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ASSESSING THE EFFECTS OF CLEAN COOKING INTERVENTIONS ON WOMEN'S EMPOWERMENT IN UGANDA AND KENYA

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INTRODUCTION

Climate change is generally presented as an environmental and technological challenge, yet its consequences extend well beyond changes in temperature, precipitation patterns or the increasing frequency of extreme events. Climate-related impacts are experienced within social and economic systems that are characterised by inequalities, and these inequalities influence people's ability to respond to environmental change. Gender is one of the dimensions through which these differences become particularly visible. In many contexts, women have more limited access to land, income, education, technology and decision-making, while at the same time bearing a substantial share of unpaid domestic and care work. These conditions can increase their exposure to climate-related risks and reduce their capacity to adapt to them.

The connection between gender equality and environmental issues has not always been recognised within international climate policy. For a long time, environmental governance and gender policies developed along separate paths. The evolution of feminist thought, together with the emergence of ecofeminist approaches, gradually challenged this separation and drew attention to the links between social inequality, the organisation of work and the exploitation of natural resources. More recently, the discussion has moved beyond the representation of women simply as vulnerable groups. Increasing attention has instead been devoted to their participation, knowledge and role in shaping adaptation and mitigation processes. At the same time, the development of intersectional approaches has shown that gender cannot be considered in isolation from other factors such as class, ethnicity, age, socio-economic position and geographical context.

This issue becomes particularly relevant when climate change is considered together with energy poverty. Access to energy is not simply a matter of having a source of electricity or fuel. It also depends on whether energy services are affordable, accessible, reliable and suitable for the needs of the people who use them. In many rural and low-income communities, cooking still depends heavily on biomass, and collecting and using firewood represents a considerable burden in terms of time, physical effort and exposure to household air pollution. Since these activities are frequently carried out by women, energy poverty can reinforce existing inequalities and restrict the time available for education, paid work, social participation and other activities.

For this reason, the transition towards cleaner and more efficient cooking technologies

deserves to be examined not only from an environmental or technical perspective, but also as a social issue. An improved stove, a biodigester or another clean cooking technology may reduce fuel consumption and household pollution, but these outcomes do not automatically translate into greater equality. The effects of an intervention depend on how the technology is introduced, whether it is affordable and culturally appropriate, whether users are involved in its design and maintenance, and whether the time and resources made available are actually translated into new opportunities and greater decision-making power. The thesis therefore considers clean cooking as a possible point of connection between climate action, energy access, health and gender equality.

The purpose of this research is to investigate this connection by combining a theoretical analysis of gender and climate change with an examination of clean cooking technologies, policy frameworks and concrete interventions. Particular attention is given to Uganda and Kenya, two contexts in which energy poverty, environmental vulnerability and gender inequalities interact with national climate and development policies. The research ultimately asks under what conditions clean cooking interventions can produce benefits that go beyond the simple introduction of a more efficient technology, contributing instead to more sustainable and gender-responsive forms of development.

The thesis is structured into five chapters. The first one provides the theoretical background of the study. It begins with the historical development of gender inequality and examines how feminist thought progressively entered the debate on development and environmental protection. The chapter discusses the transition from Women in Development (WID) to Women and Development (WAD) and Gender and Development (GAD), as well as the contribution of ecofeminism to the interpretation of the relationship between social and environmental forms of domination. It then introduces the intersectional approach, which allows climate vulnerability to be understood through the interaction of gender with other social and economic factors. The chapter also considers the scientific and institutional governance of climate change, including the UNFCCC framework, mitigation and adaptation, and the emergence of gender mainstreaming within environmental policy.

The second chapter moves from the broader theoretical discussion to the specific issue of energy access and clean cooking. It examines the concept of energy poverty and the role of

Improved Cooking Stoves (ICS), focusing on their potential effects on household air pollution, fuel consumption, women's time and health. The chapter also considers how women can participate in the different stages of the clean-energy value chain rather than being treated only as final users of technology. To illustrate these dynamics, the analysis considers different geographical experiences, including the Upesi Project in Kenya, the introduction of electric rice cookers in Nepal and community-based interventions in rural China. These examples make it possible to identify the social, technological and cultural conditions that can influence the adoption and effectiveness of clean cooking solutions.

The third chapter examines the institutional dimension of the relationship between gender, environmental sustainability and energy transition. It traces the development of international and regional policies and focuses on the growing recognition of women's participation, gender mainstreaming and monitoring within climate and development agendas. The second part of the chapter concentrates on Uganda and Kenya, analysing the national policies and strategies through which international principles are translated into concrete regulatory and development frameworks. Particular attention is given to the distance that may emerge between formal commitments and implementation, especially where financial, institutional, informational and socio-cultural barriers limit access to clean energy and women's effective participation. The theoretical and policy foundations established in the first three chapters provide the basis for the fourth chapter, which constitutes the empirical part of the research and adopts a comparative case-study approach. Two projects are analysed: the Cookstove Project in Uganda and the Be0Gas project in Kenya. The assessment considers a range of indicators rather than focusing only on the number of technologies distributed. Continued use, fuel consumption, time savings, health and safety, participation, income opportunities, technical skills and maintenance are examined in order to understand whether the interventions produced lasting effects and how these effects were distributed. The comparison is deliberately not reduced to a simple distinction between success and failure; instead, the analysis identifies the conditions that supported implementation, the difficulties encountered and the areas in which the available evidence remains incomplete.

The final chapter builds on the evidence discussed in the previous chapters. It brings together the principal findings of the comparison between Uganda and Kenya and considers their implications for public policy and project design. The chapter develops recommendations

concerning the integration of clean cooking within gender, climate and development strategies, the removal of financial and legal barriers, women's participation in technical and economic activities, gender-responsive monitoring and the role of international climate finance. It also proposes possible directions for NGOs and social enterprises and identifies areas in which further research is needed, particularly with regard to long-term and gender-disaggregated evidence.

Taken as a whole, the thesis follows a path that moves from theory to technology, from policy to practice and, finally, from evidence to future perspectives. The central issue is not simply whether cleaner cooking technologies can reduce emissions or fuel consumption, but whether their introduction can also contribute to changes in the everyday conditions that shape women's lives. The cases examined in Uganda and Kenya suggest that the environmental, health and socio-economic dimensions of energy transition are closely connected, while also showing that durable outcomes depend on factors such as participation, affordability, local knowledge, maintenance, institutional support and the distribution of decision-making power. In this sense, clean cooking can be understood not as an isolated technological intervention, but as part of a broader discussion on climate resilience, sustainable development and substantive gender equality.

CHAPTER 1

Gender equality and Climate change issues: the evolution of the discourse

Historically, the patriarchal system has relegated women to a subordinate position, defining them through male stereotypes that limited their autonomy to domestic and caregiving roles. This inequality has not only been social, but structural: exclusion from political rights (such as voting) and economic dependence on the male breadwinner have created a basic vulnerability that is now dramatically reflected in the impact of climate change.

Since the 20th century, feminist struggle has transformed gender claims into a matter of international law. From the United Nations Charter to Goal 5 of the 2030 Agenda, gender equality has been recognized as a fundamental pillar of development. However, theory does not always align with reality: in developing countries, environmental disasters act as "inequality multipliers." The denial of property rights or access to education leaves women less equipped to survive a flood or famine, making gender a critical variable in climate survival.

With the Beijing Platform for Action, it was officially acknowledged for the first time that the degradation of the biosphere disproportionately affects the well-being of women and girls. This link between the exploitation of women's bodies and the exploitation of the Earth found its theoretical synthesis in the ecofeminism that emerged in the 1970s.

This current argues that the climate crisis is not just a technical problem of CO₂ emissions, but the end result of a culture of domination that views both Nature and Women as inert resources to be possessed. Over the past twenty years, the discourse has evolved: women are no longer seen merely as victims, but as leaders and essential agents of change. From local communities to international negotiations, their influence is crucial in defining parameters of global justice. Effective climate adaptation is inconceivable without considering that women manage a large portion of the world's subsistence resources (water, food, domestic energy).

Ultimately, the investigation aims to demonstrate a central thesis: the stability of the climate system and the achievement of gender equality are not separate objectives, but rather two sides of

the same global challenge. Without gender justice, there can be no effective ecological transition; Likewise, without safeguarding the planet, women's hard-won rights remain exposed to new and devastating risks of regression.

1.1 The linkages between climate change and gender issues: an introduction

Understanding the connection between gender and climate change requires, first of all, looking beyond purely environmental data to delve into the social structures that shape how we live, consume, and respond to crises. This is not a biological issue, but a profound intertwining of roles and responsibilities that society has layered over time. The climate crisis, in this sense, does not create new injustices out of thin air, but rather acts as a magnifying glass on existing ones, revealing how gender dramatically impacts each individual's ability to cope in a changing world. First, vulnerability is not evenly distributed. Being a woman, especially in the poorest areas of the planet, often means navigating a limited range of options: fewer property rights, limited access to education, and mobility limited by cultural norms make it more difficult to find safety during an extreme event or rebuild one's life after a disaster. This structural fragility directly impacts the capacity for adaptation: while women are often the custodians of a profound, age-old knowledge of land and water resources, the lack of decision-making power and access to credit prevents them from transforming this knowledge into recognized and funded resilience strategies. Finally, the discussion shifts to the level of everyday behavior and consumption patterns. Even in industrialized societies, the behaviors that fuel global warming display a clear gender bias: from different mobility habits to dietary choices, it emerges that women, on average, tend to adopt more sustainable lifestyles, despite often being burdened by "time poverty" resulting from the burden of caregiving.

Analyzing these differences therefore means recognizing that the climate challenge is not "neutral" and the gender analysis emerges as an essential critical tool for deconstructing the idea that policies and programs are

inherently "unbiased." A "gender-neutral" approach, in fact, is based on the assumption that interventions and initiatives affect the population uniformly, regardless of gender, and ignores the fact that different starting positions require differentiated solutions to achieve truly equitable results.

To measure and correct these differences, specific indicators such as the Gender

Development Index (GDI) or the Gender Empowerment Measure (GEM) are used, which are used for the evaluation of women's participation in decision-making processes and their share of earned income.

These tools become central when the analysis shifts to the field of climate change, a phenomenon that does not act in isolation but builds on pre-existing critical issues such as poverty, globalization, health crises and the gender dimension.

Despite the absence of the gender element from the discourse, it is clear that climate vulnerability is not distributed evenly: 70% of the 1.3 billion people in the developing world living below the threshold of poverty are women (Denton 2002) and climate change can lead already marginalised sections of communities into further deprivation. Social norms limit women's physical mobility and access to land, they define the gendered divisions of labour and who is entitled to take part in decision making at household and community levels, leaving them with little or no chance to participate in adaptation strategies. At the same time, they are usually responsible for collecting water and fuel, and they take on most of the agricultural work, which makes them heavily dependent on the health of ecosystems for their survival. As environmental degradation increases material poverty, they are forced to work longer to provide for their families; consequently, they are more exposed to risks, injuries and health problems.

Just as women and men are vulnerable in different ways to the effects of climate changes, their views regarding the risks associated with it are also divergent: the same risk may have different meanings for men and women, who also express different levels of concern about them. However, the lack of attention to gender issues in the field of climate change (Terry, 2009) reflects the fact that social scientists became involved in the discourse fairly recently; since then, various frameworks have been presented to analyze the social aspects of this issue, such as sustainable development, climate justice or ethics, but gender equity has not been central to any of these paradigms either.

1.1.1 The evolution of the gender equality concept in climate change context

In this context of global climate policies, numerous funding bodies, task groups and action plans, including the Green Climate Fund, the Intergovernmental Panel on Climate Change (IPCC) and the Global Environment Facility (GEF), require gender equality to be integrated across all aspects. Yet, there persists a phenomenon of “gender-blindness”, where gender issues are not considered at all, or there is a systematic recourse to stereotypes that essentialize the

female figure.

These assumptions depict women as innately connected to the environment and naturally predisposed to care, reviving instances of 1970s ecofeminism that linked biological female body traits, like birth and breast feeding to an innate connection with nature and as a result, a connection to a social destiny: thinking of it as an instinctive tendency overcasts the extensive range of factors that shape people's experiences and expectations about their roles.

Such a stereotype produces the misinterpretation of "homogeneous vulnerability": women are seen as passive, more vulnerable victims of climate change because of their closeness and dependence on natural resources. Essentializing women as a vulnerable group with homogenous climate change experiences and adaptation needs can exacerbate inequalities and discard opportunities to address different people's necessities. Indeed, this approach, rooted in the "Women in Development" era, treats equality in an instrumental way: women are involved as tools to improve the results of environmental projects. In this framework, equality slips into a "numbers game," which suggests that increasing the numbers of women that participate in, or benefit from, development programmes corresponds with women becoming empowered.

To deconstruct these practices, an ontological rethinking of the term "gender" is necessary. The commonsense definition is based on the female-male dichotomy, but this interpretation clashes with various scientific arguments: first, human life doesn't simply branch into two spheres,

invalidating our dichotomous gender image. Secondly, a definition based only on "difference" makes gender invisible where there is similarity or minimal psychological differences between and within the sexes.

To overcome this definition, social sciences have shifted their focus from the concept of difference to the one of relations: gender is primarily a matter of social relations within which individuals and groups act. Specifically, gender must be understood as a social structure built through everyday activities or practices regulated by social arrangements; at the same time it involves a specific relationship with bodies and the bodily distinction of male from female.

The theoretical path that led to this view is complex. Drawing on psychoanalysis, literature and the activist philosophy, de Beauvoir (1949) challenged gender categories and gender domination at the same time, exploring how women were constituted as 'other' in the consciousness of men. Likewise, nature, as something other, has been conceived as an element to be dominated, possessed, and exploited. The climate crisis is the result of this dualistic vision,

where the "Subject" -understood as civilized man- believes it can transcend the limits of nature, considering it an inert object at its disposal.

Moreover, Beauvoir was critical of the idea that women are "naturally" closer to the Earth. She saw this connection as a trap to keep women confined to the roles of mothers and nurturers.

She explored the variety of ways in which women could respond to this situation and realize gender differently through "life projects". Her work paved the way for the mobilizations of the 1960s and 1970s, characterized by a categorical approach that perceived women as an oppressed "sexual class".

This was followed by a fragmentation of the theory during the the 1980s and 1990s: with the work of the 1980s and 1990s saw a fragmentation and enrichment of the theory. With the work of authors like West and Zimmerman and theories on identity fluidity, gender was understood to be a daily "performance", a category constantly renegotiated and articulated through dimensions of power and political economy. Maria Mies (1986) theorized how the global economy has been fueled by a process of "housewifization", where women—especially in the colonized world—have been pushed toward economic dependence and domestic isolation. These gender regimes make it possible to apply the products of men's and women's joint work in gendered ways, reinforcing inequalities. They exist across a range of resources, from income and wealth to social honourhonor and cultural authority and gender ones are usually expressed in terms of women's lack of resources relative to men's. However, this definition allows us to reverse the perspective and shift the focus to the surplus of resources made available to men, defined as the

"patriarchal dividend" (Connel 2009). It pushes men as a group to maintain an unequal gender order, in pursuance of different kinds of benefits: money, authority, respect, service, safety, housing, access to institutional power.

The latter was central to developing the concept of patriarchy, which

wasn't intended as just a matter of direct control of women by individual men, but also as realized impersonally through the state. In the 1970s and 1980s, feminists made a number of attempts to formulate a theory of the patriarchal state: it is considered the core of the structure of power relations in gender., because it has a well-marked internal gender regime: there is an overall gender division of labour, with men concentrated in departments such as the military, police, infrastructure and economic agencies, women concentrated in social welfare, health and education; also the centres of state power, the top decision-making units, are heavily masculine, and women's interests are represented in more peripheral agencies than men's interests.^[1] Secondly, the state regulates gender relations in the wider society through policies,

from housing through education to criminal justice and the military. This activity not only administers existing gender relations but also helps to constitute new ones and form gender identities. Because of these capacities, the state is the key target in gender politics. It is the focus of most political mobilization on gender issues, as pressure groups and popular mobilization try to reach their goals via the state.

One of the most significant movements was Ecofeminism. It took shape during the 1980s, emerging in a climate of profound collective anxiety linked to global existential threats. In this scenario, the movement did not limit itself to sectoral criticism, but proposed a radical change in society, mentality, and lifestyles to counter the prospect of an imminent end of the world. The movement has its epistemological roots in three seminal works published at the end of the decade: *Woman and Nature* by Susan Griffin (1978), *Gyn/ecology* by Mary Daly (1979), and *The Death of Nature* by Carolyn Merchant (1980). These texts, which have become classics, do not merely provide theoretical abstractions, but offer empirical investigations into memory and history, allowing women to trace unusual practical genealogies.

In the wake of these foundations, the transition from theory to practice took place symbolically in Amherst, Massachusetts, where the group Women and Life on Earth organized the meeting “Ecofeminism in the Eighties” (1980), attracting six hundred participants. The catalyst for action was the Three Mile Island nuclear disaster, but the topics quickly reached a systemic level: militarism, nuclear testing, chemical discharges, toxic waste, intensive agriculture, and the subordination of women.

Compared to other contemporary movements, Women and Life on Earth's approach stood out for its use of unconventional tools for change: along with traditional information and lobbying activities, activists resorted to collective artistic projects, the reformulation of shared values, and forms of expression of women's experiences that included mythical tales, rituals, and a spirituality deeply connected to the earth.

In this context, figures such as Ynestra King and Gwyn Kirk played a crucial role, understanding ecofeminism mainly as a means of political action. For King and Kirk, it was essential to prevent the movement from becoming an abstract idea. This need to keep the movement on a practical level became even more compelling after the Ecofeminist Perspectives conference, organized by the University of Southern California in Los Angeles in 1987, which sealed the beginning of the academization and theorization of the subject. With that intent, King and Kirk tried to establish the WomanEarth Institute in the late 1980s, together with other activists such as Charlene Spretnak and Starhawk.

The institute was supposed to operate as a resource center for women eager to combat the destructive nature of patriarchal capitalism through social and ecological projects supporting self-sufficient communities, promoting permaculture, the use of unused land, and the reclamation of toxic landfills.

However, despite initially enthusiastic reactions, the project never really got off the ground.

At the same time, activism in the field found one of its highest expressions in peace camps, such as those at Greenham Common in the United Kingdom or Seneca and Puget in the United States, and in demonstrations such as the Pentagon Action, where resistance was fueled by the idea that change had been achievable through care, education, and regeneration.

These spaces adopted alternative approaches: small groups, rotating leadership, inclusive decision-making processes, and so-called “feeling checks” to monitor the emotional well-being of the group. Rituals such as “Embrace the Base” or the “Silo Dance” became tools of symbolic resistance. It is essential to emphasize that every protest in those years, from marches to permanent camps, was based on the strength of the groups, regardless of their size.

The debate has expanded; ecofeminist theories have developed intersectional analyses identifying the links between different forms of domination (gender, class, race, species). At the core of their dissection is the “patriarchal conceptual framework”, which is structured around oppositional and hierarchical dualisms: high/low, male/female, black/white, mind/body, culture/nature, reason/emotion, action/passivity, public/private, heterosexual/homosexual. In these pairs, the first term is systematically elevated, while the second is devalued and subjugated.

Against this logic, authors such as Mary Mellor, Ariel Salleh, Vandana Shiva, and Amaia Pérez Orozco have condemned the collision between capitalism and the sustainability of life. A fundamental contribution has come from the “Bielefeld School” with Maria Mies, Veronika Bennholdt-Thomsen, and Claudia von Werlhof, who have taken up Rosa Luxemburg's theory of “continuous primitive accumulation” (Luxemburg 1913).

Since the 1990s, these scholars have radicalized their critique of the economic development model, introducing the “subsistence perspective”, where subsistence is not intended as poverty but as what exists in itself and remains; an approach that recognizes human beings as part of nature's reproductive cycles and promotes an economy based on local resources and the rhythm of life.

In the new millennium, the movement has shifted its focus to the climate crisis, criticizing the dominant narrative that presents it as an external threat coming from an angry and out-of-control nature, which can be solved purely with mathematical or technological solutions, without

affecting the ideologies of domination and colonialism. By emphasizing the interconnectedness of all forms of life, ecofeminist ethics challenge dominant models by placing inclusion and social bonds at the center, arguing that the protection of life must begin with the recognition of everyone's vulnerability. It identifies the commodification of the environment and hyper-consumerism in the global North—including intensive agricultural systems—as the structural causes of the climate crisis. Its exponents contest the ‘mitigation and adaptation’ approach, proposing instead a strategy of ‘reduction and prevention’, and extend the vulnerability paradigm to queer and transgender people."

Ecofeminist discourse, therefore, highlights (a) some of the important conceptual links between the symbolic c women and nature and the ways of acting upon Merchant alone goes beyond the level of assertion links in concrete terms, historically); (b) the underlying commonality between the premises and goals of the women’s movement and the environmental movement; and (c) an alternative vision of a more egalitarian and harmonious future.

A turning point came with the 27 principles of climate justice affirmed in Bali in 2002, which have their roots in the People of Color Environmental Justice Leadership Summit in Washington in 1991. These principles reaffirmed the sacredness of Mother Earth, the rights of indigenous peoples, women, and future generations.

This push has resulted in the emergence of global networks such as the Women's Earth and Climate Action Network (WECAN) in 2013, and at the institutional level, it led to the creation of the Global Gender and Climate Alliance (GGCA) in 2007. The Alliance's actions are based on the fundamental assumption that the fight against climate change and the promotion of gender equality are two closely intertwined and complementary objectives: to this end, it is necessary to integrate the gender perspective into decision-making processes and to support women's participation and cooperation in environmental protection projects.

The most significant pivotal moment in terms of political recognition came on January 16, 2018, when the European Parliament adopted a resolution on women, gender equality, and climate justice, following a detailed report from the Committee on Women's Rights and Gender Equality. Despite the fact that the resolution is non-binding in nature, it is nevertheless considered an element of international practice. Specifically, the resolution invokes the 1948 Universal Declaration of Human Rights and relevant United Nations conventions, including the 1979 Convention on the Elimination of All Forms of Discrimination against Women.

This resolution follows the report by the European Institute for Gender Equality (EIGE) of 26 January 2017 entitled ‘Gender in environment and climate change’: the European Parliament

emphasizes the effects on countries and communities that are least responsible for global warming and on women, who are considered “more vulnerable” and “at higher risk” for a number of reasons, ranging from unequal access to resources, education, employment opportunities, and land rights, as well as social and cultural norms and their intersectional experiences. Climate change is considered to exacerbate pre-existing gender inequalities regarding health threats, loss of livelihoods, displacement, migration, poverty, human trafficking, violence, sexual exploitation and food insecurity.

1.1.2 From WID to GAD: Women in Development to Gender and Development

Those political recognitions are adopted within certain social and cultural structures, of which ecofeminism represents the latest frontier. It is the result of a long process that started with the Women in Development (WID) movement. It has its roots in anthropological research conducted before 1970, which provided the empirical basis for the advocacy of gender rights and the pursuit of social justice in the United States. However, the formal establishment of the term and model came about in the early 1970s, stimulated by the publication of Ester Boserup's seminal work, *Women's Role in Economic Development*. She was the first to systematically outline the sexual division of labor in agrarian economies on a global scale, highlighting how modernization affects men and women differently: she found that in sparsely populated regions, women perform most of the agricultural work; in more densely populated areas that use simple technologies, male labor prevails; lastly, in irrigation-based contexts, agricultural tasks are equally divided between the genders. Although criticized for oversimplification, Boserup's research was instrumental in shifting academic attention to the differentiated impact of development strategies based on gender.

The term “WID” was formally adopted by the women's committee of the Society for International Development in Washington, D.C., as a strategy for bringing Boserup's scientific evidence to the attention of American policymakers. This approach has been promoted both within development agencies and by external critics since the early 1970s.

Its orientation can be assimilated with American liberal feminism, characterized by a demand for legal and administrative changes to integrate women into economic systems, with a focus on egalitarianism and the goal of eliminating employment discrimination through targeted action programs. This perspective was based on the modernization theory that prevailed from the

1950s into the 1970s: it was believed that modernization, which usually equated with industrialization, would improve the standard of living in developing countries. It was argued that through massive expansion of education systems a stock of well-trained workers and managers would emerge. Political strategies based on this theory focused on massive investments in education systems, with the aim of training a solid base of skilled workers and managers. In this theoretical context, however, women were rarely considered as an independent subject of analysis. Indeed, it was believed that the male development model was also applicable to females without the need for distinctions and that social progress and modernization would have benefited men and women equally. Some differences can be found in the perception of their relationship with the environmental context; indeed, the WID model saw it mainly through two lenses: women were identified as victims and guardians of nature. The first refers to their dependence on natural resources for family subsistence and the fact that they are more exposed to the effects of natural disasters. The latter is based on the belief that they are "naturally" closer to the earth.

Nevertheless, by the 1970s, statistical data began to show that the relative position of women had not improved at all in the previous two decades; in fact, the WID approach focused on women and gender as a unit of analysis without recognizing the important implications and differences linked to class, race, and culture. Moreover, the model's contextualization of women in environmental discourse increased their workload, because it asked women to "save the planet", adding responsibility, without actually giving them political power.

The approach also tended to focus solely on the productive aspects of women's work, ignoring or minimizing the reproductive side of their lives, and not acknowledging exploitation as an element of the global capitalist system. Hence, it was necessary a strategic review that led international agencies to officially adopt a focus on women.

In the second half of the 1970s the Women and Development (WAD) emerged, focused on the relationship between women and development processes rather than purely on strategies for the integration of women into development. It was based on the assumption that women have always been part of development processes: they have always been important economic actors in their societies and the work they do both inside and outside the household is central to the maintenance of those societies.

Thus, both women's poverty and environmental degradation are not attributed to women's lack of integration, but to global capitalist structures and inequalities between the global North and the global South. WAD highlights that it is the unpaid environmental work done by women

in the South that allows large economies to pollute without paying the true cost of environmental regeneration. It also adds that climate change is caused by a system that exploits both natural resources and women's bodies.

Although the WAD perspective theoretically recognizes the importance of social class, its practical application often ends up mirroring the WID approach, treating women as a homogeneous group. In doing so, crucial variables such as ethnicity and race, which profoundly influence social status, are overlooked. WAD is based on the assumption that improving the status of women depends on greater equity in international structures. However, women's low participation in public and economic life is still addressed through targeted interventions rather than a radical transformation of gender relations. As a result, WID/WAD projects often focus on income generation, while ignoring the additional time and

As far as the role of the United Nations (UN), until the Seventies, the agency focused on systematizing women's legal and civil rights and collecting statistics on women. In 1975 the first World Conference on Women took place in Mexico City: different kinds of actors participated - government and non-governmental (NGO) development agencies, academics and women's advocates- and it focused on women as an invisible resource for development. Minimum targets were set: the adoption of a World Plan of Action promoting their equal participation in development; the establishment of the International Research and Training Institute for the Advancement of Women (INSTRAW) and the United Nations Development Fund for Women (UNIFEM) that together established the institutional framework for research, training and operational activities in the area of women and development.

The second World Conference on Women in Copenhagen in 1980 focused on implementing action plans and addressing obstacles: it was recognized that laws and conventions didn't automatically lead to women being able to exercise their rights and barriers were identified, including women's lack of ownership of property; women's lack of inheritance rights, insufficient political will and the lack of male involvement and support for change.

In this context, 1985 marked a pivotal moment for women's rights: during the third World Conference in Nairobi there was an incredible participation of non-governmental organizations (NGOs). This massive presence led many observers to call the conference the true birth of "global feminism." By that time, progress was already visible at the institutional level: 127 United Nations member states had already established national bodies specifically dedicated to policies and research for the advancement of women. Despite these advances, the major equity goals had not yet been achieved; that awareness induced a change of direction, leading to the

adoption of the "Nairobi Forward-Looking Strategies for the Advancement of Women", based on the revolutionary principle that every global issue is a women's issue: a strategy of total integration ("mainstreaming") was adopted, in which women's rights were to be integrated into every institutional office and program.

However, the progresses made within the WID framework were only about bringing women into projects and in providing women with resources, but it had not influenced women's social and economic power relative to men's. Such critiques eventually led to the shift from WID to GAD. Moving from WID to GAD was the challenge to be met by the fourth World Conference on Women held in Beijing in 1995. Participants at this meeting recognized the need to shift the focus from women to gender relations. It was acknowledged that the entire structure of society, and all relations between men and women within it, had to be re-evaluated. The change from WID to GAD represented a strong reaffirmation that women's rights were human rights and that gender equality was an issue of universal concern, benefiting all. The Beijing Declaration and Platform for Action (BPfA) adopted at the Beijing conference established gender mainstreaming as a key strategy for addressing gender inequalities.

The Gender and Development (GAD) approach has its roots in socialist feminism. Unlike previous models, this model analyzes how and why society organizes work and power between the sexes; it doesn't deal with women as an isolated category, but within social gender relations. GAD rejects the separation between the "public sphere" - as in paid work- and the "private sphere" - as in household and family care: it argues that unpaid domestic work is what allows the economic system to function. The approach looks at social organization as a whole and welcomes the contribution of men who share the goals of social justice and equality.

Furthermore, GAD introduces two revolutionary concepts for development policies: the State as a service provider, which plays a fundamental role in women's empowerment; if it reduces social services (healthcare, nurseries), the burden of care falls privately on women. It is therefore a public responsibility to provide these infrastructures in order to free up women's time. In addition, the approach brings up the idea of women as agents of change: they are not seen as passive recipients, but as active protagonists, whose political self-organization is promoted. Finally, GAD recognizes that oppression is not the same for everyone: although patriarchy is a structure that cuts across all social classes, it is intricately intertwined with social class and race. It is to the concept of patriarchy that Merchant links his analysis of the relationship between gender and the environment. She argues that nature-culture dichotomy is not a biological fact,

but rather an ideological construct of patriarchy that serves to maintain social hierarchies. Merchant demonstrates how, in pre-modern Europe, the image of nature as a “nurturing mother” imposed ethical constraints on its exploitation; however, with the Scientific Revolution and the rise of the market, Nature, transformed into a machine to be dominated, legitimized both environmental degradation and the subordination of women. This translates today into a striking reality for rural communities in the global South: the degradation of common resources and their privatization and nationalization disproportionately affect women. As they are primarily responsible for collecting water, food, and fuel, the reduction of forests and soils drastically prolongs their working days, reducing the time available for productive activities and aggravating their psychological and physical stress.

After the Rio Summit and the Beijing Conference, these issues have been absorbed into official discourse through the WED (Women, Environment and Development) model and ecofeminism. However, this integration into international policy has often been overly simplistic. Development agencies, including the World Bank, have embraced a “win-win” logic in which women are celebrated as “natural allies” of conservation or as agents of climate resilience. This view, however, has been criticized for its essentialism: it portrays women as one-dimensional victims or environmental heroines, ignoring the fact that their deep knowledge of nature often stems from an obligation of subordination rather than a free choice. Furthermore, by focusing exclusively on women, such policies tend to overlook the role of men and the complex power relations that define access to resources.

Despite this criticism, the link between women and the environment continues to feature prominently in current climate change agendas, although it requires a more complex lens: that of intersectionality. Although technical institutions such as the IPCC have long ignored the gender dimension, the mobilization of global networks has forced feminist issues into official negotiations, highlighting how vulnerability does not affect “women” as a homogeneous category (Connell, 2009). The intersectional approach reveals that gender is inextricably intertwined with class, race, and geopolitical position, creating unique forms of oppression. The persistence of binary views in contemporary politics is due to a kind of institutional inertia: it is strategically easier for international organizations to relate to the image of women as “vulnerable victims” than to address the intersectional factors and profound power asymmetries—stemming as much from patriarchy as from the colonial legacy—that fuel real climate vulnerabilities

1.1.3 The intersectional approach

The concept of intersectionality, which emerged in the early 1990s in the field of Critical Race Theory thanks to the seminal work of Kimberlé Crenshaw (1991), was born as a critical response to binary gender analyses that tended to isolate the experience of women from that of other vectors of discrimination (i.e. 'race'/ethnicity, class, sexuality and ability). Based on the assumption that social categories are constructed and change over time, intersectionality requires a more complex approach to address the system that creates power imbalances, analyzing the different levels to which relations of power manifest. The categorisations derived from these dynamics define what is considered normal or deviant, what is to be included or excluded; this classification, pervaded by a tendency for simplification, reflects and reinforces the societal structures and practices, often marked-out as natural differences.

Given the fluidity of the categories, an intersectional lens necessitates a shift from categorical enumeration toward a systemic interrogation of how these identities are embedded within institutional mechanisms and normative imaginaries. This perspective allows the development of critical insights and alternative knowledge, which can help in addressing some of the important issues in the debates on vulnerability and adaptive capacity to climate change.

Indeed, social equality and environmental discussions can vary considerably regarding what types of behavioural, political, and technical changes are thought to be required for achieving a better society. For example, the social theories behind emancipatory missions, such as Marxist and neo-materialist inspired analysis on class and gender, generally take economic growth and consumption as an indicator of equality and equity. Even theories on participation and freedom are adopting the angle that material resources equal freedom and emancipation: this perspective is not compatible with the reconciliation of the human and natural dimensions. On the other hand, researches on environmental problems often lack a deeper understanding of social relations and power structures, underestimating the complex social and political dimensions when exploring solutions.

On the contrary, from an intersectional point of view, power structures in a specific social organization determine how individuals acknowledge and connect to climate change. Moreover, intersectionality recognizes complex, horizontal (inter-community) and vertical (national, regional, local) interactions, allowing people and communities to express and experience their own capacity. The latter, as well as strategies for mitigation and adaptation, is influenced by characteristics such as gender, socio-economic status, ethnicity, nationality, health, sexual

orientation, age, and place; at the same time, climate change impacts can reinforce or challenge those categorisations. As an example, looking at individual emissions of greenhouse gases, income is the main determining factor for lifestyle and thereby levels of emissions: higher income generally equals higher emissions, with variations related to other elements such as age and gender. (Kaijser & Kronsell, 2014)

The construction and reinforcement of injustices and intersectional categorisations is sustained also by political and societal institutions that regulate and create demands for transport, energy, and consumption. At the same time, they can contribute to an actual change in the system: for instance, bioenergy policy privileges other actors – involved in designing, building, and investing in alternative energy – and as a consequence, it may lead to new power schemes.

Reversing the perspective, gender aspects are really minimized in the international climate policy matters: the United Nations Framework

Convention on Climate Change (UNFCCC), adopted in 1992, completely lacks a gender perspective, and gender aspects have emerged on the global climate agenda only recently, but they are considered primarily in terms of women as a particularly vulnerable group. With this angle, the power dynamics and the social differences are not considered.

That is why using intersectionality in the study of climate issues makes it possible to reach a more complete and accurate understanding of the social and political conditions for climate governance, in order to expose the underlying norms of current economic activities and to be able to generate effective and functional change for the well-being of all individuals.

The importance of intersectionality finds its most direct impact in overcoming a universal and abstract vision of environmental crises. Only by critically examining the evolution of climate negotiations and the IPCC reports can we verify whether governance is truly shifting toward inclusive management. Ensuring equity means transforming the decision-making system so that it doesn't simply "include women" as a homogeneous category but recognizes and addresses the various forms of marginalization that determine resilience in the face of global warming.

1.2 The Science and the Governance of Climate Change

The intersectional approach should not be considered a mere theoretical exercise, but rather an essential critical tool for analyzing how climate change is managed globally. Using this lens allows us to understand that environmental vulnerability does not affect all people equally; rather, it is intertwined with social variables such as class, age, and ethnicity. Without this

awareness, international institutions risk enacting policies that are "blind" to social diversity, based on purely technical data that ignore local realities, thus drastically limiting the effectiveness of global treaties.

Indeed, a central paradox exists in the history of climate governance: while sociological research has long emphasized the urgency of listening to diverse voices, decision-making structures (such as the UNFCCC) have struggled to include them, building a political knowledge that often excludes the very people most exposed to risk.

From a scientific perspective, climate change is a complex systemic challenge, caused by the accumulation of greenhouse gases that alters the planet's equilibrium. Interestingly, the very definition of this phenomenon varies depending on the context: while IPCC scientists consider it to include both natural and anthropogenic variations, political bodies emphasize human responsibility. Warming is not a linear process, but is fueled by feedback mechanisms: for example, melting polar ice exposes darker waters that absorb more heat, further accelerating the process in a vicious cycle that impacts high latitudes more violently.

Projections for the next century outline a worrying scenario, with temperatures rising unevenly: land masses and the polar regions will experience the most rapid changes. This imbalance will radically transform the water cycle, leading to extreme geographical polarization: while some areas will be hit by floods and torrential rains, others will face chronic droughts, necessitating an urgent review of land and coastal management.

The tipping point between human activity and the stability of the biosphere historically coincides with the Industrial Revolution. Since then, dependence on fossil fuels and intensive land use have exceeded the planet's natural capacity to absorb emissions. Although responsibility for emissions is now being shared equally between industrialized and developing countries, the distribution of risks highlights a profound climate injustice.

Countries in the Global South, despite having historically contributed less to the problem, suffer the most severe consequences. In tropical regions, even small temperature fluctuations can destroy crops, triggering food and health crises. These nations are doubly vulnerable: they are the most exposed to environmental shocks and, simultaneously, have fewer financial and technological resources to defend themselves.

Added to all this is the gender issue. In fact, research highlights a consistent gender

difference in risk perception and environmental behaviors (Ramstetter & Habersack, 2020). Women not only tend to perceive ecological problems differently but are statistically more likely to take pro-environmental actions, especially when these affect everyday life.

This divergence is explained by two main factors: gender socialization and social roles (Ramstetter & Habersack, 2020). The first one refers to the fact that from childhood, women are often educated according to an "ethic of care" (compassion, cooperation), while men are taught competition and independence. This leads women to develop stronger "altruistic" or "biospheric" values, making them more attentive to the consequences of climate change on the health of their families and communities. The latter underlines that different experiences in society shape the way men and women interact with the environment. Responsibility for care work, for example, makes women more sensitive to risks related to food and water security.

This link between gender and climate is directly reflected in institutions. The impact of gender is also reflected in parliaments. Women politicians tend to occupy more progressive positions, reflecting the "modern gender gap" within the electorate. Since "green" issues are often positioned on the left of the political spectrum, women's presence in legislative assemblies is directly correlated with greater support for environmental regulations. Two main mechanisms produce this gap at the elite level: the descriptive and substantive representation, which means that the numerical presence of women improves politicians' responsiveness to female voters' preferences- and the elite socialization, which refers to the socialization patterns and lived experiences that influence the construction of individual values, even among political leaders. (Hathaway, 2025)

Although causality may appear fragile in some contexts, the literature confirms a strong and persistent link between female political participation and the quality of climate governance (Hathaway, 2025).

In this context, climate change can no longer be treated as a simple environmental variable, but as a "vulnerability multiplier" that exacerbates existing inequalities. In a world approaching 9 billion inhabitants, marked by economic disparities and energy crises, the climate issue is redefining the very concept of international cooperation and gender equality becomes essential for its governance. Integrating a gender perspective isn't just about "adding women" to decision-making tables, but transforming the way science shapes political discourse. Only by including those who experience the burden of care and vulnerability firsthand can governance move from purely technical management to real and inclusive climate justice.

1.2.1 The UNFCCC and the Paris Agreement

The international climate protection system that shapes the actions and programmes that are implemented has its roots in 1992, during the Earth Summit in Rio de Janeiro. The United Nations Framework Convention on Climate Change (UNFCCC) was adopted there, with the fundamental objective of stabilizing greenhouse gas concentrations to prevent dangerous human interference with the climate system. The next step was the Kyoto Protocol in 1997, which marked a fundamental turning point in international climate policy, committing industrialized countries to collectively reduce their emissions by 2012. To facilitate the achievement of that objective, the Protocol introduced three market-based mechanisms, known as "flexible mechanisms", designed to break down the costs of mitigation. The operational rules for implementing these mechanisms were formalized during COP-7 with the Marrakesh Accords. These established strict eligibility criteria: industrialized countries must have ratified the Protocol and established a reporting system, while developing countries must have appointed a National Designated Authority (DNA). Individually, the International Emissions Trading (ET) based on the Assigned Quantity Unit Assignment (AAU), allows countries that have not exhausted their permits to sell the surplus to nations that have exceeded their targets. The Joint Implementation (JI), defined by Article 6, concerns joint projects between partner developed countries. The credits generated, called ERU (Emission Reduction Units), are transferred from the host country's budget to that of the investor in a zero-sum transaction. Lastly, the Clean Development Mechanism (CDM) is the only mechanism that allows collaboration between industrialized and developing countries.

Specifically, Article 12.2 clarifies the dual purpose of the CDM: to assist developing countries in achieving sustainable development and to help industrialized countries comply with their emission ceilings. It is a bilateral agreement between an industrialised country that must reduce its greenhouse gas emissions under the Convention and a developing country: through the CDM, Northern countries invest in projects that increase economic productivity and may reduce local environmental problems in developing countries in the Global South; at the same time they will produce commodities for a market in emissions reduction credits (CER). Unlike other systems, the CDM is described in great detail: it is supervised by an Executive Committee (Executive Board) and verified by external operational entities. A distinctive feature is the withdrawal of a percentage of project proceeds to cover administrative costs and feed adaptation

funds in developing countries, ensuring that the host country receives sustainable technologies at no additional cost.

However, the international debate in Marrakech and subsequent COPs highlighted divergent positions: while nations such as the United States pushed for unlimited use of the CDM, the European Union supported the need for limits, especially regarding land use measures. Complex technical topics such as "additionality" (checking whether emissions reductions actually occur thanks to the project) and the definition of "baselines" to avoid overestimations of credits remained at the heart of the negotiations. Despite the CDM's potential to promote "clean development" and create energy infrastructure on continents like Africa, many authors consider it a "double-edged sword." The mechanism tends to favor countries with strong institutions and high technical capacities, risking excluding least developed countries (LDCs) that have weak economies and limited human resources. Moreover, structural constraints like the lack of education and entrepreneurial skills, and cultural restrictions, tend to inhibit women's efforts in entrepreneurial activities.

Indeed, since its inception, the UNFCCC has presented a critical singularity. While all the other fruits of the Rio Summit —such as Agenda 21, the Convention on Biodiversity and the Rio Declaration— placed strong emphasis on women's concerns, the UNFCCC was the only one without a gender perspective. This represents a departure from Principle 1 of the Rio Declaration, which places human beings at the centre of sustainable development. Excluding the social and gender dimensions, the climate regime has begun to emerge as a purely technical and economic area.

Despite the formal absence of a gender perspective in official texts, thought, civil society has consistently sought to influence decision-making: as the first COP kicked off in Berlin in 1995, a group of 200 women from around the world gathered at the 'Solidarity in the Greenhouse' forum to make their voices heard on climate policy. It was a time of great participation, which led to the presentation of specific requests to governments and direct contact with the presidency of the conference, then led by Angela Merkel. That encouraging start was fueled by the collective euphoria that still followed the great successes of the Rio Summit, marking a moment of optimism for the integration of social demands into the environmental debate. Subsequently, at COP6 in 2000, women's and gender perspectives appeared again in the conference programme in a collateral event, however confined to marginal spaces and without real official recognition. In 2001, at the COP7 in Marrakech, for the first time (and for years the only one), an official resolution¹ formally recalled the need to increase women's participation in the UNFCCC and

Kyoto bodies. At COP8 in New Delhi, in 2002, a workshop organized by the gender and energy network ENERGIA received a lot of attention, but focused exclusively on the situation in developing countries.

Finally, a change of strategy came during the COP11 in 2005, with the creation of research networks and the identification of technical entry points to insert the topic of gender into the climate debate. Nevertheless, the quality of women's input has often been instrumental in drafting key documents, but at the formal level women still do not constitute a distinct observer group ("constituency") within the UNFCCC, unlike sectors such as business or indigenous peoples. This systematic underrepresentation in delegations and leadership positions reflects the persistent difficulty of the international system in recognizing that climate change is not only a technical challenge, but a social phenomenon deeply linked to gender equality.

Therefore, the effectiveness of climate action depends critically on the kind of interventions planned for the next two to three decades and the ability to integrate the gender equality discourse in the climate change action plan.

1.2.2 Action for the climate: mitigation and adaptation

In order to achieve the international climate protection system's goals, it developed policies that run along two main tracks: mitigation, aimed at reducing greenhouse gas emissions at their roots, and adaptation, aimed at preparing societies to manage the inevitable impacts of climate change.

Although mitigation has dominated the international political regime for decades, adaptation has only recently entered the debate, with the emergence of the awareness that some changes are now irreversible. The two strategies present divergent characteristics in terms of timing, goals, tools and benefits.

Mitigation focuses on addressing rising greenhouse gas (GHG) emissions through two main avenues: reducing emissions at source by intervening directly where gases are produced and gas sequestration, by increasing gas absorption through "sinks" or reservoirs (such as forests or storage technologies) and it entails immediate costs against global and time-deferred benefits (to the benefit of future generations). It focuses primarily on the transformation of energy systems and land use, through several practical and structural approaches: switching to renewable sources of energy and using fossil fuels more efficiently, curbing deforestation and adopting more efficient agricultural practices. For instance, in least developed countries, energy substitution

reduces indoor air pollution, lowering mortality and morbidity; it also reduces women and children's workload because of the diminishing usage of fuelwood.

Many environmental organizations also believe that the problem is rooted in the unsustainable lifestyles of rich nations (IPCC,2012). Indeed, people consume energy both directly -when fossil fuels are burned to provide domestic energy and transport - and indirectly, through the products they buy, which produce greenhouse gases during their manufacture, transport, and disposal. Hence, the organizations argue the need to move away from consumerism and reject globalization driven by big corporate interests in order to avoid environmental disaster.

It is necessary to transform consumption patterns, to educate on the importance of a more conscious lifestyle. Such measures should not only concern North American and European countries, which are responsible for most greenhouse-gas emissions, but also developing countries, which due to population growth, will be responsible for future growth in emissions.

However, the applicability of the national policies and instruments available to governments to create the incentives for mitigation action depends on national circumstances and an understanding of their interactions, but experience from implementation in various countries and sectors shows there are advantages and disadvantages for any given instrument.

On the other hand, adaptation can be defined as the process of regulating natural or human systems in response to current or expected climate stimuli. Unlike mitigation, which targets global causes and produces deferred benefits over time, adaptation often generates local and immediate benefits. While simple "coping" (the ability to cope) ensures short-term survival, true adaptation aims to transform processes and structures to minimize risks or exploit new opportunities. It manifests itself in two main forms: Spontaneous (or Reactive) Adaptation, which consists of unplanned responses of local actors (farmers, communities) to weather changes based on traditional experience and knowledge and Planned (or Anticipatory) Adaptation, which involves Governmental or institutional interventions aimed at reducing future vulnerability through structured policies, such as National Adaptation Action Programs (NAPAs).

Moreover, the scientific debate often distinguishes between "intentional development" and "specific adaptation": development aims to improve current conditions; adaptation looks to future threats, often not yet perceived by populations. Development promises progress towards well-being; adaptation, sometimes, is limited to making life possible under new and more difficult conditions (Cannon & Müller-Mahn, 2010). Development is intrinsically linked to human rights and social justice; adaptation risks becoming a purely technical or ecological concept if deprived

of its human dimension.

A real risk is posed by "non-adaptation" linked to accelerated economic growth -as in the cases of China and India: growth without redistribution can increase social vulnerability rather than reduce it. To be sure of surviving and thriving in the longer run, individuals and societies need to take action to reduce their vulnerability to future climate stresses and shocks. Within this framework, FAO proposes a closer examination of gender roles in the climate change debate. In fact, contemporary literature increasingly recognises that capacities to adapt and innovate are shaped by socio-institutional factors, including social identities and power relations, which include gender inequalities. Women's roles in natural resource use are threatened by the deleterious effects of climate change; their special knowledge, rights and skills on forest resources assign them a key agency and stakeholder role in adapting and mitigating climate change.

Nonetheless, a society's adaptive capacity -the ability or potential to adapt to the effects or impacts of climate- is not determined solely by its economic stability, but is influenced by socio-institutional factors such as access to technology, equity in the distribution of resources, and the recognition of rights. Indeed, according to the IPCC, the requirements for a country to assure a high adaptive capacity include a prosperous and stable economy, a high degree of access to technology options, well designed adaptation strategies, a system in place for the dissemination of climate change and adaptation information at all levels as well as a distribution of access to resources based on equity principles.

Specifically, during COP7 it was underlined the importance for developing countries to receive more support from the international community to support their adaptation efforts. The Accords introduced new funds such as the Special Climate Change Fund, which focus on adaptation, technology transfer, capacity building and climate change mitigation and the LDCs Fund, centered on assistance for the development of National Adaptation Programmes of Action – NAPAs. The aim of these initiatives is to incorporate adaptation objectives into other policy areas and develop a country specific prioritisation of the various adaptation options.

However, adaptation alone is not expected to cope with all the projected effects of climate change, especially not over the long term as most impacts increase in magnitude. There are barriers, limits and costs, which are not fully understood. It is also affected by multiple climate and non-climate stresses, as well as development policy. Moreover, there is a risk that adaptation policies will end up dominating or distorting the original objectives of international cooperation.

If adaptation is understood only in a technical or infrastructural sense, the fight against poverty and the reduction of social vulnerability risk being neglected. Adaptation is effective only if it is regulated towards well-being and strengthening the capacity of the most vulnerable populations, without sacrificing progress made in social rights.

Indeed, there is broad agreement that immediate mitigation actions not only avoid tying the system to carbon-intensive infrastructure but also generate short-term co-benefits that can offset much of the economic costs (IPCC AR6). Conversely, delaying emissions reductions dramatically narrows the chances of stabilizing temperatures at safe levels, increasing the risk of severe impacts.

To achieve stabilization, global emissions must peak and then decline rapidly. Integrated Assessment Models (IPCC AR6), used to explore climate outcomes, indicate that around 60-80% of reductions must come from the energy sector and industrial processes, with energy efficiency playing a leading role. However, for fossil fuel-exporting countries, these policies will entail structural challenges, such as reducing demand and prices for traditional energy resources.

One of the central theses of modern climate action is that neither mitigation nor adaptation can, on their own, avert any impact. They are complementary tools: adaptation is necessary to manage already inevitable warming in the short and long term, while mitigation is the only way to prevent the adaptive capacity of human and natural systems from being exceeded over time.

The adoption of a diversified technology portfolio (including renewable energy, research and development programmes and advanced financial instruments) is considered sufficient by the IPCC to achieve the desired stabilization levels, provided that barriers to technology transfer to least developed countries are removed (IPCC AR4). It also found that making development more sustainable inherently enhances mitigation capacities and reduces the vulnerability of territories.

However, climate change acts asymmetrically: it most strongly affects low-latitude areas, arid zones and large deltas, but vulnerability is not only geographical but also social. The poor and elderly, in both developing and industrialized countries, face the greatest risks.

Without an approach that overcomes traditional "command and control" methods, climate action risks failing to protect the most vulnerable. Moreover, effective climate action cannot ignore gender dimension, given that power inequalities and social norms profoundly influence the ability of men and women to respond to risks. Access to essential resources —land, water, credit, education— is unequally distributed, often depriving women of the tools they need for adaptation.

In light of this evidence, it is imperative to recognize that gender inequality and

intersectionality can no longer be treated as secondary, marginal issues, or confined to specific social welfare projects. They must be structurally and rigorously integrated across all sectors of both climate change mitigation and adaptation strategies.

1.3 The international notion of gender perspective in environmental issues

To understand the impact of climate change, it is first necessary to analyze how the social construct of gender profoundly shapes human relationships. Gender is not a static data, but a dynamic process driven by everyday norms and micro-political interactions.

In the discourse among scholars and organisations, the concept of gender is understood as an analytical category through which the identities, roles, and expectations that societies develop regarding the idea of man and woman are defined. This dimension then gives rise to a system of asymmetrical relationships, based on which individuals are evaluated and assigned roles.

These functions are often devalued or relegated to the private sphere through a process of "naturalization." These dynamics are fueled by traditional value systems, which tend to justify such inequalities by arguing the biological origins of women's assignment of care.

Social roles and their clear distinction are thus reduced to traits considered typically masculine and feminine, failing to acknowledge the historical processes that have limited women's access to the economic and political spheres. This vision makes it difficult to overcome them. These imbalances and forms of marginalization are still reflected today in the organization of work and social life.

Historically, feminist thought has observed how the management of space and time has given rise to "separate spheres": the public and private realms, each with its own privileges and priorities. Even within the private sector, spaces are further segregated -kitchen, work areas, common spaces-, reflecting a division of productive and reproductive labor that, although it appears fixed, is constantly renegotiated. In this context, power is not just about access to resources, but about the ability to control them. While some enjoy direct control, others must mediate their survival through those in power, making ownership and the right to resources inherently political and gender issues. In the rural context, for example, this social construction determines the division of rights, responsibilities and risks related to the use of environmental resources, particularly land.

Within this framework, several observers assert that women's vulnerability in the face of climate change is not an intrinsic trait, but the direct result of limited access and restricted rights

to core resources. This fragility emerges specifically when phenomena such as crop failure, fuel shortages, and water shortages directly affect women's ability to guarantee food security and supply for the family unit, which society imposes on them as their primary task.

That asymmetry translates into a specific climate vulnerability. Indeed, men and women depend in different ways on land, energy, water, and other natural and social resources, both for daily subsistence and long-term survival. However, it is well documented that women face many obstacles that their male counterparts do not encounter, such as structural -laws and customs-,

technological -tools not adapted to their needs-, and cultural limiting social norms- barriers. Dankelman (2010) highlights how this vulnerability is exacerbated by "time poverty", lack of education and limited access to information. During and after an extreme climate event, women are more likely to die or suffer violence, often being bound by responsibility for children and the elderly, and having fewer financial resources or property rights to protect themselves or rebuild their lives.

Despite this framework of objective difficulty, a strength emerges. Although productive and reproductive responsibilities often constitute a heavy burden, they paradoxically offer women a peculiar bargaining power, because they are at the heart of managing vital resources; women are not only passive subjects of the crisis, but are configured as agents of change endowed with a significant adaptive capacity. Their participation in economic activity, combined with managing domestic resilience, provides them with the skills and authority needed to drive processes of social and environmental transformation, making them indispensable actors in any effective climate adaptation strategy. They hold critical local knowledge that can enhance climate adaptations and assist the development of new technologies to address climate variability in areas related to energy, water, food security, agriculture and fisheries, biodiversity services, health, and disaster risk management. Yet accessing this knowledge and expertise is hampered by a lack of attention to gender equality and an often unquestioned acceptance of existing power and gender relations.

To respond to these challenges, the international community has adopted Gender Mainstreaming. Officially defined by ECOSOC in 1997, this strategy aims to integrate the concerns of women and men at every stage of policy (design, implementation and monitoring) so that inequality is not perpetuated and it is considered by Walby (1997) as the third stage of gender equality policy. This moves from a simple adjustment of existing rules to a true transformation of social structures; it ensures that women's rights and needs are addressed and that inequitable gender relations are challenged during and after climate disasters.

However, this process has not been a linear one, it clashes with what Wittman (2010) calls the "radical potential paradox." One wonders, in fact, how it is possible that, in the face of a very rapid formal adoption of gender mainstreaming on a global scale, concrete practices fail to produce a real increase in equality. Feminist research has identified several overlapping explanations to shed light on this contradiction.

The first is that gender mainstreaming has been developed by international organizations and feminist pressure groups operating at the transnational level; when this vision is translated locally, it clashes with contextual and cultural realities that can radically diverge from the original concept. Moreover, being inserted in cultural contexts, some reforms instead of being neutral, end up further "generating" gender, reinforcing stereotypes through the way they define problems. Another key obstacle is the inability, or unwillingness, of key actors to commit to substantive results. At the state bureaucratic level, this often results in procedural drift: policy success is measured through the production of disaggregated data, gender audits, or budgets, ignoring structural transformation. Finally, mainstreaming often takes place within structures that have historically supported male privilege. Wittman (2010) observes how bureaucratic processes are often conservative and tied to patriarchal values rooted in officials' personal relationships. Furthermore, the principles of "impartiality" and "neutrality" typical of institutions often serve to mask the permanence of masculine norms, emptying the feminist project of meaning.

What has emerged highlights how the success of gender mainstreaming depends on a series of determining factors; only through their satisfaction will it be possible to effectively implement equality objectives in environmental and adaptation policies. Despite the critical issues, transnational organizations remain firmly committed to this strategy, seeing it as the linchpin for connecting gender equality to social justice goals, such as those outlined in the Millennium Development Goals. The role of these entities in promoting and disseminating the feminist project remains, in fact, the most significant factor for global gender equality, especially in forums where organizations such as UN Women and major international NGOs reaffirm the indissoluble link between equality, poverty reduction, and global sustainability. This commitment must be translated into concrete interventions on the ground, through the training of local staff and institutions on gender justice issues. It is crucial that such actors question those national policies that often inadvertently penalize women in the critical stages following an extreme climate event.

Moreover, even at the national level, most United Nations-affiliated countries have formally accepted gender mainstreaming and, the reporting requirement to bodies such as the Commission

on the Status of Women (CSW) and the Convention on the Elimination of All Forms of Discrimination against Women (CEDAW) creates vital spaces for discussion and monitoring. In this context, the global coordinating role of UN Women remains a pillar that cannot be underestimated. In parallel, the internal institutional architecture of many States is another key asset. Although these units are frequently underfunded or politically marginalized, they form the necessary basis for the dissemination of equality principles in the country, because they can collaborate with local partners through training and information dissemination programs, mobilize women's action groups at the territorial level and represent women's interests at grass-roots organizations, ensuring that their voice does not remain excluded from local decision-making processes.

1.3.1 Women's role in environmental movements and the issue of ecological distribution conflicts

To understand why climate policies and gender mainstreaming often fail, we need to deconstruct how we have historically defined "work." Women's contribution to the green economy is crucial precisely because their work is embodied - in that it cares for the biological needs of the human body throughout its life cycle- and embedded, because it is intrinsically linked to local ecosystems through subsistence, care, and maintenance tasks. Women's work is also associated with repetition and presence, because the tasks they take care of are repetitive and require their continuous presence and availability. Indeed, contrary to the modern narrative of man as the sole food procurer -breadwinner-, anthropological history reestablishes the image of the woman as a "bread maker". In studies of hunter-gatherer societies and early farming communities, it is clear that women's work was much more relevant than men's because it ensured survival through sowing, harvesting, and processing raw materials (Mellor, 2017).

However, modern economics does not relate directly to human labor, but only to valued labor; in this process, "masculinity" has been associated with market value, while female labor has been relegated to an unvalued economy, defined by rigid boundaries of space and time. Being a caregiving job, it requires physical proximity, forcing women close to home and limiting their opportunities in the global labor market. Instead, from a temporal perspective, women's work is unlimited, repetitive, and never-ending, active day and night, following the biological rhythms of the sick and children.

In contemporary societies with prosperous economies women are increasingly refusing to

undertake women's work; they are joining the economy at higher status levels, but it's still an economy that is already gendered and it represents a public world as defined by dominant men, based on male experience. From the perspective of an ecofeminist political economy it can be seen as a male-experience economy, a ME economy. Its ideal is an 'economic man', who may also be female. They are fit, mobile, able-bodied, unencumbered by domestic or other responsibilities. The goods appear to them as finished products or services and there is no responsibility for the life cycle of them. The ME-economy is disembodied from the daily cycle of the life of the body, from the human life cycle as expressed in women's work and from its ecosystem, because it is not limited by local growing seasons and ecological limits.

The basic ecofeminist case argues that this current system is erected on a false basis, having expelled the inconvenience of human existence, like vulnerability, the body and nature and entrusted it to women and non-western, non-commercial and non-white marginalized economies and populations. To overcome this dualism, ecofeminism argues that Green Economics must move from a narrow focus on market to the concept of "provisioning", which puts the satisfaction of human needs, including nourishment and emotional support, at the center (Nelson, 1993; Power, 2004). This means that a provisioning economy prioritizes the life cycles and rhythms of the ecosystem, the integration of production with the dynamics of the body and shared work, fulfilling and oriented to the concept of sufficiency.

1.3.2 The effect of climate change as a stress and vulnerability multiplier

As supported by the ecofeminist discourse, the current system and the climate change that follows pose a threat to human security in its entirety, but its effects are not evenly distributed. A central priority in the current debate is to ensure that policymakers understand the different types of vulnerabilities that women and men face. According to Robert Watson (IPCC), vulnerability is not just physical exposure to risk, but the extent to which a social or natural system is susceptible to harm, a condition closely linked to its sensitivity and limited capacity to adapt.

Women's specific vulnerability is rooted in pre-existing social and economic inequalities. As already stated, in many cultures, women's social positioning is confined to the reproductive and domestic spheres, making their contribution to the national and agricultural economy often invisible and devoid of public recognition. This asymmetry manifests itself in access to resources: women, despite being responsible for family subsistence, often have less control over land, money, and technical tools. Institutions, conditioned by gender bias, tend to identify the

farmer as a male figure, excluding women from access to credit and new drought-resistant agricultural technologies. As a result, the ability to adapt at home level—which depends on mobility, health and property rights—is severely compromised for women. In this context, long-term climate change alters ecosystems in complex ways and acts as a catalyst for poverty and inequity, altering power relations within communities and families: when natural resources are scarce, women's access to and control over them declines dramatically, leading to increasing marginalization.

However, a paradox arises in coping strategies because planners often assume that women should take a central role in environmental protection, based on the false assumption that they are "naturally closer to nature" (Nelson et al., 2002). This places a huge unpaid workload on them, exacerbating "time poverty" and limiting any opportunities for income generation or education.

Moreover, faced with severe resource scarcity, migration becomes the primary strategy for men, leaving women with the entire burden of agricultural production and family management. This excess of responsibility, combined with the need to resort to precarious wage labor, creates unsustainable psychophysical pressure, reinforcing the cycle of environmental degradation and poverty.

Specifically, the women in rural areas, being the main users of natural resources, suffer the most direct impact, in particular: energy poverty, since fuel scarcity forces an energy reduction for food preparation, leading to less nutritious meals and greater physical expenditure on wood harvesting; water scarcity, which leads to the interruption in girls educational journey as they are expected to help with increasingly time consuming household chores; health risks, caused by indoor pollution linked to usage of traditional fuels, to which rising temperatures and water contamination add up.

1.3.3 Women as agents of change: mitigation and adaptation

However, contrary to the narrative that sees them only as victims, women have proven to be leaders in community revitalization. In fact, in recent years, research has begun to question some established stereotypes. Arora-Jonsson (2011) and MacGregor (2010) warn of the risk of "iconizing" female poverty without truly exploring it. Simply seeing women as "climate victims" or the "world's poorest people" is reductive and risks ignoring the complex power relations that determine vulnerability.

The traditional configuration of gender roles imposes on women a cumulation of

responsibilities that unfolds within the home, the workplace, and the community dimension. This overload of demands generates a chronic shortage of time, which directly translates into limited political participation.

Without the material time for civic engagement, women often find themselves unable to actively influence decision-making processes that impact their lives, their environment, and their future aspirations, a situation further exacerbated by systemic gender biases. Moreover, an average lower level of education limits awareness of more advanced mitigation options, such as the use of energy-efficient devices.

Despite this political marginalization, in most societies women hold primary responsibility for managing household expenditures and consumption. This role gives them crucial decision-making power regarding the intensity of emissions of the assets used by the household. In particular, women have proven indispensable in disaster response, demonstrating extraordinary effectiveness in mobilizing social networks to meet the pressing needs of the community. Through these efforts, they develop new skills in agricultural and environmental management that, if incorporated into enabling regulatory frameworks, could transform into real income opportunities. They have also proved to be powerful agents of change: in mitigation actions, women are key actors in reducing emissions through adopting clean household energy sources and technologies, since they contribute substantially to their families' security of food, health, energy and shelter (Dankelman, 2010). Fuel combustion, improved stoves, biogas digesters and solar cookers are examples of many new cleaner fuels and more efficient energy solutions that can reduce emissions and provide other benefits to women: reducing indoor air pollution and freeing time they spent collecting and transporting biomass fuels to spend on new activities, such as education, production and economic advancement. These gender-specific skills - because of their different access to primary resources- are strategic components developed over the centuries through the profound interaction between populations and the environment.

Nonetheless, the responses of communities to the climate crisis are not uniform; they are closely dependent on the local ecological, social and cultural context. Moreover, it is crucial to note that many of the strategies adopted, while effective in the short term, are not intrinsically sustainable or free of social costs. When resources are scarce, families are forced to economize. This often results in drastic choices that fall on health and well-being: food products requiring reduced cooking times are switched to, the number of hot meals is limited, or boiling water is reduced, posing serious health risks (Dankelman, 2010). In this area, the introduction of energy-saving devices could offer a solution, but these technologies often fail because they are

implemented without consulting women, who are the real end users.

The picture gets complicated when we look at high-income countries. There is evidence that, where economic opportunities increase, women tend to adopt male-like lifestyles, leading to increased individual emissions (Lambrou & Piana, 2006). This suggests that access to resources is not sufficient unless accompanied by an increase in awareness and education. Hence, the application of gender budgeting methodologies represents a fundamental analytical tool for assessing, from a gender perspective, the cost-benefit ratio of different adaptation strategies. This approach allows us to verify the real impact of economic choices, ensuring that the priorities and needs of women belonging to the poorest groups are not ignored in decision-making processes.

Moreover, while leveraging local knowledge is a key pillar of climate action, adopting exclusively community-based approaches is not without conceptual, methodological, and policy challenges. Indeed, it is necessary to avoid an idealized vision that risks obscuring the internal power dynamics and responsibilities of higher levels of governance. Over-emphasis on the local dimension, to the detriment of the national or global dimension, can be problematic. This "localism" risks further marginalizing communities, putting disproportionate pressure on them. If responsibility for adaptation is delegated entirely to the micro level, it ends up relieving state and international institutions of their obligations to provide infrastructure, financial, and political support. Local adaptation must be supported by a multi-level governance framework so as not to become an unsustainable burden for the most vulnerable.

In particular, it is important to deconstruct the mythologized idea of "community" as a homogeneous and intrinsically inclusive entity. While being aware of the resources that women have in terms of adaptation and mitigation strategies, to assume that a local group always acts as a unitary bloc is to ignore the power asymmetries, internal hierarchies and conflicts of interest that run through it. Without a critical analysis of these dynamics, there is a risk of validating decisions that reflect only the priorities of local elites, ending up once again excluding the weakest subjects and the specific needs of women.

CHAPTER 2

The link between gender equality, energy poverty and climate action

This chapter explores the critical intersection between gender equality, energy poverty, and climate action, focusing specifically on how clean energy access can serve as a catalyst for sustainable development. The core focus is on how the adoption of Improved Cooking Stoves (ICS) and modern household appliances can simultaneously address energy efficiency, mitigate environmental degradation, and foster gender equity. Specifically, this chapter aims to answer several key questions: how does energy poverty disproportionately affect women through "time poverty," labor-intensive chores, and exposure to household air pollution; in what ways can clean cooking programs transition from treating women as passive beneficiaries to empowering them as active agents and entrepreneurs in the clean energy value chain and how can technological interventions be designed and implemented to ensure long-term socio-economic viability and cultural acceptance.

To answer these questions, the chapter is organized into three sections: the first one defines what constitutes an Improved Cookstove (ICS) and provides a comprehensive overview of its multidimensional health, socio-economic, and environmental impacts. The second section examines the empirical and qualitative evidence regarding how cleaner technologies affect women's daily schedules, intra-household decision-making, and financial independence. It also analyzes the necessity of female participation in the design, distribution, and maintenance of these technologies. The last one provides a comparative analysis of three distinct geographical interventions: the Upesi Project in Kenya, the introduction of the electric rice cooker in Nepal, and regional community trials in rural China. These case studies help us understand the key point that make a project efficient and effective.

2.1. The gender perspective of clean energy access: the issue of Clean Cooking

Energy is not a static entity, but it manifests itself in different forms and possesses the capacity to be converted from one to another through specific devices, such as diesel engines or

light bulbs. However, no conversion is perfect: some energy is always lost as heat. For this reason, technological efficiency is a primary objective for both the domestic economy and the environment. When it comes to the domestic economy, it is not simply a matter of technological availability. According to the energy services approach (ref), the effectiveness of a solution depends on the intersection of technology and non-technical factors such as reliability, physical accessibility, and affordability for the end user.

Energy sources can be classified based on their sustainability (renewable vs. fossil fuels) and ease of use (traditional vs. unconventional). While renewable energy technologies (RETs) are generally considered environmentally friendly, they are not without impacts: they can require large areas of land, affect watersheds, or interfere with bird migration routes. For this reason, the need for "appropriate technology" emerges: small-scale, labor-intensive, and easily repairable solutions that take into account the expertise and spare parts available nearby.

Currently, approximately 40% of the world's population still depends on solid fuels (traditional biomass, agricultural waste, and manure) to meet their basic needs. This is why the contemporary debate on energy cannot be limited to electricity generation or large industrial plants; it must penetrate the heart of homes, where energy services translate into a vital necessity: cooking.

Adopting an energy services approach means recognizing that a technology, no matter how advanced, is useless if it is not accessible, reliable, and culturally accepted by the end user.

For millennia, cooking has been synonymous with an open fire. Even today, the "three-stone" hearth is a daily reality for nearly 40% of the world's population. It's an extremely simple and cost-effective solution, but it comes with enormous human and environmental costs. Fueled by traditional biomass such as wood, agricultural waste, or manure, this method is inherently inefficient and generates incomplete combustion, releasing a lethal cocktail of carbon monoxide and particulate matter into homes. This indoor pollution isn't just a technical challenge, it's a global health crisis that disproportionately affects women and children, the primary victims of chronic respiratory and cardiovascular diseases.

In this context, Improved Cooking Stoves (ICS) have emerged as a key transformative tool. Designed to optimize heat and reduce smoke, these technologies can reduce fuel consumption by 30–60%. However, the challenge is not just technical. There are two main paths to change: making "clean what's available" (improving biomass stoves) or making "clean what's available" (promoting the switch to gas and electricity). Although LPG and electricity represent the gold standard for health, they are marked by a profound divide between urban and rural contexts.

Globally, although 83% of the urban population has access to clean technologies, in rural areas this percentage drops to 32%. This disparity is dramatic in sub-Saharan Africa: in the western part of the continent, for example, access drops dramatically from 12% in cities to a virtually nonexistent 1% in rural areas (Mazzorra et al., 2020).

A crucial element that often escapes purely economic analysis is the profound gender inequality inherent in energy management. In many societies, women are the household "energy managers," yet paradoxically, they have the least decision-making power over technology purchases. A woman can spend up to five hours a day gathering firewood and cooking, trapped in a "time poverty" that prevents her from studying or working. Yet, if the male head of the household controls the finances and views firewood gathering as free labor, he is unlikely to invest in a modern stove. The energy transition, therefore, must necessarily involve the political and economic empowerment of women, transforming them from passive subjects into active players in resource management.

The history of stove deployment programs teaches that simply designing a device in a lab isn't enough. Past failures often stem from a lack of attention to maintenance, the quality of local materials, and user preferences. Today, new initiatives like the Climate and Clean Air Coalition and projects linked to the Clean Development Mechanism are attempting to reverse this trend, linking the reduction of global emissions to local social benefits. It's not just about reducing CO₂ or black carbon to save the climate, but about restoring time, health, and dignity to communities. Specifically, lack of access to clean cooking solutions is experienced differently and more severely by women, due to their role as household energy managers in most low- and middle- income countries; women mainly suffer the associated burden of HAP, as during cooking time, they are more widely exposed to pollutants than men. In this regard, women are the principal beneficiaries of health co-benefits related to HAP reductions. In addition, the adoption of improved or clean cooking solutions reduces fuel consumption. This lowers the time needed for fuelwood collection and the associated cost when fuel is bought. Moreover, the adoption of these kinds of cooking solutions results in a reduction in cooking time.

Depending on the country, fuelwood collection and cooking time add up to an average of 5 h per day, provoking "time poverty", especially for women, which leads to a reduction in leisure time or opportunities for market employment, and reinforces gender inequality (Mazzorra et al., 2020).

2.1.1. What is an improved cookstove

Defining an "Improved Cookstove" (ICS) is a complex and relative undertaking, as it depends on the type of traditional stove being used, the design objectives, and economic viability. It is, in fact, an intrinsically relative concept, whose effectiveness and identity depend on the interaction of three critical factors: the type of traditional technology it is intended to replace, the specific objectives guiding the new design, and, last but not least, the degree of affordability for the end user.

As noted by the World Bank (2011), the term serves as an umbrella term for a wide range of devices; while the classic "three-stone" hearth is at the lowest level, technological evolution has led to the development of fixed brick-and-mortar models, often equipped with chimneys for smoke extraction. A stove can be considered improved if it achieves at least one of these three objectives: increasing energy efficiency (reducing fuel consumption), improving indoor air quality (removing smoke from living spaces), or reducing the physical fatigue associated with cooking.

In the early stages of development programs, in the 1980s, economic sustainability was the top priority. To ensure that even the poorest segments of the population could abandon open fires, extremely rudimentary models costing less than \$5 were promoted. The so-called "first-generation" (or legacy) improved stoves emerged as a direct response to the energy crisis of the 80s. At that time, the emphasis was almost exclusively on wood conservation and energy savings. These models featured closed combustion chambers and chimneys, often built by local craftsmen or family members.

However, the lack of technical standards and quality control made these devices less durable and, in many cases, not much more efficient than traditional systems.

From the 1990s, however, the paradigm started changing. With the emergence of a robust scientific literature on the harmful effects of indoor air pollution (IAP), the focus of design shifted toward health. It was understood that saving fuel was not enough: it was necessary to remove smoke from the living environment. This led to a second generation of stoves, more robust and made from durable materials. Although more expensive, these technologies began to offer greater ease of use, encouraging families to continue using them after the first few months.

Today, we are witnessing a further paradigm shift with "Advanced Biomass Cookstoves." Unlike their predecessors, these stoves are truly industrial products, the result of years of engineering research and materials testing. They exploit advanced physical principles, such as the

use of optimized grates, thermal insulation, and forced air flows (or gasification) to ensure near-complete combustion. The result is a device that not only consumes much less biomass, but drastically reduces toxic emissions, approaching gas or electric systems in performance.

Alongside these industrial solutions, the category of "Effective Improved Cookstoves" has developed. This represents a strategic middle ground: stoves that, while assembled on-site to reduce transportation costs and support the local economy, follow rigorous installation protocols and performance standards. This mix of different technologies—from gasification stoves to pellet or charcoal stoves—now constitutes a diversified portfolio of solutions, capable of adapting to the varying economic resources and geographical needs of the Global South. This push for technological excellence—which includes the use of advanced insulation, optimized grills, and forced airflow for clean combustion—now finds a key ally in new financing mechanisms. The fight against climate change has opened up previously inaccessible financial avenues for the home cooking sector. Climate-related funds, such as the Global Environment Facility (GEF) and the World Bank's Carbon Finance unit, are beginning to see the spread of advanced stoves as one of the most effective ways to reduce black carbon and deforestation. These financing models reduce the initial cost of the devices, making high-performance industrial stoves accessible even to low-income families.

However, the success of these innovations also depends on assessing the impact of these technologies, which requires understanding the sociocultural barriers that often impede their adoption, because needs vary dramatically between rural and urban populations, and across different geographic regions, innovation must be implemented heterogeneously: what is considered "improved" in a West African village might differ significantly from a standard adopted in rural China, where adoption has already reached 40% thanks to targeted national programs. Moreover, without an analysis that includes variables such as women's decision-making power and their level of education, even the most efficient stove risks remaining an object foreign to the daily reality of those who should use it.

2.1.2. Health impact

If, as analyzed in the previous section, the definition of an 'improved stove' lies in its ability to optimize combustion through design and materials, it is precisely the efficiency of this process that determines the reduction of pollutants released. The transition from an open hearth to a gasification or closed-chamber technology is therefore not just an engineering evolution, but a necessary precondition for modifying the biochemical profile of the home environment. This

technological transition finds its most urgent justification in the need to reduce exposure to that cocktail of toxic substances which, as we will see in this chapter, represents one of the main threats to global public health.

For over three billion people, the act of boiling water or cooking a meal means immersing themselves in a thick blanket of gray smoke that makes breathing unbearable (WHO 2006). The inefficient burning of wood, manure, and agricultural residues releases a cocktail of hundreds of chemicals: carbon monoxide, nitrogen oxides, benzene, formaldehyde, and polycyclic aromatic hydrocarbons. Where coal is used, the situation is compounded by the presence of even more insidious contaminants like arsenic and fluoride.

The most critical scientific indicator of this risk is fine particulate matter (PM_{2.5}), which can penetrate deep into the lungs, cause systemic inflammation, and compromise the immune response. Although the exact biological mechanisms are still being studied, exposure data are unequivocal: in rural homes across Africa, Asia, and Latin America, particulate matter levels can reach 10,000 g/m³ during peak hours, exposing women and children to a dose of pollutants comparable to smoking two packs of cigarettes a day.

The consequences of this chronic exposure are dramatic and widely documented by the World Health Organization (WHO, 2006). Inhaling indoor smoke doubles the risk of pneumonia in children under five and triples the likelihood of women developing chronic obstructive pulmonary disease (COPD). Scientific literature from the last fifteen years has also revealed worrying links with other diseases, including cataracts, cardiovascular disease, and lung cancer (the risk doubles with coal use).

Globally, this phenomenon is estimated to cause between 1.6 and 3.8 million premature deaths each year (Aktas, Poblete-Cazenave & Pachauri, 2022). The severity of this health burden has been quantified through comparative risk assessment (CRA) methods, which measure the impact not only in terms of deaths but also in years of life lost or lived with disability (DALYs). Randomized trials, such as the RESPIRE trial in Guatemala, confirm that the adoption of improved technologies, such as fireplace stoves, leads to an immediate and significant reduction in chronic respiratory symptoms.

However, one of the most complex obstacles to the energy transition is not technological, but cultural. In many village communities, conditions such as childhood respiratory infections or eye

irritations are not seen as medical anomalies, but as "normal" parts of daily life, linked to age-old practices like burning wood. There is often a discrepancy between Western science and local interpretations of health. For example, it is common to see ventilation holes in kitchens blocked with rags or bags to prevent the entry of cold air, believed to be the true cause of coughing, thus unintentionally trapping smoke inside.

Similarly, while women with tuberculosis perceive smoke as an aggravating factor, pregnant women often ignore the critical link between pollution and low birth weight. This "normalization" of risk sometimes also affects local healthcare workers, making the promotion of new technologies even more difficult (Clancy J. et al., 2020).

2.1.3. Socio-economic impact

The successful diffusion of advanced cooking technologies is not just an engineering feat; it represents a fundamental prerequisite for the socioeconomic development of rural areas. As analyzed, barriers to the adoption of Advanced Biomass Cookstoves are often rooted in family dynamics where decision-making power and financial control are unbalanced. However, overcoming these barriers triggers a virtuous cycle that transforms the economic structure of the family and, by extension, the entire community.

In this scenario, energy poverty is defined as the inability to access modern fuels and even basic electric lighting for productive or educational purposes (UNDP 2005). For the 2.5 billion people still dependent on biomass, this condition translates into an economic paradox: the poorest end up paying the highest price, not only in terms of money spent (a proportionally much higher share of income than the rich), but above all in terms of health, fatigue, and time lost for progress.

The most immediate connection between energy and development lies in restoring individual productivity. Currently, firewood collection and basic cooking processes are extremely time-intensive activities, performed primarily by women and children. The introduction of ICS directly addresses this time bottleneck. Reducing workload through efficient technologies means eliminating "time poverty," freeing up precious hours that can be reinvested in income-generating activities, micro-entrepreneurship, or vocational training.

This shift of time resources to the labor market is one of the most powerful drivers of local GDP growth in low-income countries, transforming a subsistence activity into an opportunity for economic empowerment.

The impact of ICS extends far beyond the present, profoundly shaping the prospects of future

generations. In contexts of energy scarcity, children—and especially girls—are often pulled out of school to help collect branches, dung, and agricultural residues. Technology that optimizes the use of biomass or facilitates the transition to modern fuels dramatically reduces the demand for child labor, promoting schooling. Children’s education is globally recognized as the investment with the highest social return: a more educated workforce is intrinsically more resilient and capable of breaking the intergenerational cycle of poverty. In this sense, the improved stove ceases to be a simple kitchen tool and becomes a technology for education and gender equality, since cooking and fuelwood collection are typically considered women’s tasks and the time gained from household drudgery thanks to ICS could be used in education, training and income-producing activities.

2.1.4. Environmental impact

Last but not least, access to energy becomes a survival strategy in a context in which climate change is already altering hydrological cycles, making rainfall variable and putting hydroelectric potential and biomass production at risk. In many rural areas of India, for example, decentralized diesel generators have allowed farmers to power irrigation pumps, ensuring crops even during droughts and improving access to information via television. However, this fossil-fuel-based adaptation creates a paradox, generating local pollution in previously pristine villages. (Gaye, 2007)

On the mitigation front, several countries have experimented with alternative pathways to reduce their domestic carbon footprint. Senegal, for example, has achieved significant success by promoting technology shifts through the removal of taxes on gas-fired equipment (LPG) and fuel price subsidies. However, until recently, the use of biomass for cooking was rarely a focus of climate policies, as it was considered an inherently renewable resource. Today, the scientific debate has shifted toward assessing the profound environmental impact of improved cookstoves as a primary intervention tool.

We now know that traditional, unsustainable wood harvesting accelerates deforestation and that inefficient combustion releases short-lived climate pollutants (SLCPs) such as methane and black carbon (BC), making the ecological footprint of domestic cooking a major global concern.

Indeed, the simultaneous control of long-lived greenhouse gases (CO₂) and SLCPs is considered essential to keeping global warming below 2°C. In this scenario, the deployment of a new generation of advanced biomass stoves could reduce CO₂ emissions by 25–50%. The use of

processed solid fuels, such as biomass pellets, allows for efficiencies similar to those of liquid or gaseous fuels, transforming a traditional resource into a modern, clean solution. In the long term, the goal of international technical and financial support must be to enable developing countries to make a technological leap directly to renewable sources (leapfrogging), avoiding a phase of high dependence on fossil fuels.

Virtuous examples are already emerging: from biomass generators in Southeast Asia to solar lanterns and stoves in Africa, to rooftop solar water tanks in China. These technologies demonstrate that it is possible to integrate health, social, and economic benefits with global climate protection. The challenge remains to scale these solutions, ensuring that they do not remain isolated experiments but become the standard for the billions of people still waiting for safe, clean, and affordable energy.

2.2. Quantitative and qualitative analysis: data on the gender impact

Analyzing the impact of energy transition on gender equality reveals that the transition to clean technologies is not a neutral process, but is profoundly influenced by intra-family power dynamics and socio-cultural norms.

To understand the true impact of energy technologies, it is first necessary to analyze the social context in which they are implemented. Scientific literature highlights how the management of household energy resources is far from gender-neutral: although both men and women participate in firewood collection, the primary burden of this work systematically falls on the latter.

This dynamic is not random, but rather reflects a combination of rigid cultural norms and a domestic economic rationality that tends to assign women a lower "opportunity cost" of time than men. In many contexts, in fact, women's work is not monetized, making the manual collection of biomass—however laborious—a seemingly "free" option for the household economy.

This condition creates a veritable "time poverty" that hinders any prospect of development. When fuel scarcity forces women and girls to dedicate entire days to gathering firewood, dung, or agricultural residues, a vicious cycle is triggered that severely impacts education. Girls, expected to help their mothers, end up dropping out of school, becoming less competitive in the labor market and thus perpetuating their dependence on gathering. A paradox is thus created: social norms that devalue women's time are internalized to the point that, even when women have decision-making power, they may not prioritize the adoption of new technologies,

perceiving themselves as an "unlimited" and low-cost resource.

Furthermore, control over household finances plays a discriminatory role. Often, male heads of households manage cash accounts and decide which goods to purchase; lacking specific sensitivity, they tend to ignore women's preferences or well-being, favoring investments that do not concern cooking or respiratory health. These cultural barriers translate into market imperfections: the constraint that prevents women from accessing paid work discourages families from switching from manual energy (wood) to purchased energy (such as LPG). Breaking this cycle therefore requires interventions that go beyond simply providing a stove, but that also influence women's perception of the value of their time and their participation in community decision-making processes.

The transition from the theoretical stage to the actual adoption of clean technology finds its crucial point in the product design phase. The data collected by Clean Cooking Alliance from EcoZoom projects in Kenya, Senegal and other four countries (Hart & Smith, 2013), demonstrates how the success of energy interventions depends not solely on the engineering performance of a stove, but on the design's ability to reflect the real needs and preferences of the women who will use it. Too often, manufacturers and designers have neglected to engage with end users, leading to the development of devices that, while efficient in the laboratory, are incompatible with local culinary practices, traditional cookware, or room heating and lighting requirements.

In this scenario, the model adopted by organizations like EcoZoom offers a fundamental methodological lesson through an approach that places women at the center of the entire development process. Through iterative cycles that begin with market needs analysis and progress through controlled cooking tests and extended home trials, prototypes can be modified without compromising thermal efficiency. A prime example is the project in Mexico, where direct feedback from women transformed an initial prototype into the "La Mera Mera" stove. This name, culturally reminiscent of the figure of the matriarch and wise woman, combined with structural modifications such as the ability to directly access the flame, has ensured exceptional adoption rates, ranging between 65% and 97%.

Qualitative analysis highlights how women's involvement in the design phase also helps overcome resistance to behavioral change (Hart & Smith, 2013). If a stove is perceived as difficult to use or if it alters the flavor of food, users will inevitably tend to return to traditional

methods. Conversely, when women actively participate in focus groups and field observations, technology ceases to be a foreign object imposed from above and becomes a tool capable of generating tangible savings in time and effort. Data from contexts as diverse as India and Nepal confirm that "accepted" technology can save about an hour a day in cooking and cleaning, allowing women to better manage their time and reducing "drudgery," the degrading and tiring domestic work that for centuries has limited their opportunities for emancipation.

The qualitative analysis of the energy transition finds its natural conclusion in the transition of women from simple users to active participants in the value chain. The data demonstrate that integrating women into production, financing, and distribution processes is not only an objective of equity, but an operational strategy that ensures the sustainability of projects over time. Although large-scale industrial production tends to exclude female labor, local stove manufacturing offers unique income opportunities, leveraging traditional skills such as ceramics. Case studies such as the GERES project in Cambodia and the Maasai Stoves & Solar project highlight how the creation of modeled production centers allows women to work flexible hours, balancing care duties with the production of technical components, thus transforming their homes into micro-enterprises.

However, production efficiency faces barriers of affordability. Clean stoves often find themselves in a financial gray area: too expensive for immediate purchase by poor families, but not profitable enough to attract commercial banks. Innovative financing models such as revolving loan funds or collective savings groups (WSCGs) step into this void. In India, organizations like Jagriti have demonstrated that, although women often lack formal financial guarantees, their reliability in repaying group loans is extremely high. These subsidized credit mechanisms allow women to overcome the initial cost obstacle, transforming a luxury good into an affordable investment that pays for itself through fuel savings.

The final step in this evolution is widespread distribution, the last mile between technology and rural users. Networks like those of the Sakhis in India or Solar Sister in East Africa leverage the potential of relationship marketing: a woman selling to another woman not only passes on a product, but also a

testament to trust and technical expertise. These entrepreneurs also become experts in after-sales service, ensuring device maintenance and repair, tasks traditionally reserved for men in many societies. When a woman acquires these technical skills and begins generating income, her social perception changes radically: her self-confidence increases, patriarchal norms are

challenged, and earnings are systematically reinvested in family well-being and their daughters' education, definitively breaking the link between energy poverty and social marginalization.

Another crucial step towards ensuring that the energy transition isn't just a temporary event, but a structural change, lies in after-sales service and ongoing maintenance of technologies. A historical limitation of many international programs has been the abandonment of improved stoves at the first technical failure, often due to a lack of spare parts or local repair expertise. In this context, the emergence of professionals like the Sakhis in India represents a systemic solution: these rural entrepreneurs go beyond sales, becoming true technical experts capable of offering assistance, managing warranties, and resolving operational issues directly at the "last mile" of distribution.

The effectiveness of this model relies on woman-to-woman communication, which breaks down cultural barriers in more conservative areas where the access of male technicians to homes may be limited. The introduction of innovative practices, such as the eight-day trial period offered by organizations like SURE, allows users to familiarize themselves with the technology under the guidance of an expert, transforming initial skepticism into an informed choice. However, despite the successes of networks like Grameen Shakti in Bangladesh or CEDESOL in Bolivia, the challenge remains immense due to the persistence of extreme poverty.

Macroeconomic data remind us that approximately half of the population in developing countries still depends entirely on biomass for daily subsistence. A critical aspect that emerges from the analysis is the slowness of the income-related transition: even with a doubling of average wages, dependence on solid fuels would only decrease by 16%. This means that, in the short and medium term, total substitution with modern fuels such as LPG or electricity remains a distant goal for millions of people.

It is therefore imperative to not only promote the transition to new energy sources, but also to improve the use of existing ones, focusing on programs that ensure the complete combustion of biomass. Only by integrating women's empowerment at every stage—from design to maintenance—is it possible to hope for a transition that is not only technologically advanced, but also socially sustainable and capable of withstanding the pressures of intergenerational poverty.

Despite these successes, the analysis must address an inescapable macroeconomic reality: the profound interconnection between biomass use and extreme poverty. Approximately half of the population in developing countries still depends on wood or agricultural residues. Statistical projections suggest that even a doubling of per capita income would reduce biomass dependence

by only 16%, confirming that millions of families will remain dependent on these resources for decades.

This awareness shifts the focus of energy policies: it is no longer sufficient to wait for a complete fuel substitution; it is imperative to implement programs that ensure the complete and clean combustion of existing biomass.

Organizations like Grameen Shakti in Bangladesh, which has distributed over 600,000 improved stoves, or CEDESOL in Bolivia, demonstrate that technological intervention can mitigate the devastating impacts of household air pollution (HAP) even where switching to gas or electricity is not yet economically viable. The energy transition, therefore, should not be viewed as a single, immediate leap, but as an incremental path that requires "hybrid" and technologically accessible solutions.

Ultimately, the evidence gathered through the various case studies underscores that the effectiveness of these solutions depends entirely on their social integration. Technology, no matter how advanced, cannot operate in a vacuum: it requires an empowering infrastructure that begins with participatory design and extends to comprehensive maintenance managed by local communities. Involving women in every segment of the value chain is not only a matter of social justice, but the only way to ensure the energy transition is resilient. Only by transforming users into strategic partners and entrepreneurs can we eradicate patterns of intergenerational poverty, ensuring a future in which access to clean and safe energy is a guaranteed right, regardless of the speed of national economic growth.

Ultimately, the examination of the supply chain demonstrates that gender impact is the underlying infrastructure of technological innovation. Modern energy acts as a catalyst for change only when accompanied by cross-sector policies that reduce transaction costs and increase women's bargaining power. When women stop being passive beneficiaries and become entrepreneurs, educators, and leaders, a transformation is triggered that goes far beyond reducing emissions. We are witnessing a renegotiation of gender roles that favors daughters' education, improves collective health, and restores dignity and economic autonomy to those who have long been confined to the margins of progress.

2.3. Case studies: Examples from Sub-Saharan Africa and South Asia

The evolution of Improved Cookstoves (ICS) programs has revealed that technological efficiency, if isolated from the socioeconomic context, does not guarantee long-term success. Many past projects were limited by an exclusively supply-driven approach: laboratory-designed stoves built with local materials lacking quality control tended to deteriorate in less than a year. Poor durability, combined with the lack of a maintenance network and effective analysis of consumer needs, often led to the abandonment of the technologies once initial funding ran out.

However, the perceived failure of some historic programs, such as the initial ones in India, has obscured valuable lessons that have enabled the emergence of a "new generation" of stoves. Today, the success of an energy intervention is measured by its ability to integrate market development, ongoing monitoring, and, above all, the active involvement of women not only as users but as entrepreneurs within the value chain.

The transition from laboratory models to next-generation stoves was not a linear process, but the result of a long learning curve. As discussed previously, the limitations of early programs—related to poor-quality materials and a purely supply-driven approach—led international organizations to reconsider the role of the end user. If technology is the driving force behind the energy transition, women's involvement is the necessary path. The failure of legacy programs has demonstrated that a stove, no matter how efficient, won't be adopted unless it meets the real needs of those who use it daily.

To understand how these lessons were translated into effective practices, the following sections will analyze several geographical case studies. These examples illustrate how local contexts have shaped different technological solutions and business models, all united by the pursuit of a lasting impact on health and household income. Specifically, three projects were chosen: the Upesi project in Kenya allows for the examination of a model that has successfully combined technological effectiveness with long-term social and economic sustainability. The Upesi initiative stands out as an international benchmark—a targeted intervention focused on household energy efficiency that acts as a catalyst for women's empowerment, offering valuable lessons that can be replicated in other developing contexts. While the case of Kenya illustrates the optimization of biomass use through improved technology, the context of Nepal allows us to take a significant step forward by examining the direct impact of household electrification—specifically through the introduction of one particular appliance: the electric rice cooker. The

analysis of Nepal demonstrates that technology can drastically alleviate daily drudgery and free up valuable time for women, even without immediately dismantling pre-existing gender hierarchies. It thus serves as a perfect example of how a small material change can act as a gradual catalyst and a "gateway" to deeper social and economic modernization.

Last but not least, the focus on rural China allows for the completion of this research by introducing an essential scientific and methodological perspective. Indeed, the Chinese case enables us to analyze the complex interdependence among personalized technology, user behavior, and public health. It demonstrates the effectiveness of flexible, tailored engineering solutions designed around actual climatic, residential, and geographical needs, and highlights the limitations of relying solely on educational and behavioral programs without a qualitative leap in technology and infrastructure.

Kenya

The first case study is the Upesi Project in Kenya, which has a well-established international reputation for developing and promoting efficient cooking technologies. In a country where 85% of the population lives in rural areas and biomass meets 93% of household energy needs, improving thermal efficiency is not only an ecological choice but also a resilience strategy against the impacts of climate change on timber production. The Upesi Project, launched in 1995 by the Intermediate Technology Development Group (ITDG), represents the evolution of this approach, designed to meet the specific needs of rural families who could not afford more expensive urban models like the Kenya Ceramic Jiko.

The technical success of the Upesi stove is measurable: compared to the traditional "three-stone" fireplace, this technology reduces wood consumption by 40% (about 90 kg less per month per family) and reduces smoke emissions by 60%. This efficiency translates into immediate health and household savings, leading to an estimated annual savings of over \$100 due to less fuel purchase or collection. For women, the most significant benefit is the time savings—about 10 hours per month—previously spent gathering wood and cooking, thus alleviating the pressure of energy scarcity.

The true strength of the Upesi project, however, lies in its social architecture. Unlike many purely welfare programs, Upesi focused on marketing and local entrepreneurship. By involving women's groups from the design and testing phases, the project ensured an extremely precise problem-solution fit. The women were trained not only in the installation but also in the entire supply chain: from ceramic production to marketing, from business plan management to access to

credit.

This activity provided an unprecedented form of economic liberation: the participating producers earned approximately twenty times the average rural annual wage, significantly contributing to food security and family income.

The project's sustainability was ensured by an affordable market price—comparable to the cost of a bunch of bananas or a chicken—which allowed for widespread distribution of over 16,000 units in the initial districts involved, becoming a model replicated nationwide with 1.8 million stoves produced.

On a larger scale, the Kenyan case confirms the principle expressed by the UNDP (2000), according to which it is generally cheaper to conserve an existing unit of energy than to produce a new one. Energy efficiency of end devices, such as ICS stoves, appears to be the most cost-effective method for providing essential energy services.

Furthermore, the project emphasizes that income generation is the most powerful incentive for promoting environmental conservation behaviors. As evidenced by a comparison of programs in China and India (Nathan, 1997), where women have limited opportunities for financial gain, the incentive to reduce the time spent collecting firewood through the adoption of new stoves is minimal. In contrast, the Upesi model has demonstrated that when time savings are coupled with real economic opportunities, the energy transition becomes an unstoppable driver of rural development, forest conservation, and public health.

Nepal

The second focus is on Nepal. This case study offers a fascinating perspective on how the introduction of a single appliance, the electric rice cooker, can trigger a micro-revolution in household time management and women's well-being, without immediately dismantling pre-existing gender hierarchies.

In Nepal, the adoption of the rice cooker has produced tangible and immediate benefits. First, it has drastically reduced dependence on gathering firewood and pine cones, reducing physical effort and the time spent gathering fuel. Unlike traditional stoves, the rice cooker ensures a healthier cooking environment thanks to the total absence of soot; this not only improves respiratory health but also reduces household workload, as women find themselves having to wash fewer dishes and clean smoke-blackened walls less frequently.

A key innovation is the "autonomous" nature of the technology: by being able to leave food

unattended while it cooks without the risk of burning it or having to stoke the fire, Nepalese women can simultaneously devote themselves to other chores or caregiving activities. This phenomenon recalls what happened in rural Japan in the 1950s, where the rice cooker had a "revolutionary" impact on women's daily lives, even greater than that of more expensive appliances like televisions or refrigerators.

From a sociological perspective, however, the Nepalese case calls for careful consideration. Although the rice cooker generates an undeniable time saving and a reduction in "drudgery" (drudgery), research observes that this change cannot yet be defined as "transformative" in the strict sense, as it has not led to an immediate renegotiation of gender roles or power relations within the family. The management of this freed-up time often remains confined within the confines of traditional domestic responsibilities.

Nonetheless, from a long-term perspective, the rice cooker acts as a gateway to broader modernization. The accumulation of small time savings, combined with the adoption of other appliances and the growing participation of women in income-generating roles, can create the structural foundations for a profound and lasting shift in gender dynamics. The rice cooker, therefore, is not just a cooking tool, but a catalyst for convenience that paves the way for future socioeconomic emancipation.

China

The last case study, of rural China, based on one of the first community trials conducted in 2002, offers a fundamental analysis of the interdependence between technological innovation, user insights, and behavioral change. The primary objective of the intervention was to address household air pollution through a multisectoral perspective, assessing the cultural and organizational feasibility of customized solutions for the provinces of Guizhou, Shaanxi, Gansu, and Inner Mongolia.

Unlike standardized programs, the technological intervention was tailored to specific local needs and the prevailing fuel types: in Guizhou, attention was focused on optimizing the flow of smoke and heat in steel and cast iron stoves, improving ducting to the chimney. In Shaanxi and Gansu, the project introduced improved flue systems for brick stoves and heated beds, essential for cold climates. In Inner Mongolia, the intervention included the physical separation between the sleeping area and the stove, integrating exhaust fans to compensate for the poor natural ventilation in homes. The study's design allowed for a comparison of the effectiveness of

different approaches by dividing participants into groups based on a combination of technology and behavioral training. The results showed that households equipped with new stoves and ventilation systems experienced the most significant reductions in particulate matter (PM) and carbon monoxide (CO), with fuel consumption reductions ranging between 30% and 50%. A particularly significant scientific finding emerged from the comparison between measurements in the home environment and those under controlled conditions: the latter showed 13-15% greater reductions in pollutants, highlighting how the operator's technical skill is a key variable in stove performance.

In conclusion, the Chinese experience highlights a crucial political and clinical lesson: although health education is essential, it alone cannot produce significant reductions in household pollution without the support of superior technology. The success of the intervention therefore depends on the essential synergy between climate-appropriate engineering design (cooking vs. heating) and the adoption of integrated ventilation systems, confirming that improving rural public health necessarily requires replacing inefficient combustion technologies.

In conclusion, this chapter highlights how the intersection of technology, gender, and environmental policy is essential for achieving sustainable and equitable development. Energy poverty is not a neutral or purely technical issue, because women in low- and middle-income countries primarily bear the domestic burden of biomass collection and cooking, they suffer disproportionately from "time poverty" and the lethal health impacts of Household Air Pollution. While transitioning to clean modern energies (like LPG and electricity) remains the gold standard, the slow pace of macroeconomic transition means that billions will rely on biomass for decades. Therefore, clean cooking policies must simultaneously promote fuel switching and improve the thermal and combustion efficiency of existing biomass through advanced stoves.

Moreover, the case studies demonstrated that designing a technology in a laboratory is insufficient if it is not culturally accepted, affordable, and adapted to local cooking, heating, and regional architectural needs. Effective interventions require iterative, participatory designs that put women's feedback and needs at the center of prototype development. Indeed, to unlock the transformative potential of clean energy, women must transition from being passive users to active participants in the entire value chain. Involving women in local manufacturing, leveraging relationship-based distribution networks and offering targeted micro-finance mechanisms are the most effective ways to ensure project sustainability and economic liberation.

However, the transition to cleaner, automated, or more efficient appliances (such as the

electric rice cooker in Nepal), that dramatically reduces physical drudgery and frees up time, does not automatically translate into economic empowerment or renegotiated gender roles unless accompanied by broader cross-sectoral policies that address traditional patriarchal norms, education, and access to income-generating opportunities.

CHAPTER 3

Policy Framework at International and National level

The path to sustainable development cannot ignore an integrated vision that places equity and institutional effectiveness at its core. The domestic energy transition landscape today hinges on a complex interplay between international mandates and national sovereignty and at the heart of this balance are three strategic objectives that serve as a compass for governments and NGOs: the need to institutionalize women's participation in decision-making processes, the structural integration of gender perspectives into development agendas, and the creation of robust monitoring systems to assess the effectiveness of environmental policies. These pillars are not merely theoretical statements, but represent the foundation for transforming global commitments into concrete actions at the local level.

This configuration is part of a complex framework of international and regional legal instruments that seek to structure the historically fractured relationship between environmental regimes and gender issues; although binding treaties that unequivocally define this interconnection are still lacking, we are witnessing a gradual shift.

For decades, international environmental law and gender policies were treated as distinct fields. Environmental law initially emerged to address the transboundary challenges of industrialization (such as the pollution of rivers and landscapes), developing standards and principles that, however, ignored gender perspectives. In this context, theoretical contributions such as ecofeminism long remained marginalized in institutional debate.

The fundamental turning point occurred between the late 1990s and early 2000s, with the Fourth World Conference on Women in Beijing (1995). The Beijing Platform for Action (BPfA) represented a milestone, debunking the role of women and recognizing their essential importance in natural resource management and ecological development. This shift laid the foundation for the three strategic objectives that guide governments and NGOs today: women's active participation in decision-making processes, integrating gender perspectives into development programs, and strengthening monitoring mechanisms.

At the national level, the translation of these international principles is manifested through a mix of regulatory and financial instruments. However, the effectiveness of these policies is often limited by a structural gap. Without accurate information, it is difficult for policy makers and judicial bodies to formulate interventions that respond to the reality of the facts.

This is why this chapter aims to analyze the regulatory and strategic framework governing the intersection of gender equity, environmental sustainability, and the energy transition. The primary objective is to trace the evolution of governance models and public policies, highlighting how principles developed at the international level are adopted and adapted at regional and national levels. Through a comparative examination of hard and soft law instruments—as well as the active role played by civil society and the private sector—the chapter seeks to map the points of convergence and the implementation gaps that still characterize the landscape of environmental and gender policies.

The analysis conducted in this section serves as the essential theoretical and regulatory foundation for understanding and evaluating operational dynamics in the field. Specifically, the theoretical and legislative framework outlined in this chapter will provide the necessary insights for the subsequent examination of case studies focused on Uganda and Kenya. The analysis of these national contexts—developed in the following chapter—will make it possible to verify in concrete terms how these strategic directives and regulatory constraints translate into actual projects, impacting local communities and women's empowerment in sub-Saharan Africa.

Firstly, the first paragraphs will offer a comparative analysis at the international level between gender and environment both from the hard and soft law regimes. Secondly, the following paragraphs will focus on the regional and national level of the Sub-Saharan Africa area. Finally, the analysis will shift to the role of the private sector and the civil society and it will focus on the convergences and gaps in the policy landscape.

3.1. International norms related to gender equality and environment

Within the framework of international law, a preliminary and fundamental distinction for understanding the integration of gender perspectives into environmental policies is that between hard law and soft law instruments. This dichotomy not only reflects a difference in legal form, but also outlines an action strategy that has helped fill, over the decades, the structural gaps in the original treaties.

Hard law encompasses all those instruments, such as treaties, conventions, and international

agreements, that impose precise and legally enforceable legal obligations on signatory states. Despite their coercive force, these instruments often exhibit a rigidity that makes them difficult to negotiate, especially when they address cross-cutting and complex issues such as the nexus between human rights, the environment, and gender equality. To date, there is still a lack of a single global hard law instrument that can harmoniously synthesize these three elements into a unified and binding regulatory framework.

On the other hand, soft law consists of declarations, resolutions, guidelines, and action plans that, while not legally binding, exert significant political and moral pressure. The relevance of soft law in this context is twofold: firstly, it serves as a legal laboratory; being easier to negotiate than a treaty, it allows states to reach consensus on emerging issues (such as the disproportionate impact of climate change on women) without having to immediately undertake lengthy and complex national ratification processes. Secondly, it acts as a precursor to customary law: when soft law principles are widely adopted and followed by consistent state practice, they can crystallize into customary norms or be subsequently incorporated into new binding treaties.

In this sense, soft law has been the driving force behind regulatory evolution: whereas the original treaties of the 1990s (such as the United Nations Framework Convention on Climate Change - UNFCCC) were silent on the role of women, it was precisely the non-binding resolutions and action programmes that paved the way for gender mainstreaming, transforming an initially marginal issue into a fundamental pillar of modern climate policies, as highlighted more recently by the Paris Agreement.

As regards to hard law instruments, although awareness of the transversality of gender is a relatively recent acquisition, its path can be traced back to three fundamental normative pillars: CEDAW, the Convention on Biological Diversity and the Convention to Combat Desertification.

In the strictly human rights context, CEDAW (Convention on the Elimination of All Forms of Discrimination against Women, 1979) represents the global "bill of women's rights." Although its original text contained no explicit reference to environmental issues, the "living" nature of this instrument has allowed for significant interpretative evolution. Through the General Recommendations of its Committee, CEDAW has begun to recognize that climate change and environmental degradation are not gender-neutral phenomena, but tend to exacerbate pre-existing discrimination. In particular, the critical link between women's health, access to natural resources, and the vulnerability of rural women has been highlighted, elevating environmental

protection to a necessary condition for the full enjoyment of women's rights.

Turning to international environmental law, a turning point with the past was marked by the Convention on Biological Diversity (UNCBD, 1992). This treaty was among the first to formally recognize in its Preamble the "vital role" women play in the conservation and sustainable use of biodiversity. This recognition is not merely symbolic, but affirms the need to ensure effective female participation at all levels of decision-making regarding ecosystem protection.

An even more forceful approach is found in the Convention to Combat Desertification (UNCCD, 1994). This instrument stands out among hard law instruments as the only one containing operational provisions obliging states to promote the equal participation of women in action programs to combat land degradation. The Convention directly addresses the socioeconomic dimension of the problem, recognizing that combating desertification and poverty in arid zones cannot be successful without strengthening the role of women, who are often custodians of traditional knowledge and responsible for the day-to-day management of water and land resources.

While an analysis of these first three pillars demonstrates that environmental and human rights "hard law" had already begun to chart a path—albeit unevenly—toward integrating the gender dimension, this same trajectory did not automatically or immediately translate to the regulatory sector that is now most crucial to global governance: that of global warming. The link between gender and ecosystem protection—already established in strategies to combat desertification or preserve biodiversity—struggled for decades to gain a foothold in climate negotiations. Indeed, the evolution of climate regulation serves as a prime case study of how the initial rigidity of binding instruments required a long, multi-layered process of "soft law" to dismantle a purely technocratic approach.

The international legal architecture on climate has undergone a profound transformation, moving from an initial phase of gender neutrality (or rather, "blindness") to a recognition of its centrality to the effectiveness of mitigation and adaptation strategies. This process unfolds through three key stages that reflect the shift in global political and legal consciousness.

The starting point is the 1992 United Nations Framework Convention on Climate Change (UNFCCC). Despite its historic importance, the original text of the Convention contained no explicit reference to women or gender inequality. At that stage, climate change was interpreted almost exclusively as a technical and scientific challenge related to greenhouse gas concentrations, neglecting the social and human dimensions that determine differential

vulnerability between men and women.

This gap remained evident in the Kyoto Protocol (1997). Despite introducing binding emission reduction obligations for industrialized countries (the so-called Annex I countries), the Protocol failed to recognize the gender dimension in its implementation. The approach focused on market mechanisms and technological development, ignoring how mitigation policies might impact gender differentially or how women's participation could strengthen the resilience of local communities.

The true paradigm shift occurred with the Paris Agreement (2015). Although the term "gender" does not appear frequently in the text, its inclusion in the Preamble and key articles marks a historic step forward. The Agreement establishes that States, in taking action to combat climate change, must respect and promote their obligations regarding gender equality and women's empowerment. For the first time, the gender dimension is integrated into critical areas such as adaptation (Article 7) and capacity-building (Article 11), recognizing that adaptation strategies must be guided by participatory and transparent approaches that take into account vulnerable groups.

However, the shift brought about by the Paris Agreement and the gradual overcoming of "gender blindness" in binding climate treaties cannot be fully understood in isolation from the broader global negotiating context. This milestone in climate "hard law" is, in fact, the result of a long, parallel process of political maturation that found its ideal environment elsewhere. If it took over twenty years for core climate treaties to institutionalize the gender perspective, it is because the key concepts, language, and necessary political consensus were first tested, debated, and formalized within a different normative framework—one characterized by greater flexibility and capacity for experimentation.

While hard law instruments define states' formal obligations, it is in the field of soft law that the most dynamic conceptual development of the gender-environment nexus has taken place. Through declarations, action plans, and non-binding resolutions, the international community has been able to experiment with new approaches and define standards that have progressively influenced national legislation and subsequent treaties.

The first real turning point in this journey was the Rio Conference on Environment and Development (1992). On that occasion, the Rio Declaration established, in Principle 20, a then-avant-garde concept: women's participation is a "fundamental" element for achieving sustainable development. At the same time, Agenda 21, the action plan that emerged from the Conference,

dedicated an entire chapter (Chapter 24) to global strategies for women, emphasizing the need to eliminate the constitutional, legal, and socioeconomic barriers that prevent their full participation in environmental management.

A few years later, the Beijing Declaration (1995) further consolidated this trajectory. Identifying "Women and the Environment" as one of twelve critical areas for intervention, the Beijing Platform for Action emphasized women's health in the face of environmental risks and the need to integrate women into decision-making structures. This document marked the shift from a vision of women as mere beneficiaries to one of active political actors.

More recently, the evolution of soft law culminated in the adoption of the 2030 Agenda for Sustainable Development. Unlike the previous Millennium Development Goals (MDGs), where gender was limited to a few indicators, the 17 Sustainable Development Goals (SDGs) adopt a mainstreaming approach.

SDG 5, dedicated to gender equality, interacts directly with SDG 13 (Climate Action) and SDG 15 (Life on Land), creating an integrated framework for action.

In conclusion, the importance of these soft law instruments lies in their ability to act as a "critical conscience" of international law. While they do not provide sanctions for non-compliance, they have built such a strong global consensus that it is now essential for any state to include a gender perspective in its sustainability and environmental protection policies.

This solid transnational consensus and the conceptual evolution driven by global summits have laid the groundwork for the contemporary era of environmental governance. The "critical awareness" fostered by soft law has necessitated a shift in momentum: once gender blindness was dismantled at the theoretical level, the challenge for international law moved from political rhetoric to pragmatic implementation. The recognition—in principle—of the interconnection between women and planetary protection has thus paved the way for a radically new phase, in which the gender dimension ceases to be merely an idealistic statement and transforms into a technical, methodological, and binding pillar essential to the actual effectiveness of climate strategies on the ground.

The latest phase in the evolution of the gender-environment nexus is characterized by a fundamental transition: the shift from formal recognition of rights to their operational implementation. In recent years, the UNFCCC mechanisms and resolutions of international organizations have moved beyond considering gender as a purely ethical issue, transforming it into a technical and methodological requirement for effective climate policies.

A turning point in this regard was the Lima Work Programme on Gender (LWPG), established at COP 20 and subsequently strengthened. Its primary objective is to promote gender balance in national delegations and ensure that climate policies are informed by systematic gender analysis. This process led to the adoption of the first Gender Action Plan (GAP) at COP 23, which was subsequently renewed and expanded at COP 25 in Madrid. The GAP is not simply a document of intent, but an operational tool that articulates action across five priority areas: capacity building, knowledge management, communication, balanced participation, and monitoring results. The existence of a specific action plan demonstrates that gender equality is now considered a key factor in the success of any mitigation strategy.

At the same time, a decisive contribution came from the United Nations Human Rights Council, which between 2017 and 2018 adopted key resolutions regarding the impact of climate change on women's enjoyment of human rights. These documents introduced a fundamental narrative shift: women were no longer portrayed exclusively as "vulnerable victims" of environmental disasters—a vision that risked diminishing their autonomy—but as "agents of change."

This new approach recognizes that women possess unique skills and traditional knowledge that are crucial for the sustainable management of resources and innovation in adaptation strategies. The current challenge, highlighted by recent developments, therefore concerns not only protecting women from environmental risks, but also their active and equal inclusion in global decision-making processes. In conclusion, the normative trajectory analyzed demonstrates that integrating a gender perspective is not an optional extra, but rather an essential prerequisite for effective, equitable, and sustainable climate governance.

3.2. Regional and national level policies: a comparative analysis of the selected policies

To fully grasp the significance of major international agreements, one must examine how they are adopted and adapted within regional governance frameworks. In this regard, the African context offers one of the most dynamic examples of regulatory adaptation. As the focus shifts from the global to the continental level, attention has turned toward a development model that intertwines rights, the ecological transition, and infrastructure. The following section outlines this process, demonstrating how regional policies are seeking to overcome the continent's historical fragmentation by prioritizing three key factors: the central role of women in decision-making, climate risk management, and the creation of an integrated energy market.

3.2.1. Regional policies

African regional policies on gender equality have indeed undergone a profound transformation, evolving from an approach based on the protection of fundamental human rights to a strategy of integrated economic and political empowerment. The starting point remains the African Charter on Human and Peoples' Rights—which establishes the principle of non-discrimination in Articles 2 and 3—but the African Union Strategy for Gender Equality and Women's Empowerment (GEWE) 2018–2028 defines a multisectoral action plan. This strategy is structured around four pillars: the "technological dividend" (E-Tech), aimed at bridging the gender digital divide; dignity and security, with a particular focus on reproductive health and combating violence against women and girls (VAWG); and institutional effectiveness and leadership. At the sub-regional level, the SADC Protocol on Gender and Development (2008) represented one of the first and boldest operational instruments, introducing binding numerical targets (such as a 50% quota for women in decision-making positions) and legislative obligations to harmonize customary law with international treaties. This framework is now complemented by the decisive action of the Intergovernmental Authority on Development (IGAD) through its IGAD Regional Gender Equality Strategy 2023–2030.

This strategy stems from the recognition that the normative standards established in the past—such as those of the Beijing Declaration and the Sustainable Development Goals (SDGs)—have so far been met only partially, leaving effective implementation as the primary challenge for the continent.

The IGAD approach recognizes gender equality as a fundamental prerequisite for the socio-economic development and political transformation of member states, focusing on seven strategic priorities: equitable access to agriculture and natural resources; the elimination of disparities regarding control over land and finance; and increased female participation in peace, security, and governance processes. The goal is no longer merely the protection of women, but their participation as "agents of transformation" essential to achieving Aspiration 6 of the African Union's Agenda 2063.

Although Africa contributes less than 4% of global greenhouse gas emissions, it stands on the front lines of the impacts of global warming. The regional response, enshrined in the African Union Climate Change and Resilient Development Strategy and Action Plan (2022–2032), aims to turn this challenge into a development opportunity. The strategy emphasizes adaptive capacity and risk management, recognizing the critical link between the climate emergency and political stability (the climate-conflict nexus). In the most fragile territories—such as the Arid and Semi-

Arid Lands (ASALs) of East Africa monitored by IGAD—competition for scarce resources driven by climate change fuels insecurity and conflict, affecting men, women, boys, and girls in profoundly different ways. The culmination of this policy trajectory is the Nairobi Declaration (2023), which marks a break with the past: African leaders no longer present themselves merely as aid recipients, but as global partners possessing the critical resources—minerals for green technologies and vast carbon sinks—needed for global decarbonization. The Declaration calls for a structural reform of the global financial system, proposing a global carbon tax and mechanisms to lower the cost of capital in order to mobilize the \$3 trillion required to implement national climate plans (NDCs) by 2030.

The energy sector is where the true challenge of continental integration lies. The African Single Electricity Market (AfSEM), supported by the Roadmap 2040, aims to overcome the fragmentation of national markets to create the world's largest integrated electricity market. This process relies on integrating the five regional "Power Pools" and harmonizing regulatory frameworks to facilitate cross-border energy trade. The physical architecture of this project is defined by the Programme for Infrastructure Development in Africa (PIDA), whose Priority Action Plan (PAP) allocates over 60% of its funds to energy projects, including "electricity highways" and large-scale hydroelectric complexes. In parallel, the Africa Renewable Energy Initiative (AREI) is driving a transition that allows the continent to leapfrog the fossil fuel stage, targeting a clean energy capacity of 300 GW by 2030. This vision is coordinated by the African Energy Commission (AFREC), which manages the continental energy database and fosters local capacity building, ensuring that electrification serves not merely as a technical goal but as a tool for environmental conservation and autonomous industrial development.

An analysis of regional policies reveals a fundamental interdependence: there can be no climate resilience without a renewable-based energy transition, and such a transition cannot be effective without gender mainstreaming.

Women—as the primary managers of household energy and guardians of community food and nutritional security—stand at the heart of Africa's climate action. To fully unlock their potential, new strategies—such as that of the IGAD—highlight the need to move beyond "business-as-usual" models and resolutely address the root causes of gender inequality by dismantling the social, institutional, and legal barriers that limit autonomy. The integration of these three pillars—gender justice, green growth, and energy sovereignty—forms the backbone of the African Union's new development strategy, which aims to ensure that technological and

infrastructural progress translates into a tangible, inclusive, and peaceful improvement in the quality of life for the continent's entire population.

3.2.2. National Policies

The effectiveness of the international agendas and regional protocols examined thus far is inevitably measured by the ability of local governments to translate principles into binding legislation. In this context, the experiences of Uganda and Kenya are particularly significant for analyzing the viability of this transition. Both countries serve as crucial hubs for the region, playing a key role in the push for energy transition and in managing climate-related and social vulnerabilities. The following section reviews their respective national policy frameworks, outlining the regulatory context in which the concrete projects and initiatives—the focus of the next chapter—have taken shape.

3.2.2.1. Ugandan policies

Uganda's policy strategies outline a highly integrated, multisectoral approach aimed at modernizing the national energy system, driving ambitious climate action, and dismantling the deep-seated structural gender inequalities that hinder the country's development. The current Ugandan landscape is marked by severe ecological and social vulnerability: approximately 90.5% of total primary energy consumption still relies on traditional biomass sources, such as firewood and charcoal. This outdated energy model not only drives massive, unsustainable deforestation—estimated at 50,000 hectares annually, with a 2.6% rate that threatens to wipe out the country's forest cover in under 25 years—but also causes devastating health and social impacts, accounting for 8.2% of child mortality due to emissions and household pollution. To address these critical issues and facilitate the transition from a subsistence agriculture-based economy to a modern, industrial, middle-income society, the government has aligned its planning with the "Uganda Vision 2040" strategic initiative and the National Development Plan (NDP) III.

The overarching goal is to achieve universal access to sustainable, high-quality energy services by 2040. To this end, and in line with African regional energy guidelines—particularly the Africa Renewable Energy Initiative (AREI) and the Intergovernmental Authority on Development (IGAD) strategy—the Ministry of Energy has planned a major diversification of the energy mix under the NDP III. This mix has historically relied on hydropower and was consequently exposed to significant climate-related vulnerabilities, such as prolonged droughts

and floods. The new projection for 2040 targets a total capacity of over 52,000 MW, incorporating and combining nuclear power (accounting for 48% of the mix), solar (20%), geothermal energy, green hydrogen, and waste-to-energy systems. At the same time, because extending the central national grid to remote rural areas is often economically unfeasible, Uganda applies regional decentralized energy models by focusing decisively on developing isolated mini-grids and Solar Home Systems.

Regarding environmental sustainability and mitigation, Uganda has committed to reducing its greenhouse gas emissions by 22% by 2030 compared to the "business-as-usual" scenario. Although the country's global contribution to emissions is minimal (just 0.099%), climate action is considered a top priority for safeguarding the population. The National Adaptation Programme of Action (NAPA) and the Nationally Determined Contributions (NDCs) focus particularly on protecting rain-fed agriculture—upon which 80% of Ugandans depend—through Climate-Smart Agriculture (CSA) programs and integrated early-warning weather systems. In this context, although women constitute over 70% of the agricultural workforce in Uganda, only 25.5% have effective control over the land they cultivate. Here, the United Nations Convention to Combat Desertification (UNCCD)—the only hard law instrument that expressly binds States to guarantee equal access to resources—together with the recommendations of the CEDAW Committee, provides the necessary normative backing to support CSA programs and protect rural communities within the framework of Uganda Vision 2040. Furthermore, in the transport sector—which currently consumes 90% of imported petroleum products—policy measures are introducing legal frameworks to promote the transition to electric and hybrid mobility. To ensure the preservation of ecosystems, all new energy infrastructure must undergo rigorous Environmental and Social Impact Assessments (ESIAs) approved by the National Environment Management Authority (NEMA).

The success of this massive ecological and energy transformation is strategically linked to policies on gender equality and social inclusion. Through the systematic adoption of gender and equity mainstreaming, institutions acknowledge that existing disparities severely limit the ability of women and girls to participate in development programs and reap their benefits.

Conceptual momentum to move beyond a purely welfare-based approach has been provided by international soft law instruments, such as the Beijing Platform for Action (1995) and the 2030 Agenda (specifically SDGs 5, 13, and 15). Ugandan women represent a deeply vulnerable group: they face severe "time poverty" due to a daily domestic and agricultural workload ranging from 12 to 18 hours. Furthermore, they are exposed daily to toxic combustion fumes and face a

high risk of gender-based violence (GBV) during long treks to gather firewood.

Uganda has integrated these global principles into the primary policy framework outlined in the Uganda Gender Policy (UGP), which combines the "Women in Development" (WID) approach—focused on interventions to improve women's material conditions—with the "Gender and Development" (GAD) approach, aimed at dismantling asymmetrical power relations and macroeconomic constraints. Mirroring the UN Human Rights Council (UNHRC) resolutions and the Lima Work Programme on Gender (LWPG)—which promote women as active "agents of change"—national policies in the energy sector translate into incentivizing a shift away from traditional biomass toward clean cooking technologies (such as improved cookstoves, biogas, and ethanol) to reduce domestic health risks and alleviate time poverty.

Simultaneously, these policies foster broad economic empowerment to enable women to become entrepreneurs, suppliers, and leaders within the energy value chain. Policies also mandate the integration of gender-responsive budgeting across ministries and the collection of sex- and age-disaggregated data to monitor real-world impacts. This inclusive lens extends to other vulnerable groups as well, introducing tax incentives for assistive technologies for persons with disabilities (PWDs), concessional financing for young entrepreneurs, and specific energy response plans for the more than 1.3 million refugees hosted in the country.

Finally, this drive for democratization and social justice finds crucial support within civil society and the media sector. Global calls for democratic participation legitimate and strengthen the action of local civil society organizations (CSOs) such as the Uganda Women's Network (UWONET), Raising Voices, and media channels like the Uganda Media Women's Association (UMWA). Through initiatives like 101.7 Mama FM (Africa's first women-run radio station), these organizations put gender-lens principles into practice by adopting editorial policies that prioritize marginalized voices, applying parity quotas, and creating inclusive work environments for staff with disabilities. In the absence of widespread state intervention, these local entities translate the rights enshrined in international treaties into tangible grassroots action, providing training, literacy, and economic support to empower rural women and combat gender-based violence. In this way, environmental, energy, and gender policies in Uganda merge into a single strategic vision, where ecological sustainability becomes the instrument for achieving social equity and the full empowerment of citizens.

3.2.2.2. Kenyan policies

Kenya's national policies outline a profound and progressive institutional restructuring, positioning gender equality, climate action, and energy sovereignty as interconnected pillars of the country's sustainable development. This integrated approach is primarily grounded in the 2010 Constitution of Kenya, a pioneering document that elevates environmental protection to the status of a national value and an enforceable right. The Kenyan Constitution closely mirrors the principles enshrined in CEDAW, the Convention on Biological Diversity (CBD), and the Paris Agreement. In the Constitution's Preamble, the Kenyan people define the environment as a heritage to be sustained for the benefit of future generations. Article 42 (the right to a clean and healthy environment) and Article 69 (which imposes operational obligations on the State and sets a binding target to achieve and maintain tree cover across at least 10% of the national territory) translate these global treaty obligations into enforceable domestic law protected by judicial review.

Regarding equality, Articles 27, 81, and 197 introduce the historic "two-thirds rule," stipulating that no elected or appointed public body may be composed of more than 66.6% of members of the same gender; this affirmative action measure directly applies the representation targets promoted by the UNFCCC Gender Action Plan (GAP) and regional protocols such as the African Union's GEWE Strategy. Supported by reserved parliamentary seats and the Kenya National Human Rights and Equality Commission, alongside Article 43 (public and reproductive health) and Articles 45, 60, and 68 (eliminating gender discrimination in land tenure), this constitutional framework provides robust protection for vulnerable groups.

Despite this solid formal framework, an analysis of energy policies reveals persistent and profound structural asymmetries between the formal economy and the socio-cultural reality of rural areas. For nearly twenty years, sector planning was guided by Sessional Paper No. 4 of 2004—a policy framework that subsequent independent gender audits (conducted in 2007 by the Ministry of Energy in collaboration with Practical Action East Africa, ENERGIA, and EAETDN) deemed functionally gender-blind. The "least-cost" paradigm model effectively excluded women, who were systematically denied access to credit and the electricity grid due to discriminatory barriers regarding land ownership. The urgent need to reverse this trend is highlighted by alarming data on energy poverty: the country's energy mix has historically been dominated by biomass (68%), followed by fossil fuels (22%) and the electricity grid (9%), with rural grid connection rates historically stagnating at 5%. Nationally, over 54% of households—

rising to 84% in rural areas and 88.4% in the most isolated settings—rely exclusively on firewood for cooking. This dependency creates a dual crisis: on one hand, a domestic health emergency linked to indoor air pollution, causing severe acute respiratory infections (ARI), blindness, and cancer-related complications among those who spend the most time at home (women and children); on the other, severe "time poverty," with women spending an average of 77 minutes a week gathering fuel compared to just 13 minutes for men, thereby preventing them from accessing education or income-generating commercial activities. Vulnerability is further exacerbated in

female-headed households, which record the highest poverty rates in both rural (54.1%) and urban (63.0%) areas, as they rely heavily on low-efficiency kerosene-based lighting systems.

To bridge this gap and fully implement both Vision 2030 and the Big Four Agenda, Kenya introduced the Energy Act of 2019 and the National Climate Change Action Plan (NCCAP III 2023–2027), transforming climate action from a purely environmental issue into a strategic macroeconomic priority—especially given that climate shocks already cost the country between 3% and 5% of its GDP annually. These gender mainstreaming principles are reflected in precise operational mechanisms: the Climate Change Act and NCCAP III mandate the creation of dedicated "Gender Desks" and committees within state utilities such as KPLC and KenGen. On the economic front, international empowerment directives materialize through the rigorous implementation of the Access to Government Procurement Opportunities (AGPO) program, which legally reserves 30% of public contracts and tenders for businesses led by women, youth, and persons with disabilities (PWDs).

The plan operates on two tracks: adaptation for resilience (a national priority to protect agriculture and infrastructure from droughts and floods) and mitigation, with a commitment to reduce greenhouse gas emissions by 32% by 2030. To maintain its leadership in green energy, the strategy leverages the Rift Valley's geothermal potential (estimated at over 10,000 MW)—managed by the Geothermal Development Company—alongside large-scale wind and solar installations. However, the ecological and energy transition is now systematically linked to community well-being and gender equality through key strategic commitments:

Institutionalization of Mainstreaming and STEM: Addressing internal Ministry imbalances—where women make up 35% of total staff but hold only 15% of top-level positions and remain largely absent from technical sectors—through scholarships and internships for young women in STEM, permanent Gender Desks, and infrastructure upgrades including breastfeeding rooms and separate sanitation facilities.

Constitutional Compliance and Economic Empowerment: Combining AGPO procurement quotas with subsidized connection packages for electricity access in disadvantaged households.

Clean Cooking Strategy: A large-scale technological transition toward biogas (derived from floriculture and sisal by-products), bioethanol, LPG, and improved biomass cookstoves (ICS) to drastically reduce indoor pollution and free up women's time.

Devolved Governance and Local Plans: Clear division of responsibilities between national government and County Governments, which integrate gender and energy policies into County Integrated Development Plans (CIDPs). Information Systems and Disaggregated Data: Mandatory collection, storage, and analysis of sex-disaggregated data to implement analytical tools (like Quickscan) and genuine gender-responsive budgeting.

At the regional level, Kenya has established itself as a pioneer of the paradigm shift formalized in the Nairobi Declaration (2023), positioning Africa not as a victim, but as a global partner for the green transition. This vision led the country to update its regulatory and financial architecture through the Climate Change Act (2016, updated in 2023) to stringently regulate the carbon credit market. This framework legislation mandates the integration of gender and intergenerational equity into all climate responses, directly reflected in the National Climate Council's composition (chaired by the President of the Republic), which legally requires youth, marginalized communities, and civil society representation while adhering to the two-thirds gender quota.

Under the updated 2023 carbon market regulations, the law explicitly prohibits credits obtained through human rights violations or without the free, prior, and informed consent of affected populations. Every local project must be governed by a Community Development Agreement and redistribute between 25% (for non-land-based projects) and 40% (for land-based projects like reforestation) of earnings directly to local communities through County Climate Change Funds (CCCFs) and a National Fund, ensuring direct benefits for women and marginalized groups in Arid and Semi-Arid Lands (ASALs). Access mechanisms must ensure equity to prevent female and youth entrepreneurs from being excluded from green innovation funding.

Finally, to cement a lasting cultural shift, the system employs two powerful social levers: first, a mandate for the Kenya Institute of Curriculum Development to integrate climate change studies into school curricula at all levels; second, aligning with UNHRC resolutions that recognize climate threats to human rights, the legal framework introduces the instrument of "Climate Justice". This grants any citizen or civil society organization the right to bring a case

before the Environment and Land Court against actions harmful to the environment or adaptation efforts without needing to demonstrate direct economic or personal harm, effectively converting international jurisprudence into a powerful lever for legal activism.

Table 3.2.2 Comparative Policy Frameworks on Gender, Climate, and Energy in Uganda and Kenya

Policy Dimension	Uganda	Kenya
National energy policy	Energy Policy for Uganda, NDP III/IV e Uganda Vision 2040. Focus on modernizing the energy grid and transitioning from a hydropower-heavy system to a diversified mix. Prioritizes off-grid solar home systems and mini-grids where main-grid extension is economically unfeasible.	Energy Act (2019), Vision 2030 e Big Four Agenda. Focus on leveraging geothermal potential in the Rift Valley, complemented by wind and solar. Assigns energy planning and biomass management to County Governments via County Integrated Development Plans (CIDPs).

Climate policy/ NDCs	National Climate Change Policy (NCCP), National Adaptation Programme of Action (NAPA), and updated NDCs. Target: Reduce GHG emissions by 22% by 2030 compared to Business-As-Usual (BAU). Focuses on protecting rain-fed agriculture (80% of workforce) via Climate-Smart Agriculture (CSA), early warning systems, and UNCCD-aligned adaptation programs. It requires mandatory Environmental and Social Impact Assessments (ESIAs) approved by NEMA for all energy and infrastructure projects.	Climate Change Act (2016, updated 2023) and NCCAP III (2023–2027). Target: Reduce GHG emissions by 32% by 2030 compared to BAU. Focuses on regulating carbon credits strictly, requiring Free, Prior, and Informed Consent (FPIC) and redistributing 25%–40% of earnings directly to local communities via County Climate Change Funds (CCCFs).
Gender policy	Uganda Gender Policy (UGP) aligned with Uganda Vision 2040 and NDP III. Combines Women in Development (WID) and Gender and Development (GAD) approaches to address both practical needs and structural power imbalances Enforces gender-responsive budgeting across ministries,	2010 Constitution (Arts. 27, 81, 197) and National Gender and Development Policy. Imposes the "Two-Thirds Gender Rule" (Arts. 27 & 81), strictly prohibiting any elective or appointive public body from comprising more than 66.6% of one gender. Enshrines equal rights to land ownership, inheritance, and

	requires sex- and age-disaggregated data collection, and includes targeted inclusion plans for refugees and Persons with Disabilities (PWDs).	management (Arts. 45, 60, 68), alongside guaranteeing rights to reproductive health (Art. 43).
Clean cooking strategy	National Integrated Clean Cooking Strategy (NICCS) integrated into NDP III and Energy Policy. Context: extremely high dependency on traditional biomass (90.5% of primary energy supply). Interventions: promotes Improved Cookstoves (ICS), bioethanol, electric cooking (e-cooking), and household biogas to reduce biomass reliance to ~50% and combat indoor air pollution driving child mortality (8.2%). Goal: alleviate extreme fuel-collection "time poverty" and curb severe deforestation	National Clean Cooking Strategy, Kenya National LPG Expansion Project, and NCCAP III. Context: firewood dependency remains at 54% nationally and 84% in rural areas. Interventions: rapid transition to LPG, bioethanol, e-cooking, and biogas (utilizing sisal and floriculture agricultural waste). Goal: complete elimination of indoor air pollution causing Acute Respiratory Infections (ARIs) and eye diseases among women/children, while decentralizing biomass management via CIDPs
Main implementation challenges	Women constitute over 70% of the agricultural workforce but hold secure control over land in only 25.5% of cases, limiting their access to credit and formal decision-making.	Women represent 35% of overall staff at the Ministry of Energy but hold only 15% of executive positions and remain largely absent from technical roles.

	Severe deforestation combined with heavy reliance on traditional biomass drives high indoor air pollution and child mortality. Extreme poverty and strict commercial lending criteria mean awareness and education campaigns fail without direct asset, capital, or credit transfers.	Commercial banks heavily rely on land titles as collateral for green loans, systematically disqualifying female entrepreneurs. High risk of carbon market revenues and climate funds being intercepted by local elites or intermediaries before reaching rural ASAL communities.
Relevant targets for women's empowerment	Time Poverty & Health Relief: Drastically reduce daily unpaid domestic workload (12–18 hours/day) and lower Gender-Based Violence (GBV) risks linked to long-distance firewood collection Clean Energy Value Chains: Directly integrate women as active entrepreneurs, suppliers, and decision-makers in green energy distribution. Civic Voice & Media Access: Strengthen rural women's political participation and rights literacy via civil society organizations and community media	Public Procurement Access (AGPO): Enforce the Access to Government Procurement Opportunities mandate, legally reserving 30% of public tenders for enterprises owned by women, youth, and PWDs. STEM Leadership & Institutional Parity: Establish "Gender Desks," gender committees, and dedicated STEM scholarships for young women across state power utilities. Legal & Climate Justice: Empower citizens and women-led CSOs to file strategic litigation in the Environment and Land Court to enforce constitutional environmental rights

3.3. Non-State actors: the role of the Private sector and the civil society

Today, a great many civil society organizations (CSOs) are actively working to drive the adoption of clean, renewable energy, focusing particularly on expanding access to these resources for the benefit of the most vulnerable and marginalized population groups. Within this landscape, women's movements and groups play a leading role, advocating to ensure that gender issues are not overlooked but rather fully integrated into macroeconomic policies and sectoral development plans. Clearly, the actual ability of CSOs to influence a country's energy agenda is never a given; it depends on a complex set of factors, such as the strength of democratic institutions and the quality of the relationship between the State and its citizens. At the same time, these organizations work extensively at the grassroots level, launching projects to inform local communities about their energy-related rights and offering training to teach people how to assert those rights and make their voices heard in decision-making processes across various levels of government.

Despite the significant activism of women's organizations at the international level, there remains a strong need to better support and structure their efforts. Specialized networks focused on energy issues (such as ENERGIA) have long carried out valuable work regarding documentation, outreach, and raising awareness about gender equality in the sector. However, these networks often risk becoming overwhelmed while trying to keep pace with the myriad policy initiatives emerging at both local and global levels.

Fortunately, regarding climate change, it has been possible to build solid, successful coalitions. A prime example is the Global Gender and Climate Alliance, which works closely with delegates and activists during international environmental conferences. Another key entity is the UNFCCC Women and Gender Constituency; established to unite civil society organizations (CSOs) dedicated to women's rights, it is now formally recognized as a special observer group. Thanks to these alliances, the energy needs of women have become a permanent fixture in international debates on reducing climate impact.

To prevent the good practices pioneered by women at the local level from being lost—or, worse, co-opted by major traditional development actors possessing far stronger communication and promotional channels—international networks established the Grassroots Women's International Academy (GWIA). Officially launched in Germany during Expo 2000, the initiative was the result of a collaboration between the Mother Centres International Network for Empowerment and the Huairou Commission, with funding from various bodies, including the

German federal government and SOS Children's Villages. The GWIA operates as a genuine platform for peer-to-peer exchange and learning; the core concept is to study successful local solutions from around the world and then replicate and disseminate them, both among similar groups (horizontally) and through engagement with institutional actors (vertically). Through so-called "partner dialogues," the academy facilitates direct interaction between women from local communities and key decision-makers, ranging from United Nations officials to representatives of governments and major NGOs.

Managing such an international network entails significant practical challenges, starting with the chronic lack of funding that has long made it difficult to finance travel, accommodation, and even simultaneous interpretation booths or language mediation services for meetings. Despite this, the GWIA has successfully organized ten global and thematic gatherings—such as forums on the impact of AIDS in Africa or partnership-building events in Barcelona—demonstrating the project's viability and sustainability. The secret to this model's success lies in the women's ability to retain intellectual ownership of their solutions and in careful cultural mediation. Indeed, the daily workshops include a "temperature-taking" session to monitor participants' well-being, anticipate potential tensions, and ensure that everyone's emotional, physical, and cultural comfort zones are understood and respected, thereby safeguarding the network's long-term stability.

3.3.1. The case of Uganda

A cross-analysis of data collected in Uganda (Namuyonga & Kalikola, 2024) (Irumba & Magala, 2024) clearly highlights the pivotal role played by civil society organizations in reshaping gender dynamics and promoting women's empowerment. A comparison of projects led by the Uganda Women's Network (UWONET) and Raising Voices Uganda reveals how two distinct theoretical approaches—the former focused on political mobilization and institutional lobbying, the latter oriented more towards social change and psychological empowerment in rural communities—converge on remarkably similar and positive practical outcomes.

The most evident reflection of this effectiveness is found in the realm of education: women directly involved in the programs achieved an extraordinary

academic success rate—with 90% advancing to the next level—compared to significantly lower results (45% for UWONET and 60% for Raising Voices) among those who did not participate in the activities. This statistical disparity is confirmed by logistic regression models, which assign project participation an odds ratio ranging from 4.75 to 5.8. This demonstrates that the support provided by these networks goes beyond merely facilitating school access; it creates

the conditions for a truly high-quality educational experience.

The benefits, however, extend beyond the classroom, sparking a profound personal transformation: fully 80% of the beneficiaries demonstrated a marked increase in self-efficacy, developing strong confidence in their own abilities and independence. This individual awareness also generates a tangible collective impact, as 75% of participants take an active role in community initiatives—compared to an average of less than 40% among the population not exposed to the projects. In this way, women cease to be passive subjects and become agents of change, capable of challenging patriarchal norms and gender-based violence within their villages.

Despite these successes, complex structural obstacles remain, as clearly highlighted by the multivariate analyses in both studies. Indeed, a clear intersectional disparity linked to initial economic circumstances emerges: women from middle- and high-income backgrounds show significantly higher chances of success compared to those living in conditions of severe economic vulnerability. This finding confirms that extreme poverty and a lack of material resources continue to hinder development, limiting the impact of awareness-raising campaigns alone.

To ensure these advances are lasting and structural, the final recommendations highlight the need to adopt integrated strategies that combine training with direct financial support for the poorest segments of the population. At the same time, it is essential to consolidate multi-stakeholder alliances that bring together public institutions, international organizations, and traditional authorities into a single, coordinated action network.

3.3.2. The case of Kenya

The actual translation of the Kenyan regulatory framework into real-world impacts on the ground depends crucially on the dynamic—and sometimes conflict-ridden—interaction between public institutions, the private sector, and civil society organizations (CSOs). The private sector—comprising financial institutions, multinationals, micro, small, and medium-sized enterprises (MSMEs), cooperatives, sole proprietors, and farmers operating in both the formal and informal economies—is called upon to act as the economic engine of the green transition. However, private sector actors in Kenya face pervasive systemic barriers. Many businesses lack the internal capacity and critical information needed to interpret climate data and translate it into concrete business actions; government communication channels often fail to convey the competitive advantages of environmental action (such as cost efficiency or reduced operational risk) in language that resonates with the market. Access to finance remains the primary obstacle.

The local financial system is structurally weak in strategic green economy sectors (such as organic farming, water management, recycling, and renewable energy), and interest rates remain high. At the same time, lenders and insurance companies struggle to assess, price, and manage risks associated with climate-exposed portfolios, lacking the technical expertise required to understand green business models.

Consequently, standard financial products offer short-term loan cycles that do not align with the long-term payback periods typical of environmental adaptation investments. This mismatch disproportionately affects the economic groups most vulnerable to climate shocks—such as smallholder farmers and MSMEs—who lack the in-house expertise needed to draft bankable proposals capable of attracting capital. Even potential sources of long-term financing—such as the highly fragmented pension fund and asset management sectors—remain held back by short-term speculative mindsets and a lack of technical expertise among managers regarding the valuation of green financial instruments. Faced with government delays in adopting guarantee policies and stable incentives, the private sector often views the executive branch's implementation capabilities with skepticism, tending to disengage from national climate initiatives unless actively involved from the very early stages.

Civil society steps in to fill the structural gaps left by the state and the market, operating extensively across the board. The civil society organizations (CSOs) analyzed exhibit a distinctly multisectoral profile: none operate in a purely environmental vacuum; instead, they integrate a climate lens into pre-existing sectors such as health, education, biodiversity conservation, human rights, and agriculture. Between 2014 and 2021, many CSOs formalized and rebranded their projects, realizing that their long-standing initiatives for women's emancipation and empowerment already contained the foundations for resilience and climate action. Faced with the rigid gender-based division of labor in arid and semi-arid lands (ASAL)—where drought increases women's domestic burdens, forcing them to travel kilometers for water and firewood while exposing girls and breastfeeding mothers to malnutrition, school dropouts, early marriage, and gender-based violence (GBV) during forced migration—CSOs work to translate policy commitments into on-the-ground aid. This operational role results in a "spontaneous privatization" of services: organizations fund and install decentralized clean technologies such as biodigesters, improved cookstoves, and solar drip irrigation systems. They also support the public sector itself by providing experts for international UNFCCC negotiations, funding government workshops, and drafting key sections of national strategic plans.

The roles of civil society operate synergistically through three macro-functions: Knowledge

Generation and Monitoring: Conducting gender vulnerability assessments, mapping community-led local solutions, and compiling county-level emissions inventories. Regarding oversight, CSOs track climate finance flows and monitor compliance with Nationally Determined Contributions (NDCs), verifying whether local administrations actually allocate the mandatory share of their development budgets to climate action. Multi-level Advocacy and Demystification: At the community level, CSOs translate technical policy jargon to raise public awareness and empower citizens to voice demands during participatory budgeting processes. At local and national levels, they lobby for the integration of generational and gender perspectives into County Climate Action Plans and legislative reform review

processes (such as those concerning carbon markets), prioritizing institutional dialogue channels ("boardroom conversations") over street-level mobilization. Accountability and Strategic Litigation: Using the 2010 Constitution as a supreme legal shield, CSOs guard against tokenism and top-down gatekeeping by the government, which tends to invite only "aligned" actors to consultation forums. When institutional channels fail or the executive branch violates procedures, civil society resorts to rigorous enforcement measures and litigation.

3.4. Convergences and Gaps in the Policy Landscape

A comprehensive and coordinated analysis of international, regional, and national regulatory frameworks reveals that the policy landscape regarding the nexus of gender, climate change, and energy is currently characterized by a profound dynamic tension between significant convergence in principle and the persistence of serious operational gaps. On one hand, the primary element of convergence across all levels of governance is the definitive move beyond the traditional narrative regarding women. The "gender blindness" that marked early international treaties—such as the 1992 UN Framework Convention on Climate Change (UNFCCC) or the 1997 Kyoto Protocol—and older national sectoral plans (exemplified by Kenya's Sessional Paper No. 4 of 2004) has been progressively dismantled. Today, global instruments (the Paris Agreement, the Lima Work Programme on Gender, and the UNFCCC Gender Action Plan), continental strategies (the African Union's GEWE Strategy 2018–2028 and the IGAD Gender Strategy 2023–2030), and national

constitutional and legislative frameworks (such as Kenya's 2010 Constitution and Uganda's Gender Policy) all align on a key principle: women should no longer be viewed merely as passive victims of environmental degradation, but rather as genuine "agents of change," holders of traditional knowledge, and indispensable decision-makers in the ecological transition.

Furthermore, there is widespread strategic consensus—reflected in development plans such as Uganda Vision 2040 and Kenya’s National Climate Change Action Plan—that gender equality, climate resilience, and energy sovereignty form an inseparable triad, in which none can be achieved without the full pursuit of the others.

However, when shifting the analysis from the level of theoretical principles to the phase of practical implementation, structural bottlenecks and contradictions emerge that limit effectiveness in the field. This disconnect manifests along four fundamental lines. First, there is a profound gap between formal regulations and implementation capacity, driven by bureaucratic inertia and socio-cultural resistance. Although the Kenyan Constitution mandates the so-called "two-thirds rule" (Articles 27 and 81) and Ugandan policies promote gender mainstreaming, women's presence in energy institutions often remains limited or merely tokenistic. For instance, within the Kenyan Ministry of Energy, while women make up 35% of the total workforce, they hold only 15% of senior or decision-making roles and remain largely excluded from strictly technical sectors. Furthermore, the devolution of climate and energy action to local authorities (such as county governments in Kenya or districts in Uganda) is hampered by a chronic lack of technical expertise, financial resources, and managerial autonomy, ultimately stalling the widespread deployment of decentralized renewable energy infrastructure.

Secondly, a clear inconsistency emerges between political ambitions and the financial market architecture. While far-reaching initiatives are being promoted at international and regional levels—such as the 2023 Nairobi Declaration, which calls for a reform of the global financial system—access to capital remains out of reach for the most vulnerable groups at the local level. Despite affirmative action programs like Kenya’s AGPO, which legally reserves 30% of public procurement contracts for businesses led by women, youth, and persons with disabilities, private banking criteria continue to require tangible collateral based on land ownership. In Uganda, for instance, women make up over 70% of the agricultural workforce yet hold title deeds in only 25.5% of cases, leaving them systematically excluded from conventional credit channels. Furthermore, financial institutions view decentralized clean technologies as high-risk investments, offering short-term loans with high interest rates that are ill-suited to the long payback periods typical of rural adaptation projects. Even innovative mechanisms—such as the redistribution of carbon credit proceeds mandated by Kenyan law in 2023 through County Climate Change Funds (allocating between 25% and 40%)—risk falling prey to "elite capture," where local elites co-opt the funds to the detriment of women and marginalized groups in Arid

and Semi-Arid Lands (ASAL).

Thirdly, there remains a significant lack of disaggregated data and limitations regarding the intersectional nature of inequalities. Although both Uganda and Kenya mandate gender-responsive budgeting and the collection of data disaggregated by sex and age, national statistics still tend to present aggregated figures that mask actual disparities. Average electrification rates conceal the fact that, in the most remote rural areas, grid connection remains negligible (around 5%), leaving over 80% of households reliant on the harmful use of firewood for cooking. This lack of granular data hinders the formulation of targeted policies to address "time poverty" and the respiratory health risks faced by women. Furthermore, as evidenced by empirical studies on the work of Ugandan NGOs such as UWONET and Raising Voices, training and awareness-raising initiatives are remarkably effective for participants—boosting self-efficacy to 80% and school success rates to 90% (with an odds ratio of up to 5.8)—yet the benefits are concentrated primarily among women from middle- and high-socioeconomic backgrounds. For women living in extreme poverty, educational campaigns alone prove insufficient unless accompanied by direct resource transfers and material support for the purchase of clean technologies.

Finally, the State's inability to guarantee universal coverage has led to a progressive "spontaneous privatization" of essential services and forms of institutional co-optation. Civil society organizations (CSOs) and international networks (such as ENERGIA or the Grassroots Women's International Academy) play a crucial role in filling the gaps left by the public sector by directly installing biodigesters, efficient cookstoves, and solar irrigation systems, as well as by promoting legal actions—such as climate justice cases before Kenya's Environment and Land Court. However, when the provision of basic goods and the protection of fundamental rights are permanently delegated to the third sector or foreign donors, State accountability risks eroding, leaving project sustainability tied to the volatility of international funding. At the same time, dynamics of institutional gatekeeping are evident, with government bodies tending to include only the most aligned non-state actors in consultation processes, thereby compelling more critical organizations to resort to strategic litigation to enforce constitutional obligations.

In conclusion, although the evolution of regulations in the countries examined demonstrates a high level of conceptual alignment with international targets, the true unresolved challenge lies in overcoming financial, bureaucratic, and ownership-related barriers. Only through a genuine integration of credit reforms, resource redistribution, and effective, substantive representation will it be possible to transform principles enshrined on paper into tangible, lasting progress for local communities.

CHAPTER 4

Impact Assessment of Clean Cooking Interventions: Do Policies and Projects Work?

The previous chapters established the theoretical, technological and regulatory foundations of the relationship between gender equality, energy poverty and climate action. Chapter 1 showed that climate vulnerability is socially differentiated and that women's exposure to energy poverty is inseparable from unequal access to time, health, income and decision-making power. Chapter 2 then examined clean cooking technologies as potential instruments for reducing household air pollution, fuelwood demand and domestic drudgery, while also demonstrating that technical efficiency does not automatically produce social transformation. Chapter 3 analysed the international, regional and national policy frameworks that seek to integrate gender mainstreaming into climate and energy governance, with particular attention to Uganda and Kenya.

Building on that framework, this chapter shifts the analysis from normative commitments and anticipated benefits to document project-level outcomes. Its central question is whether clean cooking interventions generate sustained improvements in energy access and whether those improvements translate into measurable changes in women's lives. The assessment therefore considers not only the number of stoves or biodigesters installed, but also continued use, reductions in fuel consumption, time savings, health and safety outcomes, women's participation in implementation, income and leadership opportunities, local repair capacity and the durability of benefits over time.

Two interventions are examined as a comparative multiple-case study: the Cookstove Project (CSP) in Uganda and the Be0Gas project in Kenya. At the same time, the chapter does not claim to evaluate the universal impact of Ugandan or Kenyan national policy across all subgroups of women within each country. Project outcomes are treated as implementation-level evidence that can indicate whether the principles of clean energy access, participation and gender mainstreaming are being translated into practice.

The comparison is deliberately critical rather than binary. Neither project is classified simply as a success or a failure. Instead, the analysis identifies the dimensions in which

objectives and reported outcomes are closely aligned, the areas in which evidence is incomplete, and the contextual or operational conditions that explain different results. This approach is especially important in clean cooking, where distribution figures may overstate impact if households do not continue using the technology, if traditional fires remain in parallel use, or if the reduction of women's unpaid labour is not accompanied by greater control over the time and resources that are released.

The first section of the chapter explains the research design, data-collection process and gender-responsive evaluation framework. The second and the third present the within-case analyses of Uganda and Kenya respectively. The fourth paragraph compares the two interventions across effectiveness, gendered impact and sustainability. The successive identifies the critical success factors that emerge from the cross-case evidence, while the last one summarises the principal findings and their implications for the broader thesis.

4.1. Research methodology and gender-responsive evaluation framework

4.1.1. Research design and case selection

The empirical component adopts a desk-based comparative case-study design. In accordance with case-study research principles, the design is organised around five elements: clearly formulated research questions, analytical propositions, defined cases, an explicit logic linking documentary evidence to those propositions, and criteria for interpreting the strength of the findings. A multiple-case strategy is appropriate because the research questions are explanatory: they ask how clean cooking projects produce gendered outcomes, why benefits persist in some contexts, and why implementation problems arise despite broadly similar policy objectives.

The first case is the Cookstove Project in Uganda, a community-based programme centred on locally constructed improved stoves, village leadership and long-term maintenance. The second is the Be0Gas project in Kenya, which combines improved Jiko Kisasa stoves, biodigesters, climate-smart agriculture, community action planning and local technical training. The cases were selected because they operate within the national contexts discussed in Chapter 3 and because the available documentary evidence permits analysis across a common set of gender-responsive indicators.

The cases are bounded geographically by their respective project areas, institutionally by the activities described in the supplied project documentation, and temporally by the periods covered

in the available evaluations and follow-up reports. For Uganda, the principal longitudinal evidence concerns households receiving stoves in 2018-2019 and surveyed in 2025. For Kenya, the analysis relies on project monitoring, household survey and implementation evidence reported across the intervention cycle.

The comparison is guided by four propositions. First, project effectiveness depends on sustained use rather than initial distribution alone. Second, the gender impact of clean cooking should be assessed through both practical outcomes - such as reduced smoke exposure and time spent collecting firewood

- and strategic outcomes - such as income, technical authority and participation in decision-making. Third, local ownership and repair capacity should increase the probability that benefits continue after installation. Fourth, affordability and cultural compatibility should influence adoption, while technical complexity and external resource dependencies may constrain scalability.

The unit of analysis is the intervention as experienced at household and community level. Outputs such as installed units, trained technicians or completed action plans are distinguished from outcomes such as regular use, lower fuel consumption or time reallocation, and from higher-level impacts such as improved health, enhanced agency or enduring changes in gender relations. This distinction limits the risk of treating implementation activity as proof of transformation and allows the evidence to be interpreted along a causal sequence.

4.1.2. Data collection and AI-assisted documentary analysis

Data were collected through a structured review of the documentary corpus supplied by the IPSIA Organization (for the Be0Gas project in Kenya) and the Cookstove Project Organization (for the project in Uganda). The corpus includes project impact summaries, household surveys, follow-up evaluations, theory-of-change documents, implementation and maintenance descriptions, and project-level monitoring material. For Uganda, the most important sources are the CSP Evidence report, the Five-Year Impact Evaluation, the Cookstove Master System, the Theory of Change, the 10-Year Project and the project reflections on behavioural change. For Kenya, the evidence derives from Be0Gas monitoring and survey material concerning improved cookstoves, biodigesters, permaculture, local training, Community Action Plans and implementation constraints.

The data-collection procedure followed three stages. First, each document was screened to

identify stated objectives, beneficiary groups, technologies, implementation mechanisms and reported outcomes. Second, relevant passages were extracted into a predefined evidence matrix organised by project, indicator, reported evidence, documentary location and limitation. Third, numerical values and interpretive claims were checked against the source passages and compared with other evidence in the same case. If a report used unclear units, conflicting baseline numbers, or unproven claims, the figure was kept, but with a note explaining its limitations.

Generative artificial intelligence was used as an assisted documentary-retrieval and synthesis tool. Specifically, the NotebookLM program supported the identification of passages relating to adoption, affordability, time use, health, income, decision-making, sustainability and implementation problems, and it helped produce a preliminary version of the evidence matrix. AI output was not treated as an independent source and did not determine the evaluative judgement. Every statistic and project-specific statement included in the chapter was checked against the supplied documents, and claims unsupported by the corpus were excluded. The use of AI is therefore methodological rather than evidentiary: it accelerated systematic comparison across a large documentary set while source documents remained the sole basis for factual conclusions.

Evidence was interpreted according to its methodological strength.

Independently tested technical measurements and clearly described longitudinal survey results were given greater weight than general project narratives. Household survey findings and direct technical observations were treated as stronger than unquantified statements of benefit, while intended outcomes in theories of change were not presented as achieved impacts unless supported by monitoring or evaluation data. This hierarchy is especially relevant because the two cases differ in the type and depth of evidence available: the Ugandan material provides detailed long-term adoption and health figures, whereas the Kenyan material offers richer information on income, women's participation and institutional capacity.

4.1.3. Evaluation criteria, indicators and analytical procedure

The evaluation framework draws on the six OECD-DAC criteria of relevance, coherence, effectiveness, efficiency, impact and sustainability. The criteria were not applied as a mechanical checklist. They were adapted to the purpose of this study and interpreted through a gender lens. Effectiveness asks whether the interventions achieved their stated outputs and outcomes; impact examines the significance of higher-level changes in wellbeing, gender equality and the

environment; sustainability considers whether benefits and the capacities required to maintain them are likely to persist. Relevance and coherence are used to interpret cultural fit and alignment with local and national priorities, while efficiency is considered only where the available data permit an assessment of affordability or resource use.

A gender-responsive framework requires more than counting female beneficiaries. It examines who participated in design and implementation, who controls technical knowledge and income, whether women gained decision-making authority, and whether benefits were distributed in ways that reduced rather than reproduced existing inequalities. Time savings are therefore treated as an intermediate outcome: they may reduce drudgery, but they become empowering only when women can redirect the released time toward activities they value and when the domestic division of labour does not simply absorb it into additional unpaid work.

Table 4.1 sets out the common evaluation dimensions used for both cases. The dimensions are derived from the source material and from the conceptual discussion developed in Chapters 1 and 2. Quantitative indicators establish the scale and direction of change, while qualitative evidence explains the mechanisms, contextual conditions and limitations underlying the observed results.

Table 4.1. Gender-responsive impact evaluation matrix

Evaluation dimension	Core indicators	Evidence and interpretive focus
Access and adoption	Households or units reached; daily or exclusive use; discontinuation of traditional fires; frequency of use	Whether access becomes sustained behavioural change; reasons for continued traditional use or stove stacking
Women's participation and ownership	Women involved in construction, installation, committees, leadership and maintenance; local technical roles.	Degree of influence, ownership of knowledge, remuneration and control rather than numerical presence alone

Women's empowerment	Time savings; income or employment; fuel expenditure; decision-making; redistribution of domestic tasks	Whether practical benefits create greater agency, bargaining power and opportunities beyond unpaid care work
Health and safety	Respiratory symptoms; pneumonia; eye irritation; burns; indoor smoke; water-boiling practices	Strength of clinical or survey evidence and whether outcomes are measured or only perceived
Environmental outcomes	Fuelwood consumption; CO ₂ or CO ₂ e reduction; changes in fuel sourcing	Magnitude of resource savings and persistence of wider pressures such as wood scarcity
Affordability and efficiency	Up-front contribution; local material costs; fuel savings; operating and maintenance costs	Barriers to entry, distribution of costs and compatibility with household cash constraints
Sustainability and scalability	Continued use; repair capacity; follow-up systems; trained local actors; institutional alignment	Durability of benefits, dependency on external support and conditions required for responsible replication

The analysis proceeds in two steps. The within-case stage reconstructs the intervention logic and compares stated objectives with reported outcomes. The cross-case stage uses pattern matching and structured comparison to identify convergent mechanisms and context-specific differences. Particular attention is given to rival explanations. For example, lower fuelwood consumption may reflect stove efficiency, but it may also be influenced by wood scarcity, changes in household size or altered cooking practices. Because the source corpus does not provide a counterfactual design capable of isolating all such factors, causal conclusions are expressed cautiously and project reports are interpreted as evidence of contribution rather than definitive proof of attribution.

The final evaluative judgement is therefore multidimensional. A project may be effective in achieving high adoption while remaining weak in measuring income or decision-making. It may produce substantial environmental benefits while requiring a resource-intensive support model that limits rapid expansion. The assessment retains these tensions rather than collapsing them into a single success score.

4.1.4. Methodological limitations

The principal limitation is the reliance on secondary project documentation. Much of the evidence was generated or commissioned by implementing organisations, which may create positive reporting bias. The Ugandan case includes independent technical testing and a five-year household survey, but the documentation does not provide a randomised counterfactual.

The Kenyan case combines household surveys, monitoring records and technical observations, yet the available material does not always specify sample size, survey timing or the denominator used for every percentage. Consequently, the chapter evaluates the consistency and plausibility of reported outcomes rather than claiming experimental causal identification.

A second limitation concerns cross-case comparability. The interventions differ in technology, scope, duration and measurement. Uganda primarily evaluates a locally built improved biomass stove, while Kenya combines stoves, biogas, agriculture and community planning. A 66% reduction in wood use in Uganda and a 76% reduction in Kenya cannot be interpreted as a simple league table because baselines, measurement methods and household contexts are not identical. The values are used to assess performance within each case and then compared at the level of patterns rather than as perfectly commensurable estimates.

Third, the gender evidence is uneven. Uganda provides strong quantitative data on time, health, safety and continued use, but does not directly measure women's income or intra-household decision-making as primary outcomes.

Kenya reports income, committee participation and technical training, but offers less quantified health evidence and no directly comparable estimate of hours saved. These asymmetries are analytically important: they reveal how the design of monitoring systems determines which dimensions of empowerment become visible.

Finally, AI-assisted extraction introduces the risk of decontextualisation or over-synthesis. This risk was addressed by returning to the original documentary passages, preserving stated limitations and excluding unsupported extrapolation. Nonetheless, the chapter remains dependent on the quality and completeness of the documents supplied. Findings should therefore be read as

a rigorous documentary assessment and as a basis for further primary research, not as a substitute for field interviews, direct emissions monitoring or longitudinal gender-disaggregated household data.

4.2. The Cookstove Project in Uganda

4.2.1. Intervention model and theory of change

The Cookstove Project operates in five Ugandan districts - Mukono, Nakasongola, Nakaseke, Mpunge and Mbale - with the objective of replacing the traditional three-stone fire with a locally constructed, fuel-efficient stove. The programme reports that between 91% and 96% of its resources are directed to programme activities. Its operational structure combines a national team, three restoration officers and 42 Cookstove Masters selected by their communities. These local leaders train households, supervise construction and remain available for support, thereby embedding technical knowledge within the village rather than concentrating it in external contractors.

The project is supported through sustained donor funding, including philanthropic individual donors and partner foundations (which directly fund 10 of the 42 Cookstove Masters). The evaluation is carried on by CSP's internal field teams and staff, who handle longitudinal household monitoring, while also relying on the Centre for Research in Energy and Energy Conservation (CREEC) as an external independent research partner.

The stove is not distributed as a finished industrial product. Households participate in constructing a permanent clay structure from freely available materials such as clay, water, straw and banana stems. Internal dimensions and airflow are calibrated to create secondary combustion, which increases the amount of energy obtained from each unit of wood and reduces smoke.

Household participation is intended to generate both technical understanding and psychological ownership: the stove is framed as an asset constructed with the family rather than a donated object imposed by an outside organisation.

The project's theory of change links this participatory construction process to sustained adoption. Regular use should reduce fuelwood demand, cooking time and smoke exposure; those immediate outcomes should then improve health and safety, release time for women and girls, lower household costs and reduce environmental pressure. The Cookstove Master system and the 10-Year Project extend the theory of change beyond installation by incorporating maintenance,

restoration and eventual rebuilding. This long-term presence distinguishes CSP from programmes that count distribution as the endpoint of intervention.

CSP also rejects participation in carbon-credit markets. The project argues that certification would require costly monitoring infrastructure and would transfer ownership of emission reductions away from families. Whether or not this position is universally applicable, it is coherent with the programme's partnership model: affordability, local ownership and continued use are prioritised over a transactional relationship in which households become providers of verified carbon units.

4.2.2. Access, adoption and behavioural change

The strongest evidence of project effectiveness is the persistence of use.

The Five-Year Impact Evaluation surveyed 200 households across four villages in Mukono District in 2025. These households had received stoves in 2018-2019, providing a follow-up period long enough to distinguish durable adoption from short-term novelty. Before the intervention, all surveyed households relied on a three-stone fire. At follow-up, 95% reported using the improved stove every day and 97.5% had completely discontinued the three-stone fire. Only 2.5% continued to use the traditional method.

These figures are significant because stove adoption is frequently undermined by fuel or technology stacking, in which a new device is used alongside the old one. The Ugandan evidence suggests that the programme achieved not only access but substantial substitution. The result is consistent with the participatory construction model, the proximity of local Cookstove Masters and the availability of follow-up support. It also indicates that the stove is compatible with a large share of daily cooking practices in the surveyed communities.

Changes in firewood collection reinforce the interpretation of sustained behavioural change. Before adoption, 63% of households collected wood every day. Five years later, daily collection had fallen to 6%, while 65% of families collected wood only once per week. This represents an approximately ten-fold reduction in collection frequency for most households. Individual journeys still lasted two to three hours because of regional wood scarcity, but the sharp decline in frequency substantially reduced the total labour burden.

The adoption results nevertheless should not be interpreted as universal. The small group that continued using the three-stone fire demonstrates that behaviour is shaped by habit, taste, fire-management preferences and the perceived suitability of traditional cookware. The project documents recognise that new habits are especially fragile immediately after installation and that

minor difficulties in lighting the fire or regulating airflow can lead households to revert to familiar practices. Continued support is therefore part of the adoption mechanism rather than a secondary service.

4.2.3. Time use, domestic labour and opportunities for women and girls

The project reports an average saving of 7.6 hours per week in firewood collection. This is the clearest quantified gender outcome because responsibility for gathering fuel falls predominantly on women and girls. The reduction is not merely a convenience: it addresses the time poverty described in Chapter 1, in which unpaid subsistence work restricts access to education, paid activity, rest and political participation. A weekly gain of this magnitude may represent almost a full working day returned to the household's primary energy managers.

Cooking time also decreased. A meal that typically required approximately three hours on a three-stone fire could generally be prepared in one to two hours on the CSP stove, and 48.5% of surveyed households reported completing meals in one hour. The dual-chamber design permits a second pot to be heated at the same time as the main meal, frequently allowing water to be boiled without extending the cooking period. This feature increases the practical value of the stove because it reduces sequential tasks rather than improving only the efficiency of one pot.

Project documents state that the released hours are used for income-generating activity, childcare, education and rest. These pathways are plausible and consistent with the theory of change, but the evidence must be interpreted carefully. The Five-Year Impact Evaluation does not formally quantify changes in women's earnings or directly measure control over the use of saved time.

Time savings are therefore a documented outcome, while economic empowerment remains an intended or indirectly supported consequence rather than a measured causal result.

For girls, the reduction in fuelwood collection may support school attendance and study time, but the supplied documents do not provide attendance records or educational outcome data. The distinction is important. A gender-responsive impact assessment should not assume that time automatically becomes emancipatory; households may reallocate it to other domestic duties. The Ugandan project demonstrates a substantial reduction in labour demand, but further research would be needed to establish how the benefit is distributed and who decides how the saved time is used.

4.2.4. Health, safety and household sanitation

The health and safety evidence is unusually detailed for a community cookstove intervention. The CSP Evidence report records a 69% reduction in pneumonia cases, an 83% reduction in severe burns and a 75% reduction in chronic eye irritation. The enclosed combustion chamber reduces direct contact with open flames, while improved airflow and secondary combustion lower the smoke concentration around the primary cook. At five-year follow-up, less than 6% of households reported severe respiratory symptoms, compared with nearly 60% at baseline.

These outcomes are especially relevant from a gender perspective because women and young children are normally the people most exposed to household air pollution (WHO, 2006). The reduction in clinic visits and treatment needs may also create indirect economic and time savings. Nevertheless, the available material does not specify a control group or provide clinical diagnostic protocols for every indicator. The findings should therefore be interpreted as strong project-associated improvements rather than as experimentally isolated effects.

An additional and often overlooked impact concerns drinking-water practices. Before the intervention, 26.5% of surveyed households reported that they never boiled drinking water; after adoption, this proportion fell to zero.

Daily water boiling increased from 1% to 48.5%. Statistics at a national level from Uganda Demographic and Health Survey 2016 (UBOS & ICF, 2018) show that 44.4% of population boiled drinking water. While there are no specific statistics from following years Uganda Malaria Indicator Survey 2018-19 (UBOS & ICF, 2020) and Uganda Malaria Indicator Survey 2024–25: Final Report (UBOS & ICF, 2025) do show that households with access to an improved drinking water source increased from 78% to 84%. The second cooking chamber appears to make water treatment more convenient because it can occur simultaneously with meal preparation. This outcome illustrates how a technical design feature can generate a health co-benefit that extends beyond smoke reduction and was not necessarily the primary purpose of the intervention.

4.2.5. Environmental performance and affordability

Independent testing cited by the project reports a 66% reduction in wood burned. The reduction corresponds to approximately 2.15 tonnes of firewood saved per household each year and an estimated 2.89 tonnes of CO₂ emissions avoided per stove per year. While these figures indicate that the intervention contributes simultaneously to household energy security and

climate mitigation, statistics (UBOS & ICF, 2018), (UBOS & ICF, 2020), (UBOS & ICF, 2025) demonstrates that nationally, solid fuel overall usage grew from 95,1% to 97%. At the same time clean cooking fuels and technology utilization went from 1% to 1,4%.

When it comes to the effectiveness of the project, the environmental benefit depends on continued daily use; the high five-year adoption rate is therefore central to the credibility of the emissions and fuel-saving claims.

Affordability is embedded in the design. Construction relies on locally available materials supplied at no cost by participating families, while the direct programme cost is reported at approximately USD 10 per stove. The expenditure primarily covers training, local labour and technical supervision rather than imported components. This model lowers the cash barrier to entry and avoids dependence on specialised spare-parts supply chains. It also allows minor repairs to be made using the same materials employed in initial construction.

Low monetary cost does not mean that the intervention is costless.

Household labour, Cookstove Master time, repeated follow-up and restoration are real resources. Moreover, reduced wood consumption does not eliminate the structural problem of fuel scarcity. Collection trips continue to require two to three hours, and only 52.5% of households source wood from their own gardens. The project reduces pressure on the local landscape but cannot by itself resolve land degradation, unequal access to natural resources or the wider energy infrastructure deficit.

4.2.6. Ownership, technical agency and long-term sustainability

The strongest empowerment evidence concerns control over maintenance. Ninety-five per cent of households report that they can carry out minor repairs independently, and the project documents indicate that maintenance is managed primarily by women and daughters. This transfers technical knowledge to the people who use the stove daily and reduces reliance on external technicians. Participation in construction and repair therefore changes women's position from passive recipient to knowledgeable operator and owner.

The evidence does not, however, fully establish the distribution of leadership at community level. Cookstove Masters are nominated on the basis of trust and reliability and the role creates skilled local employment, but the supplied documents do not provide a gender breakdown of the 42 Masters. It is therefore not possible to determine whether the programme has translated household-level technical agency into equal access to paid or recognised leadership roles.

Sustainability is supported by a deliberately long time horizon. Follow-up is structured

approximately one year, four to five years and ten years after installation. Through the 10-Year Project, CSP reports restoring 1,172 stoves and completely rebuilding 286. Approximately one quarter of stoves assessed after a decade had deteriorated enough to require full reconstruction rather than minor restoration. The finding is not evidence of failure; clay structures exposed to daily heat and water inevitably wear. More importantly, the programme has an explicit mechanism for identifying and responding to that wear.

The combination of household repair, village-based expertise and scheduled organisational return provides strong evidence of actual and prospective sustainability. The project reports that 99.5% of households currently face no challenges using the stoves. At the same time, sustainability is partly produced by continued organisational presence. A model that remains connected to communities for a decade may generate durable benefits, but it also requires stable financing, trained personnel and logistical capacity. Its scalability therefore depends on whether those long-term commitments can be maintained as the number and geographic dispersion of villages increase.

4.2.7. Implementation constraints and residual risks

Technical performance depends on construction precision. Secondary combustion requires exact internal dimensions, and small errors in measuring household pots or shaping air passages can undermine fuel savings and smoke reduction. The model is therefore low-cost but not low-skill. Cookstove Masters and restoration officers are essential quality-control actors; rapid replication without equivalent supervision could weaken performance.

The stove also experiences predictable physical degradation. Intense heat affects the primary combustion chamber and the passage between cooking chambers, while water spilled from pots can weaken thinner clay sections.

Cracks may restrict airflow and reduce smoke removal. The capacity to repair these defects locally mitigates the risk, but the need for full rebuilding in a proportion of ten-year-old stoves confirms that material durability remains a central maintenance requirement.

Behavioural barriers persist despite the high adoption rate. Cooking is embedded in routine, identity and sensory preference, and households may prefer the fire characteristics or flavour associated with traditional pots. The project addresses these barriers through trust, local leadership and long-term accompaniment rather than one-off training. This approach appears effective, but it is slow: a village may require 18-24 months to graduate through the programme, and meaningful sustainability depends on follow-up extending well beyond the initial

construction cycle.

Overall, the Ugandan case demonstrates high effectiveness in continued use, time savings, health, safety and fuel reduction. Its principal evidentiary weakness is the limited direct measurement of income, decision-making power and gender distribution in community leadership. Its principal operational trade-off is between depth and speed: the participatory, high-contact model generates durable adoption, but requires precision, local trust and long-term support that cannot be assumed in every context.

4.3. The Be0Gas Project in Kenya

4.3.1. Integrated intervention design and implementation model

The Be0Gas project adopts a broader intervention model than the Ugandan case. It combines improved Jiko Kisasa stoves, household and communal biodigesters, climate-smart agriculture, kitchen gardening, community planning and technical training.

The project was implemented by the Institute for Peace Development and Innovation (IPSIA), that worked with technical and operational partners, like Biogas International Ltd (which contracted for the supply, installation, technical training, and maintenance of flexi biodigesters), the Laikipia Permaculture Centre Trust (for permaculture, climate-smart agriculture, and natural building supervision), Navigators Capital Limited (contracted consultancy firm for Natural Resource Management training) and five Local Self-Help Groups (Twala, Lekiji, Naatum, Chui Mama, and Rapunye) that act as primary community-level partners and beneficiaries.

It was also funded by the IKI Small Grants Programme, which is part of the International Climate Initiative (IKI) and the German Federal Ministry for Economic Affairs and Climate Action (BMWK) and Federal Foreign Office (AA).

The approach reflects the Kenyan policy framework discussed in Chapter 3, where clean cooking, climate resilience, devolved governance and women's economic participation are treated as interconnected priorities rather than isolated sectors.

The original targets were 432 improved cookstoves and 70 biogas systems.

Project reporting indicates that 718 Jiko Kisasa stoves were installed, substantially exceeding the stove target. Sixty flexible biodigesters were installed and commissioned for individual households, while ten fixed-dome systems were planned for communal kitchens,

bringing the planned total to 70. Because the ten communal systems were described as planned rather than all confirmed as operational in the same passage, the evidence supports full achievement of the stove target and substantial progress toward the biogas target, but not an unqualified statement that every planned system was functioning.

The project also sought to create an enabling environment around the technologies. Beneficiaries contributed to purchase and installation, women were trained as installers, youth were trained as community technicians, and Community Action Plans linked local priorities to county-level climate planning. Kitchen gardens and bio-slurry use were intended to convert energy intervention into food-security and livelihood benefits. This integrated design offers greater scope for multidimensional impact, but it also creates more points of dependency, including access to water, livestock feedstock, functioning equipment, markets and institutional coordination.

4.3.2. Energy access, adoption and environmental outcomes

Household survey evidence indicates a high level of use. Ninety per cent of households reported exclusive reliance on improved Jiko Kisasa stoves.

Approximately 10% continued to use the traditional three-stone fire occasionally, principally because it was perceived as faster for some tasks or better able to accommodate large cooking pots. At a national level, the percentage grows to 11,3% (KNBS and ICF, 2023). In contrast with the near-complete substitution reported in Uganda, the Kenyan data therefore show a limited but meaningful pattern of stove stacking. The reasons are not signs of irrational resistance; they reveal functional requirements that should inform future stove design.

Households with functioning biodigesters reported using biogas for cooking two to three times per day. Technicians verified active use through direct observation of connected appliances and gas pressure. This strengthens the evidence because usage was not based solely on beneficiary statements. The combination of improved biomass stoves and biogas also provides technological flexibility: households can reduce wood use even when biogas availability fluctuates, although the coexistence of several technologies complicates attribution of outcomes to any single device.

The environmental results are substantial. Average daily firewood consumption reportedly fell from 17 kg to 4 kg per household, a 76% reduction and an improvement beyond the project's stated 60% target. Reported CO₂e emissions also decreased by 76%, while 92% of households

stated that they used less firewood and spent less on fuel. The reduction lowers pressure on forest resources and directly reduces the labour required for collection.

The figures should be interpreted within their measurement context. The supplied summaries do not provide the same methodological detail as the independent testing reported for Uganda, and the CO₂e values are presented without a fully specified unit in the source extract. The percentage reduction is therefore retained as reported, while the chapter avoids recalculating or converting the estimate. The strength of the Kenyan evidence lies in the consistency between household reports, observed technology use and the large reduction in daily wood demand.

4.3.3. Time savings, income and women's decision-making

The reduction in fuelwood demand generated a clear time and labour benefit for women and girls, who had historically carried and cut heavy loads of wood on a daily basis. Unlike the Ugandan evaluation, the Kenyan documentation does not provide a single quantified estimate of hours saved. It nevertheless explicitly reports that women spent less time fetching fuel and redirected the released time toward livelihood activities, caregiving, household tasks and other productive ventures. Beneficiaries also described more manageable cooking routines and cleaner kitchens.

The project provides more direct evidence of economic outcomes than the Ugandan case. Data collected during the Mid-Year household survey in December 2025 showed that households practising permaculture and selling surplus produce (320 households; 74% of 432 targeted households) reported an average monthly income of KES 432 . Average monthly production was reported at 13.5 kg of vegetables, of which approximately 8 kg was sold.

Fuel savings also have a distributive economic effect. Ninety-two per cent of households reported lower expenditure on firewood, freeing household resources for other needs. In addition, twenty women were trained as Jiko Kisasa installers, creating a pathway into technical work and entrepreneurship. These outcomes move beyond the treatment of women as beneficiaries and place them within the clean-energy value chain as service providers.

Evidence of decision-making and leadership is both quantitative and qualitative. Women represented 64% of members in multi-stakeholder monitoring committees responsible for Community Action Plans, exceeding the project's broader participation target of at least 50% for women and youth from a baseline below 30%. Women also acted as speakers in awareness campaigns and were described as key decision-makers in households and communities. Some

women reported that men began assisting with cooking after biodigesters were installed, suggesting a limited redistribution of domestic responsibility.

These findings indicate a stronger measurement of strategic gender outcomes than in Uganda, but they still require caution. Committee membership does not automatically equal influence, and the documents do not provide a before-and-after measure of women's bargaining power within households. Similarly, a shift in men's participation reported by some beneficiaries cannot be generalised to all households. The evidence supports an expansion of roles and opportunities, not a definitive conclusion that patriarchal relations were structurally transformed.

4.3.4. Health and quality-of-life outcomes

Beneficiaries reported high satisfaction with smoke-free or lower-smoke cooking and improved kitchen air quality. Reduced firewood collection also lowered physical strain, while cleaner kitchens decreased the time required to remove soot from utensils and walls. These outcomes are consistent with the health pathways established in Chapter 2 and with the observed reduction in biomass use.

The Kenyan documentation, however, does not provide disease-specific estimates comparable to the Ugandan figures for pneumonia, burns or eye irritation. Health impact is therefore supported primarily by perceived air-quality improvement and exposure reduction rather than by clinical or epidemiological measurement. This evidentiary gap does not negate the benefit, but it limits the precision of the impact claim and makes direct cross-country comparison inappropriate.

Quality of life also improved through the interaction of energy and livelihood activities. Time released from fuel collection, reduced fuel expenditure, kitchen-garden income and the use of bio-slurry as fertiliser created a package of benefits rather than a single outcome. The integrated model is potentially more transformative because it links domestic energy to food security and income; nevertheless, the strength of this claim depends on whether gardens, biodigesters and local support remain functional under difficult environmental conditions.

4.3.5. Affordability, local capacity and institutional sustainability

The project uses a cost-sharing model in which households contribute 10% of purchase and installation costs. Recognising limited cash availability, contributions can be made in kind through activities such as collecting water or construction materials. This arrangement seeks to

balance affordability with commitment: the beneficiary contributes to the asset without bearing the full capital cost. Fuel savings then reduce ongoing expenditure, while manual fuel-free grinders are intended to limit the operating cost of biogas feedstock preparation.

Local capacity is a central sustainability mechanism. The project trained twenty women as Jiko Kisasa installers and five young people as community technicians responsible for support, repair and maintenance. Training-of-Trainers methods were used in both agriculture and technology so that knowledge could be cascaded to peers. Sixty Champion Farmers reportedly reached an additional 420 people with climate-smart agriculture skills. These arrangements reduce dependency on external consultants and create local employment, although their durability depends on continued demand, access to replacement components and adequate remuneration.

Institutional integration further differentiates the Kenyan model. Five Community Action Plans were developed and approved for the target communities, incorporating disaster-risk-reduction principles and aligning local priorities with the Laikipia County Climate Change Action Plan. Training IPSIA staff in natural-resource management was explicitly designed as a sustainability measure, while project recommendations call for monitoring every six months and refresher training on maintenance and bio-slurry use.

The agricultural adoption figures require careful reading. Approximately 320 households were reported as adopting at least one permaculture practice, and the source describes this as 74% of the target population. Elsewhere, a target of 346 households is stated. Because those denominators are not internally consistent in the supplied summaries, the chapter retains the reported number of adopting households and treats the percentage as indicative rather than recalculating a definitive achievement rate. This example illustrates the importance of transparent denominators in project monitoring.

4.3.6. Implementation constraints and adaptive responses

The Be0Gas project encountered a wider range of environmental and logistical constraints than the Ugandan stove programme. Wildlife, particularly elephants, damaged installed systems and household gardens. Domestic and wild animals also destroyed crops in Naatum and Rapunye, initially discouraging garden maintenance. Water shortages in Chui Mama, Naatum and Lekiji delayed stove construction and limited the preparation of bio-slurry.

Difficult terrain required alternative system designs, while recurrent droughts and floods

slowed implementation and threatened expected results.

Cultural fit was a decisive implementation issue. The project initially planned seventy communal kitchens, but shared cooking spaces were found to be culturally inappropriate in Maasai communities, where kitchens are private and closely tied to household identity, cleanliness, food preference and decision-making. The design was consequently revised toward household-level units. Seasonal practices also affected timing: the circumcision season in Naatum temporarily relocated families and led to the construction of new manyattas, delaying implementation.

Institutional ownership was not uniform. At Lekiji Primary School, a system remained unused and unmaintained even after full replacement, indicating that technical provision cannot compensate for weak organisational responsibility. Early implementation in Chui Mama also faced behavioural resistance, leaving fifty stoves uninstalled until local energy champions intervened. These experiences support the same mechanism observed in Uganda: trusted local intermediaries are essential for translating access into adoption.

Economic and resource constraints affected biodigester performance. Rising costs for construction materials and biogas components contributed to the shift away from communal systems. Some households lacked sufficient cattle dung or water to prime and feed biodigesters consistently. *Opuntia stricta* was promoted as alternative feedstock, but uptake was lower than expected because grinders were scarce and processing the thorny material was labour-intensive.

Technical inspections identified gas leaks, low pressure, blocked inlets and outlets, and malfunctioning burners during the defect-liability period. Long distances between households in Twala and Rapunye complicated transport, supervision and training. Some community members initially lacked the capacity to operate and maintain the systems, requiring exposure visits and refresher training. These problems do not erase the project's achievements; they show that an integrated energy system requires adaptive design, functioning maintenance networks and repeated learning.

Overall, the Kenyan case demonstrates high effectiveness in stove distribution, substantial fuel reduction and meaningful expansion of women's technical and decision-making roles. Its integrated design generates direct livelihood opportunities that are not measured in the Ugandan case. At the same time, environmental variability, cultural misalignment, feedstock constraints, component defects and institutional weakness create a more complex sustainability profile.

4.4. Cross-case comparative assessment

Table 4.2 summarises the principal quantitative and qualitative findings. The comparison should be read horizontally within each evaluation dimension rather than as a ranking. Differences in technology, source methodology and follow-up duration prevent direct statistical equivalence, but the common framework makes it possible to identify contrasting strengths and evidence gaps.

Table 4.2. Comparative evidence matrix: Uganda and Kenya

Dimension	Uganda - Cookstove Project	Kenya – Be0Gas Project	Comparative interpretation
Scale and evidence base	Five-year survey of 200 households in four villages; households receive stoves in 2018-2019; independent technical testing also cited	718 Jiko Kisasa stoves installed against a target of 432; 60 flexi biodigesters installed and 10 fixed-dome units planned; monitoring and household survey evidence	Uganda provides stronger long-term follow-up detail; Kenya provides broader programme-output and livelihood data
Continued use	95% daily use; 97.5% fully discontinued the three-stone fire	90% exclusive improved-stove use; 10% occasional traditional use; biogas used two to three times daily in functional systems	Both show high adoption; stove stacking is more visible in Kenya because of large-pot and cooking-speed requirements

Fuel and climate outcomes	66% less wood; about 2.15 tonnes of firewood saved per household/year; 2.89 tonnes CO ₂ avoided per stove/year	Daily firewood use fell from 17 kg to 4 kg (-76%); reported CO ₂ e also fell 76%; 92% reported reduced firewood use	Large reductions in both cases, but methods and baselines are not identical
Time use	Average 7.6 hours/week saved in firewood collection; cooking reduced from about 3 hours to 1-2 hours	Lower time and labour burden reported; saved time redirected to livelihood, care and household activities; no single hour estimate supplied	Uganda quantifies the time effect; Kenya documents its use and social consequences more directly

Health and safety	Pneumonia - 69%; severe burns - 83%; eye irritation - 75%; fewer than 6% severe respiratory symptoms at follow-up	Improved kitchen air quality and high satisfaction with lower-smoke cooking; comparable disease-specific estimates	Uganda has the stronger health evidence; Kenya supports an exposure pathway rather than clinical impact
Income and agency	No direct income or decision-making metric; 95% can self-repair and women/daughters manage maintenance	KES 432 average monthly income from surplus produce; 20 women trained as installers; 64% of women monitoring committees; reported shift toward shared cooking	Uganda shows household technical ownership; Kenya measures wider economic and leadership roles
Affordability	Local free materials; about USD 10 direct programme cost per stove; no specialised parts	10% cost-sharing, including in-kind contributions; fuel savings and local technical services	Both reduce cash barriers, but Kenya's more complex systems have higher material and operating dependencies

Sustainability	Follow-up at about 1, 4-5 and 10 years; 95% self-repair; 1,172 stoves restored and 286 rebuilt	20 women installers, 5 youth technicians, Training of Trainers, five Community Action Plans and recommended six-month monitoring	Uganda emphasises long-term maintenance of one core technology; Kenya combines local capacity with institutional integration
Principal constraints	Construction precision, heat and water damage, long support cycle, residual wood scarcity and persistent habits	Water and feedstock shortages, wildlife, cultural resistance to communal kitchens, rising costs, technical defects, distance and weak institutional ownership	The simple Ugandan technology faces depth-and-speed trade-offs; the integrated Kenyan model faces coordination and resource complexity

4.4.1. Effectiveness and alignment between objectives and outcomes

Both projects demonstrate a high degree of alignment between their central objectives and reported outcomes. In Uganda, the core objective of replacing

the three-stone fire is reflected in 95% daily use and 97.5% complete discontinuation five years after installation. In Kenya, the stove-installation target was exceeded, household reliance on improved stoves reached 90%, and the reported 76% reduction in firewood use surpassed the project's stated 60% objective. These results indicate that neither intervention was limited to nominal distribution.

Effectiveness is stronger where implementation models address behavioural and technical

conditions together. Uganda couples household construction with village-based support and scheduled restoration. Kenya combines technology with local installers, community technicians, awareness campaigns and adaptation of the delivery model when communal kitchens proved unsuitable. In both cases, local intermediaries are not an ancillary feature; they are a contributing mechanism linking technology to continued use.

The comparison also reveals different outcome profiles. Uganda provides stronger evidence on long-term adoption, health, safety and quantified time savings. Kenya provides stronger evidence on direct economic participation, committee representation and the integration of energy with agriculture and local planning. The projects therefore achieve different combinations of practical and strategic gender benefits. A single aggregate score would conceal this complementarity.

Neither case permits a definitive evaluation of national policy effectiveness. The projects are consistent with the Ugandan and Kenyan policy priorities described in Chapter 3, including clean cooking, gender mainstreaming, decentralised capacity and climate resilience. However, the documents do not establish that national policy caused the project outcomes, nor do they show whether benefits reach the entire population. The cases provide evidence of policy implementation possibilities, not a representative measure of national performance.

4.4.2. Gender-transformative potential

The gender effects can be understood along a continuum from practical relief to strategic transformation. Uganda produces large practical gains: less smoke, fewer burns, lower fuel demand, faster cooking and 7.6 hours per week saved in wood collection. Women's ability to maintain and repair the stove adds technical agency. Yet income and decision-making are not directly measured, so the evidence does not show whether reduced drudgery alters control over household resources or wider gender hierarchies.

Kenya provides more explicit evidence of strategic participation. Women became installers, committee members, advocates and income earners, while some households reported greater male involvement in cooking. These results correspond more closely to the Gender and Development perspective outlined in Chapter 1 because they engage with roles, authority and the distribution of technical competence. Nonetheless, numerical participation alone cannot establish equal influence, and the absence of a rigorous before-and-after bargaining-power measure limits

the claim of transformation.

The cross-case evidence confirms that time savings are necessary but not sufficient for empowerment. Technology reduces the amount of unpaid labour required, but social norms determine whether women can convert time into education, paid work, rest or public participation. Kenya's livelihood and training components create more direct conversion mechanisms than the Uganda stove intervention alone. Conversely, Uganda's deep household ownership may produce forms of agency that are not captured by income indicators. A robust gender assessment must therefore combine time-use data with evidence on control, choice and recognition.

Both cases avoid the most reductive model of women as passive recipients. Households participate in construction in Uganda, and women enter technical and governance roles in Kenya. However, neither case provides sufficient intersectional data to determine whether the poorest women, women with disabilities, female-headed households or other marginalised groups experience benefits equally. The commitment to 'leave no one behind' requires future monitoring to disaggregate outcomes beyond a simple male-female division.

4.4.3. Sustainability, scalability and contextuality

Sustainability is the most clearly differentiated criterion. Uganda demonstrates actual sustainability through five-year use data and a ten-year restoration system. Its stove is built from local materials, can be repaired by 95% of households and does not depend on imported spare parts. Kenya demonstrates prospective and institutional sustainability through local technicians, Training of Trainers, Community Action Plans and internal staff capacity. The model also diversifies benefits across energy, agriculture and income.

The same features that strengthen each model create scalability trade-offs. Uganda's low-cost technology appears replicable, but exact construction, an 18-24 month village process and decade-long engagement require significant organisational depth. Scaling too quickly could dilute quality control and trust. Kenya's integrated package can generate broader benefits, but it depends on water, feedstock, equipment quality, agricultural conditions, functioning institutions and coordination across dispersed households. Replication without adapting these dependencies would reproduce technical failures rather than outcomes.

Cultural compatibility is decisive in both cases. Uganda's small proportion of persistent traditional-fire users and Kenya's 10% stove stacking show that households retain technologies

that perform functions the new devices do not fully replace. Kenya's abandonment of the communal-kitchen model is particularly instructive: an intervention can be technically rational and financially efficient on paper while remaining socially unacceptable. Adaptive redesign should therefore be treated as evidence of learning rather than deviation from a fixed plan.

The comparison suggests that scalability should be defined as the transfer of principles, not the mechanical replication of devices. The transferable principles are participatory design, trusted local leadership, affordable entry, reliable maintenance, culturally appropriate cooking capacity and gender-responsive monitoring. The physical technology and business model must remain context-specific.

4.5. Critical success factors

4.5.1. Women's participation, ownership and decision-making

The first critical factor is meaningful participation throughout the intervention cycle. Uganda demonstrates the value of involving families in construction and transferring repair knowledge to women and daughters. Kenya demonstrates the value of placing women in technical, monitoring and advocacy roles. In both cases, participation strengthens trust and reduces the distance between the technology and its primary users.

Participation must nevertheless be assessed qualitatively. Counting women in a meeting, committee or training course does not reveal whether they shaped design decisions, controlled income or were paid on equal terms. Project monitoring should therefore distinguish attendance from influence, unpaid contribution from remunerated work, and technical responsibility from formal authority. This would prevent gender mainstreaming from becoming the 'numbers game' criticised in Chapter 1.

The strongest model combines household-level ownership with community-level leadership. Women should be involved in selecting technologies, testing pot size and cooking performance, defining payment arrangements, delivering after-sales service and reviewing project results. Where men control household finance, engagement must also include intra-household dialogue so that the value of women's time and health is recognised in purchasing and maintenance decisions.

4.5.2. Accessible finance and locally viable business models

Affordability is not limited to a low purchase price. It includes the timing and form of

payment, fuel and operating costs, repair expenses, opportunity costs and the availability of finance. Uganda minimises the cash barrier through free local materials and a programme cost of approximately USD 10 per stove. Kenya combines a 10% contribution with in-kind payment, fuel savings and income-generating components. Both approaches recognise that low-income households may have labour or materials but limited liquidity.

A sustainable business model should align incentives across users, technicians and implementing organisations. Local installers and repairers require sufficient demand and remuneration to remain active after project funding ends. Households require predictable costs and access to replacement parts or repair materials. Programmes require financing for quality control and long-term monitoring. Failure in any one of these relationships can cause technically functional equipment to be abandoned.

Income generation can strengthen adoption when it is connected directly to the energy intervention. Kenya's training of women installers and use of kitchen gardens provide examples. Uganda's Cookstove Master role may also create local employment, but gender-disaggregated information is needed to establish who benefits. Future projects should track earnings, business survival and control over revenue rather than treating training completion as an economic outcome.

4.5.3. Cultural appropriateness and technical adaptability

A clean cooking device must fit local food, cookware, household architecture, fuel availability and social practice. Kenya's continued use of traditional fires for large pots and the rejection of communal kitchens demonstrate that cultural and functional fit are inseparable. Uganda's high substitution rate suggests strong compatibility, but the remaining 2.5% of traditional-fire users and the need for precise pot measurements show that no design is universally neutral.

Participatory testing should occur before large-scale installation and should continue after early use. Controlled cooking tests, home trials and feedback from women can identify problems involving heat intensity, lighting, pot stability, taste, cooking speed and simultaneous tasks. Adaptive changes should be documented so that evaluation can distinguish implementation learning from unexplained deviation.

Technical adaptability also concerns environmental conditions. Biodigesters require reliable water and feedstock; clay stoves require protection from water damage and accurate internal

geometry. Project selection should therefore be based on local resource systems rather than on a universal hierarchy of technologies. A lower-tech solution with strong maintenance support may outperform a technically cleaner system that cannot be fed, repaired or culturally integrated.

4.5.4. Long-term support, local repair capacity and institutional integration

Continued use depends on what happens after installation. Uganda's one-, five- and ten-year follow-up cycle, combined with household self-repair and the Cookstove Master network, provides the clearest evidence of long-term responsibility. Kenya's local installers, youth technicians, Training of Trainers and six-month monitoring recommendation seek to create a similar support ecosystem across a more complex technology portfolio.

Repair capacity must be both technically competent and institutionally anchored. Local technicians require tools, spare parts, refresher training and a viable service model. Schools, community groups and local governments must also accept responsibility for communal or public systems; the unused unit at Lekiji Primary School demonstrates that ownership cannot be assumed merely because equipment has been supplied or replaced.

Alignment with local plans can improve continuity after donor or NGO involvement decreases. Kenya's Community Action Plans and county-level integration provide a promising mechanism, while Uganda's village nomination of Cookstove Masters provides strong community legitimacy. The optimal institutional design is likely to combine both forms: bottom-up trust and top-down access to resources, regulation and long-term finance.

4.5.5. Gender-responsive monitoring, transparency and learning

The final success factor is a monitoring system capable of capturing both technical performance and social change. Core indicators should be defined before implementation and measured at baseline, shortly after installation and at longer follow-up intervals. At minimum, projects should report continued use, stove stacking, fuel consumption, time use, smoke exposure, repairs, household costs, income, decision-making and participation, with data disaggregated by sex, age, household type and other relevant vulnerability dimensions.

The comparison shows why this matters. Uganda can demonstrate long-term health and time outcomes but cannot quantify income or decision-making. Kenya can report participation and livelihood outcomes but lacks comparable clinical health measures and occasionally presents

unclear denominators. A common evidence framework would not erase contextual differences; it would make them more transparent and allow evaluators to separate absence of impact from absence of measurement.

Monitoring should combine objective and subjective evidence. Fuel weighing, emissions testing, technical inspection and time-use measurement can be complemented by interviews on taste, convenience, agency and intra-household negotiation. Negative and unintended outcomes - including increased unpaid maintenance, exclusion from committees, technology failure or conflict over shared facilities - should be reported alongside positive results. Transparent documentation of problems is a condition for adaptive management, not an admission of project failure.

4.6. Conclusion

The evidence reviewed in this chapter indicates that clean cooking interventions can produce substantial and durable benefits, but those benefits do not arise from technology alone. The Ugandan Cookstove Project demonstrates that a low-cost locally built stove can achieve very high continued use, reduce wood consumption, save women's time, improve health and safety, and remain functional over long periods when construction is participatory and maintenance is embedded in the community. The Kenyan Be0Gas project demonstrates that an integrated package of improved stoves, biogas, agriculture, local training and community planning can exceed distribution targets, reduce fuel use, create income opportunities and expand women's technical and decision-making roles.

The projects therefore work in important respects. Uganda reports 95% daily use and 97.5% abandonment of the three-stone fire five years after installation, together with a 66% reduction in wood use, 7.6 hours per week saved in fuel collection and major reported reductions in pneumonia, burns and eye irritation. Kenya reports 90% exclusive reliance on improved stoves, a 76% reduction in daily firewood consumption, lower fuel expenditure, training of women installers and 64% female representation in monitoring committees. These outcomes show that project-level implementation can translate clean-energy and gender-mainstreaming objectives into material change.

At the same time, the evidence does not justify an unqualified narrative of success. Uganda does not directly measure income or decision-making power, and its long-term support model is organisationally intensive. Kenya faces water and feedstock shortages, wildlife damage, cultural resistance to communal kitchens, technical defects, logistical distance and uneven institutional

ownership. In both cases, a small proportion of households retain traditional practices, demonstrating that cooking technologies are embedded in social and functional systems that cannot be replaced by distribution targets.

The comparative analysis confirms the broader argument developed throughout the thesis: gender-responsive climate action must address both practical needs and power relations. Reducing smoke and unpaid labour is essential, but transformation requires women to control technical knowledge, income, time and decisions. Kenya provides stronger direct evidence of this strategic participation, while Uganda provides stronger evidence of long-term household ownership and health impact. Neither dimension should be treated as sufficient on its own.

For policy and programme design, the key implication is that sustainability must be built from the beginning. Affordable finance, participatory testing, local leadership, repair networks, culturally appropriate design, institutional integration and transparent monitoring are not secondary components; they are the infrastructure that allows environmental and gender benefits to persist.

Scaling should reproduce these principles while adapting the technology to local conditions, rather than replicating a standard device or business model without regard to context.

Finally, the chapter highlights a central evidence gap. Project monitoring must become more consistent, long-term and gender-disaggregated if policies are to be evaluated scientifically. Future research should combine direct emissions and fuel measurements with time-use diaries, health indicators, income records and qualitative analysis of intra-household decision-making. Only through this multidimensional evidence can clean cooking be assessed not merely as an energy intervention, but as a potential pathway toward climate resilience, public health and substantive gender equality

CHAPTER 5

Recommendations and Future Perspectives

This chapter translates the empirical results of the comparative assessment into recommendations for policy design, project implementation and future research. Chapter 4 showed that clean cooking interventions can generate substantial environmental, health and socio-economic benefits, but also that the durability and distribution of those benefits depend on factors that extend well beyond the technical performance of a stove or biodigester. The Cookstove Project (CSP) in Uganda and the Be0Gas project in Kenya demonstrate two different but complementary pathways: one centred on deep household ownership, local materials and long-term follow-up, and the other on the integration of clean cooking with climate-smart agriculture, local governance and women's technical participation.

The recommendations that follow are therefore not presented as universal prescriptions. They are evidence-informed propositions derived from the two case studies and interpreted through the theoretical and policy framework developed in Chapters 1 to 3. In particular, they reflect the gender and development perspective, which distinguishes between the alleviation of practical burdens and the transformation of the social relations that produce unequal access to time, income, knowledge and decision-making power. They also respond to the implementation gaps identified in Chapter 3, where progressive international and national commitments coexist with persistent financial barriers, data deficits, institutional weaknesses and socio-cultural constraints.

Three principles guide the chapter. First, the relevant measure of success is not the number of devices distributed, but sustained and meaningful use over time. Second, reducing smoke exposure and unpaid labour is essential, but it does not by itself demonstrate gender empowerment; the analysis must also examine control over resources, income, technical knowledge and collective decision-making. Third, scaling should reproduce successful principles rather than copy technologies mechanically. A stove, a biodigester or a financing model that performs well in one location may fail elsewhere if it does not fit local cooking practices, resource availability, household architecture, institutional capacity and gender relations.

The chapter is organized in four parts. Section 5.1 synthesizes the principal empirical findings and the lessons that emerge from the comparison between Uganda and Kenya. Section

5.2 develops policy recommendations for governments and international agencies, including a local Gender Energy Audit framework. Section 5.3 translates the evidence into project proposals for non-governmental organizations and social enterprises. Section 5.4 identifies research priorities required to strengthen the evidence base on gender, energy poverty and climate action. A final section draws together the implications for a gender-responsive and socially sustainable energy transition.

5.1. Synthesis of the key research findings

5.1.1. The Ugandan case: sustained adoption through ownership and long-term support

The Ugandan case provides the strongest evidence in the study for durable household adoption. The Five-Year Impact Evaluation surveyed 200 households in four villages of Mukono District whose improved stoves had been installed in 2018-2019. Five years later, 95% of households reported using the improved stove every day and 97.5% had completely discontinued the traditional three-stone fire. These figures are particularly significant because they indicate substitution rather than simple device ownership. In clean-cooking programmes, a technology can be physically present while households continue to rely on traditional fires for part of their cooking. The CSP results suggest that, for most participating households, the intervention became embedded in daily practice.

The environmental and time-use outcomes are equally substantial. Independent testing and programme evaluations report a 66% reduction in firewood consumption, equivalent to approximately 2.15 tonnes of wood saved per household per year, alongside an estimated reduction of 2.89 tonnes of CO₂ per stove per year. The frequency of daily firewood collection fell from 63% of households before the intervention to 6% after adoption, while women saved an average of 7.6 hours per week in fuel gathering. Cooking a standard meal, which previously required approximately three hours on a three-stone fire, generally fell to one or two hours. These findings support the argument developed in Chapter 2 that the value of clean cooking cannot be assessed only through fuel efficiency: it also changes the allocation of household time, which is a scarce economic and social resource.

The health and safety results reinforce this multidimensional interpretation. The programme reports a 69% reduction in pneumonia cases, an 83% decline in severe burns and a 75% reduction in chronic eye irritation. The double-chamber design also made simultaneous water heating more

practical, with daily drinking-water boiling rising from 1% to 48.5% of surveyed households; whereas 26.5% had previously reported never boiling drinking water, none did so at follow-up. Although these indicators should be interpreted in light of the limitations of secondary project evaluation, they show how a single household energy intervention can generate co-benefits across health, sanitation, labour and environmental domains, as emerged from the literature review on the subject, conducted in the first chapter.

The mechanism behind these outcomes is as important as the figures. CSP does not treat the stove as a finished product delivered to a passive beneficiary. Families participate in constructing a permanent double-chamber clay stove from locally available materials, while community-nominated Cookstove Masters provide technical knowledge and support. Forty-two Masters operate across the programme areas, and the project maintains structured follow-up over a period that can extend to ten years. The resulting technical autonomy is visible in the finding that 95% of households are able to carry out minor repairs independently; the knowledge gained during the project not only makes the primary users not entirely dependent on external technicians, but also brings them recognition among their community.

At the same time, the Ugandan case demonstrates the trade-off between depth and speed. Long-term durability requires precise construction geometry, repeated contact with communities and restoration capacity. The ten-year programme has restored 1,172 stoves and completely rebuilt 286 units that had degraded beyond minor repair. This commitment strengthens actual sustainability, but it also makes the model organizationally intensive and potentially slower to scale than programmes based on simple equipment distribution. Moreover, the evaluation does not provide direct quantitative measures of women's earnings or changes in intra-household decision-making power. Consequently, the evidence is very strong on practical benefits and sustained use, but more limited on strategic gender transformation.

5.1.2. The Kenyan case: an integrated pathway from clean cooking to livelihoods and local governance

The Be0Gas project in Kenya presents a broader intervention logic. Rather than focusing on a single household technology, the programme combined improved Jiko Kisasa stoves, household biodigesters, climate-smart permaculture, kitchen gardening, training and Community Action Plans linked to county-level climate governance. The project installed 718 Jiko Kisasa stoves, substantially exceeding the original target of 432, and commissioned 60 flexible

household biodigesters.

The reduction in biomass demand was marked. Average daily firewood consumption fell, with a 76% reduction, and the project reported a similar decline in its CO₂e indicator.

As in Uganda, lower biomass demand translated into a reduction in the time and physical labour required from women and girls and that saved time was redirected toward productive activities, caregiving and other livelihood tasks.

The distinguishing feature of the Kenyan case is the stronger evidence on strategic participation and livelihood diversification. Twenty women were trained as Jiko Kisasa installers, creating a direct link between the energy intervention and technical employment. Also, women representation as members on multi-stakeholder committees exceeded the project's participation target. These activities move the intervention towards a model in which women enter the technical, productive and governance dimensions of the programme.

The agricultural component created measurable, although modest and uneven, income streams. This evidence is important because it illustrates a mechanism through which time savings can be converted into economic opportunity. Chapter 2 emphasized that reduced domestic labour does not automatically become empowerment if the released hours are simply reabsorbed by other unpaid tasks. The Kenyan model partially addresses this problem by connecting clean energy with productive activity, training and marketable skills.

However, integration also produces greater implementation complexity. Droughts and floods affected project delivery; water scarcity delayed stove construction and reduced the operational feasibility of biodigesters; and some households lacked sufficient feedstock. Technical inspections identified gas leaks, low pressure, blocked inlets or outlets and malfunctioning burners during the liability period. Long distances between households created logistical difficulties for staff and trainees. These constraints show that the performance of a renewable-energy device cannot be separated from the ecological and infrastructural system on which it depends.

5.1.3. Cross-case interpretation: from practical relief to structural empowerment

The comparison between Uganda and Kenya confirms that clean-cooking interventions can generate a chain of mutually reinforcing benefits, but the chain is not automatic. Both projects reduced dependence on firewood, lowered women's labour burden and achieved high levels of continued technology use. Uganda provides stronger longitudinal evidence on health, safety, time savings and household-level technical self-reliance. Kenya provides stronger evidence on women's remunerated technical roles, productive activities, committee representation and the

integration of clean energy with local climate planning. The two projects therefore illuminate different dimensions of gender-responsive energy access.

This distinction can be interpreted through the transition from practical gender needs to strategic gender interests developed in Chapter 1. Reducing smoke, burns, fuel expenditure and hours spent collecting wood addresses immediate material burdens that disproportionately affect women. These outcomes are indispensable and should not be minimized. Nevertheless, they do not necessarily alter the social rules through which income, property, authority and technical expertise are distributed. Structural empowerment becomes more plausible when women control the knowledge required to maintain the technology, receive income from related activities, participate in investment decisions and exercise influence in community governance.

The cases also confirm that time is a necessary but insufficient resource. In Uganda, the project returns a measurable number of hours to women each week, but the evaluation does not establish how those hours are ultimately allocated or whether they change bargaining power within the household. In Kenya, project documentation provides clearer examples of time being linked to livelihood activity and technical participation, yet the evidence remains insufficient to determine whether such changes persist after external support ends or whether women retain control over the income generated. Future monitoring must therefore treat time savings as an intermediate outcome rather than as a proxy for empowerment.

A second cross-case lesson concerns ownership. In Uganda, ownership is built through household participation in construction and repair. In Kenya, ownership is pursued through cost-sharing, local installers, training, community action planning and institutional alignment. Both models reduce the distance between the technology and the user, but they do so at different levels. The evidence suggests that a resilient intervention requires both forms: household-level ownership that makes the technology usable and repairable, and institutional ownership that connects the intervention to local planning, finance and public responsibility.

A third lesson concerns adaptation. The success of the Ugandan stove depends on compatibility with household cooking practices; the Kenyan programme had to abandon a communal-kitchen concept and accommodate ecological constraints affecting biodigesters and gardens. These experiences contradict a technology-first approach in which devices are selected centrally and replicated without sufficient attention to social context. The appropriate unit of scaling is therefore the set of principles that makes sustained use possible: participatory design, affordable access, technical quality, local repair capacity, cultural compatibility, trusted leadership and continuous learning.

Finally, the comparison reinforces the need to distinguish between the absence of impact and the absence of measurement. Uganda does not quantify income or decision-making, while Kenya lacks comparable clinical health measures and equivalent long-term follow-up. It would be methodologically incorrect to conclude that an unmeasured outcome did not occur. A common gender-responsive evidence framework is needed so that future comparisons can assess similar domains without erasing contextual differences.

5.1.4. Limits of the evidence and implications for interpretation

The recommendations developed in this chapter must be read in light of the methodological limitations discussed in Chapter 4. The analysis is based primarily on secondary project documentation and evaluations rather than on a new experimental or quasi-experimental data collection exercise. The absence of a common counterfactual, the different monitoring periods and the different indicator systems used by the two projects limit direct statistical comparison.

Moreover, project-generated evidence can be affected by selection, reporting and measurement bias. High adoption rates may reflect the characteristics of households that remained engaged in the programme; self-reported health improvements and time use may differ from clinical or directly observed measures; and participation figures do not by themselves demonstrate influence or control. For this reason, the policy proposals below emphasize mixed-method monitoring, transparent reporting of negative results and the separation of output indicators from higher-level measures of empowerment.

The cases should therefore be used as analytical demonstrations of mechanisms rather than as universal blueprints. They show what can work, under which documented conditions, and where implementation problems emerged. This approach is consistent with the broader argument of the thesis: gender-responsive energy policy is most effective when it is treated as an adaptive social process rather than as a one-off transfer of technology.

5.2. Policy recommendations for governments and international agencies

5.2.1. Integrating clean cooking into gender, climate and development policy

The first recommendation is to treat clean cooking as a cross-sector policy field rather than as a narrow household-energy programme. The evidence reviewed in Chapters 2 and 4 shows that the same intervention can affect emissions, forest pressure, respiratory health, safety, water

sanitation, time use, household expenditure, education and women's economic participation. When these dimensions are managed by separate ministries without a common framework, the benefits of a project may remain fragmented and important costs may fall outside the sector responsible for the technology.

National strategies should therefore connect clean cooking targets with climate commitments, public-health planning, gender-equality strategies, rural development and local economic policy. This is particularly relevant in Uganda and Kenya, where Chapter 3 identified formal commitments to gender mainstreaming, cleaner household energy, disaggregated data and climate resilience.

An integrated approach also prevents clean cooking from being framed solely as a welfare intervention for vulnerable women. The cases show that women are users, maintainers, installers, farmers, trainers and committee members. Policy should recognize these roles by designing programmes that reduce immediate burdens while simultaneously expanding women's technical and economic capabilities.

5.2.2. Removing legal and financial barriers to access

Affordability is one of the most persistent barriers to clean-energy adoption, but it should not be reduced to the retail price of a device. For low-income households, affordability includes the availability of cash at the moment of purchase, the cost and reliability of fuel, maintenance expenses, travel to repair services, replacement parts and the opportunity cost of women's unpaid labour. Governments and development agencies should therefore assess the full household cost of an energy service rather than simply subsidizing equipment.

Legal and financial exclusion interact. Where women lack secure rights to land, inheritance or productive assets, they may be unable to provide conventional collateral for loans even when the technology would reduce household expenditure over time. This creates a structural mismatch between the people who bear the greatest cost of energy poverty and those who control the resources needed to change the energy system. Reforms that strengthen women's property and inheritance rights should therefore be complemented by financial products that do not depend exclusively on land titles or formal salaried employment.

The two case studies illustrate different ways of reducing entry barriers. The CSP model minimizes the household cash requirement by using freely available local materials and embedding technical costs in programme support. Be0Gas uses a cost-sharing model in which households contribute a limited proportion of installation costs and can make part of the

contribution in kind. Neither approach should be universalized, but both demonstrate that payment design can influence ownership and access. Public policy should allow a portfolio of mechanisms, selected according to local income patterns and technology costs.

Financial support should also cover the less visible infrastructure of sustainability. Funding frameworks often favour the initial purchase or installation of equipment because these outputs are easy to count. Yet the Ugandan evidence shows the importance of restoration over ten years, and the Kenyan evidence shows the need for technicians, refresher training and repeated monitoring. Public and donor budgets should therefore recognize maintenance, community training, quality control and long-term evaluation as core investment costs rather than optional overheads.

5.2.3. Expanding women's leadership, technical roles and access to public procurement

Women's participation should be institutionalized across the energy value chain rather than concentrated in awareness-raising activities. Governments can combine representation targets with technical training, scholarships in STEM and TVET, apprenticeships, business-development services and procurement opportunities. The objective is not numerical parity alone, but a redistribution of expertise, income and authority in sectors that remain strongly gendered.

Kenya provides an important policy example through the constitutional two-thirds principle, permanent Gender Desks and the Access to Government Procurement Opportunities framework, which reserves a share of public contracting for enterprises led by women, youth and persons with disabilities. Such measures can be adapted to decentralized energy services by reserving suitable maintenance, installation, component-supply or monitoring contracts for qualified local firms and cooperatives while maintaining transparent quality standards.

Training programmes should be linked to recognized competencies and remuneration. The Be0Gas experience of training women as Jiko Kisasa installers is more significant than a generic attendance indicator because it creates a technical role with economic value. Similarly, the Ugandan Cookstove Master system shows how trusted local expertise can support long-term adoption. Future programmes should record the gender composition of these roles, payment levels, continuity of employment and progression into supervisory or entrepreneurial positions.

5.2.4. Building gender-responsive monitoring systems

The evidence gap identified in Chapter 4 cannot be solved through a larger number of uncoordinated indicators. Governments and agencies need a core monitoring framework that combines technical, environmental, health, economic and gender outcomes over time. At minimum, clean-cooking programmes should measure continued use, frequency of traditional-fire use, fuel consumption, cooking time, time spent obtaining fuel, household expenditure, repair frequency, smoke or emissions exposure, health outcomes, income generated, control over that income and participation in household and community decisions.

Data should be collected at baseline and at multiple follow-up points. Short-term surveys can capture initial acceptance, but they cannot establish sustainability. Uganda demonstrates the value of five- and ten-year follow-up, while Kenya demonstrates the need for periodic technical checks and refresher training. Longitudinal monitoring should therefore be incorporated into project budgets from the beginning rather than added only when a donor requests evidence.

Sex-disaggregated data are necessary but not sufficient. An intersectional approach requires attention to household income, age, disability, ethnicity, location, household headship and other factors that can alter access to technology and benefits. Aggregate improvements can conceal unequal distribution. For example, a programme may report high female participation while the poorest women remain unable to afford the technology, or it may reduce average fuel use while households with large cooking requirements continue to rely on traditional fires.

International agencies can support comparability by promoting a limited set of harmonized gender-energy indicators that complement SDG 7 reporting. These indicators should not reduce empowerment to the number of women present in a committee, but they should capture influence, control over productive assets, paid technical roles, time allocation and changes in decision-making.

5.2.5. Climate finance, international cooperation and safeguards

International climate finance should support the full life cycle of decentralized energy interventions. The case studies indicate that durable benefits depend on training, local repair networks, monitoring, adaptive redesign and institutional integration. These components should be eligible costs within climate and development finance instruments.

Gender should also be integrated into Nationally Determined Contributions and climate-

finance strategies through traceable commitments rather than general references. This requires defined targets, responsible institutions, budget lines and reporting rules. International agencies can support national governments by financing data systems, technical training and local-level audit capacity, particularly where sub-national administrations have responsibility for energy, agriculture or climate action but limited analytical resources.

Carbon finance may be useful in some contexts, but the evidence in this thesis cautions against presenting it as a universal solution. It should demonstrate additionality, transparent monitoring, fair distribution of revenues and free, prior and informed participation, while ensuring that measurement requirements do not divert disproportionate resources away from service delivery. The broader principle is that financing should reinforce, rather than replace, local ownership. Whether the source is public expenditure, donor grants, concessional loans, carbon revenues or household contributions, the financial mechanism should be assessed according to its effect on access, accountability and long-term maintenance.

5.3. Project proposals for NGOs and social enterprises

The central lesson from both Uganda and Kenya is that project design must begin with the problem experienced by users, not with a preferred technology. The following proposals translate the comparative findings into implementable options for NGOs and social enterprises.

5.3.1. Women-led distribution, maintenance and after-sales networks

A first model is the development of women-led energy networks inspired by approaches such as Solar Sister and the Sakhis model (Hart & Smith, 2013). Local women can be trained to demonstrate, sell or lease clean-energy devices and to provide basic maintenance and after-sales support. In rural areas, relationship-based distribution can reduce information barriers and increase trust because the seller understands local cooking practices, language and household constraints.

Participants should receive certified technical training, transparent remuneration, access to working capital and clear pathways to entrepreneurship. The Kenyan installers and the Ugandan Cookstove Masters illustrate two complementary functions that such a network can combine: technical service and trusted community leadership. A viable business model must also ensure access to spare parts, warranty procedures and refresher training so that the network remains active after initial project funding ends.

Evaluation should track not only the number of women trained but also sales continuity, repair performance, income under women's control, business survival and changes in community recognition.

5.3.2. Productive-use energy and women-led climate-smart agriculture

A second model links clean household energy to productive uses that allow time savings to generate income. The Be0Gas experience provides direct support for this approach: kitchen gardening and permaculture created small but measurable revenue streams and connected household energy transition with food security and climate resilience. NGOs can extend this logic through women-led cooperatives where environmental and market conditions are suitable. The key design principle is integration. A productive-use project should therefore include agronomic support, market analysis, group governance, maintenance and climate-risk assessment. It should also verify that women control a meaningful share of the revenue rather

By linking energy access to a productive activity, the programme creates a pathway through which time can be converted into income, skills and bargaining power. This directly addresses the gap between practical relief and strategic empowerment identified in the cross-case analysis.

5.3.3. Certified local stove-production centres with participatory design

A third proposal is the creation of local stove-production or assembly centres that combine participatory design with standardized quality control. Local users must be involved in testing pot sizes, stability, heat intensity, fuel compatibility, cooking speed and the preparation of traditional foods.

The Ugandan case shows the value of local materials and household participation, but also the risk created by small deviations in internal geometry. A local production centre should therefore combine local craftsmanship with precise templates, installation protocols and performance checks. Certification can reduce variation while preserving local adaptation. Where women already possess relevant skills production centres can create paid technical roles with schedules that take account of existing care responsibilities.

5.3.4. Community women technicians and decentralized renewable-energy services

A related proposal is the training of women from remote communities as decentralized energy technicians. Practical and visual training can be adapted for participants who have limited

formal education, enabling them to install, maintain and repair simple solar or household-energy systems in their own communities.

The potential gender effect is twofold. First, local technical capacity reduces dependence on distant service providers and increases the probability that systems remain functional. Second, technical expertise challenges the assumption that energy infrastructure is exclusively a male domain. However, these outcomes should be evaluated rather than assumed. Programmes should document remuneration, certification, decision-making authority, workload and whether women are able to retain their technical role after external support is withdrawn.

This model is particularly relevant where geographical distance makes centralized maintenance uneconomic. It can also be combined with last-mile distribution networks, creating a local ecosystem in which women participate in sales, installation, repair and user education.

5.4. Future research perspectives

The empirical analysis also reveals a set of research gaps that are important for both scholarship and policy. Future research should move beyond a predominantly engineering-based or formally gender-neutral approach and adopt a systemic, intersectional and rights-based perspective. The central methodological challenge is to connect physical performance with changes in time, health, income, agency and power over a sufficiently long period to distinguish temporary project effects from durable transformation.

5.4.1. Measuring empowerment beyond technology adoption

Future evaluations should distinguish between access, use, practical welfare gains and structural empowerment. Adoption rates are essential because no benefit can persist if a technology is not used, but adoption cannot be treated as an end point. The Ugandan evidence demonstrates high sustained use without direct measurement of income or decision-making, while the Kenyan evidence provides stronger participation and livelihood indicators but less longitudinal information. A common framework should therefore follow the pathway from technology use to time savings, from time savings to new activities, and from those activities to control over income, assets and decisions.

Qualitative research is indispensable for this purpose. Household surveys can identify who reports making a decision, but interviews and repeated observation are needed to understand

negotiation, conflict, consent and the meaning attached to new roles. Research should ask whether women can decide how saved income is spent, whether they can refuse additional unpaid work, whether technical expertise changes their authority and whether participation in committees results in substantive influence.

5.4.2. Intersectional and distributional analysis

Women should not be treated as a homogeneous analytical category. Future research should disaggregate outcomes by income, age, household headship, disability, ethnicity, geographic remoteness and other contextually relevant factors. This is consistent with the intersectional framework and with the OECD-DAC emphasis on differential effects across groups.

Such analysis can identify whether an intervention unintentionally privileges households with more land, livestock, labour or political connections. Biodigesters, for example, may be less feasible for households without reliable water or sufficient feedstock. Credit-based models may exclude those with irregular incomes. Community committees may reproduce local hierarchies even when women are numerically represented. Distributional analysis is therefore necessary to determine who benefits, who pays and who remains excluded.

5.4.3. Comparative research on policy implementation and scalability

This work identified a persistent gap between progressive policy commitments and local implementation. Future research should examine the institutional mechanisms that determine whether gender-responsive provisions in climate and energy strategies actually influence budgets, procurement, technology choice and local participation. Comparative studies across districts or counties could assess why similar national policies produce different outcomes.

Scalability should also be studied as a governance question. The Ugandan model raises questions about whether deep, long-term community engagement can be expanded without reducing quality, while the Kenyan model raises questions about coordination across multiple technologies, institutions and ecological conditions. Research should compare the costs and outcomes of scaling through centralized distribution, local production, franchise networks, public programmes and community-based models, while preserving gender-responsive indicators.

5.4.4. Rights-based governance, accountability and research transparency

Finally, future work should generate empirical evidence on rights-based energy governance. This includes studying how communities can claim access to information, participate in budgeting, challenge unsafe or exclusionary projects and influence climate-finance decisions. Social audits and community development agreements should be evaluated not only as administrative procedures but as potential mechanisms of power redistribution.

Research transparency is equally important. Documentary analysis, including AI-assisted retrieval or synthesis, should preserve a clear chain between claims and original sources, distinguish extraction from interpretation and report uncertainty where the evidence is incomplete. This is especially relevant in multidisciplinary research where technical, legal and social data are produced by institutions with different reporting standards.

5.5. Conclusions

The evidence synthesized in this thesis supports a clear conclusion: clean-energy technologies can contribute simultaneously to climate mitigation, public health and gender equality, but their transformative potential depends on the institutional and social systems in which they are embedded. The Ugandan and Kenyan case studies demonstrate that high adoption and strong environmental performance are achievable, yet they also show that technology is only one component of a durable transition.

The Ugandan CSP model demonstrates the value of participatory construction, trusted local leadership, repairable local materials and long-term organizational presence. Its strongest contribution is the evidence that adoption can remain high five years after installation while producing substantial reductions in fuel use, time burden and reported health risks. The Kenyan Be0Gas model demonstrates the potential of a broader, integrated approach that links clean cooking with biodigesters, agriculture, income generation, women's technical roles and local climate planning. Its strongest contribution is the evidence that women can move beyond the role of end user and participate in installation, monitoring, production and community decision-making.

Neither model is complete. Uganda provides limited direct evidence on income and bargaining power, while its intensive long-term support creates scaling challenges. Kenya faces ecological, technical, cultural and institutional constraints and still records some continued use of

traditional fires. These limitations are not peripheral; they identify the conditions under which future interventions must be designed. A project that ignores pot size, water scarcity, maintenance, household privacy or local decision-making can fail even when the underlying technology is efficient.

For governments and international agencies, the central recommendation is therefore to move from device-centred policy to service- and capability-centred policy. Clean cooking should be integrated into gender, climate, health and local-development strategies; budgets should be assessed through a gender-responsive lens; data systems should measure differential outcomes; and finance should support maintenance, training and monitoring as well as installation. Women's participation must be linked to influence, technical competence and control over economic resources, not measured only through attendance or beneficiary counts.

For NGOs and social enterprises, sustainable scaling requires locally adaptable models. Women-led last-mile networks, productive-use energy, participatory manufacturing, labour-saving platforms, community technicians, health-linked delivery and inclusive finance can all contribute to this goal when they respond to locally diagnosed needs. Their success should be judged by continued use, affordability, technical reliability, reduction of unpaid labour, income and agency rather than by distribution figures alone.

Finally, the research agenda must become more longitudinal, intersectional and multidimensional. The next generation of studies should connect field-based technical performance with time-use, health, income, decision-making and rights. Only then will it be possible to determine whether clean cooking merely makes existing gender roles less burdensome or contributes to changing the distribution of resources and power that sustains energy poverty. In this sense, the transition to clean household energy is not only an environmental or technological challenge. It is also a question of social justice, institutional accountability and the capacity of women to participate as full agents in the design of a low-carbon future.

CONCLUSION

This thesis has examined the relationship between gender equality, energy poverty and climate action, with particular attention to the role of clean cooking technologies in contexts where access to energy remains strongly influenced by social, economic and environmental inequalities. The analysis developed throughout the study shows that these three dimensions cannot be considered separately. Energy poverty affects much more than the availability of a fuel or a cooking device: it influences how time is distributed within the household, who is exposed to health risks, who has access to resources and who is able to participate in economic and political decisions. For this reason, the transition towards cleaner household energy should be understood as part of a wider process involving environmental sustainability, public health and social relations.

The theoretical discussion developed in the first chapter made it possible to place these issues within the broader evolution of the gender and climate debate. The transition from Women in Development to Gender and Development, together with the development of ecofeminist and intersectional perspectives, has progressively changed the way women's relationship with the environment is interpreted. Women can no longer be considered simply as a vulnerable group or as passive beneficiaries of development programmes. Their experiences are shaped by different social and economic conditions, while their knowledge and responsibilities in relation to food, water, energy and natural resources can also make them important actors in adaptation and mitigation processes. At the same time, the analysis has highlighted the limitations of approaches that treat “women” as a single and homogeneous category or assume that participation automatically produces empowerment.

The second chapter narrowed this discussion to energy poverty and, in particular, to clean cooking. The evidence reviewed suggests that the value of an improved cooking technology cannot be assessed only by measuring its technical efficiency. A technology can reduce fuel consumption and emissions, but its real usefulness depends on whether households can afford it, whether it corresponds to local cooking practices, whether it can be maintained and whether users are actually willing to adopt it. This is especially important for women, who often carry a disproportionate share of cooking and fuel-collection responsibilities. The cases examined in

Kenya, Nepal and rural China showed that the benefits associated with cleaner technologies may include reduced physical effort, lower exposure to smoke, greater availability of time and, under favourable conditions, new opportunities for economic participation. At the same time, freeing time does not necessarily mean that women gain greater autonomy: without changes in access to income, education and decision-making, the time saved may simply be absorbed by other forms of unpaid work.

The policy analysis developed in Chapter 3 further demonstrated that the recognition of gender within environmental and energy governance has progressed significantly at the international and national levels. International frameworks have increasingly incorporated gender mainstreaming, participation and gender-responsive approaches, while Uganda and Kenya have developed policies addressing energy transition, climate action and gender equality. Nevertheless, the existence of formal commitments does not necessarily guarantee their effective implementation. Financial constraints, institutional fragmentation, insufficient data, unequal access to resources and socio-cultural norms can create a substantial distance between policy objectives and everyday realities. The policy framework is therefore necessary, but it is not sufficient by itself. Its effectiveness ultimately depends on the institutional and local mechanisms through which principles are translated into concrete services and opportunities.

The empirical analysis of Chapter 4 provided the opportunity to examine this question in practice through two different interventions: the Cookstove Project (CSP) in Uganda and the Be0Gas project in Kenya. The findings indicate that substantial environmental, health and socio-economic improvements are possible when clean cooking interventions are supported by appropriate social and institutional conditions. In Uganda, five years after installation, 95% of the surveyed households reported using the improved stove every day and 97.5% had completely abandoned the traditional three-stone fire. The project also reported a 66% reduction in firewood consumption and an average saving of 7.6 hours per week in fuel collection, together with significant reported reductions in pneumonia, severe burns and eye irritation. These results are particularly relevant because they show that long-term adoption can be supported through participatory construction, locally available materials, community-based technical knowledge and continuous follow-up.

The Kenyan case reached similar goals through a different model. The Be0Gas project

combined improved stoves with biodigesters, climate-smart agriculture, community planning and technical training. The project reported 90% exclusive use of improved stoves and a 76% reduction in daily firewood consumption, while also creating opportunities for women to participate as installers and members of monitoring committees. In this case, the role of women extended more explicitly beyond that of final user, including technical and organisational responsibilities. However, the implementation also revealed a number of difficulties, including water and feedstock shortages, technical problems, logistical constraints, cultural resistance to some project components and weaknesses in institutional ownership. These difficulties are important because they confirm that even a well-designed intervention may encounter limits when environmental and social conditions are not fully compatible with the proposed technology.

The comparison between the two projects therefore does not lead to a simple conclusion that one model should replace the other. Rather, it highlights different dimensions of the same broader problem. The Ugandan experience shows the importance of ownership at household level, local repair capacity and long-term engagement. The Kenyan experience illustrates the possibilities created by a more integrated model, in which clean cooking is connected with agriculture, livelihoods, women's technical participation and local governance. The two cases also demonstrate why the number of devices distributed is not an adequate indicator of impact. Continued use, affordability, maintenance, time allocation, health, income and decision-making need to be considered together. A project may distribute a large number of technologies without producing lasting change, while a smaller intervention may generate more durable results when it is closely adapted to the context in which it operates.

One of the main findings of the research is therefore that technology should not be considered the final objective of the energy transition, but rather one of the means through which broader social and environmental objectives can be pursued. The reduction of smoke exposure and unpaid labour is an important improvement, but it should not automatically be equated with gender empowerment. A reduction in women's workload becomes potentially transformative only when the time, knowledge and resources released through the intervention contribute to greater opportunities and greater control over decisions. This distinction is central to understanding why gender-responsive energy policy must address both practical needs and the power relations that shape access to resources.

The study also highlights the importance of sustainability. The long-term functioning of a clean cooking intervention depends on factors that begin well before installation: participatory design, affordability, cultural compatibility, training, local technical capacity, access to spare parts, monitoring and institutional responsibility all play a role. The evidence from Uganda and Kenya suggests that local ownership can reduce dependence on external actors, but local responsibility cannot substitute for public and institutional support. Sustainable programmes therefore require a combination of community-level knowledge and broader access to finance, infrastructure, regulation and long-term planning.

At the same time, the conclusions of this thesis must be interpreted in light of the limitations of the available evidence. The empirical analysis relied primarily on secondary project documentation and existing evaluations rather than on original experimental fieldwork. The two projects used different indicators, different follow-up periods and different forms of measurement, making direct statistical comparison impossible in several areas. Uganda provides strong longitudinal evidence on adoption, fuel consumption, time and health, but much less direct information on income and decision-making. Kenya provides more evidence concerning women's participation and livelihood opportunities, but less comparable longitudinal and clinical health data. Consequently, the absence of evidence for a particular outcome should not be interpreted as evidence that the outcome did not occur. Future evaluations would benefit from common, gender-responsive indicators that combine technical measurements with information on time use, health, income, decision-making and agency.

Looking ahead, research on clean cooking and energy poverty should therefore become more longitudinal, intersectional and multidimensional. It should investigate not only whether technologies are adopted, but also who benefits from them, who remains excluded and how the distribution of time, resources and decision-making changes over the years. Greater attention should also be paid to the institutional dimension of the energy transition, examining how national policies are translated into local budgets, programmes and services. In this regard, women should not be included merely as a numerical category within projects or committees. Their participation needs to be connected to technical knowledge, remuneration, influence and control over economic resources.

Ultimately, the evidence examined in this thesis suggests that the transition towards cleaner household energy has implications that go beyond the environmental sphere. It can contribute to reducing fuel consumption and household pollution, improving health and safety, easing the burden of unpaid work and creating new opportunities for participation. Yet these outcomes are not automatic. They depend on the institutional, economic, cultural and social systems surrounding the technology. The central challenge, therefore, is not simply to replace traditional cooking systems with more efficient ones, but to create the conditions in which clean energy access can also support greater resilience, greater social inclusion and more equitable access to opportunities.

The relationship between climate action and gender equality should consequently be understood as part of the same transition rather than as two separate policy objectives. Environmental sustainability cannot be considered complete if the social inequalities associated with energy access remain unchanged, just as gender equality cannot be separated from the environmental conditions on which livelihoods and well-being depend. Clean cooking is only one component of this broader transformation, but the evidence discussed in this thesis shows that, when it is designed around people's real needs and supported by appropriate institutions, it can become an important entry point for addressing both environmental challenges and the unequal distribution of opportunities that continues to shape everyday life.

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