this will play a critical role in identifying the best methodologies of analysis and also maintaining the validity of further inferences reached by the use of that information. This, therefore, brings to light the important role played by the distinction between stationary and non-stationary series in empirical research and statistical analysis. Other terms used interchangeably have included the requirement of rationalizing a time series before utilizing it for forecasting, a well-recognized principle in the field. In all types of data arising in time series, the process of rationalization is essentially a prerequisite for the generation of forecasts it and is available universally. The stationarity of the variables of interest was tested using the Augmented Dickey-Fuller and Philips-Perron tests. Note that the mentioned tests have been outdated by newer versions thereby affirming the prospective nature of stationarity evaluation methodologies for time series data. The underlying importance of rationalizing the time series data before making a forecast stresses the need to determine this method in time series analysis and forecasting. Stationarity is a process of changing a non-stationary time series to a stationary series so that the forecasting models and techniques that are based on stationarity can be used. This universal step applies to a host of time-series data, ensuring the findings of the data for any forecasting purposes. The use of both, the Augmented Dickey-Fuller and Philips-Perron tests in this research is a reflection upon common practice reflective of the application of statistical tests to examine whether, or not time series data may be considered stationary. These, as one might recall, are tests developed to establish whether unit roots, indicative of non-stationarity, do exist. The continuing refinement of these tests underlines the dynamic nature of methodological developments in this branch of statistical analysis, stressing tools and techniques to judge the stationarity of time series data as an evolutionary change process. A significance threshold choice of 5% is advisable as a

common practice while taking up a statistical inquiry. Taking the following equation within the purview of a random walk, we can represent a non-stationary series as follows:

$Y_t = U_{t-1} + \epsilon_t$ …….. (3)

Reiterating within this context, it should be emphasized that the epsilon, also referred to as Epsilon variation, represents a static random disturbance term. From the viewpoint of the previous equation, the estimate for the series y remains stationary regarding time-lapse or temporal progression. This constancy, therefore, remains irrespective of the temporal dimension. But the earlier equation makes sense that as with the lapse of time, there is a larger and larger variation of the y-series as indicated by the standard deviation. Since the random walk is a unique representation of a stationary series, therefore the initial y difference is also stationary. The Epsilon variation as a stationary random disturbance term is really important in statistical modeling and time series analysis. It is, in fact, a strong symbol of randomness that is stable and does not change in the context of the specific scenario, as an essential ingredient for statistical modeling. The constancy of thevalue predictive applied by series y justifies that this particular component is stationary averting variations that would have otherwise affected stability and predictability in the overall model. Meanwhile, continually higher variability of the y-series over time displaysthat this feature displays change to time within the time series data by standard deviation.Then, the better nuance of this viewpoint is framed by the distinction to identify a randomwalk as a separate stationary series, and the identification of the starting difference in y asstationary, more definitively nailing down what stationary means, and its implications within time series analysis.

$U t – Ut\text{-}1 = (1- L) Ut = \epsilon t$ ---------- **EQ 4**

Symbol "I(d)" at that particular point in time denotes that there exists a separate stationary series then, where "d" is the degree of differencing. A represents 1 order of differencing has been done i.e. the differentiated series has only one order -difference. The order of integration serves as an indicator for the degree of non-stationarity and is expressed maximally by the number of unit roots allowed within the series and the number of times

differences were taken on the series so that it becomes stationary. Order of integration can be conceived as a hierarchical ordering of the non-stationarity in the series. If there is just one unit root in the series, then the series is an I(1) series that has a first-order integrated series property. This nomenclature is influenced by the fact that all random walks, which intrinsically introduce one unit root component, fall under this category. On the other hand, if a series has no variation over time, then it is said to be I(0), which indicates that the sequence under review is stationary and therefore needs no differencing for it to achieve equilibrium status. Conventional methods of concluding are wrong for the regressions either with integrated dependent problems or integrated regressors. Appropriately, the stated characterizations involve the fact that before crashing a series into regression analysis there is a need to establish if the series being studied holds a stationary condition and this test at all times should be done in advance to help avoid mistakes soon. The main way of establishing the stationarity of a series accommodates the use of unit root tests. This test checks on the relationship that may exist between two variables. This can create the wrong impressions that cast doubt on the integrity of time series regressions in regressions with integrated variables using conventional approaches to inference. A series is assumed to have a stationary distribution when both its mean and standard deviation neither vary over time Wooldridge, (2013). The integrated time series augers complexities that call for careful consideration and specialized analytical techniques. One has to conduct unit root tests on the variables to establish stationarity and therefore the reliability of regression results just to mention the most common. As for stationarity, the unit root test provides a fundamental tool of the groundwork for making decisions on the desired use of the time series in regression analysis. The existence of the unit roots in the variables introduces a data change possibility that may happen such that the data is not stationary. More so, in comparing stationary and non-stationary series, one will conclude that there is a difference between non-stationary series and stationary series because non-stationary series produce insensitive and defective data while stationary series are consistent with accurate and reliable results. While non-stationary series show fluctuating patterns that are erratic in nature leading to erratic unpredictable and quite misleading outcomes, stationary series always provide stable constant results over time. Variables enclosing unit roots can easily reveal non-stationary behavior with erratic and

jerky changes. Unreliable and imprecise data characterize such non-stationary series, resulting in inconsistencies an analysis results and their subsequent inferences. On the contrary stationary series lead to consistent results as they maintain their form through time.

3.1.7. ADF UNIT TEST

To test this idea, Dickey and Fuller (1979) developed a computer program to test their hypothesis. This software was designed to check the presence of a unit root in a variable and also test if the variable follows a random walk process. Furthermore, the program is equipped to determine the existence of a unit root within the variable under examination. Hamilton (1994) later tried to explain the use and effectiveness of the extended Dickey-Fuller test by giving different scenarios under which the test was optimally used. This paper primarily seeks to underscore the versatility and utility of the test in various empirical contexts. Thus, the path-breaking work by Dickey and Fuller resulted in the creation of a computer program that became itself methodological breakthrough for designing time series analysis. This software was specifically designed to enable the researcher to determine the stationarity of variables through the detection of unit roots determining their proneness towards random walk behavior. Also in the following attempts to explain the practical significance of the expanded Dickey-Fuller test that followed later, Hamilton emphasized that as for this method, the scope of its application is quite broad in many respects about various research contexts. In doing so, Hamilton sought to emphasize how the empirical viability and reliability of the test were a clear testament to its versatility as well as robustness as an instrument of measurement in multiple contexts. The basic assumption that underlies the null hypothesis is derived from the fact that the underlying variable under focus has one single unit root at every point in its distribution circumstances notwithstanding. This fundamental assertion raises a null hypothesis stating the presence of a unit root within the variable. Based on this, comparisons to the second analytical method produce some various main differences, among them being that the drift term is involved in the null hypothesis and a constant as well as a temporal trend offered in the regression used to make the test statistics. Furthermore, a basic issue in such a concern comparison is whether there exists a drift

regains part of the regression used to put up the test statistics. This weighs heavily when considering whether a drift term should be included or not in the null hypothesis. The null hypothesis represents a pivotal concept in statistical inference postulating the existence of a unit root through the entire distribution of the variable. Comparison of these various methods of analysis shows distinct differences in two regards, which are that whether a drift term is included in the null hypothesis and that contained within the regression from which the test statistics in the second method are derived are both a constant term and temporal trend. Moreover, a decision about whether or not a drift term should belong to the null hypothesis also rests on such factors. By comprehensively assessing these subtleties, a scholar is in a position to successfully navigate the complexities across the choice of an analytical framework for assessing unit roots within time series data.

$$\Delta yt=\alpha + \beta t+ \gamma yt-1+ \delta 1\Delta yt-1+\cdots+\delta p-1\Delta yt-p+1 + \varepsilon t \text{----------EQ 5}$$

This is, within the Augmented Dickey-Fuller (ADF) formulation, which might well allow for the accommodation of higher-order autoregressive processes since delays are up to order p within the ADF formulation. Therefore, it will be very important to specify the correct lag p between the happenings under study before using the ADF test on the data. This initial step is important to ensure the accurate implementation of the ADF test accounting for the potential effects of autocorrelation that are in-built into the data.

3.1.8. Johansen and Kao cointegration test

The Johansen test is one of the very well-known statistical tests, which identifies the presence of cointegration in a set of time series variables. Cointegration means that there is no long-run relationship among these variables although all of them behave non-stationary on an individual aspect. This test has significant utility in assessing the interrelationships among multiple non-stationary variables, being an extension of the Engle-Granger test. Its main objective is to look for a linear combination of the non-stationary variables showing behavior similar to stationary variables hence being able to find the underlying long-term associations among the series of variables. In the execution of this research, scholars have a good opportunity to identify relevant information on long-run relationships that may exist between variables and go beyond their stationary

characteristics. The existence of a long-run equilibrium relationship comes out explicitly in the Johansen Cointegration test. The Johansen test goes beyond the two-variable perspective of the Engle-Granger test to enable contemporaneous testing on multivariable time series variables. In the domain of panel analysis, a specific statistical paradigm developed for the exploration of data that embraces repeated observations on different entities over time, the Johansen cointegration test emerges as an important statistic for such analyses. It provides an approach that enhances the understanding of relationships between variables among various entities or groups and offers a platform to explore shared longer-term patterns or relationships among them. In addition, the Johansen test is premised on the estimation of a system in the Vector Error Correction Model (VECM) which ideally takes a given form for a system consisting of "P" variables.

3.1.9 Study Area

Table 1. Countries of Study

No.	Selected Sub-Saharan African Countries
1.	Nigeria
2.	South Africa
3.	Democratic Republic of the Congo
4.	Ethiopia
5.	Tanzania
6.	Kenya
7.	Uganda
8.	Mozambique
9.	Ghana
10.	Angola
11.	Sudan
12.	Madagascar
13.	Cameroon
14.	Côte d'Ivoire
15.	Zimbabwe

Table 2. Southern Asian Countries

No.	Selected Southern Asian Countries
1.	India
2.	Pakistan
3.	Bangladesh
4.	Sri Lanka
5.	Nepal
6.	Afghanistan
7.	Maldives

8.	Bhutan
9.	Myanmar (Burma)
10.	Cambodia
11.	Indonesia
12.	Malaysia
13.	Philippines
14.	Thailand
15.	Vietnam

Table 3. European Union Countries

No.	**Selected European Union Countries**
1.	Belgium
2.	Denmark
3.	France
4.	Germany
5.	Netherlands
6.	Spain
7.	Italy
8.	Sweden
9.	Switzerland
10.	Turkiye
11,	Norway
12.	Ireland
13.	Finland
14.	Poland
15.	Iceland

Panel A. Southern Asian Countries

Table 1. Descriptive statistics; for Southern Asian countries

	LEP	LGIQ	GDP	GDPSQ	FDI	LREN
Mean	4.070433	3.109802	5.223077	47.54301	2.415021	3.351911
Median	4.144721	3.118435	5.553500	33.12198	1.826329	3.592644
Maximum	4.602166	3.645394	26.11149	1121.767	17.13267	4.537534
Minimum	1.718013	2.406293	-33.49280	0.014434	2.757440	0.104360
Std. Dev.	0.467019	0.253841	4.508548	84.54805	2.431084	1.108127
Skewness	-1.367771	-0.099074	-2.108350	8.508976	2.183213	-1.575359
Kurtosis	5.649515	2.546616	22.75574	95.83519	10.60015	4.719734
Observations	315	315	315	315	315	315

To support the discussion, a detailed table of all the variables assessed in the present study is attached below (Descriptive statistics) which will put forward the characteristics and features of each of them. This entire table is included to allow for a detailed examination and understanding of the variables being tested. In this case, we notice the values for energy poverty, gender inequality, GDP, its quadratic form, net foreign direct investment, and renewable energy. The above variables have been assigned values of 4.0704, 3.1098, 5.2230, 47.5430, 2.4150, and 3.3519 points respectively. By providing such particularized values, we are in a position to provide a quantitative representation not only of the characteristics but also of the magnitudes of the specific variables under our analysis in this study. This will help in presenting through the table all the available data and provide a comprehensive understanding of concluding the

validity and reliability. Further, from this table, it is observed that within the distribution, the lowest value presents the net inflow of GDP. Alternatively, the quadratic form of GDP indicates the highest value observed in the series. The findings describe the range of values demonstrated by these variables enlightening the relative magnitudes and variations. Also presented in the table is the standard deviation which tells us how much individual observations deviate from their respective mean values. This measure could be regarded as trying to assess the spread or dispersion of the data points within a particular distribution. Considering the values of standard deviation, it appears that inequality regarding gender corresponded with the lowest value indicating a comparatively lesser degree of variability between the observations for this variable. On the other hand, the squared gross domestic product (GDPSQ) has the highest standard deviation indicating a relatively more dispersed or variable profile concerning this variable. Such insights of the values of standard deviation help to understand the level of variability as well as dispersion within the dataset which ultimately supports a wider analysis of the variables considered under this discussion. The data, based on a sample of 315 observations clearlyshows that most of the variables depict leftward skewness exceptions being FDI (net foreign direct investment) and GDPSQ (quadratic form of gross domestic product). This skewness indicates that the distribution of these variables is shifted towards the lower endof the range. In addition, all the variables exhibit positive kurtosis which means that the values in their distributions are more skewed and the values' tails cluster closer around theaverage or mean and have fatter extremities compared to the normal distribution. This positive skewness is a sign of the presence of anomalies or outliers in the data set. It is visible from the table that the distribution has a leptokurtic with a positive kurtosis, whichimplies that most variables have values higher than the sample average. All these indicatethat the variables tend to manifest values that are relatively larger and more dispersed concerning the average value. However, one important aspect is that the variable of gender inequality stands out differently from all others as it has a flatter bell shape. This means that the values of gender inequality are less highly concentrated at the extremes and more relatively spread around the mean. Those observations were on skewness and kurtosis serve to enhance our understanding of the variables' distributional

characteristics as well as the way these deviate from a normal distribution thus revealing the shape, measures of concentration, or measures of spread.

Table 2. Traditional unit root result: for Southern Asian countries.

Variable	ADF				PP			
	Intercept		Trend and Intercept		Intercept		Trend and Intercept	
	Level	1st Diff.	Level	1st Diff.	Level	1st Diff.	Level	1st Diff.
LNEP	0.4910	0.000	0.7957	0.000	1.000	0.000	0.5044	0.0000
LGIQ	0.8089	0.0000	0.3562	0.0000	0.8620	0.0000	0.9618	0.0000
GDP	0.9926	0.0000	0.7930	0.0073	0.9990	0.0000	0.2465	0.0000
GDPSQ	1.0000	0.0000	0.3289	0.0024	1.0000	0.0005	0.7831	0.0497
FDI	0.1803	0.000	0.1603	0.0029	0.8833	0.0040	0.4352	0.0000
LREN	0.9079	0.0000	0.8485	0.0000	0.9971	0.0000	0.9300	0.0000

The table above, hence, (Traditional unit root**),** provides an overview of the statistical results obtained through the application of the Augmented Dickey-Fuller (ADF) and Phillips-Perron (PP) methods. These tests aim to assess the stationarity of the variable under investigation, with the assumption that it does not possess a unit root. Conversely, the null hypothesis posits that the variable is non-stationary. The test outcomes enable an evaluation of the feasibility of rejecting the null hypothesis of non-stationarity in favor of the alternative hypothesis of stationarity. In statistical analysis, it is permissible to assume that a variable is stationary when the p-value associated with a particular test is less than a pre-defined level of significance, typically set at 0.05. By adhering to this criterion, we

can evaluate the hypothesis that the variable exhibits stationarity. In the present study, we aim to determine the stationarity of the dependent variable, energy poverty. To this end, we employ unit root tests, specifically the augmented Dickey-Fuller (ADF) and Phillips-Perron (PP) tests. These tests allow us to assess the presence of a unit root, which would indicate non-stationarity. Upon analyzing the results of the ADF and PP tests, we observe that the dependent variable, energy poverty, exhibits stationarity at the first difference. This implies that changes in energy poverty over time tend to be consistent and predictable, suggesting a stable pattern. However, it is important to emphasize that no definitive conclusion regarding the null hypothesis can be drawn at this stage. While the evidence supports the stationarity of the dependent variable at the first difference, further analysis and exploration are required to fully ascertain the stability and behavior of the variable under investigation. The statement encompassing both the trend and the intercept pertains to the examination of various variables. First, the independent variable of gender inequality demonstrates stationarity in its first difference form, incorporating both a trend and an intercept. However, it is found to be non-stationary in its original level form. Similarly, when observing the logarithm of the variable "renewable," it displays stationarity in its first difference form, with both the trend and the intercept being stationary. Nevertheless, the variable remains non-stationary when analyzed at its initial level. Additionally, it can be demonstrated that the gross domestic product (GDP) exhibits stationarity when analyzed in its first difference form, encompassing both the trend and the intercept. Upon careful examination of its original level, it is determined that the Gross Domestic Product (GDP) does not possess the characteristic of stationarity. However, upon taking the first difference form of the squared GDP, it is observed that both the trend and the intercept exhibit stationarity. Nevertheless, the level of the squared GDP does not demonstrate stationarity. Similarly, when considering foreign direct investment (FDI), it is found to display stationarity in its first difference form, with both the trend and the intercept exhibiting stationarity. However, in contrast to this, when evaluating FDI at its original level, it is evident that it lacks the property of stationarity. Hence, it can be deduced that the variables examined in our research exhibit integration at the first difference level. Within the realm of economics, the conversion of non-stationary data into a stationary form can be accomplished through the utilization of the first difference.

Employing the first differentiation technique on a variable, it typically eradicates any inherent trend or seasonal pattern that may be present in the initial series. This simplification of the modeling process facilitates the utilization of less intricate models, such as the Autoregressive Distributed Lag (ARDL) model. Employing panel analysis with first difference estimation reveals time-invariant statistical characteristics, thereby enabling researchers to derive accurate statistical conclusions from the data.

Table 3. Pedroni cointegration: for Southern Asian countries

Alternative hypothesis: common AR coefs. (within-dimension)				
			Weighted	
	Statistic	Prob.	Statistic	Prob.
Panel v-Statistic	7.654459	0.0000	9.803099	0.0000
Panel rho-Statistic	3.375926	0.9996	1.824645	0.9660
Panel PP-Statistic	-3.353818	0.0004	-6.933642	0.0000
Panel ADF-Statistic	-3.712653	0.0001	-7.194129	0.0000
Alternative hypothesis: individual AR coefficients. (between-dimension)				
	Statistic	Prob.		
Group rho-Statistic	3.173800	0.9992		
Group PP-Statistic	-9.677569	0.0000		
Group ADF-Statistic	-8.687930	0.0000		

The above table explains the presentation of outcomes as a part of the Pedroni residual cointegration test. The co-integration analysis is conducted to find the existence of a long-run association that may prevail amid a series of variables that have been analyzed to check the necessity of co-integration. To do so, the first differenced the variables of our study as commonly used, resulting finally in the specification of Panel Cointegration residual Pedroni. By employing such a technique as said, eight statistically significant findings resulted from the data collected. It is to be noted here, therefore, that results are significant for the relationship, though further interpretation and analysis would need to

be made to make such a definitive observation in this regard. The results of the present study keep no sound support to the null hypothesis suggesting that there is no co-integration among all selected variables. The results rather provide ample strong evidence in favor of a long-run relationship between all the variables under investigation. More specifically, the Pedroni residual-based test performs better in that it accounts for cross-sectional dependence and takes into account heterogeneity under well-formulated parameters. This new innovative technique gives a deeper and more comprehensive view of how the variables relate to one another

Table 4. Fisher combined Johansen cointegration: for Southern Asian countries

Hypothesized No. CEs	Fisher stat. (trace test)	p-value	Fisher stat. (max-eigen)	P-value
None	268.5	0.0000	1317.	0.0000
At most 1	663.5	0.0000	1011.	0.0000
At most 2	239.9	0.0000	173.3	0.0000
At most 3	98.59	0.0000	70.23	0.0000
At most 4	52.46	0.0068	44.52	0.0428
At most 5	50.40	0.0113	50.40	0.0113

Panel B. Kao Cointegration Test	**t-statistics**	**p-value**
ADF	-2.249946	0.0122
Residual variance	0.004984	
HAC variance	0.013075	

In this mode, the Fisher-Combine Johansen cointegration test described above was usedto conduct a comprehensive evaluation of the reliability of our research results. At this point, a test is done to analyze the reliability of the results obtained from Table 4. The results obtained from the pooled Johansen Fisher panel cointegration test are thus shownin Table 3 Panel A. From the results, they confirm co-integrations with all the variables

since at least five co-integrating equations show so. The results of the Johansen-Fisher panel cointegration test suggest that there exists a long-run cointegration state among the variables under consideration. This validates the sustained and firm relationship between the considering elements. Finally, to provide additional support for cointegration, we have made use of the Kao cointegration test as shown in panel B of Table 3. The use of this has allowed us to be in a position to provide additional support for the presence of cointegration. In substantial, the empirical evidence unveiled in those tests supports the claims of et. al (2011) who emphasized that the recognition of cointegration eliminates the possibilities for misspecification of long-term correlations. Thus, under such compelling evidence provided on the cointegration, therefore there is a chance to develop our core model properly and in a comprehensive manner by assessing the interrelationships among the variables under consideration. The idea of cointegration, implying a long-term equilibrium relationship among variables, puts an important premise on which we can subsequently build a sound framework for quantifying the associations and dependencies among these variables. This would mean that through identifying and making use of the presence of cointegration, we can enhance the efficiency as well as the quality of our estimations and will be able to do justice in the interpretation of these complex dynamics. Therefore, building our primary model develops the potential to make significant input into advancing knowledge in this area and thus inform decision-making processes based on a sound empirical foundation.

Table 5. Long-run PMG result: for Southern Asian countries

Variable	Coefficient	Std. Error	P-value
LGIQ	1.087465	0.041863	0.0000
GDP	0.018114	0.002367	0.0000
GDPsq	-0.001128	0.000148	0.0000
LREN	-0.656103	0.049747	0.0000
FDI	-0.006548	0.005384	0.2263

Table 3 above shows the results of the aforementioned model which was designed to be able to estimate the relationship among variables such as energy poverty, gender inequality, GDP, GDPSQ, FDI, and renewable energy consumption. The report indicates that a 1.08% rise in gender inequality corresponds to an increase in energy poverty. Women in particular suffer an undue share of energy poverty within the Southeast Asian countries through the time- and work-intensive use of traditional cooking methods involving fuel and water. This finding concurs with the result of Raihan et al.'s (2018) study. In addition, the analysis provides a strong positive relationship between GDP and energy poverty. Specifically, an increase in unitary GDP leads to a huge rise in the prevalence of energy poverty at 1.811.4%. The table, above, makes it sufficiently clearthat there is a statistically discrete and inversely proportional relationship between Gross Domestic Product per Square Kilometer (GDPSQ) and poverty rates. It could be deduced from the data that an increased amount of GDPSQ units proportionally reduces energy poverty by approximately 0.1218%. This observation establishes an inverse U-shaped income-energy poverty relationship, i.e., as income levels increase energy poverty initially reduces at an increasing rate but may eventually across a threshold¸ reduce at a decelerating rate. In addition, an analysis of the long-run results picks out a clear close negative relationship between energy poverty and foreign direct investment. More precisely, a decrease in the proportion of 0.6588% is related to increases in foreign direct investment for the energy poverty proportion. This result will strengthen the influential role of foreign direct investment in reducing energy poverty within a country. Also, results show that a significant negative relationship between renewable energy and energy poverty exists. Though not stated directly, thus from this negative relationship can be inferred that as more and more use of renewable energy sources is done, then energy poverty tends to decrease. However, the extent of such a relationship has to be further researched and analyzed. Consequently, the content of the table exposed a series of interdependencies of different factors and energy poverty. The data shows that GDPSQ, foreign direct investment, as well as renewable energy all contribute to the problem of addressing energy poverty meaningfully but through different mechanisms. The share of renewable energy grows with a significant reduction of 65.61 percent in the incidence of energy poverty. Indeed, this correlation shows that with the increase in the share of

renewable energy within the total share, these negative impacts of energy poverty are reduced to a great extent. By expanding the deployment of renewable energy technologies and reducing reliance on non-renewable sources, societies are in a better place to effectively cope with challenges associated with energy poverty which is dramatically enhancing social welfare and sustainability.

Table 6. Short-run PMG output: for Southern Asian countries

Variable	Coefficient	Std. Error	P-value
D(LEP)(-1)	-0.282910	0.106519	0.0090
D(LGIQ)	0.817423	0.741222	0.0272
D(GDP)	-0.036317	0.017913	0.0449
D(GDPSQ)	0.003417	0.001844	0.0664
D(FDI)	0.003519	0.005456	0.5203
D(LREN)	-0.143744	0.172661	0.4068
ECM (-1)	-0.182013	0.065703	0.0065

As shown in Table 6, we present the short-term result of the gauge relationship between the variables in this analysis. Similar to the long-term finding, there is a positive relationship between energy poverty and gender inequality such that a percentage increase in energy poverty increases gender inequality by 0.282%. GDP also has a positive relationship with energy poverty. An increase of one unit in GDP increases energy poverty by 0.2829%. Also, a one-unit rise in LREN is associated with a 0.1437% rise in energy poverty. All other things being equal, a 1% increase in LREN will be associated with increasing energy poverty by 0.2829%. However, following the result, there is a negative relation between per capita square GDP and energy poverty such that a unit increase in GDPSQ is associated with a 0.0034%. There is a distortion in the current or previous period that can be corrected by the ECM coefficient -0.1820 leading to attaining a long-run equilibrium from the deviation of the previous period.

Panel B. Sub-Sahara African Countries

Table 1. Descriptive statistics: for Sub-Saharan African countries

	LEP	LGIQ	GDP	GDPSQ	FDI	LREN
Mean	3.236321	3.576959	4.695405	43.65049	3.993100	3.044577
Median	3.501043	3.615463	4.781000	26.15462	4.361058	1.970593
Maximum	4.599152	4.062346	21.45206	460.1909	4.559650	39.45622
Minimum	0.879455	2.784865	-17.66895	0.004719	2.043814	-10.72495
Std. Dev.	0.878559	0.281217	4.655369	54.98017	0.703122	5.143184
Skewness	-0.510216	-0.202261	-1.090495	3.120350	-1.515138	3.654849
Kurtosis	2.480107	2.337986	7.780635	17.06168	4.093164	20.89931
Observations	315	315	315	315	315	315

As noticed from the above table, it captures expansive descriptive statistics for a sample of 315 sub-Saharan African countries about the major and critical economic indicators. The set of data involves variables that include energy poverty (LEP), gender inequality (LGIQ), gross domestic product (GDP), gross domestic product per square kilometer (GDPSQ), foreign direct investment (FDI), and renewable energy consumption (LREN). Ideally, for the mean, the interpretation is to give insight into central tendency and variation among the indicators and distributional characteristics of the said indicators within the region. The mean values depict the average levels of the respective economic indicators within the countries that are sampled. In particular, its mean gross domestic

product (GDP) is at the highest (4.695405) which means the area has a relatively high average economic output within the region. The subsequent indicators are energy poverty (LEP) (3.236321) and foreign direct investment (FDI) (3.993100), both indicating a favorable socioeconomic status in the area. In contrast, relatively inferior mean values of 3.044577 and 3.576959 are evident in renewable energy (LREN) and gender inequality (LGIQ), respectively. Median values remain superior measures for central tendency which resist outliers. Assuming that these are characteristic indicators of development for the relevant countries, then, from these indicators, GDP achieves the highest median (4.781000) with a relatively equidistant spread. On the other hand, gross domestic product per square kilometer (GDPSQ) shows a lower median value (26.15462), which indicates an asymmetric distribution towards low values. That way, such maximum and minimum values show the range and extremities of data. Gross domestic product (GDP) denotes the widest range with its maximum value at 21.45206 and the minimum value at -17.66895. This shows a wide disparity in economic performance across the selected countries. In the case of logarithm gender inequality (LGIQ) and renewable energy (LREN), they show narrow ranges indicating relatively homogeneous educational outcomes. Standard deviation measures dispersion or rather the spread of data points from the mean. In this case, the highest standard deviation is for gross domestic product per square meter (GDPSQ) with a value of 54.98017, which means that spatial economic productivity can be seen to have high variation. On the other hand, gender inequality (LGIQ) has the lowest standard deviation (0.281217) thus harboring relative uniformity in the level of gender inequality. Skewness measures the symmetry of the data distribution whereas kurtosis measures the degree of peakedness or flatness. Gross Domestic Product per Square (GDPSQ) has positive skewness (3.120350) which indicates that it's distributed to the right thus having its right tail longer than its left side, i.e., there are countries with much moreeconomic productivity per unit of area. Further, GDPSQ data exhibits a high kurtosis (17.06168) meaning that GDPSQ has a leptokurtic distribution with heavy tails which couldmean that is more volatile.

Table 2. unit root: sub-Saharan African countries

Variable	ADF				PP			
	Intercept		Trend and Intercept		Intercept		Trend and Intercept	
	Level	1st Diff.	Level	1st Diff.	Level	1st Diff.	Level	1st Diff.
LNEP	0.9906	0.0000	0.7876	0.0000	0.1928	0.0000	0.0001	-----
LGIQ	0.4920	0.0000	0.2413	0.0000	0.4135	0.0000	0.5315	0.0000
GDP	0.0883	0.0000	0.0015	0.0000	0.0000	0.0000	0.0000	0.0000
GDPSQ	0.0001	0.0000	0.0008	0.0000	0.0000	0.0000	0.0000	0.0000
FDI	0.0317	0.0000	0.0268	0.0000	0.0066	0.0000	0.0139	0.0000
LREN	0.5117	0.0000	0.9702	0.0000	0.8544	0.0000	0.9967	0.0000

The above table presents the results of the unit root tests carried out on the variableswith special concern for energy poverty (LNEP) and gender inequality (LGIQ). Thetests have used the Augmented Dickey-Fuller (ADF) and Phillips-Perron (PP) tests whichare used to test the stationarity characteristics both in level and after applying first differencing. The unit root tests play a crucial role in assessing the stationarity propertiesof these economic indicators. More specifically, concerning LNEP and LGIQ variables,unit root test results reveal that the null hypothesis could not be rejected at the current level. This is reflected for these variables as nonstationarity, which refers to the variables that do nothave a constant mean and could show trends or other systematic patterns over time. Theseare important results for making analyses and interpretations about variables. Nonstationary characteristics would prove major statistical modeling challenges and would require further analysis to discern any inherent trends or tendencies. It may involve using supplementary procedures such as first differencing or even modeling the variableslike integrated processes to meet their nonstationary nature. Overall, the unit's root

test findings bring to attention the stationarity properties of the economic indicators specifically pointing out on nonstationary of LNEP and LGIQ at the current level. Further research and analysis are imminent for a fuller understanding of the dynamics and implications of these nonstationary characteristics to the research or analysis under consideration. The first differencing applied to data reconfirms stationarity for both energy poverty (LNEP) and gender inequality (LGIQ), on its part, a result that therefore underlines the difference required of making the data typical for robust econometric modeling. The series becomes stationary since most of the trends or non-random patterns were eliminated after differencing making the data more friendly for analysis and interpretation. Further to these, the variables GDP, GDPSQ, FDI, and LREN demonstrate the presence of strong stationarity at both level and first-order differencing. This is confirmed by the statistically significant ADF and PP test statistics. These results indicate that those variables have a stable mean and do not have drifts or non-random patterns over time which makes them appropriate for econometric modeling. Therefore, from the test results, it can be deduced that the nature of integration within the variables used in this analysis is mixed in nature. This is to say that some of the variables are difference stationary while others are already stationary at their original level. In this regard, appreciation of the order of integration of the variables is handy in model selection, so as to achieve valid econometric analysis. The first differencing has, in brief, indicated that both LNEP and LGIQ are stationary after similar outcomes have already been demonstrated using the different techniques employed to difference series. Again, the variables GDP, GDPSQ, FDI, and LREN exhibit strong stationarity, both before and after differences, as proven by a high statistical significance of the test statistic. These findings inform us on the integration properties of the variables allowing us to take up appropriate modeling approaches for our analysis.

Table 3. Pedroni cointegration: for Sub-Saharan African countries

Alternative hypothesis: common AR coefs. (within-dimension)				
	Statistic	Prob.	Weighted Statistic	Prob.
Panel v-Statistic	2.926824	0.0017	3.769657	0.0001
Panel rho-Statistic	1.394917	0.9185	2.353222	0.9907
Panel PP-Statistic	-10.65660	0.0000	-7.144700	0.0000
Panel ADF-Statistic	-4.716966	0.0000	-4.706134	0.0000

Alternative hypothesis: individual AR coefs. (between-dimension)		
	Statistic	Prob.
Group rho-Statistic	3.582223	0.9998
Group PP-Statistic	-11.94481	0.0000
Group ADF-Statistic	-5.983797	0.0000

At the level of the panel analysis, the table above applies the Pedroni cointegration test to ascertain whether there are common and unique autoregressive (AR) coefficients in aspects across as well as between dimensions. The alternative hypothesis further indicated that AR coefficients were more common within the dimensions and between one dimension to another. The provided table of the series of tests conducted explains each measure from a statistical perspective. In particular, the Pedroni test of cointegration examines the presence of common and individual autoregressive (AR) coefficients in the case of panel data by embedding within-dimension and between-dimension relationships. The outcome of the analysis is as follows: 1. Common AR Coefficients (Within-Dimension). The values of the Panel v-Statistic (2.926824) and Panel PP-Statistic (-10.65660) are statistically significant with respective probabilities of 0.0017 and 0.0000. The results from the analysis provide some support that suggests that the common autoregressive (AR) coefficients exist by dimensions. However, it is only worth mentioning that the rho-statistic (1.394917) for the Panel and the ADF-statistic (-4.716966) for the Panel are statistically mom manga. These nonsignificant outcomes throughout

reflect that evidence continues to remain quite dodgy about the shared AR coefficient resting within dimensions. This will require the need for more detailed analysis and examination to be defined. In contrast, such an analysis shows strong evidence existence of AR coefficients between individual dimensions. Both the Group Rho-Statistic (3,582223), Group PP-Statistic (-11,94481), and Group ADF-Statistic (-5,983797) again produce highly significant values near zero and this time with p-values close to zero (0,9998, 0,0000, and 0,0000). This result gives the first indication that there may be needing to provide individual dimension AR coefficients. Accordingly, the magnitudes of the individual AR coefficients between dimensions found significant imply that in the long run, integration, and estimating of the variables under analysis are likely to be possible. Including these variables in the analysis is likely to provide a better view of how these features interact and together contribute to shaping the dynamics of the dataset. However, further analysis should be done and there should be more factors to be accounted for to make it robust and reliable results.

Table 4. Fisher combined Johansen cointegration: for Sub-Saharan African countries

Hypothesized No. CEs	Fisher stat. (trace test)	p-value	Fisher stat. (max-eigen)	P-value
None	2371.	0.0000	2371.	0.0000
At most 1	620.0	0.0000	385.9	0.0000
At most 2	258.2	0.0000	175.7	0.0000
At most 3	112.6	0.0000	81.43	0.0000
At most 4	56.01	0.0027	45.28	0.0363
At most 5	32.07	0.3642	32.07	0.3642

The table above represents the results of different possibilities of cointegration equations among the variables regarding the Fisher-Johansen combined cointegration test. This implies that under the null hypothesis, there is no cointegrating equation while under the alternative hypothesis, there is the presence of a cointegrated system among the regressors. The results in Table 4 indicate that, by using the trace test, the null hypothesis "at most 4 cointegrating equations" is not strongly rejected. There is evidence of accepting it since its p-value, 0.0027, was less than a significance level of 0.05 usually accepted. Yet, it is important to notice that while being statistically significant the p-value is not overtly low. They claim that there are signs in favor of the existence of cointegration between the variables but still the level of significance is not outstandingly high. While the results hardly give a conclusive basis for cointegration, it has implied the necessity to continue further research and the necessity of considering new hypotheses. These findings must be taken with caution to generate additional statistics tests or methodology to have a better and deeper interpretation of the cointegration relations between variables being studied. Hence, future research would be in a position of confirming or refuting the cointegrating presence and bringing out more robust insights on the long-run differences between the variables. To conclude, it is worth mentioning that the resultsobtained through the Fisher-Johansen joint cointegration test put a solid line under conducted analysis and raise the issue of further research to consider the alternative hypotheses more thoroughly. They offer a concise and swift stepping stone forthe formulation of further hypotheses and may also give a pointer to future research, whichwill be directed towards helping us understand the underlying cointegration relationshipsamong the variables. The max-eigen test yields a p-value of 0.0363, hence from this information, rejection follows for the interpretation posed on the analysis. This result means that there possibly exists some ambiguity or vagueness in the said findings and therefore requires cautious interpretation. Consequently, reject the null of no cointegrationleading to a conclusion that variables under consideration are co-integrated in long run asmajorly the probability values are below the 5% threshold. This confirms the cointegration property in panel data of the variables and hence points towards a stable, long-run relationship among the variables across different entities.

Table 5. Long-run PMG output: for Sub-Saharan African countries

Variable	Coefficient	Std. Error	P-value
LGIQ	0.136987	0.076457	0.0753
GDP	-0.019089	0.004639	0.0001
GDPsq	0.000982	0.000238	0.0001
LREN	-0.634395	0.089619	0.0000
FDI	0.004349	0.000792	0.0000

The above represents long-run results that are generated from the PMG model considered useful in estimating the coefficients of the variables independent from what is under study as a context to this analysis. A very important test regarding the reliability of these coefficients and confidence that can be placed in the observed as well as predicted relationships is provided by their statistical significance. In this view, the variables GDP, GDP squared, LREN, and FDI emerge to be statistically significant about the impact on a dependent variable. The important point to note with these findings is that changes in these variables significantly impact the outcome of interest. For instance, the positive relationship between a one-percent increase in gender inequality was an increaseof 0.137% in energy poverty as outlined by the results of the analysis. This means thatmore gender inequality levels are associated with an increased prevalence of energy poverty within the considered context. Apart from the above, the findings of this study provide useful information about energy poverty dynamics and arguably the fact that gender inequalities are one of the most effective strategies in the fight against energy poverty. Thereby, recognition of the statistically meaningful relationships between the variables will allow reaching the evidence-based policies and priorities of stakeholders aimed at mitigating gender inequality together with sustainable development. This should be achieved through a series of interventions that contribute to reducing energy poverty and ensuring inclusive economic growth. The analysis depicts a significant positive relationship existing between gender inequality and energy poverty, which gives an impetus to amicably deal with the issues of gender disparities to mitigateenergy poverty. Efforts aimed at reducing gender inequalities can have the effect of

improving access to energy for marginalized groups. This reveals the fact that thus policies and initiatives to augment gender parity in the scenario of energy access may be crucially reflexive in dealing with the issue of energy poverty prevailing in the context. Furthermore, the data also reflects a positive association between an enhancement in GDP rates and a decline in the figures for energy poverty. Particularly, with each unit of GDP increasing, there is a significant decrease of 1.9% in the incidence of energy poverty. This result implies that economic growth promotes increased access to factors associated with energy, hence provoking a decrease in the levels of energy poverty. This table also brings out the fact that GDPSQ (squared GDP) has a strong positive relationship with energy poverty. This could be translated to mean that there is an incremental change in energy poverty of 0.0982% for every rise of just one unit of GDPSQ. Initially, GDP growth positively contributes to the decline in energy poverty but this contribution becomes unfavorable with continued GDP growth. The results from the analysis of the relationship between GDP squared and energy poverty depict an interesting inverse U- shaped relation yet again suggesting the existence of a threshold level of economic development. Below this, energy poverty increases. This is an indication of the fact that with higher percentages of economic development gains in countries, the capacity to invest in infrastructures and technologies for effectively combating energy poverty gets enhanced. This underpins sustained economic growth and development as the key driverof reducing energy poverty. Additionally, it identifies a direct relation between foreign direct investment (FDI) and access to electricity. The coefficient for FDI in the table is 0.004349, indicating a positive correlation between FDI and energy poverty. This implies that foreign investment entry into the sector is likely to enhance increased accessto electricity, hence the reduction of energy poverty levels. This brings out the potential influence of foreign investment in supporting capacity and other activities targeting improvement and expansion of access to energy. In addition, this research brings to lightthe inverse correlation between energy poverty and renewable energy. While not broughtout in the above statement, such a highlighted inverse correlation points to the fact that increased access to power with reliance on alternative and preferably renewable sources of energy will go a long way toward the reduction of energy poverty. Through promoting theadoption of renewable energy technologies, nations could enhance access to energy by

citizens in placing them on the benefitting side of the energy equation. Secondly, the analysis indicates a statistically significant negative correlation between the use of renewable energy and energy poverty as indicated by the coefficient for LREN in the table (-0.634395). This negative relationship points out that greater reliance on renewable energy sources is associated with a lesser level of energy poverty. Consequently, these findings point out the need to transition towards sustainable and cleaner sources of energy as a promising way forward in handling energy poverty in the studied context. These are insights that inform energy policy and decision-making processes. Additionally, the results point out that research and monitoring are required on this topic to developpolicies and instruments to enhance the dynamics between energy poverty and renewable energy. With the ongoing investigations, along a similar line, they can also be used to determine the techniques, policy interventions, and technological methods that are well fitin aiding the transition process towards sustainable energy systems without forgetting at least the pressing problem of energy poverty.

Table 6. Short-run PMG output: for Sub-Saharan African countries

Variable	Coefficient	Std. Error	P-value
D(LEP)(-1)	0.217421	0.156732	0.0630
D(LGIQ)	2.023077	0.950925	0.0351
D(GDP)	0.009065	0.005426	0.0970
D(GDPSQ)	-0.000892	0.000535	0.0975
D(FDI)	0.010220	0.008005	0.2037
D(LREN)	0.784506	1.878255	0.6768
ECM (-1)	-0.626643	0.183649	0.0008

From the short-run PMG model results above, it is observable the results are significant as they outline the dynamics of energy poverty among the Sub-Saharan African nations. The following results are significant for attempted variables. Generally, this analysis has exposed the extent to which gender inequality positively and significantly influences energy poverty. Indeed, a 1% increment in gender inequality is associated with a considerable 2.023% increment in the levels of energy poverty, ceteris paribus. Besides, revisiting the statistical significance at a 10% level reveals results that report the increase in Gross Domestic Product (GDP) leading to an insignificant energy poverty increase at 0.9%, thus showing some form of variation within this relationship. It is, though, noted that there exists not a steady linear relationship between GDP and energy poverty. The inclusion of the squared GDP variable shows a statistically significant negative relationship with energy poverty.

This implies that as there is an improvement in the GDP, the decrease gets heightened due to energy poverty. Specifically, with the share's estimation of a one percent improvement in squared GDP, there is a slight percentage of 0.00892% reduction due to energy poverty. These findings shed further light on the complexity of energy poverty dynamics in Sub-Saharan African countries, manifesting as a deleterious effect of gender inequality and a nuanced GDP-EP link. The findings, therefore, bring out the need for relevant interventions and policy measures that would help decrease the gender gap as well as foster inclusive economic growth that can effectively dampen energy poverty in the region. This observed inverse relationship therefore shows that as a country observes its economic growth and increase in wealth, it tends to channel resources toward investments targeting alleviating energy poverty.

This therefore indicates the purposive effort of each of these countries toward the problem of energy poverty as a growing country. The other result of the error correction is represented by a negative and significant constant indicating to be of a built-in mechanism that has been present in the system, acting towards the restoration of equilibrium at the level of 62.7%, following any deviation from the long-run relationship between variables. What is demonstrated in practical terms then is that if a temporary shock or external factor is causing the equilibrium to deviate from its long-run position, it has

inherently corrective capacity within the system which will operate over time to bring the variables back into balance. These results emphasize the resilience and self-regulating characteristic scenario of the system against short-term turmoil. Hence, they are indicating that under the temporal deviations, the system works in favor of the long-run state of equilibrium to regain its stability and sustainability. Insight into this could help policymakers and stakeholders design strategies and interventions that respond to short-term challenges through systems' inherent corrective mechanisms as they confront short-term challenges to maintain the overall long-term equilibrium of the energy poverty conundrum. The significant observed error correction term encompasses a substantial contribution towards the reduction of energy poverty levels in the short run.

This finding underpins the dynamic nature of the investigated relationship accentuating that any temporary deviations from equilibrium characterize an active rectifying, therefore exercising a stabilization impact on energy poverty levels in Sub-Saharan African countries. The existence of an error correction term that is statistically significant signifies that the system has such kind of mechanism, where it actively responds to short-run disruptions and gets itself back within the framework of long-term equilibrium. The mechanism plays a critical rationing role in reducing the effects caused by short-lived disturbances or shocks on the levels of energy poverty in this way. Therefore, explicitly resistant behavior to situations that are deviations from equilibrium and works effectually in its basic form towards reducing energy poverty. By so doing, and from considering this dynamic relationship and responsiveness of a system to the short-term interruptions, the policymakers and stakeholders would be placed in a good position to understand the aspects responsible for energy poverty in the multivariate systems and with specific intervention measures. Such interventions would allow the harnessing of inherent corrective mechanisms of the system, promoting stability and effective mitigating of energy poverty in the Sub-Saharan African countries.

Panel C. European Union Countries

Table 1. Summary statistics of selection European Countries.

	LEP	LNGIQ	RGDP	QGDP	REN	FDI
Mean	4.603094	3.263321	4.567083	22.54165	23.08929	4.150847
Median	4.605170	3.295889	4.703202	22.12012	15.57500	2.330715
Maximum	4.605170	3.457579	9.109975	82.99164	82.79000	86.47915
Minimum	4.554402	2.874790	1.413667	1.998455	1.440000	-36.14035
Std. Dev.	0.008256	0.132803	1.299396	12.00012	19.97933	9.678882
Skewness	-4.039470	-1.000660	-0.099949	1.042865	1.266458	2.877784
Kurtosis	18.53701	3.442821	3.509238	5.856702	3.660810	23.22223
Observations	336	336	336	336	336	336

The summary statistics provided above offer a nuanced comprehension of critical variables characterizing a panel of selected European nations, which encompasses elements such as energy poverty (LEP), gender inequality (LNGIQ), Gross Domestic Product (RGDP), its quadratic form (QGDP), renewable energy (REN), and net foreign direct investment (FDI). Central tendencies, reflected in mean values, reveal Energy Poverty at 4.603094, Gender Inequality at 3.263321, GDP at 4.567083, Quadratic GDP at 22.54165, Renewable Energy at 23.08929, and Net FDI at 4.150847. Minimal deviations between means and medians suggest symmetrical distributions, barring Energy Poverty, which exhibits a slight asymmetry. As for the measures of dispersion, such as standard deviation, highlight Gender Inequality's low variability (0.132803) and Quadratic GDP's broad range (12.00012). Skewness patterns reveal pronounced asymmetry in Energy Poverty, Gender Inequality, and Net FDI, indicative of non-normality. Kurtosis, signifying tails and peakedness, indicates leptokurtosis, notably in Net FDI and Energy Poverty, while Gender Inequality deviates with a flatter distribution. Examination of maximum and minimum values uncovers notable outliers in Net FDI (86.47915, -36.14035), necessitating closer scrutiny due to their potential influence on overall distribution. Skewness and kurtosis values, particularly for Energy Poverty and Net FDI, underscore the impact of extreme values on the departure from normality. The findings emphasize the need for researchers and policymakers to consider the unique distributional characteristics of each variable for accurate interpretation and informed decision-making.

Table 2. Stationarity test for selected European Countries.

Variable	ADF				PP			
	Intercept		Trend and Intercept		Intercept		Trend and Intercept	
	Level	1st Diff.	Level	1st Diff.	Level	1st Diff.	Level	1st Diff.
LEP	0.1780	0.0073	0.7016	0.0002	0.9988	0.0091	0.8058	0.0002
LGIQ	0.7499	0.0000	0.5152	0.0000	0.8316	0.0000	0.3151	0.0000
GDP	0.5425	0.0000	0.7945	0.0017	0.7936	0.0000	0.8425	0.0339
GDPSQ	0.7440	0.0000	0.8559	0.0002	0.9326	0.0000	0.9054	0.0058
FDI	0.2502	0.0000	0.5041	0.0000	0.8744	0.0060	0.5153	0.0000
LREN	1.0000	0.0000	0.9440	0.0000	1.0000	0.0000	0.7694	0.0000

The table presents unit root test results for various economic variables across a selection of European nations, providing insights into the stationarity of these variables. Notably, the variables include LEP (log of energy poverty) and LGIQ (log of gender inequality) alongside other economic indicators like GDP, GDPSQ (GDP per capita squared), FDI (Foreign Direct Investment), and LREN (log of renewable energy). The critical information extracted from the table is that all the examined variables, including LEP and LGIQ, are found to be integrated in the first order. This implies that these variables exhibit a unit root at their levels, indicating a long-term trend or pattern. However, the first differences of these variables are stationary, suggesting that fluctuations and changes in these economic indicators are more informative for analysis than their absolute levels. In practical terms, for LEP (log of energy poverty) and LGIQ (log of gender inequality), policymakers and researchers should focus on the changes in these variables over time

rather than their raw values. This knowledge is crucial for formulating effective policies aimed at addressing energy poverty and gender inequality in the selected European nations, recognizing the dynamics revealed by the unit root tests. Based on the above information provided, we now go on to test the long-run equilibrium position of the variables considered by this study. Hence, the researchers test for the level of cointegration to establish long-run connections among the variables.

Table 3. Pedroni cointegration test for selected European countries.

Alternative hypothesis: common AR coefs. (within-dimension)

			Weighted	
	Statistic	Prob.	Statistic	Prob.
Panel v-Statistic	-9190.667	1.0000	-1.743703	0.9594
Panel rho-Statistic	-0.022573	0.4910	-0.371935	0.3550
Panel PP-Statistic	-1.602002	0.0546	-2.657141	0.0039
Panel ADF-Statistic	-1.558301	0.0596	-3.035786	0.0012

Alternative hypothesis: individual AR coefs. (between-dimension)

	Statistic	Prob.
Group rho-Statistic	0.459186	0.6769
Group PP-Statistic	-1.924073	0.0272
Group ADF-Statistic	-2.184772	0.0145

In the above table, we present Pedroni cointegration test results, which examine selected European countries by providing insights into the presence of common and individual autoregressive (AR) coefficients within and between dimensions, respectively. The null hypothesis of common AR coefficients within dimensions is not rejected, as indicated by Panel v-Statistic's extremely low p-value of 1.0000, suggesting the existence of a common trend across the panel of nations. The Panel PP-Statistic and Panel ADF-Statistic,though exhibiting p-values slightly above conventional significance levels, hint at potential common AR coefficients, reinforcing the notion of cointegration. However, thePanel rho-Statistic falls short of statistical significance, implying caution in fully acceptinga common trend. In the context of individual AR coefficients between dimensions, the

rejection of the null hypothesis is evident, supported by the statistically significant Group PP-Statistic and Group ADF-Statistic, suggesting that individual trends also play a role in the dynamics. These findings collectively suggest the likelihood of cointegration relationships among the economic variables within the selected European countries, emphasizing both common and individual trends that should be considered in further econometric modeling and policy formulation.

Table 4. Johansen Cointegration test for selected European nations.

Hypothesized No. of CE(s)	Fisher Stat.* (from trace test)	Prob.	Fisher Stat.* (from max-eigen test)	Prob.
None	124.9	0.0000	68.06	0.0000
At most 1	95.82	0.0000	50.39	0.0000
At most 2	74.48	0.0000	44.10	0.0000
At most 3	40.90	0.0000	27.44	0.0000
At most 4	19.39	0.0007	13.95	0.0075
At most 5	14.83	0.0051	14.83	0.0051

Panel B. Kao Residual Cointegration Test				
			t-Statistic	Prob.
ADF			-1.862196	0.0313
Residual variance		1.67E-07		
HAC variance		8.16E-07		

The table presents results from the famous Johansen cointegration analysis, specifically utilizing the panel Fisher combine method, to investigate the long-run convergence of variables among selected European nations. The hypotheses tested various scenarios regarding the maximum number of cointegrating relationships (CEs) among the variables. The Fisher statistics, employed for both the trace test and max-eigen test, are pivotal in assessing the significance of cointegration. Across all hypotheses, including the absence of cointegration (None), at most one cointegration relationship, up to two, three, four, and five, the Fisher statistics exhibit remarkably low associated probabilities (p-values close to zero). This compellingly rejects the null hypothesis in each case, indicating robust evidence of cointegration among the variables. Therefore, the findings suggest a stable,

long-term relationship among the considered variables for the European nations in question. This implies that these variables exhibit a level of convergence over time, a crucial insight for policymakers and researchers seeking to comprehend the interconnectedness and mutual influence of these economic factors within the context of the analyzed nations.

However, in **Panel B**, the outcomes of the Kao cointegration test are presented, serving as a robustness check in conjunction with the Johansen cointegration analysis. The findings unequivocally reveal the presence of long-run equilibrium relations among the regressors. This determination is established through the assessment of the statistical significance of the Augmented Dickey-Fuller (ADF) statistics. The reported probability values associated with the ADF statistics are observed to be statistically significant at the conventional 5% level of significance. This statistical significance underscores the robust evidence supporting the existence of long-term associations among the variables under consideration. The outcome, indicative of a strong long-run relationship among the variables, enhances the overall confidence in the stability and coherence of these relationships. This empirical validation is essential for researchers and policymakers seeking a comprehensive understanding of the enduring interconnections among the analyzed variables.

Table 5. Long run PMG output for the panel of European nations.

Variable	Coefficient	Std. Error	P-value
LGIQ	14.72119	2.537032	0.0000
RGDP	-9.222453	1.508102	0.0000
QGDP	0.656907	0.112224	0.0000
REN	-0.110932	0.011434	0.0000
FDI	0.072229	0.029962	0.0167

The above table presents the long-run Panel Mean Group (PMG) output for a panel of European nations, with energy poverty (denoted as LGIQ) as the dependent variable and gender inequality (LGIQ), Gross Domestic Product (RGDP), quadratic form of GDP (QGDP), renewable energy (REN), and net foreign direct investment (FDI) as independent variables. The estimated coefficients offer insights into the relationships between these variables. Notably, gender inequality (LGIQ) exhibits a positive and statistically significant coefficient of 14.72119, implying that an increase in gender inequality is associated with a considerable rise in energy poverty. Conversely, both RGDP and QGDP display negative coefficients of -9.222453 and 0.656907, respectively, indicating an inverse relationship with energy poverty. This suggests that higher levels of economic output and a non-linear effect of GDP contribute to a reduction in energy poverty. Furthermore, renewable energy (REN) and net foreign direct investment (FDI) exhibit negative coefficients of -0.110932 and 0.072229, respectively, both statistically significant. This suggests that an increase in renewable energy and net FDI contributes to a decrease in energy poverty. The statistically significant p-values (all < 0.05) underscore the reliability of these findings. In sum, the results suggest that gender inequality exacerbates energy poverty, while economic output, renewable energy, and net FDI serve as mitigating factors, providing valuable insights for policymakers aiming to address energy poverty in European nations.

Table 6. Short run PMG output for European countries.

Variables	Coefficients	Std. error	P-value
D(LEP)(-1)	0.601076	0.003473	0.0000
D(RGDP)	33.89066	13.96048	0.0160
D(QGDP)	-3.501901	1.266840	0.0062
D(FDI)	0.022895	0.050118	0.6482
D(LNGIQ)	-10.15492	3.856247	0.0091
D(REN)	-0.812310	2.110546	0.0345
ECM(-1)	-0.488513	0.083617	0.0000

The table above presents the outcomes of the short-run PMG analysis for European countries, focusing on the dynamic relationships among variables. In this context, the dependent variable is the first difference of energy poverty (D(LEP)), and the independent variables include the lagged first difference of energy poverty (D(LEP)(-1)), the first differences of Gross Domestic Product (D(RGDP)), quadratic form of GDP (D(QGDP)), net foreign direct investment (D(FDI)), gender inequality (D(LNGIQ)), and renewable energy (D(REN)). Additionally, the error correction term (ECM(-1)), capturing the speed of adjustment to long-run equilibrium, is included. Notably, the lagged first difference of energy poverty (D(LEP)(-1)) exhibits a positive and highly significant coefficient (0.601076), indicating a strong persistence in the short-term impact of energy poverty. Among the other variables, changes in Gross Domestic Product (D(RGDP)) and quadratic form of GDP (D(QGDP)) show significant negative coefficients (33.89066 and -3.501901, respectively), suggesting that short-term adjustments in economic output contribute to a decrease in energy poverty. Interestingly, changes in net foreign direct investment (FDI) and gender inequality (LNGIQ) do not show statistically significant impacts on short-term energy poverty changes. Additionally, changes in renewable energy (D(REN)) exhibit a negative and significant coefficient (-0.812310), implying that short-term increases in renewable energy are associated with a decrease in energy poverty. The error correction term ECM (-1) is negative and highly significant, indicating a strong adjustment towards long-run equilibrium. The negative sign indicates that the system corrects disequilibria from the previous period, converging towards long-run equilibrium. The magnitude of the coefficient (-0.488513) signifies the speed of adjustment. In this case, the economy adjusts by approximately 48% towards achieving long-run equilibrium in each period. This implies that, if the system experiences a deviation from its long-run equilibrium state, almost half of that deviation will be corrected in the subsequent period, illustrating a relatively quick adjustment process. The significance of the ECM and its negative value underscore the importance of considering the short-run dynamics and the mechanism through which the system corrects deviations to achieve a more stable long-run state. Policymakers can use this information to gauge the effectiveness and efficiency of interventions aimed at steering the economy towards equilibrium in the presence of short-term disturbances.

Chapter IV
Results and Analysis

4.1.1. Comparative Analysis of Energy Poverty and Gender Inequality

Comparative gender inequality and energy poverty results and implications in the Southern Asian, Sub-Saharan African, and European Union countries with a focus on women empowerment are viewed below:

Southern Asian Countries

Energy Poverty: From the finding of the analysis in Asian countries, it reveals a significant portion of population in Southern Asian countries lacks access to reliable and affordable energy sources, particularly in rural areas. The increasing energy inaccessibility to modern energy service contributes increased energy poverty that affect women disproportionately due to their roles in household responsibilities and informal economies.

Gender Inequality: The results suggest that gender inequalities continue to exist even at the highest level of recognition in Southern Asian countries as they become important not only for women's access to education, economic opportunities but also to decision-making positions. Women are more disadvantaged from energy poverty due to their limited participation in taking out decisions related to energy and low-income levels affecting them the most being a major domestic energy manager in most of the households.

Women's Empowerment: An analysis into the importance of empowering women in Southern Asian countries through enhanced access to education, economic opportunities and making decisions on the energy sector. Addressing gender perspectives in energy access dispirities as well as involvement of women has got positive implications for development and elimination of poverty.

Sub-Saharan African Countries

Energy Poverty: Analysis indicates lack of access to modern energy services in the selected Sub-Saharan African countries, and this explains the absence of the same that

disproportionately renders women and girl's poor. Lack of access to modern energy in the selected Sub-Saharan African countries poses hindrances to economic development as well as contributing disparities in health and education.

Gender Inequality: The results suggest that persistent gender disparities exist in the Sub-Saharan countries, undermining access by women to education, health care, and economic opportunities. Gender-based violence, together with cultural norms, heightens those long-standing disparities, hindering women from capitalizing on enhanced energy supplies.

Women's Empowerment; The analysis underlies the potential for women empowerment initiatives to influence on energy poverty and gender inequality in Sub-Saharan African countries. Female empowerment through education, entrepreneurship, and leadership roles in energy sector will reflect more inclusive and sustainable development.

European Union Countries

Energy Poverty; While access to modern energy services is more widely spread in the European Union countries, the analysis for the selected EU countries reveals pockets of energy poverty particularly among marginalized communities and vulnerable populations including women and immigrants.

Gender Inequality; Findings indicate that European Union countries have experienced little inequality change, especially the issue of gender to capture the representation in leadership, wage differentiation, and work-life. Energy-related issues affecting women are mainly characterized by affordability of services of energy and unpaid care burden.

Women's Empowerment; An analysis of the given context would thus imply the requirement of the appropriate set of policies and measures to be adopted for facilitating women in contributing towards energy access and sustainability within the member nations of the European Union. This involves actions on redressing gender imbalances in the energy sector workforce, among others in ensuring that women's needs and priorities are integrated within the approach of energy policies. Commonalities and differences based on the comparative interregional analysis are noted. This demonstrates the fact that even though manifestations of energy poverty as well as gendered inequality vary from

region to region, the systemic problems plagued upon womankind remain almost same in all nations. The analysis also specifies best practices and policy interventions that worked in other places and have been effective in other countries to counter these problems, offering possible pathways for improvement across regions.

4.1.2. Relationship between Energy Poverty and Gender Inequality

The relationship between gender inequality and energy poverty is multi-leveled and complex, it manifests itself in a special manner at countries of the Southern Asia, Sub-Saharan Africa, as well country members of European Union.

Southern Asian Countries

Gender inequality and energy poverty share the same wavelengths at countries of the Southern Asia. This is where the major household energy management responsibilities normally lie on women who involve in activities ranging from cooking to heating and collection of water. However, with limited access of modern energy services, majority of women still rely on traditional and inefficient cooking methods such as solid biomass and kerosene stoves which have adverse health and environmental impacts. This dependency on traditional sources of energy only creates a cyclical energy poverty because women end up spending hours and money getting these fuels and making use of them, which in turn limits the time they can spare for educational, employment and economic empowerment work. Additionally, energy services that are not reliable limit women from participating in the formal economy and increase gender inequality in education and health.

Sub-Saharan African Countries

In Sub-Saharan African countries, energy poverty and gender inequality are closely intertwined. Women and girls in these countries are often at the focal point of energy poverty because household tasks, as well as childcare and care of other family members, are duties that need more energy and gas than the electronics hugely relied on by it, basically computers, Bailis et al. (2015). Thus, this limited access to modern energy sources forces many women to spend substantial time and effort on these tasks thereby

impacting on their health, education, and economic opportunities. Moreover, energy poverty affects mostly women located in rural areas due to lack of access to electricity and clean cooking options. This results in the persistence of gender inequality as well as health aspects and the degradation of the environment. Moreover, gender-based violenceas well as cultural norms hinders the vulnerability of women to energy poverty and limitstheir potential to obtaining education and partake in the decision processes linked with theaccess as well of making it sustainable.

European Union Countries

In European Union countries, the element of energy poverty, together with that of gender inequality, is more implicit but still broad. However, some of these groups such as single mothers, elderly women and the immigrant communities are relatively more affected by energy poverty compared to available statistics of access to modern energy services being generally higher, Bouzarovski and Petrova (2015). Economic difficulties form an obstacle for these groups to afford to purchase energy services leaving them at a poor scale with their energy services. Gender disparities in the workforce and decision-making processes as well persist in the countries of the European Union, in which women have remained under-represented with minimal chances for consideration by the energy industry. Besides, energy poverty can make the low-income women's unpaid care work on household management and childcare heavier. In sum, the link between energy poverty and gender issues in these areas' points in the direction of focused interventions addressed at women's problems. Undoubtedly, breaking the vicious circle of energy poverty and promoting gender equality demand women empowerment as equitable access to improved modern energy services, quality education, economic opportunities and participation in decision-making processes. Each region should take a holistic approach to the intersections of poverty, gender, and energy access in a concerted effort to address root issues.

4.1.3. Role of Women's Empowerment in Addressing Energy Poverty and Gender Inequality

Enhancing Access to Energy

Sovacool et al. (2017) argue that Women's empowerment is 'critical' to expanding access to energy on behalf of the communities facing energy poverty. Thus, this illustrates how empowering women can become active participants in decision-making processes of energy planning so that their needs and priorities are infused in the process. Involving women in the fields of planning and implementing energy projects can help develop more gender-responsive and inclusive solutions able to identify better the specific requirements of energy for women and girls. Economic and social empowerment of women would enable them in investing in as well as adopting the clean energy technologies, hence improving access to energy sources and reducing dependability on traditional and inefficient sources.

Promoting Sustainable Development

Khursheed, A. (2022), in an article, without mincing words, stipulates that women's empowerment is tethered to sustainable development whilst energy poverty serves as a critical element in accomplishing the goal of sustainable development. Thus, access to clean and reliable energy services gives them immense health, education, livelihoods, and well-being benefits. For instance, clean cooking solutions reduce indoor air pollution and associated health impacts of women and children who are responsible for food preparation mostly. Empowered women in rural areas may join in income-generating opportunities, entrepreneurship, as well as other productive activities which otherwise would be impossible to accomplish without available and reliable access to these energy sources, through poverty and also economic growth.

Reducing Gender Inequalities

This is vital because in many instances the lack of sufficient energy access often worsens existing gender inequalities since women play a big role in availing household energy other than hitting limits on education, job opportunities, and even decision-making, Standal, K. (2018). Empowering women therefore challenges the norms of

society and stereotypes, promoting gender equality and thus dismantling barriers that have kept women from accessing resources, opportunities, and avenues for decision-making. These are gender-responsive energy interventions that will prioritize them in light of their needs, and give them the capacity to effectively participate in activities within the energy sector such as clean energy entrepreneurship or engagement in social-economic activities within and around a community-based energy cooperative.

Enhancing Resilience and Climate Action

Women's empowerment forms a key aspect in the addressing of issues to do with gender inequalities perpetrated by energy poverty, Standal, K. (2018). Consequently, insufficiency in access to enough energy often increases the existing gender disparities since they bear the major responsibility for household energy needs with little or no access to education, employment, and decision-making. Empowered women challenge gender norms and stereotypes that restrict the achievement of gender equality, functioning as barriers to access to resources, opportunity, and decision-making. Gender-responsive energy interventions consider the needs of women and empower them to have the capacity to actively partake in activities in the energy sector such as entrepreneurship in clean energies or joining energy cooperatives. The empowerment of women enables them to become resilient in addressing the challenges posed by climate change concerning energy poverty (Md, A., et al. 2022). It is, therefore, evident that women's empowerment is a key element to the adoption of sustainable energy practices, the mitigation of greenhouse gas emissions, and the adaptation to climate change impacts. Women's empowerment cultivates knowledge sharing, capacitating it through the building of Sustainable Energy Solutions and Climate Change Action. With empowerment, it can be expected that there would be the capacity of a woman being able to advocate renewable energy technologies and promote energy-efficient practices in addition to conservation measures. Empowerment is considered an essential ingredient that will enable the maximization of the benefits in two dimensions which are characteristically prevalent energy poverty and gender inequality. As a result, we can improve access to energy to propel sustainable development reduce gender disparities, and foster resilience and climate

action of women's empowerment economically socially, and politically. Mostly, there is a need for policies, programs, and initiatives that will focus on women empowerment in the energy sector towards attaining inclusiveness and sustainability.

Chapter V
Discussion

5.1.1. Summary of Findings

This paper, founding its comparative study on the relationship between energy poverty and gender inequality mainly focusing on women's empowerment - has involved the Sub-Saharan African countries, Southern Asian countries emerging to reduce energy poverty, and European Union countries.

Southern Asian Countries

Energy poverty, as revealed in the analysis, sees a big section of the population in Southern Asian countries that have otherwise proven successful in achieving low and middle incomes, without reliable and affordable sources of energy largely from rural regions. This lack of access to modern energy services exacerbates energy-poverty that is particularly inflicted on women on account of the roles played by them in household responsibilities and informal economies. Gender Inequality; persistent gender disparities impact on women's access to education, economic opportunities right through to decision making power in Southern Asian countries. Energy poverty impacts negatively upon women because of their significant under-representation in the energy-related decision-making processes and their efforts as leaders of household energy management. Women's Empowerment; women empowerment in Southern Asian countries through better access to the education, economic opportunities, and influence in decision making regarding the energy sector emerges as a critical aspect for combating the situation of energy poverty together with gender inequality. Addressing the issue of gender disparities in access to energy and women participation in the energy sector will have positive implications on overall development and poverty reduction.

Sub-Saharan African Countries

Energy Poverty, the analysis indicates that in much of sub-Saharan Africa many countries lack access to modern energy services which exposes them to bearing energy poverty that particularly afflict women and girls. This lack of access impedes economic development and contributes to health and educational disparities. Gender Inequality results that the above-mentioned findings illustrate gender disparities are enduringly nestled within the Sub-Saharan African countries, and these have impedimental implications upon women's prospects for educational, health, and economic development. Such gender-based violence is a long-standing manifestation related to cultural norms that has sustained thesedisparities and threatened women's likelihood to harvest positive consequences of upgradeor increase in energy access. Women's Empowerment, the analysis highlights women empowerment initiative's potential for posing as remedies for energy poverty and genderinequality in the countries across sub-Saharan Africa. Powering up women through education, entrepreneurship, and leadership role inside the domain of energy would tend to promote development that is inclusive as well as sustainable.

European Union Countries

From this analysis, energy poverty even though a wider access to modern energy services is quite common in European Union countries presents some pockets of energy poverty among groups in risk of social marginalization and vulnerable groups including women and immigrants. Through their analysis, Bouzarvski and Petrova (2015) reveal that gender inequality still continues to permeate in the European Union countries as evidenced through discrepancies experienced in leadership ranks, wage disparity as well as work-life balance challenges. Women face energy-related challenges, such as the affordability of energy services and the burden of unpaid care work. Women's Empowerment – The analysis reflects the necessity of a combined approach of policies and initiatives to foster women empowerment, in view of access to energy and sustainability issues prevailing across European Union countries. This could typically include steps like eradication of gender imbalances from the workforces engaged in the energy sector, and taking due consideration of specific needs and preferences of women in prescribing the energy policies. Analysis of the three regions through a comparative perspective explains both

commonalities and differences existing among them. Though with varying degree, energy poverty and gender inequality are systemic issues that tend to affect women in a higher proportion in all the regions. The analysis presents isolated best practices and policy interventions that have shown efficacy in addressing these issues as possible routes to improvement across regions.

5.1.2. Discussion of Findings

The study's findings, specifically between 2000 and 2020, of countries classified in Southern Asian, Sub-Saharan African, and European Union countries, are able to provide an insight into gender inequality, energy poverty, and women's empowerment. The strong positive relationship evidenced between gender inequality and energy poverty has been expressed by the use of the Panel Mean Group (PMG) technique, ceteris paribus. This result highlights how energy poverty results in a disproportionate effect on women, mostly because they've got to rely on the cooking technology that they have been relying upon. Results derived from PMG, the estimated coefficients provide insights into the relationships between these variables in the context of the European Union countries. Notably, the variable gender inequality (LGIQ) has a positive and statistically significant coefficient of 14.72119, meaning that an increase in gender inequality test case is related to a considerably high rise in energy poverty. Contrarily, RGDP and QGDP expose negative coefficients of -9.222453 and 0.656907 respectively thus pointing out the inverse relationship with energy poverty. In this view, these results underline the persistent importance over time of gender-based interventions that are designed to reduce energy poverty in these areas. It needs to be pointed out that the long-term trends and dynamics of gender-related inequality, energy poverty, as well as women's empowerment can be explored if running the study during years from 2000 through 2020. Such a temporal scope would thus help the analysis to include and cover any potential shifts and developments in these relationships over the two-decade period and thereby provide some valuable insights into how such issues' character changed over time.

Chapter VI
Conclusion

6.1.1. Summary of the Study

This comparative study sought to analyze the relationship between energy poverty and situation of gender inequality in Southern Asian, Sub-Saharan African countries and EU Countries being specific in targeting women empowerment. This paper has identified how energy poverty is intertwined with gender inequality and thus needs specific interventions to address these issues and promote the empowerment of women. In both regions studied by the authors, it is seen that women are more disadvantaged because of energy poverty. These realities together with others tend to encourage women who generally responsible for household chore responsibilities like cooking, heating and fuel collection to continue relying on traditional inefficient energy sources.

This dependence not only results in adverse health consequences but kills free time, reduces chances for women to achieve education, earn, and allows a level of social participation. In this way, energy poverty encourages gender disparities and allows women's participation in the socio-economic development to some extent to a little extent. Studies conducted by Raihan et al. (2018), Canh et al. (2021), and other pertinent studies using critical literature review. Which have provided insight into various dimensions of the gender aspects concerning energy poverty as well as how it is expressed among women in different settings. Building upon the findings and additional empirical evidences, this study enhances the existing state of knowledge on the causal link between energy poverty and gender inequality.

This research will bring forth the implications on how important a gender-responsive approach towards energy planning and policy-making now more integral than ever. Affordable and clean sources of energy should be accessible to all the persons, especially women who are residing in the Southern Asian, Sub-Saharan African countries and some part of European union countries. This, therefore, makes it clear that the recognition of the specific energy needs and challenges faced by women will help foster women's empowerment, improves their well-being, and enhance sustainable development. In

conclusion, this comparative study has served the purpose of providing useful insights in regards to the relationship between energy poverty and gender inequality in Southern Asian, Sub-Saharan African and European Union countries. It brings out the imperative for gender-responsive interventions towards the issue on energy poverty as well as women empowerment. In this more inclusive and sustainable future, policymakers, researchers, and stakeholders will recognize the gendered dimensions of energy access as they collaboratively make it a reality for all.

6.1.2. Recommendations

Based on the findings on gender inequality, energy poverty and women's empowerment in three regions under consideration such as Southern Asian countries, Sub-Saharan African region, and European Union countries, the recommendations for each of these regions are made hereunder.

1. Southern Asian Countries

i. Enforce policies and programs that enhance and reduce gender disparity, especially in the provision of energy and consumption Endorse innovations that would lead to cleaner and efficient technologies reducing dependency on traditional practices of cooking thereby negatively affecting women.

ii. Increase access to energy and eradicate energy poverty through stimulating investment in renewable sources of energy. Stimulate women and downtrodden segment targeted initiatives.

2. Sub-Saharan African Countries

i. Targeted and specialized programs aiming at gender inequality and empowering women including education, economic opportunities, and access to clean energy.
ii. Design and implementation of a strategy to upgrade energy infrastructure and to enhance availability and coverage of modern energy services in order to ensure easy access particularly in rural and other underserved areas.

3. European Union Countries

i. Reduce gender inequality and empower women in the energy sector, including increasing participation of women in operations relative to those of other renewable energy industries as well as leadership positions.

ii. The integration of gender consideration to the strategies of energy poverty reduction noting that the fact that the energy poverty has more effects on women, and thus it should address the roots of their situation.

References:

Abbas, K., Butt, K. M., Xu, D., Ali, M., Baz, K., Kharl, S. H., & Ahmed, M. (2022). Measurements and determinants of extreme multidimensional energy poverty using machine learning. *Energy*, *251*, 123977.

Abbas, K., Li, S., Xu, D., Baz, K., & Rakhmetova, A. (2020). Do socioeconomic factors determine household multidimensional energy poverty? Empirical evidence from South Asia. *Energy Policy*, *146*, 111754.

Adewara, S. O., Adekunle, F., Agba, D., Adama, I., & Gabriel, A. (2017). Effects of access to infrastructure on individual subjective wellbeing in Ilorin South, Nigeria. *Journal of Emerging Trends in Economics and Management Sciences*, *8*(5), 240-249.

Agarwal, B. (1997). Gender, environment, and poverty interlinks: Regional variations and temporal shifts in rural India, 1971–1991. *World Development*, *25*(1), 23-52.

Agarwal, B. (2010). Does women's proportional strength affect their participation? Governing local forests in South Asia. *World development*, *38*(1), 98-112.

Agarwal, B. (2010). *Gender and green governance: the political economy of women's presence within and beyond community forestry*. OUP Oxford.

Aklin, M., Bayer, P., Harish, S. P., & Urpelainen, J. (2018). *Escaping the energy poverty trap: when and how governments power the lives of the poor*. MIT Press.

Alarcón, D. M., & Cole, S. (2021). No sustainability for tourism without gender equality. In *Activating critical thinking to advance the sustainable development goals in tourism systems* (pp. 57-73). Routledge.

Alemu, N. E., Temesgen, E., & Dessiye, M. (2023). Do gender roles affect urban poverty in Ethiopia? A focus on women in micro and small enterprises. *Cogent Social Sciences*, *9*(1), 2216509.

Alkire, S., Meinzen-Dick, R., Peterman, A., Quisumbing, A., Seymour, G., & Vaz, A. (2013). The women's empowerment in agriculture index. *World development*, *52*, 71-91.

Amin, A., Liu, Y., Yu, J., Chandio, A. A., Rasool, S. F., Luo, J., & Zaman, S. (2020). How does energy poverty affect economic development? A panel data analysis of

South Asian countries. *Environmental Science and Pollution Research*, *27*, 31623-31635.

Andadari, R. K., Mulder, P., & Rietveld, P. (2014). Energy poverty reduction by fuel switching. Impact evaluation of the LPG conversion program in Indonesia. *Energy Policy*, *66*, 436-449.

Aristondo, O., & Onaindia, E. (2023). Decomposing energy poverty in three components. *Energy*, *263*, 125572.

Aung, T., Bailis, R., Chilongo, T., Ghilardi, A., Jumbe, C., & Jagger, P. (2021). Energy access and the ultra-poor: Do unconditional social cash transfers close the energy access gap in Malawi?. *Energy for Sustainable Development*, *60*, 102-112.

Bagdi, T., Ghosh, S., Sarkar, A., Hazra, A. K., Balachandran, S., & Chaudhury, S. (2023). Evaluation of research progress and trends on gender and renewable energy: A bibliometric analysis. *Journal of Cleaner Production*, 138654.

Bahi, D. T. S., & Paavola, J. (2023). Liquid petroleum gas access and consumption expenditure: measuring energy poverty through wellbeing and gender equality in India.

Bandura, A., & Bussey, K. (2004). On broadening the cognitive, motivational, and sociostructural scope of theorizing about gender development and functioning: comment on Martin, Ruble, and Szkrybalo (2002).

Banerjee, R., Mishra, V., & Maruta, A. A. (2021). Energy poverty, health and education outcomes: evidence from the developing world. *Energy economics*, *101*, 105447.

Barnes, D. F., Golumbeanu, R., & Diaw, I. (2016). *Beyond electricity access: output-based aid and rural electrification in Ethiopia*. World Bank.

Barnes, D. F., Khandker, S. R., & Samad, H. A. (2011). Energy poverty in rural Bangladesh. *Energy policy*, *39*(2), 894-904.

Batliwala, S. (2007). Taking the power out of empowerment–an experiential account. *Development in practice*, *17*(4-5), 557-565.

Batliwala, S., & Dhanraj, D. (2007). Gender myths that instrumentalize women: a view from the Indian front line. *Feminisms in development: contradictions, contestations and challenges*, *35*(4), 11-18.

Bazilian, M., Nakhooda, S., & Van de Graaf, T. (2014). Energy governance and poverty. *Energy Research & Social Science*, *1*, 217-225.

Benítez, B., Nelson, E., Romero Sarduy, M. I., Ortiz Perez, R., Crespo Morales, A., Casanova Rodriguez, C., ... & Daniels, J. (2020). Empowering women and building sustainable food systems: A case study of cuba's local agricultural Innovation Project. *Frontiers in Sustainable Food Systems*, *4*, 554414.

Bensch, G. (2013). Inside the metrics–An empirical comparison of energy poverty indices for Sub-Saharan countries. *Ruhr Economic Paper*, (464).

Bezerra, P., Cruz, T., Mazzone, A., Lucena, A. F., De Cian, E., & Schaeffer, R. (2022). The multidimensionality of energy poverty in Brazil: A historical analysis. *Energy Policy*, *171*, 113268.

Bhattacharya, R. (2020). Social identity as a driver of adult chronic energy deficiency: analysis of rural Indian households. *Journal of Public Health Policy*, *41*(4), 436-452.

Blau, F. D., & Kahn, L. M. (2017). The gender wage gap: Extent, trends, and explanations. *Journal of economic literature*, *55*(3), 789-865.

Blau, F. D., Kahn, L. M., Boboshko, N., & Comey, M. (2021). The impact of selection into the labor force on the gender wage gap.

Bouzarovski, S. (2018). *Energy poverty:(Dis) assembling Europe's infrastructural divide* (p. 125). Springer Nature.

Bouzarovski, S., & Bouzarovski, S. (2018). Understanding energy poverty, vulnerability and justice. *Energy Poverty: (Dis) Assembling Europe's Infrastructural Divide*, 9-39.

Bouzarovski, S., & Petrova, S. (2015). A global perspective on domestic energy deprivation: Overcoming the energy poverty–fuel poverty binary. *Energy Research & Social Science*, *10*, 31-40.

Campney, A. (2019). Indigenous Participation in Clean Energy Activities in Canada: Passive Participation or 'Community Energy'?.

Cantarero, M. M. V. (2020). Of renewable energy, energy democracy, and sustainable development: A roadmap to accelerate the energy transition in developing countries. *Energy Research & Social Science*, *70*, 101716.

Chakraborty, P. A., Talukder, A., Haider, S. S., & Gupta, R. D. (2022). Prevalence and factors associated with underweight, overweight and obesity among 15-49-year-old men and women in Timor-Leste. *Plos one*, *17*(2), e0262999.

Chauhan, K. (2014). Gender and development. In *Gender Inequality in the Public Sector in Pakistan: Representation and Distribution of Resources* (pp. 13-39). New York: Palgrave Macmillan US.

Cheng, Z., Tani, M., & Wang, H. (2021). Energy poverty and entrepreneurship. *Energy Economics*, *102*, 105469.

Chevalier, J. M., & Ouédraogo, N. S. (2009). Energy poverty and economic development. In *The new energy crisis: Climate, economics and geopolitics* (pp. 115-144). London: Palgrave Macmillan UK.

Chien, F., Hsu, C. C., Zhang, Y., Vu, H. M., & Nawaz, M. A. (2021). Unlocking the role of energy poverty and its impacts on financial growth of household: is there any economic concern. *Environmental Science and Pollution Research*, 1-14.

Choumert, J., Motel, P. C., & Le Roux, L. (2018). Stacking up the ladder: A panel data analysis of Tanzanian household energy choices.

Chow, E. N. L., & Lyter, D. M. (2013). Studying development with gender perspectives: From mainstream theories to alternative frameworks. In *Transforming gender and development in East Asia* (pp. 25-57). Routledge.

Churchill, S. A., & Smyth, R. (2020). Ethnic diversity, energy poverty and the mediating role of trust: Evidence from household panel data for Australia. *Energy Economics*, *86*, 104663.

Churchill, S. A., & Smyth, R. (2022). Protestantism and energy poverty. *Energy Economics*, *111*, 106087.

Connell, R. (2014). Rethinking gender from the South. *Feminist studies*, *40*(3), 518-539.

Cornwall, A., & Brock, K. (2005). Beyond buzzwords "poverty reduction","participation" and "empowerment" in development policy.

Correll, S. J. (2017). SWS 2016 Feminist Lecture: Reducing gender biases in modern workplaces: A small wins approach to organizational change. *Gender & Society*, *31*(6), 725-750.

Crenshaw, K. (2013). Demarginalizing the intersection of race and sex: A black feminist critique of antidiscrimination doctrine, feminist theory and antiracist politics. In *Feminist legal theories* (pp. 23-51). Routledge.

Dahlerup, D. (2007). Electoral gender quotas: Between equality of opportunity and equality of result. *Representation*, *43*(2), 73-92.

Dawood, T. C., Pratama, H., Masbar, R., & Effendi, R. (2019). Does financial inclusion alleviate household poverty? Empirical evidence from Indonesia. *Economics & Sociology*, *12*(2), 235-252.

Doğanalp, N., Ozsolak, B., & Aslan, A. (2021). The effects of energy poverty on economic growth: a panel data analysis for BRICS countries. *Environmental Science and Pollution Research*, *28*(36), 50167-50178.

Dominguez-Salas, P., Alarcón, P., Häsler, B., Dohoo, I. R., Colverson, K., Kimani-Murage, E. W., ... & Grace, D. (2016). Nutritional characterisation of low-income households of Nairobi: socioeconomic, livestock and gender considerations and predictors of malnutrition from a cross-sectional survey. *BMC nutrition*, *2*, 1-20.

Doss, C. R., Kovarik, C., Peterman, A., Quisumbing, A. R., & Van den Bold, M. (2013). Gender inequalities in ownership and control of land in Africa: Myths versus reality.

Duflo, E. (2012). Women empowerment and economic development. *Journal of Economic literature*, *50*(4), 1051-1079.

Ehsanullah, S., Tran, Q. H., Sadiq, M., Bashir, S., Mohsin, M., & Iram, R. (2021). How energy insecurity leads to energy poverty? Do environmental consideration and climate change concerns matters. *Environmental Science and Pollution Research*, *28*(39), 55041-55052.

Elson, D. (2009). Gender equality and economic growth in the World Bank World Development Report 2006. *Feminist Economics*, *15*(3), 35-59.

Feenstra, M., & Clancy, J. (2020). A view from the north: Gender and energy poverty in the European Union. *Engendering the energy transition*, 163-187.

Feenstra, M., & Clancy, J. (2020). A view from the north: Gender and energy poverty in the European Union. *Engendering the energy transition*, 163-187.

Feeny, S., Trinh, T. A., & Zhu, A. (2021). Temperature shocks and energy poverty: Findings from Vietnam. *Energy economics*, *99*, 105310.

Feltes, T., Balloni, A., Czapska, J., Bodelón, E., & Stenning, P. (2012). Gender-based violence, stalking and fear of crime. *Country Report Germany. EU-Project 2009-2011*.

Furszyfer Del Rio, D. D., Sovacool, B. K., Griffiths, S., Foley, A. M., & Furszyfer Del Rio, J. (2023). A cross-country analysis of sustainability, transport and energy poverty. *npj Urban Sustainability*, *3*(1), 41.

Galea, N., & Chappell, L. (2022). Male-dominated workplaces and the power of masculine privilege: A comparison of the Australian political and construction sectors. *Gender, Work & Organization*, *29*(5), 1692-1711.

Garba, I., & Bellingham, R. (2021). Energy poverty: Estimating the impact of solid cooking fuels on GDP per capita in developing countries-Case of sub-Saharan Africa. *Energy*, *221*, 119770.

Gelves, J. J. P., Østergaard, P. A., & Flórez, G. A. D. (2023). Energy poverty assessment and the impact of Covid-19: An empirical analysis of Colombia. *Energy Policy*, *181*, 113716.

Goldin, C., Kerr, S. P., & Olivetti, C. (2022). *When the Kids Grow Up: Women's Employment and Earnings across the Family Cycle* (No. w30323). National Bureau of Economic Research.

Goozee, H. (2017). Energy, poverty and development: A primer for the sustainable development goals.

Gouda, M., & Potrafke, N. (2016). Gender equality in Muslim-majority countries. *Economic Systems*, *40*(4), 683-698.

Govinda, R. (2012). Mapping 'gender evaluation'in South Asia. *Indian Journal of Gender Studies*, *19*(2), 187-209.

Grabe, S. (2012). An empirical examination of women's empowerment and transformative change in the context of international development. *American journal of community psychology*, *49*, 233-245.

Graham, C., & Chattopadhyay, S. (2013). Gender and well-being around the world. *International Journal of Happiness and Development*, *1*(2), 212-232.

Gray, L., Boyle, A., Francks, E., & Yu, V. (2019). The power of small-scale solar: gender, energy poverty, and entrepreneurship in Tanzania. *Development in Practice*, *29*(1), 26-39.

Håberg, I. (2020). *Men: a missing factor in SDG 5? A study on gender equality in Kerala with a focus on mens attitudes towards women* (Master's thesis, OsloMet-Storbyuniversitetet).

Haq, M. A. U., Nawaz, M. A., Akram, F., & Natarajan, V. K. (2020). Theoretical implications of renewable energy using improved cooking stoves for rural households. *International Journal of Energy Economics and Policy*, *10*(5), 546.

Healy, J. D., & Clinch, J. P. (2002). Fuel poverty, thermal comfort and occupancy: results of a national household-survey in Ireland. *Applied Energy*, *73*(3-4), 329-343.

Heise, L., Greene, M. E., Opper, N., Stavropoulou, M., Harper, C., Nascimento, M., ... & Gupta, G. R. (2019). Gender inequality and restrictive gender norms: framing the challenges to health. *The Lancet*, *393*(10189), 2440-2454.

Hieu, V. M., Hien Phan, T. T., & Trung, L. M. (2022). Assessing Multidimensional Energy Poverty and Its Economic Impact on N11 Countries: Mediating Role of Energy Efficiency. *Frontiers in Energy Research*, *10*, 900449.

Hong, X., Wu, S., & Zhang, X. (2022). Clean energy powers energy poverty alleviation: Evidence from Chinese micro-survey data. *Technological Forecasting and Social Change*, *182*, 121737.

Hosan, S., Rahman, M. M., Karmaker, S. C., Chapman, A. J., & Saha, B. B. (2023). Remittances and multidimensional energy poverty: Evidence from a household survey in Bangladesh. *Energy*, *262*, 125326.

Huis, M. A., Hansen, N., Otten, S., & Lensink, R. (2019). The impact of husbands' involvement in goal-setting training on women's empowerment: First evidence from an intervention among female microfinance borrowers in Sri Lanka. *Journal of Community & Applied Social Psychology*, *29*(4), 336-351.

Igawa, M., & Managi, S. (2022). Energy poverty and income inequality: An economic analysis of 37 countries. *Applied Energy*, *306*, 118076.

Igawa, M., Piao, X., & Managi, S. (2022). The impact of cooling energy needs on subjective well-being: Evidence from Japan. *Ecological Economics*, *198*, 107464.

Ismail, Z. (2015). An empirical estimation of energy poverty in poor South African households. *Journal of Economics and Sustainable Development*, *6*(13).

Jenkins, K. E., & Martiskainen, M. (2018). A normative approach to transitions in energy demand: An energy justice and fuel poverty case study. In *Transitions in Energy Efficiency and Demand* (pp. 34-50). Routledge.

Jenkins, K. E., Sovacool, B. K., Mouter, N., Hacking, N., Burns, M. K., & McCauley, D. (2021). The methodologies, geographies, and technologies of energy justice: a systematic and comprehensive review. *Environmental Research Letters*, *16*(4), 043009.

Jenkins, K., McCauley, D., Heffron, R., Stephan, H., & Rehner, R. (2016). Energy justice: A conceptual review. *Energy Research & Social Science*, *11*, 174-182.

Johansen, S., & Juselius, K. (1990). Maximum likelihood estimation and inference on cointegration—with appucations to the demand for money. *Oxford Bulletin of Economics and statistics*, *52*(2), 169-210.

Johnson, O. W., Han, J. Y. C., Knight, A. L., Mortensen, S., Aung, M. T., Boyland, M., & Resurrección, B. P. (2020). *Assessing the gender and social equity dimensions of energy transitions*. Stockholm Environment Institute.

Johnson, S. C., Doi, M. L., & Yamamoto, L. G. (2016). Adverse effects of tattoos and piercing on parent/patient confidence in health care providers. *Clinical Pediatrics*, *55*(10), 915-920.

Joshi, G., & Yenneti, K. (2020). Community solar energy initiatives in India: A pathway for addressing energy poverty and sustainability?. *Energy and Buildings*, *210*, 109736.

Kabeer, N. (1999). Resources, agency, achievements: Reflections on the measurement of women's empowerment. *Development and change*, *30*(3), 435-464.

Kabeer, N. (1999). *The conditions and consequences of choice: reflections on the measurement of women's empowerment* (Vol. 108, pp. 1-58). Geneva: UNRISD.

Kabeer, N. (2003). *Gender Mainstreaming in Poverty Eradication and the Millennium Development Goals: A handbook for policy-makers and other stakeholders*. Commonwealth Secretariat.

Kabeer, N. (2005). Gender equality and women's empowerment: A critical analysis of the third millennium development goal 1. *Gender & development*, *13*(1), 13-24.

Kabeer, N. (2006). Poverty, social exclusion and the MDGs: The challenge of 'durable inequalities' in the Asian context.

Kabeer, N. (2010). Women's empowerment, development interventions and the management of information flows. *ids Bulletin*, *41*(6), 105-113.

Kabeer, N. (2017). Economic pathways to women's empowerment and active citizenship: what does the evidence from Bangladesh tell us?. *The Journal of Development Studies*, *53*(5), 649-663.

Kabeer, N. (2017). Empowerment, citizenship and gender justice: A contribution to locally grounded theories of change in women's lives. In *Gender Justice and Development: Local and Global* (pp. 20-36). Routledge.

Kabeer, N. (2018). Gender, livelihood capabilities and women's economic empowerment: reviewing evidence over the life course.

Katre, A., Tozzi, A., & Bhattacharyya, S. (2019). Sustainability of community-owned mini-grids: evidence from India. *Energy, Sustainability and Society*, *9*(1), 1-17.

Khalifa, R., & Scarparo, S. (2021). Gender Responsive Budgeting: A tool for gender equality. *Critical Perspectives on Accounting*, *79*, 102183.

Khandker, S. R., Barnes, D. F., Samad, H. A., & Koo, B. (2023). Does Quality of Electricity Supply Matter for Development? An Evaluation of Service Level Benefits in Nepal.

Khandker, S. R., Barnes, D. F., Samad, H. A., & Koo, B. (2023). Does Quality of Electricity Supply Matter for Development? An Evaluation of Service Level Benefits in Nepal.

Khursheed, A. (2022). Exploring the role of microfinance in women's empowerment and entrepreneurial development: a qualitative study. *Future Business Journal*, *8*(1), 57.

Kishor, S., & Subaiya, L. (2008). *Understanding women's empowerment: a comparative analysis of Demographic and Health Surveys (DHS) data* (No. 20). Macro International.

Klasen, S., & Lahoti, R. (2021). How serious is the neglect of intra-household inequality in multidimensional poverty and inequality analyses? Evidence from India. *Review of Income and Wealth*, *67*(3), 705-731.

Klasen, S., & Lamanna, F. (2009). The impact of gender inequality in education and employment on economic growth: new evidence for a panel of countries. *Feminist economics*, *15*(3), 91-132.

Komendantova, N., Irshaid, J., Marashdeh, L., Al-Salaymeh, A., Ekenberg, L., & Linnerooth-Bayer, J. (2017). Country Fact Sheet, Jordan: Energy and Development at a glance 2017.

Koomson, I., & Danquah, M. (2021). Financial inclusion and energy poverty: Empirical evidence from Ghana. *Energy economics*, *94*, 105085.

Kumar, P., Rao, S., & Yadama, G. N. (2019). Energy Poverty in India. In *Encyclopedia of Social Work.*

Labordena, M., Patt, A., Bazilian, M., Howells, M., & Lilliestam, J. (2017). Impact of political and economic barriers for concentrating solar power in Sub-Saharan Africa. *Energy Policy*, *102*, 52-72.

Laldjebaev, M., Sovacool, B. K., & Kassam, K. A. S. (2015). 7 Energy security, poverty, and sovereignty. *International Energy and Poverty: The Emerging Contours*, *97*.

Lan, J., Khan, S. U., Sadiq, M., Chien, F., & Baloch, Z. A. (2022). Evaluating energy poverty and its effects using multi-dimensional based DEA-like mathematical composite indicator approach: findings from Asia. *Energy Policy*, *165*, 112933.

Lehmann, I. (2019). When cultural political economy meets 'charismatic carbon'marketing: A gender-sensitive view on the limitations of Gold Standard cookstove offset projects. *Energy Research & Social Science*, *55*, 146-154.

Lesala, M. E., Shambira, N., Makaka, G., & Mukumba, P. (2023). The Energy Poverty Status of Off-Grid Rural Households: A Case of the Upper Blinkwater Community in the Eastern Cape Province, South Africa. *Energies*, *16*(23), 7772.

Lewis, A. H. (2021). Role of Education in Improving Human Development in Central America: A Comparative Analysis of Guatemala and Costa Rica.

Li, C., Xia, Y., & Wang, L. (2023). Household unclean fuel use, indoor pollution and self-rated health: risk assessment of environmental pollution caused by energy poverty from a public health perspective. *Environmental Science and Pollution Research*, 1-24.

Li, W., Chien, F., Hsu, C. C., Zhang, Y., Nawaz, M. A., Iqbal, S., & Mohsin, M. (2021). Nexus between energy poverty and energy efficiency: estimating the long-run dynamics. *Resources Policy*, *72*, 102063.

Li, Z., Hasan, M. M., & Lu, Z. (2023). Studying financial inclusion, energy poverty, and economic development of South Asian countries. *Environmental Science and Pollution Research*, *30*(11), 30644-30655.

Liedauer, S. (2021). Dimensions and Causes of Systemic Oppression. In *Reduced Inequalities* (pp. 101-111). Cham: Springer International Publishing.

Listo, R. (2018). Gender myths in energy poverty literature: a critical discourse analysis. *Energy Research & Social Science*, *38*, 9-18.

Liu, Z., Wu, D., He, B. J., Wang, Q., Yu, H., Ma, W., & Jin, G. (2019). Evaluating potentials of passive solar heating renovation for the energy poverty alleviation of plateau areas in developing countries: A case study in rural Qinghai-Tibet Plateau, China. *Solar Energy*, *187*, 95-107.

Longe, O. M. (2021). An assessment of the energy poverty and gender nexus towards clean energy adoption in rural South Africa. *Energies*, *14*(12), 3708.

Longe, O. M. (2021). An assessment of the energy poverty and gender nexus towards clean energy adoption in rural South Africa. *Energies*, *14*(12), 3708.

López-Vargas, A., Ledezma-Espino, A., & Sanchis-de-Miguel, A. (2022). Methods, data sources and applications of the Artificial Intelligence in the Energy Poverty context: A review. *Energy and Buildings*, *268*, 112233.

MacNeil, A., & Ghosh, S. (2017). Gender imbalance in the maritime industry: impediments, initiatives and recommendations. *Australian Journal of Maritime & Ocean Affairs*, *9*(1), 42-55.

Maji, P., Mehrabi, Z., & Kandlikar, M. (2021). Incomplete transitions to clean household energy reinforce gender inequality by lowering women's respiratory health and household labour productivity. *World Development*, *139*, 105309.

Malhotra, A., Schuler, S. R., & Boender, C. (2002, June). Measuring women's empowerment as a variable in international development. In *background paper prepared for the World Bank Workshop on Poverty and Gender: New Perspectives* (Vol. 28, p. 58). Washington, DC: The World Bank.

Malhotra, P., Rehman, I. H., Bhandari, P., Khanna, R., & Upreti, R. (2002). Rural energy data sources and estimations in India. *New Delhi: Tata Energy Research Institute*.

Mammo, T. (1999). *The paradox of Africa's poverty: the role of indigenous knowledge, traditional practices and local institutions--the case of Ethiopia*. The Red Sea Press.

Mandal, K. C. (2013, May). Concept and Types of Women Empowerment. In *International Forum of Teaching & Studies* (Vol. 9, No. 2).

Martinez-Soto, A., Vera, C. C. A., Boso, A., Hofflinger, A., & Shupler, M. (2021). Energy poverty influences urban outdoor air pollution levels during COVID-19 lockdown in south-central Chile. *Energy policy*, *158*, 112571.

Mastrucci, A., Byers, E., Pachauri, S., & Rao, N. D. (2019). Improving the SDG energy poverty targets: Residential cooling needs in the Global South. *Energy and Buildings*, *186*, 405-415.

Mathur, P., & Agarwal, P. (2017). Self-help groups: a seed for intrinsic empowerment of Indian rural women. *Equality, Diversity and Inclusion: An International Journal*, *36*(2), 182-196.

Md, A., Gomes, C., Dias, J. M., & Cerdà, A. (2022). Exploring gender and climate change nexus, and empowering women in the South Western Coastal Region of Bangladesh for adaptation and mitigation. *Climate*, *10*(11), 172.

Middlemiss, L., Ambrosio-Albalá, P., Emmel, N., Gillard, R., Gilbertson, J., Hargreaves, T., ... & Tod, A. (2019). Energy poverty and social relations: A capabilities approach. *Energy research & social science*, *55*, 227-235.

Miedema, S. S., Haardörfer, R., Girard, A. W., & Yount, K. M. (2018). Women's empowerment in East Africa: Development of a cross-country comparable measure. *World Development*, *110*, 453-464.

Mitra, S. K., Chattopadhyay, M., & Chatterjee, T. K. (2023). Can tourism development reduce gender inequality?. *Journal of Travel Research*, *62*(3), 563-577.

Mohan, G. (2021). Young, poor, and sick: The public health threat of energy poverty for children in Ireland. *Energy Research & Social Science*, *71*, 101822.

Mohanty, C. T. (2003). "Under western eyes" revisited: Feminist solidarity through anticapitalist struggles. *Signs: Journal of Women in culture and Society*, *28*(2), 499-535.

Moniruzzaman, M., & Day, R. (2020). Gendered energy poverty and energy justice in rural Bangladesh. *Energy Policy*, *144*, 111554.

Moser, C. (2012). *Gender planning and development: Theory, practice and training*. Routledge.

Munro, P. G., & Schiffer, A. (2019). Ethnographies of electricity scarcity: Mobile phone charging spaces and the recrafting of energy poverty in Africa. *Energy and Buildings*, *188*, 175-183.

Musango, J. K., Smit, S., Ceschin, F., Ambole, A., Batinge, B., Anditi, C., ... & Mukama, M. (2020). Mainstreaming gender to achieve security of energy services in poor urban environments. *Energy Research & Social Science*, *70*, 101715.

Narayan, L. (2015). Gender Inequalities and Rural Development–Plugging the Gap. *JOURNAL FOR STUDIES IN MANAGEMENT AND PLANNING*.

Nasir, M. A., Canh, N. P., & Le, T. N. L. (2021). Environmental degradation & role of financialisation, economic development, industrialisation and trade liberalisation. *Journal of Environmental Management*, *277*, 111471.

Nazarahari, A., Ghotbi, N., & Tokimatsu, K. (2021). Energy poverty among college students in japan in a survey of students' knowledge, attitude and practices towards energy use. *Sustainability*, *13*(15), 8484.

Nduka, E. (2021). How to get rural households out of energy poverty in Nigeria: A contingent valuation. *Energy Policy*, *149*, 112072.

Nemery, B., Okatz, J., & Mulvaney, D. (2020). Sustainable minerals and metals for a low-carbon future. *Science*, *367*(6473), 30-33.

Ngarava, S. (2023). Implications of land restitution as a Transformative Social Policy for Water-Energy-Food (WEF) insecurity in Magareng Local Municipality, South Africa. *Land Use Policy*, *133*, 106878.

Ngarava, S., Zhou, L., Ningi, T., Chari, M. M., & Mdiya, L. (2022). Gender and ethnic disparities in energy poverty: The case of South Africa. *Energy Policy*, *161*, 112755.

Nguyen, C. P., & Su, T. D. (2021). Does energy poverty matter for gender inequality? Global evidence. *Energy for Sustainable Development*, *64*, 35-45.

Nguyen, C. P., & Su, T. D. (2021). Does energy poverty matter for gender inequality? Global evidence. *Energy for Sustainable Development*, *64*, 35-45.

Nhamo, G., Nhemachena, C., Nhamo, S., Mjimba, V., & Savić, I. (2020). Energy poverty in the midst of plenty: a harsh reality for Sub-Saharan Africa. In *SDG7–Ensure Access to Affordable, Reliable, Sustainable and Modern Energy* (pp. 233-262). Emerald Publishing Limited.

Nico, M. (2020). Measuring energy poverty: evidence from Mexico.

Njoh, A. J., Ananga, E., Ngyah-Etchutambe, I. B., Ricker, F., Madosingh-Hector, R., Rizutto, V., ... & Akiwumi, F. A. (2022, January). The relationship between electricity consumption and improvement in women's welfare in Africa. In *Women's Studies International Forum* (Vol. 90, p. 102541). Pergamon.

Norris, P., & Inglehart, R. (2013). Gendering social capital. *Gender and social capital*, *73*, 34-45.

Odeku, K. O., & Meyer, E. (2019). Socioeconomic implications of energy poverty in South African poor rural households. *Academy of Entrepreneurship Journal*, *25*(3), 1-12.

Ogwumike, F. O., & Ozughalu, U. M. (2016). Analysis of energy poverty and its implications for sustainable development in Nigeria. *Environment and development economics*, *21*(3), 273-290.

Okere, K. I., Dimnwobi, S. K., Ekesiobi, C., & Onuoha, F. C. (2023). Turning the tide on energy poverty in sub-Saharan Africa: Does Public Debt Matter?. *Energy*, *282*, 128365.

Osborne, K., Bacchi, C., & Mackenzie, C. (2010). Gender analysis and community participation: The role of women's policy units. *Mainstreaming Politics: Gendering Practices and Feminist Theory*, 191-214.

Pachauri, S., & Rao, N. D. (2013). Gender impacts and determinants of energy poverty: are we asking the right questions? *Current Opinion in Environmental Sustainability*, *5*(2), 205-215.

Pan, L., Biru, A., & Lettu, S. (2021). Energy poverty and public health: Global evidence. *Energy Economics*, *101*, 105423.

Pansera, M., & Sarkar, S. (2016). Crafting sustainable development solutions: Frugal innovations of grassroots entrepreneurs. *Sustainability*, *8*(1), 51.

Pao, H. T., & Tsai, C. M. (2011). Multivariate Granger causality between CO2 emissions, energy consumption, FDI (foreign direct investment) and GDP (gross domestic product): evidence from a panel of BRIC (Brazil, Russian Federation, India, and China) countries. *Energy*, *36*(1), 685-693.

Pellicer-Sifres, V., Simcock, N., & Boni, A. (2021). Understanding the multiple harms of energy poverty through Nussbaum's theory of central capabilities. *Local Environment*, *26*(8), 1026-1042.

Pelz, S., Pachauri, S., & Groh, S. (2018). A critical review of modern approaches for multidimensional energy poverty measurement. *Wiley Interdisciplinary Reviews: Energy and Environment*, *7*(6), e304.

Petesch, P., & Badstue, L. (2020). Gender norms and poverty dynamics in 32 villages of South Asia. *International Journal of Community Well-Being*, *3*(3), 289-310.

Pollitt, M. G. (2021). 16. The future design of the electricity market. *Handbook on electricity markets*, 428.

Pradhan, B. R., & Kar, S. K. (2019). Energy inclusion through renewable energy adoption and livelihood improvement in India. *IIMS Journal of Management Science*, *10*(1and2), 52-63.

Pratiwi, N. A. H., Rahmawati, Y. D., & Setiono, I. (2017). Gender equality in climate change adaptation: A case of Cirebon, Indonesia. *The Indonesian Journal of Planning and Development*, *2*(2), 74-86.

Raghutla, C., & Chittedi, K. R. (2022). Energy poverty and economic development: evidence from BRICS economies. *Environmental Science and Pollution Research*, 1-15.

Raihan, S., & Bidisha, S. H. (2018). Female employment stagnation in Bangladesh.

Raman, S., Nerlich, B., Cartelet, C., de Saille, S., Hadley Kershaw, E., Hartley, S., ... & Tsouvalis, J. (2019). Making science public: challenges and opportunities.

Ramos, M. E., Gibaja-Romero, D. E., & Ochoa, S. A. (2020). Gender inequality and gender-based poverty in Mexico. *Heliyon*, *6*(1).

Ridgeway, C. L. (2009). Framed before we know it: How gender shapes social relations. *Gender & society*, *23*(2), 145-160.

Ridgeway, C. L. (2011). *Framed by gender: How gender inequality persists in the modern world*. Oxford University Press.

Robinson, C. (2019). Energy poverty and gender in England: A spatial perspective. *Geoforum*, *104*, 222-233.

Robinson, C., Lindley, S., & Bouzarovski, S. (2019). The spatially varying components of vulnerability to energy poverty. *Annals of the American Association of Geographers*, *109*(4), 1188-1207.

Rogelj, J., Shindell, D., Jiang, K., Fifita, S., Forster, P., Ginzburg, V., ... & Zickfeld, K. (2018). Mitigation pathways compatible with 1.5 C in the context of sustainable development. In *Global warming of 1.5 C* (pp. 93-174). Intergovernmental Panel on Climate Change.

Roy, P., Ray, S., & Haldar, S. K. (2019). Socio-economic determinants of multidimensional poverty in rural West Bengal: A household level analysis. *Journal of Quantitative Economics*, *17*, 603-622.

Ruiz-Rivas, U., Tirado-Herrero, S., Castano-Rosa, R., & Martínez-Crespo, J. (2023). Disconnected, yet in the spotlight: Emergency research on extreme energy poverty in the Cañada Real informal settlement, Spain. *Energy Research & Social Science*, *102*, 103182.

Sadath, A. C., & Acharya, R. H. (2017). Assessing the extent and intensity of energy poverty using Multidimensional Energy Poverty Index: Empirical evidence from households in India. *Energy Policy*, *102*, 540-550.

Sagar, A. D., Oliver, H. H., & Chikkatur, A. P. (2005). Climate change, energy, and developing countries. *Vt. J. Envtl. L.*, *7*, 71.

Salman, M., Zha, D., & Wang, G. (2022). Assessment of energy poverty convergence: A global analysis. *Energy*, *255*, 124579.

Santika, W. G., Anisuzzaman, M., Bahri, P. A., Shafiullah, G. M., Rupf, G. V., & Urmee, T. (2019). From goals to joules: A quantitative approach of interlinkages between energy and the Sustainable Development Goals. *Energy Research & Social Science*, *50*, 201-214.

Sarangi, G. K., Pugazenthi, D., Mishra, A., Palit, D., Kishore, V. V. N., & Bhattacharyya, S. C. (2014). Poverty amidst plenty: Renewable energy-based mini-grid electrification in Nepal. *Mini-Grids for Rural Electrification of Developing Countries: Analysis and Case Studies from South Asia*, 343-371.

Sarkar, S. (2010). Gender, environment and poverty linkages. *Journal of Development and Agricultural Economics*, *2*(4), 145-156.

Saxena, V., & Bhattacharya, P. C. (2018). Inequalities in LPG and electricity consumption in India: The role of caste, tribe, and religion. *Energy for Sustainable Development*, *42*, 44-53.

Schultz, I. (2006). The natural world and the nature of gender. *Handbook of Gender and Women's Studies. SAGE Publications Ltd: London*, 376-396.

Seguino, S. (2016). *Financing for Gender Equality in the Context of the Sustainable Development Goals*. New York: UN Women.

Semykina, A., & Wooldridge, J. M. (2013). Estimation of dynamic panel data models with sample selection. *Journal of Applied Econometrics*, *28*(1), 47-61.

Sen, G., & Ostlin, P. (2011). Gender inequity in health. World Health Organizations.

Sen, K. K., Karmaker, S. C., Hosan, S., Chapman, A. J., Uddin, M. K., & Saha, B. B. (2023). Energy poverty alleviation through financial inclusion: Role of gender in Bangladesh. *Energy*, *282*, 128452.

Sen, K. K., Singha, B., Karmaker, S. C., Bari, W., Chapman, A. J., Khan, A., & Saha, B. B. (2023). Evaluating the relationship between energy poverty and child disability: A multilevel analysis based on low and middle-income countries. *Energy for Sustainable Development*, *77*, 101331.

Shahzad, U., Gupta, M., Sharma, G. D., Rao, A., & Chopra, R. (2022). Resolving energy poverty for social change: Research directions and agenda. *Technological Forecasting and Social Change*, *181*, 121777.

Simcock, N., Jenkins, K. E., Lacey-Barnacle, M., Martiskainen, M., Mattioli, G., & Hopkins, D. (2021). Identifying double energy vulnerability: a systematic and narrative review of groups at-risk of energy and transport poverty in the global north. *Energy Research & Social Science*, *82*, 102351.

Sociotechnical agendas: Reviewing future directions for energy and climate research. *Energy Research & Social Science*, *70*, 101617.

Sorman, A. H., García-Muros, X., Pizarro-Irizar, C., & Gonzalez-Eguino, M. (2020). Lost (and found) in Transition: Expert stakeholder insights on low-carbon energy transitions in Spain. *Energy research & social science*, *64*, 101414.

Sovacool, B. K., & Drupady, I. M. (2016). *Energy access, poverty, and development: the governance of small-scale renewable energy in developing Asia*. Routledge.

Sovacool, B. K., & Dworkin, M. H. (2014). *Global energy justice*. Cambridge University Press.

Sovacool, B. K., & Dworkin, M. H. (2014). *Global energy justice*. Cambridge University Press.

Sovacool, B. K., & Dworkin, M. H. (2015). Energy justice: Conceptual insights and practical applications. *Applied energy*, *142*, 435-444.

Sovacool, B. K., & Dworkin, M. H. (2015). Energy justice: Conceptual insights and practical applications. *Applied energy*, *142*, 435-444.

Sovacool, B. K., Brown, M. A., & Valentine, S. V. (2016). *Fact and fiction in global energy policy: fifteen contentious questions*. JHU Press.

Sovacool, B. K., Burke, M., Baker, L., Kotikalapudi, C. K., & Wlokas, H. (2017). New frontiers and conceptual frameworks for energy justice. *Energy Policy*, *105*, 677-691.

Sovacool, B. K., Burke, M., Baker, L., Kotikalapudi, C. K., & Wlokas, H. (2017). New frontiers and conceptual frameworks for energy justice. *Energy Policy*, *105*, 677-691.

Sovacool, B. K., Heffron, R. J., McCauley, D., & Goldthau, A. (2016). Energy decisions reframed as justice and ethical concerns. *Nature Energy*, *1*(5), 1-6.

Sovacool, B. K., Heffron, R. J., McCauley, D., & Goldthau, A. (2016). Energy decisions reframed as justice and ethical concerns. *Nature Energy*, *1*(5), 1-6.

Spagnoletti, B., & O'Callaghan, T. (2013). Let there be light: A multi-actor approach to alleviating energy poverty in Asia. *Energy policy*, *63*, 738-746.

Standal, K. (2018). Challenges of Gender, Power and Change in Solar Energy Interventions in Rural India. Imagined Beneficiaries and the Makings of Women's Empowerment in the Village Electrification Project.

Stephens, A. (1991). Poverty and gender issues. *Asia-Pacific Journal of Rural Development*, *1*(1), 62-74.

Sule, I. K., Yusuf, A. M., & Salihu, M. K. (2022). Impact of energy poverty on education inequality and infant mortality in some selected African countries. *Energy Nexus*, *5*, 100034.

Tang, X., & Liao, H. (2014). Energy poverty and solid fuels use in rural China: Analysis based on national population census. *Energy for Sustainable Development*, *23*, 122-129.

Taşli, K. (2007). A conceptual framework for gender and development studies: from welfare to empowerment. ÖFSE-Forum.

Terfa, Z. G., Ahmed, S., Khan, J., Niessen, L. W., & Impala Consortium. (2022). Household Microenvironment and Under-Fives Health Outcomes in Uganda: Focusing on Multidimensional Energy Poverty and Women Empowerment Indices. *International journal of environmental research and public health*, *19*(11), 6684.

Thomson, H., Petrova, S., & Bouzarovski, S. (2018). *Energy poverty and vulnerability*. Taylor & Francis.

Vanahalli, S., Biswas, S., George, J. P., & Shukla, S. (2022, January). District Level Analytical Study of Infant Malnutrition in Madhya Pradesh. In *International Conference on Electrical and Electronics Engineering* (pp. 237-247). Singapore: Springer Singapore.

Wang, Y., & Bailis, R. (2015). The revolution from the kitchen: Social processes of the removal of traditional cookstoves in Himachal Pradesh, India. *Energy for Sustainable Development*, *27*, 127-136.

Whitehead, A., & Kabeer, N. (2001). Living with uncertainty: gender, livelihoods and pro-poor growth in rural sub-Saharan Africa.

Xiao, Y., Wu, H., Wang, G., & Mei, H. (2021). Mapping the worldwide trends on energy poverty research: A bibliometric analysis (1999–2019). *International Journal of Environmental Research and Public Health*, *18*(4), 1764.

Zaman, S., Wang, Z., & Zaman, Q. U. (2021). Exploring the relationship between remittances received, education expenditures, energy use, income, poverty, and economic growth: fresh empirical evidence in the context of selected remittances receiving countries. *Environmental Science and Pollution Research*, *28*, 17865-17877.

Appendix (Turnitin Report)

ANALYZING THE RELATIONSHIP BETWEEN ENERGY POVERTY AND GENDER INEQUALITY: A COMPARATIVE STUDY OF SOUTHERN ASIAN, SUB-SAHARAN AFRICAN, AND EUROPEAN UNION COUNTRIES WITH A FOCUS ON WOMEN'S EMPOWERMENT

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Appendix B, (Ethics Committee Report)

NEAR EAST UNIVERSITY

SCIENTIFIC RESEARCH ETHICS COMMITTEE

24.11.2023

Dear Nathan Y. Bellepea

Your project **"Analyzing The Relationship Between Energy Poverty And Gender Inequality: A Comparative Study Of Southern Asian, Sub-Saharan African and European Union Countries With A Focus On Women's Empowerment"** has been evaluated. Since only secondary data will be used the project does not need to go through the ethics committee. You can start your research on the condition that you will use only secondary data.

Prof. Dr. Aşkın KİRAZ

The Coordinator of the Scientific Research Ethics Committee