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Just Energy Transition: Learning from the Past for a More Just and Sustainable Hydrogen Transition in West Africa

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Abstract: The rising demand for energy and the aim of moving away from fossil fuels and to low-carbon power have led many countries to move to alternative sources including solar energy, wind, geothermal energy, biomass, and hydrogen. Hydrogen is often considered a "missing link" in guaranteeing the energy transition, providing storage, and covering the volatility and intermittency of renewable energy generation. However, due to potential injustice with regard to the distribution of risks, benefits, and costs (i.e., in regard to competing for land use), the large-scale deployment of hydrogen is a contested policy issue. This paper draws from a historical analysis of past energy projects to contribute to a more informed policy-making process toward a more just transition to the hydrogen economy. We perform a systematic literature review to identify relevant conflict factors that can influence the outcome of hydrogen energy transition projects in selected Economic Community of West African States countries, namely Nigeria and Mali. To better address potential challenges, policymakers must not only facilitate technology development, access, and market structures for hydrogen energy policies but also focus on energy access to affected communities. Further research should monitor hydrogen implementation with a special focus on societal impacts in producing countries.

Keywords: energy transition; renewable energy; social impacts; hydrogen; ECOWAS

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1. Introduction

Energy transition that includes large-scale deployment of new energy generation technologies, such as renewable energy sources or hydrogen, is ongoing around the world. This process is driven by concerns about energy and climate security policies.

From the perspective of energy security, reliable and available access to energy and energy supply is essential to the functioning of any society. Energy and its infrastructure are not just critical due to their significant impacts on a variety of human life, but are also essential for contemporary civilization [1]. In fact, energy availability is a key component for achieving sustainable development [2]. This is highlighted by UN Sustainable Development Goal 7: Ensure access to affordable, reliable, sustainable, and modern energy for all [3]. Nevertheless, the growing energy demand due to exponentially rapid population growth (e.g., in Africa) and rapid economic development (e.g., in China and India) [4] is a challenge for energy security policy-making and planning [5]. On a global scale, energy demand is projected to increase by 50% by 2040 over 2012 usage [6].

This increasing global energy demand is resulting in the increased use of fossil fuels and nuclear energy, with resulting negative implications for the environment and the exhaustion of non-renewable energy sources. Oil, gas, and coal reserves are predicted to be depleted between 2042 and 2112 [7]. Moreover, the use of fossil fuels incurs huge economic, social, and political costs for both present and future generations [1]. Therefore, ensuring global energy security and electricity access as well as independence from fossil fuels are among the greatest challenges and tasks of the 21st century [8].

Rising demand for energy and the aim to move away from fossil fuels have led many countries to move to alternative sources including solar energy, wind, geothermal energy, biomass, and hydrogen. For example, the European Green Deal aims to ensure the climate neutrality of Europe by 2050 [9]. Within the Green Deal, the hydrogen economy is mentioned as an essential milestone toward carbon neutrality [10,11]. In line with the European Green Deal, the EU strategy on hydrogen, adopted in 2020, explores how producing and using hydrogen can help to decarbonize the EU. Global green hydrogen partnerships will contribute to incentivizing decarburization [12]. The large-scale deployment of hydrogen is frequently considered to be a “missing link” to guarantee energy transition, provide storage, as well as to cover the volatility and intermittency of renewable energy generation. In Europe, it is planned to reach at least 6 GW electrolyzer capacity by 2024 and 40 GW of electrolyzer by 2030. As of 2021, green hydrogen makes up only 3% of the global hydrogen production [13].

There are benefits associated with the deployment of hydrogen capacities, such as additional investment and potential multiplier impacts on local economies. With its long value chain, a hydrogen economy is said to offer significant potential for job creation and would help attract international investment into producing countries or regions [14,15]. A clean hydrogen economy might help to reduce exposure to geopolitical and oil price instability as well as reduce the CO_2 emissions for countries relying on diesel [16,17]. Green hydrogen, produced only using renewable energy sources with a low carbon footprint, is increasingly viewed as an important pathway to reducing imports of fossil-based fuels and chemicals [18].

However, on the one hand, green hydrogen production is still a relatively new field and in comparison to grey and blue hydrogen production costs are significantly higher [19]. On the other, large-scale deployment of hydrogen is a contested policy issue because of the distribution of risks, benefits, and costs of such projects between various social groups and local versus national levels of governance as well as the involvement of communities in decision-making processes on such projects. There are also several risks connected with large-scale hydrogen deployment, especially for local communities. There are numerous examples where social unrest and conflict have been created by unjust development, with examples ranging from the forceful appropriation of natural resources—land grabbing—to ecologically unsustainable and socially unfair exploitation—water grabbing and desertification [20–22]. Such negative examples are also frequent in the frame of the energy transition as shown in several cases: Kenya’s and Africa’s largest wind park [23], Brazil’s wind energy program [24], Morocco´s concentrated solar power stations [25], or the use of renewable energy sources in Mexico [26,27]. The existing risks and the available evidence from the past in the frame of energy transition suggest that large-scale deployment of renewable energies may also result in conflict.

The Kenyan, Moroccan, and Mexican cases exemplify that it is not just about bringing technical and economic advancement, but that social and ecological problems must also be addressed simultaneously in order to reduce inequalities and potential conflict risks related to access and distribution of the natural capital. Negative perceptions of fairness and ownership can result in conflict, thus contributing to increasing social fragmentation. This again can be counter-productive to development efforts. Thus, because conflicts can jeopardize change processes and negatively impact development, we argue here that it is paramount to address conflict potential within the frame of the energy transition. This need to include social dimensions in transformation processes is also increasingly recognized by governments and international donor organizations, such as the World Bank and the OECD [28]. If conflict (risk) is addressed, the opportunity for change can emerge [29]. Thereby, we argue that conflict-sensitive approaches, defined as approaches that address and recognize the causes, actors, and impacts of conflict in order to minimize conflict risks or escalation of existing conflict and maximize peacebuilding opportunities [29,30], are key for a successful, more just, and inclusive energy transition.

The need to address conflict potential in energy transition and to work toward an inclusive and just transition through conflict-sensitive approaches directly links to the concept of energy justice. Here, a direct link between development and justice is established and equitable resource distribution is considered a pre-requisite for sustainable development [31,32]. However, so far, both resource access and the benefit from new industries are often unfairly distributed, an unjust condition that may become exacerbated during the energy transition, regardless of the scale considered, whether local or global [23,25]. This is particularly the case with the increased sourcing and production of resources across the Global South for export to the Global North, whilst energy demand in the Global South is also growing and the pressure on resources needed for energy generation is increasing. Thus, acknowledging the great complexity and expansiveness of today's energy and climate problems, we consider conflict potential, including ethical questions regarding the distribution of resources when working toward a more energy-just world [27,33].

So far, there is still a lack of knowledge and scientific data on renewable energy implementation [34]. In the literature to date, the focus of research on regenerative energies is primarily on technical, legal, and economic issues. In 2014, only 3% of the published studies published dealt with social issues [35]. In Global South countries, this research gap is even greater, despite the high potential for renewable energy expansion, the strong commitment of developing countries to increase renewable energies, and the multiple renewable energy projects undertaken [36,37]. Our paper aims to contribute to the discourse on an inclusive and just energy transition. The objective is to identify conflicts and conflict drivers emerging during previous energy transition projects in selected Economic Community of West African States (ECOWAS) countries, namely Nigeria and Mali, in order to derive recommendations for the hydrogen transition. The underlying research questions are: (1) what conflicts emerged during previous energy projects in Nigeria and Mali; and (2) what lessons can be learned for future hydrogen projects? For this purpose, based on conflict theory, we establish conflict drivers that can impact renewable energy projects and assess their applicability in the frame of selected energy projects implemented in Nigeria and Mali.

The next section of this article provides a general context of the study and subsequently, the methods are presented (Section 3). The results are described in Section 4 and subsequently discussed in Section 5. The overall conclusions are presented in Section 6.

2. Contextual Background

So far, existing research shows that conflict potential during an energy transition is high [36–38], with possible negative implications for societal relations and the long-term sustainability of energy projects [39–46]. Conflict potential is also high in countries in which an overall high approval of the energy transition on the part of politicians and the population exists, as well as favorable framework conditions, like in Germany, for example. Practice shows that there is no social consensus for the implementation of the energy transition [40,47] and public acceptance either of the energy transition process or the projects and technologies are still an issue. Technological solutions for a sustainable energy supply are typically evaluated without consideration of societal structures, developed externally, i.e., developed and offered from outside on the initiative of the state or the market. This implies a top-down perspective of the relationship between the technical and the social sides of energy systems. Thus, the social side is considered to be downstream of the technical side [48].

Historically, natural resources, including land, water, oil, and environmental issues, are predominantly regarded as a source of conflict. The environment-conflict literature relates conflict to multiple aspects, particularly to natural resource management, resource scarcity, abundance, access, distribution, and the institutions that manage these resources [22,49–51]. Thereby, conflicts tend to be strongly connected with perceptions of inclusion (participation) and justice, namely procedural and output justice.

Output justice is about how the consequences, costs, risks, and benefits of projects, such as hydrogen, are spread across various social groups or between local and national levels [52]. Procedural justice is about how communities have an opportunity to be involved in decision-making processes on the definition of the project needs and subsequent deployment, i.e., if people are consulted, given an opportunity to provide input or if they were simply informed about the plans [53]. If decisions are taken top-down or by neglecting selected stakeholder groups, such as local communities, women, and internally displaced people, then the risk of conflict increases, and development may become unsustainable [54].

Output and procedural justice are also connected with the issue of the ownership and involvement of communities. In the frame of energy transition, this is supported by Schilling, Locham [23] on oil and winder energy in Kenya as well as Brannstrom, Gorayeb [24] who find that the most prominent drivers of conflict are closely linked to mismatched community expectations, the lack of ownership, and also negative environmental impacts.

Since 2000, a new string of research has emerged—environmental peacebuilding—that focuses on linkages between environment, conflict, peace, and security to motivate cooperation, transformation, and the consolidation of peace [49,55]. Environmental peacebuilding, which addresses the root causes of potential conflicts by focusing on equitable resource distribution as a prerequisite for sustainable development and peace, is related to the topic of an equitable and just energy transition.

The primary focal areas of environmental peacebuilding are on issues related to natural resource management, scarcity, abundance, access, distribution, and those institutions that manage these resources. The resources can be leveraged to either mediate potential and ongoing conflicts or for peacebuilding. It is within this notion that we aim to identify conflict drivers that can negatively impact renewable energy and to derive recommendations for policymakers to address these conflict lines in energy transition, thereby turning potential conflict risk into a driver of positive change. Based on those factors that are relevant for similar projects in various countries in the ECOWAS region, identified in the literature, conclusions for hydrogen transformation are derived. Better understanding of the pitfalls in energy transition contributes to a more informed and just hydrogen transition by helping diverse stakeholders, particularly policymakers and investors, to implement hydrogen projects.

3. Materials and Methods

3.1. Countries of Study: Mali and Nigeria

For our study, we analyze experience in renewable energy projects in two ECOWAS countries—Nigeria and Mali—to derive lessons for hydrogen expansion. These two West African countries were chosen because the region has the greatest energy production potential from both non-renewable and renewable sources, including solar, wind energy, and hydroelectric power [56]. The West African focus is also chosen due to the overall strategic importance of the region for Europe's path to carbon neutrality. As European nations struggle to procure the territorial capacity for the production of all of their renewable energy domestically, many European governments and institutions are turning to African nations as potential partners to help them achieve the green future they have committed to under the Paris Agreement.

However, it must be noted that substantial progress is being made with regard to the expansion of electricity access, with universal electrification a global priority as noted, for example, in UN Sustainable Development Goal 7 (universal access to energy services by 2030) and regionally in the West African Power Pool [57,58]. As African economies continue to further their green ambitions, alongside the continent's high solar and wind energy potential, efforts to develop the hydrogen industry can be seen across the continent [18].

Nigeria and Mali both show high potential for renewable energies. Consequently, different plans of action on international and national levels as well as different initiatives and programs on renewables have been put in place. This provides a good basis to analyze historical experiences and derives learnings for hydrogen transformation. Additionally, an initial literature review indicates better documentation of conflict-related cases in these two countries compared to other ECOWAS countries. In the following, background information on the energy situation in both countries is given, before the presentation of specific cases to draw lessons for energy transition.

3.1.1. Mali

In Mali, only around half of the population in Mali has access to electricity (48% in 2019). Great regional differences exist between rural (15%) and urban areas (>90%). The country's CO_2 emission in metric tons per capita was below 0.5 in 2018. According to the World Bank, the share of consumption of renewable energy of total final energy consumption was 77% in 2018 (global average: <20%) [59]. Specifically, the International Renewable Energy Agency (IRENA) listed the total generation of energy at 2868 GWh in 2019, with 40% stemming from non-renewable (1135 GWh) and 60% of renewable sources (1700 GWh), mainly from hydro and marine sources [60].

The main energy sources in Mali are biomass and imported fossil fuels [60,61]. The greatest challenges for energy sector are the dependence on fuel imports (oil), the fact that energy consumption is dominated by traditional biomass sources, and low rural energy access [62]. On the one hand, while great parts of the Malian population cannot access electricity, on the other hand, Mali has a large and, in great parts, unexploited potential for renewable energy sources, namely solar radiation, hydropower, wind, and biomass or biofuel [61]. The overall capacity for renewable energy sources is estimated to be 425 MW (48% of total capacity) in 2020 according to IRENA [60]. In addition to the potential for manufacturing hydrogen using renewable energy sources such as wind or solar, Mali also has natural hydrogen resources that hold a great opportunity for the country.

Both the expansion of energy access and a transition to renewable energy sources are high on the Malian political agenda and actively promoted [63]. In Mali, the transition is very much state driven with several direct (tax incentives, energy saving, energy subsidy, women's empowerment in RE) and a few integrative (solar tender) policies implemented, whereas enabling policies are still in the planning stage [64]. Programs to expand the use of renewable energy sources date back to the 1990s. Table A1 (Appendix A) provides an overview of different programs promoted by the Mali government to foster energy transition.

3.1.2. Nigeria

Nigeria is an interesting case regarding energy transitions. In the context of the geopolitics of a global energy transition, Nigeria, in line with other countries that are highly dependent on fossil fuel export revenues, is considered to be a potential loser during the global energy transition from fossil fuels to renewables. It will certainly face economic, social, and political risks if steps are not taken to transform and diversify its economies [65].

At 55.4% in 2019, overall electricity access is slightly higher in Nigeria than in Mali (48%). Similarly, access in rural areas access is more limited (25.5%) than in urban areas (83.9% (both in 2019)). In 2018 the country emitted around 0.7 metric tons per capita of

CO_2. The renewable energy consumption of the total final energy consumption amounted to 80% in 2018 [59]. Rural households in Nigeria have an estimated requirement of 2324.5 Wh/day or 850.8 kWh/year to meet their basic power requirements (lighting and electric appliances) [66]. The country has one of the lowest electricity consumption rates per capita in Africa [67]. Nigeria is rich in conventional energy sources, such as crude oil, that are produced on a large scale for export. Other resources include natural gas, tar sands, coal, and lignite. However, fossil fuels are estimated to become depleted by 2050. Further, the country is rich in renewable energy sources, including wind, solar, biomass, and hydropower [67]. The main energy sources are biomass/waste, oil, and natural gas. The renewable energy capacity was reported to be 2153 MW (16% of total capacity) in 2020, thus ranking Nigeria 10th in Africa with regard to renewable energy capacity. In 2019, Nigeria generated 33,552 GWh in total, 25% (8492 GWh) stemming from renewable sources, mainly hydro and marine sources [68,69].

The first National Energy Policy (NEP) was approved by the Nigerian government in 2003, aiming at optimal utilization of the nation's energy resources. Early on, the Nigeria Electric Power Authority (NEPA, now Power Holding Company of Nigeria (PHCN), privatized in 2013) emphasized the diversification of the energy sector and the pursuit of renewable energy. The Energy Commission of Nigeria (ECN) was installed as an agency for the development and promotion of renewable energy technologies assigned to strategic energy planning, policy coordination, and performance monitoring of the sector [67,70]. The country seeks to expand its electricity access from 75% in 2020 to 90% by 2030. Nigeria also aims to generate 30% of its total energy from renewable sources by 2030. So far, more than USD 20 billion have been invested in solar power projects, seeking to boost the capacity of the national grid and reduce reliance on it by building mini-grids in rural areas without mains electricity. The government is also heavily investing in hydropower [71]. A more detailed overview of previous and ongoing national as well as international projects targeting the expansion of renewable energy sources in Nigeria is provided in Table A2 (Appendix B).

3.2. Methods

A systematic literature review was conducted to identify relevant studies based on guidelines for systematic review mapping [72]). We followed 6 research stages to develop a database for historical analysis of conflict in energy projects in Mali and Nigeria. The first stage involved the development of study protocol, setting of scope, research question, as well as the inclusion and exclusion criteria for studies. During the second and third stages, we searched for potentially relevant literature and screened the documents, respectively. During the fourth stage, we coded the selected documents to collect information relevant to our study. The second coding was conducted in the fifth stage to assess the reliability of the database and identify additional codes. The last stage synthesized and described the results.

3.2.1. Literature Search and Screening Strategy

Identification of case studies was carried out using three search engines and databases: Scopus, Web of Science, and Google Scholar. The search on Google Scholar was completed with aid of Harzing's Publish or Perish software [73]. Keyword searches included the respective country (Mali or Nigeria) in combination with search terms: renewable energy, biofuel, biomass, jatropha, land use, land reform, land degradation, water, solar, hydrogen, natural hydrogen, conflict, energy, potential, wind, windmill, oil, gas, peace, peacebuilding, natural resources, fossil fuels, electricity, energy transition, energy transformation, and ECOWAS. Documents retrieved from searches were uploaded to EndNote for removal of duplicates. To exclude irrelevant papers, the titles and abstracts were screened with the aid of ASReview, an open-source machine learning tool for conducting a systematic literature review [74]. The full text of all potentially relevant papers was retrieved. Additional literature sources were selected via screening the reference lists of selected papers. The number of studies screened, assessed for eligibility, and included in the review are presented in a PRISMA flow diagram (Figure 1) [75]. The following inclusion and exclusion criteria were used.

Inclusion Criteria:

- Publications on implementation and impacts of energy projects in the frame of energy transition or transformation;
- Geographical location: Mali and Nigeria;
- Peer-reviewed papers; and
- Papers that report social effects, linked drivers, and/or possible strategies to mitigate negative social effects.

Exclusion Criteria:

- Study is outside Mali and Nigeria;
- Energy projects that, rather than transition, are just to expand existing capacity or improve energy infrastructures;
- Non-peer-reviewed or gray literature;
- Studies that do not report social effects.

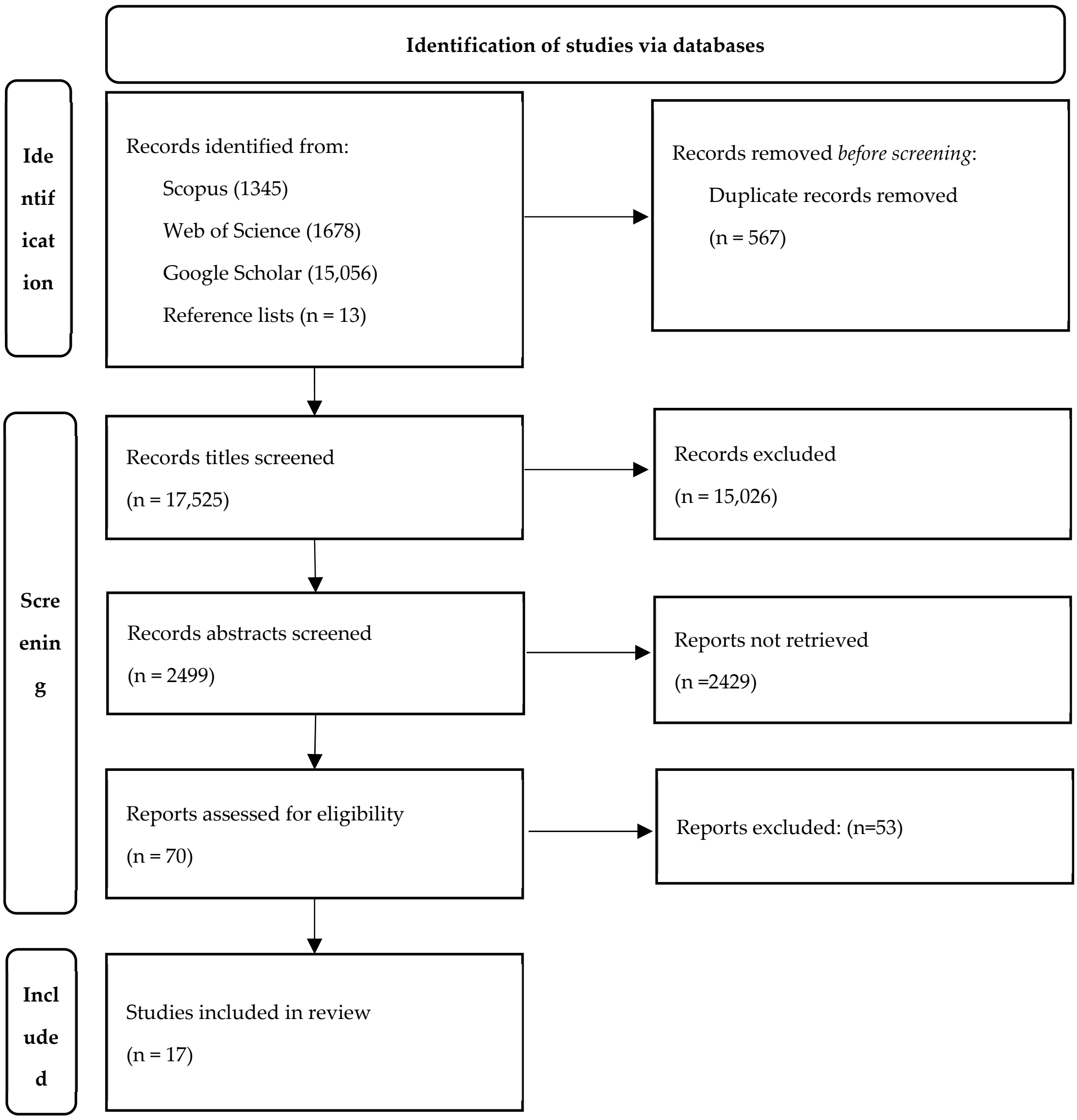

Figure 1. PRISMA diagram flow (adapted from Page, Moher [75]).

Additionally, specific details on energy projects operating in both countries were collected by reviewing company websites and news articles via Google News. Based on our literature review, four different cases were taken into account as examples. Thereby, the selection of projects was purposive: we aimed for a selection of projects from the two countries of studies and projects that represent different renewable energy sources, namely biomass, natural hydrogen, solar, and wind. Based on the literature analysis and the criteria of being from one of the two countries and covering different energy sources, we ended up analyzing two projects in Mali and two in Nigeria. All cases illustrate different drivers of conflict within the planning/implementation and maintenance of a renewable energy project. All also offer possible solutions and lessons for future projects in the field.

3.2.2. Data Extraction

Full texts of 70 articles that met the inclusion criteria during the screening stage were assessed to ensure the documents contained sufficient full-text information to extract relevant data. In this phase, 53 studies were excluded for not containing sufficient tangible detail or documentation on social effects. Data extraction methods consisted of line-by-line coding of the papers guided by three main questions: Does the study report social effects related to energy transition? What are the linked drivers? And what are possible strategies to mitigate negative effects? This process collected both closed and open-ended narrative answers.

3.2.3. Data Analysis and Synthesis

We conducted basic descriptive statistics to estimate the total number of articles based on key restricted-answer and created simple bar charts. The open-ended narrative answers helped to provide a contextual understanding of the effect of energy transition projects. The authors discussed the key effects that emerged during extracting data from the studies and a synthesis table was developed. A narrative was developed that drew on both the line-by-line coded text.

4. Results

We assessed the previous experience of energy transitions in Mali and Nigeria through a systematic review of the literature. Our results show that multiple drivers can affect the implementation success of energy transition. Figure 2 provides an overview of conflict drivers identified through our literature review. Highlighting these critical variables raises awareness of the complexity of energy transition and informs policymakers and other actors on how to better implement just transitions. The two most reported factors, livelihood issues and competition of production factors are both cited in 7 out of 17 studies. These are followed by insufficient coordination and management of local stakeholders, which is cited in five studies. A detailed description of each of the 20 identified drivers is provided in the following subsections.

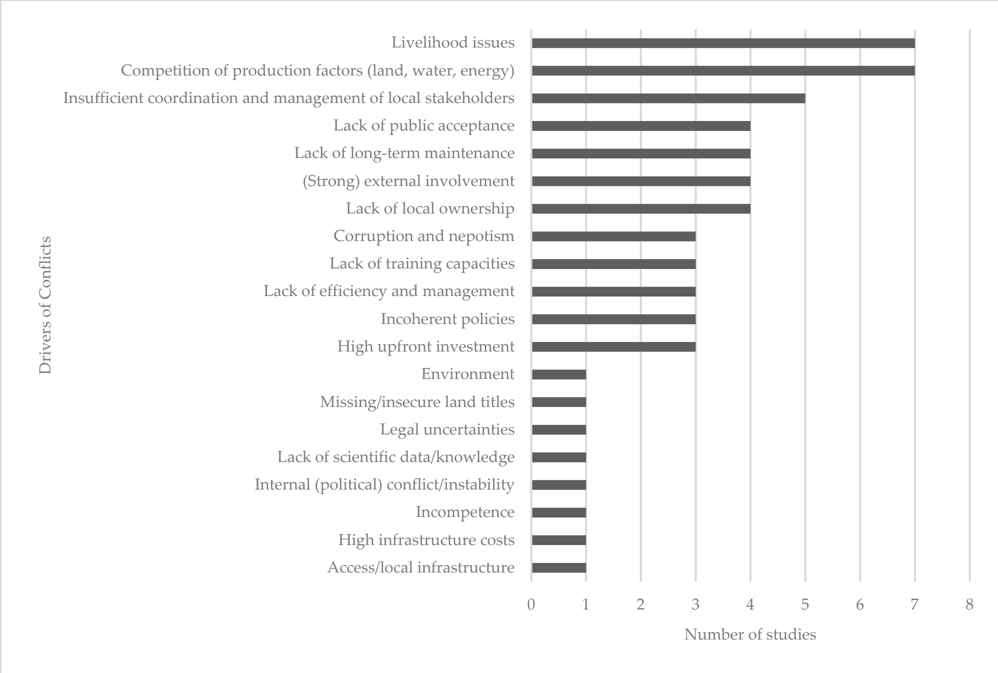

Figure 2. Number of studies reporting each of the drivers of conflicts in the context of energy transition.

4.1. Livelihood Issues

Livelihood is one of the key challenges for energy transition projects. This is highlighted in seven of our reviewed studies [76–82]. Before and during the implementation of energy projects, people's livelihoods and habitats can be impacted due to population displacement, loss of income, and ecosystem change [81]. The development of energy projects can cause dislocations to the environment and socioeconomic conditions of communities surrounding such activities that leave people with poorer living conditions [77]. This can happen since the immigration of people into the community can lead to an inflation of household commodities prices and an increase in house rent prices [76], which decreases residents' purchasing power. Therefore, it is important to carry out environmental and social impact studies while aligning local environmental and social standards to, for example, the Equator Principles to ensure projects adhere to both local law and the principles imposed by international financial institution [81]. These principles were created to ensure that large infrastructure and industrial projects are developed in a manner that is socially responsible and reflects sound environmental management practices in order to avoid or at least minimize the negative impacts on project-affected ecosystems, communities, and the climate [83]. Moreover, the social and economic status of underprivileged groups needs to be taken into account when determining the provision of material/financial support to local communities and ensuring that energy access is coupled with productive uses and income generation.

4.2. Competition of Production Factors (Land, Water, Energy) and Insecure Land Titles

Frequently, communities have their land, forests (biomass energy source), and water resources taken by the government for the prospecting and development of energy projects, as well as for operating multinationals [77,79–81,84–86]. This exploitation and dispossession of agrarian or indigenous people's lands can create conflicts, violence, and suppression of social resistance. The customary traditional communal ownership of land in rural areas of Nigeria has been substituted with individual ownership under the auspices of the federal government with the land use decree. However, customary land tenure practices continue to dominate [84]. This opens space for land disputes between investors and local communities. Therefore, appropriate compensation is suggested as one possible strategy to address land acquisition issues. Preferably this should be completed through land-for-land resettlement and rehabilitation, and not through monetary compensation, especially for marginalized communities, such as subsistence farmers [87]. Nevertheless, hindrances may arise since, in some cases, compensation is only granted for the dispossession of formally owned tenancy land [88]. In many areas, households often use land informally [89]. Energy projects can require water resources leading to serious water stress for agricultural production and human/animal consumption resulting in land dispossession. This clearly constitutes an unequal and unjust energy transition pathway that affects marginal/vulnerable groups the most. Thus, future energy projects in ECOWAS must give adequate attention to the management of competing resource demands for energy production and human/animal consumption in order to ensure that the meeting of clean energy targets does not exacerbate water insecurity. In the European Union, there is already awareness that the expansion of green hydrogen may lead to land conflicts, for instance, when land is used for generation facilities of renewable electricity and hydrogen production or for desalination, transportation, and harbor infrastructure and that issues of land use completion may arise and need to be taken into account when aiming at a sustainable energy transition [90]. Hence, energy policy requires a carefully articulated land use policy to ensure that land allocation to energy production is tempered by the need to allocate arable land to food production.

Assessing the green hydrogen production potential in Niger, a neighboring country to both Nigeria and Mali, which is high due to its great solar energy potential, Bhandari [91] concludes that only a small fraction of 5% of the land area in Niger would be sufficient to generate the required demand for electricity and transport related use projected for 2040 from solar PV to produce hydrogen. That way leaving scope to sell hydrogen on the international market. Bhandari however also points out that the economic analysis of hydrogen production further needs to be checked.

The competition for production factors, namely labor and land, is a serious problem during energy transitions. Adewuyi [84] shows that jatropha biofuel production in Mali directly competes with food crops such as cereal, which might lead to further food insecurity. In fact, an expansion of jatropha farming would only be beneficial if solely land that has not been used for agriculture previously or is protected as a forest is utilized for production.

Large-scale green-energy projects will have a significant impact on especially pastoralist people. An analysis by Waters-Bayer and Wario [92] on pastoralism and large-scale renewable energy and green hydrogen projects shows, consultation of local land users during the development of solar and wind farms in various countries including Morocco and Kenya was in most cases non-inclusive and of poor quality, pastoralism was given little to no value by planners despite the potential dual-purpose land use for grazing and generating green energy.

Water scarcity is another driver affecting the energy transition in Mali. The water-scarce country is characterized by a mean annual rainfall of 440 mm [93]. In order to obtain higher yields, the cultivation of jatropha may require irrigation. Thus, is recommended to shift attention to energy projects that do not require substantial amounts of water as well as to the use of areas that are not suitable for crop production.

4.3. Incompetence, Insufficient Coordination, and Management of Local Stakeholders

The incompetence of project managers negatively affects the effective and efficient implementation of public projects, in general [94]. If not adequately equipped with skills and competence, project managers might contribute to the failure of a project. In some instances, project managers are just not genuinely interested in the project, only working to fulfill obligations [95]. There is usually a lack of communication and insufficient support from the project managers [78]. These issues are also highlighted in studies by Watts and Ibaba [96], Favretto, Stringer [78], Favretto, Stringer [79], MacCarty and Bryden [97], and Ikejemba, Schuur [98].

Problems occur at the planning stage of the project. For instance, in the case of a solar energy project, when identifying suitable locations, solar panels are reportedly installed right next to young trees that will eventually cover the panels in the shade once they mature, which also points to a lack of professional and technical competence.

Ikejemba and colleagues carried out extensive studies on the failure of renewable energy projects in Sub-Saharan Africa (including many Nigerian projects) [94,95,98]. They explain that factors that are key to the success of projects need to be determined and considered. Demographic and geographic factors need to be taken into account when implementing new projects. Stakeholders involved in public renewable energy projects must be responsible for the implemented or planned project, contributing to its management and sustainability. Therefore, the literature suggests that before selecting a specific strategy to supply improved energy services to households in a community, is crucial to ensure better communication between stakeholders as well as to conduct a holistic systems-level analysis.

4.4. Lack of Local Ownership and Public Acceptance

The lack of local ownership is prominent in four studies [76,77,81,98]. Energy projects usually have an impact on forest land, rivers, and human settlements; regarding the latter, the commercial, historical, and cultural heritage of such people is also impacted. Such impacts can fuel rebellions in which people assert more vehemently their rights over resources in their areas [77]. It is crucial to make people feel that they are genuine owners of the transition, rather than submitting to the process. The lack of ownership has led critics to question which interests are being served in the country's energy reform program [81]. Under such situations, local residents can easily be involved in violent demonstrations, fearing the introduction of alien ideas and cultures [76], especially if the expectations of international energy financiers and business interests are prioritized over the local community needs and expectations [81]. Therefore, for a just and sustainable energy transition in ECOWAS, people must also take the lead in the energy transition, with their insights, perspectives, and acceptance undergirding every stage of the energy transition process. Governments or regional bodies and their international financial partners must ensure that communities take an active, rather than passive, role in delivering energy services. In some instances, conflicts exist between stakeholders when it is not clear which stakeholders own and has direct responsibility over the projects [98]. Thus, the ownership of the project, including the responsibility and the role of the local communities, must be clearly defined.

Fuel change also implies major changes in the habits of consumers and their relationship with their environment [99]. Thus, public acceptance of renewable energy projects is generally very low in Sub-Saharan Africa, especially due to inadequate awareness creation toward its adoption and implementation, as well as the failure of implementing organizations to unerringly include the local community through a combination of training and resource provision [98]. This generally leads to sabotaging of the project and undermines long-term project sustainability [94]. Moreover, the absence of public acceptance for energy projects is strongly related to the lack of general public involvement as a stakeholder [98]. Thus, the creation of more awareness on the importance of new energy forms and a participatory project conception and community consultation is important for a better acceptance of programs and projects by indigenous host communities.

4.5. Lack of Scientific Knowledge, Long-Term Maintenance and Training Capacities

The transition to new energy systems brings new challenges related to the new set of skills and knowledge required to operate them. Some technologies are more complex and challenging to operate, requiring specific training that might not be available in the producing country. Therefore, it might be necessary to import labor, which creates a feeling of exclusion among local residents. Thus, educational opportunities and capacity building should always be provided to ensure the understanding of technical aspects among local residents, creating possibilities for employment.

Lack of maintenance after project implementation is one reason for the failures of renewable energy projects [82,94,95,98]. This issue is a result of the project's comprehensive planning and execution. The physical maintenance and the stakeholder carrying out the maintenance are strongly correlated. However, there neither is a maintenance plan nor actual maintenance performed on the majority of the executed projects, making it simple for the projects to fail [98]. Projects utilizing renewable energy require regular inspection, cleaning, and performance monitoring of the entire system. If no monitoring systems are installed, the projects might eventually fail. Infrastructures are frequently only updated when they break and, occasionally, the expense of fixing poorly maintained systems can outweigh income increases [82].

Although the Nigerian government has initialized various programs and initiatives to promote the utilization of solar energy (e.g., tax reductions, Nigerian Economic Sustainability Plan), a lack of proper planning is often accompanied by a lack of long-term government support and implementation problems that are exacerbated by missing long-term maintenance. Maintaining installed solar panels (cleaning management, availability of parts/repairs) as well as the lack of maintenance of the corresponding infrastructure (e.g., transmission lines) might lead to the deterioration of a solar project [95]. Ikejemba and Schuur [95] suggest a "clear definition of ownership of the project and the entity responsible for the project maintenance" as a possible solution.

4.6. External Involvement

Energy transition projects are very often introduced by international funding organizations and companies [77,80,81,98] that, in addition to undermining local ownership, can favor the interests of the governing elites and their international and market partners at the risk of neglecting local needs [81]. Government agencies may cooperate closely with various international partners, leasing large areas of land to large-scale investors, while displacing smallholders, even without any benefit to local communities from energy revenues.

Conflicts can also arise over the issue of energy pricing. External organizations can impose restrictions or sanctions that lead to increases in fuel prices and economic decline, which result in the erosion of the purchasing power of the population [77]. The increase in the cost of living results in violent demonstrations. Therefore, the energy models imposed by international financial institutions and experts should be aligned with the concerns and material conditions/needs of local communities or the other peculiarities of the local context of implementation.

In the case of natural hydrogen in Mali, strong international dominance might become a major conflict driver. Nevertheless, while, on the one hand, the company extracting natural hydrogen gas in the country is not local and produces hydrogen for export and, thusly, might not prioritize local interests. On the other hand, one important fact is that the produced hydrogen also fuels an internal combustion engine supplying the nearby village with free-carbon electricity [100], making the Malian case a milestone in the natural hydrogen business.

4.7. Incoherent Policies, Legal Uncertainties, and Corruption

Public policy instruments can be incoherent, thus losing their capacity for achieving the intended objectives. In the case of Mali, for example, the National Strategy for Biofuels sets quantitative targets for Jatropha biofuel production; however, policy priorities and the lack of a comprehensive national bioenergy policy are key challenges in the expansion of renewable energy projects in Mali. Estimations of the timeframe for substituting diesel-powered energy generation in rural areas are unavailable [79]. Therefore, the production of feedstock for biofuels may be unlikely to contribute to the expansion of rural energy security. Policies are often based on the potential impacts of the transition to new forms of energy without an understanding of the country's production capacity [78]. Policymakers tend to integrate internationally agreed principles into national policies as a way to attract institutional, monetary, and technical support from international organizations, but gaps may exist between policies and the local context. Moreover, the increase in the domestic production of feedstock for biofuels can compete with domestic food production, reducing the food supply and driving up food prices [85]. In Nigeria, governmental policy, especially with regard to land tenure, is not well framed, resulting in challenges to biofuel acceptance [84].

Malian land tenure arrangements are complex and the land reforms in rural areas are generally top-down, leading to a "disruption of social fabric" [101]. Specific market-based land tenure arrangements arose in Mali as a result of urbanization pressure and government-designed land reform. The issues raised include land-related tensions, socioeconomic inequities, vulnerability, and, as a result, labor shortages, a deterioration of social cohesiveness, and a system of mutual support. Additionally, the lack of security brought on by these land tenure systems discourages investment in the agricultural industry.

Corruption is one factor that contributes to the crisis in the energy sector [96]. It manifests in the allocation of contracts to companies with no track records or prior experience in the field [102]. Audit reports are usually not available, with political parties being more interested in implementing their specific agenda [98]. Therefore, there are calls for transparency, with a non-partisan anti-corruption campaign across West Africa discouraging the menace of corruption and nepotism.

4.8. Access to Local Infrastructure, High Upfront, and Infrastructure Costs

Despite the long-term benefits, the initial costs required for investment in renewable energy technology are generally high [80,94,99] and can even exceed that of the fossil fuel [84]. Thus, the implementation of energy projects must account for dimensions of rural poverty. Financial incentives, such as government subsidies and tax reductions are encouraged to promote the inclusion of local populations. If there is no infrastructure to facilitate access to energy, local people may not accrue any benefits from the projects. Energy projects are often implemented in remote and isolated areas with inadequate physical infrastructure and a lack of access to basic services [82]. Thus, it is crucial to plan and support the deployment of infrastructures to guarantee that local communities also benefit from the energy produced locally. Nevertheless, this should be in line with the national development and poverty alleviation programs.

4.9. Environmental Problems

The environmental problems caused by energy production are also a concern with regard to the possible outbreak of conflicts. Energy production processes can result in water pollution, water contamination, soil degradation, and deforestation [77]. This limits the ability of communities affected by the introduction of energy projects to survive, especially in rural areas where most of the population depends on natural resources (land, water, and forest).

4.10. Internal (Political) Conflict/Instability

Internal conflicts can lead to insurgency against energy projects. There are examples of attacks against infrastructure and energy sector employees. This is aggravated by the occurrence of land dispossession, marginalization, deprivation, and political repression [96]. Internal conflicts or instability can lead to the vandalization of energy infrastructure. Stolen equipment as well as government bureaucracy are named as further obstacles in the completion of energy projects [103,104]. In such instances, authorities in many countries have opted for the military option to solve the problem. However, several cases throughout the world show that the military approach is inefficient [105,106]. Thus, there are calls for a nonviolent, participatory resolution of internal conflicts to dismantle armed local resistance and build sustainable peace.

5. Discussion

There are several key topics that are relevant in the context of the hydrogen transition. This is the potential positive interrelation between the environment and society during the process of designing interventions and transition processes in a way that inherently incorporates collaboration. Additionally, trust building and enhanced ownership of stakeholders and local communities have high potential. In the vast body of literature, it is frequently noted that technical and infrastructural barriers are still a major challenge to building a hydrogen economy. Further, social support and the acceptance of these projects by people in local communities, in the medium and long term, is also a challenge [107,108]. Therefore, pitfalls and best practice approaches need to be identified to inform energy transition.

Overall, renewable energy could be an important policy option for many African countries to boost their energy supplies for manufacturing and industrial sectors. However, the extent to which many countries, such as those in the ECOWAS region, can effectively pursue this policy option is rather short, as multiple obstacles exist [109]. In this paper, we show a multitude of factors impacting energy transition and the need to focus not just on economic and technological advancement, but also on social aspects, especially ownership. Whilst the renewable energy transition is generally complex, the complexity of a hydrogen transition is even greater. Table 1 presents some of the potentials and challenges of hydrogen transition.

Table 1. Potentials and challenges of hydrogen transition in the ECOWAS region.

Potentials	Challenges
• Existing international demand for hydrogen • The discovery of natural hydrogen reserves in Mali • The existence of past projects from which lessons can be learnt	• Lack of social support and the acceptance of these projects • Poor infrastructures • High production costs resources • High demand for natural resources (e.g., water) • Pre-existing conflicts • Lack of local capacity (e.g., experts) for energy production

Hydrogen is a highly resource-intensive energy resource as it requires much know-how and resources, including economic set-up cost, land, water, and labor. Therefore, plans for the deployment of hydrogen must be evaluated from the perspective of the social, economic, and environmental impacts of such plans in the producing countries. Additionally, the question of whether this export commitment of Europe’s neighboring countries will be an enabler or obstacle for the energy transition in the exporting countries should be addressed. Exporting countries need to benefit not just financially from the physical trade of green hydrogen but also from new industrial activities along the entire value chain. Further, the environmental impacts of the production of green hydrogen and its byproducts need to be analyzed in detail to comply with environmental protection at all stages of the production and distribution of green hydrogen. Understanding these issues will allow for an inclusive and just energy transition in Europe as well as in the neighboring countries while also increasing social acceptance, participation, and ownership of energy transition.

For example, hydrogen production from renewables is still more expensive than other sources. A significant upfront investment is required in order to establish the infrastructure needed to produce and transport green hydrogen. Although African countries have significant potential for exporting hydrogen, the logistics of transporting hydrogen to far-away markets are challenging, whether by ship or via pipelines. Another major challenge relates to the availability of natural resources, especially water. Hydrogen production requires high water inputs. Sourcing water for green hydrogen can be very challenging considering the immense water scarcity in African countries including the ECOWAS region [110]. Therefore, multiple additional questions relating to cost, availability of natural resources (land, water, energy), capacity building, and other ethical aspects arise in the frame of hydrogen transitions.

As presented in our results, a key challenge for a successful hydrogen energy transition is local ownership. However, cases for both Mali and Nigeria show renewable energy policies are predominately state-driven, pushed by international actors more than by local stakeholders [64]. This notion of great external involvement is also found by Edomah [111], who reviews the stakeholders and interventions in Nigeria's electricity sector. They find that external stakeholder groups such as multi-lateral organizations or donor agencies exert great influence in the sector through financial interventions.

The paper identifies a lack of coordination and engagement of various stakeholder groups that sets a challenge to effective electricity interventions addressing the population's needs. The lack of ownership as a major challenge for energy transition is also found in other studies. Moreover, social participation in planning and implementation is central to the success of energy projects. If decision-making processes are designed in a participatory manner and joint utilization concepts are developed, this makes it possible to build trust and cooperation between the actors involved and can strengthen social cohesion [38,40,47]. Thus, shared environmental challenges offer potential entry points for cooperation between actors to promote social cohesion. Careful and integrative energy approaches are crucial not just for the immediate success of projects, but also for society's overall well-being.

In the case of Nigeria, for instance, changing perceptions, changing goals, direct government interventions in infrastructure provision by the government, and changes in market rules are identified as underlying influences on energy transitions in the energy sector.

Relating to a more inclusive and just transition, it is not only direct involvement of the local population that is key, but also an explicit focus on marginalized groups including women. In the scope of her research on community-based micro-hydropower cooperatives in Ethiopia, Wiese [45] highlights the importance of considering gendered aspects in energy transitions, to address women's energy needs, as well as to analyze the energy needs women have and the challenges they face as an important step toward a more energy just world. She stresses a lack of access to information, a general knowledge gap, and a deficit in consultation opportunities and active participation in decision-making processes [45]. All aspects are to be considered when aiming at a just energy transition.

Ownership is also key, especially when considering the fragile political context prevailing in many developing countries including Nigeria and Mali. If pre-existing conflicts are neglected, energy projects can deepen power imbalances and contribute toward societal fragmentation. Access to resources and benefits from new industries is often unfairly distributed, an unjust condition that could become exacerbated during the hydrogen transition. The need to address internal conflict dynamics and to put plans for transitions to low-carbon energy hand-in-hand with a transition to peace and racial equity is supported by, for example, Theiventhran [112]. In a study of Sri Lanka, he observes that, oftentimes in post-war settings, renewable energy projects, as part of an energy transition, encounter resistance despite them being clean and green. He argues that energy injustices are produced historically, geographically, and materially, meaning that in cases like Sri Lanka, where wounds of racial conflict and injustices are still fresh, equity and justice are of even greater importance [112,113]. This emphasizes the aforementioned close link between natural resources, conflict, and peacebuilding [114–116].

Therefore, we argue that the linkages need to be proactively attended to when targeting energy measures. This aligns with recommendations in the report by Druet and

Lyammouri [117] on the process from renewable energy to peacebuilding in Mali; they advocate broadening the decision-making structures around renewable energy solutions, integrating conflict analysis, political risks, and opportunities into the process, as well as ensuring that a renewable energy transition delivers a peace dividend.

Aligning with Schilling, Locham [23], we recommend a regular platform or forum where actors from all levels can discuss their views and grievances in an open, transparent, and constructive manner.

Relating to ownership, capacity building is another crucial aspect to attend to in the frame of hydrogen transition. It is argued that energy transition and policy require technical training and education across diverse fields, from the hard to the soft sciences [118]. Nonetheless, although hydrogen expansion requires high technological knowledge, few universities currently offer hydrogen-related curricula in Africa, thus highlighting that ownership of the process is murky: will it be owned by producing countries or by global players? A "domestic" hydrogen economy can only be sustainable in the long run if societies grow local expertise to develop and maintain it. There is a danger that, by focusing on exporting green hydrogen to Europe, attention could be taken away from the energy transition processes in the producing countries themselves. It must not happen that a country exports clean energy, i.e., green hydrogen, whilst simultaneously providing energy from polluting sources to their own citizens [119]. A step in this direction is the development of theoretical and applied research into green hydrogen at universities throughout Africa [18]. Furthermore, an International Master's Program in Energy and Green Hydrogen, funded by BMBF, the German Federal Ministry for Education and Research in partnership with the WASCAL (the West African Science Service Centre on Climate Change and Adapted Land Use), has started at RWTH Aachen University [120].

Linked to capacity building is the need for (accompanying) research on how the hydrogen transition can facilitate knowledge gain and capacity building. The careful study of previous experiences, policies, and impacts of renewable energy transition in African countries is needed in order to facilitate a sustainable energy transition that benefits the producing countries as well as the planet as a whole. Druet and Lyammouri [117] propose that, to keep pace with technological change, is critical to collect systematic data on best-fit project design, and experimentation as well as to learn lessons from pilot projects. Additionally, the environmental impacts of producing green hydrogen and its byproducts must be analyzed in detail to comply with environmental protection at all stages of the production and distribution of green hydrogen. Understanding these issues will allow for an inclusive and just energy transition while also increasing social acceptance, participation, and ownership of energy transition.

Hydrogen production will not succeed if the public does not welcome it, even if the production is technologically sound, economically viable, and environmentally sustainable. Social acceptance is increasingly acknowledged as an aspect that can determine whether or not renewable energy goals in a given community can be achieved. Obstacles standing in the way of accomplishing effective developments at the operation level can be measured as a manifestation of the lack of social acceptance [40]. It is confirmed that, without social acceptance, a sustainable energy transition is unlikely to be viable [121]. Therefore, it is key to study hydrogen potential not only from technical, economic, and environmental perspectives but also by following a nexus approach that integrates the various dimensions affecting energy transitions, specifically including, foremost, the social dimension and related questions of equity and justice. We argue that if social aspects are considered from the planning phase onwards, not only will social acceptance be enhanced, which is key for project success, but also that this can offer a platform to foster societal relations, contributing to access and distribution of resources that is both more inclusive and more equal.

While this study presents important insights for future hydrogen projects, it has a potential limitation as it draws lessons from energy projects of a different nature (e.g., solar and biomass energy). Thus, the technical specificities of such projects are not entirely comparable to hydrogen projects. Nevertheless, as we focus on the social perspective in more general terms, we are confident that similarities can be found between the projects analyzed and the hydrogen projects. More specifically, these projects are generally implemented in rural contexts with high rates of poverty and dependence on natural resources, which can potentially cause conflicts if social aspects are not taken into account.

6. Conclusions

This study assesses the experiences of renewable energy projects in Mali and Nigeria, deriving learnings for the ECOWAS hydrogen transition. West Africa is a region with very high potential for renewable energy, with both countries' governments having announced high commitment, albeit with different plans of action on international and national scales, as well as different initiatives and programs implemented for renewable energies. This study shows that local ownership or co-ownership is a critical challenge for the hydrogen transition. The various existing ownership options should be further carefully studied. Subsequently, sustainable hydrogen production should manage a balance between the local population's needs, for instance, for fresh water and the water needed by the hydrogen industry. Awareness is needed in regard to competing interests in various production factors such as land and water. Moreover, other economic, social, and political aspects can potentially cause conflicts. Thus, policymakers must not only facilitate technology development, access, and market structures for hydrogen energy policies but also focus on energy access to local communities. As this study is based on a historical analysis of past energy projects, further research should closely monitor hydrogen implementation with a special focus on societal impacts in producing countries across the Global South.

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Appendix A

Table A1. Projects and initiatives targeting the expansion of renewable energy sources in Mali. Source: [60,62,122–128].

Project	Description
PENRAF	PENRAF (Promotion des Energies Nouvelles et Renouvelables pour l`Avancement des Femmes) was first implemented as a pilot program between 1992 and 1995. The program was reinitiated in 2003 by the Ministry for Energy and Water, in cooperation with UNDP in order to empower women through savings on energy bills, solar water pumps, and solar cooking in 400 villages.
AMADER	Founded in 2003, the Malian Agency for the Development of Domestic Energy and Rural Electrification (AMADER) targets development of access to electricity, specifically in rural and peri-urban areas by increasing the distribution of solar panels.
PVEPP	In 2004, the National Program to popularize the Jatropha plant (PVEPP) for use as biofuel was implemented.
Action Plan for Renewable Energy Promotion	In 2007, the Action Plan for Renewable Energy Promotion in Mali was put in place, seeking to increase the percentage of renewable energy sources to 15% by 2020 (from 1% in 2002). Further objectives of the plan include the improvement of access to (renewable) energy, the rational use

	of existing energy sources, the sustainable use of biomass resources, as well as the strengthening of government capacity and administrative procedures in the energy sector.
SEforAll	Launched in 2011, SEforALL is an initiative between multiple stakeholders from governments, the private sector, and civil society including, among others, the African Development Bank and the United Nations Development Programmes. It comprises three interlinked objectives: universal access to modern energy services, doubling of the global rate of improvement in energy efficiency, and doubling of share of renewable energy in global energy mix. Within this scope, Mali's SEforALL Action Agenda, Renewable Energy, and Energy Efficiency Action Plan includes the aim to expand general electricity to 87% of the population by 2030 (100% in urban areas, 81% in rural areas) and the availability of clean cooking options to 10%. The share of renewable energy sources in the electricity mix is also to be increased to 37% by 2030.
SREP	Mali is part of the Scaling Up Renewable Energy Program in Low Income Countries (SREP) that aims at economic stimulation by scaling-up the development of renewable energy solutions. The state-led investment plans follow a coherent programmatic approach for transformational changes, promoting public and private sector operations.
AER-Mali, ANADEB	Mali established a Renewable Energy Agency (AER-Mali) as well as a special agency for bioenergy (ANADEB).
Tax exemptions	As of 2014, tax exemptions on renewable energy equipment were granted (Décret n°2014-0816/P-RM).
Solar Energy Project for Rural Development	In 2021, through AMADER and within the Solar Energy Project for Rural Development Mali launched a tender for the construction of two solar power plants in Saye and Sarro with a combined capacity of 2.6 MW.
Mali solar rural electrification project	In 2021, with support of the Green Climate Fund, the Mali solar rural electrification project (FP102) was implemented. It includes the establishment of isolated solar photovoltaic green mini-grid systems.

Appendix B

Table A2. Projects and initiatives targeting the expansion of renewable energy sources in Nigeria. Source: [67,68,122,123].

Project/Program/Initiative	Description
National Energy Policy (NEP)	The National Energy Policy (NEP), approved in 2003, targets the optimal utilization of the nation's energy resources.
Nigeria feed-in tariff of renewable energy sourced electricity	Since 2016, Nigeria grants Feed-in Tariffs (FiTs)/REFiT that aim to provide a simple way to incentivize small domestic and business use of renewables and increase investment in renewable energy technologies by granting long-term contracts to renewable energy producers.
Biofuel blending mandate	A domestic biofuels industry is to develop by introducing a blending of ethanol up to 10% as promoted by the National Government and the Nigerian National Petroleum Cooperation.
Nigeria import duty reduction	Exemption of import duty are granted on PV panels and duty on solar, wind, and gas-powered generators is reduced to 5% (plus 5% VAT).
Rural Electrification Strategy and Implementation Plan of Nigeria (RESIP)	RESIP targets an electrification rate of 75% by 2020. It further aims at full electrification by 2040 by connecting 513,000 households each year between 2020 and 2030.
Nigerian Electricity Regulatory Commission Mini-Grid Regulation 2016	A mini-grid policy was adopted in 2016 to regulate and further enable the sector of mini-grids in Nigeria.
Multi Year Tariff Order MYTO I (2008–2013) and II (2012–2017)	NERC implemented multi-year tariff orders to regulate prices to be paid to licensed electricity generation companies.

Flare Gas (Prevention of Waste and Pollution) Regulations 2018	The regulation adopted in 2018 aims to reduce both environmental and social impacts resulting from flaring of methane and natural gas.
Nigeria's National Action Plan (NAP) to reduce short-lived climate pollutants (SLCPs)	The NAP, in 2019, developed 22 mitigation measures to reduce the emission of SLCPs, including black carbon, methane, carbon-dioxide, and other air pollutants.
FDNIS ECOSTAND 071-2:2017EE: Minimum Energy Performance Standards Part 2: Air conditioning products	The 2019 standards cover requirements for portable, unitary, split, and centralized air conditioning systems.
Framework for implementation of intervention facility for the national gas expansion programme	In 2020, this program was introduced to stipulate investments in the gas value chain; for example, to improve private financing access and adoption of CNG and LPG.
Nigerian Economic Sustainability Plan	As part of the COVID-19 recovery strategy, in 2021 a total of USD 5.9 billion was approved to support the economy. It includes the installation of solar home systems ($619 million) and the promotion of domestic gas utilization.
Nigeria Renewable Energy Master Plan	The Federal Ministry of Environment aims to increase renewable energy from 13% in 2015 to 23% in 2025 and 36% by 2030.

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