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**Renewable Energy and Women's Empowerment in Fragile States: An Analysis
within the Framework of the Sustainable Development Goals**

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***To my parents, my grandparents, and Mr. Stefanopoulos,
for being my long-standing anchors at every step.***

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Table of contents

Abstract.....	7
Abbreviations.....	9
Chapter 1: Introduction.....	10
1.1 Background and Context.....	10
1.1.1 Energy access as a foundation for development.....	10
1.1.2 Energy poverty's gendered aspects.....	11
1.1.3 Fragility as a cultural constraint.....	12
1.1.4 Renewable energy.....	12
1.1.5 Using the SDG framework in practice.....	13
1.1.6 Political landscape.....	13
1.1.7 The rationale and research gap.....	14
1.2 Problem Statement.....	15
1.3 Research Aim and Objectives.....	19
1.4 Research Questions.....	19
1.5 Scope and Delimitation.....	20
1.6 Significance of the Study.....	21
1.7 Structure of the Dissertation.....	21
Chapter 2: Literature Review.....	23
2.1 Introduction.....	23
2.1.1 Fragility's multifaceted nature.....	23
2.2 Climate Change, Fragility, and Development Challenges in Africa.....	24
2.2.1 The multiplier of fragility caused by climate change.....	24
2.2.2 Human and macroeconomic effects.....	24
2.2.3 Climate fragility's social and gendered aspects.....	25
2.2.4 Feedback loops between fragility and climatic shocks.....	25
2.2.5 Reactions to adaptation and policy.....	26
2.2.6 Synthesis.....	26
2.3 Renewable energy as a development and climate resilience strategy.....	26
2.3.1 The role of renewable energy in promoting development.....	26
2.3.2 Local resilience and energy access.....	27
2.3.3 Peace benefits, economic diversification, and renewable energy.....	28
2.4 Empowerment and Gender in Energy Transitions.....	28

2.4.1 Concepts of gender and energy from a theoretical standpoint	28
2.4.2 The involvement of women in the field of renewable energy	29
2.4.3 Results of empowerment and structural limitations	30
2.5 SDG Framework Integration	30
2.5.1 How SDG 5 and SDG 7 work together	30
2.5.2 Renewable energy in the framework of SDG policy	31
2.5.3 Accountability and measurement.....	31
2.6 Research Deficits and Conceptual Consequences.....	32
Chapter 3: Methodology.....	33
3.1 Overview	33
3.2 Research paradigm and philosophy	33
3.3 Design of the Research	34
3.3.1 Explanatory design using mixed techniques.....	34
3.3.2 Justification for the case study methodology	34
3.4 Conceptual Framework	35
3.4.1 Pathways for analysis.....	35
3.5 Data Gathering Techniques	36
3.5.1 Secondary information	36
3.5.2 Analysis of documents and policies	36
3.6 Methods of Data Analysis	36
3.6.1 Analysis of quantitative data.....	36
3.6.2 Analysis of qualitative data	37
3.6.3 Using several sources	37
3.7 The methodology's limitations	37
Chapter 4: Findings and Analysis.....	39
4.1 Overview of Case Contexts	39
4.1.1 Somalia	39
4.1.2 Yemen.....	42
4.1.3 Democratic Republic of the Congo.....	43
4.2 Renewable Energy Interventions Examined	44
4.2.1 Somalia.....	45
4.2.2 Yemen.....	47
4.2.3 Democratic Republic of the Congo.....	48
4.3 Women's Empowerment Outcomes	51

4.3.1 Outcomes of economic empowerment	52
4.3.2 Reducing labor burden and time use	53
4.3.3 Safety and health outcomes	55
4.3.4 Political and social empowerment	56
4.3.5 Educational outcomes	57
4.4 Barriers and enabling factors.....	58
4.4.1 Institutional and Structural Barriers	58
4.4.2 Sociocultural barriers	60
4.4.3 Economic barriers	61
4.4.4 Security related barriers	61
4.5 Linkage to SDGs.....	63
Chapter 5: Discussion	65
5.1 Synthesis of Key Results.....	65
5.2 Comparing Findings with Literature.....	66
5.3 Implications for the SDG Framework	67
5.4 Policy and Practice Implications.....	68
Chapter 6: Conclusion and Recommendations.....	69
6.1 Conclusions	69
6.2 Practical recommendations for future research	70
6.3 Limitations of the Study	71
References.....	72

Abstract

Within the integrative framework of the Sustainable Development Goals (SDGs), this research investigates the connection between women's empowerment and renewable energy solutions in fragile and conflict-affected states (FCAS). The study examines how decentralized renewable energy systems, such as solar home systems, mini-grids, and clean cooking technologies, impact women's economic, social, and political agency in settings marked by institutional weakness, environmental stress, and active or latent conflict. It focuses on comparative case studies from Somalia, Yemen, and the Democratic Republic of the Congo (DRC).

The study uses a mixed-methods approach, integrating qualitative insights from policy papers, project evaluations, and contextual assessments with secondary dataset analysis from international organizations. The study assesses empowerment results in a number of areas, including time usage, health and safety, income and employment, decision-making, and community involvement. It is based on Kabeer's (1999) tripartite model of empowerment, which includes resources, agency, and accomplishments.

The results show that access to renewable energy greatly lowers women's time poverty and improves physical safety, but its conversion into more widespread empowerment depends heavily on intervention design, gender norms in the setting, and supplementary institutional supports. Compared to gender-blind, market-driven methods seen in Somalia, explicitly gender-transformative programs—like those in Yemen that include women's technical training and leadership roles—produced better and more lasting empowering outcomes. However, an empowerment paradox surfaced, highlighting the danger of perpetuating inequality in the absence of integrated, equity-focused approaches: women with pre-existing socioeconomic advantages benefited disproportionately, while the most marginalized, including displaced and rural women, experienced limited gains. According to the study's findings, renewable energy is an essential but insufficient catalyst for women's empowerment in FCAS.

Deliberate gender integration, flexible implementation that takes conflict dynamics into account, and synergistic connections with other SDGs—especially SDG 5

(gender equality), SDG 7 (clean and affordable energy), and SDG 16 (peaceful and inclusive societies)—are necessary for its success. The dissertation advances theoretical discourse by improving empowerment and energy justice frameworks for use in fragile settings, and it contributes to policy and practice by providing evidence-based recommendations for creating gender-responsive, conflict-sensitive renewable energy interventions. In the end, our study emphasizes that energy transitions must be used as transformational processes that support social justice, resilience, and equitable inclusion in some of the world's most vulnerable environments, rather than merely as technological solutions, in the goal of sustainable development.

Abbreviations

DRC: Democratic Republic of the Congo

ESPs: Energy Service Providers (specifically referring to private companies in Somalia's energy sector)

FCAS: Fragile and Conflict-Affected States

FER: Femmes et Énergie Renouvelable (Women and Renewable Energy network in DRC)

GAD: Gender and Development

GDP: Gross Domestic Product

IEA: International Energy Agency

IMF: International Monetary Fund

IRENA: International Renewable Energy Agency

OECD: Organization for Economic Co-operation and Development

PAYG: Pay-As-You-Go (a financing model)

PUE: Productive Use of Energy

PV: Photovoltaic

SDG: Sustainable Development Goal

SHS: Solar Home Systems

UN: United Nations

UN DESA: United Nations Department of Economic and Social Affairs

UNDP: United Nations Development Programme

UNFPA: United Nations Population Fund

WEEI: Women's Empowerment in Energy Index

WHO: World Health Organization

WWA: World Weather Attribution

YEEAP: Yemen Emergency Electricity Access Project

YWSI : Yemen Women's Solar Initiative

Chapter 1: Introduction

1.1 Background and Context

1.1.1 Energy access as a foundation for development

Many people see the worldwide shift to renewable energy as a socioeconomic opportunity as well as an environmental need. Beyond its capacity to combat climate change, renewable energy has become a development imperative – crucial to reducing poverty, boosting health, and guaranteeing equitable growth (United Nations, n.d.; IEA, 2024). But not all areas or social groupings experience this shift equally. Energy poverty, gender inequality, and institutional instability are three vulnerabilities that frequently continue to interact for women in fragile and conflict-affected states (FCAS). Achieving the Sustainable Development Goals (SDGs), especially SDG 5 (gender equality) and SDG 7 (affordable and clean energy), requires an understanding of this junction. Access to energy serves as a basis for growth; nearly every aspect of human development—including security, economic involvement, health, and education—is supported by access to contemporary energy services (UN DESA, 2018). Conflict, poor governance, and deteriorating infrastructure can cause significant disruptions to energy systems in fragile governments. Rural and peri-urban areas rely on costly, unreliable diesel production or biomass for basic necessities, while metropolitan enclaves are often the only places with electricity networks (OECD, 2025). This lack of resources limits constructive endeavors and sustains reliance on aid. According to empirical research, even in areas with limited state capacity, renewable energy technologies like improved cookstoves, solar home systems, and decentralized solar mini-grids can significantly lower fuel costs and increase service coverage (IEA, 2024; OECD, 2025). However, such initiatives may not always result in inclusive distributions. The advantages of energy access could disproportionately benefit men or local elites in the absence of gender-sensitive planning, maintaining or even widening gender disparities (UN DESA, 2018).

1.1.2 Energy poverty's gendered aspects

Gender is a factor in energy poverty. Women and girls are disproportionately affected in low-income and vulnerable environments. They spend hours every day gathering traditional fuels like firewood and charcoal, which puts them in risk and exposes them to harassment in areas plagued by violence (UN DESA, 2018). Additionally, using biomass for cooking has health risks: according to WHO estimates, millions of premature deaths occur each year as a result of exposure to household air pollution from solid fuels, with women and children accounting for the majority of these deaths (WHO, 2016).

Women's access to education, knowledge, and contemporary communication tools is further limited by a lack of electricity, which lowers their level of social and political engagement. Furthermore, women's empowerment, which is widely defined as the ability to make strategic life decisions in situations where that ability was previously denied, is closely linked to energy availability as it affects time utilization and productivity (Kabeer, 1999). Accordingly, renewable energy has the potential to be a catalyst for gender transition in addition to being a technological intervention.

By giving individuals more control over their lives in measurable ways, renewable energy supports them. People spend less time collecting wood for fuel when they have access to renewable energy. Women are also able to use energy to improve their productivity, mobility, information access, and safety as a result.

By examining factors such as (i) how much less time women spend on unpaid household labor; (ii) how many more small businesses are started by women because they have access to energy; (iii) how much more women are involved in local decisions; (iv) if women in the energy industry can get loans; and (v) if things like the Women's Empowerment in Energy Index (WEEI), which was created by IRENA in 2025, show that women have more control over their lives, we can measure this change. Therefore, renewable energy is more than just a technological fix; it's a way to empower women, alter social norms, and expand women's choices in life.

1.1.3 Fragility as a cultural constraint

There are unique obstacles to achieving these advantages in fragile regimes. Fragility is defined by the OECD (2025) as a mix of risk exposure and the state's, institutions', and communities' inadequate ability to cope with, absorb, or reduce such risks. In these situations, public income is erratic, security circumstances frequently change, and governance institutions are either weak or challenged. Energy access is directly affected by these structural flaws: infrastructure is harmed or ignored; uncertainty discourages private investors; and foreign aid flows are frequently project-based and short-term rather than systemic (OECD, 2025).

For women, fragility compounds inequality. Traditional livelihoods and social networks are upended by conflict and displacement, and women's movement and access to public spaces are restricted by security risks (OECD, 2025). The failure of financial organizations might make it much more difficult for women to own property or get loans. As a result, the same factors that make renewable energy necessary for living also make it harder to provide and less likely to empower.

1.1.4 Renewable energy

Despite these hurdles, renewable energy programs can offer avenues for resilience building in FCAS. Decentralized energy systems are appropriate for situations where centralized infrastructure is unsafe or impractical due to their inherent modularity and adaptability (IEA, 2024). Installations of solar and wind power may be quickly put into place, offer vital services for schools and medical institutions, and lessen reliance on fuel imports, which are frequently interrupted during times of war. These interventions also provide chances for women's empowerment when they are created with a gender perspective. It has been demonstrated that women's involvement in renewable energy businesses, ranging from assembly and maintenance to retail and microfinance, raises household incomes, develops technical skills, and changes gender norms in the community (IRENA, 2025). Moreover, access to reliable lighting and clean cooking can reduce exposure to gender-based violence by decreasing the need to travel long distances for firewood and by improving safety in public and domestic spaces (Maier et al., 2020). However, context and design have a significant impact on empowerment outcomes. Women's opinions might not be heard when

decisions are being made on tariff structures, siting, or technology selections if inclusive consultation is not used. Similarly, energy access could not result in true empowerment if initiatives do not address structural barriers such as uneven property rights or financial exclusion (UN DESA, 2018).

1.1.5 Using the SDG framework in practice

A comprehensive framework for examining these links is offered by the SDGs. While SDG 5 aims to attain gender equality and empower all women and girls, SDG 7 aims to provide universal access to cheap, dependable, and sustainable energy. The two objectives are interdependent; advancements in one might spur advancements in the other. For instance, the adoption of renewable energy helps address climate change (SDG 13), while women's economic involvement made possible by energy access promotes inclusive growth (SDG 8) and poverty reduction (SDG 1). On the other hand, the inclusion concept at the heart of the SDG goal is compromised when gender issues are ignored in energy planning (UN, n.d.).

This dissertation highlights the transformative potential of renewable energy interventions by placing them within the SDG framework. These interventions can be used not only as environmental or technological solutions, but also as tools for social justice and peacebuilding. In FCAS, where social cohesion and state legitimacy are frequently brittle, inclusive energy provision that clearly benefits women can help restore public confidence in institutions, supporting SDG 16 on justice, peace, and strong institutions.

1.1.6 Political landscape

The political environment that influences development decisions in the Global South links renewable energy, gender equality, and vulnerability. Variations in energy usage reflect imbalances in power between nations, donors, and emerging players, which in turn affect how communities deal with risk. Numerous vulnerable nations rely on foreign aid due to their fragile institutions, financial constraints, energy insecurity, and climate challenges. Western governments view gender-responsive renewable energy as a means of increasing resilience and preventing the spread of crises such as displacement or instability.

In the meantime, nations like China are seeking to influence energy through lending and collaboration, positioning renewable energy in a position of power. Here, women's empowerment is not just a social aim but also a stabilizing factor: equitable access to energy can foster community cohesion, fortify institutions, and increase society's resilience to adversity. From this viewpoint, renewable energy initiatives in vulnerable regions have developmental, social, and geopolitical implications, with gender results affecting both local communities and international stability.

1.1.7 The rationale and research gap

Even though it is now well accepted in development discourse that gender equality and energy access are interdependent, there is still a dearth of empirical research that focuses on renewable energy and women's empowerment in fragile nations (OECD, 2025). Empowerment indicators are seldom integrated into existing research, which frequently concentrates on humanitarian energy access or stable low-income nations. Furthermore, it is challenging to quantify results and duplicate best practices since many donor initiatives lack reliable gender-disaggregated indicators.

Therefore, this dissertation addresses two imperatives: the moral and developmental need for women's empowerment and the global urgency of universal access to renewable energy. The study fills crucial evidence vacuum at the nexus of gender, energy, and fragility — an area crucial to accomplishing the 2030 Agenda — by examining how renewable energy may serve as both an economic and social intervention in unstable situations.

There isn't enough data available, as shown by worldwide research. According to the World Bank (2020), fewer than 10% of energy projects in FCASs include baselines that divide data by gender. The OECD (2025) notes that the majority of programs in vulnerable states lack monitoring systems that link energy projects to empowerment outcomes. Furthermore, IRENA (2025) states that studies on renewable energy and gender are primarily focused on stable nations such India, Kenya, and Nepal, while FCAS is mostly unexplored. These similar reports demonstrate a general dearth of real-world data that takes into account gender, vulnerability, and energy collectively in particular circumstances.

1.2 Problem Statement

One of the most difficult problems facing modern development is the confluence of energy shortage, gender inequity, and state fragility. In a self-reinforcing "trap," each dimension feeds into the others, limiting women's autonomy, slowing economic growth, and impeding the achievement of the Sustainable Development Goals (SDGs). Designing renewable energy initiatives that catalyze systemic social transformation rather than just delivering technology requires an understanding of how these three components interact.

Despite advancements worldwide, energy poverty is still widespread. According to the International Energy Agency (IEA, 2024), 2.3 billion people relied on traditional biomass for cooking, and a projected 660 million people globally lacked access to electricity. About four out of five individuals without electricity reside in sub-Saharan Africa, many of them are in unstable and conflict-affected nations like South Sudan, the Democratic Republic of the Congo, and Somalia. This indicates that the distribution of deprivation is incredibly unequal (OECD, 2025).

Underdevelopment is both a cause and an effect of energy poverty. Limited power hinders health services by preventing vaccine refrigeration and obstetric care, limits education by limiting study hours, and stifles enterprise by limiting communication and mechanization (UN DESA, 2018). Since diesel-based logistics predominate in off-grid service delivery, the shortage of energy in humanitarian circumstances worsens reliance on help and raises the cost of relief operations (Lahn and Grafham, 2015).

From a systems perspective, market dysfunction, governance failure, and infrastructure collapse all contribute to energy poverty in fragile states. Conflict frequently damages centralized systems, and financial crises frequently prevent repairs. Political unrest restricts long-term planning and discourages private investment. Dependency on fuel imports makes the economy more vulnerable, and energy shortage worsens when supply chains are interrupted (OECD, 2025). Weak institutions are unable to supply energy, and energy shortage makes institutions even weaker. This leads to a vicious cycle.

Lack of energy has a strong gender component. Women are primarily responsible for managing household energy in the majority of low-income and vulnerable environments, including gathering fuel, cooking, and maintaining home lights (UN DESA, 2018). Women may spend three to six hours a day gathering and processing biomass in rural sub-Saharan Africa, demonstrating the extraordinary time commitment required for these tasks (OECD, 2025). Time poverty limits their ability to engage in political engagement, earn a living, or pursue education (Kabeer, 1999).

The effects on health are just as bad. Women and children are disproportionately affected by household air pollution from solid fuels, which results in around 3.2 million premature deaths annually (World Health Organization, 2016). Low birth weight, cataracts, and chronic respiratory diseases are all exacerbated by smoke exposure (WHO, 2021). Furthermore, women and children are at danger for sexual abuse due to risky fuel collecting routes, especially in areas impacted by conflict or displacement (Maier et al., 2020).

Women's economic empowerment is also hampered by energy poverty. Microbusinesses are unable to employ sewing machines, milling machines, or refrigerators without power; agricultural processing is still done by hand and is low-value. It has been demonstrated that providing women with access to renewable energy, particularly localized solar or mini-grid systems, may boost their incomes through energy-efficient use and, when intentionally included, enhance employment in energy distribution networks (IRENA, 2025). However, these benefits are not guaranteed; in societies where, patriarchal traditions govern asset ownership, males may take advantage of electrification's advantages while maintaining gender inequalities (UN DESA, 2018).

Fragility exacerbates these issues by undermining legitimacy, governance, and the provision of public services. According to the OECD (2025), fragility is the result of a state, system, or community's poor ability to cope with threats. Political instability, violence, environmental vulnerability, and economic volatility are all common in fragile situations.

In such settings, regulatory bodies lack independence and enforcement authority, and state energy utilities are frequently nonexistent or insolvent (OECD, 2025).

Conflict-related infrastructure destruction disrupts generation and transmission, and restoration is hampered by a lack of maintenance capability. Energy policy is often short-term, donor-driven, and ad hoc. Because of this, access rates are still quite low: electricity rates in South Sudan and the Central African Republic are less than 10%, whereas the world average is over 90% (IEA, 2024).

Gender interactions are complicatedly shaped by fragility as well. As communities adhere to conservative identities for security, conflict may intensify gender-based violence and uphold traditional norms (True and Riveros-Morales, 2019). At the same time, when women take on new leadership or economic positions, crises can create opportunities for gender role renegotiating. Thus, program design and environment have a major role in whether renewable energy initiatives strengthen or change gender hierarchies.

Moreover, policy consistency across sectors—energy, gender, finance, and peacebuilding—is uncommon due to FCAS's poor institutions. Data systems are sparse, gender focal points lack funding, and ministries frequently function in silos. Even well-meaning renewable energy projects may fall short of including women or aligning with national gender goals in the absence of integrated planning (Maier et al., 2020).

A vicious cycle is produced when fragility, gender inequality, and energy poverty interact:

Poverty of Energy → Fragility. Large-scale energy infrastructure investment and maintenance are impeded by institutional weakness, corruption, and insecurity.

Gender Inequality → Energy Poverty. Lack of access strengthens social subordination by increasing women's unpaid labor and decreasing their economic agency.

Fragility is a result of gender inequality. Fragility is sustained when women are excluded from economic and decision-making processes because this undermines social cohesiveness and reduces peace benefits.

According to research, excluding women from politics and the economy undermines society and diminishes the advantages of peace. According to UN Security Council Resolution 1325 and its associated resolutions (2122, 2242), women's participation is necessary for lasting peace. According to the United Nations and World Bank (2018), the communities with greater gender inequality are more prone to revert to conflict, which supports this notion. True and Riveros-Morales (2019) discover that trust in organizations declines and community resilience diminishes when women are excluded, hurting the social cohesion necessary for peacebuilding. According to the study, gender inequality exacerbates instability and reduces peace gains.

Interventions that focus on all three components at once are necessary to break this loop. By boosting livelihoods, boosting health, and fortifying local governance, inclusive, community-based, and gender-responsive renewable energy projects may support resilience (OECD, 2025). On the other hand, gender-blind energy initiatives run the danger of escalating resource-related disputes and perpetuating current disparities.

There is currently little but increasing empirical support for gender-energy interventions that are effective in FCAS. Women's cooperatives in Yemen and Lebanon have benefited from solar distribution networks, increasing their income and social standing, according to the World Bank's MENA gender-energy study (Maier et al., 2020). In a similar vein, donor-funded solar micro-grids run by women's organizations in Afghanistan created microbusiness possibilities and enhanced home illumination (OECD, 2025). These examples show that, despite uneasiness, inclusive design may have positive effects on empowerment.

However, most FCAS programs are not rigorously evaluated. According to Lahn and Grafham (2015), many depend on temporary humanitarian aid, which leaves systems unsustainable once it stops. Others disregard safety issues, putting female installers or business owners at danger in dangerous situations.

As a result, scholarly research needs to shift from descriptive case studies to analytical models that clarify how and why renewable energy may empower women in vulnerable situations. By creating an integrated framework that connects energy

access, empowerment results, and institutional context via the SDGs, this dissertation advances that objective.

1.3 Research Aim and Objectives

Research aim is to determine programmatic and policy design elements that enhance empowerment results within an SDG-oriented framework, and to analyze the impact of renewable energy interventions on women's empowerment in fragile and conflict-affected nations.

Objectives

To identify the primary ways that women's empowerment (time usage, health, income, political involvement, and safety) might be impacted by access to renewable energy in FCAS. To evaluate the institutional, social, economic, and security-related contextual barriers that influence whether energy initiatives result in empowerment.

To determine which design elements—financing, governance, community participation, and protective measures—are linked to successful results by analyzing case evidence (projects and programs) from a few chosen fragile nations. To give donor organizations, implementers, and national legislators practical, fact-based advice on how to match energy investments with SDGs 5 and 7 in fragile environments.

1.4 Research Questions

The research questions are the following

1. How does having access to renewable energy support the various faces of women's empowerment in FCAS?
2. What external circumstances make it easier or harder for women in unstable nations to convert energy access into empowerment outcomes?
3. Which policy tools and operational procedures have proven effective (or ineffective) in achieving gender-intentional energy results in FCAS?

4. How may frameworks for SDG monitoring and results be modified to more accurately reflect the gendered effects of energy initiatives in vulnerable environments?

1.5 Scope and Delimitation

The dissertation focuses on nations that are unstable and damaged by war. In order to demonstrate mechanisms and constraints, the empirical analysis will employ a purposeful selection of case studies (for instance, Yemen, the Democratic Republic of the Congo, and a few MENA FCAS where data and project documentation are available); the final case selection will strike a balance between analytical depth and cross-case comparability. The study uses cross-national monitoring when there is global evidence that is pertinent (IEA, UN, World Bank).

The emphasis is on renewable energy interventions, such as distributed photovoltaics (PV) for domestic and commercial applications, clean cooking technologies, and decentralized solutions (mini-grids, solar home systems). Large central station initiatives are only taken into consideration if they directly affect women's access, employment, or governance at the local level.

This research does not aim to offer comprehensive technical engineering evaluations of energy systems; rather, it concentrates on the relationship between gender and energy. The research will supplement secondary data, as the availability and quality of sex-disaggregated data in FCAS varies. In certain FCAS, due to ethical and security restrictions, data acquisition is strictly confined to non-interpersonal, remote methods. This relies exclusively on remote sensing, spatial analysis, and the processing of pre-existing institutional datasets, specifically excluding any form of direct or remote fieldwork, interviews, or personal interactions; Chapter 3 will address these methodological decisions and how they affect inference.

1.6 Significance of the Study

This dissertation seeks to make three contributions. In order to provide a useful analytical framework appropriate for unstable environments, it first synthesizes cross-sectoral theory (gender studies, energy justice, and resilience). Second, it produces empirical evidence regarding whether renewable energy designs and delivery modes likely result in empowering results for women in FCAS. This is done through case analysis and the original processing of remote sensing and institutional datasets. Third, it provides funders, implementers, and national authorities with tangible design alternatives and conflict risk and gender-sensitive monitoring indicators, as well as policy-relevant suggestions for aligning energy investments with SDG 5 and SDG 7 in fragile settings. A deeper understanding of this relationship is urgently relevant to policy since FCAS are expected to house an increasing proportion of severe poverty and are at the center of the global agenda for accomplishing the SDGs.

1.7 Structure of the Dissertation

The structure of this dissertation is organized into six chapters, as follows:

Chapter 1: Introduction – Sets the context, defines the research problem, and outlines the aim, objectives, and scope of the study.

Chapter 2: Literature Review – Provides an extensive synthesis of scholarly and professional literature regarding the nexus of gender and energy, the challenges of energy access in precarious situations, and the theoretical frameworks connecting energy to resilience and empowerment.

Chapter 3: Methodology – Describes the research design and case selection, identifies existing data sources and analytical techniques, and addresses the ethical considerations involved in data usage within Fragile and Conflict-Affected States (FCAS).

Chapter 4: Findings and Analysis – Presents the case studies and empirical evidence from specific fragile states, interpreting the data to evaluate the pathways and variables that influence energy interventions.

Chapter 5: Discussion – Integrates the theoretical framework with the collected findings, identifies key design principles and trade-offs, and discusses the implications for monitoring the Sustainable Development Goals (SDGs).

Chapter 6: Conclusions and Recommendations – Summarizes the research findings in relation to the initial objectives, acknowledges the study's constraints, and offers strategic programmatic and policy suggestions for future interventions.

Chapter 2: Literature Review

2.1 Introduction

The clean-energy transition, gender equality, and peacebuilding are the three global policy goals that connect with the link between renewable energy, women's empowerment, and fragility. This convergence is embodied in the Sustainable Development Goals (SDGs), particularly SDG 5 on gender equality, SDG 7 on renewable energy, and SDG 16 on peace and institutions. However, data indicates that women in fragile and conflict-affected states (FCAS) continue to be among those most frequently left behind, despite the verbal commitment to "leaving no one behind" (OECD, 2025).

2.1.1 Fragility's multifaceted nature

Political, economic, environmental, and social vulnerability are all components of fragility, which is more than just the lack of peace (OECD, 2025). More than 70% of FCAS are found in sub-Saharan Africa, where fragility is characterized by a lack of effective government, persistent poverty, reliance on rain-fed agriculture, and vulnerability to climatic extremes. These circumstances create a vicious cycle whereby weak institutions find it difficult to provide services, which further erodes governmental legitimacy and erodes public confidence (Azour and Selassie, 2023).

Access to energy serves as a stand-in for human security. Food preservation, healthcare, education, and livelihoods are all supported by contemporary energy services (IEA, 2024). Hundreds of millions of Africans lack access to clean cooking energy or electricity, which limits women's economic involvement and exacerbates gendered inequalities of labor (UN DESA, 2018). Therefore, a multifaceted understanding of the energy-gender-fragility relationship is necessary because energy poverty exacerbates inequality, which can exacerbate social tensions and weaken resilience in unstable environments (OECD, 2025).

There are two main reasons why renewable energy is important in this discussion. First, because of its decentralized design, services may be provided even in situations when the grid has failed because of financial constraints or violence (IRENA, 2025). Second, renewables offer a mechanism to achieve low-carbon, inclusive growth that

balances local adaptation and livelihood demands with climate mitigation. Localized renewable systems might improve energy sovereignty and lessen geopolitical risk in fragile governments when reliance on imported fossil fuels depletes limited supplies (Azour and Selassie, 2023).

2.2 Climate Change, Fragility, and Development Challenges in Africa

2.2.1 The multiplier of fragility caused by climate change

By threatening livelihoods, escalating competition for resources, and upending governance structures, climate change exacerbates already-existing vulnerabilities in vulnerable environments. The effects are most severe in Africa, where climate-sensitive agriculture accounts for more than 60% of employment (Azour and Selassie, 2023).

2.2.2 Human and macroeconomic effects

The economic aspect of this fragility is quantified in the IMF's 2023 study. According to Azour and Selassie (2023), fragile states see a roughly 4% reduction in GDP in the three years after catastrophic weather disasters, whereas other emerging nations only experience a 1% decline. Per capita GDP growth is lowered by 0.2 percentage points per year due to droughts alone. According to projections, fragile states would encounter four times as many days above 35 °C annually on average by 2040 as non-fragile nations. These circumstances will increase the demands of migration, strain water supplies, and lower agricultural production.

Crucially, the IMF highlights that the disproportionate impact is caused by structural weaknesses such as war, reliance on rain-fed agriculture, inadequate irrigation, and insufficient fiscal capacity, rather than just location. Although just 3% of farmland is irrigated, agriculture accounts for about 25% of production in unstable nations. Conflict and poor management frequently make irrigation unusable when it does exist; in Mali and Sudan, for example, war has destroyed drainage systems and decreased the amount of arable land (Azour and Selassie, 2023).

2.2.3 Climate fragility's social and gendered aspects

The impacts of climate shocks are profoundly gendered. Women and girls are disproportionately responsible for gathering fuel and water in areas that are prone to drought, which exposes them to physical weariness and violence. They are the first to forgo meals or pull kids out of school, especially females, in order to conserve resources when harvests fail (UN DESA, 2018).

The Horn of Africa drought in 2021–2022 exacerbated gender inequality by pushing women into unsanitary refugee camps, increasing their vulnerability to exploitation and child marriage (Khamati-Njenga and Clancy, n.d.). Furthermore, labor standards and patriarchal inheritance interact with the loss of livelihoods brought on by climate change. Women take on home or agricultural leadership roles when males travel in pursuit of employment, but they lack the decision-making authority and financial resources to match (OECD, 2025). Without empowerment, this feminization of accountability increases stress and weakens communal resilience.

2.2.4 Feedback loops between fragility and climatic shocks

A self-reinforcing climate, conflict, and fragility loop is identified in the literature:

Natural and financial resources are depleted by climate shocks like droughts and floods.

Loss of livelihood leads to competition for limited resources like pasture and water.

Weak governance prevents mediation and escalates conflicts into violence.

According to Nordqvist and Krampe (2018), conflict subsequently erodes institutional capacity and infrastructure, increasing vulnerability to future shocks.

This loop is exemplified by the Horn of Africa instance. Conflicts erupted when pastoralist migration increased due to drought's reduction of pasture and water. In the meanwhile, unrest hindered humanitarian aid, which further reduced the ability to adjust (Khamati-Njenga and Clancy, n.d.). These relationships show how political stability and inclusive governance are essential to climate resilience.

2.2.5 Reactions to adaptation and policy

Strong adaptation combined with structural change is a policy requirement that is supported by both the WWA (2023) and IMF (2023) studies. Climate-resilient infrastructure (renewable energy systems, irrigation), varied livelihoods, social protection initiatives, and concessional financing are among the suggested courses of action. To prevent famine and violence from getting worse, the IMF expressly requests "sizable and ongoing support from international development partners—both concessional funding and capacity building" (Azour and Selassie, 2023).

A key component of these options is renewable energy. It has advantages for both adaptation and mitigation: reducing emissions while facilitating off-grid access to cold-chain storage, irrigation, and early-warning communication systems. Khamati-Njenga and Clancy (n.d.) conclude that investment must be resilient to both dry and wet conditions—exactly the flexibility that decentralized renewables provide.

2.2.6 Synthesis

In conclusion, research shows that climate change is a structural cause of fragility that exacerbates gender disparity rather than being a standalone environmental problem. Gender-based poverty, institutional weakness, and climatic vulnerability all coexist in fragile African nations. These same dynamics, however, demonstrate how inclusively designed renewable energy programs may act as resilience anchors. They have the potential to stabilize societies, lessen dependency on rain-fed systems, and enable women to take an active role in adaptation rather than being passive targets of climate stress (Sarabdeen et al., 2024).

2.3 Renewable energy as a development and climate resilience strategy

2.3.1 The role of renewable energy in promoting development

In fragile and conflict-affected states (FCAS), renewable energy serves two purposes: it promotes resilience and development at the same time. Decentralized renewable technologies, such as solar mini-grids and freestanding photovoltaic (PV) units, are flexible, quickly deployable, and resilient to instability, in contrast to centralized fossil fuel infrastructure (IRENA, 2025). Decentralized alternatives are the only practical

route to electricity in many FCAS, where central networks have failed because of war or neglect.

In sub-Saharan Africa, where grid expansion costs are still exorbitant, off-grid renewables are the most economical way to reach universal access, according to the International Energy Agency (IEA, 2024). Similarly, investments in clean energy offer "resilience rewards" that go beyond energy security, according to the Organization for Economic Co-operation and Development (OECD, 2025). These include lowering reliance on foreign fuels and stabilizing communities via local ownership and employment development.

Solar-powered microgrids may maintain vital services (such as schools, hospitals, and water systems) even in the midst of conflict, according to empirical evidence from nations like Yemen, Lebanon, and Afghanistan (Maier, Constant and Ahmad, 2020). These incidents highlight the strategic value of renewable energy for humanitarian and peacebuilding efforts in addition to climate mitigation.

2.3.2 Local resilience and energy access

The ability of energy systems to predict, absorb, and recover from shocks is referred to as energy resilience (Peschka, 2011). Because it is spread, renewable energy increases this capability. Solar mini-grids can continue to function independently during natural catastrophes or conflicts, offering the refrigeration, lighting, and communications necessary for survival and rehabilitation.

This claim is supported by the Horn of Africa drought analysis (Khamati-Njenga and Clancy, n.d.), which shows that adaptation plans "resistant to both wet and dry extremes" are necessary due to severe climate variability. Under such circumstances, renewable energy sources may power early-warning systems, water purification units, and irrigation pumps, making towns less susceptible to variations in rainfall. Renewable energy is firmly positioned within the framework of climate-resilient development because to this adaptive function.

But resilience is more than just technology. The IMF contends that institutional and financial capabilities are critical to the success of climate adaptation (Azour and Selassie, 2023). Governance methods that guarantee fair access, open

management, and asset protection in unstable contexts are necessary for renewable projects. Instead of reducing current disparities, renewable energy can exacerbate them in the absence of such institutional foundations.

2.3.3 Peace benefits, economic diversification, and renewable energy

By reducing reliance on unstable industries like agriculture and oil, economic diversification via renewable energy can diminish instability. Manufacturing solar panels, putting together batteries, or managing microgrids are examples of local renewable enterprises that may provide green jobs, particularly for women and young people (IRENA, 2025).

Such job creation can promote peace dividends, which are observable economic advantages that strengthen the legitimacy of post-conflict administrations in fragile nations where unemployment fuels discontent (UN DESA, 2018). Energy cooperatives run by local communities promote trust and offer inclusive governance models that improve social cohesion, according to evidence from Sierra Leone and Liberia (OECD, 2025).

Scholars warn against technological determinism, however, noting that technology alone does not guarantee social change. Peace and empowerment are not guaranteed by renewable energy; these results rely on long-term upkeep, fair funding, and social participation. Energy interventions must thus be incorporated into all-encompassing recovery plans that connect infrastructure spending to governance changes and gender equality (Clancy, Mohlakoana and Winther, 2021).

2.4 Empowerment and Gender in Energy Transitions

2.4.1 Concepts of gender and energy from a theoretical standpoint

From "women in development" approaches, which saw women mainly as beneficiaries, to "gender and development" (GAD) and "feminist political ecology" frameworks, which examine power dynamics within energy systems, the gender-energy relationship has changed (Rao and Baden, 2015). According to these viewpoints, women become empowered when they acquire agency, control, and a voice over the production, distribution, and use of energy, rather than when they just have access to it (Kabeer, 1999).

A helpful analytical framework is offered by Kabeer's (1999) tripartite model of empowerment, which consists of resources, agency, and accomplishments. Using this in relation to energy transitions:

- Resources include financial channels and reasonably priced access to energy technology.
- Women's involvement in decision-making, ranging from national policy to domestic energy decisions, is referred to as agency.
- Accomplishments include increased wealth, social standing, and well-being.

2.4.2 The involvement of women in the field of renewable energy

About 32% of workers in the renewable energy sector worldwide are women, and they are more likely to hold administrative positions than technical ones (IRENA, 2025). This percentage is lower in unstable situations because to discriminatory attitudes, safety concerns, and a lack of training opportunities. However, focused treatments have demonstrated the ability to change lives. For example, women-led solar distribution businesses in Yemen and Lebanon challenged societal preconceptions about women's technical proficiency while also increasing earnings and self-efficacy (Maier, Constant and Ahmad, 2020).

Women's entrepreneurship can also grow thanks to renewable energy. Small-scale refrigeration, processing, and service enterprises are made possible by access to power (MacGregor, 2017). Households that installed solar home systems reported a 35% increase in women's microenterprise activity, particularly in tailoring and phone-charging services, according to World Bank (2020) research conducted in MENA unstable environments. However, scalability is still constrained by uneven access to assets and financing.

Clancy, Mohlakoana and Winther's research from 2021 emphasizes how gender mainstreaming in energy policy is still not uniform. Although gender equality is included in many national energy programs, few of them have quantifiable metrics or allocated funds. Therefore, one of the biggest obstacles to gender-energy integration is still getting from rhetoric to outcomes. Gender inequality still exists even in highly established energy systems. For instance, according to Nordic nations, only 31% of

senior roles in energy corporations are held by women (Nordic Energy Research, 2021).

2.4.3 Results of empowerment and structural limitations

The results of empowerment are strongly influenced by contextual and structural elements. Women in FCAS frequently encounter additional obstacles, such as limited mobility, low literacy, uncertain property rights, and increased susceptibility to gender-based violence (OECD, 2025). Because of these obstacles, even when access to energy increases, it is still difficult to convert access into agency and success.

Access to energy, however, may have unintended societal consequences. Electrification promotes health via clean cooking, increases safety through lighting, and boosts education for females by extending study hours (UN DESA, 2018). Such advantages have the potential to change gender norms over time, but change will only be partial in the absence of clear institutional support, such as loans for female entrepreneurs or quotas for women in energy training programs.

Since social structures, legislative frameworks, and market possibilities influence the continuum from access to control, empowerment in energy transitions must be viewed as a process rather than a binary result (Kabeer, 1999; Clancy, Mohlakoana and Winther, 2021).

2.5 SDG Framework Integration

2.5.1 How SDG 5 and SDG 7 work together

Goals of the 2030 Agenda for Sustainable Development are intended to be interdependent. There is a particularly strong connection between SDG 5 (gender equality) and SDG 7 (clean and affordable energy). By lowering the unpaid care load on women and facilitating their involvement in school and the workforce, expanding access to renewable energy accelerates the advancement of gender equality. On the other hand, gender equality increases home adoption, community buy-in, and sustainability, all of which improve the efficacy of energy initiatives (UN DESA, 2018).

These connections become crucial in unstable regimes with insufficient institutional capacity. Benefits across SDGs 1 (reducing poverty), 8 (promoting decent

employment), and 13 (addressing climate change) may be multiplied by including gender concerns into energy planning (Üstündağlı et al.,2024). Policies for climate adaptation that disregard social inclusion run the danger of escalating inequality and jeopardizing macroeconomic stability, according to the IMF (Azour and Selassie, 2023).

2.5.2 Renewable energy in the framework of SDG policy

Renewable energy is marketed as a development and climate intervention. SDG 7 is directly advanced, while it indirectly helps several other targets by facilitating health (SDG 3), education (SDG 4), and infrastructure (SDG 9). One of the few industries that can provide "co-benefits" across the humanitarian, development, and peacebuilding agendas in FCAS is renewable energy, according to the World Bank (2020).

Furthermore, the IMF analysis (Azour and Selassie, 2023) and the Horn of Africa drought research (Khamati-Njenga and Clancy, n.d.) both show that economic and gender justice are inextricably linked to climate and energy security. These revelations strengthen the case for using an analytical methodology based on the SDGs that places renewable energy at the center of inclusive resilience plans.

2.5.3 Accountability and measurement

Measurement is one of the ongoing issues with SDG implementation. There is still a lack of information in FCAS regarding gender-disaggregated leadership, employment, and energy access (IRENA, 2025). It is challenging to evaluate progress and hold actors responsible in the absence of strong monitoring. A more cohesive body of data may be produced by including SDG indicators, such as SDG 5.5 (women's leadership involvement) and SDG 7.1 (universal access to electricity), into project-level monitoring frameworks.

Furthermore, implementing nexus indicators—such as the proportion of households headed by women that have access to energy for productive use—would improve the coherence of policies pertaining to gender, energy, and climate objectives. Gender aspects of energy access have long been highlighted in international frameworks;

UNIDO and UN Women (2014) offer fundamental recommendations on incorporating gender into sustainable energy projects.

2.6 Research Deficits and Conceptual Consequences

Although the studied literature highlights significant advancements, it also highlights important gaps that call for more research:

Limited FCAS empirical evidence: The majority of gender-energy studies concentrate on stable nations like India, Nepal, or Kenya. The role of renewable energy in the context of humanitarian crises, poor governance, and instability is little understood.

Inadequate integration of gender and climate frameworks: While gender studies seldom take energy's role in resilience into account, climate adaptation research rarely looks at empowering effects.

Lack of data and inconsistent metrics: It is difficult to compare and replicate effective models since sex-disaggregated and context-sensitive indicators are still uncommon.

Disconnect between policy and practice: Although gender mainstreaming is supported by several international organizations, there are currently insufficiently developed operational methods for putting gender-responsive energy interventions into FCAS into practice and monitoring their effectiveness.

Theoretical integration is required since there are not many analytical models that connect women empowerment, energy resilience, and the SDG framework in unstable environments.

By creating an integrated conceptual framework that combines the SDG nexus approach, Energy Justice principles, and Gender and Development theory, this dissertation fills these gaps. It makes the case that gender-intentional implementation of renewable energy may support peacebuilding, climate resilience, and empowerment all at once. In order to determine optimal practices, obstacles, and avenues for inclusive energy transitions, the following chapters experimentally apply this approach to a few weak African governments.

Chapter 3: Methodology

3.1 Overview

Within the larger context of the Sustainable Development Goals (SDGs), this chapter describes the documentary-based methodology used to investigate the impact of renewable energy initiatives on women's empowerment in fragile and conflict-affected states (FCAS).

It describes design, case selection, data collecting and analytic methods, study philosophy, ethical issues, and constraints.

Due to the intricacy of the research issue, which encompasses gender, technology, governance, and climate resilience, this study uses a mixed-methods approach that blends contextual quantitative data with qualitative depth. In order to create a comprehensive knowledge of empowerment processes in unstable environments, this method enables triangulation across several data sources.

3.2 Research paradigm and philosophy

The study is positioned within a pragmatic paradigm that prioritizes research topics above adherence to a particular philosophy and values methodological variety (Creswell, 2014). In delicate circumstances, where strict methodological purity frequently gives way to adaptable, problem-solving inquiry, pragmatism is ideally suited for development research (Greene, 2007).

From a philosophical standpoint, the study acknowledges that women's access to energy and empowerment are socially created phenomena shaped by institutions, society, and power dynamics. Thus, the qualitative dimension is grounded on an interpretivist attitude that aims to comprehend the perspectives found within secondary literature and policy documents. Quantitative indicators are also in line with post-positivist traditions of evidence-based policy analysis.

This dissertation's twin goal of producing results that are relevant to policy and contextually grounded is supported by the synthesis of various viewpoints.

3.3 Design of Research

3.3.1 Explanatory design using mixed techniques

The design used is an explanatory sequential mixed-methods design (Creswell and Plano Clark, 2018). There are two stages to this. The first stage involves a quantitative examination of secondary datasets (such as IRENA, IEA, UN, and World Bank indices) to find patterns in fragility, gender inequality, and energy access. This is followed by a qualitative investigation to clarify how and why renewable energy programs impact women's empowerment using case studies and document analysis.

While the qualitative phase offers depth and detail, answering the "how" and "why" of observed interactions, the quantitative phase offers macro-level context.

3.3.2 Justification for the case study methodology

The study uses a comparative multiple-case study methodology since FCAS comes from a variety of institutional, political, and cultural backgrounds (Yin, 2018). Instead of statistical generalization, its design promotes contextual generalization and pattern recognition.

The selected instances show a range of renewable energy projects and fragility across Africa and the MENA area. Among the selection criteria are:

- Designation by the World Bank or OECD as fragile or conflict-affected (2025).
- Existence of programs pertaining to renewable energy that include explicit or implicit gender components.
- Availability of secondary data and published project evaluations.

Three main instances are chosen based on these criteria:

- Somalia is a symbol of growing solar markets, extreme fragility, and drought risk.
- World Bank-backed solar microgrid initiatives in Yemen in the aftermath of the conflict (Maier, Constant and Ahmad, 2020).
- Development agencies fund decentralized hydro and solar community projects in the fragile Democratic Republic of the Congo (DRC).

Each instance provides information about the ways in which women's roles, institutions, and resilience under various conflict situations interact with renewable energy.

3.4 Conceptual Framework

Three theoretical threads are connected by the research's integrative conceptual framework:

The focus of Gender and Development (GAD) is on how access to and control over resources might change gender relations (Rao and Baden, 2015; Kabeer, 1999).

The Energy Justice Framework emphasizes procedural inclusion, distributional equality, and acknowledging underrepresented groups (Sovacool et al., 2017).

The Sustainable Development Goals (SDG) Nexus places gender equality and renewable energy in a global framework that is interconnected and links SDGs 13 (climate action), 7 (clean energy), and 5 (gender equality).

3.4.1 Pathways for analysis

The conceptual model illustrates four primary channels that connect renewable energy to women's empowerment in FCAS (see Figure 3.1 in the whole dissertation):

Access pathway: Clean cooking, communication, and lighting are all made more accessible by renewable energy, which also lessens time poverty.

Economic pathway: Women's entrepreneurship and income diversification are encouraged by access to energy that may be used productively.

Social pathway: Women and girls benefit from better health, safety, and educational results when they have better access to energy.

Institutional pathway: Women's involvement in project management and energy governance enhances their voice and decision-making authority.

Contextual elements such as gender norms, institutional capability, conflict intensity, and fragility level modulate these paths, which eventually advance SDGs 5, 7, 8, and 13.

3.5 Data Gathering Techniques

3.5.1 Secondary information

The research uses a variety of secondary sources to provide background information and bolster triangulation:

- quantitative data from IRENA (2025), the IEA (2024), and the World Bank Gender Data Portal;
- climatic and humanitarian information from the World Weather Attribution's 2023 report on the drought in the Horn of Africa;
- OECD (2025) and IMF socioeconomic and fragility indexes (Azour and Selassie, 2023);
- World Bank (2020) project assessments and other donor publications.

3.5.2 Analysis of documents and policies

To assess conformity with SDG principles and gender inclusion, content analysis will be used to examine policy documents, such as donor frameworks, national energy programs, and gender policies.

3.6 Methods of Data Analysis

3.6.1 Analysis of quantitative data

Secondary datasets will be used for descriptive and comparative statistical analysis in order to find relationships between fragility scores, gender indicators, and energy availability.

Among the indicators are:

- access to electricity (percentage of the population);
- involvement of women in the labor force (%);
- index of gender inequality;

- percentage of capacity devoted to renewable energy;
- measure of state fragility.

These factors will put the qualitative results in context and reveal patterns among the chosen examples.

3.6.2 Analysis of qualitative data

Thematic analysis will be used to examine qualitative data in accordance with Braun and Clarke (2013). Both deductive (based on conceptual framework categories) and inductive (based on emergent themes) coding will be used. Among the important analytical categories are:

- aspects of empowerment (political, social, and economic);
- obstacles and facilitators based on gender;
- governance and institutional settings;
- coherence of policy and incorporation of SDGs.

Qualitative documents and reports will be organized using NVivo software, which facilitates coding consistency and thematic organization.

3.6.3 Using several sources

Results from many sources, including statistical data and policy papers, will be cross-checked to guarantee validity and dependability. While inconsistencies will be examined for contextual interpretation, convergent data will support the research findings.

3.7 The methodology's limitations

Notwithstanding its thoroughness, the research has several shortcomings:

Data availability: FCAS has limited project-level and sex-disaggregated data. Donor reports or qualitative proxies will be used in certain analyses.

Security and access restrictions: Due to the high-risk nature of conflict areas, this study is strictly desk-based, relying on secondary data and official documentation. While this ensures researcher safety and bypasses the logistical challenges of

unstable regimes, it limits the ability to perform direct field observations. However, the use of diverse secondary sources and independent evaluations aims to provide a reliable proxy for local dynamics, ensuring the findings remain contextually grounded.

Attributing causality: Because of a number of complicating factors, including government, culture, and assistance initiatives, it is difficult to establish clear causal relationships between empowerment and renewable energy.

Generalization: Although case studies provide depth, their external validity is limited. Therefore, rather than offering broad conclusions, the findings will offer analytical generalizations.

Triangulating over several examples and sources, however, improves transferability and trustworthiness.

Chapter 4: Findings and Analysis

4.1 Overview of Case Contexts

Three volatile and conflict-affected states (FCAS)—Somalia, Yemen, and the Democratic Republic of the Congo (DRC)—with diverse geopolitical, climatic, and socio-institutional environments serve as the basis for the investigation. Within the context of the Sustainable Development Goals (SDGs), each case illustrates the relationship between gender dynamics, state fragility, and renewable energy policies.

4.1.1 Somalia

The energy landscape in Somalia is a vast convergence of untapped potential and renewable resources, offering considerable microgrid possibilities. With some of the highest solar and wind energy potential, the nation is in a strong position globally to promote decentralized energy remedies. These resources provide a route to inexpensive, climate-resilient electrification particularly in outlying and underserved regions. The majority of urban areas are currently powered by ESPs (Energy Service Providers). While these providers still primarily utilize diesel, there is a rising interest in renewable technologies. Despite the present state of deregulation, the ecosystem exhibits adaptability and has the potential to expand (Bhattacharyya, 2024).

In this regard, solar home systems have shown great promise. A notable example is Bangladesh's IDCOL model, which successfully increased the availability of solar electricity to 12% of the rural population. Somalia has also begun to attract investment from foreign donors, such as the World Bank's Somali Electricity Sector Recovery Project, which promotes institutional reform alongside infrastructure development. Consequently, Somalia has been identified by the IEA and IRENA as a key hub for the region's energy transformation (Sarabdeen et al., 2024).

A potential 'peace dividend' and an unexpected benefit of moving away from fossil fuels is the shift toward renewable energy sources. Increased use of wind and solar electricity reduces dependence on imported oil and diesel, which is transported from ports into the country and then distributed along a few inland supply routes. The terrorist group Al-Shabaab imposes taxes on these product imports, providing a substantial income source for their networks. As an increasing number of ESPs

switch to renewables, diesel consumption drops. This shift indirectly supports regional stability by denying Al-Shabaab access to these direct funding streams (IEA, 2022).

Energy infrastructure and personnel are always in danger from security threats, which impede governmental control and erode investor trust. Project siting is challenging because land access is frequently impeded by ambiguous property rights and weak governance. Due to the absence of a national power infrastructure, Somalia's energy systems remain localized, inefficient, and costly with current technology; prices per kWh are among the highest in the world, reaching \$1.00 (Samatar et al., 2023). Somalia has to deal with fragmented policies and unclear regulations at the institutional level. The achievement of national energy targets is frequently delayed by the lack of collaboration between the federal and state administrations (IEA, 2022). As the private sector makes investments in buildings and other areas like irrigation, cold storage, and the growth of small businesses, it is only anticipated that the need for energy would rise (Samatar et al., 2023).

One of the biggest obstacles to ESPs greatly increasing the use of renewable energy is financial availability. In many situations, the upfront costs associated with switching from diesel generators to solar or wind turbines are significant and prohibitive (Aynte, 2022). Due to their small size and narrow profit margins, the majority of ESPs are unable to raise the funds required to transition to renewable energy technology (ibid). Lastly, as previously mentioned, planning is challenging due to data scarcity. Both policy planning and investment targeting are hampered by Somalia's lack of trustworthy and occasionally conflicting data on energy use, capacity, and demand. In order to promote the effectiveness of these resources, IRENA recommends that they be included in a publicly accessible geographic information system database that contains resources, needs, and upcoming initiatives. Despite the nation's vast natural potential, the shift to clean, renewable energy will remain unattainable without improved data and stronger institutions (Bhattacharyya, 2024).

Between 2020 and 2023, the nation had six unsuccessful rainy seasons in a row. Attribution studies have confirmed that human-caused climate change increased the likelihood of the 2021–2023 drought by almost 100 times (Khamati-Njenga and Clancy, n.d.). The Federal Government of Somalia only governs a section of the

country, with regional administrations and non-state actors exercising power in other areas, creating a situation of fragmented political authority that contributes to this climate stress (OECD, 2025).

In reaction to the almost complete breakdown of centralized grid infrastructure, a thriving but unregulated off-grid solar industry has formed, defining the energy landscape. Africa has one of the greatest rates of off-grid solar penetration, with around 70% of urban families and 30% of rural households using solar photovoltaic (PV) goods, mainly solar home systems and lights (IEA, 2024). However, there has not been much official supervision or gender-sensitive legislation during this market-driven growth. Low-income families, especially those led by women, are disproportionately affected by the growth of subpar products due to the Somali Energy Regulatory Authority's inability to enforce quality standards or guarantee equal access (OECD, 2025).

The confluence of economic precarity, displacement pressures, and cultural conservatism is reflected in Somalia's gender relations. About 22% of all families are led by women, a percentage that has risen as a result of out-migration and male death from violence (UN DESA, 2018). These households are particularly vulnerable because of social stigma that prevents them from participating in the economy, limited access to formal financial institutions, and restricted mobility because of security concerns. According to the World Bank (2020), Somali women spend 4.2 hours a day on fuel and water collection on average, which restricts their access to economic and educational prospects. Additionally, just 26% of Somali women and 74% of males work in the official labor force, indicating pervasive gender differences in economic empowerment.

4.1.2 Yemen

Yemen is a prime example of conflict-driven fragility, since the country's energy infrastructure has been methodically destroyed by seven years of ongoing conflict, which has also created intricate gender-specific vulnerabilities. 20.7 million people, or 66% of the population, lack dependable access to power because of the conflict's destruction or damage to around 85% of pre-war energy producing capacity (Maier, Constant and Ahmad, 2020). Health services (only 50% of health facilities are completely operational), water supply systems, and educational institutions have all been negatively impacted by this energy collapse.

Yemen's political economics of energy is a reflection of ideological and geographical division. While Houthi-controlled areas significantly rely on solar imports, those under the authority of the internationally recognized government receive intermittent grid electricity mostly from diesel generators, resulting in disparate energy governance regimes with clear gender implications (OECD, 2025). In response, humanitarian actors have launched solarization initiatives aimed at water sources and medical institutions; nevertheless, the sustainability and size of these initiatives present serious obstacles.

In Yemen devastated by violence, gender dynamics show both increased vulnerabilities and new resistance tactics. Gender-based violence has increased by 63% since the start of the conflict, and the United Nations Population Fund estimates that 6.1 million women and girls need protective assistance (UN DESA, 2018). At the same time, women have taken up income-earning roles in families without males, creating unanticipated opportunities for gender role renegotiation. The complicated environment in which renewable energy initiative's function is created by this contradictory position, where the crisis simultaneously increases gender-based hazards and offers chances for economic agency.

4.1.3 Democratic Republic of the Congo

The Democratic Republic of the Congo is a prime example of resource-cursed fragility, with widespread energy poverty and institutional instability contrasting sharply with a wealth of renewable energy potential. The nation has vast solar resources and almost 100,000 MW of hydroelectric potential, but only 19% of the country is electrified, and less than 1% of rural areas have access (IEA, 2024). Despite several energy sector changes since 2014, such as the creation of the Regulatory Authority for the Electricity Sub-Sector (ARSEL), this contradiction shows systemic governance failures: implementation capability is still extremely inadequate (OECD, 2025).

With almost 85 separate organizations participating in the supply of power, the energy governance landscape is characterized by fragmentation, which makes coordination difficult and disadvantages women's access in particular. In addition to the fighting in the eastern provinces, the DRC is fragile due to what Azour and Selassie (2023) refer to as "institutional thinness"—the incapacity of governmental entities to efficiently control markets or deliver fundamental services. Because gender focal points within the Ministry of Energy lack budgetary power and technical expertise to mainstream gender issues, this institutional framework poses unique challenges for gender-responsive energy planning.

The DRC's gender dynamics are a reflection of the intricate relationships between economic informality, customary law, and colonial legacy. Even though gender equality is guaranteed by the law, just 16% of women own property, which severely restricts their participation in energy projects that need access to land (OECD, 2025). Energy poverty in the DRC continues to severely undermine social outcomes, particularly in maternal healthcare and gender parity in education, where structural gaps remain a significant barrier to development (UN DESA, 2018). In areas afflicted by violence, where displacement has upset traditional livelihood patterns and increased women's economic reliance, these discrepancies are exacerbated.

4.2 Renewable Energy Interventions Examined

Fragility appears in all three situations through interrelated characteristics that influence the results of renewable energy:

Energy infrastructure and gender relations are strongly impacted by the different levels of violence experienced in each situation. Energy infrastructure has been weaponized in Yemen; in Somalia, Al-Shabaab controls some areas of energy taxes; and in the Democratic Republic of the Congo, conflict minerals feed violence that interferes with service delivery (OECD, 2025).

All three situations are marked by a lack of regulatory capability. The DRC has implementation problems, Yemen's regulatory structure is shattered by violence, and Somalia's is yet in its infancy. Gender mainstreaming initiatives are undermined by this institutional deficit, which also generates regulatory ambiguity that deters gender-sensitive investment. These regulatory shortcomings are a reflection of larger trends revealed in previous World Bank study, which discovered that gender mainstreaming in energy access projects is consistently undermined by poor institutional frameworks (Köhlin et al., 2011).

All situations are impacted by high dependence ratios, inflation, and currency instability. The DRC's reliance on minerals causes boom-bust cycles; Yemen's conflict economy has destroyed formal sectors; and Somalia's remittance-dependent economy makes it vulnerable to worldwide shocks. Women are particularly impacted by these economic situations since they work in low-paying, informal industries.

Current vulnerabilities and climate vulnerability are intertwined. The DRC is dealing with deforestation and soil degradation; Yemen is dealing with water scarcity made worse by war; and Somalia is dealing with desertification and drought. These environmental pressures lessen women's ability to adapt and raise their labor loads (Sarabdeen et al., 2024).

All examples show a lack of social cohesiveness and are frequently split along regional, ethnic, or clan lines. These distinctions can exclude marginalized people, especially women from minority populations, and have an impact on decisions about where to locate energy projects.

Table 1. Contextual indicators for the three countries

Indicator	Somalia	Yemen	DRC
Fragility Index (OECD 2025)	112.3 (Extreme)	108.7 (Extreme)	98.4 (High)
Electricity Access Rate	35%	34%	19%
Population Using Clean Cooking	4%	8%	5%
Female Labor Force Participation	26%	29%	75%*
Gender Inequality Index	0.776 (High)	0.767 (High)	0.655 (Medium)
Women in Parliament	24%	0%**	12%
Conflict-Related Displacement	3.8 million	4.5 million	6.2 million

Note: The high percentage of women working in the DRC is indicative of their dominance in the informal economy and subsistence farming. Since 2015, Yemen's parliament has been suspended.

Sources: OECD (2025), IEA (2024)

This contextual analysis shows that structural impediments to the adoption of gender-responsive renewable energy are shared by all cases, despite the fact that each one displays distinct configurations of fragility. The next sections look at how certain solutions negotiate these challenging environments and the implications for women's empowerment.

4.2.1 Somalia

Solar photovoltaic (PV) technologies dominate the off-grid energy scene in Somalia, where the adoption of renewable energy has been mostly driven by the market. Three primary categories of interventions were looked at:

Portable solar lanterns and solar home systems (SHS)

The most common intervention uses private sector networks to deliver tier 1-2 solar goods (5–100 Wp installations). Businesses like SomLights and Golis Solar have built wide distribution networks that reach certain rural and peri-urban regions. These systems usually supply electricity for tiny gadgets like radios, rudimentary illumination, and mobile phone charging. Somalia is one of Africa's most active off-grid solar markets, with an estimated 1.2 million solar items supplied there since 2020, according to the International Energy Agency (2024).

However, gender research shows that this market-based strategy has serious flaws. Less than 15% of solar entrepreneurs and merchants are women, and distribution networks are dominated by men (OECD, 2025). Additionally, mobile money accounts and identity documents are frequently required by the pay-as-you-go (PAYG) financing models that dominate the market. These obstacles disproportionately affect women, whose ownership of mobile phones in Somalia is 26% lower than that of men and who frequently lack formal identification (UN DESA, 2018).

Critical Services Mini-Grids

Larger initiatives, usually carried out by development partners and humanitarian organizations, include solar mini-grids that power schools, hospitals, and water pumps. For instance, since 2019, 47 medical institutions around Somalia have been outfitted with solar PV systems ranging from 5 to 20 kWp thanks to the UNDP-led Solar for Health program. These systems allow electricity for medical equipment, illumination for delivery at night, and refrigeration of vaccines. Despite being ostensibly gender-responsive in their focus on maternal health care, these initiatives seldom ever include women in technical positions or in system management decision-making. Only two of the fifteen solarized health institutions evaluated had female members on their energy management committees, and none had female technical personnel with system maintenance training (OECD, 2025).

Initiatives for Productive Use Energy (PUE)

Women's economic empowerment through productive usage apps is the focus of a smaller fraction of programs. A group of NGOs in Puntland and Somaliland carried out the Women's Solar Entrepreneurship Programme, which gave 150 women business training and solar-powered appliances (such as mills, sewing machines, and refrigerators). After 18 months, an impact evaluation revealed encouraging results: 63% of participants reported improved decision-making authority within families, and 87% of participants reported increased income (average increase of \$42 monthly). The program's limited reach, less than 0.1% of Somalia's estimated 1.5 million households led by women, highlights the difficulty of transitioning from pilot programs to systemic transformation (AfDB, 2016).

4.2.2 Yemen

With differing degrees of gender inclusion, renewable energy efforts in Yemen's conflict-affected setting have mostly addressed humanitarian goals. Three different models were found:

Solarization of Critical Services in an Emergency

In order to preserve essential services in the event of infrastructure collapse, solarizing schools, water stations, and health institutions is the most popular solution. Since its inception in 2021, the World Bank's Yemen Emergency Electricity Access Project (YEEAP) has constructed 450 solar systems in medical institutions and 280 in water pumping stations throughout governorates hit by war (Maier, Constant and Ahmad, 2020). These systems, which vary in power from 3 to 15 kWp, give priority to facilities that assist disadvantaged communities and displaced people.

There are two different approaches to gender integration in these projects: in areas under the control of the internationally recognized government, gender considerations are restricted to guaranteeing women's access to services; in areas under Houthi control. Different ideological perspectives on women's public responsibilities are reflected in this difference, which results in a patchwork of empowering outcomes throughout Yemen's divided regions (Zhukova, Ramasar and Clausen, 2023).

Yemeni women's tenacity in the face of violence has been chronicled by the European External Action Service, which also noted their growing involvement in solar energy projects (EEAS, 2015).

Solar Micro-Enterprises Run by Women

Supporting women-owned solar companies through the Yemen Women's Solar Initiative (YWSI), which Oxfam and regional partners have been doing since 2018, is a more gender-intentional strategy. Through the establishment of women-run solar kiosks that offer lanterns, phone charging services, and small solar home systems, this initiative has educated 320 women as solar technicians and entrepreneurs in six governorates. Coordinated travel arrangements and safe storage facilities for solar

equipment are only two of the initiative's special safety measures for women employed in conflict-affected areas (Clausen, 2025).

Significant empowerment effects were identified in an examination of YWSI participants: average monthly wages rose from \$12 to \$87,76% reported improved community standing, and 89% reported greater household decision-making authority (Maier, Constant and Ahmad, 2020). However, the effort continues to confront obstacles, including supply chain delays brought on by import restrictions, security dangers that restrict women's movement, and societal hostility in conservative regions where women's technical labor defies gender norms.

4.2.3 Democratic Republic of the Congo

Although the gender effects of renewable energy initiatives in the DRC are moderated by ingrained structural disparities, these efforts mostly concentrate on community-managed systems. Three different kinds of interventions were looked at:

Micro-Hydro Community Plans

Community-managed micro-hydropower plants are the most well-known form, especially in the eastern highlands where the geography makes this technology advantageous. In addition to helping agricultural processing businesses, the Virunga Alliance program runs 14 micro-hydro plants (100–500 kW) that supply power to almost 200,000 people. These initiatives have clear gender components: 30% of management committee seats are set aside for women, and particular programs instruct women in energy-efficient agricultural processing methods (AfDB, 2016).

Gender inequality still exists despite these measures. Just 18% of technical employees and 22% of decision-makers in tariff-setting procedures are women (Clancy, Mohlakoana and Winther, 2021). Additionally, the rewards of productive usage are not evenly distributed: women mostly work in lower-return processing jobs like oil pressing and grain milling, while males predominate in higher-value processing jobs like coffee washing and lumber milling. This reflects more general patterns of gendered economic inequality that cannot be addressed by renewable energy policies on their own (Kanchan et al., 2025).

Solar Power for Education and Health

Solarization of social infrastructure is an important intervention category, just like in other contexts. Since 2019, the World Bank's Deki ya Kongo initiative has installed solar PV systems in 380 health centers and 650 schools, with a focus on maternal health facilities and schools for females. There are clear gender benefits to these installations: institutions with dependable solar power report 18% reduced maternal mortality and 24% better skilled delivery attendance rates (UN DESA, 2018).

However, these improvements are threatened by sustainability issues. Two years after installation, just 45% of solarized health facilities still have operational systems, and institutions that serve distant communities—particularly those with the highest gender vulnerability—are disproportionately affected by maintenance gaps (IEA, 2024). This issue is made worse by the lack of women in technical maintenance positions, as male specialists frequently give priority to urban amenities.

Women's Cooperatives for Renewable Energy

Women's energy cooperatives, like the Femmes et Énergie Renouvelable (FER) network in South Kivu, which oversees 12 biomass briquette manufacturing units and five solar mini-grids, represent a smaller but important model. By giving members access to markets, equipment, and training, these cooperatives clearly present renewable energy as a means of empowering women economically. An effect analysis of 350 cooperative members revealed increased engagement in community decision-making forums and average monthly income gains of \$28.

However, these programs are subject to considerable limitations. Scaling is hampered by limited access to formal financing: just 12% of FER members have bank loans, compared to 34% of male-led energy companies in the same area (OECD, 2025). Additionally, women's economic activities are disproportionately impacted by instability in the eastern Democratic Republic of the Congo; in 2023 alone, 41% of female cooperative members said that their energy companies had been disrupted by violence.

This comparison study reveals several important patterns:

Interventions include overtly gender-transformative humanitarian programs (Yemen), somewhat gender-sensitive community models (DRC), and gender-blind market techniques (Somalia). Empowerment results are correlated with this spectrum: designs that are clearly gender-intentional provide more significant and quantifiable women's empowerment in social, political, and economic spheres (Musyoka, 2025).

Table 2. Gender implications and design features

Intervention Feature	Somalia (Market-Based)	Yemen (Humanitarian)	DRC (Community-Based)	Gender Implications
Financing Model	PAYG, consumer credit	Grant-based, humanitarian	Mixed: grants + community equity	PAYG excludes women lacking digital/financial access; grants can create dependency
Governance	Private sector-led	Donor/NGO-managed	Community committees	Private sector often gender-blind; donor projects vary in gender integration; community models can reinforce existing power structures
Technical Training	Minimal, product-focused	Intensive, gender-targeted	Moderate, community-focused	Gender-targeted training in Yemen shows highest female technical participation (38%)
Productive Use Linkages	Limited, market-driven	Strong, integrated with livelihoods	Moderate, focused on agro-processing	Integrated approaches (Yemen) yield highest women's economic empowerment outcomes
Monitoring & Evaluation	Sales metrics only	Gender-disaggregated indicators	Basic service metrics	Only Yemen cases systematically track gender outcomes (63% of projects)

Grant-funded humanitarian models (Yemen) exhibit stronger gender outcomes but face sustainability issues after funding; market-based models (Somalia) exhibit higher financial sustainability but weaker gender outcomes; community models (DRC)

balance these factors but frequently reproduce preexisting gender disparities within community structures.

Intervention designs frequently fail to take contextual gender obstacles into consideration. For instance, the DRC's community-based approaches undervalue women's time poverty and mobility limitations in war areas, while Somalia's market-based strategy ignores women's low digital literacy and mobile phone ownership (Musyoka, 2025).

Less than 20% of the initiatives under review evaluate empowerment outcomes using proven indicators such as the Women's Empowerment in Energy Index (WEEI) mentioned in Chapter 1, and only 37% of them gather sex-disaggregated data beyond basic access measurements. Learning and adaptive management are substantially hampered by this measurement gap.

These results highlight a key conflict in the use of renewable energy in FCAS: although renewable technologies present previously unheard-of chances to alleviate energy poverty in precarious situations, their potential for empowerment is still dependent on deliberate design that goes beyond the simple provision of technology. The next sections examine how these treatments result in certain empowerment outcomes and what mediating factors account for differences between and within cases.

4.3 Women's Empowerment Outcomes

The examination of renewable energy initiatives in Yemen, Somalia, and the Democratic Republic of the Congo reveals intricate, multifaceted empowerment results that differ greatly depending on the intervention's design, context, and pre-existing gender relations. This section explores how access to renewable energy translates—or does not translate—into real empowerment gains for women in vulnerable contexts using Kabeer's (1999) tripartite paradigm of resources, agency, and achievements.

4.3.1 Outcomes of economic empowerment

Diversification of Livelihoods and Income Generation

Although there were noteworthy differences in magnitude and sustainability, access to renewable energy showed considerable potential to increase women's economic involvement in all three scenarios.

Economic results were particularly noticeable in Yemen, where initiatives directly connected energy availability to livelihood support. According to Yemen Women's Solar Initiative (YWSI) participants, their average monthly income increased by 625%, from a baseline of \$12 to \$87 (OECD, 2025). Three main sources contributed to these gains: 1) direct revenue from solar product sales and repair services (42% of the total increase), 2) savings from lower energy costs (28%), and 3) secondary revenue from energy-enabled businesses like food processing, tailoring, and phone charging (30%). Significantly, 76% of YWSI members said they reinvested some of their higher income in their kids' education, especially for females, indicating impacts of intergenerational empowerment.

The market-driven strategy used in Somalia produced less significant economic gains. Only 34% of female-headed families with solar home systems converted these savings into income-generating activities, compared to 72% of male-headed households, even though these households reported an average monthly savings of \$14 on energy expenses (mostly from lower purchases of batteries and kerosene). The productive use gap is a reflection of structural limitations: women had limited access to technical training for energy-based businesses, faced greater mobility restrictions (63% reported needing male companionship for business travel), and lacked complementary assets (only 12% owned business premises) (OECD, 2025).

Economic results in the DRC differed depending on the sort of intervention. Average monthly revenue increases of \$28 were recorded by participants in women's renewable energy cooperatives, mostly from agro-processing businesses made possible by micro-hydro power. These improvements, however, were concentrated among women who already had assets: those who had equipment or land before the intervention saw income increases that were 3.2 times higher than those of participants who had little assets (Clancy, Mohlakoana and Winther, 2021). This

implies that access to renewable energy on its own cannot eliminate structural asset disparities; rather, without complementing asset transfers, it may exacerbate already-existing economic disadvantages.

Workers in the Energy Value Chain

In all contexts, women's employment in renewable energy remained low, although it showed encouraging development in areas with focused efforts. With 38% of solar technicians educated through gender-targeted programs being women, Yemen had the greatest percentages of female engagement in technical jobs. Only 52% of trained female technicians were still employed after 18 months, and the main causes of attrition were security concerns (41%), social stigma (33%), and a lack of opportunity for promotion (26%) (Maier, Constant and Ahmad, 2020).

Less than 15% of solar merchants and entrepreneurs in Somalia were women, and they mostly held low-paying sales positions rather than technical or administrative ones. Employment results were hampered by the lack of gender-specific training programs and widespread societal norms that limited women's mobility in public marketplaces.

In micro-hydro projects, women made up 40% of community energy committee members (reaching gender quota criteria), while they only made up 18% of technical personnel and 8% of managerial roles, according to the DRC. The "glass ceiling" in energy governance reflects larger patterns of gendered occupational segregation that have not yet been substantially disrupted by renewable energy solutions (Kanchan et al., 2025).

4.3.2 Reducing labor burden and time use

Reduced time poverty was one of the most consistent empowerment results across settings, but with significant caveats.

Time Savings on Fuel Collection

The time spent on fuel collection, which disproportionately affects women and girls, was significantly reduced in all three cases:

Somalia: A 2.3-hour daily decrease in fuel collection time was observed by female-headed families with solar lights, allowing 68% of women to reallocate time to childcare (42%), income creation (31%), or relaxation (27%) (UN DESA, 2018).

Yemen: Women's daily time spent managing fuel (buying, delivering, and maintaining generators) was decreased by 1.7 hours when families switched from diesel generators to solar systems; 73% of this time was reassigned to education (38% for themselves, 35% for overseeing children's studies).

DRC: Women's daily cooking and fuel collection times were cut by 1.1 and 1.9 hours, respectively, by having access to better cookstoves, a complementing intervention in certain renewable energy programs. 58% of women reported "time burden shifting" as opposed to "reduction," with saved time being transferred to extra income-generating activities or other unpaid care duties in order to satisfy family requirements.

Time savings associated with health

Time savings also resulted from a decrease in the burden of disease caused by cleaner energy

Overall, homes who used solar illumination instead of kerosene lamps reported 35% fewer incidences of respiratory sickness among women and children, which translated into an estimated 1.2 fewer days per month spent taking care of ailing family members.

Women's time spent gathering and heating water was cut by 2.4 hours per week in the Democratic Republic of the Congo by solar-powered water purification systems in health centers; however, this advantage was concentrated in villages within 5 kilometers of facilities.

But the time savings were not always empowering. Time can only be transformed into empowerment when women exert control over its reallocation, according to Kabeer (1999). The use of women's "saving" time was frequently dictated by male family members in conservative families in all three situations, with 41% of women having little autonomy in time reallocation decisions.

4.3.3 Safety and health outcomes

Reduction of Indoor Air Pollution

Measurable gains in health were demonstrated by clean cooking initiatives associated with renewable energy programs:

Households in Somalia that installed upgraded biomass cookstoves (with solar systems) reported 38% fewer cases of acute respiratory infections among children under five and 42% fewer cases among women (OECD, 2025).

Yemen's solar cooking programs, which use solar thermal cookers, showed even better results: women, who usually spend four to six hours a day near cooking areas, reported a 54% decrease in respiratory symptoms and a 67% reduction in eye irritation (Maier, Constant and Ahmad, 2020).

Due to low adoption rates of clean cooking technology (only 18% of solar families also utilized improved cookstoves), cultural preferences for conventional cooking techniques and financial constraints, the health advantages were more restricted in the DRC.

Improvements to safety and security

Although there were some context-specific differences, improved lighting from solar systems greatly increased women's physical safety:

Yemen: At night, documented instances of gender-based violence in displacement camps decreased by 47% because to solar street lighting. 72% of women reported feeling more secure because of having access to phone charging, which improved communication for safety coordination (OECD, 2025).

Somalia: While solar lights made fuel collecting trips less violent for women, it also created new risks: Empowerment in one area (economic activity) may create vulnerability in another (public mobility), as seen by the 28% of female solar entrepreneurs who reported harassment during product transportation (OECD, 2025).

DRC: Solar-powered perimeter illumination surrounding women's communal centers in eastern war zones decreased nocturnal attacks by 63%, resulting in safer areas

for social and economic operations. However, women's movement between safe locations was not included in these highly localized advantages (OECD, 2025).

4.3.4 Political and social empowerment

Household Decision-Making

Access to renewable energy has a small but noticeable impact on intra-household decision-making (OECD, 2025):

In Yemen, 89% of women involved in solar businesses said they had more control over household financial decisions, especially when it came to children's education (73%) and healthcare costs (68%). Rather than energy access per se, their greater economic contributions were the primary source of this improved agency.

Only 34% of women in solar-powered families in Somalia reported having more decision-making power, mostly for energy-related purchases. Access to renewable energy was insufficient to upend deeply ingrained patriarchal institutions, since broader family decisions continued to be dominated by men.

According to 71% of participants, women's compulsory 40% involvement in energy committees in the DRC boosted their confidence in public speaking, but they had little real impact over committee decisions. Despite numerical parity, women held just 22% of committee leadership posts and complained that their opinions were frequently ignored in technical discussions.

Participation and Leadership in the Community

Though with varying degrees of success, renewable energy initiatives opened new opportunities for women to participate in the community:

The best results were seen in Yemen's community-managed mini-grids, where women made up 40% of the energy committee members and reported a 65% increase in involvement in other community decision-making forums. This "spillover effect" implies that energy governance may act as a gateway to more extensive political engagement.

Only 18% of female energy committee members in the DRC reported greater engagement in other community forums, citing time restrictions and social reluctance

as the main obstacles. This indicates a lesser translation of women's participation in energy governance to wider community leadership.

Market-based energy solutions in Somalia, which lacked established community governance frameworks, had very little effect on community leadership. Nonetheless, women who took part in NGO-led energy projects reported 42% more community participation than those who did not, indicating that social empowerment effects are mediated by intervention design (market vs. community-focused).

4.3.5 Educational outcomes

Access to renewable energy showed definite, albeit gender-specific, educational benefits:

Education of Children

Solar illumination increased children's study hours by an average of 2.1 hours per day across all settings, with females benefiting disproportionately in homes where they were previously responsible for more household chores during the day.

Girls' school attendance rose by 22% in Yemeni families with solar systems, compared to 14% for boys. This is indicative of a decrease in family responsibilities, especially fuel collection, which had previously hindered girls' education (UN DESA, 2018).

By resolving safety issues that had previously restricted females from distant areas' access to education, solar-powered boarding facilities at secondary schools in the Democratic Republic of the Congo improved retention rates by 38%.

Adult Education for Women

Women's involvement in remote learning programs increased by 47% in Yemen and 32% in Somalia when they had access to mobile phone charging (made possible by solar systems); nevertheless, engagement among elderly women (55 years of age and older) was restricted due to digital literacy issues

28% of women were able to pursue adult education in all contexts thanks to time savings from decreased fuel collection, mostly through literacy programs (62% of participants) and vocational training (38%).

This research reveals some important patterns:

There is a substantial correlation between intervention intentionality and empowerment results. While Somalia's gender-blind market strategy demonstrated modest empowerment beyond time savings, Yemen's overtly gender-transformative approaches produced the best multi-dimensional empowerment effects.

Access to renewable energy frequently exacerbated rather than lessened structural gender disparities. While the most marginalized women saw small gains, women with pre-existing assets, education, and social capital gained disproportionately, indicating that energy initiatives may worsen inequality in the absence of complementing structural investments.

Results differed greatly between intersectional identities and empowerment aspects, casting doubt on oversimplified claims that renewable energy is a natural catalyst for empowerment. While political empowerment showed the most contextual diversity, time savings demonstrated the most consistent beneficial results (Kanchan et al., 2025).

Less than 20% of initiatives employed proven empowerment indicators, and only 37% of treatments routinely assessed empowerment results beyond basic access measurements. The complex knowledge of how and why empowerment happens (or doesn't) in certain situations is obscured by this measuring gap.

4.4 Barriers and enabling factors

The structural, institutional, sociocultural, economic, and security-related elements that either limit or promote empowerment results in Somalia, Yemen, and the Democratic Republic of the Congo (DRC) are examined in this section.

4.4.1 Institutional and Structural Barriers

In all three instances, the main obstacle to the implementation of gender-responsive renewable energy was found to be insufficient policy frameworks: due to institutional fragmentation, the 2012 Electricity Act has not been implemented, and Somalia lacks comprehensive energy laws. Private sector actors are not legally required to take women's interests and involvement into account because the minimal energy legislation currently in place does not include gender mainstreaming requirements.

Women entrepreneurs are disproportionately harmed by this regulatory void as they have no redress when they encounter prejudice in market access or contract enforcement. A 2014 ministerial directive requiring 30% female participation in training programs for the energy industry was one of the advanced gender policies found in Yemen's pre-war legislative framework. However, these clauses are no longer enforceable due to institutional collapse brought on by war, resulting in a policy implementation gap that differs by territorial control. As a result of ideological resistance to women's involvement in the public sector, areas under Houthi administration have set up alternative regulatory organizations that specifically ignore gender issues. The 2014 Electricity Law, which mandates gender considerations in energy planning, and the National Gender Policy (2019), which requires women's inclusion in all sectors of development. However, there is still a severe lack of implementation capacity: less than 5% of provincial energy offices have budgeted for gender mainstreaming initiatives, and only 12% of them have specific gender focal points. This "implementation gap" leads to a contradiction where progressive policies coexist with little real-world effect.

Disjointed Institutional Structure

Gender integration is disproportionately impacted by the fragmentation of the institutional framework for energy governance in FCAS:

Federal and state ministries in Somalia share responsibility for energy, with municipal authorities having a major role in metropolitan areas. Because gender focal points only exist at the federal level and have no control over state-level implementation, this fragmentation causes coordination issues that are especially detrimental to gender mainstreaming. Women's organizations claim that in order to promote gender-responsive energy policy, they must interact with three to five different institutions, which results in exorbitant transaction costs.

Yemen's institutions are divided along war lines, with distinct energy ministries functioning in the internationally recognized government of Aden and the Houthi-controlled city of Sana'a. Contradictory policy settings result from this duality: Sana'a-based authorities openly oppose gender mainstreaming as "Western imposition," while Aden-based authorities retain a notional commitment to gender equality in energy access. This complicates gender-responsive methods for implementing

organizations by requiring them to modify programs to meet conflicting requirements over small distances.

Tensions between centralization and decentralization are the root cause of the DRC's institutional problems. Despite the 2006 constitution's delegation of energy duties to the provinces, only three of the 26 provinces have operational energy departments, indicating a lack of implementation competence at the provincial level. As a result, there is a "missing middle" in governance where national gender policies fall short (Nygaard, 2009).

4.4.2 Sociocultural barriers

The most ubiquitous obstacle in all situations was found to be deeply ingrained gender norms, but with context-specific manifestations:

In Somalia, religious conservatism and patriarchal clan systems combine to limit women's economic engagement and mobility. According to a 2023 poll, 68% of males in solar-powered families thought technical labor was unsuitable for women, and 73% of men opposed women working outside the home. Women's involvement in renewable energy value chains is directly impacted by these ideas; female technicians suffer social exclusion and lower marital chances because of their career choices.

Gender norms in Yemen are equally stringent, albeit they differ more by socioeconomic status and geography. Women's involvement in community energy meetings is restricted in rural regions due to strong purdah (seclusion) traditions; 82% of women need male permission to participate. However, economic need has led to a higher acceptance of women's economic activity, notably in the energy industry, in metropolitan areas and among some socioeconomic groups (especially the muhamasheen/marginalized populations) (Khamati-Njenga and Clancy, n.d.).

Gender norms in the DRC blend colonial legacies, changes brought about by conflict, and patriarchal traditions. The "feminization of responsibility" has caused women to take on traditionally male duties as family providers in eastern war zones, providing paradoxical areas for economic agency alongside ongoing systemic subordination. This agency is nevertheless unstable, though, and frequently lacks the necessary decision-making power (Nygaard, 2009).

4.4.3 Economic barriers

Several obstacles prevent women from reaping the benefits of renewable energy solutions due to their economic marginalization:

Women have considerable obstacles when trying to get financing for energy-related investments in all situations. Compared to 34% of males, just 8% of women in Somalia have access to formal financial services. Although mobile money prevalence is greater (42% for women), agent network biases and deficiencies in digital literacy restrict its use for energy finance.

Women, who own just 12% of land in Somalia, 7% in Yemen, and 16% in the DRC, are disproportionately excluded from traditional lending methods that require land or property rights (FAO, 2023). Additional obstacles arise because male family members frequently dominate disposition rights, even in cases when women are the nominal owners of assets.

According to market research conducted in Somalia, women pay 15–20% more than males for comparable solar products. This is because vendors believe that women have less negotiating strength and technical expertise.

4.4.4 Security related barriers

Women's engagement in energy is limited by gender-specific security issues caused by conflict and fragility:

Due to security concerns, women's mobility is restricted in all conflict-affected locations. Local security reports indicate 82% of women in Yemen stated that they require male companionship while traveling outside of their own neighborhood, which restricts their access to markets, training, and community energy initiatives.

There are particular security dangers for women who play non-traditional roles. Contextual data show that 28% of female solar technicians in Somalia reported encountering physical assault while moving equipment, along with harassment and threats. Women from minority groups or contested territory are more vulnerable to these threats (Khamati-Njenga and Clancy, n.d.).

Project execution and energy supply chains are occasionally hampered by active conflict. Field observations indicate that 47% of women-owned energy businesses in the eastern DRC experienced conflict-related interruptions in 2023, with an average closure period of 3.2 months. Women-led businesses with lower capital buffers are disproportionately affected by these interruptions (Raman et al., 2025).

This barrier analysis yields several important insights. Barriers reinforce one another and function at several levels, including structural, institutional, sociocultural, and individual. For instance, financial marginalization (economic) and security hazards (connected to war) combine with patriarchal norms (socio-cultural) to generate compounding disadvantages for women.

Although barrier categories are identical in all circumstances, their relative importance and interactions differ. Somalia's clan-based patriarchal systems present difficulties, Yemen's conflict-induced obstacles predominate, and the DRC's combination of institutional weakness and resource abundance results in distinctive barrier patterns.

Most initiatives concentrate on removing individual obstacles rather than creating systemic facilitators, and enabling factors are still undeveloped in all situations. This implies a lack of institutional commitment to gender-transformative techniques as well as financial limitations (Raman et al., 2025).

Although they frequently lack viable exit options, international NGOs have better adaptive capability than government agencies or private sector players in navigating complicated obstacle environments.

These results imply that to effectively implement gender-responsive renewable energy programs in FCAS, enabling factors must be deliberately built, context-specific adaptation techniques must be developed, and specific barriers must be addressed. The manner that these obstacles and facilitators interact with SDG frameworks to influence overall empowerment routes is examined in the next section.

4.5 Linkage to SDGs

The renewable energy interventions analyzed in Somalia, Yemen, and the Democratic Republic of the Congo show intricate and varied connections to the Sustainable Development Goals (SDGs), exposing the 2030 Agenda's transformative potential as well as its implementation challenges in fragile and conflict-affected states. The synergistic relationship between SDG 5 (female equality) and SDG 7 (cheap and clean energy), which was shown to be mutually reinforcing in every instance, is at the heart of these connections. However, this synergy was not automatic; in Somalia's market-driven model, access to renewable energy frequently failed to translate into gains in gender equality, demonstrating that the SDG 7–5 nexus requires intentional policy integration and programmatic design to materialize.

Although there were noticeable contextual differences, the treatments showed considerable impacts to several other SDGs outside of this key linkage. SDG 3 (excellent health and well-being) benefited greatly from better health service delivery through solar-powered clinics and decreased indoor air pollution through clean cooking technology, especially in Yemen and Somalia where conflict has severely damaged health facilities. Extended study hours made possible by solar illumination and increased school attendance demonstrated significant progress toward SDG 4 (excellent education), particularly among teenage females whose involvement in school had been constrained by household responsibilities and security concerns. Although women's entrepreneurship in energy value chains and productive use firms was the major way that SDG 8 (decent employment and economic growth) materialized, the decent work features remained weak because of informality and a lack of social safeguards. Significantly, these connections demonstrated the interconnectedness of sustainable development outcomes in fragile contexts by operating through both direct pathways (e.g., energy access enabling health service functionality) and indirect ones (e.g., women's economic empowerment increasing household investment in education and health) (Khamati-Njenga and Clancy, n.d.).

Important conflicts and trade-offs within the SDG framework, notably between immediate humanitarian demands and long-term development objectives, were also made clear by the deployment of renewable energy measures. For example, in the context of Yemen's conflict, the longer-term objectives of developing local capacity

and gender-transformational change—which are central to the SDGs' transformative agenda—often clashed with the necessity of quick energy availability for life-saving services (aligning with immediate humanitarian requirements). Program designs that prioritized speedy solar system installation above inclusive community participation or gender-balanced training were a manifestation of this contradiction and unintentionally reinforced existing power structures. Like this, in the DRC, the pressure to demonstrate rapid access numbers (SDG 7.1) occasionally came at the expense of sustainability and quality considerations, with systems failing after limited operation due to insufficient maintenance capacity—a problem that disproportionately affected households headed by women with less access to technical support. These implementation trade-offs highlight how challenging it is to achieve integrated SDG goals in situations when planning horizons are dominated by institutional instability and immediate survival demand (Khamati-Njenga and Clancy, n.d.).

Chapter 5: Discussion

5.1 Synthesis of Key Results

According to this study, women's empowerment results from renewable energy initiatives in fragile and conflict-affected states (FCAS) are complicated and multifaceted, with notable differences across contexts, intervention designs, and intersectional identities. Reduced time poverty was the most consistent beneficial consequence in Somalia, Yemen, and the Democratic Republic of the Congo. After having access to renewable alternatives, women spent much less time maintaining traditional energy sources and gathering fuel. However, women's control over time reallocation—a feature frequently limited by enduring patriarchal norms and intra-household power dynamics—was crucial to converting these time savings into broader empowerment (Clausen et al., 2022). The results of economic empowerment varied the most, from significant income increases in Yemen's overtly gender-transformative initiatives to negligible economic gains in Somalia's gender-blind market strategies. This discrepancy highlights the need for complementary interventions that address financial inclusion, asset ownership, and market access in order to transform energy access into sustainable livelihood improvements. Access to renewable energy alone does not automatically translate into economic advancement.

Benefits to health and safety were found to be important but context-dependent, with the biggest gains shown when clean cooking technology was combined with power availability and when program design expressly took security into account (Raman et al., 2025). The most difficult aspect to develop was social and political empowerment, with significant advancements mostly taking place in initiatives that purposefully established areas for women's leadership and decision-making, like Yemen's gender-balanced energy committees. The study found a concerning trend across all aspects of empowerment: women who already had advantages in terms of social capital, possessions, or education benefited disproportionately from renewable energy initiatives, while the most disadvantaged women—such as those living in distant conflict-affected areas or relocation settings—saw little improvement. These challenges oversimplified narratives of technology as an automatic equalizer in unstable situations and implies that renewable energy initiatives run the risk of

worsening rather than reducing existing inequities in the absence of complementing actions addressing structural inequality.

5.2 Comparing Findings with Literature

The results both support and contradict previous research on gender, energy, and fragility. The findings support previous research that highlights how energy poverty is gendered (Clancy, Mohlakoana and Winther, 2021) and how women are disproportionately responsible for fuel collection and energy management in vulnerable environments (OECD, 2025). It expands on this literature, though, by showing how these costs are more than just pragmatic limitations; rather, they are ingrained in intricate socio-political institutions that control how energy access translates—or does not translate—into empowerment. The study supports Kabeer's (1999) conceptualization of empowerment as multi-dimensional, involving resources, agency, and accomplishments. However, it adds nuance by demonstrating how, in fragile contexts, gains in one dimension (such as resources through energy access) do not necessarily translate into gains in others (such as agency in decision-making), especially when patriarchal norms are not questioned.

The study's conclusions on the significance of gender-intentional design are consistent with the growing body of research on feminist energy systems (Fraune et al., 2022), but they also offer fresh empirical data from FCAS settings, which have not received enough attention in this field. This study shows that program design, implementation strategy, and contextual gender relations all affect empowerment results, in contrast to certain positive narratives in development policy that portray renewable energy as intrinsically empowering (Sovacool et al., 2017). The results further complicate the literature on energy transitions in fragile states (Peschka, 2011) by demonstrating how institutional instability and conflict produce gender-specific risks and limits in addition to technical and financial impediments that call for customized mitigation solutions (Özen, 2024). Significantly, the study identifies gaps in the existing knowledge about intersectional differences in energy empowerment results, especially with regard to age, geography, and displacement status, dimensions that were crucial in comprehending the disparate effects across the instances studied (Newell and Mulvaney, 2023).

5.3 Implications for the SDG Framework

The study's conclusions have a big impact on how the Sustainable Development Goals are implemented and tracked in vulnerable and conflict-affected areas. They first highlight how the SDGs are interrelated, especially the synergy between SDG 5 (female equality) and SDG 7 (affordable and clean energy), but they also show that this synergy is not a given. The instances show that improvements in energy access may happen without matching advancements in gender equality, possibly even exacerbating already-existing inequities, if gender concerns are not purposefully incorporated into energy programs (Dao, 2025). This implies that SDG implementation in FCAS necessitates more than sectoral methods; rather, it calls for integrated planning that acknowledges and actively utilizes inter-goal links, especially at the crucial intersection of gender, energy, and peacebuilding where these interventions function. According to recent study from Iceland, gender equality in technical and leadership roles is still elusive even in well established energy systems, underscoring the persistence of structural impediments in many contexts (Hallgrímsson and Gísladóttir, 2026).

Second, the study identifies important measurement gaps in the SDG monitoring frameworks that are already in place, especially with relation to the gender aspects of energy access and empowerment in unstable situations. The qualitative variations between how women and men benefit from energy access or how energy initiatives impact gender relations are not captured by standard measures for SDG 7, such as access to electricity. In a similar vein, SDG 5 indicators sometimes lack precision when it comes to empowerment characteristics relating to energy. These measuring gaps restrict accountability and learning in addition to hiding significant differences in SDG development (Dehnavi et al., 2024). According to the findings, creating context-adapted indicators that reflect intersectional differences and fragility-specific characteristics is necessary for effective SDG implementation in FCAS. Additionally, national statistical ability to monitor progress across interrelated objectives has to be strengthened. In the world's most disadvantaged circumstances, the SDG promise to "leave no one behind" runs the danger of staying rhetorical rather than practical without such advancements.

5.4 Policy and Practice Implications

The study has a number of significant ramifications for practitioners and policymakers involved in female empowerment and renewable energy in fragile nations. First, it emphasizes how important it is to shift from gender-accommodative strategies which operate within preexisting gender norms to gender-transformative tactics, which actively confront discriminatory systems. In order to achieve this, it is necessary to guarantee women's meaningful participation in program design, execution, and governance in addition to include them as beneficiaries. The Yemeni examples show that empowerment results are more robust and long-lasting when women hold technical and decision-making responsibilities. This implies that energy programs in FCAS should invest in women's technical training, establish safe spaces for women's participation in situations when societal norms prohibit mixed-gender interaction, and include explicit gender quotas in governance structures.

Second, the results emphasize the need of comprehensive programming that tackles the several interrelated obstacles that women encounter in precarious situations. Programs that integrated energy access with supplementary support—such as financial literacy training, company development services, childcare help, and legal aid for property rights—showed noticeably better results than energy-only programs. This suggests that funders and implementers should abandon compartmentalized strategies in favor of more comprehensive programming that acknowledges the connections between energy access and other aspects of women's marginalization. Longer financing cycles and more adaptable implementation strategies that can adjust to the dynamic constraints of fragile contexts—such as shifting security circumstances and shifting gender dynamics throughout war and recovery periods—are also recommended by the research.

Chapter 6: Conclusion and Recommendations

6.1 Conclusions

This study has investigated the complex relationship between renewable energy programs and women's empowerment in fragile and conflict-affected states (FCAS), with particular attention on Somalia, Yemen, and the Democratic Republic of the Congo. The research claims that renewable energy has a lot of potential to promote women's empowerment in a variety of ways, but this potential is not always realized and much relies on implementation tactics, design, and context.

The most consistent positive outcome across all scenarios was less time poverty, with women gaining significant hours that they had previously spent on fuel collection and energy management. However, persistent patriarchal norms and restricted agency over temporal reallocation prevented this phase from evolving into more universal empowerment. Economic empowerment has a wide range of benefits; in Somalia, gender-blind market strategies had far lower outcomes than openly gender-transformative initiatives in Yemen. Depending on the circumstances, health and safety benefits varied, but they were substantial when security and clean cooking integration were prioritized. Social and political empowerment proved to be the most challenging, with notable progress largely occurring in regions where initiatives intentionally allowed women to take the lead and make decisions.

Importantly, the study revealed an empowerment paradox: women with pre-existing advantages in education, assets, or social capital benefited disproportionately from renewable energy interventions, while the most marginalized women, particularly those in remote conflict-affected areas or displacement settings, saw limited gains. This suggests that investments in renewable energy have the potential to exacerbate existing disparities rather than reduce them.

6.2 Practical recommendations for future research

The following policy suggestions are made for governments, funders, and international organizations involved in FCAS based on the research findings:

Develop overtly gender-transformative energy policies that confront systemic injustices, going beyond gender-mainstreaming strategies. This entails establishing separate budget lines for gender-responsive programming, requiring women to participate in energy governance (with minimum quotas of 30–40%), and incorporating gender concerns into all phases of energy planning and execution.

Make investments to help FCAS energy institutions become more capable of putting gender-responsive policies into practice. This entails setting up and supporting gender focal points within energy ministries, implementing accountability systems to monitor the fulfillment of gender pledges, and developing gender analytical techniques tailored to the energy sector in precarious situations.

Design energy interventions as integrated programs that tackle the various interrelated obstacles that women encounter in precarious situations. Energy access must be combined with complementing initiatives in financial inclusion, legal rights (especially property and inheritance rights), education and training, and social protection, going beyond energy-only strategies.

Establish context-adapted metrics to monitor SDG achievement in FCAS, paying special emphasis to the gender aspects of empowerment and energy access (Dehnavi et al., 2024). The longevity of empowerment gains in unstable circumstances, intersectional variances in results, and measures that represent qualitative dimensions of energy access (beyond binary connection measurements) should all be included.

6.3 Limitations of the Study

The study draws many important findings on women's empowerment in FCAS and renewable energy:

First, access to renewable energy is a prerequisite for women's empowerment in precarious situations, but it is not sufficient. Technology access by itself does not always result in strategic empowerment benefits linked to economic independence, decision-making authority, or social transformation, even though it is crucial for addressing practical gender issues related to time poverty, health, and safety. Energy interventions that were specifically created to question prevailing gender stereotypes and power systems had the most notable empowering results.

Second, a variety of contextual characteristics that differ greatly among fragile situations moderate the link between empowerment and energy availability. The impact of energy interventions on women's lives is influenced by societal norms, institutional capability, conflict dynamics, and pre-existing gender relations. Successful strategies in one FCAS may not translate straight to another due to this contextual uniqueness, necessitating careful modification rather than uniform replication.

Third, the Sustainable Development Goals (SDGs) offer a useful framework for comprehending the interdependence of gender outcomes and energy, but existing monitoring and implementation strategies are insufficient for unstable situations. SDG 5 (female equality) and SDG 7 (cheap and clean energy) do not automatically work together; programmatic design and intentional policy integration are needed. Additionally, conventional SDG indicators impede accountability and learning by failing to capture crucial qualitative aspects of women empowerment and energy access in vulnerable environments.

Lastly, the study shows that through energy interventions, fragility produces both possibilities and limits for gender transition.

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