

**Elucidating the Conceptual, Institutional, and Practical Dimensions of
the Social Sustainability of Off-Grid Electrification in the Philippines
(フィリピンにおけるオフグリッド電化の社会的持続可能性に関する
概念・制度・実践各側面の解明)**

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Abstract

Expanding access to reliable, affordable, and clean electricity remains a persistent global challenge, particularly in rural and remote regions where grid extension is technologically and economically difficult. Off-grid electrification systems have emerged as critical solutions for achieving total electrification. While recent electrification efforts increasingly emphasize economic viability and environmental performance, the social dimension of sustainability remains relatively underexamined and inconsistently integrated into research, policy, and practice. This dissertation addresses this gap by investigating the social sustainability of off-grid electrification, with a focus on the Philippines, across three levels: the conceptual level (how social sustainability is defined and framed in academic literature), the institutional level (how social sustainability is embedded in national energy policies), and the practical level (how relevant government stakeholders perceive and prioritize social aspects). By synthesizing insights across these levels, the dissertation develops a unified framework that can guide the inclusion of social sustainability in planning, decision-making, and evaluation processes for off-grid electrification in the Philippines and beyond.

The dissertation begins with an overview of the research (Chapter 1), including the research background, questions, and contribution. Three relevant topics are also discussed to provide readers with essential information for the succeeding chapters: social sustainability and existing frameworks, the Philippine electric power industry, and off-grid electrification process in the country.

Then, the first empirical chapter (Chapter 2) systematically reviews 143 peer-reviewed articles on social sustainability assessment in electricity generating systems. Despite growing research about sustainability in the energy sector, the review reveals persistent ambiguity in the conceptualization of social sustainability. Various studies adopt implicit or narrow definitions, and many embed social aspects under other sustainability dimensions without clear justification. The chapter identifies recurring themes, including “social development/well-being, quality of life”, “socio-economic benefits and employment”, “health and safety”, “energy access and reliability”, “social acceptance”, “social equity”, “education”, “involvement and governance”, “gender”, and “human rights”. These insights provide a foundation for understanding social sustainability and serve as a basis for analyzing Philippine energy policy and context.

Building on Chapter 2’s conceptual foundation, Chapter 3 analyzes the integration of social sustainability in Philippine energy policies related to off-grid electrification. Using qualitative content analysis, the chapter assesses relevant national laws and department-level guidelines. Six prominent social sustainability categories emerge: energy access, socio-economic benefits and employment, involvement and governance, social development and quality of life, social equity, and health and safety. Meanwhile, underrepresented categories—including social acceptance, gender, human rights, and education—signal institutional gaps in recognizing and operationalizing social sustainability.

Chapter 4 focuses on the practical level, investigating government stakeholders’ perceptions and priorities in off-grid electrification. Semi-structured interviews, a follow-

up questionnaire, and document analysis reveal institutional perspectives on social sustainability's relevance, meaning, and feasibility. Stakeholders acknowledge affordability, livelihood enhancement, education, and health and safety but lack awareness of broader social sustainability beyond economic and basic welfare. Institutional challenges like unclear mandates, overlapping responsibilities, weak coordination, and lack of awareness on social sustainability hinder systematic integration. This chapter presents integration pathways for social sustainability in three key stages of off-grid identification: area identification, electrification option evaluation, and post-implementation monitoring. While concern for socially responsive electrification grows, practical implementation is constrained by institutional structures and knowledge gaps.

The previous chapters have analyzed the conceptual, institutional, and practical dimensions independently. As such, Chapter 5 synthesizes insights from the preceding chapters to develop a coherent and actionable framework for integrating social sustainability into off-grid electrification systems. It compares and consolidates findings from literature, policy analysis, and stakeholder perspectives, identifying similarities, differences, and recurring gaps across conceptual, institutional, and practical levels. The chapter discusses the implications of the framework for theory, policy, and practice, highlighting its potential applicability beyond the Philippine context. It also situates the proposed framework alongside prominent other social sustainability frameworks.

Overall, this dissertation makes four key contributions. Conceptually, it contributes to energy and social sustainability research by clarifying concepts related to the social sustainability of electrification systems and providing empirical insights into how social aspects are integrated at the national governance level. At the policy level, the research offers empirical evidence on the gaps in Philippine energy policy regarding social sustainability and proposes actionable pathways for integrating social dimensions across the off-grid electrification process. Methodologically, the research employs a multi-method approach, including systematic literature review, qualitative content analysis, and interviews, to understand and assess social sustainability. Overall, it proposes an integrated framework that bridges the conceptual, institutional, and practical dimensions of social sustainability in energy governance. It provides a structured basis for designing, evaluating, and monitoring socially sustainable off-grid electrification projects.

By examining social sustainability across multiple levels and synthesizing these insights into a structured, actionable framework, this dissertation contributes to ongoing efforts to ensure that off-grid electrification not only expands access to electricity but also promotes inclusive, equitable, and meaningful improvements in people's well-being.

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LIST OF ABBREVIATIONS

AHP	Analytic Hierarchy Process
CSO	Civil Society Organization
CSP	Competitive Selection Process
DC	Department Circular
DDP	Distribution Development Plan
DOE	Department of Energy
DSWD	Department of Social Welfare and Development
DU	Distribution Utility
EC	Electric Cooperative
EPIRA	Electric Power Industry Reform Act
ERC	Energy Regulatory Commission
HRES	Hybrid Renewable Energy Systems
IP	Indigenous Peoples
IPRA	Indigenous Peoples' Rights Act
KALAHI-CIDSS	<i>Kapit-Bisig Laban sa Kahirapan</i> -Comprehensive and Integrated Delivery of Social Services
LCA	Life Cycle Analysis
LGU	Local Government Unit
LTER	Local Total Electrification Roadmap
M&E	Monitoring and Evaluation
MCDA	Multiple Criteria Decision Analysis
MEDP	Missionary Electrification Development Plan
MGSA	Microgrid Systems Act
MGSP	Microgrid Service Provider
NEA	National Electrification Administration
NGCP	National Grid Corporation of the Philippines
NGO	Non-Government Organization
NPC	National Power Corporation
NPC-SPUG	National Power Corporation – Small Power Utilities Group
NTER	National Total Electrification Roadmap
PDA	Policy Discourse Analysis
PEP	Philippine Energy Plan
QCA	Qualitative Content Analysis
QTP	Qualified Third Party
RA	Republic Act
RE	Renewable Energy
RPS	Renewable Portfolio Standards
SDG	Sustainable Development Goal
SEIA	Socio-Economic Impact Assessment

SIA	Social Impact Assessment
SLCA	Social Life Cycle Assessment
SSI	Social Sustainability Indicator
TOPSIS	Technique for Order of Preference by Similarity to Ideal Solution
TransCo	National Transmission Corporation
UC-ME	Universal Charge for Missionary Electrification
UNEP	United Nations Environment Programme
VIKOR	ViseKriterijumska Optimizacija I Kompromisno Resenje

Chapter 1 Introduction

1.1 Background and motivation

Access to reliable and affordable electricity is widely recognized as a cornerstone of sustainable development. It enables improvements in education, health services, livelihood opportunities, and overall quality of life [1]. Yet despite global advances in electrification, around 685 million people, particularly those living in remote and underserved communities, remain without adequate access [2].

For archipelagic and geographically dispersed countries such as the Philippines, expanding electricity access to remote islands and mountainous regions continues to be a persistent policy priority [3,4], despite encountering long-standing logistical and financial challenges [5,6]. Off-grid electrification systems, such as solar home systems, mini-grids, and hybrid solutions, are increasingly recognized as critical pathways to bridging this energy access gap [7,8], particularly in geographically isolated areas where grid extension is technically difficult or financially prohibitive [9].

National government agencies play central roles to ensure the success of off-grid electrification programs as they take the lead in planning, implementing, and regulating such programs. Meanwhile, private sector players and other non-government organizations supplement electrification efforts through various initiatives [10,11].

Aside from ensuring access to electricity services, the growing emphasis on sustainability has reshaped how energy systems are planned, implemented, and evaluated. Although the energy sector is often discussed in terms of its economic and environmental performance, the social dimension of sustainability has received comparatively less attention [12,13]. The lack of conceptual clarity, inconsistent use of indicators, and limited operational frameworks have constrained efforts to meaningfully integrate social considerations into electrification initiatives [14–16]. In the context of off-grid systems, this gap is especially consequential as long-term technical and economic success often depends on whether systems are socially acceptable, responsive to community needs, and supported by the appropriate institutions [17–19].

In the Philippines, landmark policy developments, including the Electric Power Industry Reform Act (EPIRA), the Renewable Energy (RE) Act, and the Microgrid Systems Act (MGSA), reflect the government's commitment to achieving universal access. While there have been steady gains in household electrification in the Philippines and worldwide, questions remain about the extent to which social sustainability is systematically integrated into a country's energy sector, including its policies, planning, project evaluation, and monitoring processes [20,21]. Furthermore, the extent to which social

sustainability is embedded in these policies and translated into practice remains uncertain [22–24]. The perspectives of national-level stakeholders, who play a central role in planning and governance, also remain underexplored. Understanding how these actors interpret, prioritize, and implement social sustainability is vital for improving electrification outcomes and enhancing the inclusivity of energy transitions.

Given this context, there is a pressing need to examine how social sustainability is conceptualized in global research, how it is integrated in national electrification policies, and how it is perceived and operationalized by decision-makers in the Philippines. Addressing these gaps is essential not only for advancing academic understanding but also for informing policy reforms and guiding future off-grid electrification initiatives in the Philippines and beyond.

1.2 Research questions and objectives

The Philippines' continuing commitment to achieving complete electrification coincides with the global imperative to adhere to sustainability principles. Concurrently, the social dimension of sustainability has been underemphasized in comparison to the economic and environmental pillars. This disparity raises the pertinent question of how off-grid electrification effectively integrates social sustainability in the conceptual, institutional, and practical levels. This broad research question is subsequently translated into four specific questions, within the context of the Philippines:

1. How is social sustainability defined, interpreted, and assessed in the literature on electrification systems?
2. To what extent is social sustainability integrated in Philippine energy policies governing off-grid electrification?
3. How do key government stakeholders in the Philippines perceive and prioritize social sustainability in off-grid electrification?
4. How can social sustainability be better integrated in off-grid electrification in the Philippines?

The purpose of the first question is to establish a foundational understanding of how social sustainability concepts are defined and operationalized. By addressing this initial question, subsequent research questions gain a reference point for comparison with policies and stakeholders. The second research question aims to investigate the extent of social sustainability integration within pertinent policies for off-grid electrification in the Philippines. The third research question seeks to determine the perceptions and prioritizations of national-level stakeholders regarding social sustainability in the context of off-grid electrification. Finally, the fourth research question aims to propose recommendations to better incorporate social considerations within policy and practice.

1.3 Literature review

1.3.1 Social sustainability and existing frameworks

Social sustainability, often considered the least defined pillar of sustainability, covers the social dimensions that support equitable and resilient societies [25]. While economic and environmental sustainability focus on growth and ecological balance, it ensures that energy transitions are just, inclusive, and beneficial to communities [26]. Key elements include social equity, human well-being, participation, and governance [27]. In energy systems, social sustainability extends beyond mere energy access to include affordability, employment, stakeholder participation, and long-term social benefits [28,29].

Several conceptual frameworks have been developed to understand and evaluate social sustainability in energy systems. This subsection presents an overview of the following: social footprint, SEEBalance, social life cycle assessment (SLCA), Roundtable Handbook, social impact assessment (SIA), Social Life Cycle Metrics, energy justice, and Just Energy Transition.

Richter et al. [30], in their review of social sustainability assessment literature, identified three prominent approaches. The social footprint method, initially proposed by McElroy [31] and improved by Weidema [32], adapts principles of ecological footprint to social dimensions, emphasizing the social carrying capacity of communities and the performance of organizations in meeting basic human needs.

The next approach is SEEBalance [33], which integrates environmental and social dimensions into what their authors term socio-eco-efficiency analysis. Originating from corporate sustainability efforts, SEEBalance primarily evaluates the sustainability performance of products and processes, focusing on balancing social and ecological impacts in industrial contexts.

The third and more widely used approach is the SLCA, originating from Benoit et al. [34], which adapts the structure of environmental life cycle assessments (LCAs) to evaluate social impacts across the product life cycle. SLCA has influenced several major assessment frameworks, including the United Nations Environment Programme (UNEP) Guidelines for SLCA of Products [35], the Product Social Impact Assessment Handbook developed by Goedkoop et al. [36], and the Social Life Cycle Metrics by the World Business Council for Sustainable Development [37].

Another approach present in literature, and one of the oldest in practice, is the SIA, which is a tool used to evaluate the social consequences of projects and systems in the future [38]. The work of Alomoto et al. [39] provides a comprehensive review of SIA, including

its theoretical origins and evolution. Examples of SIA application include energy resource planning [40] and policy outcomes [41].

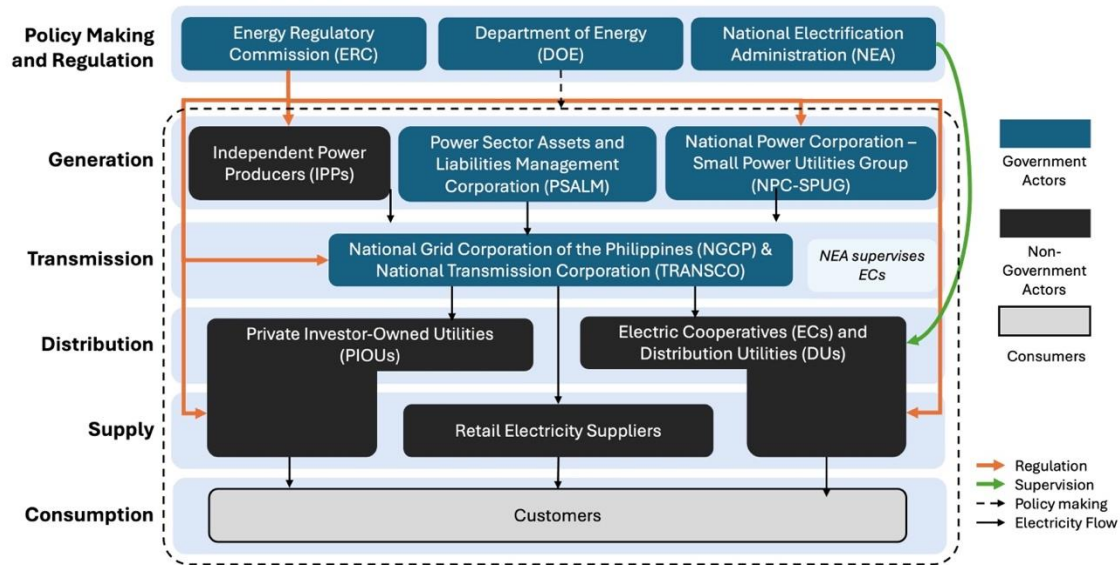
In parallel, energy justice literature has also heavily shaped the understanding and evaluation of social sustainability. One example is the energy justice framework [13,42], which focuses on distributive, procedural, and recognition justice. Closely related is the concept of Just Energy Transition, which emphasizes addressing social justice concerns for marginalized and vulnerable populations [43].

Despite the relevance of these approaches and frameworks, their application in national energy policy evaluations remains limited. Most tools, including SEEBalance, SLCA, and SIA, are mainly utilized at the project or product level [44,45] and often lack the scalability for national energy policy evaluation. In some instances, however, they are applied to evaluate energy transition programs and policies [46–49]. Few studies have focused on energy policy analysis, although mostly through the lens of energy justice and equity. These include the works of Chapman et al. [50] and Hartwig et al. [51] in the Australian and Japanese contexts, respectively. These efforts signal a growing recognition of the need for socially inclusive energy transitions, though systematic operationalization at the policy level remains an area of significant gap and opportunity. These gaps also present an opportunity for country-specific, policy-level investigations into how social sustainability is operationalized within national electrification systems.

1.3.2 Structure of the Philippine electric power industry

The Philippines is a particularly relevant case given its long-standing electrification agenda and extensive power sector reforms. Total electrification has long been a central pillar of the Philippines' energy policy, linked both to national development goals and to global commitments on sustainable development. The EPIRA of 2001 created a competitive electricity market and restructured the country's power industry and unbundled it into four major subsectors: generation, transmission, distribution, and supply [52]. This structure is elaborated further in Figure 1-1. The reform aimed to promote competition, encourage private sector participation, and ensure reliable and affordable electricity service across the country [53,54].

Under EPIRA, the Department of Energy (DOE) is mandated to craft national energy policies, guidelines, and strategic roadmaps. Meanwhile, the Energy Regulatory Commission (ERC) regulates the sector. Meanwhile, the generation subsector includes all electricity-producing entities. Due to EPIRA, generation was opened to competition, encouraging private sector investment. In off-grid areas, however, the National Power Corporation – Small Power Utilities Group (NPC-SPUG) remains a key player as they are mandated to generate power when private providers are unable to.



Note: Modified from the Asian Development Bank [55].

Figure 1-1: Overview of the Philippine electric power industry.

For transmission, the National Transmission Corporation (TransCo) holds ownership of the country's transmission assets. However, operations and maintenance of the transmission system are currently undertaken by the National Grid Corporation of the Philippines (NGCP) under a concession agreement. TransCo continues to play a key role in the planning of interconnection projects, particularly for small and off-grid systems.

Meanwhile, electricity distribution is carried out primarily by private distribution utilities (DUs), electric cooperatives (ECs), and, in some instances, local government units (LGUs). These entities hold franchises to distribute electricity to end-users within their service areas. Finally, the supply subsector comprises electricity suppliers other than DUs and ECs, such as retail electricity suppliers. They operate under the open access framework and are licensed to engage in the sale of electricity to contestable customers.

Aside from restructuring the sector, EPIRA also recognized the need for “missionary electrification”, which corresponds to the government’s mandate to provide electricity services in remote and off-grid areas unlikely to be served by the private sector. Despite an apparent rapid progress in expanding grid connections, the household electrification rate is close to 93% as of 2024 [56], insufficient electrification remains a problem. One way to address this is through missionary electrification.

1.3.3 Overview of off-grid electrification in the Philippines

Several actors play key roles in realizing full electrification in the country. On the government side, the DOE develops policies, oversees national energy planning, and sets electrification targets. Meanwhile, the National Electrification Administration (NEA)

supervises and supports ECs, which distribute electricity to most rural areas. The NPC-SPUG acts as provider of last resort in missionary areas. The ERC regulates tariffs and ensures consumer protection, while the TransCo facilitate interconnection projects and ensures stability of the country's grid systems. On the non-government side, private sector players and civil society organizations (CSOs) may participate as Qualified Third Parties (QTPs) and microgrid systems providers (MGSPs). Additionally, they may influence decision-making through consultations conducted by the government.

The Philippine energy sector participants are guided by a layered set of policy instruments that structure electrification planning and implementation. At the national level, the Philippine Energy Plan (PEP), Missionary Electrification Development Plan (MEDP), Distribution Development Plan (DDP), Power Development Plan (PDP), and National Total Electrification Roadmap (NTER) outline targets and strategies for expanding electricity access. These national frameworks are informed by Local Total Electrification Roadmaps (LTERs), which are prepared at the local level by DUs and ECs with the support from NEA. Together, these plans provide the basis for identifying grid, off-grid, and missionary areas, as well as determining which projects are viable for private sector participation.

Meanwhile, DUs and ECs are obligated to provide electricity services to their jurisdiction, including unviable areas. If the relevant DU does not have a viable solution, the area may be transferred to another available DU. MGSPs, as specified in Republic Act (RA) 11646, or the Microgrid Systems Act, may step in if the DUs are unable to serve the area. Overall, the DOE is tasked to identify these areas—formally termed as missionary areas—and open it to the private sector.

If areas are deemed viable, projects are opened to the private sector through mechanisms such as the competitive selection process (CSP). As a last resort, the NPC-SPUG performs the missionary electrification. The ERC regulates tariffs and subsidies under this structure.

The challenges facing the Philippines are not unique. Many countries with archipelagic geographies, such as Indonesia, rely on subsidies and state-owned utilities to provide off-grid electrification, while struggling to attract private investment [57,58]. Others, like India, have adopted hybrid approaches combining central planning with decentralized solutions [59], and more recently, have introduced social impact metrics in rural electrification programs [60].

In this context, the Philippines presents a strong case: while institutional arrangements and financing mechanisms for missionary electrification are well developed, social sustainability considerations remain marginal in planning, evaluation, and monitoring. This gives importance to investigate how stakeholders, particularly government actors,

understand social aspects of off-grid electrification, and how these can be better integrated into the policy process.

1.4 Overarching research methodology and research stages

This research employs a qualitative, multi-method research design that integrates insights from academic literature, national policy documents, and stakeholder perspectives. The methodological approach is aligned with the research’s central aim of capturing the conceptual, institutional, and practical levels of social sustainability in off-grid electrification in the Philippines. The overall research design is presented in Figure 1-2.

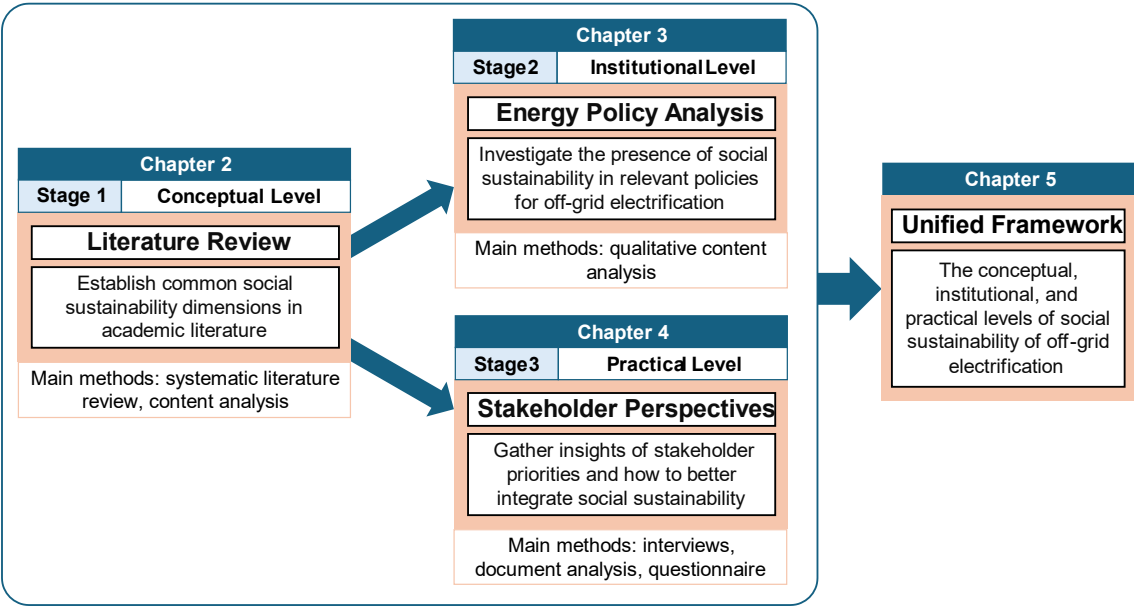


Figure 1-2: Overall research methodology.

The first stage (Chapter 2) corresponds to a systematic literature review of peer-reviewed academic literature was conducted to examine how social sustainability has been defined, interpreted, and assessed in the context of electricity generating systems. The review followed established guidelines for systematic searches, screening, and thematic analysis. This approach provides a structured foundation for understanding current knowledge on social sustainability in electrification systems.

The next stage (Chapter 3) carried out a qualitative content analysis (QCA) of relevant Philippine energy policies to assess the extent to which social sustainability is integrated into the policy landscape governing off-grid electrification. Policy documents, including laws and department-level guidelines, were systematically coded using a coding framework informed by the results of the first stage. The QCA enabled the identification of explicit and implicit social dimensions, thematic patterns, and policy gaps.

The third stage (Chapter 4) primarily examined stakeholder perspectives through a combination of document analysis, semi-structured interviews, and a follow-up questionnaire involving national-level government representatives and supplementary input from non-government actors. This mixed data collection strategy captured both institutional viewpoints and experiential insights. The interview and survey data were analyzed using QCA and descriptive methods to identify perceived priorities, challenges, and institutional constraints related to social sustainability.

Across the three stages, the research takes a grounded approach because social sustainability is shaped by contextual meanings, institutional arrangements, and stakeholder interpretations. While each stage utilized different methods, they all contribute to a coherent understanding of social sustainability from conceptual, institutional, and practical perspectives, leading ultimately to an integrated framework.

1.5 Research contribution

This research contributes to energy and social sustainability research in various ways:

- Firstly, this research contributes to the theoretical foundations of social sustainability by clarifying concepts surrounding the social sustainability of electrification systems. Through a case study focused on the Philippine setting, it also provides empirical insights into how social aspects are integrated at the national governance level.
- Next, at the policy and practical levels, this research provides empirical evidence on the gaps in Philippine energy policy in terms of integrating social sustainability, a research endeavor that has not been conducted yet. These are supplemented by insights from stakeholders in the electric power industry. As a response to these gaps, this research provides actionable pathways for integrating social dimensions across the off-grid electrification process.
- In terms of methodology, this research demonstrates a multi-method approach for understanding and assessing social sustainability. Specifically, systematic literature review, qualitative content analysis, and interviews were conducted to primarily address the research questions.
- Ultimately, the research proposes an integrated framework that bridges the conceptual, institutional, and practical dimensions of social sustainability in energy governance. This serves as a structured basis for designing, evaluating, and monitoring socially sustainable off-grid electrification projects.

1.6 Dissertation structure

The dissertation structure is shown in Figure 1-3. Chapter 1 provides the necessary background surrounding the research and presents the research objective, research questions, and structure of the thesis.

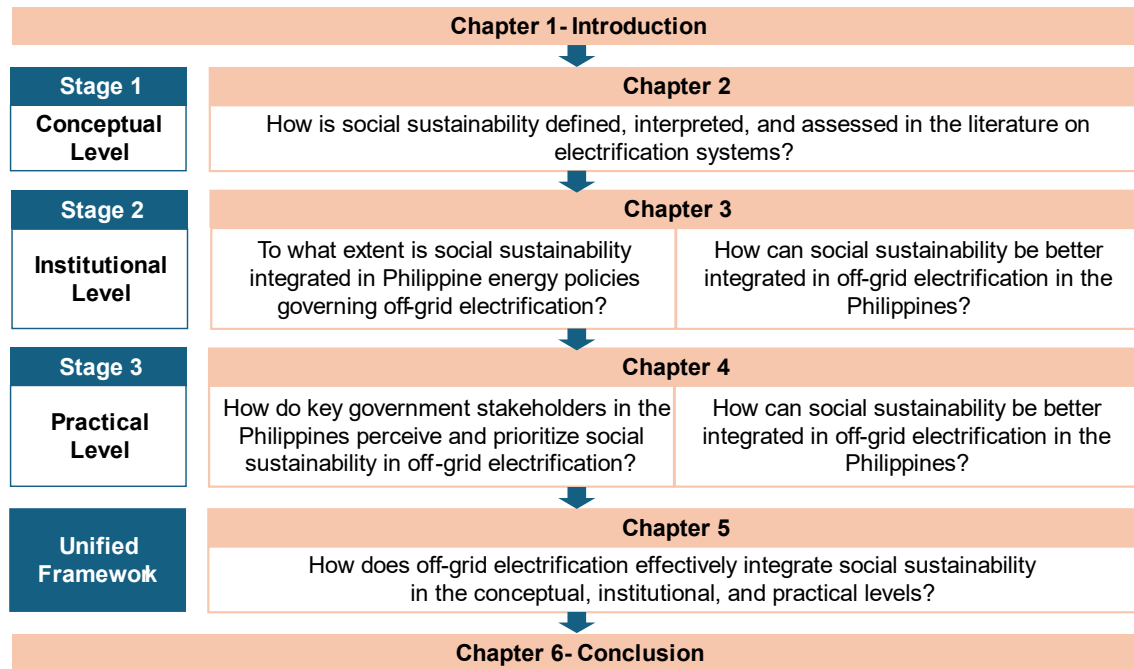


Figure 1-3: Structure of the dissertation.

Chapter 2 presents a systematic review of international peer-reviewed literature on social sustainability assessment in electricity generating systems. It synthesizes findings from 143 articles to clarify how social sustainability is defined, operationalized, and evaluated across diverse contexts. By mapping current knowledge and highlighting research gaps, this chapter provides the conceptual foundation for understanding how social dimensions are framed globally and establishes the analytical basis for the subsequent chapters.

Chapter 3 investigates the extent to which social sustainability is integrated into Philippine energy policies governing off-grid electrification. By performing a QCA of key policy documents, the chapter applies a structured coding framework to identify the presence of social sustainability dimensions. The analysis reveals six prominent categories (energy access, socio-economic benefits and employment, involvement and governance, social development and well-being, social equity, and health and safety) as well as underrepresented areas such as social acceptance, gender, human rights, and education. By uncovering policy gaps and institutional blind spots, this chapter provides an empirical foundation for understanding how social sustainability is framed within the national policy landscape.

Chapter 4 examines how national-level government stakeholders perceive and prioritize social sustainability in off-grid rural electrification in the Philippines. Drawing on semi-structured interviews, and guided by document analysis and a follow-up questionnaire, the chapter identifies key institutional challenges, including unclear mandates, misaligned responsibilities, and limited awareness of social dimensions. It reveals that stakeholders place strong emphasis on affordability, access, livelihood enhancement, education, and health and safety, while other social aspects receive less attention. The chapter also proposes illustrative social indicators relevant to planning, evaluation, and monitoring stages of off-grid electrification.

Chapter 5 synthesizes insights from the preceding chapters to develop a coherent and actionable framework for integrating social sustainability into off-grid electrification systems. The chapter compares and consolidates findings from the literature, policy analysis, and stakeholder perspectives. Specifically, this chapter identifies similarities, differences, and recurring gaps across the conceptual, institutional, and practical levels. The chapter discusses the implications of the framework for theory, policy, and practice, comparison with prominent social sustainability frameworks, and highlights its potential applicability beyond the Philippine context.

Chapter 6 concludes this dissertation by summarizing the previous chapters, explaining how the research questions were addressed, highlighting the limitations of the research, and suggesting future works.

Chapter 2 Review of Social Sustainability Assessments of Electricity Generating Systems

2.1 Introduction

The global pursuit for sustainable development has necessitated the transition of the energy industry to a low carbon future. While serving as the cornerstone of progress and modern society, the energy sector, particularly electricity generating systems, is expected to reduce its emissions of greenhouse gases and other pollutants. Additionally, electricity generating systems play an important role in advancing economic growth and influencing various aspects of people's daily lives [1]. In this regard, sustainability in these systems entails three fundamental aspects: economic, environmental, and social sustainability.

The most common definition of sustainability stems from the Brundtland Report, which suggests that development must “meets the needs of the present without compromising the ability of future generations to meet their own needs” [61].

Based on this principle, economic sustainability in electricity generating systems typically revolves around cost-effectiveness, profitability, and financial viability. It involves analyzing factors related to costs (investment, operating costs, etc.) and potential returns on investment. Indicators such as the capital cost and the cost of energy provide clear quantitative measures to assess economic sustainability [14]. For instance, if an electrification project can generate electricity at a lower cost over its lifetime compared to alternatives, it is considered economically sustainable.

Similarly, environmental sustainability in electricity generating systems focuses on minimizing negative environmental impacts, such as greenhouse gas emissions, pollution, and habitat destruction. Common indicators used to measure environmental sustainability include the amount of carbon dioxide emissions and fraction of renewable energy in the system [14].

Aspects of social sustainability are core to sustainable development, in that they consider the “needs” of current generations and the distribution of the benefits both inter- and intra-generationally. However, in comparison to economic and environmental sustainability, the social pillar has received less attention despite the growing amount of research on sustainability assessment. This can be attributed to different reasons, such as lack of a common definition of the concept and the absence of mature quantitative and qualitative tools to measure social sustainability, among others [14–16].

Furthermore, only minimal research has sought to address the ambiguity of social sustainability. For example, the work of Vallance et al. [62] attempted to clarify the

concept and presented a three-point scheme—development sustainability, bridge sustainability, and maintenance sustainability—to represent social sustainability. Meanwhile, the work of Eizenberg et al. [63] proposed that social sustainability is principally grounded on the concept of risk. Their work encompasses equity, safety, eco-consumption, and urban forms as the main facets of their proposed conceptual framework for social sustainability.

Despite these attempts to clarify social sustainability, fewer work has focused on applying the concept in the context of energy system assessments. Although various review articles have covered sustainability assessment of energy systems [64–70], these works catered to a more general sense of sustainability, thereby limiting the discussion of the social aspect, while heavily discussing the economic and environmental ones. Not many review articles solely focused on social sustainability. One example is the list of 101 social impacts of energy systems presented by Ribeiro et al. [15]. Meanwhile, the work of Rafiaani et al. [71] compared three major social sustainability assessment tools used in the biobased economy, namely, social impact assessment (SIA), socio-economic impact assessment (SEIA), and social life cycle analysis (SLCA). Recently, SLCA was reviewed in the context of industrial solar energy applications in the work of Zafar, et al. [72].

The recent work of Afshari et al. [73] developed a framework for social sustainability assessment based on studies covering energy and non-energy sectors, such as manufacturing, supply chain, and construction sectors. The authors identify three gaps in the literature of energy system social sustainability assessment: lack of a common definition for social sustainability, lack of studies about social sustainability aspects, and absence of comprehensive review of indicators to assess the social sustainability of energy systems. Overall, however, their work focused highly on the indicators.

Generally, four major problems are identified from the existing literature. First, the reviews [64–70] focused on general sustainability and have only partially discussed the social aspect. Some of these reviews recommend further investigation of the social aspect [65,69].

Another problem is the limited number of articles considered in previous reviews. Previous studies [15,70], which can potentially exclude other relevant information. While Afshari et al. [73] reviewed relatively more articles, not all articles pertain to the energy sector.

The third problem is that some review articles covered only specific tools, such as the work of Wang et al. [64] focused on multiple criteria decision analysis (MCDA), the work of Campos-Guzmán et al. [65] focused on combining MCDA with life cycle analysis (LCA) approach, and the work of Rafiaani et al. [71] focused on only SIA, SEIA, and

SLCA. Meanwhile, other review articles focused solely on negative social impacts, such as in the work of Feron [68].

The last problem is that some articles focused only on a particular energy type, for example the literature reviews of previous studies [66,67,71] focused on bioenergy while previous studies [68,72] focused on solar energy.

Acknowledging the above limitations in the existing literature explains our motivation to examine related literature to social sustainability assessments of energy systems to update the status of the research in the field. In this regard, the chapter's objectives are to explore the existence of explicit definitions and social sustainability indicators, to develop themes categorizing social sustainability, to identify the roles of stakeholders involved in related literature, and to investigate the intersections between the themes and the energy types studied.

In doing so, the study also presents the current research landscape and a conceptual framework centered on social sustainability assessment of energy systems. This is achieved through a comprehensive review of peer-reviewed articles, to ensure that texts exhibit academic rigor and have undergone constructive scrutiny. Compared to previous literature reviews, this work focuses on the intersection of literature covering energy systems and literature covering social sustainability assessment as depicted in Figure 2-1.

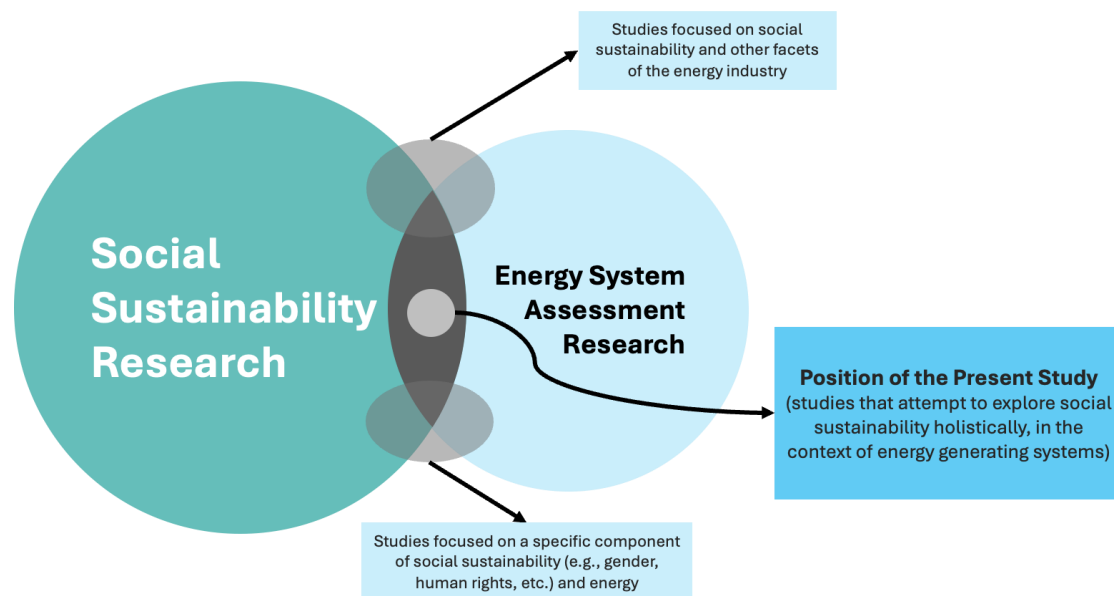


Figure 2-1: Position of this research in the wider literature.

The study significantly contributes to social sustainability research by examining the contextual definition of social sustainability, scrutinizing the indicators used to measure energy systems' social sustainability, and expounding the roles and nature of involvement among stakeholders. Furthermore, the study presents research opportunities by analyzing

the intersections between social sustainability themes, stakeholders, and energy types studied.

This chapter is organized as follows: Section 2.2 outlines the literature search protocol and analysis, Section 2.3 presents the framework and its elements, Section 2.4 provides deeper analyses regarding the intersection of the framework elements, and Section 2.5 concludes the chapter by highlighting the main points as well as presenting future research directions.

2.2 Literature review methodology

A literature review was performed to explore the state of research on social sustainability within the context of energy systems. Figure 2-2 outlines the sequential steps undertaken during this investigation. These steps are discussed in detail in Section 2.2.1, which narrates the literature search and screening process, and Section 2.2.2, which expounds the analysis performed on the gathered information.

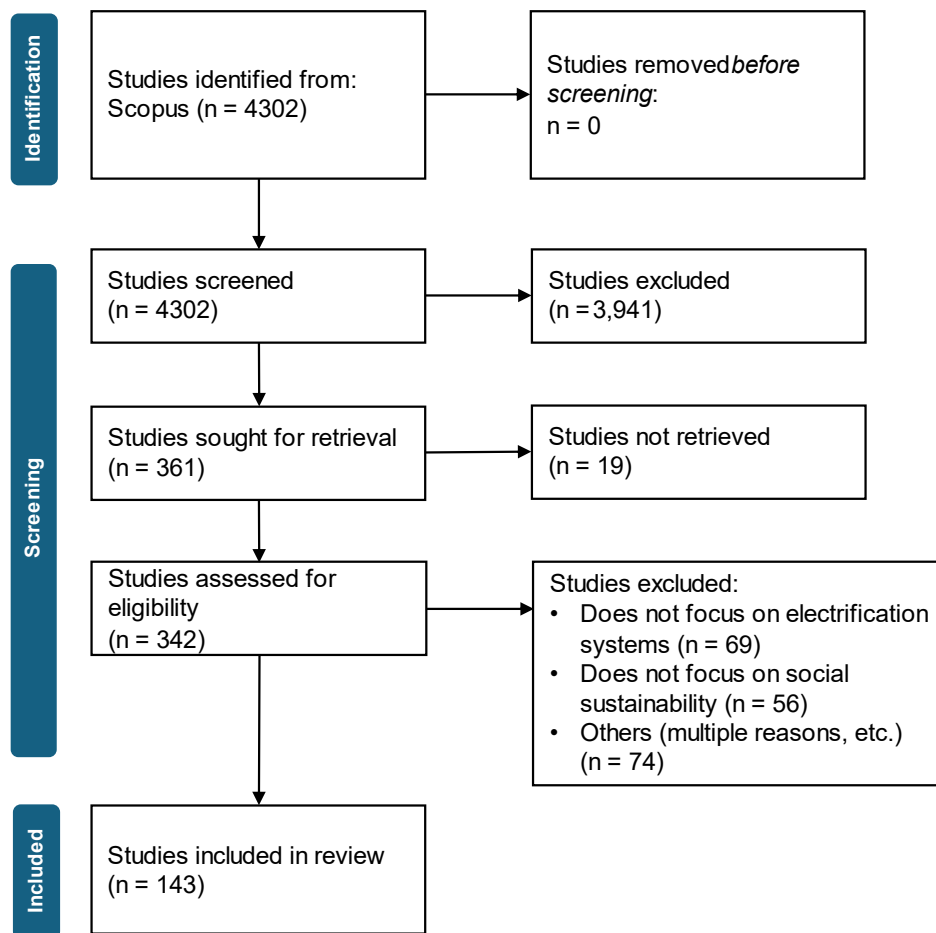


Figure 2-2: Literature review methodology.

2.2.1 Literature Search and Screening

The study commenced with a literature search on the Scopus database in October 2022, employing “social sustainability” and “energy systems” as the primary keywords. The search considered original research articles and review articles, with no temporal restrictions to incorporate earlier contributions. The literature search was updated on October 2024 to include additional articles from 2022 to 2024. A total of 4,302 articles were identified through this process.

To refine the selection of pertinent studies for the review, a two-level screening process was implemented. The first level involved evaluating the title and abstract of each article. An article was deemed relevant if its title and/or abstract indicated a focus on electricity generating systems and an assessment of the system’s social sustainability. No constraints were imposed regarding energy type or assessment tool. Following this screening criteria, 361 articles progressed to the next level.

Subsequently, the second level of screening involved a comprehensive examination of the article’s entire text to ensure adherence to the criteria established in the first screening. Articles were also excluded for reasons such as solely evaluating either positive or negative social impacts, relying extensively on previous literature without conducting an independent assessment, or lacking clear discussion of methods for measuring social sustainability. Additionally, certain review articles, including those mentioned in the introduction, were excluded to prevent redundancy, while 19 articles were excluded due to inaccessibility. A total of 143 articles successfully passed the second screening and were included in the literature review. Table 2-1 summarizes the criteria for including and excluding articles for the literature review.

Table 2-1: Inclusion and exclusion criteria for the literature review.

Inclusion Criteria	Exclusion Criteria
• Incorporates social sustainability assessment • Involves assessment of electricity generating system • Overall, studies were included if they perform analysis at system-level and have multi-faceted view of social sustainability	• Deals with fuel types only (e.g., comparison of fuel A and B, without regard to the entire system) • Deals with a specific system component only • Deals with scenarios that include aspects beyond the scope of electricity generation (e.g., demand-side management policies, behavioral changes, etc.) • Deals with only either the positive or the negative aspects of social sustainability • Deals with only a specific aspect of social sustainability (e.g., only about gender or human rights without regard to social sustainability as a whole)

While this study focused on the social sustainability assessment of electricity generating systems, readers interested in exploring social sustainability assessment in other aspects of the energy sector can consider the following: energy supplier selection [74], specific energy system components [75], energy scenarios [76,77], energy storage systems [78–80], policy evaluation [81–83], plant location decisions [84–86], energy sector trends [87], and fuel/supply choices [88–90].

2.2.2 Data Extraction and Analysis

The 143 articles that passed the two levels of screening were subjected to data extraction. In particular, this study gathered the following information from the selected articles: geographic origins, case study locations, research gaps and aims, considered energy types, social sustainability definitions, stakeholder information, sustainability assessment methods, and social sustainability indicators. Microsoft Excel and Covidence¹ were employed to organize and analyze the gathered information. Covidence is a web-based tool that helps in streamlining literature reviews.

All of the above data, except social sustainability definitions, were retrieved and analyzed in a straightforward manner. These data are explicitly available and were extracted upon reading an article's full text. The next step was to count the frequency of similar data to generate insights. Some aspects regarding stakeholder information also require careful comprehension, specifically the nature of the stakeholders' involvement. Additionally, some indicators were not straightforward (e.g., the indicator name is ambiguous or means differently how it was defined), as such additional description needed to be comprehended.

Meanwhile, social sustainability definition required a more complex approach. In this study, conceptual content analysis [91,92] was used to derive meaning out of the data generated from the articles. Phrases, sentences, and/or paragraphs, which provide an explicit definition of social sustainability were first extracted from the articles. The next step was to identify and comprehend concepts that exist within these texts to develop common themes.

It is noted that a preliminary version of the results based on the initial literature search conducted in October 2022 was presented in a conference [93], but additional analysis has since been undertaken, including the addition of more recent literature.

¹ Covidence systematic review software, Veritas Health Innovation, Melbourne, Australia. Available at www.covidence.org.

2.2.3 Background of the Reviewed Literature

The detailed analysis component of this review analyzed 143 articles, comprising 133 original research articles and ten review articles. The reviewed articles span the years 2000 to 2024. Figure 2-3 illustrates the annual count of articles incorporated in the literature review. The figure shows that there has been an increase in research activity in recent years, aligning with the overall trend in research during this period (no attempt has been made in this study to compare the increase quantitatively across fields). A noticeable decline can also be observed from 2022 to 2024. Although this aspect was not investigated in the study, potential reasons include: some research articles were not included in the database, and additional articles may have become available only after the screening period.

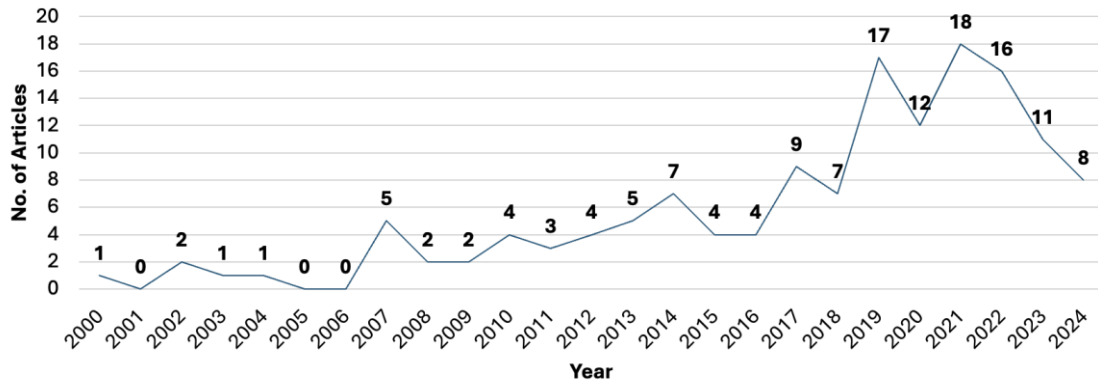


Figure 2-3: Yearly number of articles included in the literature review.

Among the 143 articles analyzed in this review, over half originate from Europe and Asia, based on the country affiliation of the article's first author. Meanwhile, 118 articles incorporated case studies, and, consistent with the regional distribution of articles, these case studies were predominantly carried out in Asia and Europe. The remaining 25 articles either did not conduct a case study or did not explicitly specify the location. Figure 2-4 displays the distribution of article counts and case studies per region of origin.

The majority of the articles examined in this literature review have incorporated evaluations of solar energy systems, with biomass and wind energy technologies following closely. In general, a greater emphasis has been placed on the sustainability assessment of renewable energy technologies. Figure 2-5 shows how frequently different energy types were considered in previous articles.

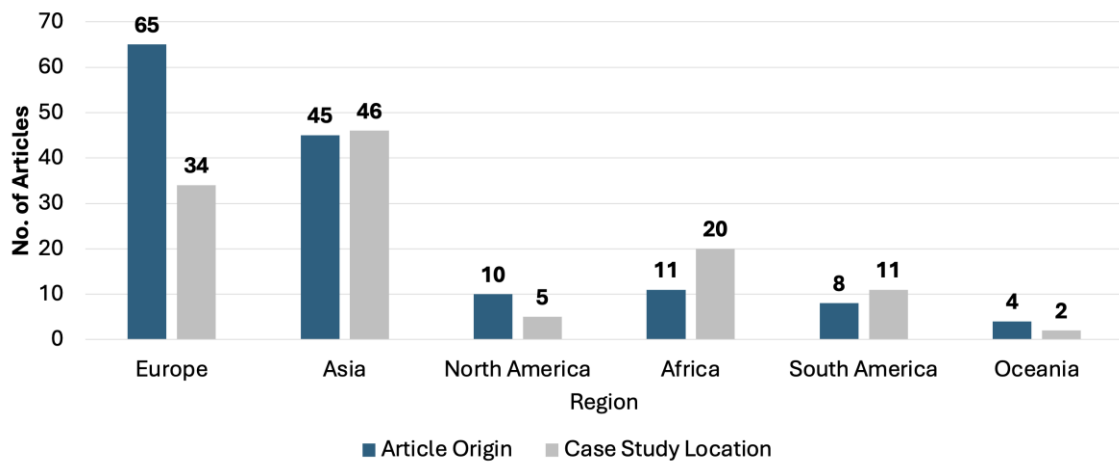


Figure 2-4: Geographical origin of articles and case studies (25 articles without a case study).

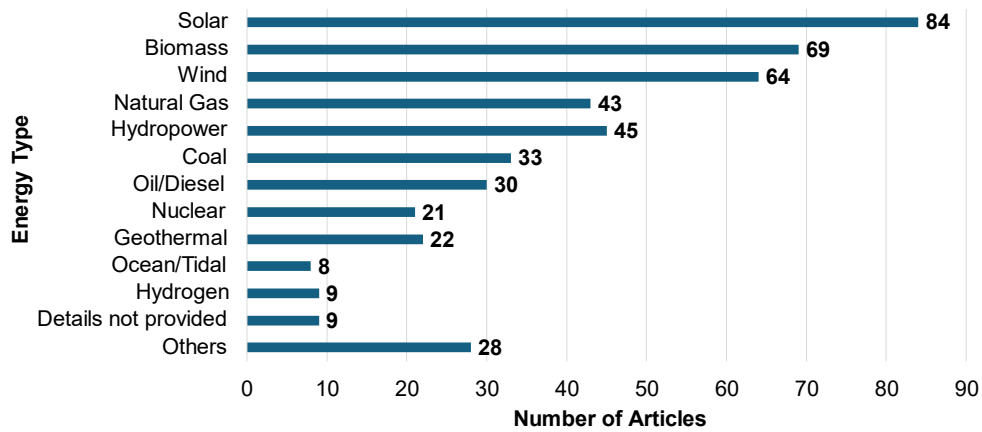


Figure 2-5: Frequency of energy type considered in the reviewed articles.

2.3 Selected Elements of the Proposed Framework for Social Sustainability Assessment

The primary results of this paper highlight three elements of the proposed framework for social sustainability assessment for energy systems. Section 2.3.1 introduces the simple framework for social sustainability assessment. This is followed by sections that describe selected framework elements: Section 2.3.2 summarizes the social sustainability definitions found in the literature; Section 2.3.3 discusses the indicators found in previous literature to measure social sustainability; Section 2.3.4 synthesizes the two previous sections into cohesive themes; and Section 2.3.5 discusses the role of stakeholders in previous assessments.

2.3.1 Overview of the proposed framework

A conceptual framework for social sustainability assessment of energy systems was developed as shown in Figure 2-6. Elements 1 and 3 are discussed briefly in this subsection while elements 2, 4, and 5 are discussed more thoroughly in the succeeding subsections.

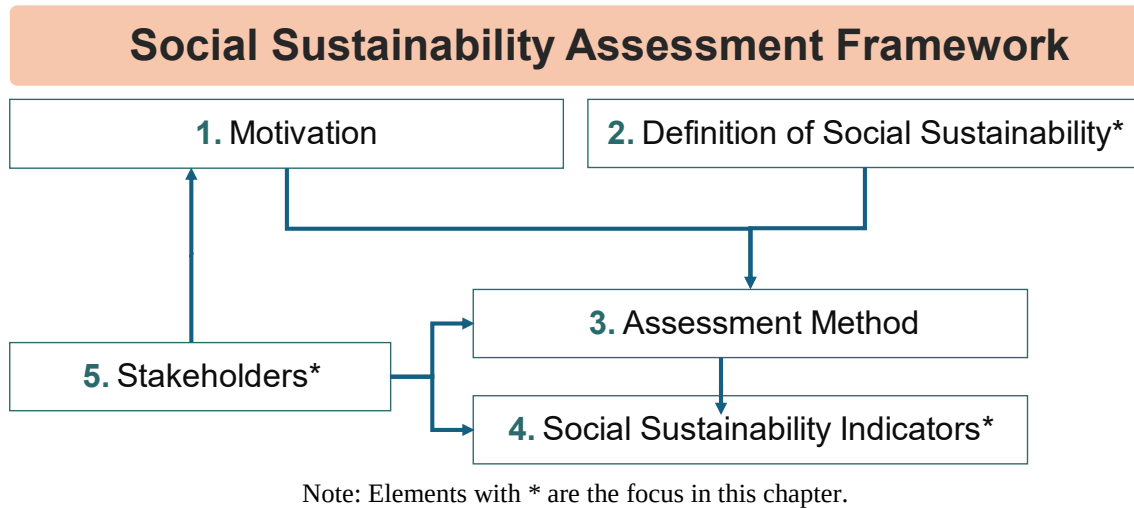


Figure 2-6: Overview of the conceptual framework.

An assessment of social sustainability begins with a clear motivation—which can be represented in the form of a problem statement, a specific goal, or a list of objectives. This element is not discussed extensively in this paper since all research mainly point to the overarching goal of evaluating the sustainability of energy systems. In addition to this main goal, four other motivations have been identified:

- *To try a new approach/method for sustainability assessment.* For example, Shakouri G. et al. [94] and Pereira et al. [95] explored the application of data envelopment analysis in sustainability assessment. Other studies explored combinations of weighting and aggregation techniques in MCDA [96–98] or incorporated life cycle approaches [99,100].
- *To conduct sustainability assessment in a particular country or region.* There were studies conducted in China [101–103], Egypt [104–106], India [100,107,108], Iran [109–111], and the United Kingdom [112–114], to name a few. Meanwhile, others shifted their focus to wider geographic coverage, such as developing countries [94,97,115], Europe [116–118], remote communities [119,120], countries along the Belt and Road [121], or the Arctic region [122].
- *To conduct sustainability assessment for a particular energy type.* The most prevalent energy types under this context are biomass [106,109,123–139] and solar energy systems [68,112,140–144].

- *To explore the social aspect of energy system sustainability assessments.* Only few studies exclusively or heavily focused on social sustainability [95,117,129,136,137,140,141,145]. Others conducted a multi-pillar sustainability assessment, but have emphasized the role of the social pillar [1,105,119,128,130,131,134,146–158].

Next, to proceed with the assessment, the term “social sustainability” should be clearly defined or operationalized. Doing so will guide the selection of the assessment method and the indicators to measure social sustainability, among others. A more detailed discussion of social sustainability can be found in Sections 2.3.2 and 2.3.4. Respectively, these sections summarize the existing definitions of social sustainability found in literature, and present synthesized themes generated from such definitions as well as the indicators that were used in prior literature.

The next element in the framework is the assessment method. The present work does not focus on this topic for two main reasons. Firstly, previous work has already reviewed prevalent social sustainability assessment methods. For example, the work of Rafiaani et al. [71] previously discussed three main assessment methods for social sustainability: SEIA, SIA, and SLCA. Additionally, a methodological review paper would warrant a more extensive discussion, and often this would involve a significant in-depth discussion of the context and other components, which is not in balance with the analysis of the remaining components discussed below.

The review of 143 peer-reviewed articles performed in this research highlighted various methods. In order to streamline the discussion of such methods, the three major assessment categories provided by Ness et al. [159] were adopted as follows:

- *Indicators and indices* are simple measures that reflect system status according to their economic, social, and/or environmental aspect. Indicators/indices can be integrated (involves aggregation of sustainability aspects) or non-integrated (sustainability aspects are treated as mutually exclusive).
- *Product-related assessments* comprise methods focused on analyzing the systems’ flows and processes. Since life cycle analysis is the most common assessment under this category, this type usually addresses the environmental aspect. However, life cycle tools for economic (life cycle costing) and social aspects (SLCA) have also emerged.
- *Integrated assessments* are usually done for policy or project decision-making and often involve evaluating different scenarios or alternatives. This type generally applies systems analysis approaches to incorporate all sustainability dimensions. Common examples of this type of assessment are MCDA, conceptual modelling, system dynamics, risk and uncertainty analyses, vulnerability analysis, cost-benefit analysis, and impact assessments.

Table 2-2 summarizes the articles covered in this review according to the abovementioned categories. A more detailed categorization of the assessment methods can be accessed from the supplementary file (<https://www.mdpi.com/article/10.3390/en17236058/s1>).

From the pool of reviewed articles, integrated assessments are the most used assessment tool, with MCDA as the leading approach to perform sustainability assessment. The common MCDA tools used in previous studies were analytic hierarchy process (AHP), Technique for Order of Preference by Similarity to Ideal Solution (TOPSIS), ViseKriterijumska Optimizacija I Kompromisno Resenje (VIKOR), and fuzzy MCDA, among others. However, to improve the assessment and address certain limitations, other articles have combined MCDA with tools such as strengths-weaknesses-opportunities-threats analysis [102], fuzzy logic [160], and system dynamics [161]. The scope, advantages, and disadvantages of MCDA are already adequately discussed in previous literature [64,71,159]. Readers are directed to the work of Wang et al. [64], where detailed background about general MCDA steps and the different weighting, aggregation, and ranking techniques are thoroughly discussed.

Table 2-2: Summary of methods used for sustainability assessment.

Category	Tool Details	References
Integrated assessments	MCDA (including combination with other techniques)	[1,94,96–98,101–103,105,106,110,113,115,116,119–121,123–126,132,133,135,139,142,147,148,150,155,156,160–204]
	Multi-objective optimization	[128,153,205–212]
	Others	[95,127,134,213]
Product-related assessments	LCA-related techniques	[136,137,144,149,151]
Indicators and indices	Integrated indices	[107,118,214–217]
	Non-integrated indicators	[68,104,109,111,114,122,129,138,140,141,146,157,158,218–225]
Combination of integrated assessment and non-integrated indicators		[108,117,130,145,152,154,226]
Combination of integrated assessment and product-related assessment		[99,100,131,143,227–231]
Combination of product-related assessment and non-integrated indicators		[112,232–234]

Related to assessment methods are indicators, which were observed to have widespread use across all identified assessment methods in this literature review. In Section 2.3.3, sub-themes surrounding the main themes of social sustainability have been developed to depict the variety of indicators that have been used in the pool of articles included in this review.

Finally, energy system stakeholders represent the final element of the proposed framework. These stakeholders can influence the social sustainability assessment of energy systems. Specifically, they help in providing data, selecting indicators, and assigning weights to these indicators. In other cases, they also help define scenarios as well as identify assumptions. The stakeholder groups identified from previous studies, as well as the common nature of involvement among these stakeholders, are presented in Section 2.3.5.

From a practical standpoint, this framework offers a valuable reference for stakeholders tasked with evaluating the social sustainability of energy systems. It provides a structured approach that can be seamlessly integrated with economic and environmental assessments, particularly through the utilization of MCDA techniques.

From an academic standpoint, the framework illustrates numerous avenues for researchers to explore further. For instance, researchers could delve into refining the definition of social sustainability within energy systems. Moreover, considering the widespread use of MCDA tools in sustainability assessment, there is room for researchers to enhance existing tools or investigate tools that have not yet been utilized in the energy sector. Stakeholder involvement can also be investigated, specifically the nature, methods, and extent of their involvement in sustainability assessments. Lastly, the intersections of these elements, as elaborated in Section 2.4, offer diverse research opportunities.

2.3.2 Social Sustainability Definitions

This research argues that, along with having a clear motivation, it is fundamental to define social sustainability first before performing an assessment. The definition will guide how to perform the assessment, as well as the tools or indicators that will be used to measure social sustainability.

After analyzing the full texts, 51 articles were found to have explicit definitions of social sustainability. In these articles, their authors have clearly defined how they view social sustainability. “Social sustainability is...”, “the social impacts of energy systems are...”, and “the social aspect is concerned with...” were some of the phrases that signaled an article’s definition of the concept. The extracted definitions are presented in the supplementary file (<https://www.mdpi.com/article/10.3390/en17236058/s1>).

Meanwhile, 92 articles were identified to have an unclear or non-specific explanation of social sustainability. These studies either immediately proceeded to enumerate indicators or methods they used to measure social sustainability or just referred to a broad statement mentioning “social impacts” or “influences of the energy system to society”, without defining what those impacts or influences are. Despite the absence of an explicit

definition, it can be implied that these articles view social sustainability based on the indicators that they use, which will be discussed in Section 2.3.3.

Through conceptual content analysis, ten themes were developed from the definitions provided by the 51 articles. This is summarized in Table 2-3, along with a brief description of each theme. The succeeding parts of this subsection provides insights into how previous articles' definitions relate to each developed theme.

To this end, “social development/well-being and quality of life” and “socio-economic benefits” are the predominant themes reflecting social sustainability based on the number of articles, with 28 and 24 articles referring to the said themes, respectively. Meanwhile, social sustainability in the form of “health and safety,” “energy access, quality, and reliability,” “social acceptance,” and “social equity” were also attributed to social sustainability, although in fewer articles. The remaining parts of this subsection briefly discuss each theme, as reflected by the definitions provided by previous literature.

Table 2-3: Social sustainability themes developed based on definitions found in literature.

Social Sustainability Theme	Article Count	% of Total (n=143)	References
<i>Social development/well-being and quality of life:</i> sustainable energy systems enrich the well-being of the communities and people's quality of life.	28	20%	[95,103,111,117–120,130,136,145,153,155,158,161,162,168,169,176,190,192,211,215–217,221,225,232,235]
<i>Socio-economic benefits:</i> sustainable energy systems improve the livelihood of society by providing jobs and contributing to local/regional development.	24	17%	[94,95,106,111,120,129,130,136,139,141,156,158,162,173,184,186,190,194,205,211,215,217,221,228]
<i>Health and safety:</i> sustainable energy systems improve human health and ensure safety across its life cycle stages	15	10%	[106,111,120,129,136,139,153,162,164,173,211,215,218,219,235]
<i>Energy access, quality, and reliability:</i> sustainable energy systems are accessible and reliably meet the users' demand.	14	10%	[94,107,129,140,158,168,176,184,186,192,193,206,211,225]
<i>Social acceptance:</i> sustainable energy systems and technologies are socially acceptable to the community or the public	10	7%	[94,130,136,140,145,153,162,169,193,209]
<i>Social equity:</i> sustainable energy systems help close disparities in terms of socio-economic status, energy access, and resources, among others	10	7%	[68,95,111,139,153,184,216,218,219,235]
<i>Education:</i> sustainable energy systems help bring access to education opportunities and improve the skills of the labor force	9	6%	[102,120,130,136,158,215,218,219,235]

<i>Involvement and governance:</i> sustainable energy systems encourage and allow participation of stakeholders as well as be compatible with various institutional frameworks	7	5%	[104,106,129,192,218,219,225]
<i>Gender:</i> sustainable energy systems help narrow the gender gap by empowering women and other gender minorities	3	2%	[215,218,235]
<i>Human Rights:</i> sustainable energy systems observe and uphold human rights at the local and international levels	3	2%	[95,129,193]

2.3.2.1 Social Development/Well-Being and Quality of Life

The theme “social development/well-being and quality of life” takes on several essential aspects of society and daily life, with prevalent terms and phrases including words and phrases “welfare,” “well-being,” “quality of life,” and “living conditions/standards”, as commonly found in previous literature [103,111,120,136,153,155,158,161,168,169,176,192,215,216,232]. Articles frequently attribute energy systems as instrumental in enhancing or improving this “quality of life” [103,192,215–217] or as solutions to address diverse social issues while contributing to the United Nations SDGs [107,118,119,232]. In the same context, previous studies [161,168] associate social sustainability with indicators that measure quality of life or well-being.

However, “quality of life” and “well-being” are inherently broad and subject to various interpretations. Moreover, expounding these terms inevitably intertwines with other themes of social sustainability described in the following subsections and with the other pillars of sustainability overall. For instance, Fedorova et al. [136] correlates well-being with factors such as “prosperity, education, health, and safety”, while Fonseca et al. [153] attributes quality of life to elements of equity and health.

Overall, the concept of social sustainability in the context of this theme is also intricately linked with diverse factors. These include environmental health and effects on local scenery [162,190], societal and human development [111,117,120,130,235], workplace dynamics in the form of social support for the labor force [221], and cultural preservation [216], all of which collectively shape the well-being and quality of life within society.

2.3.2.2 Socio-Economic Benefits and Employment

Under the “socio-economic benefits and employment” theme, the majority of the articles referred to job creation, employment, or provision of livelihood opportunities as one of the significant social impacts of energy systems [95,106,130,156,158,173,186,205,221].

Although some articles did not directly refer to employment, they mention the energy systems' impacts on people's livelihood [139,141,228].

In addition to the focus on job creation and livelihood opportunities, several articles explore the broader socio-economic implications of energy systems [120,136]. These discussions include factors such as affordability [184] and economic growth [106,130,190,221].

By providing opportunities for employment and livelihood, coupled with the wider socio-economic impacts brought by energy systems, it can be said that socially sustainable energy systems also contribute to lifting individuals and communities out of poverty [111,215].

2.3.2.3 Health and Safety

Health and safety are fundamental aspects of social sustainability of energy systems, intersecting with various dimensions of social development, well-being [136], and quality of life [153], as previously mentioned. Across several studies, there is a consistent call to address health concerns as integral components of social sustainability in the context of energy systems [111,120,136,139,153,164,173,215,219,235].

In rural electrification projects, as outlined by Assefa and Frostell [218] and Juanpera et al. [219], the establishment of energy systems facilitates access to vital health services, further proving the vital role of energy in improving public health.

Alongside health considerations, several authors advocate prioritizing safety within energy systems [111,129,136]. As emphasized by Fedorova and Pongrácz [136], safety not only impacts individual well-being but also influences broader societal well-being.

In a broader scope, socially sustainable energy systems are expected to contribute to the overall improvement of society's living environment [106,136]. Additionally, as highlighted by Wilkens and Schmuck [162], evaluating social sustainability encompasses factors such as the impact on personal and local environments, reflecting the interconnection between energy systems and community well-being.

Lastly, it is essential to recognize the broader environmental implications of energy systems that are related to health and safety. For instance, the type of energy systems directly affects indoor and air pollution [164,215], as well as determines how much the system can contribute to global warming [164].

2.3.2.4 Energy Access and Reliability

A significant portion of the literature under this theme highlights the fundamental role of energy access [107,158,168,176,184,186,192,193]. However, some articles delve deeper into this concept. For instance, the social aspect of energy system is attributed to the right of consumers to energy access [193]. Meanwhile, others underscore the importance of ensuring that this access to energy must be delivered in an equitable, affordable, and reliable manner [107,168]. Moreover, several authors argue that energy access facilitates other social benefits, including employment opportunities [186], enhancements in an individual's quality of life [192], and improved access to essential services such as water [140].

Alongside access, discussions about energy access and social sustainability often extend to reliability [94,107,129,206], as previously mentioned, and to energy security [206].

2.3.2.5 Social Acceptance

Public perception and social acceptance play a critical role in the success of sustainable development projects, particularly those involving energy systems. Effectively addressing concerns and garnering support from different stakeholders are essential for overcoming barriers to implementation. The most widely used term is “social acceptance” [94,136,169,193,209], but other terms have been used: public acceptance [130] and community acceptance [140].

Notably, measuring social acceptance poses challenges, specifically in terms of cultural values as well as stakeholder perception and opinion [136]. Previous studies have equated social sustainability with stakeholders' perceptions [155,162] or preferences [155], but it can also be ultimately aligned with societal preferences [145].

Ultimately, the study of social acceptance can be linked to other aspects of social sustainability, specifically the quantifiable ones such as job creation, access to energy, and economic growth. But, it is also influenced by context-specific and subjective aspects such as preservation of cultural preservation, visual aesthetics, and well-being.

2.3.2.6 Social Equity

The majority of articles within the social equity theme emphasize the importance of equity [68,127,139,153,216,218,219] and addressing social disparities [68,184] as key issues that energy systems can help mitigate. However, in the work of Lillo et al. [235], energy systems are not directly presented as solutions to equity issues; rather, it underscores the necessity of addressing these disparities when introducing such systems, especially in rural contexts. Finally, as previously highlighted, there is an overlap between the themes of social sustainability and socio-economic impacts, particularly evident in the context of poverty alleviation [111,215].

2.3.2.7 Education

The availability of energy systems is central to education primarily because energy availability enhances educational opportunities and reduces illiteracy by facilitating better access to education [215,219]. This theme does not have in-depth discussion compared to other themes since previous literature mainly espouses the idea that energy systems are means to improve society through education [102,120,130,136,158,215,218,219,235].

2.3.2.8 Involvement and Governance

The theme of involvement and governance is primarily derived from the notion that microgrids are rooted in social structures, because they comprise decentralized socio-technical networks that foster a community characterized by significant interaction among its participants [192]. This can be applicable different scales of energy systems, but the complexity between participant interactions can be greater in larger-scale systems and more manageable in smaller-scale systems.

As such, this theme corresponds to the nature of involvement among different stakeholders in the development and eventual operations of energy systems. This can be through open and participatory practices [129,225], to solicit the opinions and perceptions of stakeholders [104]. By involving stakeholders, particularly end-users, the concept of empowerment can be fulfilled [219]. More broadly, this theme also relates to the compatibility of the energy system with societal infrastructure, specifically in politics and governance [106].

2.3.2.9 Gender

Despite gender gaining attention in the research sphere in the recent decades, few articles included in this review have explicitly integrated gender and gender equity with the concept of social sustainability [215,218,235]. However, a specific literature search using the terms gender and energy produces numerous recent articles concerning these topics. For example, a recent study explored how female labor participation is impacted by energy access and availability in developing countries [236].

2.3.2.10 Human Rights

The “human rights” theme recognizes that socially sustainable energy systems firstly promulgate people’s right to have access to energy [193]. However, this theme also corresponds to energy systems’ obligations to other humanitarian and human rights issues [129], such as the rights of indigenous and traditional communities to their lands as well as protecting society’s heritage in the cultural, historical, and archeological aspects [95].

The discussion up to this point only considers the articles that have provided an explicit definition or contextualization of social sustainability. Even though most of the articles in this review did not have an explicit working definition of social sustainability, it can be implied that social sustainability aspects are reflected by the indicators chosen by the article's authors. As such, Section 2.3.3, which focuses on indicators, will reflect an updated categorization of articles based on the social sustainability themes.

2.3.3 Social Sustainability Indicators

In this study, a total of 709 social sustainability indicators (SSIs) were identified from the 143 articles reviewed for this study. The number of SSIs used in these articles range from as few as one indicator to as many as 30 indicators, as depicted in Figure 2-7. An average of five SSIs were used, with a mode of two indicators among the reviewed articles.

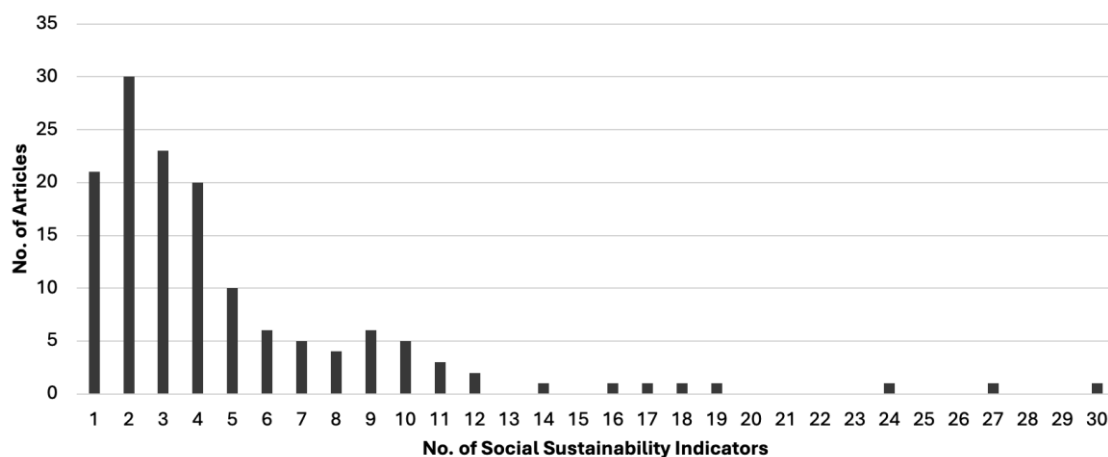


Figure 2-7: Histogram of social sustainability indicators used in previous studies.

For this research, the major categories for SSIs were based on the themes that have been identified in Section 2.3.2. Sub-themes were also developed to group indicators that cover similar characteristics. Table 2-4 summarizes the number of indicators per theme and sub-themes. The downloadable file (<https://www.mdpi.com/article/10.3390/en17236058/s1>) provides a complete list of the indicators and concept diagrams showing the connections between the themes, sub-themes, and indicators through.

The categorization of indicators into themes and sub-themes was done to create a streamlined discussion and to allow readers to get a general sense of the types of indicators found in literature. However, it should not be ignored that some of these indicators are context-specific. For example, Terrapon-Pfaff et al. [141] provided an extensive list of SSIs, but some are specifically addressed to the circumstances of their study site (Morocco). Meanwhile, the indicators used by Khan [1] are catered to

developing countries. Thus, when actual assessments are performed, proponents should also consider stakeholder inputs and other specific or unique circumstances.

When developing Table 2-4, an indicator was allowed to be classified under two or more themes based on their description or how the authors defined them. Furthermore, themes and sub-themes can overlap in some aspects — for example, “pollution and emissions-related indicators” under the “health and safety” theme can be related to “surroundings, environment, ecosystems” subtheme of the “social development, well-being, quality of life” theme.

The overlaps suggest the multi-faceted nature of social sustainability and the challenge of defining and contextualizing the concept. Nonetheless, the themes and sub-themes provided here establish a starting point for stakeholders to identify potential social aspects to be considered when performing an energy system sustainability assessment.

Overall, similar to the themes based on explicit definitions discussed in Section 2.3.2, the prominent themes based on the number of indicators are “socio-economic benefits and employment” and “social development, well-being, quality of life”, with 210 and 183 SSIs, respectively. These themes are followed by “health and safety,” “energy access and reliability,” and “social acceptance”. The “involvement and governance” theme surpasses the “social equity” theme based on the number of indicators.

Sub-themes mainly from the prominent themes have more indicators compared to other major themes. For example, job creation, economic benefits/economic-related, social welfare, surroundings/environment/ecosystems, labor and plant-related safety, and energy access sub-themes have more indicators compared to social equity, education, gender, and human rights themes. This could signal the need to develop more indicators under the less-incorporated themes or to further standardize the indicators of these themes to ensure that they are more frequently used in sustainability assessments. Dedicated literature review covering these specific less-incorporated themes can be explored to expound the discussion.

Taking into account all individual indicators, the most used SSI in the pool of articles considered in this review was job creation, which essentially corresponds to the total number of jobs that an energy system employs. A total of 98 studies used this indicator to measure social sustainability. Other common terms for this indicator include employment, employment generation, and created jobs. There are also different ways to measure this indicator: total number of jobs [111,119], total number of jobs per generating capacity [123,150,178], and total number of working hours per generating capacity [174,175,180], among other variations. Although most studies have classified the job generation indicator under the social aspect, some studies [95,169] have classified it under the economic aspect.

Table 2-4: Frequency of indicators in the developed social sustainability themes and sub-themes.

Social Sustainability Themes	No. of Indicators	Sub-themes	No. of Indicators
Socio-Economic Benefits and Employment	210	Job Creation	103
		Economic Benefits/Economic-Related	80
		Worker Welfare	28
		Consumption Related	5
Social Development, Well-Being, Quality of Life	183	Social Welfare, Improvement of Way of Life	79
		Surroundings, Environment, Ecosystems	45
		Regional and Community Development	30
		Technological Advancements, Innovations	13
		Worker Welfare	13
		Food Security	8
		Per Capita Indicators	6
Health and Safety	115	Labor- and Plant-Related Safety	49
		Pollution, Emissions-Related	38
		General Health	23
Energy Access and Reliability	103	Access	39
		Energy Security	36
		Capacity and Reliability	18
Social Acceptance	58	Social Acceptance	25
		Public/Community Acceptance, Satisfaction	30
		Political/Institutional Acceptance	2
Involvement and Governance	55	Stakeholder Involvement	19
		Compatibility with Current Political Frameworks	19
		Institutional Support	9
		Transparency and Corruption	7
		Ownership	4
Social Equity	37	General Equity	16
		Rural Electrification	10
		Rural Development	6
		Poverty Alleviation	4
		Peace	3
		Labor Equity	1
Education	25	Employee Education	14
		Education (General)	11
Gender	13	Women	7
		Related to Labor	6
		Gender Equality/Equity (General)	5
Human Rights	24	People Displacement	11
		Forced Labor/Labor Rights	4
		Human Rights (General)	3
		Child Labor	3
		Indigenous People and Traditional Communities	2
		Cultural Rights	2

Note: Indicators that overlap in terms of social sustainability themes and sub-themes were allowed to be counted multiple times.

In some cases, the social aspect is extended to include matters concerning culture and traditions [68]. Others [66] have treated the cultural aspect as an entirely separate sustainability pillar from the social aspect. As such, indicators that pertain to cultural sustainability were also identified and were treated separately from the social ones.

Section 2.3.2 previously discussed that, in the absence of an explicit definition of social sustainability, it can be assumed that the authors' definition of the concept is reflected by the indicators that they use. Following this approach, the articles were categorized under the same themes as in Section 2.3.2 based on the indicators they used. Table 2-5 summarizes the updated article count per theme.

Table 2-5: Article count per social sustainability theme, based on indicators.

Social Sustainability Theme	Article Count	% of Total (n=143)
Socio-Economic Benefits and Employment	116	81%
Social Development, Well-Being, Quality of Life	74	52%
Health and Safety	57	40%
Energy Access and Reliability	52	36%
Social Acceptance	50	35%
Involvement and Governance	35	24%
Social Equity	23	16%
Education	19	13%
Human Rights	16	11%
Gender	10	7%

Finally, a more comprehensive study about indicators in general is recommended. Such study could cover the meanings (description) of the indicators, their data sources, methods/techniques/quantification/qualification, units of measurement, and criteria for inclusion.

2.3.4 Focus on the Social Sustainability Themes

Considering both the explicit definitions discussed in Section 2.3.2 and the indicators discussed in Section 2.3.3, there were minor adjustments to the article count per social sustainability theme. An article is considered to incorporate a theme as long as it either has an explicit definition or used an indicator that falls under the corresponding theme. The adjustments are reflected in Table 2-6.

Ideally, the articles that provided definitions of social sustainability would have used indicators that correspond to the themes present in their definitions. However, this was not the case in a number of articles. For example, the definition provided by Assefa and Frostell [218] incorporates social equity, education, involvement and governance, and gender; however, the main indicators used in the article fall primarily under the social

acceptance theme. Meanwhile, the definition of Shakouri G. et al. [94] attributes social sustainability to socio-economic benefits and employment, energy access and reliability, and social acceptance themes, but used job creation as the only indicator to measure social sustainability. On the other hand, some of the articles that provided definitions had indicators that fall under themes that were not present in the definitions.

Table 2-6: Updated article count per social sustainability theme, based on both explicit definitions and indicators.

Social Sustainability Theme	Based on Definitions		Based on Indicators		Based on both	
	Article Count	% (n=143)	Article Count	% (n=143)	Article Count	% (n=143)
Socio-Economic Benefits and Employment	24	17%	116	81%	116	81%
Social Development, Well-Being, Quality of Life	28	20%	74	52%	82	57%
Health and Safety	15	10%	57	40%	62	43%
Energy Access and Reliability	14	10%	52	36%	61	43%
Social Acceptance	10	7%	50	35%	56	39%
Involvement and Governance	7	5%	35	24%	39	27%
Social Equity	10	7%	23	16%	27	19%
Education	9	6%	19	13%	22	15%
Human Rights	3	2%	16	11%	18	13%
Gender	3	2%	10	7%	12	8%

Overall, the most prevalent themes remain as “socio-economic benefits and employment” and “social development, well-being, quality of life”. These are followed by “health and safety”, “energy access and reliability”, and “social acceptance”. The remaining themes may be considered minor themes if only article count is considered. However, this does not necessarily mean that they are less important with regards to their actual implications in practice.

Analyzing the articles from a chronological perspective provides additional insights into the growth of each theme in terms of the number of articles incorporating them. Figure 2-8 shows the annual number of studies that reflect different social sustainability themes, considering both the explicit and implicit definitions discussed in the previous sections. The themes of “socio-economic benefits and employment” and “social equity” were already present in the earlier studies considered in this review, specifically in 2000. This was followed by the themes of “social development, well-being, quality of life” and “health and safety” in studies appearing in 2002.

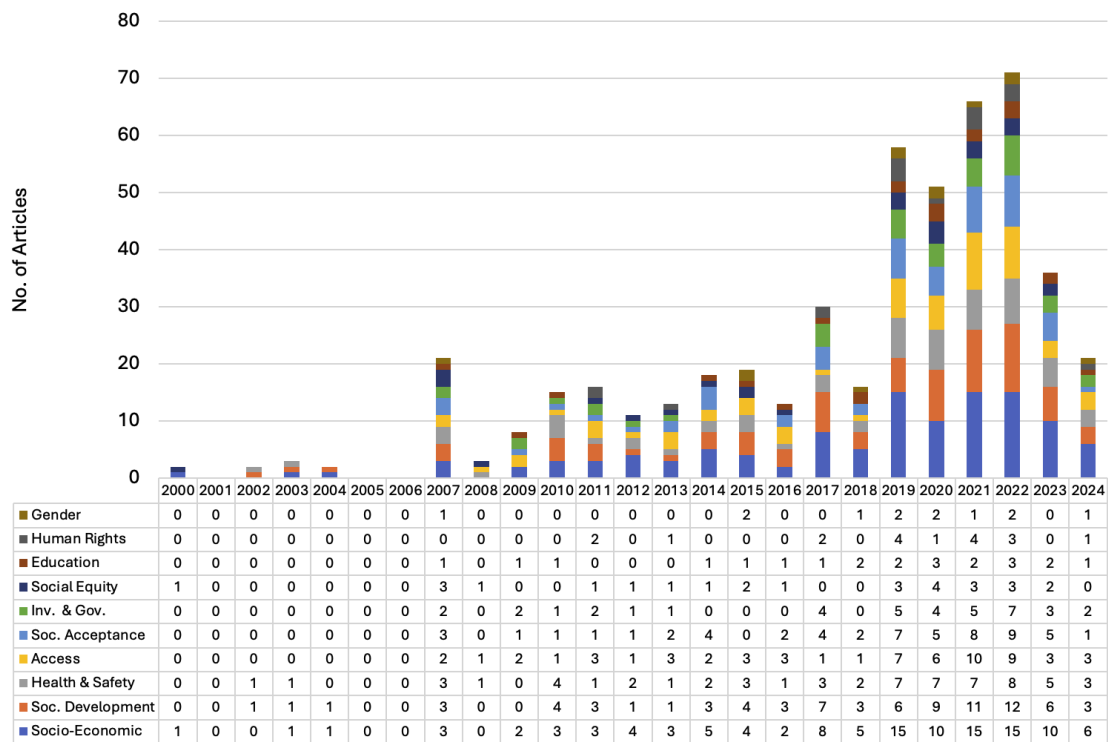


Figure 2-8: Yearly number of studies incorporating different social sustainability themes.

Most of the other themes — “energy access and reliability”, “social acceptance”, “involvement and governance”, “education”, and “gender” — appeared later (2007), while the theme of “human rights” emerged the most recently compared to other themes, in 2011.

A more focused view of each theme is represented in Figure 2-9, which shows individual line charts of the number of articles reflecting each social sustainability theme. Based on these charts, it can be observed that the number of articles covering the themes of “socio-economic benefits and employment” and “social development, well-being, quality of life” generally have an upward trend since 2000.

Articles reflecting the theme of “health and safety” did not grow as much despite having appeared as early as 2000. Meanwhile, starting in the mid-2010s, more articles have started incorporating the themes of “energy access and reliability”, “social acceptance”, as well as “involvement and governance”. Generally, the number of articles covering the themes of “social equity”, “education”, “gender”, and “human rights” did not grow as significantly as the more predominant themes. As research on sustainability assessment of electricity-generating systems progresses, it is expected that these themes will continue to be incorporated.

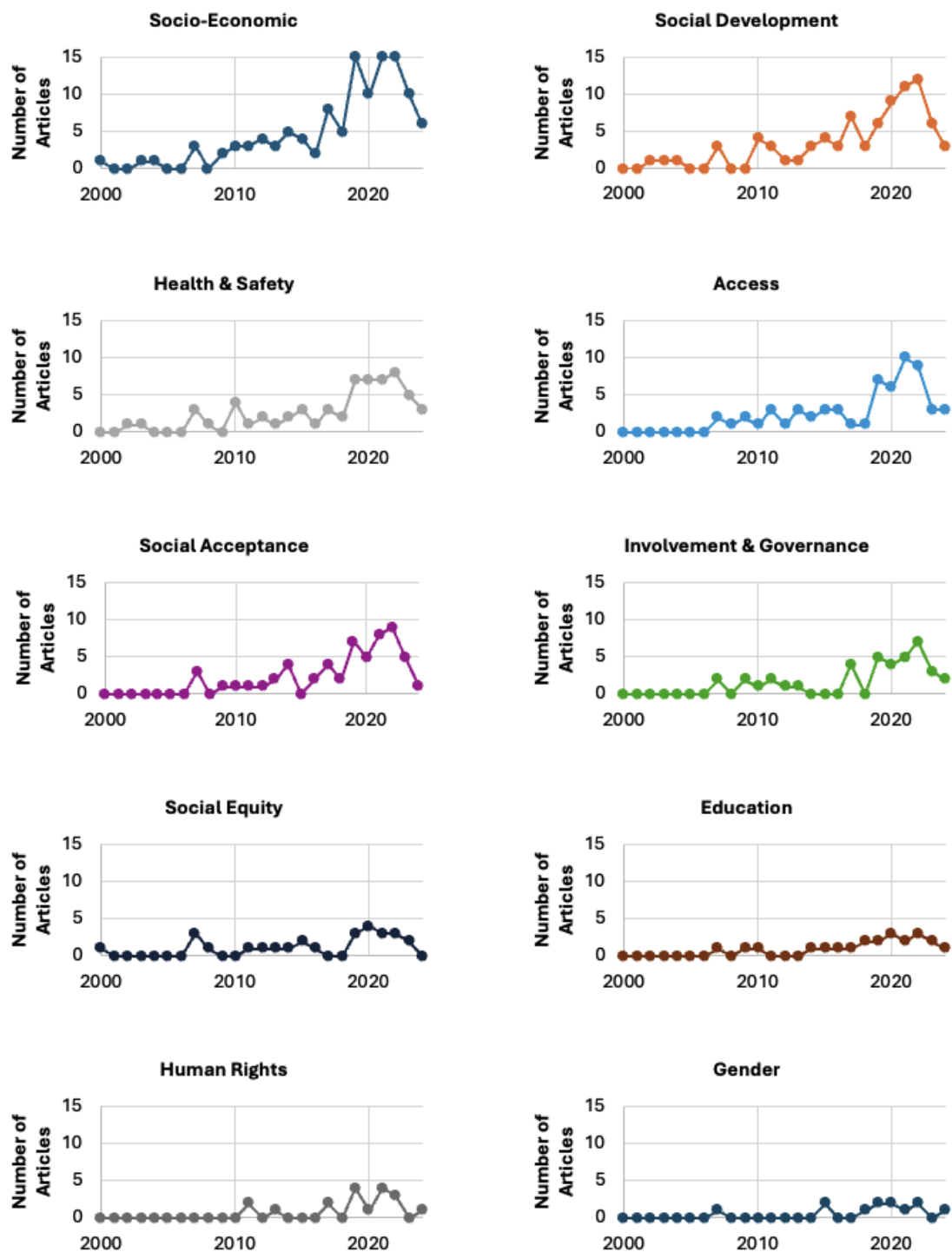


Figure 2-9: Yearly article count per social sustainability theme considered.

Articles reflecting the theme of “health and safety” did not grow as much despite having appeared as early as 2000. Meanwhile, starting in the mid-2010s, more articles have started incorporating the themes of “energy access and reliability”, “social acceptance”, as well as “involvement and governance”. Generally, the number of articles covering the themes of “social equity”, “education”, “gender”, and “human rights” did not grow as significantly as the more predominant themes. As research on sustainability assessment

of electricity-generating systems progresses, it is expected that these themes will continue to be incorporated.

The discussion up to this point has primarily treated the themes as mutually exclusive facets of social sustainability. However, the multifaceted nature of social sustainability has been a recurring discussion in previous literature and in earlier sections of this paper. As such, co-occurrence of themes were investigated and is graphically shown on Figure 2-10. The percentage shows the frequency of co-occurrence of the theme in the column relative to the number of articles that incorporated the theme in the row. For example, 80% of the 82 articles that incorporated “social development, well-being, quality of life” have also employed “socio-economic benefits and employment”. Whereas, 57% of the 116 articles that had the “socio-economic benefits and employment” also have the theme of “social development, well-being, quality of life”.

Social Sustainability Themes	n	Percentage of studies in rows that also have the following themes:									
		Socio-Economic	Social Development	Energy Access and Reliability	Health and Safety	Social Acceptance	Involvement and Governance	Social Equity	Education	Gender	Human Rights
Socio-Economic	116	x	57%	38%	42%	40%	28%	16%	15%	15%	9%
Social Development	82	80%	x	54%	56%	39%	39%	23%	22%	17%	11%
Energy Access and Reliability	62	71%	71%	x	48%	44%	40%	29%	23%	13%	8%
Health and Safety	61	80%	75%	49%	x	41%	41%	25%	26%	20%	16%
Social Acceptance	56	82%	57%	48%	45%	x	39%	18%	13%	14%	9%
Involvement and Governance	39	82%	82%	64%	64%	56%	x	26%	33%	26%	15%
Social Equity	27	70%	70%	67%	56%	37%	37%	x	33%	15%	15%
Education	22	77%	82%	64%	73%	32%	59%	41%	x	14%	27%
Gender	18	94%	78%	44%	67%	44%	56%	22%	17%	x	28%
Human Rights	12	83%	75%	42%	83%	42%	50%	33%	50%	42%	x
Average		80%	72%	52%	59%	42%	43%	26%	26%	19%	15%

Notes: Darker-colored cells correspond to a higher percentage; conversely, lighter-colored cells correspond to a lower percentage. “Socio-Economic” and “Social Development” correspond to “Socio-Economic Benefits and Employment” and “Social Development, Well-Being, Quality of Life”, respectively.

Figure 2-10: Co-occurrence of social sustainability themes.

Across all themes, “socio-economic benefits and employment” and “social development, well-being, quality of life” are the themes that were co-incorporated with the other themes. This complements earlier findings that the two themes were the most prominent.

Furthermore, it also suggests two possible implications: first, other themes hinge upon the said themes. Another is that the two themes have been studied more frequently, resulting to more indicators and frequent appearance in sustainability assessments. Future social sustainability assessment of energy systems can also benefit from including less incorporated aspects, such as social equity, education, gender, and human rights. Doing so can help make the assessments more holistic.

Meanwhile, Figure 2-11 serves as an attempt to synthesize these facets, illustrating their interconnectedness and the simple relationships they form.

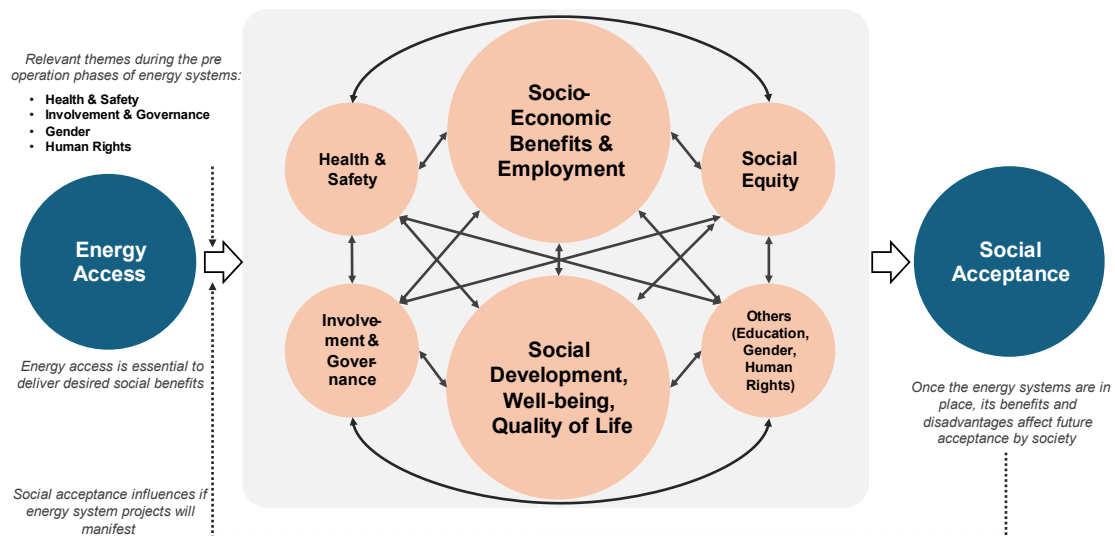


Figure 2-11: Synthesis of social sustainability themes.

Firstly, energy access is an essential driver of social sustainability since it allows for the realization of other social benefits and impacts. However, considering a life cycle perspective requires incorporating other social sustainability themes at earlier stages of the energy system. For instance, ensuring health and safety during the system's construction must be ensured. Moreover, involvement of different stakeholders during the planning phase can significantly contribute to the long-term success of the energy system, as they have more ownership of the system. Simultaneously, adhering to existing administrative and political frameworks is crucial for ensuring legitimacy and securing institutional support. Meanwhile, gender empowerment and human rights issues must also be considered prior to the establishment of energy systems to ensure respect to all who might be involved.

Once energy becomes accessible to society, a variety of benefits can be realized, particularly in terms of social development and socio-economic growth. This is supported by the number of indicators that have been used which relate to these themes. Additionally, energy availability facilitates improved access to essential social services such as health and education. Access can also play a vital role in addressing social inequities and gender disparities. From the inception to disposal or decommissioning of electrification systems,

considerations of involvement and governance, as well as human rights must be upheld to ensure holistic adherence to social sustainability principles.

Figure 2-11 also highlights the current prominence of socio-economic benefits and employment along with social development, well-being, quality of life as the major themes that represent social sustainability. Although these two themes are the most incorporated, the bi-directional arrows represent that these themes connect and exist simultaneously with other themes.

Ultimately, these net social benefits shape the social acceptance of energy systems. This level of acceptance – or opposition – significantly eventually influences the success of future electrification projects. Thus, understanding and addressing social dimensions are imperative for fostering widespread acceptance and ensuring the efficacy of these initiatives.

Although it is ideal to incorporate all social sustainability themes when conducting an assessment of an energy system, the decision can be influenced by the interests of different stakeholders. In particular, the stakeholders can direct the criteria considered in the sustainability assessment and dictate how these criteria match each other. The roles of stakeholder are discussed more thoroughly in the next subsection.

2.3.5 Stakeholder Roles and Nature of Involvement

Stakeholders correspond to the actors that are directly or indirectly involved in electrification systems throughout its life cycle. In this research, stakeholders were classified into seven major groups: industry experts, academics, government, end users/public, non-government organizations and community groups, suppliers, and private companies. These terms were taken directly from the articles and merged for similarities. The following list provides a brief description for each stakeholder group:

- *Industry experts* are individuals who were involved specifically because they have extensive experience in various fields; for example, in the energy sector [97,114], specific energy technologies [99,106,214], or sustainability or life cycle assessments [99,144,147]. These stakeholders are usually drawn from other categories, such as government or academia. When an article provides a description or profile that clearly identifies the background of the stakeholder, the stakeholder was categorized to the appropriate group (e.g., if Stakeholder ABC comes from University XYZ, then the stakeholder will be assigned to Academic group).
- *Academic stakeholders* are people who are currently employed at universities or research institutes and also provide specific expertise related to the sustainability assessment [68,102,170].

- *Government stakeholders* are representatives from different government agencies or offices, such as environmental ministries [108,121,150], energy ministries [110,220], or local government units [112,124,163].
- *End-users/public* are the primary recipients of the energy systems, they are usually the consumers of the energy produced by the system and/or those who live within the approximate vicinity of the energy system [162,220,235].
- *Non-government organizations (NGOs)*, CSOs, and community groups are associations that usually represent or advocate environmental [117,209,228], labor-related [96], or humanitarian causes [124,228].
- *Suppliers* are actors along the supply chain, specifically those who are from the trade industry or those that provide or manufacture technologies or fuel [113,117,162].
- *Private companies* are those who participate in energy projects through corporate social responsibility mandates or by providing financial assistance to enact such projects [96,136,150].

The full-text investigation of the 143 articles included in this review reveals that the article pool is divided almost evenly, with 73 articles involving stakeholders, and the remaining 70 articles not involving stakeholders. Involvement of stakeholders means that the authors of the articles specified that they have invited persons outside of the authors pool or research team to solicit assistance for the sustainability assessment. The nature of this assistance is also discussed in this subsection.

In this study, no attempt was made to investigate the reasons other articles did not involve stakeholders. Additionally, studies of this type often referred to the findings of other studies in terms of criteria selection, weight assignments, or indicator valuations.

Overall, industry experts, academics, and representatives of the government have been the most involved stakeholders in the reviewed articles. The involvement of these stakeholder groups is expected as they have more knowledge in the different operations along the life cycle of an energy system as well as in the field of sustainability assessments. They also have technical expertise that allow them to provide information regarding certain features of energy systems, and eventually, to evaluate system alternatives.

The remaining stakeholder groups, namely the end-users/public, NGOs, suppliers, and private companies were involved to a lesser extent. Meanwhile, eight studies did not explicitly disclose the backgrounds of the stakeholders involved in their respective studies. Table 2-7 shows the number of articles involving the different stakeholder groups (a study can involve multiple stakeholder groups).

Table 2-7: Frequency of involvement of different stakeholder groups.

Stakeholder Group	No. of Studies	% of total (n = 73)
Industry Experts	52	71%
Academic	30	41%
Government	26	23%
End-Users/Public	17	16%
NGOs	12	16%
Suppliers	4	5%
Private Companies	5	7%
No details provided	8	11%

In terms of the nature of involvement, stakeholders were primarily involved in four major ways, as outlined in Table 2-8. Predominantly, their involvement centered around assessing energy system options or assigning values to sustainability indicators (“Evaluated Alternatives/Assigned Values to Indicators”). Moreover, they were also usually involved in developing or selecting the sustainability criteria (“Developed/Selected Criteria”), alongside assigning relative weights to these criteria. A smaller subset of studies engaged stakeholders in additional aspects of research, such as validating assumptions, crafting scenarios, and coordinating on-site activities.

Table 2-8: Common nature of involvement among stakeholders.

Nature of Stakeholder Involvement	No. of Studies	% of Total (n = 73)
Evaluated Alternatives/Assigned Values to Indicators	44	60%
Developed/Selected Criteria	36	49%
Assigned Weight to Criteria	29	40%
Provided Other Data/Information/Others	21	29%

To clarify the understanding of the specific nature of how each stakeholder group participated in the assessment, this research attempted to cross-tabulate each stakeholder group with respect to the specific activity categories. Table 2-9 and Table 2-10 summarize the level of involvement of each stakeholder group across the four primary involvement categories discussed earlier. Table 2-9 and Table 2-10 respectively depict percentages relative to the total number of studies covering different involvement categories and the total number of studies involving different stakeholder groups.

However, it is important to note that the values presented are only approximations since not all articles included in the study provided clear or transparent indications of the extent and manner of involvement for each stakeholder group. The assumption was made that an article involved all mentioned stakeholders in all described activities unless explicitly stated otherwise.

Table 2-9: Nature of involvement per stakeholder group, as percentage of the number studies covering different involvement categories.

Nature of Involvement	Stakeholder Group						
	Industry Experts	Academic	Government	End-Users/Public	NGOs	Supplier	Private Companies
Developed/ Selected Criteria (n=36)	72%	53%	47%	25%	22%	8%	8%
Assigned Weight to Criteria (n=29)	76%	34%	28%	10%	10%	3%	3%
Evaluated Alternatives/ Assigned Values to Indicators (n=44)	73%	36%	34%	16%	20%	7%	7%
Provided Other Data/Information/Others (n=21)	67%	38%	43%	38%	19%	10%	5%

Table 2-10: Nature of involvement per stakeholder group, as percentage of the number of studies involving each stakeholder group.

Stakeholder Group	Nature of Involvement			
	Developed/ Selected Criteria	Assigned Weight to Criteria	Evaluated Alternatives/ Assigned Values to Indicators	Provided Other Data/Information/ Others
Industry Experts (n = 52)	50%	42%	62%	27%
Academic (n = 30)	63%	33%	53%	27%
Government (n = 26)	65%	31%	58%	35%
End-Users/Public (n = 17)	53%	18%	41%	47%
NGOs (n = 12)	67%	25%	75%	33%
Suppliers (n = 4)	75%	25%	75%	50%
Private Companies (n = 5)	60%	20%	60%	20%

For future studies, it is advisable to provide explicit clarification on how each stakeholder group was engaged, especially concerning activities related to the social aspect of sustainability assessment. This transparency would enhance the accuracy and reliability of the findings.

Referring to Table 2-9, it can be seen that across all natures of involvement, industry experts are the primarily involved stakeholder group, followed by representatives from the academe and the government. End-users/public and NGOs were involved to a lesser extent when developing or selecting criteria. While NGOs are more involved in

evaluating alternatives or assigning values to sustainability indicators, the end-users/public were more involved in auxiliary assessment activities such as providing data or other necessary information. Generally, suppliers and private companies were the least involved across all major assessment activities.

Meanwhile, from the perspective of the number of studies involving each stakeholder group, as shown in Table 2-10, stakeholders are more often involved in developing or selecting criteria as well as evaluation of alternatives or assigning values to indicators. That is, if a certain stakeholder group was involved, they are more likely to assist in developing sustainability criteria. Overall, industry experts, academics, and government representatives were more involved in the evaluation of alternatives, but slightly less involved when it comes to assigning weight to these criteria — complementing the insights from Table 2-9.

To involve stakeholders, previous studies have mainly implemented surveys or questionnaires [95,117,147,150,170,185] and interviews [97,106,142,207,209]. These methods were used primarily for stakeholders to convey which criteria were most relevant as well as to assign weights to these criteria. Focus group discussions [141,145,169,178] and workshops [124,136,139,162] were employed less frequently. These methods were used to gather more qualitative information, and were useful when developing scenarios or formulating assumptions.

There were few studies that used other methods. For example, Rosso-Cerón et al. [192] Delphi method, while Schmidt-Scheele [145] used discrete choice experiment. Overall, there were 22 articles that were unclear about the method used to involve stakeholders; these articles simply indicated “participatory process” or similarly non-specific methods. A complete picture of the manner of involvement is presented in the supplementary file (<https://www.mdpi.com/article/10.3390/en17236058/s1>).

2.4 Intersection of Framework Elements: Opportunities for Research

This section presents results as intersections of the different elements of the framework as well as energy types studied to provide insights that can be useful for future research. Two intersections are specifically discussed in this paper: energy type and social sustainability themes (Section 2.4.1), stakeholders and social sustainability themes (Section 2.4.2). The article count for social sustainability themes reflect the updated count based on Section 2.3.4.

2.4.1 Energy Type and Social Sustainability Themes

The first intersection is focused on energy types and social sustainability themes. Figure 2-12 illustrates the percentage of studies that considers each energy type and that falls

within the corresponding social sustainability themes, relative to the total number of studies considered in the study. For example, 48% of the reviewed articles considered both “solar” energy type and the “socio-economic benefits and employment” theme. Meanwhile, 39% of the reviewed articles focused on both “biomass” energy type and the “socio-economic benefits and employment” theme.

Energy Type	Social Sustainability Themes									
	Socio-Economic	Social Development	Health and Safety	Energy Access and Reliability	Social Acceptance	Involvement and Governance	Social Equity	Education	Gender	Human Rights
Solar	48%	32%	23%	26%	24%	13%	10%	10%	4%	4%
Biomass	39%	24%	20%	17%	17%	15%	8%	6%	5%	5%
Wind	39%	26%	20%	19%	20%	11%	6%	7%	2%	3%
Hydropower	25%	18%	15%	13%	15%	10%	6%	5%	2%	4%
Natural Gas	24%	14%	15%	10%	12%	6%	5%	2%	1%	4%
Coal	18%	13%	13%	8%	9%	5%	3%	1%	1%	3%
Oil/Diesel	17%	10%	10%	9%	9%	6%	2%	3%	1%	3%
Nuclear	10%	8%	8%	6%	7%	4%	3%	1%	1%	3%
Geothermal	13%	10%	8%	5%	8%	4%	2%	2%	2%	1%
Ocean/Tidal	3%	5%	4%	2%	3%	2%	3%	2%	1%	0%
Hydrogen	4%	3%	3%	1%	3%	1%	1%	1%	1%	1%

Notes: Darker-colored cells correspond to a higher percentage while lighter-colored cells correspond to a lower percentage. The complete names of the first two column headings under “Social Sustainability Themes” are “Socio-Economic Benefits and Employment” and “Social Development, Well-Being, Quality of Life”, respectively.

Figure 2-12: Intersection of social sustainability themes and energy types considered, as percentage of the total number of studies considered in the review.

The general picture that can be derived from Figure 2-12 is that the “socio-economic” theme is the most explored, particularly in solar, biomass, and wind energy systems. This is followed by the theme of “social development”. It can also be interpreted that most other themes have room to be explored further in the context of conventional energy types (natural gas, coal, oil/diesel, nuclear, geothermal) and emerging renewable energy types (ocean/tidal, hydrogen).

Meanwhile, Figure 2-13 shows the same data but presented as the percentage of the number of studies covering each energy type. For example, 81% of the studies that considered the “solar” energy type also focused on the “socio-economic benefits and employment” theme, while 88% of the studies covering the “biomass” energy type also considered evaluating the “socio-economic benefits & employment” theme.

Based on Figure 2-13, “socio-economic” and “social development” were likewise the prevalent themes. The same pool of articles has incorporated the “involvement and

governance”, “social equity”, “education”, “gender”, “and human rights” themes to a lesser extent, indicating that improvements on social sustainability assessment covering these aspects can be explored further.

Energy Type	n	Social Sustainability Themes									
		Socio-Economic	Social Development	Health and Safety	Energy Access and Reliability	Social Acceptance	Involvement and Governance	Social Equity	Education	Gender	Human Rights
Solar	84	81%	55%	39%	44%	42%	23%	18%	18%	7%	7%
Biomass	64	88%	53%	45%	39%	38%	33%	19%	13%	11%	11%
Wind	69	81%	54%	42%	39%	42%	23%	13%	14%	4%	7%
Hydropower	43	84%	60%	49%	44%	51%	35%	19%	16%	7%	14%
Natural Gas	45	76%	44%	49%	33%	38%	20%	16%	7%	2%	13%
Coal	33	79%	58%	58%	33%	39%	21%	12%	6%	3%	12%
Oil/Diesel	30	83%	47%	47%	43%	43%	27%	10%	13%	7%	17%
Nuclear	21	71%	57%	57%	43%	48%	29%	19%	10%	5%	19%
Geothermal	22	86%	68%	55%	32%	55%	27%	14%	14%	14%	9%
Ocean/Tidal	8	63%	88%	75%	38%	50%	38%	50%	38%	25%	0%
Hydrogen	9	67%	56%	56%	22%	44%	22%	11%	11%	11%	11%

Notes: Darker-colored cells correspond to a higher percentage while lighter-colored cells correspond to a lower percentage. The complete names of the first two column headings under “Social Sustainability Themes” are “Socio-Economic Benefits and Employment” and “Social Development, Well-Being, Quality of Life”, respectively.

Figure 2-13: Intersection of social sustainability themes and energy types considered, as percentage of studies covering different energy types.

Taking both Figure 2-12 and Figure 2-13 into account suggests that future research on social sustainability assessment of electrification systems could cover more energy types and thematic considerations. In particular, ocean/tidal and hydrogen energy systems warrant deeper investigation given their recent emergence compared to established systems like solar, biomass, and wind.

Integrating social aspects to these emerging technologies presents a significant challenge. One of the main obstacles is the lack of practical applications, which hinders researchers from gathering empirical evidence about the social impacts of these technologies. To address this gap, researchers could use proxies from established technologies to estimate the potential social impacts of emerging technologies. However, this approach also poses difficulties, specifically in terms of identifying the most appropriate existing technologies for comparison, as the characteristics may differ substantially between the new and established technologies.

On the other hand, consideration of social aspects in emerging energy technologies should not overshadow the need to evaluate conventional energy systems such as coal, oil/diesel,

and natural gas power plants, since these technologies are still being used as society transitions to a low-carbon future.

In terms of the themes, two suggestions are available. The first suggestion involves broadening the thematic scope of social sustainability assessments. This approach entails incorporating a diverse array beyond socio-economic and social development themes, such as social equity, gender, and human rights considerations. By integrating these additional themes into the assessment framework, a more holistic understanding of the social implications of energy systems can be achieved. This comprehensive approach ensures that the assessment accounts for the multi-faceted nature of social sustainability, and allows to produce context-specific indicators across different energy types and even locations.

On the other hand, a more targeted examination of specific themes is also suggested, with the aim of contributing to holistic evaluation as the end goal. Each energy source carries unique social implications that may vary depending on factors such as geographical location, supply chain, community demographics, and cultural context. By focusing on the social aspects relevant to each energy type, researchers can identify specific indicators or aspects that are most pertinent for assessment.

This analysis, however, is primarily limited due to the present study's search and screening criteria. In this study, articles that implied a more holistic social sustainability assessment were prioritized, while those focusing solely on specific social aspects were not included. This does not dismiss the extent of research performed to explore a specific social sustainability aspect, such as the work of Johnson et al. [236], which investigated the impacts of low-carbon technologies on gender and social equity or works focused on human rights and energy justice [237,238]. Nonetheless, Figure 2-12 and Figure 2-13 imply that several studies, despite promising to perform a holistic and multi-faceted sustainability assessment, still lack certain social aspects.

2.4.2 Social Sustainability Themes and Stakeholders

The second intersection that was investigated is that between stakeholder groups and social sustainability themes. Figure 2-14 shows the percentage of studies that incorporated different social sustainability themes, relative to the total number of studies that involved stakeholders, which is 73 articles.

The figure shows that industry experts, academics, and government representatives were the most involved stakeholder groups, particularly in the “socio-economic” and “social development” themes. Industry experts were involved to a lesser extent in studies covering the other themes, but overall, they were still more involved compared to other stakeholder groups.

Stakeholder Group	Social Sustainability Themes									
	Socio-Economic	Social Development	Health and Safety	Energy Access and Reliability	Social Acceptance	Involvement and Governance	Social Equity	Education	Gender	Human Rights
Industry Experts	63%	47%	27%	30%	36%	29%	14%	11%	7%	12%
Academic	32%	33%	16%	22%	21%	21%	12%	8%	4%	7%
Government	29%	23%	14%	18%	16%	14%	10%	4%	1%	1%
End-Users/Public	18%	16%	15%	12%	11%	12%	7%	11%	4%	3%
NGOs	11%	14%	5%	11%	5%	8%	4%	5%	3%	3%
Suppliers	3%	4%	4%	3%	5%	4%	1%	0%	0%	0%
Private Companies	5%	5%	3%	4%	4%	3%	3%	1%	0%	0%

Notes: For all cells, the n considered is 73 articles. Darker-colored cells correspond to a higher percentage while lighter-colored cells correspond to a lower percentage. The complete names of the first two column headings under “Social Sustainability Themes” are “Socio-Economic Benefits and Employment” and “Social Development, Well-Being, Quality of Life”, respectively.

Figure 2-14: Intersection of social sustainability themes and stakeholders, as percentage of the total number of studies that involved stakeholders.

Some intersections are particularly interesting. For example, studies involving end-users/citizens and NGOs were less involved in studies incorporating the “social acceptance” theme. This is counterintuitive to how “social acceptance” was explained in Section 2.3.2, in which the theme generally reflects the public or society’s priorities. A more thorough study that investigates the role of stakeholders in terms of criteria selection is recommended. This can verify if certain stakeholder groups favor certain themes or influence the inclusion/exclusion of the different themes.

From the perspective of the number of studies covering each stakeholder group, as shown in Figure 2-15, all stakeholder groups have been generally more involved in studies incorporating themes on “socio-economic” and “social development”. In other words, if a certain stakeholder group is involved, they will likely be in studies that incorporate “socio-economic” and “social development” themes. The stakeholder groups have been less involved in studies that incorporated “social equity”, “education”, “gender”, and “human rights” themes.

Two research directions can be explored following this analysis. First is to investigate how each stakeholder group can contribute to each theme. Previous research has demonstrated the involvement of key stakeholders such as government, industry experts, and academics. However, this approach overlooks the potential contributions of other less commonly engaged groups, including end-users/public, NGOs, suppliers, and private companies.

Stakeholder Group	n	Social Sustainability Themes									
		Socio-Economic	Social Development	Health and Safety	Energy Access and Reliability	Social Acceptance	Involvement and Governance	Social Equity	Education	Gender	Human Rights
Industry Experts	52	88%	65%	38%	42%	50%	40%	19%	15%	10%	17%
Academic	30	77%	80%	40%	53%	50%	50%	30%	20%	10%	17%
Government	26	81%	65%	38%	50%	46%	38%	27%	12%	4%	4%
End-Users/Public	17	76%	71%	65%	53%	47%	53%	29%	47%	18%	12%
NGOs	12	67%	83%	33%	67%	33%	50%	25%	33%	17%	17%
Suppliers	4	50%	75%	75%	50%	100%	75%	25%	0%	0%	0%
Private Companies	5	80%	80%	40%	60%	60%	40%	40%	20%	0%	0%

Notes: Darker-colored cells correspond to a higher percentage while lighter-colored cells correspond to a lower percentage. The complete names of the first two column headings under “Social Sustainability Themes” are “Socio-Economic Benefits and Employment” and “Social Development, Well-Being, Quality of Life”, respectively.

Figure 2-15: Intersection of social sustainability themes and stakeholders, as percentage of the number of studies covering each stakeholder group.

By focusing on these stakeholders, researchers can gain valuable insights into their perspectives, priorities, and potential contributions to advancing social sustainability within specific themes. For instance, understanding how end-users perceive and interact with energy systems can inform strategies for enhancing accessibility and affordability. Similarly, NGOs may offer expertise in community engagement and advocacy, while suppliers and private companies could provide insights into supply chain management and environmental, social, and governance goals. By exploring the diverse perspectives and capabilities of all stakeholder groups, researchers can develop more inclusive and effective strategies for promoting social sustainability across all themes.

Another direction that can be undertaken is to focus on a specific theme and to investigate the relevance and contributions of different stakeholder groups within that context. Rather than examining a broad range of themes, future research can concentrate on a single dimension. In doing so, researchers can explore the nuanced interactions between stakeholders and identify opportunities for collaboration and intervention. For example, in “socio-economic benefits and employment” theme, researchers might examine how various stakeholders can support initiatives to create jobs, stimulate local economies, and alleviate poverty. By focusing on a specific theme, researchers can tailor their engagement strategies to address the unique challenges and opportunities associated with that theme with respect to each stakeholder group, ultimately facilitating more targeted and relevant interventions.

In general, future studies could investigate to what extent stakeholder groups should be involved in social sustainability assessments. Furthermore, the level of involvement among these stakeholder groups might differ based on the interests and roles they play along the entire energy supply chain.

2.5 Conclusion and Recommendations for Future Research

Social sustainability assessment in electrification systems is still an evolving topic. This chapter analyzed an updated sample of articles that have included the social component in sustainability assessments of energy systems. At the onset, a simple conceptual framework of social sustainability assessment was proposed, where three elements – social sustainability definition, social sustainability indicators, and stakeholders – are highlighted as the main results of this research.

Based on the explicit definitions inside the reviewed research, this study developed ten themes that surround social sustainability in electrification system assessment: “social development/well-being, quality of life”, “socio-economic benefits and employment”, “health and safety”, “energy access and reliability”, “social acceptance”, “social equity”, “education”, “involvement and governance”, “gender”, and “human rights”.

The indicators identified through the review were also categorized according to the ten themes, in addition to subcategories that can provide future researchers with a baseline when considering which social aspects to include in assessing sustainability.

Next, the roles of stakeholders as well as the nature of their involvement were discussed. Industry experts, academics, and government representatives were identified as the most commonly involved stakeholder groups. In particular, they significantly help in develop criteria and evaluate energy system alternatives.

Aside from the detailed discussion of the framework elements, this study also identified research opportunities by examining the intersection of the framework elements. Some social sustainability themes (e.g., social equity, gender, and human rights) can be investigated further. Likewise, emerging energy technologies, such as ocean/tidal and hydrogen energy systems, present opportunities for more meaningful integration of social sustainability concepts. Meanwhile, in terms of stakeholders, while industry experts are already highly involved in existing assessments, it would be beneficial to engage other stakeholder groups, such as end-users/citizens, suppliers, and private companies. The extent and value of their involvement is also an aspect that researchers could look further into.

Finally, two main suggestions are presented for improving research in the social sustainability assessment of electrification systems. Since the present research included

only peer-reviewed research articles, the first suggestion is to include gray literature (project reports, white papers, government documents, etc.). These types of literature can provide more practical insights and validated information from actual implementation and from stakeholders involved in these projects. Furthermore, other academic articles that are more focused, e.g., covering a specific aspect of social sustainability for a specific energy type, can be considered. As this would likely result in a bigger pool of articles to review, automation tools and/or more researchers, among others, can help make the review more efficient and effective. Nonetheless, investigating specific aspects for specific energy types could result to some social aspects to be more prominent relative to other aspects as well as be more relevant to a specific technology compared to others.

In conclusion, this chapter provides a comprehensive analysis of the evolving field of social sustainability assessment in electrification systems. By reviewing current literature, the chapter identifies key themes that shape the social sustainability dimension of energy systems. Additionally, the research also categorizes relevant indicators as well as highlights the roles and involvement of stakeholders. These findings, particularly the developed social sustainability themes lay foundation to investigate the extent of social considerations in energy policies, the focus of Chapter 3, and the perspectives of stakeholders, the focus of Chapter 4.

The findings of this chapter also suggest several avenues for future research, including further exploration of themes like gender, human rights, and social equity, and the integration of social sustainability considerations in emerging energy technologies. Lastly, further investigation of stakeholder engagement, particularly end-users, suppliers, and private sector representatives, could enhance the robustness and relevance of sustainability assessments.

Chapter 3 Investigating Social Sustainability in Philippine Electrification Policies through Qualitative Content Analysis

3.1 Introduction

Overall, energy policies can play a critical role in embedding social sustainability considerations, such as justice and equity, within national and local energy strategies [13]. Prioritizing energy equity, consumer protection, and social inclusion contribute to socially sustainable energy transitions [239]. Policies must balance meeting energy demands and promoting social justice, as evidenced by ongoing debates surrounding energy poverty and transition [240,241].

Previous studies have examined how energy policies integrate social dimensions, pointing that while economic and environmental aspects are well represented, social aspects are frequently underdeveloped [12]. Despite growing recognition of social sustainability, policy integration varies across regions, indicating the need to further investigate how these principles are incorporated [242–245].

Various social sustainability frameworks have already been discussed in Section 1.3.1 of Chapter 1. As such, this introduction section focuses on the Philippine case, including its electrification initiatives and policy landscape.

3.1.1 Electrification efforts in the Philippines

The Philippines, an archipelago consisting of over 7,000 islands, faces a complex challenge of achieving full electrification while ensuring that energy production and distribution remain socially sustainable. As the nation strives for comprehensive energy access, a balance must be struck between meeting the growing energy demand and ensuring that these efforts contribute positively to social development. Energy transition in the country has also been influenced by international agenda such as the United Nations Sustainable Development Goal (SDG) 7, which calls for affordable, reliable, sustainable, and modern energy for all [246], as well as highlights the central role of energy in promoting social sustainability.

Energy policies in the Philippines have been historically shaped by the country's vulnerability to climate change, economic growth aspirations, and dependency on imported fossil fuels [3,247]. However, the Philippine government has recently made strides towards a cleaner energy future through significant legislative acts, such as the Renewable Energy Act and the Microgrid Systems Act.

With the intention of achieving total electrification up to the off-grid areas, the government has explored the use of hybrid renewable energy systems (HRES) as sustainable alternatives to diesel power plants, which are costly and not environmentally friendly. The implementation of HRES is supported by government policies that aim to enhance energy security, equity, and sustainability [5,11].

While these efforts are commendable for their environmental and economic benefits, there remains a gap in how they address critical social sustainability concerns. Despite the increasing recognition of social sustainability in energy transitions, there remains a significant research gap in evaluating the extent to which social sustainability is explicitly embedded within energy and related policies [22–24].

Existing literature has primarily focused on economic and environmental aspects of energy policy, leaving the social pillar underexplored [12,13]. While frameworks such as social sustainability or social impact assessments [33–35,37], energy justice [42,43] and multi-level governance [248] offer valuable perspectives, a systematic assessment of social sustainability within energy policies has yet to be conducted. This gap emphasizes the need for a comprehensive investigation as to how energy policies address social sustainability considerations. Furthermore, the absence of studies explicitly investigating social sustainability within energy policies limits our understanding of how policies impact different societal groups [249,250].

In the Philippine context, the integration of social sustainability is especially critical given persistent inequalities and geographical challenges that complicate energy delivery [251]. Without deliberate efforts to embed social sustainability, energy transitions risk reproducing existing inequities or leaving vulnerable groups behind.

3.1.2 Overview of Philippine energy policy on off-grid electrification

The relevant institutional structure for Philippine off-grid electrification has been presented in Section 1.3.2 of Chapter 1. Since the country's independence, the Philippine government has employed a variety of electrification strategies, particularly to remote and underserved communities [4]. Previous initiatives include National Electrification Administration's (NEA) rural electrification programs in the 1970s, which supported the formation and growth of ECs. Recent programs include the Sitio Electrification Program and the Barangay Line Enhancement Program.

Despite significant progress, challenges such as rugged and island terrains, sparse populations, economic unviability, and technical difficulties impede electricity provision in some areas [5,6], especially in off-grid regions. As of 2024, the Philippine household electrification has reached 92.78% [56]. Approximately 2,889 barangays, which are the

smallest administrative divisions in the country, remain off-grid. They are spread across 188 municipalities in 35 provinces nationwide [252].

In recent years, the Philippines enacted new laws to strengthen electrification efforts. The RE Act of 2008 marked a significant policy shift toward sustainable and indigenous energy sources, specifically by introducing fiscal and non-fiscal incentives for RE developers and use of cleaner technologies [253]. More recently, the MGSA of 2022 envisions accelerated electrification of unserved and underserved areas by enabling QTPs to establish and operate microgrid systems. This law is expected to remove many of the regulatory bottlenecks that previously hindered private investment in small-scale electrification projects [254].

The existence of these policies, combined with growing global and national calls for sustainable development, underscores the Philippine government's recognition of electricity access as a fundamental right and a cornerstone of socio-economic progress. However, questions remain regarding the extent to which these policies integrate principles of social sustainability.

This chapter addresses this gap by investigating the integration of social sustainability into Philippine energy policies concerning off-grid rural electrification. Specifically, the chapter answers the second main research question, “To what extent is social sustainability integrated in Philippine energy policies governing off-grid electrification?”

Through this analysis, the chapter presents twofold contributions. Practically, it provides policymakers with a comprehensive understanding of which social sustainability principles are present and underrepresented in current energy policies and how different stakeholders are implicated. On a broader scope, this chapter seeks to contribute to a more comprehensive understanding of how energy governance can align with social sustainability objectives and identify areas where further integration is necessary. Academically, this chapter offers a structured coding framework for conducting qualitative content analysis of social sustainability integration within energy policy.

3.2 Methodology

Social sustainability in energy policy can be investigated using qualitative and quantitative methods. Qualitative content analysis (QCA), also known as and highly overlaps with thematic analysis [255–257], has been used to evaluate the extent to which policies incorporate sustainability principles [258,259]. This approach allows researchers to systematically code and categorize documents to identify recurring categories and patterns [260,261] and social sustainability considerations.

Meanwhile, policy discourse analysis (PDA) has examined the framing of sustainability aspects in policies [245,262]. Discourse analysis is suitable for examining the language or manner of communicating policies [257]. Methods such as social impact assessments (SIA), combine quantitative and qualitative approaches by measuring tangible social outcomes, including employment generation, energy affordability, and public acceptance [263]. A combination of these methods provides a comprehensive evaluation of social sustainability.

Overall, QCA is well-suited for investigating social sustainability within Philippine energy policies. It systematically analyzes policy texts, identifying implicit and explicit themes [264,265]. This method is valuable in complex policy contexts which require interpretive depth to uncover underlying narratives and stakeholder influences. QCA allows for the structured examination of how social sustainability are embedded within Philippine energy policies, encompassing legislative and regulatory documents.

QCA offers a systematic and replicable approach for comparing policy documents over time [266,267]. By coding and categorizing policy content, QCA identifies recurring themes or categories, tracks policy evolution, and evaluates the integration of social sustainability into the policy landscape. This makes QCA effective for assessing policy strengths and limitations and identifying areas for improvement.

3.2.1 Research design: qualitative content analysis

This study primarily employed a QCA approach described by Schreier [257] to examine relevant Philippine energy policies. The QCA approach was adopted for three main reasons. First, it focuses on latent meaning, or meaning that is not immediately apparent, which is important when understanding policy provisions. Next, and related to the first reason, is that QCA takes more context in consideration compared to its quantitative predecessor [257]. Interpreting policy provisions within a wider context allows for a more accurate representation of the text. Lastly, QCA is deemed appropriate for research that have structured research questions and previously established categories [268].

The QCA focused on identifying references to social sustainability within policy documents issued by relevant government agencies. The analysis performed mainly follows the QCA frameworks of Schreier [257] and Braun and Clarke [260], which involves systematic coding and categorizing of content to identify themes and patterns.

In this chapter, a concept-driven coding approach was used to build the coding framework [91,256,261]. Specifically, two pre-defined sets of codes were used to address the research questions: a set based on social sustainability categories and a set based on stakeholder groups likely to be impacted by energy policies. However, emerging categories, particularly subcategories for the first set of codes, were also developed when

necessary. This is a characteristic of QCA; the approach allows for new themes and categories to emerge, driven by the data [256,257].

The approach started with familiarization, where policy documents were reviewed to understand the overall context. Next, initial coding was conducted using a predefined framework, assigning codes to relevant sections of text based on specific categories. The coded texts were then refined through iterative review to ensure they accurately represent the assigned codes and account for emerging patterns. The frequency of references to social sustainability categories provided an initial measure of their prevalence in Philippine energy policy. Coding was performed through the NVivo 15 software. To enhance consistency and minimize subjectivity, ambiguous provisions were discussed and resolved collaboratively with the PhD supervisors.

Finally, the coded data were summarized according to their assigned categories to assess their prominence. This analysis generated insights to address the research questions. However, the study deviates from traditional quantitative content analysis. In other words, it does not merely report the frequency of codes and texts but rather focuses on their substance as well [269]. This was achieved by highlighting the evidence of categories in various types of policy documents and different levels of integration. An overview of the research methodology is presented in Figure 3-1.

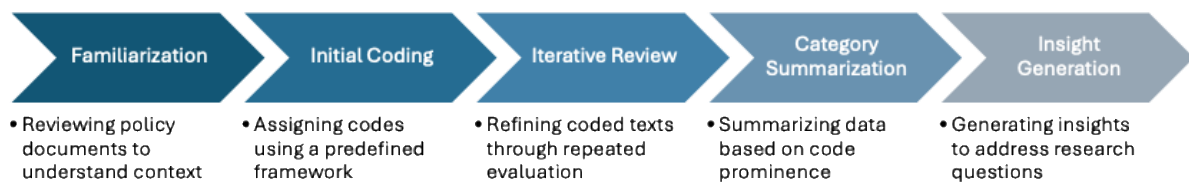


Figure 3-1: Overview of the qualitative content analysis approach.

3.2.2 Data Collection

The primary data sources for this research consist of official policy documents provided by relevant government offices, such as the DOE and the ERC. Publicly available documents that are uploaded in government websites were also screened and considered in addition to the documents provided.

3.2.3 Inclusion and Exclusion Criteria

The selection of documents was primarily guided by recommendations from stakeholders, which could restrict the analysis's scope. To address this, additional relevant documents from government websites and those referenced in the initial set were screened and included. Specifically, the titles and short description of additional potential documents were screened to show relation to off-grid electrification processes.

Furthermore, excluding non-binding instruments such as plans and roadmaps presents limitations. These documents reflect government priorities and provide insights into future policy direction. Although not legally enforceable, they can precede and inform binding legislation. Nonetheless, the focus on binding documents ensures that the analysis is based on policies with direct legal implications and enforceable obligations, which are crucial for assessing the actual regulatory impact on social sustainability.

Finally, documents pertaining to specific regions (e.g., the Mindanao grid) or specific circumstances (e.g., national elections) were excluded from the analysis to concentrate on documents with nationwide applicability and relevance under ordinary circumstances.

3.2.4 Data Analysis - Coding Framework

A set of pre-determined social sustainability categories was used to address the research objective. These categories are based on the review conducted in Chapter 2, which focused on research articles incorporating social sustainability assessment of electrification systems. The categories and their corresponding description are summarized in Table 3-1. To minimize redundancy, textual references within and among documents were excluded. For instance, legislative objectives referenced in departmental documents were not re-coded to avoid multiple instances of the same concept.

Table 3-1: Summary of categories used in the analysis.

SOCIAL SUSTAINABILITY CATEGORIES AND THEIR DESCRIPTION	
▪	Socio-Economic Benefits and Employment – enhancing financial capability, livelihood, reduction of costs
▪	Social Development/Well-Being, Quality of Life – enrichment of the community’s well-being and people’s quality of life
▪	Energy Access –provision of electricity, satisfaction of energy demand
▪	Health and Safety – human/public health, safety from risks
▪	Social Acceptance – ways of enhancing or acknowledging the perspectives and acceptance of different stakeholders
▪	Involvement and Governance – stakeholder participation, interactions of different stakeholders, compatibility with current frameworks
▪	Social Equity – reduction of social disparities, assistance for marginalized groups
▪	Education – upskilling of stakeholders, formal education
▪	Gender – narrowing of gender gap, empowerment of women
▪	Human Rights – respect of human rights, rights of indigenous people

To improve the robustness of the findings, partial results were presented in-person during scheduled meetings and email correspondence with different government offices to solicit their feedback and validation. Specifically, these government offices include the DOE, ERC, TransCo, NEA, and the NPC.

3.3 Results and discussion

3.3.1 Documents included

A total of 17 documents were included in the analysis as presented in Table 3-2. This pool comprises four laws and 13 departmental policies that were found to be relevant to off-grid rural electrification.

3.3.2 More prevalent social sustainability categories in current energy policies

Out of the 10 social sustainability categories, six were found to have prominence in terms of the coded texts from the policy documents. Figure 3-2 shows an illustrative summary of the number of referenced texts each policy document has with respect to the social sustainability categories. More than half of the referenced texts come from department-level policies. However, the referenced texts found from the four laws also provide substantial evidence of social sustainability considerations in Philippine energy policies. Thematic saturation was reached upon reviewing the four laws, no new categories or subcategories emerged beyond this point as they have provided adequate background of the policy landscape considered. The codebook, which summarizes the social sustainability categories, number of sources, and number of references, is presented in Appendix A.

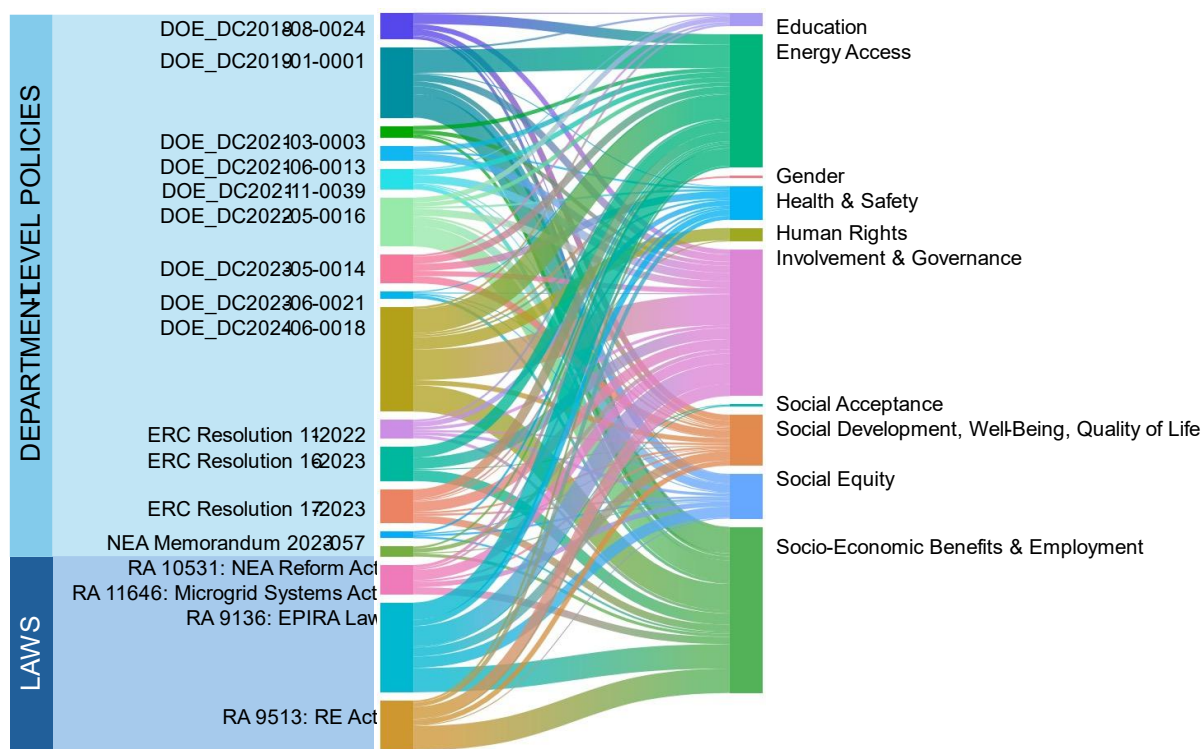


Figure 3-2: Sankey diagram showing document sources of referenced text to assigned social sustainability categories.

Table 3-2: List of policy documents included in the qualitative content analysis.

Type of Document	Name of Specific Document
Laws	▪ Republic Act (RA) 9136: Electric Power Industry Reform Act (EPIRA) of 2001 ▪ RA 9513: Renewable Energy Act of 2008 ▪ RA 10531: National Electrification Administration Reform Act of 2013 ▪ RA 11646: Microgrid Systems Act
Department-Level Policies	<i>Department Circulars (DC) from the Department of Energy:</i> ▪ DC 2018-02-0024 – Promulgating the Rules and Guidelines Governing the Establishment of the Renewable Portfolio Standards for Off-Grid Areas ▪ DC 2019-01-0001 – Prescribing the Omnibus Guidelines on Enhancing Off-Grid Power Development and Operation ▪ DC 2021-03-0003 – Prescribing the Policy and Guidelines for the Distribution Utilities Distribution Development Plan Integrating the Relevant Laws, Policy Issuances, Rules and Regulations ▪ DC 2021-06-0013 – Adopting a General Framework Governing the Test and Commissioning of Generation Facilities for Ensuring Readiness to Deliver Energy to the Grid or Distribution Network ▪ DC 2021-11-0039 – Mandating the National Transmission Corporation as Small Grid System Operator in Specific Off-Grid Areas ▪ DC 2022-05-0016 – Adopting and Integrating the Policies and Programs for the Graduation and Rationalization of the Universal Charge for Missionary Electrification Subsidy Pursuant to Department Circular No. DC2019-01-0001 ▪ DC 2023-05-0014 – Promulgating the Revised Rules and Guidelines Governing the Operationalization of the Renewable Portfolio Standards for Off-Grid Areas Pursuant to Section 12 of the Renewable Energy Act of 2008 ▪ DC 2023-06-0021 – Prescribing the Policy for the Mandatory Conduct of the Competitive Selection Process by the Distribution Utilities for the Procurement of Power Supply for Their Captive Market ▪ DC 2024-06-0018 – Revised Omnibus Guidelines Governing the Award and Administration of Renewable Energy Contracts and the Registration of Renewable Energy Developers <i>Resolutions from the Energy Regulatory Commission:</i> ▪ Resolution 11-2022 – A Resolution Adopting the Rules Governing Distributed Energy Resources (DER) ▪ Resolution 16-2023 – Implementing Guidelines for the Procurement, Execution, and Evaluation of Power Supply Agreements Entered into by Distribution Utilities for the Supply of the Electricity to their Captive Market ▪ Resolution 17-2023 – A Resolution Adopting the 2023 Revised Rules for the Issuance of Certificates of Compliance for Generation Facilities <i>Memorandum from the National Electrification Administration:</i> ▪ Memorandum 2023-057 – The National Electrification Administration Competitive Selection Process Guidelines Implementing the Department of Energy’s Department Circular No. DC2023-06-0021 and the Energy Regulatory Commission’s Resolution No. 16, Series of 2023

Additionally, Figure 3-2 shows the relative prevalence, through the thickness of the end nodes, of each social sustainability category within the reviewed Philippine energy policies. Based on this illustration, the categories of “energy access”, “involvement and governance”, and “socio-economic benefits and employment” are seen to have the greatest presence in terms of the number of referenced texts.

However, instead of focusing on the quantitative aspect, i.e. frequency of referenced texts, the succeeding subsections expound on the prominence of these categories through qualitative discussions.

3.3.2.1 Energy access

Energy access is one of the most prevalent social sustainability categories within Philippine energy policies. The representative excerpts for this category and its three subcategories are presented in Table 3-3.

Table 3-3: Representative excerpts for the energy access category and its subcategories.

Subcategory	Representative Excerpts	Source Document
Provision of Reliable Electricity Services	“... To ensure and accelerate the total electrification of the country.”	Republic Act 9136
	“The interconnection of off-grid areas shall... improve the reliability and adequacy of power supply...”	DOE DC 2019-01-0001
	“... Improve efficiency in power supply through integration of RE in the power generation supply mix on a per off-grid area basis...”	DOE DC 2023-05-0014
	“No COC [certificate of compliance] shall be issued without a technical inspection having been conducted and completed by ERC on the DER [distributed energy resource].” • Interpretation: Technical compliance of the DER would help ensure access to reliable electricity services.	ERC Resolution 11-2022
Energy Security	"The RPS Off-Grid Rules is intended to ... improve self-efficiency in power generation through integration of RE in the supply mix in Off-Grid Areas."	DOE DC 2018-08-0024
	“Ensure the ... security, ... of electricity service in off-grid areas.”	DOE DC 2019-01-0001; Republic Act 9136
	“To promote the utilization of indigenous and new and renewable energy resources in power generation in order to reduce dependence on imported energy;”	Republic Act 9136

A fundamental aspect of Philippine energy policies aims at ensuring that all citizens, including those in off-grid and underserved areas, have access to reliable electricity. Representative examples include the EPIRA, which mandates the state “to ensure and accelerate total electrification of the country”, and DOE DC 2019-01-0001, which promotes interconnection to improve grid reliability.

The implementation of this mandate relies on several mechanisms, including “missionary electrification”, an overarching program to provide basic electricity services in unviable and underserved areas and other strategic plans. These plans include the Missionary Electrification Development Plan (MEDP), which identifies household beneficiaries and appropriate electrification strategies, as well as the Distribution Development Plans (DDPs) and interconnection projects, which reflect the government's commitment to improving electricity services and addressing distribution system’s deficiencies.

Philippine energy policies also emphasize electricity reliability and availability. System impact studies and compliance with grid and distribution codes ensure new generation facilities do not compromise reliability. Policies like DOE DC 2019-01-0001 also mandate DUs to forecast load and submit quarterly reports on supply-demand balances to improve service availability in off-grid areas. These efforts enhance system resiliency and reliability, ensuring infrastructure remains operational despite challenges. Additionally, there is a strong focus on modernization, rehabilitation, and interconnection projects.

Closely linked to energy access is energy security, which focuses on enhancing the country’s energy self-sufficiency. Policies, like the RE Act and related department-level documents, emphasize developing and utilizing RE and indigenous resources. National-level policies also promote reducing dependence on imported energy sources through promoting the exploration of indigenous resources.

DOE DC 2018-08-0024 and DOE DC 2023-05-0014 support this national-level direction by mandating electricity generating companies to source a portion of their supply from eligible RE resources as part of the Renewable Portfolio Standards (RPS). Additionally, hybridization of diesel power plants with renewable systems have been mandated, aligning with the broader goal of energy self-sufficiency.

However, while policies often cite targets for total electrification, they do not clearly report on whether access leads to meaningful and productive use of energy in off-grid communities. The lack of integrated and established monitoring frameworks that connect access to other social dimensions constrains the evaluation of whether access alone results to sustainable outcomes.

3.3.2.2 Socio-economic benefits and employment

The next central category concerns socio-economic benefits and employment. The representative excerpts for this category and its four subcategories are presented in Table 3-4.

Table 3-4: Representative excerpts for the socio-economic benefits and employment category and its subcategories.

Subcategory	Representative Excerpts	Source Document
Affordability and Minimizing Costs	“To ensure the ... affordability of the supply of electric power”	Republic Act 9136
	“Pursuant to the objective of lowering electricity rates to end-users, sales of generated power by generation companies shall be value added tax zero-rated.”	Republic Act 9136
	“The conduct of CSP shall be considered by the ERC in the determination of the compliance by DU with its obligation to supply its Captive Market in the least cost manner...”	DOE DC 2023-06-0021
	“Institutionalize least-cost generation planning to enable the entry of low-cost generation technologies in small grids and other off-grid power systems...”	DOE DC 2022-05-0016
Financial Benefits and Incentives	“... end-users shall be granted a rate reduction from NPC rates of thirty centavos per kilowatt-hour (P0.30/kWh)”	Republic Act 9136
	“Income Tax Holiday (ITH) – For the first seven (7) years of its commercial operations, the duly registered RE developer shall be exempt from income...”	Republic Act 9513
	“Allotment of [Universal Charge for Missionary Electrification] UC-ME or government subsidy for the NPC-SPUG, NPPs, QTPs, DUs and RE developers...”	DOE DC 2019-01-0001
Economic Growth, Livelihood	“To ensure transparent and reasonable prices of electricity ... to achieve greater operational and economic efficiency and enhance the competitiveness of Philippine products in the global market...”	Republic Act 9513
	“Give preference to Philippine companies/agencies entering into subcontracts on goods or services that are required in the Biomass Energy Operations...”	DOE DC 2024-06-0018
Employment	“Give priority in employment to qualified residents within the Host LGUs...”	DOE DC 2024-06-0018
	“... Filipino Employees who have adequate training and experience to render the services required by the RE DEVELOPER shall be given preference... “	DOE DC 2024-06-0018

Ensuring electricity affordability, particularly in off-grid areas with high power generation costs, is a key Philippine energy policy objective. Least-cost planning, tax exemptions, subsidies like the Universal Charge for Missionary Electrification (UC-ME), and other technologies and strategies that reduce electricity prices manifest this central policy objective.

Meanwhile, financial assistance mechanisms play a significant role in supporting energy stakeholders, particularly in off-grid and missionary areas. The UC-ME is one such example, although policies are shifting toward its rationalization and phase out, as outlined in the DOE DC 2022-05-0016. This category also includes other financial assistance mechanisms, such as NEA's financial assistance for ECs, which funds

feasibility studies and infrastructure development. There are also tax benefits and subsidies under the RE Act, encouraging private sector participation in energy development. Overall, financial incentives are closely related to institutional support (covered in Section 3.3.2.3), as many financial assistance mechanisms are also government efforts to capacitate industry stakeholders.

However, financial mandates do not always translate into lower electricity costs. Electricity rates in the Philippines remain among the highest in Southeast Asia, raising questions about the effectiveness and fairness of current subsidy systems [270,271]. For example, urban poor households connected to the grid may end up subsidizing off-grid areas with relatively higher economic activity through the UC-ME.

Similarly, economic growth and employment are often framed as indirect benefits rather than core objectives. For example, the MGSA aims to use electrification to promote economic growth, alleviate poverty and promote nation-building. Similarly, employment-specific provisions are limited to preferential hiring practices in select RE contracts, without broader mandates or measurable job creation targets.

Through an interview, the NPC mentioned they do consider socio-economic indicators in their monitoring and evaluation frameworks. These include average household income and employment creation, including for women, suggesting that electrification can promote local development. However, the use of these findings to inform policy feedback loops remain unclear.

Finally, while affordability and financial assistance are well-integrated, employment is comparatively underrepresented. When compared to academic literature [29] and to global energy transition discussions, which often emphasize employment as a primary benefit of sustainable energy projects [272,273]. Current policies focus on affordability and system reliability. Although policies acknowledge job creation, potential employment is often an indirect benefit rather than a central policy objective. Integrating job creation metrics into energy policy could clarify how energy systems contribute to this social sustainability aspect.

3.3.2.3 Involvement and governance

Effective governance frameworks require the involvement of diverse actors, including governments, civil society, and local communities, to ensure that social sustainability principles are upheld [248]. This direction is encapsulated in the involvement and governance category. The representative excerpts for this category and its five subcategories are presented in Table 3-5.

Table 3-5: Representative excerpts for the involvement and governance category and its subcategories.

Subcategory	Representative Excerpts	Source Document
Non-Government Stakeholder Engagement	“Develop policies and procedures ... to enable and encourage electric power industry participants to provide adequate capacity to meet demand ...”	Republic Act 9136
	“... the RE Developers shall submit wind data set to the DOE, through the Energy Data Center of the Philippines (EDCP).”	DOE DC 2024-06-0018
	“The DOE shall conduct consultations with all concerned stakeholders to update policies and to finalize the MEDP.”	DOE DC 2019-01-0001
	“Pre-Application Orientation of Interested Participants...”	DOE DC 2024-06-0018
Inter- and Intra-Government Collaboration	“The DOE shall formulate the annual MEDP based on the submissions of the NPC, concerned DUs, and other stakeholders...”	DOE DC 2019-01-0001
	“Responsibilities of the Composite Team [<i>which is composed of different government offices</i>]: (a) Evaluate and monitor the RPS Requirements and Compliance Plan per Mandated Participant; [<i>among others</i>]”	DOE DC 2023-05-0014
	“The [<i>Philippine Development Plan</i>] PDP shall consider and integrate the individual or joint development plans of the transmission, generation, and distribution sectors of the electric power industry, which are submitted to the Department.”	Republic Act 9136
Compatibility with Institutional Framework	“GenCo, MGSP, Entities with SGF, QE, and Entities with DER shall ensure that its Generation Facilities comply with applicable environmental laws, rules and regulations.”	ERC Resolution 17-2023
	All RE explorations, development, utilization, and RE systems operations shall be conducted in accordance with existing environmental regulations as prescribed by the [<i>Department of Environment and Natural Resources</i>] DENR and/or any other concerned government agency.	Republic Act 9513
	“The crafting of the [<i>Distribution Development Plan</i>] DDP must take into account all the applicable provisions prescribed in the Philippine Distribution Code and other appropriate laws, policies, and regulations.”	DOE DC 2021-03-0003
Institutional Support	“The NEA shall be responsible for providing technical assistance and financing support to ECs serving off-grid areas in order to enhance their capability as the Default [<i>system operator</i>] SO.”	DOE DC 2019-01-0001
	“Capacity Building on RE Development. The DOE shall provide trainings and orientations on RE Development policies and guidelines, including securing RE Contracts to interested RE Developers.”	DOE DC 2023-05-0014
Accountability	“The ERC shall ... penalize abuse of market power in the restructured electricity industry.”	Republic Act 9136
	“Adopting a transparent process for the procurement of electric power supply...”	ERC Resolution 16-2023

Policies mandate consultations with non-government stakeholders (e.g., DOE DC 2022-05-0016) and encourage private sector participation in energy planning (e.g., DOE DC 2024-06-0018 and ERC Resolution 17-2023).

Inter- and intra-government collaboration is also emphasized, particularly among government agencies like the DOE, ERC, NEA, and NPC. Provisions require coordinated planning, such as in the formulation of strategic plans, compliance monitoring, and shared data reporting.

However, despite these efforts, the lack of monitoring data on stakeholder participation or the enforcement of collaborative mechanisms undermines the potential of effective stakeholder engagement. Furthermore, while policies frequently mandate public consultations and coordination among government bodies, these processes are often procedural rather than transformative. For example, consultative language is present, but there is limited institutional accountability to ensure that stakeholder inputs influence final policy decisions. This proceduralism may result in tokenistic participation, undermining trust and legitimacy.

Governance in energy policy also manifests in compatibility with institutional frameworks. This includes harmonizing regulations, streamlining government procedures, and ensuring compliance with broader policy objectives and Philippine laws.

Meanwhile, institutional support for energy stakeholders is evident in government-led initiatives providing financial assistance, capacity building, and technical support. Financial assistance has already been covered in Section 3.3.2.2. Other examples of institutional support include the DOE's training programs and technical assistance to ECs and DUs. These efforts, done in coordination with NEA and NPC, include capacity-building activities for system operators and financial aid for capital expenditures related to monitoring and control systems. The government also assists in off-grid areas by developing transition plans for grid interconnection.

Despite these efforts, institutional support mechanisms are heavily directed toward energy developers, DUs, and ECs. End-users, especially vulnerable communities, are rarely targeted as recipients of capacity development. This suggests capacity is built where economic returns are expected, rather than where empowerment is critical. Future policies may consider explicit provisions catering to the capacity building needs of communities, especially those situated in off-grid areas.

The final subcategory, accountability, is manifested in Philippine energy policies through provisions that ensure transparency and responsibility among key players in the sector. These include comprehensive procurement guidelines, performance monitoring, and penalties for non-compliance. Accountability relates to procedural equity, discussed in

Section 3.3.2.5, as ensuring accountability strengthens fairness in decision-making processes.

3.3.2.4 Social development, well-being, quality of life

To facilitate the discussion of the “social development, well-being, quality of life” category, three subcategories are highlighted. The representative excerpts for this category and its subcategories are presented in Table 3-6.

Table 3-6: Representative excerpts for the social development, well-being, quality of life category and its subcategories.

Subcategory	Representative Excerpts	Source Document
Social Welfare, Improvement of Way of Life	“To protect the public interest as it is affected by the rates and services of electric utilities and other providers of electric power...”	Republic Act 9136
	“Benefits to Host Communities. – The obligations of generation companies and energy resource developers to communities hosting energy generating facilities ... shall continue...”	Republic Act 9136
Surroundings, Environment, and Ecosystems	“To assure ... environmentally compatible energy sources and infrastructure...”	Republic Act 9136
	“Encourage the development and utilization of renewable energy resources as tools to effectively prevent or reduce harmful emissions...”	Republic Act 9513
Technological Advancements	“Encourage the entry of advanced and efficient power technologies towards the provision of flexible and adaptive power systems and low-cost electricity services in off-grid areas.”	DOE DC 2019-01-0001
	“To promote appropriate investments, new capabilities, and advanced technologies towards enhancing the performance of the system operation in small grids and other off-grid power systems...”	DOE DC 2021-11-0039

Philippine energy policies recognize the importance of electricity access in improving social welfare and overall quality of life. Mandates include protecting public interest and ensuring benefits to host communities (e.g., EPIRA). These measures attempt to balance energy development with community welfare, ensuring local populations benefit from electricity access and mitigating socio-economic disruptions brought by large-scale energy projects. However, more targeted programs to address specific socio-economic concerns, such as livelihood enhancement and community-based energy initiatives, are necessary in the future.

Enhancing quality of life also covers efforts to improve and conserve the environment. This represents the intersection of social sustainability with environmental sustainability. It manifests through mandates on RE adoption (e.g., DOE DC 2023-05-0014, and as

discussed in Section 3.3.2.1) and compliance with environmental laws and mandates (e.g., DOE DC 2019-01-0001).

Finally, policies also promote advanced and emerging technologies, particularly in off-grid and small-grid systems. These policies suggest a forward-looking approach to enhance both affordability and sustainability. For example, DOE DC 2019-01-0001 emphasize modern, flexible, and adaptive power technologies for reliable (Sections 3.3.2.1) and low-cost (Section 3.3.2.2) electricity. Furthermore, DOE DC 2021-11-0039 promotes investments in new capabilities and innovations that enhance energy system efficiency in small grids.

Overall, while policies consistently promote that electrification facilitates development, they seldom systematically define or track the broader well-being outcomes they aim to achieve. Future policies could benefit from clearly defining what well-being or quality of life means and identifying indicators that can be used to evaluate these dimensions.

3.3.2.5 Social equity

Social equity is present in Philippine energy policies mainly through distributive and procedural mechanisms. The representative excerpts for social equity and its three subcategories are presented in Table 3-7.

Distributive equity is manifested by provisions (e.g., RA 11646, ERC Resolution 11-2022 and DOE DC 2022-05-0016) pertaining to subsidies (e.g., the UC-ME) and fair cost-sharing mechanisms for off-grid electrification, differentiated tariff-setting, and infrastructure investments for off-grid areas. These mechanisms also closely relate to poverty alleviation and rural development efforts of the government.

However, the government's long-term goal of phasing out of subsidies, particularly the UC-ME, may raise questions about just energy transition, especially for marginalized consumers. Tariff-setting mechanisms aimed at mitigating negative consequences of this phaseout through price differentiation also requires careful evaluation of the long-term impacts.

Furthermore, explicit references to vulnerable groups are rare in the reviewed policies. Policies often rely on geographic targeting, such as off-grid areas, without attention to possible inequalities within these areas. In this regard, future policies could enhance distributive equity by addressing context-specific inequalities and segmenting beneficiaries into identified marginalized groups.

Table 3-7: Representative excerpts for the social equity category and its subcategories.

Subcategory	Representative Excerpts	Source Document
Distributive Equity	“Devise ways and means of giving direct benefit to the ... community and people affected, and equitable preferential benefit to the region that hosts the energy resource and/or the energy-generating facility...”	Republic Act 9136
	“An equitable recovery mechanism, if applicable, for an MGSP’s assets to ensure just compensation at the expiration of the [contract] MSC...”	Republic Act 11646
	<i>Sections 17.1 and 17.2 regarding On-grid Pricing and Off-grid Pricing, respectively.</i>	ERC Resolution 11-2022
	“The ERC shall pursue a more appropriate tariff mechanism in off-grid areas that optimizes the recovery of all costs of electricity services from consumers while taking into consideration the socio-economic condition in said areas.”	DOE DC 2022-05-0016
Poverty Alleviation and Rural Development	“... Pursue sustainable rural development and poverty reduction towards nation-building through energy access...”	Republic Act 11646
	“Those customers that have significant contribution to the demand requirements shall pay more than the marginal customers of electricity in the off-grid areas.”	DOE DC 2022-05-0016
Procedural Equity	“... Monitor and take measures in accordance with this Act to penalize abuse of market power, cartelization, and anti-competitive or discriminatory behavior by any electric power industry participant...”	Republic Act 9136
	“... Adopting a transparent, competitive, and timely process for the procurement of electric power supply by ECs for the Captive Market.”	NEA Memorandum 2023-057

Meanwhile, procedural equity, which relates to concepts of due process, transparency, and accountability [274], is manifested in Philippine energy policies through principles of transparency, fairness, and inclusivity. For example, CSP for power procurement requires bid opportunities to be widely disseminated and all eligible suppliers have equal chances to participate. This prevents anti-competitive behavior, such as price manipulation and market concentration. Regulatory measures also require open access to transmission and distribution systems, preventing discrimination between public and private sector entities.

Additionally, policies emphasize market safeguards to prevent monopolistic practices and ensure the fair benefit distribution. The ERC also monitors potential market abuses, enforces rules against cross-subsidization, and ensures transparent subsidies and cost allocations. The objective is to promote an equitable energy sector with the same regulatory standards for large and small players, fostering competition that benefits consumers.

3.3.2.6 Health and safety

Health and safety also form part of social sustainability. The representative excerpts for this category and its two subcategories are presented in Table 3-8.

Table 3-8: Representative excerpts for the health and safety category and its subcategories.

Subcategory	Representative Excerpts	Source Document
Public Health, Pollution-Related	“Prioritize ... environment-friendly sources of energy...”	Republic Act 11646
	“Accelerate green energy transition by reducing use of fossil fuels through hybridization or use of alternative technologies.”	DOE DC 2023-05-0014
	“... exert its best efforts to prevent pollution and damage to the atmosphere, oceans, rivers, lakes, harbors and land...”	DOE DC 2024-06-0018
Safety from Injury and Accidents	“Ensure end-user safety and protection at all times...”	Republic Act 11646
	“Prior to the installation of an exporting DER, a [distribution impact study] DIS shall be conducted by the DU to ensure the safety ...of the Distribution System.”	ERC Resolution 11-2022

Philippine energy policies recognize energy generation affects public health, particularly in pollution and environmental impacts. Several policies, already discussed in Sections 3.3.2.1 and 3.3.2.4, emphasize a transition toward RE sources and cleaner technologies to limit greenhouse gas emissions and other pollutants. Health-related provisions also include compliance with existing environmental regulations. Meanwhile, safety is enforced through technical inspections, impact studies (e.g., ERC Resolution 11-2022), and compliance requirements in plant operations and distribution systems.

Despite these efforts, broader community health outcomes are largely absent in policies. Furthermore, there is no clear integration of energy policies with public health frameworks. For example, off-grid health clinics are not mentioned as priority beneficiaries, nor are there mention of cross-sectoral collaborations with the Department of Health. In this regard, future policies may benefit from clearer mandates that reflect the intersection of energy access and public health directives.

3.3.3 Less prevalent social sustainability categories in current energy policies

This section presents the four categories that did not receive as much prominence in Philippine energy policies in terms of the referenced texts.

3.3.3.1 Social acceptance

Social acceptance plays a fundamental role in ensuring the success of energy policies by fostering public support. While this dimension is found to be present in the policies reviewed, they are limited and in a targeted manner. Table 3-9 presents the representative excerpts for the social acceptance category.

Table 3-9: Representative excerpts for the social acceptance category.

Representative Excerpts	Source Document
"The ERC shall... ensure customer choice"	Republic Act 9136
"The DOE shall establish a Green Energy Option program which provides end-users the option to choose RE resources as their sources of energy."	Republic Act 9513

Two references were attributed to this social dimension. The first is the ERC's mandate to promote consumer choice. The other is the Green Energy Option Program by the DOE, which enables end-users to select renewable energy sources.

This underrepresentation of social acceptance might be due to the assumption that consultations and public dialogues (which were covered in stakeholder involvement under Section 3.3.2.3), already suffice and expected to enhance stakeholder acceptance. However, without deliberate social acceptance strategies that consider long-term community engagement and trust-building efforts, electrification projects may face local resistance.

To improve the social acceptance dimension, future policies may consider mechanisms to address local resistance and promote outcome-oriented indicators (e.g., measuring end-user satisfaction or acceptance) over procedural ones (e.g., holding consultations).

3.3.3.2 Gender

Although gender considerations are increasingly recognized as essential to energy policy and governance [275,276], Philippine energy policies exhibit minimal integration of this social dimension. Only few references, found in the annexes of DOE DC 2024-06-0018, mention gender equality in employment and training opportunities. Furthermore, according to the NPC, government offices are expected to adhere to the Gender and Development framework in terms of earmarking budgets for different programs. Although the current provisions and mechanisms are commendable, they remain isolated instances in the broader context of energy policy and are not integrated into legally binding frameworks in the energy sector.

This limited focus on gender equality raises concerns about the absence of a comprehensive approach to addressing gender issues within the energy sector. One

possible explanation is the emphasis, if not isolation, of gender within broader labor or development policies, resulting in minimal provisions in energy policies that can explore how gendered impacts might be considered in the energy sector.

Without stronger mandates or more explicit guidelines in the primary policy texts, gender considerations risk being ignored. A more explicit and extensive incorporation of gender-related provisions could ensure that energy policies promote inclusivity and equal opportunities across all sectors of society. Table 3-10 presents the representative excerpts for the gender category.

Table 3-10: Representative excerpts for the gender category.

Representative Excerpts	Source Document
“The RE DEVELOPER shall maintain as much as possible, an equal percentage men and women employees and accord them equal access to development and training programs”	DOE DC 2024-06-0018
"In no case shall an employee be denied employment and access to such development and training programs on the basis of sex and/or gender.”	DOE DC 2024-06-0018

3.3.3.3 Human rights

The category of human rights in Philippine energy policies primarily pertains to the protection of indigenous peoples’ (IPs) rights, ancestral domains, and environmentally critical areas. These are largely framed around procedural compliance with existing laws such as the Indigenous Peoples’ Rights Act (IPRA) and related instruments. Table 3-11 presents excerpts for the human rights category.

Table 3-11: Representative excerpts for the human rights category.

Representative Excerpts	Source Document
“If the [Area of Interest] AOI overlaps with ancestral domains with a Certificate of Ancestral Domain Title or Claim, the REMB Assistant Director shall issue a Notice to Apply for the said AOI: Provided, that the Contract Area may be reduced subject to RA 8371, or 'The Indigenous Peoples’ Rights Act of 1997' (IPRA), and its IRR.”	DOE DC 2024-06-0018
"For applications affecting Indigenous Cultural Communities / Indigenous People (ICCs/IPs) in lands of Ancestral Domain, proof of the appropriate Certification Precondition issued by NCIP.”	ERC Resolution 17-2023

While ancestral domains and IPs receive attention, other human rights concerns like labor rights, forced displacement, and child labor are less addressed. This may be because these issues are likely covered under broader laws and regulations. Nevertheless, the absence of direct references to such protections suggests a potential gap in ensuring energy projects adhere to human rights standards. To better integrate social sustainability, energy

policies could explicitly link energy policies to existing labor and human rights frameworks for comprehensive protection of vulnerable populations.

3.3.3.4 Education

The last social sustainability category in this analysis is education. Within Philippine energy policies, this category is mainly characterized by capacity-building programs among stakeholders, which form part of institutional support discussed in Section 3.3.2.3. While these efforts are necessary to equip industry participants, the reviewed policies rarely attribute energy access to broader education goals, such as education of citizens and energy literacy. Future policies can therefore consider being more explicit about the intersection of energy access to broader education outcomes. This can include prioritizing electrification of off-grid public schools and improving energy literacy of off-grid end users.

Lastly, provisions related to general information, education, and communication campaigns were not included in this discussion. However, it is important to note that such provisions are a standard inclusion in Philippine laws and policies, ensuring that relevant stakeholders are made aware of their responsibilities and the key components of policy implementation. Table 3-12 presents the representative excerpts for the education category.

Table 3-12: Representative excerpts for the education category.

Representative Excerpts	Source Document
"...the DOE, in collaboration with the NEA and NPC, shall develop a system to support the capacity building of the Mandated Participants..."	DOE DC 2018-08-0024
"Strengthen the capacity of all stakeholders involved in off-grid electrification to proficiently perform their respective roles and responsibilities through the conduct of trainings, workshops, and other forms of capacity building and institutional strengthening activities."	DOE DC 2019-01-0001

3.4 Characterizing Philippine energy policies within the social sustainability context and future outlook

The discussion up to this point highlights the prevalence of different social sustainability categories within the reviewed Philippine energy policies. Figure 3-3 shows these interconnections across the ten categories and their subcategories, demonstrating the systemic nature of social sustainability.

Central to this figure is the “socio-economic benefits and employment” category, which serves as an anchor for multiple other categories. Its subcategories are intertwined with

broader objectives like energy access and social equity. For example, it connects with “social equity”, particularly through the distributional dimension of financial benefits and incentives. Programs such as the UC-ME aim to reduce disparities but may unintentionally reinforce them if not carefully improved. Another instance is its connection with “energy access”. Improved electricity services in rural or off-grid areas can lead to local development, increased productivity, and new employment opportunities. However, without mechanisms to enable productive use of energy, electrification alone may not yield significant socio-economic development.

The “involvement and governance” category also emerges as a highly interconnected and relevant category. It supports other categories by enabling institutional coordination and facilitating stakeholder consultations. The connection between this category and social acceptance is especially important, because policies that foster meaningful engagement, through consultations, feedback loops, and transparent reporting, can enhance public trust and reduce resistance to energy projects. Tokenistic participation, however, may prevent legitimacy and hinder implementation.

Connections between “health and safety” and “social development, well-being, quality of life” categories are also evident. Electrification reduces dependence on traditional fuels, improving indoor air quality and health outcomes. Electrified health facilities enhance medical services, contributing directly to community well-being. However, few policies explicitly integrate public health metrics or involve the health sector in energy planning, which is a missed opportunity to strengthen cross-sectoral benefits.

Although Figure 3-3 illustrates interconnections based on the currently reviewed policies, various interconnections may also exist as energy policies are improved in the future. For example, the link between gender and social equity can help address women’s disproportionate burdens from energy poverty. Human rights can also cut across all other categories, in the sense that rights-based framework may offer a unifying rationale for improved energy access, stakeholder involvement, acceptance, gender empowerment, education, and health, among others.

Across all categories, future policies can generally benefit from establishing comprehensive frameworks to assess the impacts of energy access in terms of different social aspects. Embedding such frameworks into binding policy documents can also strengthen the integration of social sustainability in the electrification of the government. Meanwhile, evaluation of future electrification projects can consider social impacts, aside from techno-economic and financial indicators. These indicators can also be used when developing national energy plans and roadmaps.

The analysis has so far focused on current binding policies in the form of laws and department-level guidelines. However, upon consideration of government roadmaps and

plans, there are facets that point to social aspects. For example, the PEP 2023-2050 [277] layout targets in terms of green jobs to be generated for the country’s low carbon future. Additionally, gender mainstreaming efforts are also mentioned. Thus, a deeper analysis into government roadmaps, plans, and reports in conjunction with existing binding policies would provide additional insights about the state of social sustainability integration in the Philippine energy context.

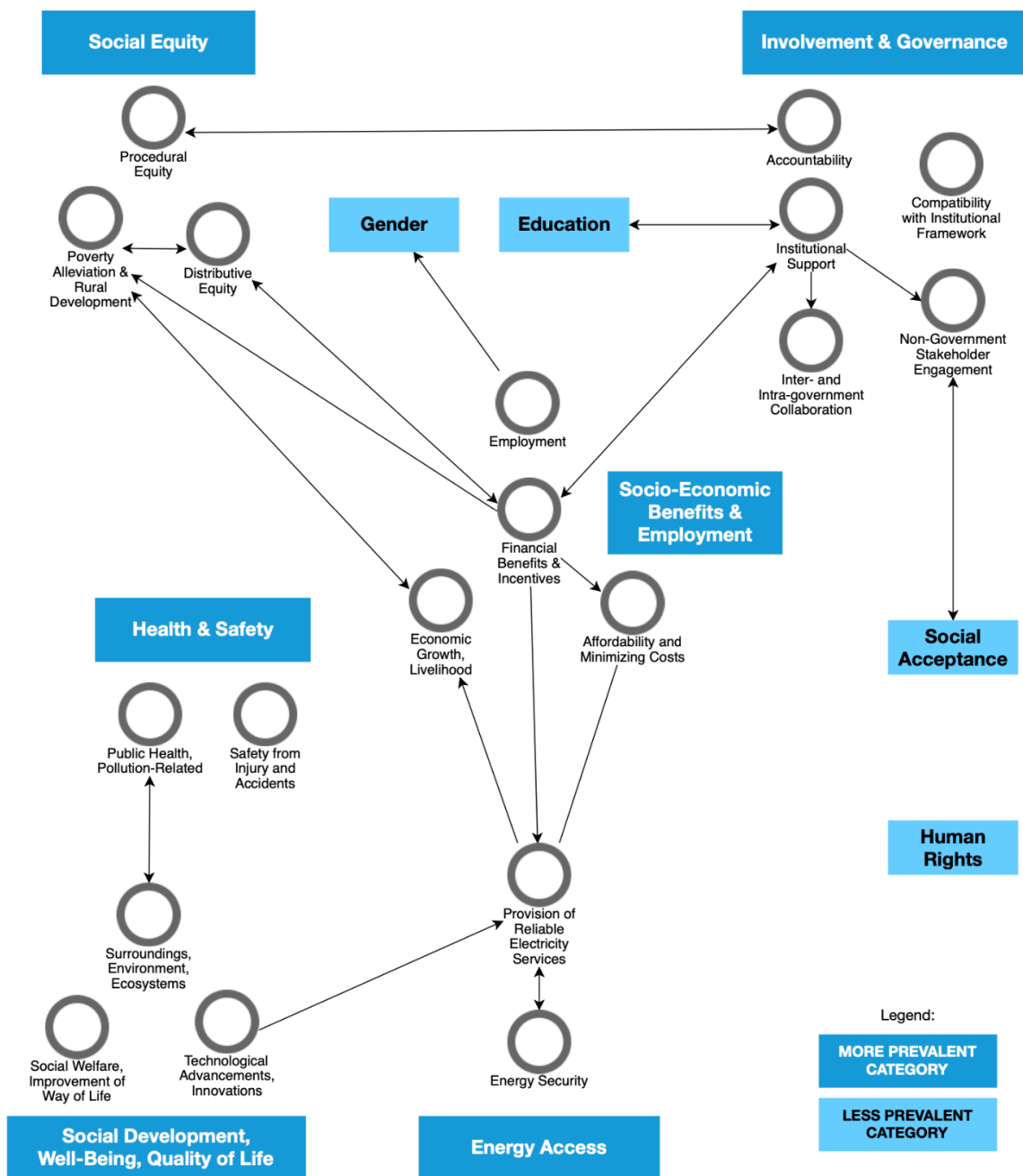


Figure 3-3: Relationships of social sustainability categories and their subcategories.

3.5 Conclusion

A qualitative content analysis was conducted to investigate the presence of social sustainability considerations within selected Philippine energy policies. The analysis revealed that while categories such as “socio-economic benefits and employment,” “energy access,” and “involvement and governance” are prominently reflected, other social aspects — particularly social acceptance, gender, human rights, and education — were less integrated.

Overall, Philippine energy policies could benefit from institutionalizing underrepresented dimensions by incorporating them into core mandates and performance indicators within energy regulations, not just in annexes or voluntary guidelines. Additionally, mainstreaming social sustainability principles in energy policies could prevent isolation of such principles in other spheres, including labor and environmental laws. Metrics and indicators for social impacts can also better incorporate social sustainability by ensuring that these impacts are measurable and monitored. An overview of identified gaps and policy recommendations in each social sustainability category is represented in Figure 3-4.

Beyond the Philippine context, policymakers from other countries can draw inspiration from the provisions currently found in Philippine energy policies. Academic stakeholders and researchers can also refer to the paper’s research design, coding framework, and approach to investigate the context of other countries.

Furthermore, this chapter contributes to the developing interdisciplinary nature of energy research and social science. The study builds on the principles of energy justice and social sustainability to evaluate how national energy policies translate these concepts into regulatory practice.

Future research could be enhanced by incorporating a broader range of policy documents (plans, roadmaps, and relevant laws implemented by other government agencies), using inductive approaches to identify emerging themes, incorporating a temporal dimension to assess how policies have changed over time in relation to social concerns.



Figure 3-4: Overview of identified gaps and recommendations across all social sustainability categories.

Chapter 4 Social Sustainability Aspects of Off-Grid Rural Electrification Systems: Insights from Philippine Government Stakeholders

4.1 Introduction

Building on the policy analysis in Chapter 3, this chapter shifts the focus to the perspectives of government stakeholders involved in off-grid rural electrification. By examining how they conceptualize social sustainability, identify relevant social aspects, and perceive challenges in implementation, the chapter complements the policy review.

Examining these perspectives is particularly important given that much of the existing research on energy has often emphasized technological solutions and financial mechanisms, with less attention to the social dimensions that shape long-term outcomes. Recent literature emphasizes the addition of social factors, including affordability, inclusivity, governance, gender equality, and community engagement, as key determinants of sustainability [29,194,239]. Yet empirical evidence on how policymakers and implementing agencies understand and prioritize these social aspects remains limited, particularly in Southeast Asia. In the Philippines, policy documents acknowledge social objectives, but little is known about how these are operationalized in practice, which aspects are considered most relevant, and how they might be better integrated into existing electrification pathways [20].

This chapter addresses these gaps by examining how Philippine government stakeholders perceive social sustainability in the context of off-grid rural electrification. Furthermore, three specific questions guide the analysis:

1. How is off-grid electrification organized institutionally in the Philippines?
2. Which social aspects do stakeholders consider important?
3. How can social aspects be better integrated in off-grid electrification?

Drawing primarily on semi-structured interviews and a follow-up questionnaire with national level institutions and supplemented by insights from non-government stakeholders, the chapter provides an empirical account of how social sustainability is understood within the Philippine energy sector.

The contribution of this chapter is twofold. First, it offers evidence on the perspectives and priorities of key stakeholders responsible for off-grid electrification in the Philippines. Second, it identifies opportunities for strengthening policy by integrating social aspects more systematically into key stages of off-grid electrification. In doing so, the article seeks to elevate academic debates on social sustainability with policy practice as well as

to offer lessons for countries confronting similar challenges making off-grid electrification more sustainable.

4.2 Literature review

In this chapter, social sustainability broadly refers to promoting equity, inclusion, participation, and improvements in human well-being, among others. In the energy sector, this includes issues such as affordability, community empowerment, local employment, gender equality, and social acceptance [29]. These dimensions highlight the importance of going beyond technical and economic outcomes to consider how energy systems shape social development and everyday life in communities.

Several frameworks have been developed to guide the assessment of social sustainability in energy systems. The SDGs, particularly SDG 7 (Affordable and Clean Energy), provide a global benchmark for universal energy access and highlight connections to health, education, and livelihoods [2]. SLCA offers tools to evaluate social impacts across supply chains, including worker rights, community well-being, and governance [34]. Meanwhile, a project's future social consequences are evaluated in social impact assessments or SIA [38]. Finally, MCDA approaches have also been applied to integrate social criteria alongside technical and economic ones when comparing energy options [89,132,142,179].

While these frameworks offer valuable entry points, they face limitations when applied to off-grid rural electrification in national contexts, particularly in the Philippines. First, they tend to operate at a high level, making them less sensitive to the local realities of specific countries and communities [278,279]. Second, many frameworks require data that are often scarce or difficult to collect in rural or off-grid contexts [280,281]. Finally, existing approaches may overemphasize measurable indicators while underestimating qualitative aspects such as trust in institutions, perceptions of fairness, or the lived experiences of energy users [280].

Additionally, previous research points to different challenges in terms of integrating sustainability concepts in policy. Among these challenges are unclear mandate [282], untoward segmentation of sustainability concepts [283], and possible institutional alignments [284].

These gaps suggest the need for more context-specific and empirically grounded approaches, especially in countries like the Philippines where electrification is ongoing and deeply tied to governance structures and community dynamics.

Understanding social sustainability in practice requires insights from electrification stakeholders. In the Philippines, national government agencies, private sector providers,

and CSOs shape policies and implement projects. Exploring their definitions and priorities grounds abstract frameworks in local realities. This study builds on existing literature, particularly supplementing a recent investigation of social considerations in Philippine national energy policies [20], aiming to empirically understand the most important social dimensions in the Philippine off-grid electrification context and how to integrate them into policy and planning.

4.3 Methodology

4.3.1 Research design: qualitative, exploratory, national-level case study

This stage of the research is largely qualitative and exploratory in nature, built on a national-level case study of the Philippines [20], as presented in Chapter 3. The exploratory orientation reflects the limited prior empirical work on social sustainability in off-grid rural electrification, particularly from the perspective of national government and other institutional stakeholders. Prior literature suggests that case study research is particularly useful when investigating contemporary phenomena within their real-life contexts, especially when boundaries between phenomenon and context are not clearly defined [268,285]. In this study, the case of the Philippines offers a valuable setting, given its long-standing missionary electrification program and its complex institutional structure for off-grid electrification.

By focusing on the national level, the study prioritizes the government agencies and organizations that design, regulate, and oversee off-grid electrification programs. Such an orientation follows the argument that case studies can illuminate institutional roles and interdependencies that shape policy outcomes. It also responds to calls in energy and sustainability research for greater attention to top-level actors, such as policymakers and regulators, whose decisions influence the implementation of electrification projects [286,287].

Meanwhile, the qualitative nature of the study is reflected in the QCA of interviews with relevant stakeholders. The QCA is preceded by a document analysis to establish the context of off-grid electrification. The interviews and document analysis were conducted to verify the accuracy of each method. Furthermore, they are supplemented by a follow-up questionnaire to identify priority social aspects. Figure 4-1 encapsulates these activities, along with the steps performed for the QCA. Additional details are discussed in the succeeding subsections.

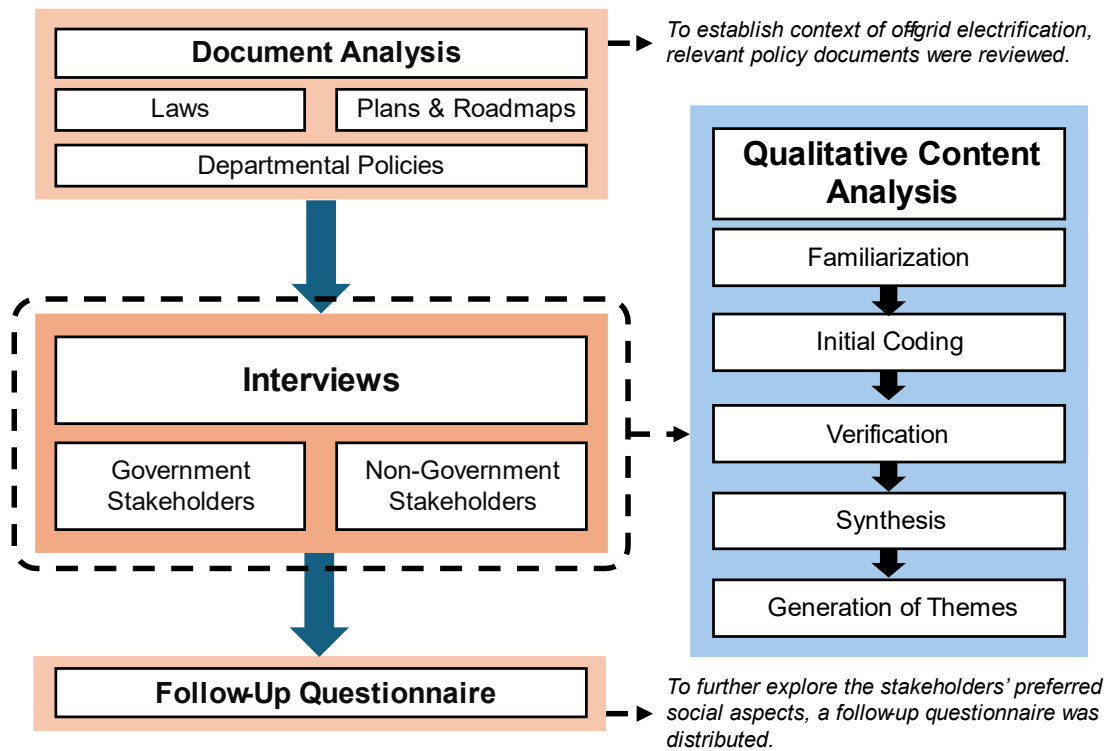


Figure 4-1: Overview of the research methodology.

4.3.2 Document analysis

Document analysis was conducted to analyze the context of off-grid electrification in the Philippines. The documents included cover legislations, department-level guidelines, plans, and roadmaps. These documents provide information about the stakeholders' roles, key processes, requirements, and other details. All documents considered in this chapter are listed in Appendix B. The context of off-grid electrification, as presented in Section 1.3.2 of Chapter 1, is already well-discussed. In contrast, Section 4.4.1 presents a narrative that delves into its institutional organization and offers critical insights.

4.3.3 Interviews and qualitative content analysis

The main research instrument for this chapter was semi-structured interviews. This approach allowed the researchers to have a set of guiding questions while also giving space for participants to share their own views in detail [268]. Since the aim of the study was to understand the roles of stakeholders, their priorities for social aspects, and how these might be better integrated into policies, a flexible method was appropriate. Semi-structured interviews also made it possible to gather both comparable answers across participants and deeper insights that might not come out in a more rigid format [288].

To select the participants, the research team first reached out to the DOE, which is the government agency mandated to develop policies for the energy sector. Through initial

consultations with key representatives, additional government stakeholders were identified. In summary, the core respondents of this study are the DOE, ERC, NPC-SPUG, NEA, and TransCo as the main government stakeholders involved in the electric power industry.

To supplement the insights of the core respondents, the Department of Social Welfare and Development (DSWD), a department not directly related to the electric power industry, was included upon recommendations of energy-related national institutions. Additionally, non-government stakeholders were contacted, including existing MGSPs, major energy generating companies that had off-grid operations, and CSOs. In total, three private sector players and one CSO participated in the study.

For all stakeholders, an orientation meeting was conducted to discuss the research overview, confidentiality guidelines, and expected collaborations. The orientation was also necessary to secure the participants' consent to proceed with the study. Interview sessions were mainly conducted online from August 2024 to October 2025; however, in-person interviews were held when the researchers visited the Philippines in March 2025. Written responses through email were also allowed for some stakeholders based on their preference. A list of the stakeholders and interview details are summarized in Table 4-1. In all interviews, respondents were allowed to speak in English or Filipino, the local language. Copies of the interview questions are summarized in Appendix C.

Table 4-1: List of stakeholders and interview details.

Name of Office/Stakeholder Group	Method of Interview	Number and Duration of Online/In-Person Interviews
<i>Core Respondents</i>		
Department of Energy (DOE)	Online and in-person interviews	3 interviews; 60-75 minutes each
Energy Regulatory Commission (ERC)	Online and in-person interviews	3 interviews; 38-75 minutes each
National Electrification Administration (NEA)	Online and in-person interviews; Email	1 interview; 40 minutes
National Power Corporation (NPC)	Email	Not applicable
National Transmission Corporation (TransCo)	Online and in-person interviews; Email	1 interview; 50 minutes
<i>Supplementary Respondents</i>		
Department of Social Welfare and Development (DSWD)	Online interview	1 interview; 54 minutes
Three private sector players	Online interviews; Email	1 interview; 30 minutes (2 opted for written responses)
One civil society organization	Online interviews; Email	1 interview; 60 minutes

To analyze the results of the interviews, qualitative content analysis (QCA), as described in the works of Schreier [257] and Braun and Clarke [260], was performed with the use of the NVivo 15 software. A data-driven approach was adopted, whereby categories and codes emerged inductively from the material rather than being imposed through pre-determined frameworks. This allowed the analysis to remain grounded in the perspectives of stakeholders and to capture nuances specific to the Philippine context of off-grid electrification. This inductive strategy aligns with the exploratory character of the study and has been recognized as effective for generating insights in under-researched areas [91,256,289].

Before the QCA began, all recorded interviews were transcribed. The web-based platform Good Tape² was used to automatically transcribe the recordings. The transcriptions were then verified for accuracy and revised as needed. Additionally, the transcriptions were sent back to the relevant stakeholders for their verification or clarification when needed.

Following established procedures, as depicted in Figure 4-1, transcripts of the interviews and written responses were first read in their entirety to gain an overall sense of the material. Initial codes were then generated, capturing recurring ideas and concepts mentioned by participants. These preliminary codes were organized into broader categories, which were iteratively refined through repeated comparison across transcripts. This iterative process of reading, coding, and revising continued until consistent and coherent themes emerged. By moving from descriptive codes to more abstract categories, the analysis revealed patterns that directly addressed the study's research questions on stakeholder roles, priority social aspects, and avenues for integrating social sustainability into off-grid electrification. The codebook, outlining the themes developed, number of sources, and number of references, is presented in Appendix D.

4.3.4 Follow-up questionnaire

In addition to the interviews, a follow-up questionnaire using the SurveyMonkey platform was used as a qualitative prioritization tool. This questionnaire also served to triangulate the responses in relevant interview questions, particularly those seeking to identify the stakeholders' perspective on important social aspects.

In this questionnaire, stakeholders were primarily asked to rank different social sustainability aspects in terms of their perceived importance regarding evaluation of off-grid electrification systems. The social sustainability aspects were based on the developed social sustainability themes in Chapter 2, with minor modifications to reflect insights from the interviews. A copy of the questionnaire is presented in Appendix E.

² Good Tape is an automatic transcription tool capable of turning audio recordings to text, in a variety of languages. (<https://goodtape.io/>)

4.3.5 Limitations

Two key limitations should be acknowledged for this study. First, the scope is primarily government-centric, reflecting the perspectives of agencies and institutions responsible for planning and overseeing off-grid rural electrification. While this focus was intentional, given their central role in policy and implementation, it inevitably excludes a fuller picture of how communities themselves experience and interpret social sustainability. However, the study addresses this partially through the involvement of key private sector players and other non-government organizations, which have grassroots project catering to local communities.

Additionally, efforts were made to include selected LGUs, ECs, and DUs in the study. However, despite repeated invitations, no favorable responses were received during the data collection period.

Second, the questionnaire used to complement the semi-structured interviews was non-statistical in design. It aimed to gather additional reflections and validate emerging insights rather than to come up with generalizable, quantitative results. As such, the findings are better understood as exploratory and illustrative. Additionally, although end-users' participation in this type of questionnaire is ideal, several constraints, as outlined in the work of Gallego Carrera and Mack [117], make it difficult to achieve. These include financial and logistical constraints as well as varying levels of technical competence to answer the survey.

4.4 Results and discussion

The first part of this section highlights the three key stages in the off-grid electrification process and observed gaps, as derived from policy documents and through interviews. The next subsection summarizes the priority social aspects, as identified in the QCA and complemented by the follow-up questionnaire. The final subsection presents recommendations on how important social aspects can be integrated into the three key stages.

4.4.1 Key stages in off-grid electrification in the Philippines

The governance architecture of the electric power industry in the Philippines, as discussed in Section 1.3.2 of Chapter 1, illustrates the complexity of off-grid electrification in the Philippines: planning and target-setting occur at the national level, but implementation is dispersed across local electric cooperatives, state-owned utilities, private firms, and community actors. This study proposes to examine how social sustainability fits into the electrification process through three key stages: planning and identification of service areas, evaluation of electrification solutions, and monitoring and evaluation after implementation. These stages are presented in Figure 4-2, along with the key observations

that will be discussed in the succeeding subsections. While all stakeholder groups play some role in advancing off-grid electrification, their levels of involvement and influence vary across stages.

Table 4-2 presents a summary of these roles, which are further elaborated in the succeeding subsections.

	1. IDENTIFICATION OF OFF-GRID AREAS	2. EVALUATION OF ELECTRIFICATION SOLUTIONS	3. POSTIMPLEMENTATION MONITORING & EVALUATION
 Relevant plans and programs	Missionary Electrification Development Plan, National and Local Total Electrification Plans, Distribution Development Plans	Qualified Third Party program, competitive selection process, micro-grid systems program	DOE/NEA reports, NPCSPUG monitoring, reports in plans and roadmaps
 Key considerations	demand, costs, technical feasibility	technical and financial viability, least cost manner	increase in electrification rate, reliability, availability, supply-demand balance
 Gaps	Other social aspects are secondary or optional	Social criteria are secondary or optional	Absence of other social impact indicators

Figure 4-2: Key observations identified in the major stages of off-grid electrification in the Philippines.

4.4.1.1 Identification of off-grid areas

The first stage of missionary electrification is the planning and identification of off-grid areas. At the top level, the DOE prepares the Philippine Energy Plan (PEP) that sets the direction of the entire energy sector. Presented in the PEP are other planning documents, such as the Missionary Electrification Development Plan (MEDP), which outlines strategies for serving unviable areas. Meanwhile, the Distribution Development Plans (DDPs) present demand forecasts, unelectrified households, and expansion strategies. These DDPs are then consolidated by NEA and DOE into broader planning instruments such as the National Total Electrification Roadmap (NTER). At a more localized level, some ECs and LGUs prepare Local Total Electrification Roadmaps (LTERs), often with NEA support, which serve as inputs to the NTER.

This planning system theoretically integrates local realities into national priorities. In practice, however, technical and financial aspects take precedence. DDPs and LTERs often emphasize technical feasibility and projected load growth, while the MEDP focuses on the geographic distribution of missionary areas and the costs of electrifying them. Social dimensions such as education, health, gender, and local economic development are treated as optional considerations, represented in Figure 4-3, as confirmed in interviews with government stakeholders.

Table 4-2: Stakeholder roles and their involvement in off-grid electrification in the Philippines.

Stakeholder		Identification of Off-grid Areas	Evaluation of Electrification Solutions	Post-Implementation Monitoring & Evaluation
Core Respondents	DOE	develops national roadmaps and plans	oversees CSP, MGSA, tariffs	establishes M&E frameworks, publishes national-level reports
	ERC	mainly involved in regulations	approves tariff, develops CSP guidelines	has some monitoring role via consumer protection
	NEA	oversees ECs, DDPs, LTERs; contributes to national plans and roadmaps	assists EC proposals and projects	monitors EC performance, reports to DOE
	NPC-SPUG	contributes to national plans and roadmaps	main project proponent for unviable areas	reports performance of missionary electrification
	TransCo	contributes to development of national plans and roadmaps	serves as system operator in some off-grid areas	has some role in operations monitoring of off-grid systems
Supplementary Respondents	Private sector (developers, MGSP, QTP)	can conduct independent site identification; may engage with the DOE	mainly competes in CSP and delivers electrification projects	may be required to do M&E reports
	CSOs	can conduct independent site identification; may engage with the DOE	may propose solutions and/or help in evaluation	may conduct social impact follow-up
	DSWD*	identifies areas based on own database and metrics (e.g., poverty incidence)	implements various environmental and social safeguards frameworks for evaluation	conducts monitoring and evaluation using multistakeholder approach

Note: *The DSWD operates independently from the frameworks implemented in the electric power industry, i.e., the DOE and related offices. The description of the DSWD's roles provided in this table reflects what is closely related to each key stage.

In practice, anticipated social benefits—for example, school electrification or livelihood opportunities—are included only as optional details in planning documents, rather than as mandatory requirements. This tendency reflects a broader gap in policy design, where electrification is measured primarily by connections and costs, and lacks insights on how it can deliver transformative social outcomes for communities.

At this stage, the central question is whether social sustainability aspects, aside from access and costs, are explicitly recognized when identifying off-grid areas and determining electrification strategies.

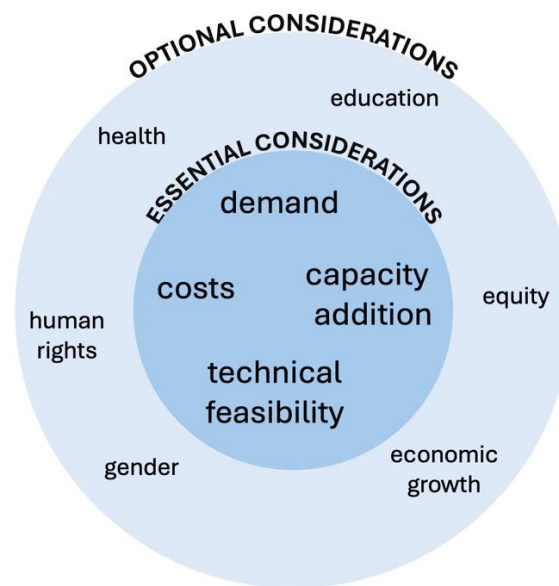


Figure 4-3: Essential and optional considerations in identifying off-grid areas in the Philippines.

4.4.1.2 Evaluation of electrification solutions

Once areas are identified, the next step is determining how electrification will be carried out and by whom. The EPIRA introduced mechanisms to encourage private sector participation, including the QTP program, under which private companies, cooperatives, or NGOs can apply to serve areas deemed unviable for DUs. Their proposals are reviewed by the DOE and require tariff approval from the ERC. Another mechanism is the CSP, which mandates competitive bidding for power supply contracts to ensure least-cost procurement.

More recently, the RA 11646 or the Microgrid Systems Act has created a legal framework to accelerate private sector involvement in off-grid electrification through MGSPs. This program authorizes qualified entities to develop, operate, and maintain micro-grid systems in unserved and underserved areas, complementing existing QTP and CSP arrangements. In missionary areas, DOE and NPC-SPUG may auction generation

contracts to private providers, while NPC-SPUG itself remains the default provider if no private entity participates.

Financing is a critical issue in this stage. Because most missionary areas are not commercially viable, providers rely heavily on subsidies from the UC-ME, which is collected from all electricity consumers nationwide. Despite these mechanisms, private sector participation has been limited, largely due to regulatory delays, tariff uncertainties, and high logistical costs. NPC-SPUG continues to dominate missionary generation, mostly through diesel-powered facilities.

At this stage, evaluation processes prioritize least-cost solutions and technical feasibility, while social aspects are rarely explicit in decision-making. For example, CSP guidelines emphasize financial efficiency but not community acceptance or inclusiveness. QTP applications require proof of technical and financial capability, but not evidence of local stakeholder engagement. This highlights a gap in current practice, where evaluation criteria remain focused on techno-economic aspects, while other social considerations such as impacts on gender, health, and overall well-being are not systematically integrated.

4.4.1.3 Post-implementation monitoring and evaluation

The third stage is monitoring and evaluation (M&E) of electrification outcomes. The NEA oversees the performance of ECs to assess financial viability, system losses, and service reliability. The DOE monitors overall electrification progress against targets in the PEP and MEDP, while the ERC ensures compliance with regulatory requirements and consumer protection. Meanwhile, the NPC-SPUG reports on missionary generation costs.

However, most existing M&E frameworks emphasize technical and financial performance. Indicators typically include household electrification rates, power availability, system losses, and cost recovery. Social indicators, such as impacts on household welfare, community empowerment, or gender equity, are not yet systematically measured and not in a comprehensive scale.

The absence of social sustainability indicators in formal M&E reveals a gap in understanding whether off-grid electrification delivers meaningful social benefits. Existing reporting systems focus largely on technical and financial outcomes, leaving other social dimensions underexplored. Questions of responsibility for collecting and analyzing such data also remain unresolved, as no clear institutional mandates and mechanism currently integrates these aspects into routine monitoring.

4.4.1.4 Off-grid electrification efforts beyond the electric power industry

Beyond the agencies directly mandated to implement or regulate off-grid electrification, other government institutions also play indirect yet meaningful roles. For example, the DSWD, through its *Kapit-Bisig Laban sa Kahirapan*-Comprehensive and Integrated Delivery of Social Services (KALAHI-CIDSS) program, has facilitated community-based electrification sub-projects as part of its broader poverty alleviation initiatives.

While such initiatives demonstrate how energy access intersects with social development objectives, the DSWD operates largely independently from the DOE and other offices within the electric power industry. Coordination typically occurs at the local level, often mediated through LGUs and community organizations rather than through formal inter-agency frameworks. This suggests that linkages between energy access and social welfare remain underdeveloped, reflecting broader institutional silos between the social and energy sectors. In practice, the DSWD follows different mechanisms and approaches to identify beneficiary communities, to evaluate electrification solutions, and to monitor their projects post-implementation.

In parallel, CSOs and private sector stakeholders, while participating through the frameworks established within the electric power industry, may engage in independent efforts. The interviewed participants from the private sector and civil society disclosed their own mechanisms for identifying areas to electrify, establishing design criteria, and implementing monitoring frameworks. These mechanisms are influenced by their organization's thrusts and advocacy.

However, the processes and mechanisms adopted by the DSWD and non-government stakeholders were not examined in depth in the present study, as the focus was on institutions directly involved in the electric power industry. This choice reflects the intent to first establish a sectoral understanding of how social sustainability is integrated within energy governance frameworks.

Nevertheless, their experiences offer a future research opportunity. Particularly, a comparative or integrative analysis of electrification initiatives led by the DSWD or non-government stakeholders as well as the energy sector could reveal how social development frameworks might inform or complement energy sector policies. This could help identify entry points for intersectoral collaboration and streamline electrification efforts.

4.4.1.5 Gaps in institutional mandate and capacity

Interviews with government stakeholders revealed that the limited integration of social sustainability in off-grid electrification is not only a matter of oversight or neglect. It also

reflects deeper institutional and knowledge-related challenges that shape how policies are designed and implemented. Four interrelated barriers were identified, which are discussed below and summarized in Table 4-3.

Table 4-3: Excerpts of institutional barriers to incorporating social sustainability.

Barriers	Illustrative excerpts
Lack of clear mandate	“... <i>ang</i> challenge, sir, <i>una</i>, <i>yung</i> policy itself, <i>yung</i> mandate <i>namin</i>, sir, does not include any social indicator (the first challenge is that the policy itself, our mandate, does not include any social indicator).” “<i>Yung</i> social impact <i>parang nagiging ano siya... diba may mga</i> whereas <i>tayo</i>. <i>Yung parang</i> before <i>dun sa mga mismong</i> guidelines, may mga <i>parang</i> basis <i>tayo</i> <i>dun sa</i> rules. So I think <i>dun lang din nababanggit yung magiging</i> social impact.” [respondent says that social aspects are only mentioned in “whereas” clauses; those that precede or set the context of specific guidelines] “<i>Pero yung mga talagang</i> policies <i>na para dun sa</i> social sustainability, <i>hindi siya</i> explicitly <i>na naka-direct din</i> <i>doon</i>. It's mostly <i>yung sa</i> economic... <i>sa</i> environmental. [Policies that are supposed to tackle social sustainability are still mostly directed to economic and environmental aspects].”
Unclear institutional responsibility and coordination	“There are a lot of different entities that are involved in the industry, particularly in the off-grid. So sometimes there can be misalignments in the implementation.”
Lack of know-how and information	“Energy agencies may ... have limited in-house expertise on social, gender, and participatory issues.” “There is limited availability of disaggregated data ..., making it difficult to design responsive and inclusive policies.” “... technical capability, because if you're going to put a solar rooftop or wind or other renewable energy resources in the area, there will be operational maintenance and you will assign personnel to monitor, oversee the operation of such facility...” [personnel must be knowledgeable about measuring/gathering data related to social aspects]
Limited awareness on and overlooking of social sustainability concepts	“Energy policies often focus on technical and economic targets, while social equity, inclusion, and community welfare are treated as secondary concerns.”

Note: Words in italics are in Filipino. Their English translations are inside parentheses. Phrases or sentences within square brackets, “[]”, were added to provide more context.

First, and possibly the root of the other barriers, is the absence of a clear mandate. Government stakeholders frequently mentioned that while social objectives are stated in policy documents, no specific agency is formally tasked to translate these objectives into measurable criteria. As a result, technical and economic indicators continue to dominate planning and reporting processes. Without an explicit policy directive or performance target related to social outcomes, agencies tend to focus on mandates where accountability is clearly defined, such as electrification access, financial performance, or service reliability.

Another recurring theme in the documents and interviews was uncertainty over which government body should lead the integration of social sustainability. The DOE sets the national direction for energy access, while NEA oversees DUs and ECs, and NPC-SPUG handles missionary generation. However, the social dimensions of electrification, such as community participation, welfare monitoring, or livelihood enhancement, fall between institutional boundaries.

Additionally, the experiences shared by the DSWD illustrate how social sustainability concerns are often addressed outside the formal electrification governance structure. Although initiatives under the DSWD's KALAHI-CIDSS program have successfully implemented electrification projects as part of community-driven development, these efforts occur in parallel with DOE- and NEA-led programs rather than in collaboration. This institutional disconnect reflects one of the observed reasons for the limited integration of social considerations, namely, the absence of formal institutional responsibilities and coordination among government offices.

Next, even when agencies recognize the importance of social sustainability, many lack the information, tools or procedures to operationalize it. Current planning templates, data reporting formats, and evaluation criteria are heavily focused on technical and financial performance. Stakeholders expressed the need for practical instruments, such as social impact templates, indicator lists, or standardized reporting formats, that could help mainstream social aspects into everyday planning and monitoring. This gap reflects not only a lack of institutional mandates but also a shortage of technical capacity in areas such as social assessment, participatory planning, and qualitative data collection.

The final barrier identified reflects the government stakeholders' limited awareness of social sustainability concepts. While interviewed respondents and policy documents mention "sustainability", "sustainable development", and "social objectives", they often lack a shared understanding of what social sustainability entails in practical terms, and under the Philippine context. This limited awareness may constrain both policy development and collaboration, as agencies struggle to translate broad development goals into measurable, energy-specific actions.

Together, these findings suggest that the current gaps in integrating social aspects across the three key stages of electrification stem from systemic governance and capacity constraints rather than mere policy omission. Addressing these barriers requires coordinated efforts to establish clear mandates, build institutional capacity, and cultivate a shared understanding of social sustainability within the energy bureaucracy. While these gaps highlight the need for a more comprehensive and rigorous approach, the present study provides an important foundation for such efforts. Specifically, these

institutional gaps inform the integration pathways, presented in Section 4.4.3, that the Philippine government could consider.

Prior to that, however, Section 4.4.2 presents how key stakeholders interpret and define social sustainability within this specific context. Understanding these interpretations is a necessary step toward aligning perspectives and developing assessment approaches that are contextually relevant and widely accepted by the stakeholders.

4.4.2 Priority social aspects

Before identifying the preferred social aspects of the respondents, they were asked about concrete social impacts attributed to off-grid electrification, which is based on their field work experiences and current M&E frameworks.

Three major categories were developed in relation to this. The first, educational benefits, stand to be the most discussed social impact in off-grid areas. In particular, the respondents attribute the following to electricity access: increase in schoolchildren's studying hours, better access to information (through internet use), and electrification of schools. Meanwhile, livelihood opportunities have also been emphasized. These correspond to community members' use of devices and appliances used for livelihood (e.g., cold storage for fishing communities and small grocery stores and charging stations). Another prevalent effect of electricity access is the improvement of health and safety. Respondents mention electrification of health centers and associated devices, as well as reduction in crime rate due to improved community lighting.

To a lesser extent, stakeholders have also mentioned other benefits attributed to electrification, such as improved communication and information access, improved living conditions at home, and capacity development of the community. Illustrative excerpts for the reported concrete social impacts mentioned by the stakeholders are provided in Table 4-4.

The study then investigates the priority social aspects based on the interviews conducted. Overall, government stakeholders would want to prioritize the socio-economic impacts, education benefits, and improved health and safety. Among these, affordability is already largely present in policies as reflected by the government's emphasis on least-cost planning and preference for low-cost solutions [20].

Meanwhile, other social aspects have been rarely mentioned. These include social equity, particularly prioritizing the poor and marginalized; respect for indigenous peoples' rights; gender considerations; and social acceptance. This also follows the results of an analysis of relevant off-grid electrification policies [20], wherein policies were found to have less

provisions concentrated on the said social aspects. Illustrative excerpts for the priority social impacts based on the interviews are provided in Table 4-5.

Table 4-4: Excerpts of concrete social impacts of electricity access according to the respondents.

Social aspect	Illustrative excerpts
Educational benefits	▪ “More time and better lighting for studying at night” ▪ “Extended study hours for students with reliable lighting in homes and schools.” ▪ “Access to electricity-powered appliances improved ... digital learning.” ▪ “But now that they have [24 hours, for 7 days of the week] access, so during school hours, teachers can now use TVs or laptops to show videos to the students <i>kasi</i> usually, <i>parang mas madali nga naman</i> to learn visually (because usually, it might be easier for them to learn visually).” ▪ “Education benefits from extended study hours, digital tools, and internet access.”
Livelihood opportunities and local economic growth	▪ “Access to electricity can enable households to build small businesses.” ▪ “Creation of income-generating opportunities for residents.” ▪ “New business opportunities (e.g., sari-sari stores with refrigeration, phone charging, welding shops).” ▪ “... extending productive hours, enabling individuals to work ... in the evening.”
Health and safety	▪ “Reduced use of fuel [for cooking and lighting] lowers air pollution. Access to electricity also provides lighting to households at night, improving safety.” ▪ “Reliable power for clinics, allowing them to operate after dark and use diagnostic or life-saving equipment.” ▪ “Healthcare improves with access to essential services and equipment, such as vaccine storage.” ▪ “<i>Nagkakaroon na tayo mga</i> street lights (They now have street lights). <i>Alam mo naman, di ba, kapag madilim, minsan, mas higher yung</i> crime rate (You know, if there is poor lighting, there may be higher crime rate)... So, <i>bumaba yung</i> crime incidents (So, crime incidents decreased) [because of better lighting].”
Others	▪ Better communication and information access: “Communication is enhanced by enabling mobile phone use and access to current news.” ▪ Improved comfort and living conditions at home: “Eases household tasks with basic appliances (fans, radios, charging); “they can enjoy the comfort of fans during hot evenings”; “It enhances comfort with appliances such as fans, TVs, and refrigerators.” ▪ Capacity development: “[because of electrification projects]... <i>nagkaroon ng trainings, saka mentoring</i> (there were trainings and mentoring) [of community members]”

Note: Words in italics are in Filipino. Their English translations are inside parentheses. Phrases or sentences within square brackets, “[]”, were added to provide more context.

Table 4-5: Excerpts of priority social impacts to consider based on interviews.

Social aspect	Illustrative excerpts
Livelihood opportunities and local economic growth	▪ “One is improvement in livelihood... employment rate of the area, <i>paano tumaas</i> (how much did increase?), and also, usually, ... its their average family household income, <i>tumataas din ba</i> (did it also increase?), and why did it increase?” ▪ [Listed as possible metrics to consider in the future]: livelihood activity; increase in household or community income; energy spending; new local jobs created; poverty indicators ▪ “... supporting livelihood opportunities to boost economic stability” ▪ “Furthermore, electricity can open doors to economic opportunities and development, such as creating jobs and supporting livelihoods.”
Affordability	▪ “Designed to reach many communities without financial exclusion.” ▪ “Ability and willingness to pay.” ▪ “Ensuring affordable electricity for low-income households.”
Educational benefits	▪ “Electrification enables students to study at night, enhancing learning outcomes.” ▪ [Listed as possible metrics to consider in the future]: number or percentage of schools electrified; increase in hours of evening studies by students; improvement in school attendance
Health and safety	▪ “Additionally, we need to focus [on] health and safety... replacing kerosene or wood with safer lighting options to reduce the risk of fire.” ▪ “<i>Tingin ko yung sa</i> (I think for) social impacts, <i>yung sa</i> health and safety <i>din</i> (also [consider] health and safety). Especially [in] off-grid areas [that are] mostly dependent on conventional fuels.”

Note: Words in italics are in Filipino. Their English translations are inside parentheses. Phrases or sentences within square brackets, “[]”, were added to provide more context.

To supplement the interviews, a follow-up questionnaire was conducted with all participating institutions and organizations. The results, fully presented in Appendix F, reveal that electricity access remain a top priority, highlighting the government’s continuing focus on total electrification of the country, up to the off-grid rural areas. This was followed by social development, quality of life, and well-being, indicating that stakeholders view electrification not only as a technical intervention but also as a catalyst for broader social progress. Socio-economic benefits and employment, as well as education, also ranked highly, reflecting the expectation that electrification can generate livelihood opportunities and improve education outcomes. Meanwhile, aspects such as involvement and governance, social acceptance, health and safety, human rights, social equity, and gender received moderate attention.

Overall, the priorities resulting from the questionnaire closely mirror the themes that emerged from the interviews, where stakeholders emphasized economic growth, education benefits, and health and safety as key social outcomes of rural electrification.

While these priorities reflect a growing recognition of the social aspects of off-grid electrification, their translation into practice remains limited, potential reasons of which have been discussed in Section 4.4.1.5. Addressing this gap requires understanding not only which social aspects matter to stakeholders but also how existing mechanisms and programs can enable their integration. As such, the Section 4.4.3 explores pathways for integrating social sustainability more effectively across the key stages of off-grid electrification.

4.4.3 Integrating priority social aspects to off-grid rural electrification

Building on preceding discussions, the social aspects identified by stakeholders offer valuable insight into how social sustainability is perceived and prioritized within the context of off-grid rural electrification. However, as discussed in Section 4.4.1.4, these social dimensions, although widely acknowledged, remain in the background of formal decision-making. Technical and financial metrics continue to dominate planning and evaluation frameworks, while social impacts are often treated as secondary outcomes rather than fundamental performance indicators. Accordingly, this subsection outlines practical opportunities to institutionalize social considerations within the three key stages of off-grid electrification process, thereby providing pathways toward a more socially responsive energy planning framework. Figure 4-4 summarizes these suggestions.

In the identification of off-grid areas stage, at present, DUs and ECs primarily emphasize electrification rates, forecasted demand, and technical viability in their LTER and DDPs. To strengthen the social dimension of planning, additional parameters could be incorporated, such as the potential to electrify existing or planned public schools, health centers, and other public infrastructures. Equally important is the documentation of prevailing and potential livelihood activities in the target areas (e.g., agriculture, fishing, or small-scale enterprise based). Integrating such data would allow stakeholders to anticipate broader social impacts and design projects that directly support local development priorities, rather than viewing communities only through the lens of electricity demand.

Next, at the stage of evaluating electrification solutions, particularly through the CSP mandate, technical and financial metrics currently dominate decision-making. A more holistic framework would require project proponents to present site-specific data not only on projected load and costs but also on expected social impacts. For example, the CSP criteria could incorporate indicators such as the extent to which projects enable the electrification of schools, health centers and other public infrastructures; the extent to which proposed projects align with community livelihoods; and the estimated number of jobs to be generated. By formalizing such requirements, both private sector and NPC-SPUG projects would be evaluated not only on least-cost provision but also on their capacity to deliver meaningful social benefits.

At the post-implementation M&E stage, current mechanisms tend to measure electrification progress primarily in terms of access and reliability. To better integrate social considerations, government agencies could improve and standardize methods to capture the broader social outcomes of off-grid projects. This may include quantitative and qualitative metrics on educational benefits (e.g., improved student performance and retention linked to school electrification), livelihood and income gains, and enhancements in health and safety. While these perceived effects were highlighted in stakeholder interviews, they are yet to be systematically reflected in the reporting processes of the government. Embedding such indicators would enable policymakers to assess not only whether communities have been electrified, but also how electrification has meaningfully advanced social development.

Although this discussion primarily focuses on institutions within the energy sector, future work could also consider the complementary role of institutions outside the industry. For example, the DSWD, through its KALAHI-CIDSS program, applies community-driven development approaches that emphasize participatory decision-making and local capacity-building. Exploring how such frameworks intersect with off-grid electrification efforts could provide new insights into integrating social sustainability principles into energy governance, particularly in empowering communities to collaboratively develop electrification priorities and outcomes.

In terms of the sequence of integrating social aspects, this chapter does not propose that all dimensions be integrated simultaneously at the same depth. Instead, it argues for a phased and strategic approach. Based on stakeholder preferences and practical constraints identified in the interviews, three priority aspects (socio-economic benefits and employment, education, and health and safety) can be integrated first alongside the government's efforts to expand energy access, as these are both highly valued and relatively feasible to operationalize within existing planning and evaluation systems.

The integration of other social aspects, such as social equity, gender, human rights, and social acceptance, warrants further investigation and institutional preparation, and can be progressively incorporated as capacities, data availability, and policy mandates improve. Ideally, as the Philippines strengthens its planning, monitoring, and evaluation systems, all core social sustainability categories should be gradually integrated over time, moving from a limited set of priority dimensions toward a more comprehensive framework within a medium- to long-term policy horizon.

It is also important to note that this study did not examine causal relationships among social aspects. Future research could therefore explore if and how the achievement of certain social aspects enables or reinforces others, including potential interdependencies and sequencing effects. Such analysis could help clarify pathways for more strategic and coherent integration of social sustainability considerations in policy.

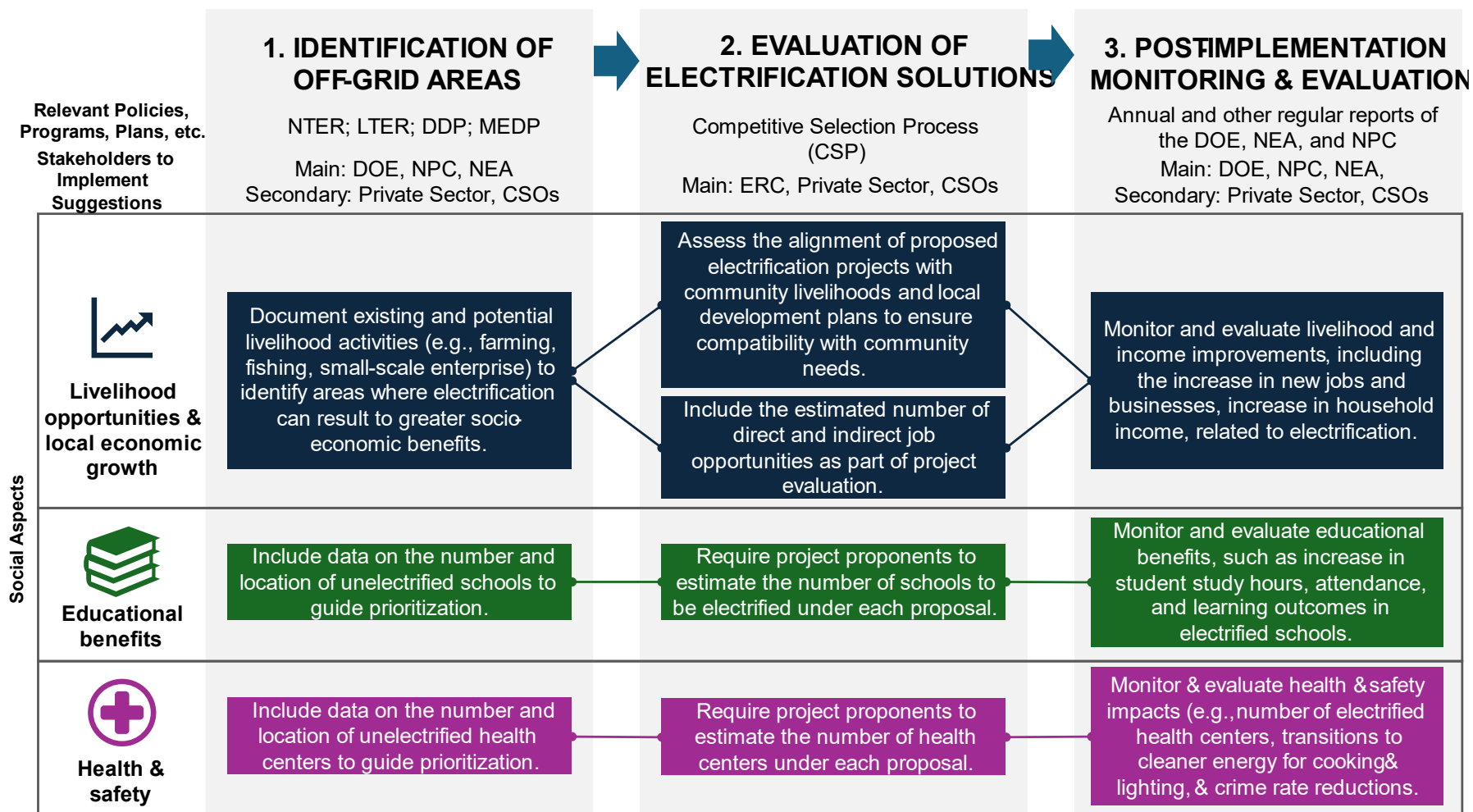


Figure 4-4: Suggested ways to incorporate social sustainability considerations in the key stages of off-grid electrification.

Finally, while the discussion in this section has primarily focused on opportunities within the Philippine energy sector, it is worth noting that similar institutional and social challenges have been observed in other developing contexts. Countries such as Indonesia and India have likewise faced challenges in aligning electrification targets with broader social development goals, as noted in Section 1.3.2 in Chapter 1. Additionally, the challenges of integrating sustainability discussed in Section 4.2 also reflect the same challenges faced by the Philippines. The Philippine case thus adds to this broader discourse by demonstrating how institutional mainstreaming of social considerations can strengthen rural electrification initiatives and make policies more holistic.

4.5 Conclusion

This chapter explored how social sustainability is understood and addressed in off-grid electrification in the Philippines through document analysis and interviews with key government and non-government stakeholders. While social objectives, such as improved education, health, and safety, are widely acknowledged in principle, they remain only partially operationalized in practice. Across planning, evaluation, and post-implementation stages, technical and financial criteria continue to dominate decision-making, with limited mechanisms to assess social outcomes. These findings highlight that integrating social sustainability is not only a question of adding new metrics, but of achieving stronger alignment among different institutions.

Moving forward, incorporating social sustainability requires not the creation of entirely new systems, but the strategic integration of social dimensions within existing policy and planning instruments. This integration depends on coordinated action among key institutions to ensure that social considerations are consistently embedded throughout the electrification process. At the national level, this could involve revising data templates for DDPs and LTERs to factor in socio-economic indicators in the identification of electrification areas; expanding CSP evaluation criteria to account for job creation and community alignment; and strengthening current reporting frameworks to measure social impacts.

The study also acknowledges the role of other institutions, such as the DSWD and other non-government stakeholders, whose community-driven programs intersect with electrification initiatives. While they operate largely outside the energy sector's formal processes, its experience in participatory development offers valuable insights into how social impacts can be better identified, monitored, and sustained at the community level. This study did not examine these processes in depth, which presents a limitation but also an opportunity for future research to explore cross-sectoral coordination.

Beyond its policy implications, this chapter opens several avenues for future study. One direction is to extend the analysis to local and community levels, where social outcomes

of off-grid electrification are most visible. A second area for further research involves the development and validation of context-specific social indicators, which can bridge the gap between policy intentions and measurable social impacts. Finally, future work may examine how institutional coordination can be strengthened both within and beyond the energy sector to ensure that social sustainability is not only acknowledged but systematically implemented.

Overall, this chapter highlights that achieving universal and sustainable energy access is not only a technical or financial endeavor. The Philippine experience illustrates both the challenges and opportunities of operationalizing social sustainability in practice. Insights from this study can therefore inform broader policy reforms in other developing contexts, where the pursuit of energy access continues to intersect with the goals of equity, inclusion, and well-being.

Chapter 5 Multi-Level Social Sustainability Framework for Off-Grid Electrification Systems

5.1 Introduction

Off-grid electrification plays a central role in expanding energy access in geographically isolated and underserved areas. Yet its long-term effectiveness depends not only on technical performance or financial viability but also on its social outcomes. While research on social sustainability of energy systems has grown, existing efforts remain fragmented across conceptual, institutional, and practical aspects. This obscures how social sustainability considerations emerge, evolve, and interact across levels of governance and decision-making.

This dissertation addressed these gaps through three interconnected studies: a conceptual mapping of social sustainability in electrification systems (Chapter 2), an analysis of Philippine energy policies (Chapter 3), and an investigation of stakeholder perceptions and practices in off-grid electrification (Chapter 4). Building on these three studies, this chapter responds to the main research question: “How does off-grid electrification effectively integrate social sustainability at the conceptual, institutional, and practical levels?”

The purpose of this chapter is to synthesize insights across the three chapters and to present a unified framework for the social sustainability of off-grid electrification systems, developed specifically to connect the conceptual, institutional, and practical foundations. The chapter highlights the interdependence of these levels, clarifies where misalignments occur, and identifies pathways for enhancing the social sustainability of off-grid systems. In doing so, this dissertation contributes both to academic literature and to the advancement of policy and practice in contexts similar to the Philippines.

5.2 Cross-chapter synthesis

5.2.1 Conceptual insights from global literature

The systematic literature review in Chapter 2 revealed that social sustainability, in the context of electrification systems, is best understood as a multi-dimensional and context-sensitive concept. It is commonly defined through a set of interrelated themes, including “socio-economic benefits and employment”, social development, well-being, quality of life”, “health and safety”, “energy access and reliability”, “social acceptance”, and “involvement and governance”. Other themes, which were evident to a lesser extent based on explicit definitions and indicators, include “social equity”, “education”, “human rights”, and “gender”. Rather than a single fixed definition, social sustainability is

therefore operationalized through these thematic dimensions and their associated indicators.

The literature review also highlighted the role of stakeholders, particularly in developing the relevant criteria covering social aspects. Industry experts, government stakeholders, and people from the academia are the commonly involved groups in sustainability assessments.

Although the conceptual foundation points to a variety of important social aspects to consider in sustainability assessments of electrification systems, there is still a need to contextualize these aspects in policy and practice.

5.2.2 Institutional insights from policy analysis

The policy analysis in Chapter 3 showed that the social sustainability aspects that were developed in Chapter 2 are present in Philippine energy policies, but unevenly integrated. Policies emphasize energy access (emphasizing full electrification); socio-economic benefits and employment (highlighting financial benefits and affordable electricity); involvement and governance (enhancing stakeholder participation in policy decisions); social development, well-being, and quality of life (addressing environmental concerns); social equity (focusing on distributive and procedural aspects); and health and safety (prioritizing public health and pollution mitigation). Underrepresented categories, such as social acceptance, gender, human rights, and education, indicate policy gaps that warrant further integration. Overall, these social aspects appear unevenly across policy instruments, with many concentrated in high-level legislation but not consistently operationalized in specific guidelines.

5.2.3 Practical insights from stakeholder perspectives

Chapter 4, which focused on stakeholder insights, revealed that government stakeholders would generally want to prioritize energy access, affordability, livelihood, education, and health and safety. Other social dimensions identified in the literature (such as social equity, gender, long-term well-being, and community empowerment) received less attention among stakeholder perceptions. Furthermore, stakeholders shared challenges to social sustainability integration in off-grid electrification, such as unclear mandates, overlapping institutional roles, and limited awareness.

While social sustainability can be conceptually established as shown in Chapter 2, it is also inherently context-dependent. Its meaning and priorities are shaped by local conditions, institutional arrangements, cultural norms, and development needs, which means that the relative importance of specific social aspects varies across countries and projects.

Through the policy analysis in Chapter 3 and stakeholder interviews in Chapter 4, this dissertation defines social sustainability through both conceptual and empirical lenses. Conceptually, it is treated as a multidimensional construct encompassing the ten social themes identified in the literature. Empirically, based on the Philippine case study, social sustainability is more narrowly prioritized around access, socio-economic benefits, educational outcomes, and improvements in health and safety, which reflect the social dimensions most important to stakeholders and most relevant to current implementation challenges.

5.3 Alignment and misalignments across the three levels

Across the three levels, several areas of alignment and divergence emerge in how social sustainability themes are recognized and operationalized in off-grid electrification. These are graphically shown in Figure 5-1.

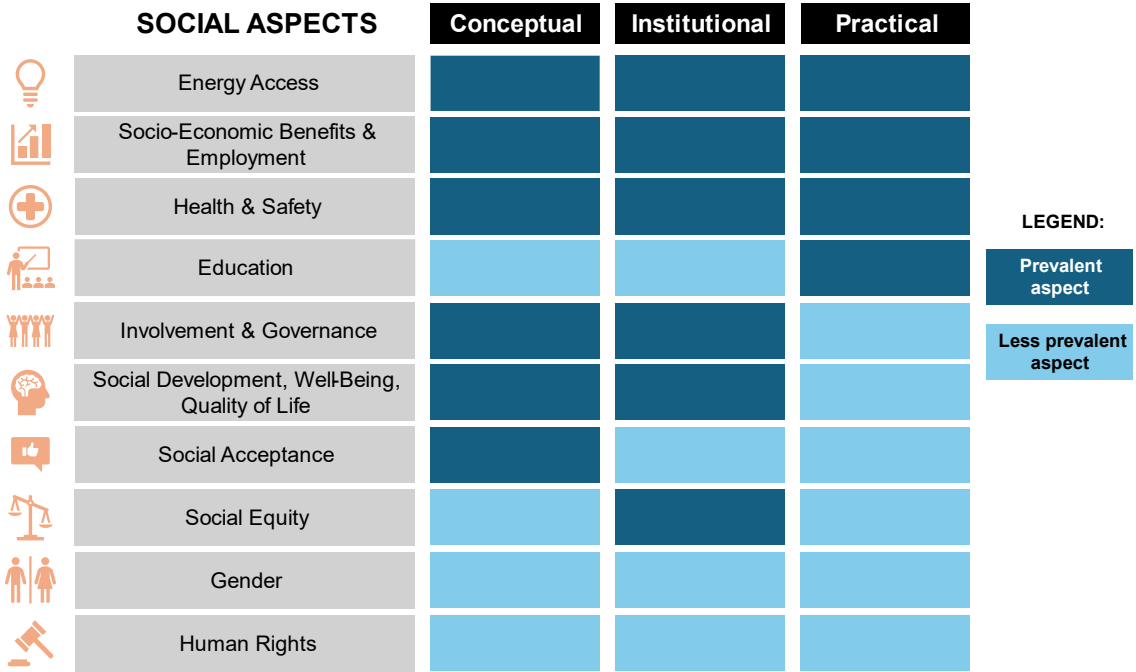


Figure 5-1: Alignment and misalignments of social sustainability aspects in off-grid electrification across the three levels of analysis.

Energy access is the most consistently represented theme across all levels. Its prominence reflects the widely accepted view that energy access serves as an enabling condition for achieving broader social and developmental outcomes. Because access directly affects household well-being, service delivery, and local productivity, it is expected that it remains central not only in conceptual discussions but also in policy frameworks and stakeholder practice.

The theme of socio-economic benefits and employment is also evident across all three levels. Conceptually, the literature highlights job creation, affordability and economic growth as the core elements. At the institutional level, these translate into policies emphasizing affordability, financial incentives, and cost-based decision-making. These priorities were echoed at the practical level, where stakeholders repeatedly emphasized affordability for both end-users and implementing agencies as a key determinant of project viability and community acceptance.

The health and safety theme illustrates alignment across the three levels, where it appears as a major theme. However, the misalignment occurs at how it is interpreted and implemented. At the conceptual and institutional levels, health and safety pertain to public health due to pollution mitigation and safety from injuries at energy facilities. However, at the practical level this aspect pertains to electrification of health facilities and improvements in community safety. This suggests that stakeholders recognize health impacts more directly than policy frameworks do, pointing to an opportunity for institutional mechanisms to better capture these community-level priorities.

The education dimension shows a more uneven integration. While it receives limited emphasis in the conceptual and institutional levels, it gains significant attention in the practical findings. Notably, there is a clear divergence in how this theme is interpreted: at the conceptual and policy levels, “education” primarily refers to capacity building within the energy sector (e.g., training programs, skills development, and institutional learning). At the practical level, however, stakeholders associate electrification with improvements in community education outcomes, including extended study hours for students and the electrification of schools. This divergence suggests that policies may not fully capture how communities experience the educational impacts of electrification.

Meanwhile, the involvement and governance dimension emerges as relatively prominent at both the conceptual and institutional levels, where it is framed around stakeholder participation, procedural fairness, and the effectiveness of institutional arrangements. However, it received comparatively less explicit attention in stakeholder interviews, where discussions often centered on operational challenges rather than governance design. Nevertheless, Chapter 4 shows that institutional gaps—many of which relate directly to coordination, mandates, and participation—remain critical barriers to integrating social sustainability in off-grid electrification. This highlights the indirect but important role of governance in shaping practical outcomes.

Similarly, the theme of “social development, well-being, and quality of life” appears more prominently in the conceptual and institutional levels than in practical stakeholder narratives. This may be due to the broad and multifaceted nature of “well-being,” which is often embedded implicitly within other themes rather than discussed as a standalone category in practice.

The theme of social acceptance is prominent conceptually, particularly in discussions on community approval, involvement, and user satisfaction. In contrast, it receives limited attention within policy documents and practical stakeholder narratives. This may be due to the assumption that electrification projects inherently benefit communities, reducing perceived need for explicit social acceptance processes. The lack of structured mechanisms for gauging acceptance also means that local attitudes are often assessed informally, making this dimension less visible at the institutional and practical levels.

On the other hand, social equity received relatively less attention in conceptual discussions, but greater attention at the institutional level. This is reflected in mechanisms such as missionary electrification, which comprise of policy provisions designed to ensure that remote and underserved areas receive access despite high costs. However, social equity received limited attention with the testimony of stakeholders, where discussions of fairness were often implicit rather than articulated through equity-oriented language. This suggests that while equity is embedded institutionally, it may not be explicitly framed or assessed systematically.

Finally, gender and human rights remain consistently underrepresented across all three levels. While these themes appear in global frameworks and are occasionally referenced in conceptual literature, they seldom translate into specific policy provisions or operational practices in the Philippine context. Their limited presence in policies suggests that these themes are not yet institutionalized within the mandates or reporting requirements of energy agencies. At the practical level, stakeholders may not view gender and human rights as directly related to technical electrification tasks, which contributes to their continued marginalization within energy governance.

5.4 Unified framework for the social sustainability of off-grid electrification systems

The findings across the dissertation reveal that while social sustainability is widely recognized as an important dimension of off-grid electrification, its integration remains inconsistent and fragmented across different levels of decision-making. Conceptual models emphasize comprehensive social themes, yet these are only partially translated into national policy, and even less into the practical experience of stakeholders and communities. This misalignment creates gaps that limit the realization of social benefits, particularly in rural and remote areas where electrification is most needed.

A unified framework is therefore proposed to bridge these gaps by integrating insights from conceptual foundations, institutional arrangements, and practical stakeholder priorities; clarifying how social themes should be operationalized across levels; and providing a structured guide for governments, practitioners, and researchers to improve the social sustainability of off-grid electrification systems.

5.4.1 Framework overview

The framework operates across three interconnected levels: conceptual, institutional, and practical, as shown in Figure 5-2. Elements of this framework are discussed as follows:

- The conceptual level captures the broader theoretical understanding of social sustainability and the themes developed from literature. It outlines what should matter in socially sustainable electrification. This level provides the prescriptive foundations and the comprehensive scope of social themes.
- The institutional level focuses on how governments, regulatory bodies, and policies translate conceptual themes into rules, incentives, guidelines, and strategies. It reflects the operationalization of social sustainability within the national governance system. The institutional level is critical because it either enables or constrains the integration of social considerations at the practical level.

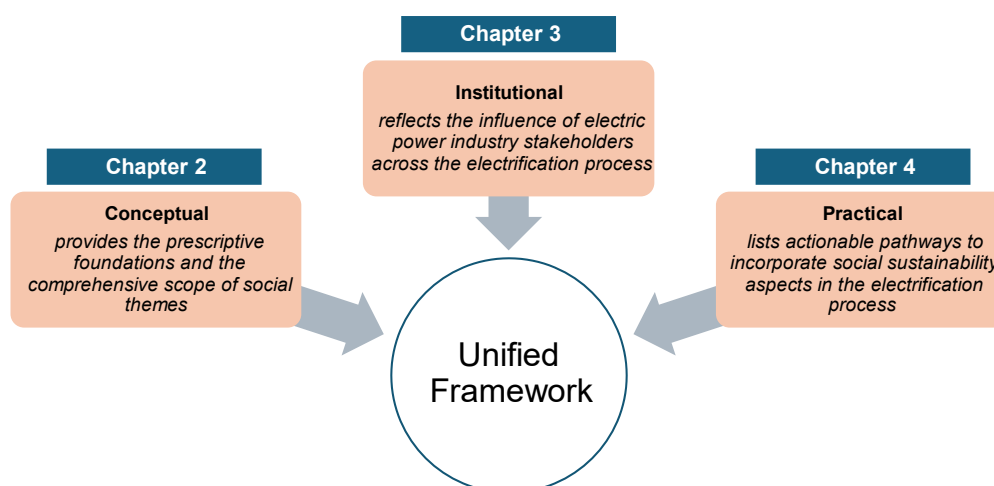


Figure 5-2: Elements of the unified framework.

- The practical level captured how relevant stakeholders experience and interpret social sustainability. It reflects their priorities, perceptions, and lived realities. The framework lists down actionable pathways that incorporate social sustainability in the electrification process. Incorporating this level ensures that social sustainability assessment is not merely top-down, but responsive to real community needs and expectations.

5.4.2 Framework dimensions

From the cross-chapter analysis, several aspects emerged as particularly important due to either strong alignment or recurrent gaps. These aspects form the essential dimensions of the unified framework:

- Energy access is the only theme that strongly aligns across all levels. It is conceptualized as a fundamental right, institutionalized through clear policy mechanisms, and valued by stakeholders as the key determinant of well-being. In the framework, energy access functions as the entry point and foundational dimension from which other social benefits arise.
- The socio-economic dimension includes affordability, income opportunities, job creation, and financial incentives. It is consistently present across levels, although interpreted differently. The framework emphasizes affordability and local economic integration as central indicators, given their importance in policy and stakeholder perspectives.
- The education theme appears weak in policy but strong in practical experience, especially through improved study conditions and electrified schools. The framework distinguishes between capacity building for system actors and educational benefits for communities. Both should be assessed to avoid misalignment.
- Although conceptually strong, health and safety are not well reflected in policy. Stakeholders, however, see electrification of health facilities as a major benefit. The framework therefore elevates health-related impacts by requiring their explicit assessment within project planning and evaluation.

Meanwhile, additional desired dimensions are also reflected in the framework due to their prominence in the conceptual and institutional levels, such as:

- The involvement and governance dimension includes participation, accountability, institutions, and inter-agency coordination. It is strong conceptually and in policy but weak at the community level. The framework highlights the need to evaluate governance effectiveness not only by policy provisions but by stakeholder perception and experience.
- The social development, well-being, and quality of life dimension captures broader improvements in daily life, some of which overlap with environmental considerations. Although prominent in conceptual and institutional discourse, it was less emphasized by stakeholders, who tended to focus on more tangible and immediate benefits. The framework encourages explicit assessment to ensure these broader outcomes are not overlooked.
- Social equity is strong in conceptual frameworks and translated in policy primarily through missionary electrification. However, it was nearly absent in stakeholder narratives. The framework suggests inclusion of both distributive and procedural equity.
- Although conceptually important, social acceptance received limited policy and practical attention. The framework requires structured approaches for information campaigns, community consultations, and transparency mechanisms to enhance acceptance.

- The gender and human rights aspects were consistently underrepresented across all levels. The framework elevates them as essential cross-cutting considerations, suggesting gender-responsive and rights-based indicators regardless of whether stakeholders or policies explicitly reference them.

Figure 5-3 integrates the ten social sustainability themes into the unified framework by distinguishing between the four core social dimensions most consistently reflected across all levels and the six additional dimensions that, while present, require further institutional strengthening and practical operationalization. This structure reflects both the prominence of these themes in the literature and the specific priorities highlighted by Philippine stakeholders, allowing the framework to remain grounded in empirical evidence while accommodating context-specific emphasis.

The framework also incorporates the institutional configuration of the Philippine off-grid electrification landscape, illustrating how various actors influence decision-making across different phases of the process. To enhance applicability to other national contexts, the stages depicted in Figure 5-3 use generalized terms instead of the terms used in Chapter 4. This allows adaptation of the framework to different governance structures and planning mechanisms. However, additional grounded studies could be performed to adjust the framework as necessary.

Lastly, Figure 5-3 provides illustrative examples of potential pathways within the practical level of the framework. These pathways serve as starting points for understanding how social sustainability themes might translate into implementation strategies or community-level outcomes. However, a more detailed development of these pathways is necessary to ensure that they reflect geographic conditions, institutional capacities, and policy environments, and to provide clearer guidance for integrating social sustainability into practice.

5.4.3 Application of the framework

The unified framework is designed to be context-flexible while remaining grounded in universally relevant principles of social sustainability. Although this dissertation focuses on the Philippine off-grid electrification landscape, the framework can be adapted to other national or regional settings by accounting for a range of contextual factors.

First, institutional indicators will naturally differ across countries due to variations in governance structures, regulatory mechanisms, and electrification strategies; the framework accommodates these differences without altering its conceptual foundations.

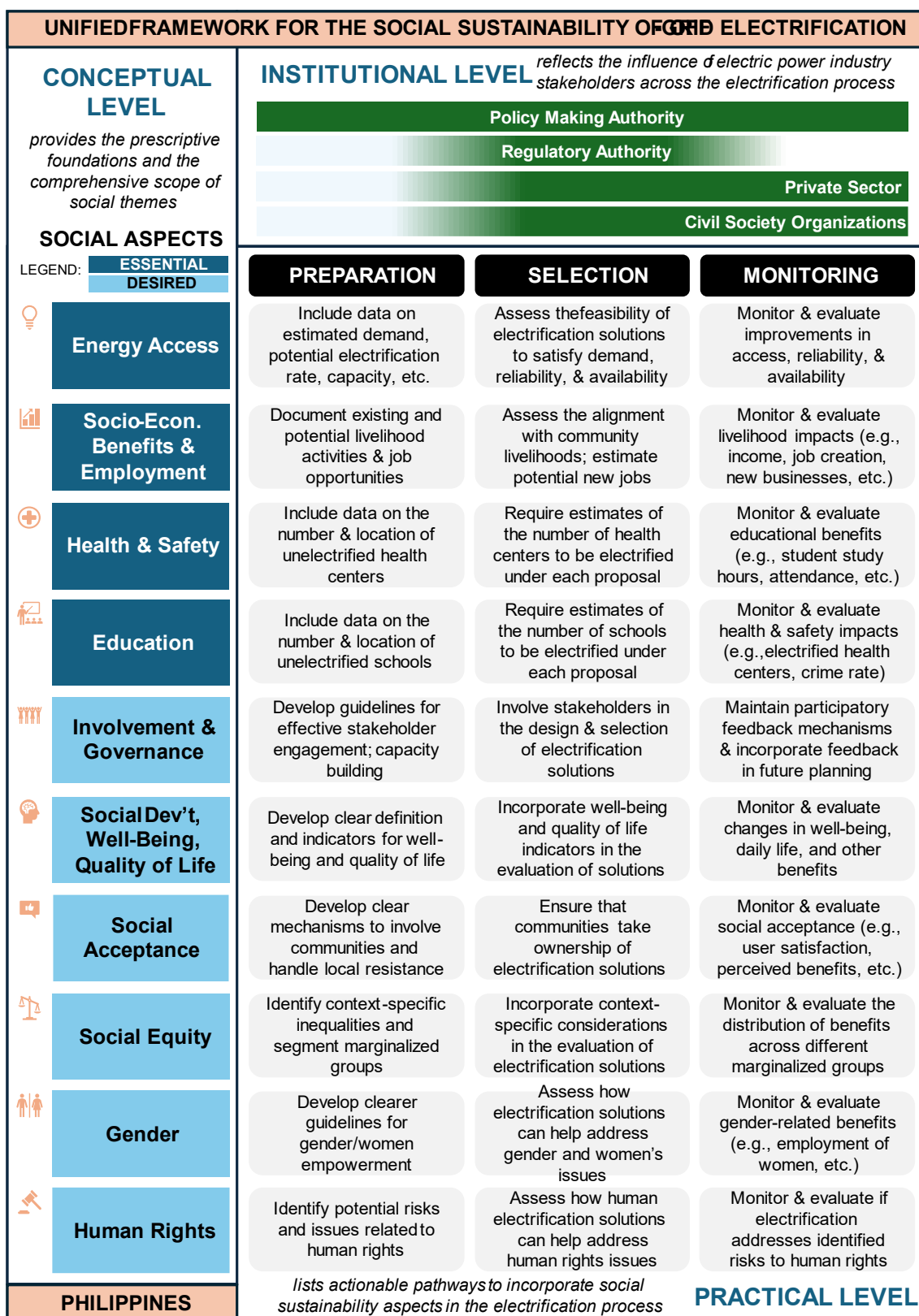


Figure 5-3: Unified framework for the social sustainability of off-grid electrification systems.

Second, stakeholder priorities and local realities, which are shaped by cultural norms, geographic conditions, existing infrastructure, and socio-economic circumstances, can influence which social themes receive greater emphasis as well as the existence of other social themes, allowing the framework to be adjusted in terms of prioritization.

Third, the framework is applicable across diverse technological pathways, since this dissertation did not focus on a specific technology. However, particular attention should be given for possible changes in the relevant social dimensions should there be a focus on a specific technology. For example, installing solar home systems at the household level could have different social implications compared with a community microgrid.

Finally, the framework can be aligned with broader policy and development goals, including SDG 7, national electrification strategies, just transition agendas, and climate resilience initiatives, ensuring that it remains responsive to both global and country-specific priorities.

Overall, because the framework is built from empirical insights and recognizes the disconnections between the conceptual, institutional, and practical levels, the framework provides a starting point for countries seeking to strengthen the social sustainability dimension of rural electrification. While the unified framework is designed to be adaptable across different national and regional contexts, its contribution also needs to be understood in relation to existing social sustainability frameworks commonly used in energy research and policy analysis.

5.4.4 Comparison with other social sustainability frameworks

This subsection situates the proposed unified framework within the broader landscape of social sustainability-related frameworks used in energy research. It compares the framework with established approaches, focusing on differences in scope, analytical levels, purpose, and social considerations. The aim of this subsection is not to evaluate which among these frameworks is the best, but rather to clarify how the proposed unified framework complements existing frameworks by addressing specific gaps related to cross-level integration in off-grid electrification.

To provide context for this comparison, this subsection first briefly acknowledges MCDA as a methodological approach commonly used to operationalize social sustainability in energy system analysis. MCDA has frequently been employed to incorporate social sustainability considerations into energy system evaluations, as discussed in Chapter 2. While MCDA primarily serves as a decision-support method, the unified framework, through its conceptual and practical elements, can inform MCDA applications by structuring and contextualizing the selection and development of social indicators, particularly through its conceptual grounding and attention to implementation processes.

Beyond MCDA, there are two more established frameworks which guide the evaluation of social sustainability in energy systems.

The first is energy justice, which is an emerging framework for incorporating social considerations into energy systems analysis. It has been applied across the entire energy system, from production and governance to consumption, which shows it is scalable and not limited to project-level assessments [13,290]. Conceptually, energy justice offers a strong principle-based structure through its core tenets of distributional, procedural, and recognition justice, alongside expanded dimensions such as restorative and cosmopolitan justice [13,42,291]. These principles have been widely used to investigate institutional arrangements, energy governance, and policy instruments, and to reveal normalized injustices embedded within national energy frameworks [51,292–294].

At the same time, reviews note that systematic national policy applications remain less common than project- or sector-level studies, and that translating conceptual depth into consistent policy instruments and implementation guidance remains an ongoing challenge [290,295,296]. Most energy justice research has been oriented toward normative evaluation and critique, assessing whether energy policies and transitions are just, rather than prescribing how justice can be operationalized across planning, regulatory, and implementation stages [13,295,297].

The unified framework proposed in this study intersects with social breadth emphasized by energy justice, such as covering equity, participation, affordability, governance, and rights [13,287,291,295]. However, it differs in analytical orientation. Rather than focusing on normative evaluation, the unified framework traces how social sustainability dimensions have been conceptualized, institutionalized, and operationalized. This chapter also highlighted points of alignment and disconnection across these levels. This cross-level focus allows the framework to complement justice-based approaches by offering a structured lens for examining how social objectives evolve as they move from principles to policy instruments and into off-grid electrification practice, particularly in developing-country contexts.

Another prominent framework used to assess social dimensions in energy systems is the Social Life Cycle Assessment (SLCA). Unlike energy justice, SLCA is primarily designed for application at the level of products, services, organizations, or sectors, following the ISO-style LCA steps and value-chain boundaries rather than whole policy systems [35,298,299]. The vast majority of SLCA studies focus on products and processes, with only limited extension to higher-level systems [300]. Some tools and databases, such as the Social Hotspot Database and PSILCA, operate at the sector–country scale and enable higher-level screening of social risks along supply chains, which may indirectly inform national energy policy development [299,301]. However, these

approaches do not heavily focus on policies, institutional dynamics, or system-wide transitions, which limits their application to national policy analysis [299,301].

Conceptually and methodologically, SLCA is focused on assessing impacts assessment and identifying hotspots along life cycles, rather than toward the evaluating or designing institutional arrangements and policy instruments [298,299,301]. Its methods have emphasized indicator development, data quality, and impact pathways. Although SLCA frameworks consider various social aspects—including human rights, health, working conditions, governance, community impacts, and socio-economic effects [35,299,302,303]—applications tend to prioritize worker-related indicators, with equity, participation, gender, and governance less consistently operationalized [302,304]. As a result, it limits SLCA’s application to national energy policy analysis.

Overall, SLCA provides valuable life cycle-based insights into supply-chain and community risks, but its product- and organization-centered orientation and limited treatment of institutions and policy instruments constrain its use as a standalone framework for systematic national energy policy analysis. Instead, SLCA can be best understood as a complementary tool within a broader analytical framework, such as the proposed unified framework.

Taken together, energy justice and SLCA offer significant but limited approaches for examining social sustainability in energy systems and policy. Energy justice provides a strong normative foundation and consideration of equity, participation, and recognition, yet its application to concrete policy design and implementation remains uneven. SLCA, on the other hand, offers structured and operational social indicators based on life cycle thinking, but is largely confined to analysis of products, projects, or supply chains.

The unified framework proposed in this chapter is positioned alongside these approaches and addresses complementary gaps by explicitly linking conceptual principles, institutional arrangements, and practical implementation processes. In doing so, it offers an integrative, policy-oriented lens that is well suited to examining how social sustainability is translated from ideas into governance structures and on-the-ground outcomes in off-grid electrification systems.

5.5 Conclusion

This integrative chapter brought together the conceptual, institutional, and practical insights generated across the dissertation to address the guiding question: “How does off-grid electrification effectively integrate social sustainability at the conceptual, institutional, and practical levels?” By synthesizing findings from the three chapters, the analysis demonstrated that social sustainability is increasingly recognized within global

and academic discourse, partially reflected in national policy environments, yet still only inconsistently operationalized in electrification efforts.

The cross-chapter synthesis showed that some social dimensions, particularly energy access and socio-economic benefits, were consistently present across all three levels. These themes have clearer operational pathways and established policy support, making them easier to integrate in practice. Other dimensions, however, revealed misalignments. Education, health and safety, involvement and governance, and social equity were found to be well-articulated in literature and partially embedded in policy but remained unevenly implemented. Social acceptance, gender, and human rights were the most weakly represented across all levels, indicating deeper conceptual and institutional gaps that hinder their translation into practice. These patterns demonstrate that effective integration of social sustainability is dependent not only on the availability of indicators or stakeholder recognition but also on the coherence between conceptual clarity, institutional mechanisms, and practical processes.

To address these gaps, the unified framework developed in this chapter provides a structured approach for understanding and strengthening how social sustainability can be embedded in off-grid electrification. By organizing insights across the conceptual, institutional, and practical levels, the framework identifies key dimensions and offers a basis for aligning research, policy, and implementation.

A brief subsection also highlights the framework's flexibility, which allows its adaptation to diverse contexts by accommodating differences in governance structures, stakeholder priorities, technological pathways, and national development agendas.

This chapter also positioned the proposed unified framework in relation to energy justice and SLCA, emphasizing the framework's cross-level integration and clarifying how social sustainability is operationalized in policy design and implementation.

Overall, this chapter highlights that achieving socially sustainable off-grid electrification is a multi-level undertaking. Strengthening social outcomes requires clearer conceptual foundations, better alignment of institutional mandates, and practical mechanisms that support consistent implementation. The Philippine case demonstrates both the barriers, and the opportunities present in this process, offering lessons relevant to other countries pursuing equitable and inclusive electrification.

Chapter 6 Conclusion

6.1 Dissertation summary

Efforts to expand electrification, particularly in remote and off-grid areas, have increasingly emphasized the need to consider not only technical and economic factors but also social dimensions. Social sustainability has therefore gained relevance as countries seek to understand how electrification initiatives shape, and are shaped by, local communities, institutional arrangements, and broader development goals. In contexts such as the Philippines, examining the role of social sustainability provides important insights into how energy access can be more responsive and inclusive.

This dissertation investigated how social sustainability is conceptualized, institutionalized, and operationalized within the Philippine off-grid electrification landscape. Across its five chapters, the study traces how social dimensions appear in international and academic literature, how they are expressed within national energy policies, and how they are interpreted and applied by institutions involved in planning and implementing off-grid systems. These analyses reveal both areas of progress and points where social considerations remain only partially integrated into existing policy and practice.

The findings indicate that the incorporation of social sustainability is shaped by factors operating at multiple levels. While the importance of social outcomes is widely acknowledged, translating these aims into consistent policy provisions, assessment tools, and implementation processes remains a challenge. This pattern reflects broader global discussions on how to meaningfully embed social considerations within electrification efforts, especially in settings characterized by resource and capacity constraints.

By examining these levels individually and then synthesizing them through a proposed integrative framework, this dissertation offers a structured lens for understanding how social sustainability evolves within off-grid electrification systems. The insights contribute to ongoing policy dialogues, provide direction for future research, and support practitioners seeking to align electrification initiatives with community needs and long-term development outcomes.

The main insights from each chapter are summarized below:

- Chapter 2 presented an updated and comprehensive review of how social sustainability is assessed in electrification systems internationally. The chapter proposed a simple but foundational conceptual framework encompassing three key elements: definitions of social sustainability, indicators used to evaluate social

dimensions, and stakeholder roles and involvement. Ten thematic clusters were developed from the literature, reflecting the breadth of social concerns considered across contexts. Importantly, Chapter 2 highlighted gaps in the literature, especially in themes such as human rights, social equity, and gender, and called for greater methodological diversity and inclusion of gray literature. This chapter answers the first research question, “How is social sustainability defined, interpreted, and assessed in the literature on electrification systems?”, and established the conceptual foundation for understanding social sustainability in energy systems. It also provided the social categories used throughout the dissertation.

- Chapter 3 investigated how social sustainability categories are reflected in the Philippine energy policy landscape. Through qualitative content analysis of key policy documents, the chapter revealed that several social sustainability themes—particularly socio-economic benefits and employment, energy access, and involvement and governance—are relatively well embedded in regulations. However, other themes identified, such as gender, human rights, education, and social acceptance, were minimally addressed or only indirectly implied. The findings demonstrate that institutional integration remains uneven, with some themes covered only in annexes or nonbinding guidelines rather than core policy mandates. Chapter 3 proposes that stronger institutionalization of underrepresented themes, development of measurable indicators, and mainstreaming of social sustainability principles across agencies and policy instruments would significantly improve alignment between policy objectives and the broader social aims of electrification. Chapter 3 answers the third research question, “To what extent is social sustainability integrated in Philippine energy policies governing off-grid electrification?” and the fourth research question, “How can social sustainability be better integrated in off-grid electrification in the Philippines?”
- Chapter 4 shifted to the practical level, examining how social sustainability is understood and applied by stakeholders involved in off-grid rural electrification in the Philippines. Through interviews and document analysis, the chapter showed that while social objectives such as education, health, safety, and economic betterment are widely acknowledged, they are not systematically operationalized. Decision-making processes across planning, evaluation, and implementation stages remain heavily dominated by technical and financial considerations, with limited tools or mechanisms for identifying, measuring, or tracking social outcomes. Institutional challenges further hinder the integration of social dimensions. It concluded by recommending pathways for better integration of social sustainability in three key stages of off-grid electrification. Chapter 4 answers the second research question, “How do key government stakeholders in the Philippines perceive and prioritize social sustainability in off-grid electrification?” and the fourth research question,

“How can social sustainability be better integrated in off-grid electrification in the Philippines?”

- Chapter 5 synthesized insights from the conceptual, institutional, and practical analyses to understand how social sustainability can be more effectively integrated into off-grid electrification. The findings show that although social objectives are broadly acknowledged in literature and policy, their implementation remains uneven. Some aspects, particularly energy access and socio-economic benefits, appear consistently across all levels, while others, such as education, health and safety, involvement and governance, and social equity, are only partially embedded as they translate from concept to practice. Social acceptance, gender, and human rights remain the least integrated, revealing persistent structural and operational gaps. In response, the chapter proposed a unified framework, which emphasize core social dimensions. The framework is expected to be adaptable to different governance systems, local priorities, technologies, and development goals. The chapter also provides the merits of the unified framework in relation to two prominent frameworks, energy justice and SLCA. Overall, the integrative chapter answers the dissertation’s main research question, “How does off-grid electrification effectively integrate social sustainability in the conceptual, institutional, and practical levels?” and highlights that achieving socially sustainable off-grid electrification requires stronger coherence between concepts, policies, and implementation practices.

Together, these chapters offer a comprehensive examination of social sustainability in off-grid electrification, highlighting the disconnections between conceptual models, institutional arrangements, and practical implementation. They identify pathways to better integrate social aims in a more sustainable energy future for off-grid areas.

6.2 Future work

This dissertation opens several promising avenues for future research, which are listed below:

- Conceptually, future research can deepen and refine the thematic structure developed in Chapter 2. Underexplored themes such as gender, social equity, and human rights need more systematic investigation to clarify how they manifest in electrification contexts. Cross-cultural studies could examine how meanings and priorities of social sustainability differ across countries, technologies, and governance arrangements. Incorporating gray literature, project evaluations, and field studies can also enrich conceptual models with grounded insights.
- At the institutional level, future research could expand the scope of policy analysis both within and beyond the Philippine case. This includes examining additional

policy documents such as development plans, local government codes, and cross-sectoral regulations. A longitudinal analysis could track changes in social sustainability integration over time, revealing how political shifts, technological developments, and international commitments influence policy. Comparative studies across countries could also shed light on which institutional arrangements most effectively integrate social dimensions into electrification policy.

- At the practical level, further inquiry is needed into how social outcomes unfold at community, household, and local government levels. Detailed case studies of electrified and unelectrified communities could explore how energy access interacts with social priorities such as education, livelihoods, health and safety, or gender. Participatory or community-driven research methods could also provide richer insights into end-users' lived experiences. There is also significant potential to develop practical tools for implementers, such as streamlined social assessment templates, community engagement guidelines, or user-oriented monitoring systems that integrate both qualitative and quantitative data. Strengthening cross-sectoral coordination is another promising area for both empirical research and piloting.
- Because the dissertation highlights misalignments across three levels, future work should also focus on linkages between them. Research could examine how new conceptual insights filter into policy, how policy shapes practice, or how practical evidence informs conceptual refinement.
- Although rooted in the Philippine context, the dissertation's findings have broader relevance for many developing countries pursuing rural electrification. Future research should investigate how the integrative framework performs in diverse socio-political and energy landscapes. Comparative applications could improve the framework and enhance its international applicability. As such, additional grounded studies in different contexts are essential to further develop the proposed framework.

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Appendices

Appendix A – Codebook for the qualitative content analysis in Chapter 3

In the following table, “sources” refer to the number of source files (i.e., policy documents), while “refs.” correspond to the total number of referenced texts/provisions assigned to the specific code.

Codes	Description	Sources	Refs.
a. Education	Employee education; education (general)	7	17
b. Energy Access	Access, energy security, capacity and reliability	24	290
<i>Energy Security</i>		16	87
<i>Provision of Reliable Electricity Services</i>		24	277
c. Gender	Women empowerment; labor-related; gender equality/equity (general)	2	3
d. Health & Safety	Labor- and plant-related safety; pollution, emissions-related; general health	14	60
<i>Public Health, Pollution-Related</i>		13	54
<i>Safety from Injury and Accidents</i>		5	8
e. Human Rights	People displacement; forced labor/labor rights; human rights (general); child labor; indigenous people and traditional communities; cultural rights	2	13
f. Involvement & Governance	Stakeholder involvement; compatibility with current political frameworks; institutional support; transparency and corruption; ownership	23	226
<i>Accountability</i>		9	28
<i>Compatibility with Institutional Framework</i>		9	27
<i>Institutional Support</i>		16	57
<i>Inter- and Intra-government Collaboration</i>		15	60
<i>Non-Government Stakeholder Engagement</i>		22	139
g. Social Acceptance	Social acceptance; public/community acceptance; satisfaction; political/institutional acceptance	4	5
h. Social Development, Well-Being, Quality of Life	Social welfare (general), improvement of way of life; surroundings, environment, ecosystems; regional and community development; technological advancements, innovations; worker welfare; food security; per capita indicators	20	111

<i>Social Welfare, Improvement of Way of Life</i>		7	15
<i>Surroundings, Environment, Ecosystems</i>		16	91
<i>Technological Advancements, Innovations</i>		7	20
i. Social Equity	General equity; rural electrification; rural development; poverty alleviation; peace; labor equity	16	87
<i>Distributive Equity</i>		14	66
<i>General Equity</i>		2	5
<i>Poverty Alleviation & Rural Development</i>		11	54
<i>Procedural Equity</i>		5	10
j. Socio-Economic Benefits & Employment	Job creation; economic benefits/economic-related; worker welfare; consumption-related	22	259
<i>Affordability and Minimizing Costs</i>		21	173
<i>Economic Growth, Livelihood</i>		6	20
<i>Employment</i>		2	17
<i>Financial Benefits & Incentives</i>		17	126

Appendix B – Documents reviewed to establish the context of off-grid electrification in the Philippines

Table A.1 - List of documents reviewed.

Type of Document	Name of Specific Document
Laws	▪ Republic Act 9136: Electric Power Industry Reform Act (EPIRA) of 2001 ▪ Republic Act 9513: Renewable Energy Act of 2008 ▪ Republic Act 10531: National Electrification Administration Reform Act of 2013 ▪ Republic Act 11646: Microgrid Systems Act
Department-Level Policies	<i>Department Circulars (DC) and Department Orders (DO) from the Department of Energy:</i> ▪ DC 2018-02-0024 – Promulgating the Rules and Guidelines Governing the Establishment of the Renewable Portfolio Standards for Off-Grid Areas ▪ DC 2019-01-0001 – Prescribing the Omnibus Guidelines on Enhancing Off-Grid Power Development and Operation ▪ DC 2021-03-0003 – Prescribing the Policy and Guidelines for the Distribution Utilities Distribution Development Plan Integrating the Relevant Laws, Policy Issuances, Rules and Regulations ▪ DC 2021-06-0013 – Adopting a General Framework Governing the Test and Commissioning of Generation Facilities for Ensuring Readiness to Deliver Energy to the Grid or Distribution Network ▪ DC 2021-11-0039 – Mandating the National Transmission Corporation as Small Grid System Operator in Specific Off-Grid Areas ▪ DC 2022-05-0016 – Adopting and Integrating the Policies and Programs for the Graduation and Rationalization of the Universal Charge for Missionary Electrification Subsidy Pursuant to Department Circular No. DC2019-01-0001 ▪ DC 2022-05-0016 – Rules and Regulations to Implement Republic Act No. 11646 (Microgrid Systems Act) ▪ DO 2022-12-0016 – Creating the Total Electrification Steering Committee to Accelerate the National Total Electrification ▪ DC 2023-03-0005 – Providing Supplemental Policy for the Systematic Management of the DOE Reportorial Requirements for the Electric Power Industry Participants - Distribution Utilities ▪ DC 2023-04-0006 – Providing Supplemental Policy for the Systematic Management of the DOE Reportorial Requirements for the Electric Power Industry Participants - Retail Electricity Suppliers ▪ DC 2023-05-0014 – Promulgating the Revised Rules and Guidelines Governing the Operationalization of the Renewable Portfolio Standards for Off-Grid Areas Pursuant to Section 12 of the Renewable Energy Act of 2008 ▪ DC 2023-06-0021 – Prescribing the Policy for the Mandatory Conduct of the Competitive Selection Process by the Distribution Utilities for the Procurement of Power Supply for Their Captive Market ▪ DC 2024-06-0018 – Revised Omnibus Guidelines Governing the Award and Administration of Renewable Energy Contracts and the Registration of Renewable Energy Developers ▪ DC 2025-04-0007 – Revised Implementing Rules and Regulations to of Republic Act No. 11646, otherwise known as “The Microgrid Systems Act” <i>Resolutions from the Energy Regulatory Commission:</i> ▪ Resolution 11-2022 – A Resolution Adopting the Rules Governing Distributed Energy Resources (DER)

	▪ Resolution 16-2023 – Implementing Guidelines for the Procurement, Execution, and Evaluation of Power Supply Agreements Entered into by Distribution Utilities for the Supply of the Electricity to their Captive Market ▪ Resolution 17-2023 – A Resolution Adopting the 2023 Revised Rules for the Issuance of Certificates of Compliance for Generation Facilities <i>Memorandum from the National Electrification Administration:</i> ▪ Memorandum 2023-057 – The National Electrification Administration Competitive Selection Process Guidelines Implementing the Department of Energy’s Department Circular No. DC2023-06-0021 and the Energy Regulatory Commission’s Resolution No. 16, Series of 2023 <i>Executive Orders (EO) from the Office of the President:</i> ▪ EO No. 156 - Instituting Measures to Ensure Consistent and Reliable Electricity Service in Inadequately Served Areas, Improve Performance of Ineffective Distribution Utilities, and Achieve Total Electrification of the Country
Plans and Roadmaps	▪ 2023-2032 Distribution Development Plan ▪ 2024-2033 National Total Electrification Roadmap ▪ Missionary Electrification Development Plan 2024-2028 ▪ National Power Corporation Missionary Electrification Plan 2025-2029 ▪ Philippine Energy Plan 2023-2050 (Volumes I to III) ▪ Power Development Plan 2023-2050 ▪ Transmission Development Plan 2025-2050

Appendix C – List of interview questions

The following shows the specific interview questions for the relevant government stakeholders within the electric power industry, corresponding to each of the main research questions.

Research Question 1: *How is off-grid electrification organized institutionally in the Philippines?*

- a. Structure and Nature of Involvement
 - 1. What does your office do? Please describe your overall involvement in off-grid rural electrification projects.
 - 2. Which specific offices are involved in off-grid rural electrification projects?
- b. Off-Grid Rural Electrification
 - 1. What are previous and current strategies or programs implemented with regards to off-grid rural electrification?
 - 2. How does your office/company develop and implement an electrification project in off-grid rural areas?
 - 3. How do you evaluate off-grid rural electrification projects?
 - 4. What are the challenges you face in implementing off-grid rural electrification projects?
- c. Policy and Process
 - 1. Which policies or processes do you observe/adhere to when developing and implementing off-grid rural electrification projects?
 - 2. How are policies developed and implemented? Who are involved in this process?
 - 3. What policies or processes facilitate or hinder effective implementation of off-grid rural electrification projects?

Research Question 2: *Which social aspects do the stakeholders consider important?*

- 1. Based on your experiences or stories from off-grid rural communities, what are concrete social impacts that can be attributed to off-grid rural electrification systems? How did the electrification system affect their daily lives?
- 2. Which social aspects do you consider important for off-grid rural electrification systems?
- 3. What are the social impacts of energy systems in off-grid rural communities?
- 4. Are these social aspects/impacts currently being evaluated or considered when implementing an electrification project? How?
- 5. What information, measures or techniques do you think are necessary to evaluate the social sustainability/impacts of energy systems in off-grid rural communities? How can we gather these information?
- 6. How would you define a socially sustainable electrification system? How will these systems impact the social aspect/daily lives?
- 7. Will the same answer be the same for urban and rural? For off-grid and on-grid systems? What would be the similarities and differences?

Research Question 3: *How can social aspects be better integrated in off-grid electrification?*

- a. Social Aspects Considered Important
 - 1. Based on the discussion about the prominent social aspects in Philippine energy policies (please see the attached slide deck in the email), please provide your feedback (agreement, disagreement, thoughts).
 - 2. How do you see these social aspects influencing energy-related decision-making in the Philippines?
 - 3. Are there any social dimensions that tend to be overlooked in energy policies? Why do you think that is the case?
- b. Indicators for Evaluating Social Aspects
 - 1. What indicators do you currently use (if any) to measure social sustainability in energy policies or programs?

2. Are there existing monitoring and evaluation mechanisms for social indicators in the energy sector? If so, how effective are they?
3. Which social impacts would you want to be considered when evaluating an electrification project? How would you define and measure these social impacts?
- c. Integrating Social Aspects into Philippine Energy Policies
 1. What are the current challenges in integrating social aspects into energy policy formulation?
 2. How can policies be improved to better incorporate social sustainability considerations?
 3. What role do different government agencies play in ensuring social aspects are addressed in energy planning? Which stakeholders should implement and monitor these social aspects?
- d. Closing Questions
 1. Do you have any final thoughts or recommendations regarding the integration of social sustainability in Philippine energy policies?

The following shows the interview questions for the Department of Social Welfare and Development (DSWD) and non-government stakeholders (private sector players and civil society organizations):

1. What does your organization do? Please describe your overall involvement in off-grid rural electrification projects.
2. What are previous and current strategies or programs implemented with regards to off-grid rural electrification?
3. How does your organization develop and implement an electrification project in off-grid rural areas?
4. How does your organization evaluate off-grid rural electrification projects?
5. What are the challenges faced by your organization in implementing off-grid rural electrification projects?
6. What are concrete social impacts that can be attributed to off-grid rural electrification systems? How did the electrification system affect their daily lives?
7. Which social aspects do you consider important for off-grid rural electrification systems?
8. What are the social impacts of energy systems in off-grid rural communities?
9. Are these social aspects/impacts currently being evaluated or considered when implementing an electrification project? How?
10. What information, measures or techniques do you think are necessary to evaluate the social sustainability/impacts of energy systems in off-grid rural communities? How can we gather these information?
11. How would you define a socially sustainable electrification system? How will these systems impact the social aspect/daily lives?
12. Will the answer be the same for urban and rural? For off-grid and on-grid systems? What would be the similarities and differences?

Appendix D – Codebook for the qualitative content analysis in Chapter 4

In the following table, “sources” refer to the number of source files (i.e., policy documents), while “refs.” correspond to the total number of referenced texts/provisions assigned to the specific code.

Codes	Description	Sources	Refs.
a. Experiences - Concrete Social Aspects	Relevant questions: Based on your experiences or stories from off-grid rural communities, what are concrete social impacts that can be attributed to off-grid rural electrification systems? How did the electrification system affect their daily lives? What are the social impacts of energy systems in off-grid rural communities?	7	110
<i>Better (access to) lighting</i>	Can also be connected to improved comfort at home, but distinct in a sense that the replacement of kerosene lamps for lighting also offer a healthier air quality. Usually connected to other benefits, such as reduced crime rate, better education outcomes, health and safety, etc.	6	15
<i>Capacity building of community</i>		2	4
<i>Communication and information access</i>		6	11
<i>Educational Benefits</i>		7	24
<i>Health and safety</i>		6	20
<i>Improved comfort and living conditions at home</i>		4	9
<i>Livelihood opportunities</i>		6	21
<i>Others</i>		3	6
b. Important Social Aspects	Relevant questions: Which social aspects do you consider important for off-grid rural electrification systems? Which social impacts would you want to be considered when evaluating an electrification project? How would you define and measure these social impacts?	11	114
<i>Access to new technology</i>		3	5
<i>Access, demand, or energization levels</i>		7	13
<i>Affordability</i>		9	14
<i>Communication</i>		2	3
<i>Education</i>		6	13
<i>Environmental impacts</i>		2	2
<i>Gender</i>		2	4
<i>Health and safety</i>		6	10
<i>Indigenous Peoples</i>		3	4
<i>Livelihood opportunities, economic growth</i>		8	28
<i>Others, overall quality of life</i>		6	7
<i>Prioritizing the poor and marginalized</i>		3	5
<i>Social acceptance</i>		5	6

c. Current Social Aspects Being Considered	Relevant questions: Are these social aspects/impacts currently being evaluated or considered when implementing an electrification project? How? What indicators do you currently use (if any) to measure social sustainability in energy policies or programs? Are there existing monitoring and evaluation mechanisms for social indicators in the energy sector? If so, how effective are they?	10	87
<i>Access, demand, or energization levels</i>		8	27
<i>Education</i>		3	6
<i>Environmental impacts</i>		2	2
<i>Gender-related</i>		4	5
<i>Health and safety</i>		2	3
<i>Limitations</i>		4	4
<i>Livelihood opportunities, economic growth</i>		8	18
<i>Presence of other public infrastructures</i>		2	4
<i>Price protection and ensuring affordability</i>		5	11
<i>Social acceptance and stakeholder consultation</i>		7	7
d. Recommended Process to Evaluate Social Impacts	What information, measures or techniques do you think are necessary to evaluate the social sustainability/impacts of energy systems in off-grid rural communities? How can we gather these information?	5	18
<i>Related to sources of information</i>		5	18
e. Definition of Social Sustainability	Relevant questions: How would you define a socially sustainable electrification system? How will these systems impact the social aspect/daily lives? Will the same answer be the same for urban and rural? For off-grid and on-grid systems? What would be the similarities and differences?	7	21
<i>Difference Between Rural and Urban</i>		7	11
f. Challenges to Integrate Social Aspects	Relevant questions: What are the current challenges in integrating social aspects into energy policy formulation?	7	44
<i>Compliance procedures</i>		3	9
<i>Lack of funding</i>		3	5
<i>Lack of information</i>		3	3
<i>Lack of institutional and technical capacity, no clear mandate</i>		5	8
<i>Lack of understanding what social aspects or impacts are</i>		2	3
<i>No clear mandate</i>		3	5
<i>Others</i>		1	1
<i>Overlooked aspects</i>		4	10

g. Policy Improvements for Better Integration	Relevant questions: How can policies be improved to better incorporate social sustainability considerations? What role do different government agencies play in ensuring social aspects are addressed in energy planning? Which stakeholders should implement and monitor these social aspects? Do you have any final thoughts or recommendations regarding the integration of social sustainability in Philippine energy policies?	5	31
<i>Improve stakeholder coordination and participation</i>		5	22
<i>Increased funding</i>		1	2
<i>Mainstreaming social goals in policy objectives</i>		3	7

Appendix E – Sample of the supplementary questionnaire

The supplementary questionnaire was conducted through the SurveyMonkey platform, which is online and browser based. As such, the questions below are phrased to reflect the functionalities of the said platform.

Introduction Message

Dear respondent,

Thank you for allotting time in answering this survey. This survey seeks to investigate the insights of relevant Philippine government stakeholders when evaluating off-grid electrification systems/projects, specifically in terms of the priority social aspects to consider. Please answer the questions as best as you can. The survey should take approximately 10 minutes to complete. By default, all questions are required, unless otherwise stated.

Rest assured that your responses will be treated with confidentiality and will be used for research purposes only. Data will be stored in accordance with [Kyoto University's data management and sharing policies](#). The results of the survey shall primarily be presented in summary form and measures will be implemented to ensure that no individual respondent can be identified from the results.

Finally, you may choose to opt out of the survey at any time.

PART I. RESPONDENT INFORMATION AND PRELIMINARY QUESTIONS

Q1. Name (*optional*):

Q2. What is your affiliation? (Name of Department/Office):

Q3. What is your position in the department/office?:

Q4. About how many years have you been in your current position?:

- ☐ Less than 1 year
☐ At least 1 year but less than 3 years
☐ At least 3 years but less than 5 years
☐ At least 5 years but less than 10 years
☐ 10 years or more

Q5. Please rate your level of familiarity with the following concepts:

Concepts	Extremely Familiar	Moderately Familiar	Somewhat Familiar	Slightly Familiar	Not at All Familiar
Sustainability / Sustainable Development					
Economic Sustainability					
Environmental Sustainability					
Social Sustainability					
Off-Grid, Rural Energy Systems					

PART II. SOCIAL SUSTAINABILITY CATEGORIES AND IMPORTANCE

The following aspects relate to social sustainability.

Note: SES refers to "sustainable electrification systems".

- **Education:** SES help improve education levels and worker skills.
- **Energy access, quality, and reliability:** SES are accessible, reliably provide user demand, and increase energy self-sufficiency.
- **Gender:** SES help bridge the gender gap, particularly by empowering women.
- **Involvement and governance:** SES are aligned with institutional frameworks and promote stakeholder engagement stakeholders.
- **Health and safety:** SES improve human health and ensure safety across its life cycle stages.
- **Human rights:** SES recognize and respect various human rights as well as observe local and international humanitarian laws.
- **Social acceptance:** SES and technologies are socially acceptable to the community or the public.
- **Social development/well-being and quality of life:** SES enrich community well-being and people's quality of life.
- **Socio-economic benefits:** SES improve livelihood by providing jobs and contributing to economic development, among others.
- **Social equity:** SES help close disparities in terms of socio-economic status, energy access, and resources, among others.

Q6. (Optional) What other aspects or themes do you think are relevant to a socially sustainable off-grid rural electrification system or project?

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Q7. Referring to the social sustainability categories described in Questions 6, please rank your perceived importance of each category in terms of assessing the social impacts of off-grid rural electrification systems or projects, with "1" being the most important.

IMPORTANT: This is a ranking question. Even if you agree with the default order, please ensure that each item has a rank/number (shown at the left side). Otherwise, the platform will treat it as unanswered. You can also check N/A if you think the item is not applicable or you do not want to consider it in the ranking.

Rank	Social Sustainability Categories
	Education
	Energy access, quality, and reliability
	Gender
	Involvement and governance
	Health and safety
	Human rights
	Social acceptance
	Social development/well-being and quality of life
	Socio-economic benefits
	Social equity

PART III. SOCIAL SUSTAINABILITY CATEGORIES, SUBCATEGORIES AND IMPORTANCE

IMPORTANT:

- The following questions are under the context of assessing the social sustainability off-grid rural electrification systems or projects. When beginning each question, it would be useful to ask, "Should I consider [subcategory] when evaluating a proposed off-grid rural electrification system/project?"
- For most subcategories, example indicators are enclosed in parentheses to provide you more context/description.
- The following are ranking questions. Even if you agree with the default order, please ensure that each item has a rank/number (shown at the left side). Otherwise, the platform will treat it as unanswered. You can also choose N/A if you think the item is not applicable or if you do not want to consider it in the ranking.

Q8. Regarding the "*social development/well-being and quality of life*" category, please rank your perceived importance of each subcategory, with "1" being the most important.

Rank	Subcategories: Social Development/Well-Being and Quality of Life
	Security of Food Supply
	Technological Advancements and Innovations (e.g., capacity for innovation, availability of latest technologies, etc.)
	Regional and Community Development (e.g., potential for local development, impact on local culture, access to TV/internet/appliances, etc.)
	Improvement of Way of Life and Social Welfare (e.g., human development index, population growth, social benefits, etc.)
	Welfare of Workers (e.g., workforce development, decent work, job quality, etc.)
	Surroundings, Environment, Ecosystems (e.g., visual pollution, air pollution/emissions, noise impact, etc.)

Q9. Regarding the "*health and safety*" category, please rank your perceived importance of each subcategory, with "1" being the most important.

Rank	Subcategories: Health and Safety
	Labor- and Facilities-Related Safety (e.g., work-related injuries/accidents, provision of safety suits, periodic health assessments, etc.)
	Pollution, Emissions-Related (e.g., air pollution, NOx emissions, waste management, etc.)
	Other Health (e.g., healthcare access, food safety risk, life expectancy, etc.)

Q10. Regarding the "*social equity*" category, please rank your perceived importance of each subcategory, with "1" being the most important.

Rank	Subcategories: Social Equity
	Other Equity (e.g., equality, diversity indicator, etc.)
	Rural Development (e.g., development of new roads, decreasing energy deprivation in distant areas, electrification rate, percentage of villages electrified, etc.)
	Distributive Equity and Alleviation of Poverty (e.g., subsidies, fair cost-sharing mechanisms, income inequalities, increase standards of living among low-income groups, etc.)
	Peace and Justice (e.g., social justice, peace, strong institutions, etc.)

Q11. Regarding the "*gender*" category, please rank your perceived importance of each subcategory, with "1" being the most important.

Rank	Subcategories: Gender
	Empowerment of Women (e.g., women are trained for O&M, share of women in staff and management, etc.)
	Other Gender (e.g., gender employment gap, gender wage gap, consideration of gender aspect, etc.)

Q12. Regarding the "*human rights*" category, please rank your perceived importance of each subcategory, with "1" being the most important.

Rank	Subcategories: Human Rights
	Other Human Rights (e.g., observance of humanitarian laws, etc.)
	Displacement of People (e.g., number of displaced people, migration rate, resettlement indicator, etc.)
	Prevalence of Child Labor (e.g., total child labor, involvement of child labor in any activity, etc.)
	Forced Labor and Other Labor Rights
	Rights of Indigenous and Traditional Communities
	Cultural Rights (e.g., level of damage to local cultural identity, level of damage to cultural/historical/archaeological heritage, etc.)

Q13. Regarding the "*socio-economic benefits*" category, please rank your perceived importance of each subcategory, with "1" being the most important.

Rank	Subcategories: Socio-Economic Benefits
	Creation of Jobs (e.g., net job creation, new job creation, etc.)
	Welfare of Workers (e.g., transportation services, employment benefits, job stability, equal opportunities, etc.)
	Economic Benefits (e.g., energy/electricity price, poverty alleviation, subsidies/financial services, etc.)

Q14. Regarding the "*energy access, quality, and reliability*" category, please rank your perceived importance of each subcategory, with "1" being the most important.

Rank	Subcategories: Energy Access, Quality, and Reliability
	Access to Electricity Services (e.g., electrification rate, number of customers serviced)
	Capacity and Reliability of Electricity Services (e.g., availability, energy quality, peak shortage)
	Energy Security (e.g., use of local resources, dependency on imported fuels)

Q15. Regarding the "*social acceptance*" category, please rank your perceived importance of each subcategory, with "1" being the most important.

Rank	Subcategories: Social Acceptance
	Social Acceptance (e.g., overall acceptance/opposition, etc.)
	Public/Community Satisfaction (e.g., user preference, etc.)

Q16. Regarding the "*education*" category, please rank your perceived importance of each subcategory, with "1" being the most important.

Rank	Subcategories: Education
	Employee Knowledge/Capacity Development (e.g., employee training and education, improvement of educational levels, etc.)
	Other Education (e.g., education access, literacy, etc.)

Q17. Regarding the "*involvement and governance*" category, please rank your perceived importance of each subcategory, with "1" being the most important.

Rank	Subcategories: Involvement and Governance
	Compatibility with Current Political Frameworks (e.g., policy adaptability, low planning and monitoring needs, political acceptance, etc.)
	Institutional Support (e.g., fiscal support, partnerships, international cooperation, etc.)
	Stakeholder Engagement (e.g., stakeholder participation, frequency of neighborhood meetings, roles in decision-making, etc.)
	Ownership (e.g., control of energy, level of community ownership, etc.)
	Accountability (e.g., access to information, level of corruption, etc.)

PART III. CLOSING QUESTIONS

Q18. A follow-up survey will be conducted to identify the *specific indicators* that can be used for the priority social aspects identified from the current survey. Your participation will be greatly appreciated. Would you be willing and available to participate in this follow-up survey?

- ☐ No
☐ Yes (please type your email address below)

Email Address:

Q19. If you would like to receive a copy of the survey results, please input your email address below. Otherwise, you may leave it blank.

- ☐ Yes, please use the email address I entered in the previous question.
☐ No, I do not require a copy of the survey results.
☐ Yes (please type your email address below if you did not type an email address in the previous question): _____

Q20. (Optional) We are hoping to access a broad base of respondents. If there are colleagues that you recommend to answer this survey, we would appreciate you indicating their name and email address/contact details below. Or alternatively, you may directly send to them the link of the survey.

Name: _____ Email Address: _____
Name: _____ Email Address: _____
Name: _____ Email Address: _____

Appendix F – Key results of the supplementary questionnaire

The following show the selected results of the ranking questions based on the responses of government stakeholders. A total of six responses from the five core government offices were received. The values represent a simple average of the ranking per option.

Q7. Referring to the social sustainability themes described above, please rank your perceived importance of each theme in terms of assessing the social impacts of off-grid rural electrification systems or projects, with "1" being the most important.

Table D.1 – Ranking results for Q7.

Ave. Ranking	Social Sustainability Category	Respondent					
		A	B	C	D	E	F
1.2	Energy access, quality, and reliability	1	1	1	1	1	2
3.2	Socio-economic benefits and employment	2	7	2	4	3	1
4.7	Involvement and governance	8	2	3	3	6	6
4.7	Education	4	8	4	5	2	5
4.8	Social development/well-being and quality of life	3	4	5	2	5	10
6.3	Health and safety	5	9	7	10	4	3
7.0	Human rights	9	3	8	7	7	8
7.0	Social acceptance	7	6	6	6	10	7
7.7	Social equity	6	10	10	8	8	4
8.5	Gender	10	5	9	9	9	9

Q8. Regarding the "social development/well-being and quality of life" category, please rank your perceived importance of each subcategory, with "1" being the most important.

Table D.2 – Ranking results for Q8.

Ave. Ranking	Subcategories	Respondent					
		A	B	C	D	E	F
2.2	Improvement of Way of Life and Social Welfare (e.g., human development index, population growth, social benefits, etc.)	2	1	3	2	1	4
3.0	Surroundings, Environment, Ecosystems (e.g., visual pollution, air pollution/emissions, noise impact, etc.)	4	2	2	1	6	3
3.3	Security of Food Supply	6	3	1	6	2	2
3.8	Technological Advancements and Innovations (e.g., capacity for innovation, availability of latest technologies, etc.)	1	5	4	3	4	6
4.0	Regional and Community Development (e.g., potential for local development, impact on local culture, access to TV/internet/appliances, etc.)	3	6	6	5	3	1
4.7	Welfare of Workers (e.g., workforce development, decent work, job quality, etc.)	5	4	5	4	5	5

Q9. Regarding the "health and safety" subcategory, please rank your perceived importance of each subcategory, with "1" being the most important.

Table D.3 – Ranking results for Q9.

Ave. Ranking	Subcategories	Respondent					
		A	B	C	D	E	F
1.3	Labor- and Facilities-Related Safety (e.g., work-related injuries/accidents, provision of safety suits, periodic health assessments, etc.)	1	1	2	1	1	2
2.0	Pollution, Emissions-Related (e.g., air pollution, NOx emissions, waste management, etc.)	2	2	3	2	2	1
2.7	Other Health (e.g., healthcare access, food safety risk, life expectancy, etc.)	3	3	1	3	3	3

Q10. Regarding the "social equity" category, please rank your perceived importance of each subcategory, with "1" being the most important.

Table D.4 – Ranking results for Q10.

Ave. Ranking	Subcategories	Respondent					
		A	B	C	D	E	F
1.2	Rural Development (e.g., development of new roads, decreasing energy deprivation in distant areas, electrification rate, percentage of villages electrified, etc.)	1	1	1	2	1	1
2.5	Distributive Equity and Alleviation of Poverty (e.g., subsidies, fair cost-sharing mechanisms, income inequalities, increase standards of living among low-income groups, etc.)	3	2	2	1	3	4
2.7	Peace and Justice (e.g., social justice, peace, strong institutions, etc.)	2	3	3	3	2	3
3.7	Other Equity (e.g., equality, diversity indicator, etc.)	4	4	4	4	4	2

Q11. Regarding the "gender" category, please rank your perceived importance of each subcategory, with "1" being the most important.

Table D.5 – Ranking results for Q11.

Ave. Ranking	Subcategories	Respondent					
		A	B	C	D	E	F
1.3	Empowerment of Women (e.g., women are trained for O&M, share of women in staff and management, etc.)	1	1	1	1	2	2
1.7	Other Gender (e.g., gender employment gap, gender wage gap, consideration of gender aspect, etc.)	2	2	2	2	1	1

Q12. Regarding the "human rights" category, please rank your perceived importance of each subcategory, with "1" being the most important.

Table D.6 – Ranking results for Q12.

Ave. Ranking	Subcategories	Respondent					
		A	B	C	D	E	F
2.3	Rights of Indigenous and Traditional Communities	1	1	4	5	2	1
3.2	Prevalence of Child Labor (e.g., total child labor, involvement of child labor in any activity, etc.)	4	4	2	4	1	4
3.3	Cultural Rights(e.g., level of damage to local cultural identity, level of damage to cultural/historical/archaeological heritage, etc.)	2	2	6	3	5	2
3.5	Displacement of People (e.g., number of displaced people, migration rate, resettlement indicator, etc.)	3	3	3	2	4	6
4.2	Forced Labor and Other Labor Rights	5	5	5	1	6	3
4.5	Other Human Rights (e.g., observance of humanitarian laws, etc.)	6	6	1	6	3	5

Q13. Regarding the "socio-economic benefits" category, please rank your perceived importance of each subcategory, with "1" being the most important.

Table D.7 – Ranking results for Q13.

Ave. Ranking	Subcategories	Respondent					
		A	B	C	D	E	F
1.7	Economic Benefits (e.g., energy/electricity price, poverty alleviation, subsidies/financial services, etc.)	3	1	1	1	1	3
1.8	Creation of Jobs (e.g., net job creation, new job creation, etc.)	1	3	2	2	2	1
2.5	Welfare of Workers (e.g., transportation services, employment benefits, job stability, equal opportunities, etc.)	2	2	3	3	3	2

Q14. Regarding the "energy access, quality, and reliability" category, please rank your perceived importance of each subcategory, with "1" being the most important.

Table D.8 – Ranking results for Q14.

Ave. Ranking	Subcategories	Respondent					
		A	B	C	D	E	F
1.5	Access to Electricity Services (e.g., electrification rate, number of customers serviced)	3	1	1	2	1	1
2.0	Capacity and Reliability of Electricity Services (e.g., availability, energy quality, peak shortage)	2	3	2	1	2	2
2.5	Energy Security (e.g., use of local resources, dependency on imported fuels)	1	2	3	3	3	3

Q15. Regarding the "social acceptance" category, please rank your perceived importance of each subcategory, with "1" being the most important.

Table D.9 – Ranking results for Q15.

Ave. Ranking	Subcategories	Respondent					
		A	B	C	D	E	F
1.2	Social Acceptance (e.g., overall acceptance/opposition, etc.)	1	1	1	2	1	1
1.8	Public/Community Satisfaction (e.g., public opinion, user preference, etc.)	2	2	2	1	2	2

Q16. Regarding the "education" category, please rank your perceived importance of each subcategory, with "1" being the most important.

Table D.10 – Ranking results for Q16.

Ave. Ranking	Subcategories	Respondent					
		A	B	C	D	E	F
1.2	Employee Knowledge/Capacity Development (e.g., employee training and education, improvement of educational levels, etc.)	1	1	1	1	1	2
1.8	Other Education (e.g., education access, literacy, etc.)	2	2	2	2	2	1

Q17. Regarding the "involvement and governance" theme, please rank your perceived importance of each sub-theme, with "1" being the most important.

Table D.11 – Ranking results for Q17.

Ave. Ranking	Subcategories	Respondent					
		A	B	C	D	E	F
2.3	Compatibility with Current Political Frameworks (e.g., policy adaptability, low planning and monitoring needs, political acceptance, etc.)	1	2	2	1	5	3
2.3	Stakeholder Engagement (e.g., stakeholder participation, frequency of neighborhood meetings, roles in decision-making, etc.)	2	4	3	2	2	1
2.8	Accountability (e.g., access to information, level of corruption, etc.)	5	1	1	3	3	4
3.7	Institutional Support (e.g., fiscal support, partnerships, international cooperation, etc.)	4	5	5	5	1	2
3.8	Ownership (e.g., control of energy, level of community ownership, etc.)	3	3	4	4	4	5

List of publications

Journal Papers

1. Allen Lemuel G. Lemence, Jordi C. Cravioto, & Benjamin C. McLellan (2024). “Review of Social Sustainability Assessments of Electricity Generating Systems”, *Energies*, MDPI, Volume No. 17, Issue No. 23, Article No. 6058, <https://doi.org/10.3390/en17236058>
2. Allen Lemuel G. Lemence, Jordi C. Cravioto, & Benjamin C. McLellan (2025). “Investigating Social Sustainability in Philippine Electrification Policies through Qualitative Content Analysis”, *Energy for Sustainable Development*, Elsevier, Volume No. 88, Article No. 101817, <https://doi.org/10.1016/j.esd.2025.101817>
3. Allen Lemuel G. Lemence, Jordi C. Cravioto, & Benjamin C. McLellan (2025). “Social sustainability aspects of off-grid rural electrification systems: insights from Philippine government stakeholders”, *Energy Research and Social Science*, Submitted on November 27, 2025
4. Multi-Level Social Sustainability Framework for Off-Grid Electrification Systems (in preparation)

International Conferences

1. Oral presentation, “Investigating Social Sustainability in the Philippine Electric Power Industry Subsectors through Qualitative Content Analyses of Philippine Rural Electrification Policies”, *7th International Conference on Public Policy*, July 2-4, 2025; Chiang Mai, Thailand
2. Oral presentation, “Social Acceptance and Stakeholder Engagement in Philippine Rural Electrification Policies: A Qualitative Content Analysis”, *20th Singapore Graduate Forum on Southeast Asian Studies*, June 16-27, 2025; Asia Research Institute - National University of Singapore, Singapore
3. Oral presentation, “Social sustainability assessment of energy systems: research status and opportunities”, *2024 The 8th International Conference on Green Energy and Applications*, March 14-16, 2024; NTU@one-north, Singapore