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Environmental Justice in Green Hydrogen Trade?

A Case Study of German-Moroccan Partnership

Written Assignment

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Foreword

This report was written by students of PD Dr. Philipp Späth's three-week "Technology Assessment" course, as part of their respective Masters' programs in Environmental Governance and in Environmental Sciences at the Albert Ludwig University of Freiburg, Germany.

Students were introduced to the concept and theory of technology assessment during the first week. The rest of the course was dedicated to practical application by conducting a technology assessment from Jan 17 to Jan 27, 2022. The practical component included an element of roleplay where four students represented the *Büro für Technikfolgen-Abschätzung beim Deutschen Bundestag* (Office of Technology Assessment in the Bundestag, also known as TAB) while the other five students played two roles: 1) the role of TAB's principal, the parliamentary Committee on Education, Research and Technology Assessment, and 2) specialist experts providing input to the study commissioned by the parliamentarians and organised by TAB.

The students representing the TAB played the role of organising and compiling the report, whereas the specialist experts contributed to the case study.

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1 Executive Summary

The technology assessment "Environmental Justice in Green Hydrogen Trade? A Case Study of German-Moroccan Partnership" aims at assisting German policymakers in reflecting on and incorporating environmental justice (EJ) dimensions into green hydrogen partnerships. The study focuses on environmental justice challenges within the exporting country. Through applying a environmental justice framework in the case study of a German-Morocco partnership, the study highlights key considerations for policy makers when evaluating potential international hydrogen partnerships.

This study was conducted based on an iterative process of literature review and case study research. A list of criteria was formulated based on the environmental justice framework to operationalise three dimensions of environmental justice: distributional justice, procedural justice, and recognition of justice. This framework was then used to evaluate a specific case study – the 2020 German-Moroccan green hydrogen partnership. Based on that assessment, it was found that almost all the criteria in the EJ framework were either not meaningfully addressed or left out of the renewable energy projects implicit in the German-Moroccan partnership. We therefore concluded that the bilateral hydrogen agreement does not meaningfully address environmental justice implications in the production of green hydrogen. Given the considerable potential for solar and wind power generation in the Western Sahara, both countries are dependent on the current and projected renewable energy projects in the Occupied Territory to reach their climate action and development goals ((Federal Ministry for Economic Cooperation and Development 2022); WSWR (Western Sahara Resource Watch 2021). Based on the findings from the case study, the last section describes the policy-relevant end products of the project. First, a preliminary criteria list to assess hydrogen partnerships, and second, a policy instrument toolbox that is available to policy makers to mitigate risks identified from the assessment.

The criteria of the environmental justice framework based on (Hess and Ribeiro 2016) were extended based on the research and fine-tuned towards hydrogen partnerships specifically. The following options for action were drawn:

1. **Fine-tune the criteria list for assessments**

   a) Generally, the questions can be fine-tuned to be more specific to hydrogen and also to reduce redundancies between the questions

   b) Additional resources such as the assessment frameworks mentioned by Fredershausen et al. 2021 should be reviewed to ensure no component is missing. In particular, the criteria list from Sovacool and Dworkin 2015 should be further incorporated, as they include temporal and technological aspect missing in the Hess framework (for more details, see 10.2 Appendix 2 – Selection of Frameworks)

   c) The criteria list can be further fine-tuned by testing it out in more applications (e.g. with different potential hydrogen partnerships)
2. **Formulate assessment methodology, scales of assessments/scoring, decision threshold for deciding on a partnership, etc.**

   In particular, the guidelines published by UNEP for a Social Life Cycle Assessment of Products and Organisations (Benoit Norris. et al. 2020) may provide a starting point that can be integrated into the life cycle approach already prevalent in hydrogen assessment literature
3. **Integrate these criteria into a holistic sustainability assessment, rather than as a separate "environmental justice" component**

   In particular, the categorization by Sovacool and Dworkin 2015 or (Fredershausen et al. 2021) offer potentials to move beyond the environmental justice dimensions and towards a more holistic and integrated approach

Based on the case-specific policy options from the Moroccan context and supplemented by literature review, we generalised the country-specific policy recommendations towards more overarching policy recommendations. From this non-comprehensive list of policy instruments, Germany can start to mitigate the risks of exacerbating environmental justice issues through partnerships.

Table 1: Policy instruments Toolbox

Policy Instruments Toolbox
Conduct unbiased Environmental Risk Assessments/ Social impact assessment including sustainability and EJ criteria
Cooperate with the EU to develop trade regulations and certification schemes to ensure that hydrogen imports have been produced in a socially just and democratic manner (with special attention paid to local water security)
Provide further investments and technological support for sustainable hydrogen infrastructure (focus on water efficiency)
Formal acknowledgement of the harmful legacies of colonial structures and fossil fuel systems in partnering countries
Provide vocational and technical training for local stakeholders, including transfer of know-how to take part in the labour market opened by the hydrogen economy
Enhance involvement of local companies (SMEs) and education and research centers in the hydrogen production and transportation process
Formalise land tenure rights so that revenues could potentially be generated for local communities from lending their land for hydrogen projects
Strengthen (and enforce) current environmental protection laws to avoid misuse of water resources and biodiversity loss
Develop mechanisms to share financial gains with communities hosting parts of hydrogen value chain
Shape narratives/discourses by utilising "soft power" methods to steer international energy patterns towards more democratic and socially just energy governance regimes which better reflect these values
Research into/development of policy instruments for partnership agreements related to hydrogen

As next action steps, we recommend that policy makers:

1. Formulate a comprehensive and holistic assessment criteria list for potential hydrogen partnership
    a. The one provided above can serve as a starting point, but research should be done to include additional components such as technological and environmental components (e.g. distance to Germany, potential for renewable energy generation, environmental impact analysis, etc.)
2. Ensure assessments are conducted prior to starting hydrogen partnership talks (or at least as part of the negotiations)

A preliminary scorecard beyond the hydrogen production and export potential should be taken into consideration when assessing potential hydrogen partnerships

2 Introduction

The aim of the study is to formulate and evaluate a framework for environmentally just hydrogen partnership development, an integral part of Germany's green hydrogen strategy. This report assesses the 2020 bilateral agreement for the production and export of green hydrogen from Morocco to Germany, which will tap into Morocco's considerable capacity for wind and solar power generation. While this partnership is a major step toward both countries' climate action and sustainable development goals, relatively little attention has been given to the environmental justice implications for the current and projected activities related to the production and transport of green hydrogen. Therefore, this report will offer a set of criteria as a reference for defining more sustainable and just energy partnerships, as well as a set of policy instruments and mitigation options that could promote justice in Germany's green hydrogen agreements with Morocco and with other potential partner countries.

This report presents the findings of the 2-week study. It begins with an introduction section describing the background and motivation of the report, as well as the key assumptions and methodology. This is followed by an overview section providing the context of international hydrogen partnerships, the concept of environmental justice, identification of key environmental justice challenges with regards to hydrogen partnerships, and an overview of criteria for environmentally just hydrogen partnerships. The report then dives deep into the case study on Morocco. First, an overview of the Moroccan context briefly outlines existing relationships with Germany, the hydrogen developmental potential, and existing or emerging hydrogen cooperation. This is followed by findings from applying the criteria to the partnership with regards to the three environmental justice dimensions. This section concludes with case-specific mitigation and governance options. The last section concludes the report with the two policy-relevant end products of the project: 1) a preliminary criteria list to assess hydrogen partnerships, and 2) a policy instrument toolbox that is available to policy makers to mitigate risks identified from the assessment. Limitations and further research areas are also described.

It is our hope that the work of this project will serve as a starting point for further research and development in order to support policy makers in assessing potential hydrogen partnerships in a more holistic manner beyond the technological and economical considerations.

2.1 Background and Motivation

The background and motivation for the project was the growing concern from climate change and Germany's stated aim to achieve climate neutrality by 2045. Green hydrogen is considered a significant element of the energy transition required to achieve this aim. It is estimated that Germany will need to import green hydrogen in order to meet anticipated domestic demands. Thus, international hydrogen partnerships are considered a key part of Germany's National Hydrogen Strategy (Federal Ministry for Economic Affairs and Energy 2020) and the Office of Technology Assessment in the Bundestag (TAB) has been commissioned to study the opportunities and risks of hydrogen partnerships and technologies in developing countries (Office of Technology Assessment at the German Bundestag 2021).

Beyond the technical considerations of building and expanding an international hydrogen market, potential partnerships to import hydrogen from countries of the Global South may run into many pitfalls from an environmental justice perspective. Yet, there is limited focus on this area as the existing literature mainly focuses on the technological and economic aspects of hydrogen (Fredershausen et al. 2021). However, a transition of this scale encompasses issues beyond technological and economic concerns, as stated by Sovacool & Dworkin;

> "As we exhaust energy resources and have to find substitutes to them, change our way of life, or transition to renewable energy, the biggest challenge will be determining how we make this transition, and more specifically who gets to make it, and who has to pay for it. This is not a question that can ever be answered by economics or engineering alone." (Sovacool and Dworkin 2015).

Therefore, this study aims to address this gap by looking into potential environmental justice challenges posed by international hydrogen partnerships. Our research objective is to formulate a criteria list from an environmental justice lens to assess potential hydrogen partnerships and to explore policy instruments and mitigation options that could promote justice in Germany's green hydrogen partnerships with potential producing and exporting countries.

2.2 Scoping the Project

In light of our objectives, we aim to answer the following research question: What are the criteria for environmentally just hydrogen partnerships? In our approach, we adopt a technology-based assessment as opposed to a problem-based assessment, where alternatives to achieve the energy transition (such as through reduced energy consumption in Germany) is considered out of scope. The scope of the project is summarised in table 2:

Table 2: Project Scope, divided in different aspects

Aspect	Project Scope
Future scenario assessed	Germany importing green hydrogen to fulfil climate neutrality aim by 2045
Technology assessed	Green hydrogen
Object of assessment	Germany-Morocco Hydrogen Partnership
Spatial scale	Germany and Morocco, with focus on Morocco and Western Sahara
Temporal scale	Present to 2045
Types of knowledge	Interdisciplinary, scientific knowledge (peer-reviewed journals), political documents published by governmental organisations, as well as reports produced by NGOs.

The focus of this study is green hydrogen as policymakers see CCS-based hydrogen (Carbon Capture and Storage) as a short term strategy for quickly ramping up production (Federal Ministry for Economic Affairs and Energy 2020). More specifically, this study aims to assess the potential impacts of a hydrogen partnership on conditions in the producing country, Morocco, as this area of research has received less attention in the literature (Office of Technology Assessment at the German Bundestag 2021) Impacts to German society are not included within this study. The temporal scale considered is from the present to 2045.

This study is conducted by a team of interdisciplinary Masters students with backgrounds in social science, humanities, and natural sciences (for more details, please view 10.3 Appendix 3 – Reflections on Positionality). It should be noted that there are no participants in the team with technical background or expertise in renewable energy and hydrogen technologies.

Typical for technology assessments dealing with future scenarios, assumptions must be made to project a certain future in order to inform policy decisions made in the present (Grunwald 2019). Here are our key assumptions for this technology assessment study:

- There will be no better alternative to generate and store enough renewable energy directly within Germany to meet its needs (including reducing demand) and green hydrogen is required to fulfil some of this gap (e.g. in aviation, steel production, etc.) (Federal Ministry for Economic Affairs and Energy 2020).
- Germany will not have the capacity to generate enough green hydrogen and will need to import it in order to meet domestic demands (Ibid).
- Importing green hydrogen to meet Germany's demands is economically viable (e.g. technology and governance conditions will exist where it is cost-effective to import or demand will be high enough to justify the cost).
- Relations with Morocco remain stable for the duration of the partnership, or do not affect signed agreements.
- Social acceptance of hydrogen remains neutral to positive and it is politically viable for Germany to pursue hydrogen partnerships to achieve climate neutrality by 2045.

If these conditions do not hold true, then the potential partnerships to develop an international hydrogen market may not materialise. For instance, if catastrophic accidents were to happen that raise concerns about the safety of transporting hydrogen, the public may not accept importing hydrogen as an element of the energy transition. This has been observed in the case of nuclear power plants, where the public attitude in Germany shifted against nuclear power after the Chernobyl and Fukushima incidents.

2.3 Clarification of Key Terms

2.3.1 Hydrogen

Table 3 summarises the different hydrogen types based on their production method. In this report, we will only be considering green hydrogen and its products, and the term hydrogen would refer only to these unless otherwise specified.

Table 3: The different types of Hydrogen (Federal Ministry for Economic Affairs and Energy 2020)

"Types" of Hydrogen	Definition
Green hydrogen	Green hydrogen is produced via the electrolysis of water; the electricity used for the electrolysis must derive from renewable sources. Irrespective of the electrolysis technology used, the production of the hydrogen is zero-carbon since all the electricity used derives from renewable sources.
Blue hydrogen	Blue hydrogen is hydrogen which is produced using a carbon capture and storage (CCS) system. This means that the CO_2 produced in the process of making hydrogen does not enter the atmosphere, and so the hydrogen production can be regarded on balance as carbon-neutral.
Turquoise hydrogen	Turquoise hydrogen is hydrogen produced via the thermal splitting of methane (methane pyrolysis). This produces solid carbon rather than CO_2. The preconditions for the carbon neutrality of the process are that the heat for the high-temperature reactor is produced from renewable or carbon-neutral energy sources, and the permanent binding of the carbon.
Grey hydrogen	Grey hydrogen is based on the use of fossil hydrocarbons. Grey hydrogen is mainly produced via the steam reforming of natural gas. Depending on the fossil feedstock, its production entails considerable carbon emissions.

Downstream products	Further products can be made from hydrogen (ammonia, methanol, methane, etc.). As long as these products are produced using "green" hydrogen, the overarching term "Power-to-X" (PtX) is used.

2.3.2 Environmental Justice

Definition from the U.S. Environmental Protection Agency:

> "The fair treatment and meaningful involvement of all people regardless of race, colour, national origin, or income with respect to the development, implementation, and enforcement of environmental laws, regulations, and policies. Fair treatment means that no population, due to policy or economic disempowerment, is forced to bear a disproportionate share of the negative human health or environmental impacts of pollution or environmental consequences resulting from industrial, municipal, and commercial operations or the execution of federal, state, local and tribal programs and policies" (U.S. Environmental Protection Agency 1999).

3 Methodology

This project was conducted with the following approach:

- **Formulation of criteria list based on environmental justice framework:** Existing environmental justice frameworks were reviewed through a literature search in order to operationalise the three dimensions of environmental justice.
- **Application and evaluation of the framework:** The selected framework was applied on a specific case study - a Germany-Morocco hydrogen partnership. Lessons learned from the application were outlined.
- **Additions to criteria list:** Based on the lessons learned, a preliminary list of criteria was drafted that could be generalised to potential partnerships with other countries.
- **Formulation of policy options for mitigation:** Based on both the case study findings as well as literature search, policy options to promote environmental justice and mitigate potential issues from hydrogen partnerships were outlined.

These phases were not distinct, but were instead part of an iterative process based on discussions throughout the study. Due to the compact nature of the study, limitations in the methodology were unavoidable and further details can be found in the Limitations section.

3.1 Formulation of Criteria List based on Environmental Justice Framework

In the first phase, a quick scan of the literature was conducted to search for frameworks to operationalise environmental justice dimensions in the case of energy, international partnerships, large infrastructure projects, and development cooperation. Further details regarding the search strategy can be found in 10.1 Appendix 1 – Search Strategy.

The preliminary literature search did not yield many frameworks initially, as this appears to be an emerging field without established frameworks or methodology (Hess and Ribeiro 2016). Due to the compact timeline of the study, a decision had to be reached very early to select a framework. The Environmental Justice Protocol formulated by Hess and Ribeiro 2016 was deemed adequate because it attempted to close the gap between the environmental justice lens and energy transition. Subsequently, other resources and frameworks were also identified but due to time and resource constraints, it was decided to continue only with

using the framework by Hess and Ribeiro 2016. Further details regarding the selection of frameworks can be found in 10.2 Appendix 2 – Selection of Frameworks.

3.2 Application and Evaluation of the Framework

3.2.1 Case Study Selection

In the second phase, the selected framework was tested by applying it to the case study of a German-Morocco hydrogen partnership. Morocco was selected because it is estimated to be a good potential partner (Groll 2021). Norway and Morocco both had medium export potential, would be reasonably affordable in cost estimation, and have relatively good political-economical conditions. However, Morocco provided a better case than Norway as it would be more representative of a partnership between Germany and Global South nations, such as with North African countries that are under consideration (van Wijk et al. 2019).

3.3 Additions to Criteria List

A preliminary list of criteria to assess hydrogen partnerships was drafted by supplementing the criteria from Hess (2016) with additional aspects identified through the case study. Additional assessment tools were found during the study but could not be incorporated due to time and resource constraints. This is mentioned in 10.2 Appendix 2 – Selection of Frameworks. This preliminary list is intended to serve as a starting point for policy makers to assess potential partnerships with other countries.

3.4 Assessment of Environmental Justice Framework

The environmental justice framework from Hess and Ribeiro 2016 provided structure to the case study research. Two reviewers were assigned to each dimension of environmental justice and used the questions from the list in order to guide their research in searching for data or proxies to address the criteria. Research from available data on the hydrogen partnership and national energy plans, as well as secondary research conducted on associated green hydrogen initiatives in Morocco and Western Sahara, informed much of our work. We then drew main conclusions from the overall framework as well as from each dimension of environmental justice. Finally, we discussed additional criteria or dimensions not included in the framework that could enable further assessment of the environmental justice implications of green hydrogen production in Morocco.

3.4 Formulation of Policy Options for Mitigation

Based on both the case study findings and the literature search (see Appendix 2 for more details), policy options to promote environmental justice and mitigate potential issues from hydrogen partnerships are outlined. This is a preliminary list that should be expanded upon in future research to compile a "policy instrument toolbox" at the policy makers' disposal in order to ensure environmentally just hydrogen partnerships.

The policy options were derived using a "problem-solution framework", where main problems were identified within the German-Morocco hydrogen agreements. Following this, mitigation policies were suggested within the Moroccan context, which further helped develop a broader framework for policies that may be used between any countries developing a hydrogen partnership.

3.5 Methods

Due to time and resource constraints, only a literature review has been conducted, with limited sources and availability of data, leading to knowledge gaps which will be described in 7.1 Limitations of the Study.

4 Overview: International Hydrogen Partnerships and Environmental Justice

4.1 International Hydrogen Partnership

4.1.1 Interest in Hydrogen

The transition to renewable energy has created economies of scale with costs of wind and solar energy dropping down significantly and predicted to fall further still (Kost and Hanisch 2021). However, certain sectors of the economy, such as transportation and industry, have proven difficult to decarbonise (Blas et al. 2020). Hydrogen and its derivatives are seen as a potential solution to this problem (International Energy Agency 2019). That being said, hydrogen is not a panacea, as it is primarily an energy vector and therefore can be classified along the same lines as other technologies such as various types of batteries (Ibid). As a result, hydrogen is viewed as a critical component of a net-zero emissions scenario, helping to replace existing GHG-based infrastructure in tandem with batteries (Ibid).

Current production of hydrogen is typically colour-coded to signify its carbon footprint. A brief overview of these definitions is available in table 3.
For the purposes of this paper, we have chosen to focus on green hydrogen since reliance on blue hydrogen is primarily seen as a short-term transitional strategy (Federal Ministry for Economic Affairs and Energy 2020)).

4.1.2 Hydrogen Policy and Demand in Germany

Current demand for hydrogen is approximately 55 TWh, but is expected to see an increase of 10TWh by 2030, and between 110-380 TWh by 2050 (Federal Ministry for Economic Affairs and Energy 2020). The country has outlined a hydrogen strategy to meet these demands and attain its goal of GHG neutrality by 2045. In order to meet these needs, international agreements with markets outside the EU are viewed as a necessity (Ibid). One region that has been the subject of much discussion is North Africa (van der Zwaan et al. 2021). The region is rich in wind and solar power potential, and can form an integral component of Germany's decarbonization strategy (Ibid). North Africa is particularly suitable to meet Germany's hydrogen needs due to its proximity and available infrastructure as well (Ibid). For example, pipelines and HDVC lines between Europe and North Africa are already in place (Ibid).

4.1.3 Germany's International Hydrogen Partnership Agreements: Morocco

Germany has signed multiple hydrogen partnership agreements with countries around the world (Dietz-Polte and Vacha 2021). However, as previously mentioned, the North African region is consistently viewed as a major source of hydrogen. In this regard, the country signed an agreement with Morocco in 2020 for cooperation in hydrogen technologies, with a view of importing hydrogen and its derivatives.

As mentioned in 2.1 Background and Motivation, assessment on the potentials of hydrogen technologies have often neglected the social component, focusing mainly on the technical and economical components (Fredershausen et al. 2021). Germany's National Hydrogen Strategy does take sustainable development of the partner countries into consideration (Federal Ministry for Economic Affairs and Energy 2020), but it does not adequately take into account power dynamics and inequality from energy transition. To address this issue, hydrogen is considered in the context of environmental/energy justice in this study. This concept has the potential to address the social impacts of technologies from different interdisciplinary perspectives (Jenkins et al. 2016).

4.2 Environmental & Energy Justice

The concept of environmental justice is complex and much debated (Mohai et al. 2009). However, it is outside the scope of our research to offer a comprehensive view of the philosophical discussion about the concepts of justice and environment. Instead, the following definition from the U.S. Environmental Protection Agency was found to adequately fit our needs given the aims of this technology assessment:

> "The fair treatment and meaningful involvement of all people regardless of race, colour, national origin, or income with respect to the development, implementation, and enforcement of environmental laws, regulations, and policies. Fair treatment means that no population, due to policy or economic disempowerment, is forced to bear a disproportionate share of the negative human health or environmental impacts of pollution or environmental consequences resulting from industrial, municipal, and commercial operations or the execution of federal, state, local and tribal programs and policies" (U.S. Environmental Protection Agency 1999).

For example, this definition addresses not only the inequitable distribution of environmental risks between the industrialised countries, the main cause of global climate change, and the less developed countries of the South, but also the uneven distribution of risks within individual countries and population groups (Hornberg et al. 2011). As shown in Table 4, to ensure a more balanced analysis, the division into three "equity dimensions" has been used (Walker 2009):

Table 4: The three environmental justice dimensions (Modified from Jenkins et al. 2015)

Dimension	Evaluative	Normative
Distributional	Where are injustices?	How should we solve them?
Recognition	Who is ignored?	How should we recognize?
Procedural	I there fair process?	Which new process?

For our study, we used a subcategory of environmental justice – Energy justice. The concept of energy justice has previously been defined as, "a global energy system that fairly distributes both the benefits and burdens of energy services, and one that contributes to more representative and inclusive energy decision-making" (Sovacool and Dworkin 2015). Or in other words:

> "an energy-just world would be one that promotes happiness, welfare, freedom, equity, and due process for both producers and consumers. It would distribute the environmental and social hazards associated with energy production and use without discrimination. It would ensure that access to energy systems and services is equitable. It would guarantee that energy procedures are fair and that stakeholders have access to information and participation in energy decision-making" (Ibid.).

The concept of three justice dimensions is also used in this field (Hess and Ribeiro 2016; Jenkins et al. 2017; McCauley and Heffron 2018; Zhou and Noonan 2019). Hess & Ribeiro give a good overview of what they look like, when adapted to energy justice (Table 5).

Table 5: The three dimensions of energy justice (Modified from (Hess and Ribeiro 2016))

Dimension	Content
Distributional	The distribution of benefits and burdens along the energy supply chain.
Recognition	Recognition of affected groups, traditional cultures, and local knowledge.
Procedural	The way how projects are implemented, including participation in decision making.
Other aspects	Aspects of community capabilities that cannot be fully captured by the three previous dimensions.

4.3 Hydrogen Economy: Environmental Justice Challenges

The environmental justice challenges posed by the hydrogen economy, particularly in the developing world, have not been explored. This is primarily because as an emerging technology, hydrogen has not yet been implemented on scale. Nevertheless, we argue that potential challenges can be identified on the basis of developments in thematically adjacent areas, pre-existing socio-economic conditions, as well as technicalities of hydrogen technology itself.

4.3.1 Technology Gap

Developing countries are particularly dependent on developed countries for obtaining access to key technologies, as well as to infrastructure to effectively utilize them. As a result, this dependency creates challenges from an environmental justice perspective, as implementation of new technologies is slow, expensive, and unequal, thereby creating a barrier for socio-economically disadvantaged groups (Yale Insights 2016).

4.3.2 Potential Health Impacts from Hydrogen across the Supply Chain

Production, storage, and transportation of hydrogen require specialised equipment and monitoring systems to prevent accidents and potential adverse health impacts on workers and residents living in proximity. For example, hydrogen is more combustible than natural
gas, and requires specialised monitoring systems for identifying leakages. Furthermore, high concentrations of hydrogen can lead to a lack of oxygen and potentially death, though this risk affects employees handling hydrogen more than residents living near hydrogen facilities (Crowl and Jo 2007).

4.3.3 Access to Water Resources for Locals

The production of hydrogen via hydrolysis splits water into its respective components, hydrogen and oxygen. Further requirements for water may arise due to related industrial processes. Depending on the efficiency of the process and the amount of hydrogen produced, significant quantities of water may be sourced from the environment (Webber 2007). This has potential implications for the availability of water to local residents, particularly in water-stressed regions.

4.3.4 Electricity Costs

Production of hydrogen via hydrolysis requires electricity which can be sourced from renewable or non-renewable resources. However, electricity demand by the hydrogen economy can lead to potential increases in costs for local residents (Ball and Weeda 2016).

4.3.5 Unequal Employment Opportunities & Dependencies on Foreign Contractors

Increased investments in the hydrogen economy offer multiple opportunities for employment. However, fulfilling labour needs from the local environment may prove to be a challenge owing to technology gaps between developed and developing countries. As a result, there is a risk of dependency on foreign contractors to meet requirements for labour, since a well-trained, equipped, and skilled workforce is required (Bezdek 2019). In addition, a transition to a hydrogen economy can lead to potential job losses in other sectors.

4.3.6 Lack of Stakeholder Engagement & Inequitable Distribution of Potential Benefits

Stakeholder engagement is a critical component for avoiding environmental justice challenges. International partnerships not taking local communities on board for the transition to a hydrogen economy raises the risk of potential impact on marginalised groups. There is also a risk that potential benefits and

disadvantages of the hydrogen economy will be unequally distributed, thereby entrenching pre-existing inequalities. Another critical factor to take into consideration is that international hydrogen partnerships lacking a comprehensive discussion on the broader aspects of the hydrogen economy may exacerbate existing inequalities within countries. For example, the creation of hydrogen production infrastructure may be used primarily for export, instead of local use of the resource. As such, the development of infrastructure that can distribute locally produced hydrogen is imperative.

4.4 Criteria for Environmentally Just Hydrogen Partnerships

To systematically assess hydrogen partnerships through an environmental justice perspective, we needed to find a suitable framework. Based on our literature review, there was no framework that specifically focuses on hydrogen partnership challenges. We considered energy justice to be the most relevant topic related to hydrogen within the environmental justice movement. Energy justice is gaining attention withing the environmental justice movement (Jenkins et al. 2016; Sovacool and Dworkin 2015). There are multiple frameworks related to energy justice in the literature. Our chosen framework is based on Hess and Ribeiro 2016 and provides a qualitative method, based on environmental justice protocols, to systematically evaluate energy projects. It thereby attempts to close the identified gap of environmental justice considerations in energy systems. The authors did not describe in sufficient detail how they developed the framework. Although the chosen framework is not hydrogen specific, it still covers the main challenges identified in the literature (see table 6). We therefore considered the framework from Hess and Ribeiro 2016 to be a relevant starting point for assessing hydrogen partnerships from an environmental justice perspective.

Table 6: Framework of energy justice (Modified from Hess and Ribeiro 2016)

Dimensions	Relevant Aspects	Relevance to identified key environmental justice challenges with regards to hydrogen partnerships
Distributional Justice	What are the purposes of the project? What will the energy produced be used for? How much of it will be exported to other regions and how much will be used in the region? Which policies can be applied to secure a socially and economically positive contribution of energy production to the local region? Who/which groups of people will primarily be affected negatively by the project (including its possible supply chain)? Do they belong to already environmentally and socially discriminated groups? What can be done to protect them and include them in the benefit sharing? Does the project include fundamental conflicts on the mode of appropriation of nature (with indigenous or traditional populations)? What can be done to approach this conflict within the project? Will the project possibly lead to further distributional conflicts on the use of natural resources? What can be done to secure the fair distribution of natural resources?	Technology gap Potential health impacts from hydrogen across the supply chain Access to water resources for locals Electricity costs Unequal employment opportunities & dependency on foreign contractors Lack of stakeholder engagement & inequitable distribution of potential benefits

	Should multiple purposes be considered in the project? How can the benefits of these purposes be distributed in a just manner?	
Recognition	Which people and populations will be affected by the project (considering physical and livelihood displacement, direct and indirect impacts) -> Definition of the proper territorial scale to ensure recognition. Is recognition of all (directly and indirectly) from the project affected people possible? What has to be done to ensure this? Are there special cultural or traditional populations affected by the project, whose particular socioeconomic conditions and cultural needs have to be taken into account? Does the project involve religious and/or spiritual conflicts?	Technology gap
Procedure	Definition of the proper territorial scale for impact studies (if water resources are affected: river basin) IEIA: Are there other important projects/socioeconomic transformations occurring or planned in the area that have to be taken into account? Allocate the IEIA before the decision making Is a differentiated consultation process of indigenous and tribals peoples necessary? If yes, how can it be approached? How can representative entities of the local population be included in the decision process? Is the project likely to lead to attempts of political manipulation? What can be done to avoid this?	Lack of stakeholder engagement Local dependency on foreign contractors
Other aspects	Which community capabilities are at stake? Which communities will possibly benefit and which will be negatively affected by the project? Can a functioning of all communities with the project be secured or is there a realistic chance to achieve this outcome? Are there traditional populations and/or communities with special demands? If yes, which are these demands? How can they be addressed? Is there an incommensurability of values involved in a possible conflict situation?	Lack of stakeholder engagement & inequitable distribution of potential benefits Unequal employment opportunities & dependency on foreign contractors

5 Case Study: German-Morocco Hydrogen Partnership

5.1 Overview of Morocco Context

The energy sector in Morocco is dominated by fossil fuels, which are almost entirely imported. Approximately 96% of its net energy supplies come from abroad: oil mainly from Saudi Arabia, gas almost exclusively from Algeria, and coal from Russia and South Africa (IEA 2019; Amegroud 2018), making it one of the major importers of conventional fossil fuels in the Middle East and North Africa (MENA) region (Chentouf and Allouch 2021). This dependence on energy imports places a heavy burden on the country's economy and generates undesired environmental and social effects (Chentouf and Allouch 2021).
Simultaneously, Morocco is among the most vulnerable regions globally to the impacts of climate change, especially in terms of water resources and agriculture (Heinrich Böll Stiftung 2016). Therefore, the local government has been striving to reduce its GHG emissions, coming mainly from activities related to energy harvesting. Projections state that reaching a renewable energy capacity of 15.72 GW by 2030 can reduce carbon emissions by 35MT by the same year (Chentouf and Allouch 2021).
On the other hand, the country's electricity consumption is projected to double by 2025 and to increase over five times by 2050, so substantial investments in additional power generation capacities are required (Schinke and Klawitter J. 2016).

5.1.1 Existing Relationship with Germany

Morocco and Germany enjoy significant economic and trade relations. Germany is one of Morocco's most important trading partners, and there is German equity participation in nearly 300 companies in Morocco. Germany is one of the country's largest bilateral donors, pledging funds of approximately 1.2 billion euros in 2020 alone. The development cooperation efforts between the countries revolve mainly around sustainable development and renewable energy efforts (Federal Foreign Office 2021).

5.1.2 Hydrogen Development Potential

Morocco has vast potential for renewable energy (RE) sources. It has favourable conditions, especially for wind and solar energy production, because of its long coastline and its lengthy and intensive solar radiation throughout the year (Schinke and Klawitter J. 2016). This is why Germany and other EU member states have highly supported Morocco's energy transition, in order to benefit from hydrogen exports in the future.

In addition, transportation of green hydrogen from Morocco to Germany by pipeline is more cost-effective than other forms of energy transportation, such as electricity transport by cable (Modern Power Systems 2021). With the signing of the Germany-Morocco Hydrogen Agreement in 2020, Germany pledged to allocate €300 million to support Morocco in the construction of a hydrogen production plant, and with the subsequent production of green hydrogen (Baumann 2021).

However, Morocco is not yet capable of exporting green hydrogen because it must first produce more electricity from renewable sources than it is currently doing. In 2019, just 4% of all electricity produced was from solar (1,581 GWh), 12% from wind power (4,587 GWh), and 4% from hydropower (1,654 GWh), which was much less than the solar power generated in Germany that year. Another reason is that green hydrogen production requires large amounts of water that is already a scarce resource in Morocco. The country is planning to obtain the needed freshwater from desalination plants, which will also have to be powered by green electricity to generate genuine green hydrogen. Therefore, the entire process requires significantly more solar energy capacity than currently available (Baumann 2021).

5.1.3 Existing/Emerging Hydrogen Cooperation

Morocco and Germany have a long tradition of cooperation in the energy field, and multiple partnerships have been formed between the Moroccan and German governments and private companies. The current energy partnership is called PAREMA and is the central platform for the institutionalised political dialogue on energy policy between both countries. It was created in 2012 and then restarted in 2016 with joint declarations of intent. The German Federal Ministry for Economic Affairs and Energy (BMWi) and the Moroccan Ministry of Energy, Mines and Environment (MEME) are responsible for the overall coordination of this partnership (PAREMA 2019).

In June 2020, after the approval of the German National Hydrogen Strategy, Germany and Morocco signed a Green Hydrogen Cooperation Agreement. The partnership aims to produce green hydrogen by developing the first African green hydrogen production plant and implementing research and investment projects on using this energy source. The estimated German funding for this project is over 300 million euros. As a result of the long-standing energy cooperation between the two countries, the Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) provided strategic advice to the Moroccan government in advancing both their Green Hydrogen Map and Hydrogen National Strategy (Torres and Perner 2021).

5.1.4 Broader Regional Context

The European Union energy system is highly reliant on imports of oil, natural gas, and solid fuels. In 2017, the imports amounted to 55% of the total energy consumption, according to van Wijk et al. 2019, 13% of the natural gas and 10% of the oil consumed in Europe come from North Africa, and 60% of North Africa's oil exports and 80% of its gas exports are sent to Europe (Ibid.). Given population density and comparatively limited RE sources and land, Europe will continue to import energy to meet not only its energy needs in the future, but to comply with its emission reduction targets (Ibid.). Europe's electricity sector alone needs to be fully decarbonised by 2050 to achieve the binding commitments laid out in the Paris Agreement (Ibid.).

On the other hand, the energy market in North Africa is not as homogenous. Some countries, such as Libya and Algeria, are energy exporters because they have built their economies around the exploitation of fossil fuels. In contrast, Morocco has always had to import energy from neighbouring countries. However, the creation of this European-North African partnership to develop a green hydrogen market is claimed to benefit both importing and exporting countries alike, because it is justified based on economic growth and social stability (Ibid.).

The main advantage to making North Africa a supplier of green hydrogen is its potential to generate large quantities of solar and wind energy required for its production. Similarly, the transportation of green hydrogen from North Africa to Europe can be done by using the existing gas grid infrastructure (Ibid.).

The European Union has to establish multilateral agreements and partnerships to achieve its objective of becoming climate neutral by 2050. Therefore, in 2020 the EU adopted a new energy system integration strategy and a new hydrogen strategy to promote the use of green hydrogen in its member states. Additionally, the EU adopted a new regulation in 2021 aimed at funding international cooperation for supporting climate objectives. The so-called "Global Europe Instrument" is now the central EU financing platform to promote green transition worldwide, including North Africa (Bennis 2022).

5.1.5 Stakeholder Mapping

As part of the case study, a stakeholder mapping was conducted to gain a better understanding of the stakeholders involved in the hydrogen partnership. This mapping is depicted in Figure 1 below.

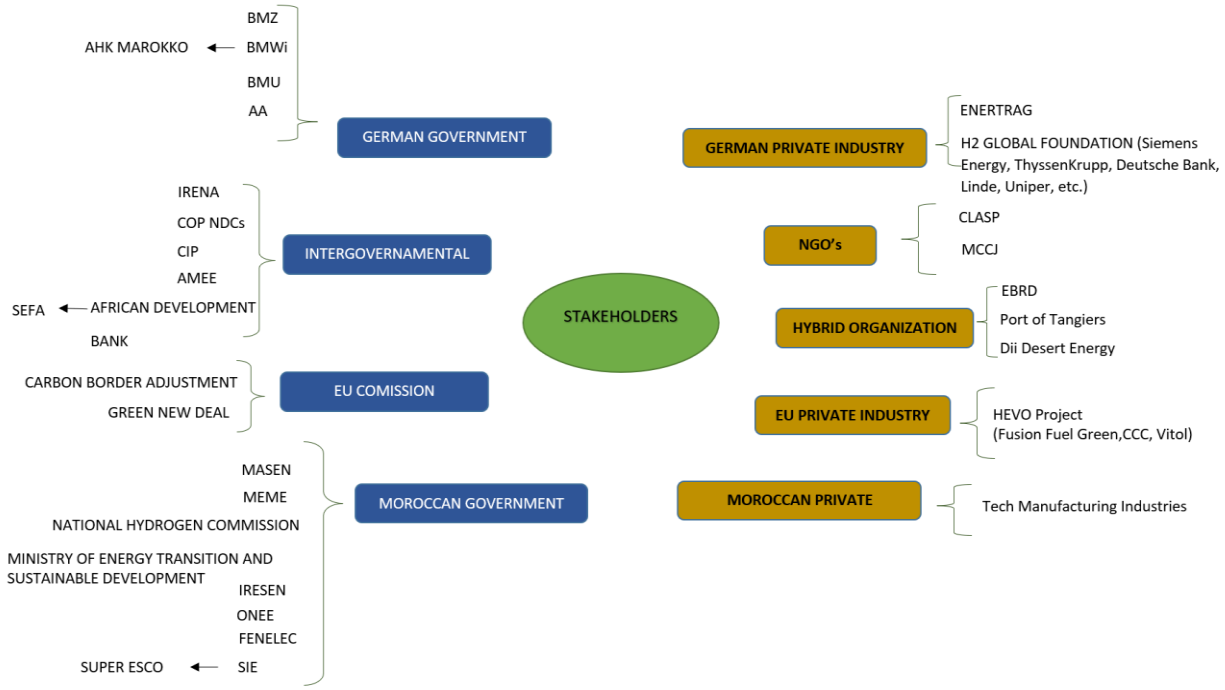

Figure 1: Stakeholders in a German-Morocco hydrogen partnership. Acronyms of the stakeholders in Appendix 4.

The stakeholders are grouped into different categories according to their sectors. Those on the left represent stakeholders more aligned to the governmental sector and those on the right represent non-governmental actors such as the private sector and civil society. This is not an exhaustive list, but represent, the key actors identified through the literature review and highlights the complexity of the situation, especially considering the different motivations and interests for each stakeholder.

5.2 Environmental Justice Assessment: Findings from the German-Morocco Partnership

The Environmental Justice (EJ) framework is an effective tool for broadly identifying some of the key conflicts either brought about or exacerbated by the expanding green hydrogen sector in Morocco. Most of the discussion revolves around land use conflicts for renewable energy infrastructure projects in Western Sahara. Morocco refers to the large track of territory along the western coast of Western Sahara as its "Southern Provinces," despite the UN officially recognizing the country's independence post-Spanish colonisation in 1966 (Western Sahara Resource Watch 2021). Despite the international rulings and UN peace efforts, Morocco continues to colonise the territories, which are formally part of the Sahrawi Arab Democratic Republic, primarily for infrastructure projects to extract its natural resources.

Morocco and Germany have different motivations for entering green hydrogen partnerships: Germany's energy transition (*Energiewende*) focuses on a complete, sustainable (renewable) energy transition, and is largely dependent on energy imports and by extension, international diplomacy (Steinbacher 2015). Meanwhile, Morocco is less intent on a "transition" per se, but rather on expanding to change the country's overall energy mix. Importantly, the major goal is energy independence and economic stimulation through job creation and industrial development (Steinbacher 2015). These differences are notable because they

highlight the diverging priorities between the countries, and generally include narrow definitions of sustainability and development that exclude major justice considerations.

From our assessment, almost all the criteria in the EJ framework were either not meaningfully addressed or left out of the renewable energy projects implicit in the German-Moroccan partnership. We therefore concluded that the bilateral hydrogen agreement does not meaningfully address environmental justice implications in the production of green hydrogen. Given the considerable potential for solar and wind power generation in the Western Sahara, both countries are dependent on the current and projected renewable energy projects in the Occupied Territory to reach their climate action and development goals (BMW 2022; Western Sahara Resource Watch 2021). According to a Belgian campaign group, an estimated 15-18% of Morocco's current solar and wind capacity, respectively, are sourced from projects within the disputed territory of the Western Sahara (Foroudi 2021). Data also shows that energy produced in occupied Western Sahara could generate 47.2% of Morocco's total wind capacity and up to 32.6% of their total solar capacity by 2030 (Western Sahara Resource Watch 2021).

Large scale infrastructure projects in Western Sahara result in problems such as green grabbing, population displacement, and water extraction in a drought sensitive region (Allan et al. 2021). These projects, in large part commissioned and owned by the Moroccan monarchy, are concealed under dominant green hydrogen discourses: these include mainstream and technocentric narratives related to "clean" energy transitions, climate leadership, and sustainable development. As such, Germany, and the EU more generally, are arguable participants in Morocco's violation of international humanitarian law (Western Sahara Resource Watch 2021). Because several of the major players in the renewable energy sector are analogous to the fossil fuel industry, namely multinational corporations (i.e. Siemens Energy, ThyssenKrupp) and federal ministries for energy (i.e. Moroccan Energy Investment Company, German Federal Ministry for Economic Affairs and Energy), the race for green hydrogen risks reinforcement of exploitative fossil fuel power dynamics.

While future hydrogen projects should explicitly include all dimensions of environmental justice, for example the participation of local populations in planning and implementation of projects and the right to due process, it is questionable to what extent environmentally just projects can be enacted under the current governance structure. Moreover, we question what role bilateral or multilateral hydrogen energy partnerships can play in addressing complex and historically loaded geopolitical conflicts. This again is a reflection of fossil fuel geopolitics, as seen in the international support of undemocratic regimes for the purposes of European and North American energy security (Mitchell 2009).

5.3.1 Distributional Justice

At the most basic level, there is a fundamental conflict in the appropriation of nature between energy infrastructure investors and local communities living in Western Sahara. Desert areas are seen as spaces for energy generation and profit, due to their potential for solar and wind power, for Moroccan ruling elite and international business elites (Steinbacher 2015). Morocco also benefits from its carefully cultivated "green" image due to its investments in renewable energy and its ambitious commitments to the Paris Agreement. However, infrastructure projects are sited on land historically used by nomadic groups and pastoralists, and are built at the expense of agricultural or forested land (International Energy Agency 2019).

Renewable infrastructure projects in Western Sahara have detrimental effects on local populations, particularly the Sahrawi people, from daily abuses caused from military occupation to complete displacement (Allan et. al, 2021). These projects continue to be built without their consent or respect for their internationally recognised right to self-determination (Allan et al. 2021). Moreover, Sahrawi people are not only

not reaping energy (or other) benefits from renewable energy projects, but imposed blackouts have been used as a political tool against them (Ibid.). A 2018 report from the UNHCR and WFP show that there are more than 173,000 refugees resettled across five camps in the Tindouf region of the Sahrawi Arab Democratic Republic (SADR) alone (Sahrawi Arab Democratic Republic 2021). These camps have extremely low energy usage and are mostly powered through solar panels and (Ibid.). Other displaced populations from energy projects in Western Sahara have been resettled in Algeria, which are more exposed to the hazards of climate change, such as heat and drought (Lo 2021). The Liberated Territories of the SADR are also more exposed to climate change extremes, and due to a range of socio-economic and political circumstances, are less equipped to handle them. These include,

> "poor infrastructure, economic marginalisation, lack of access to natural resources in the areas occupied by Morocco, lack of access to technical expertise and international research networks and outputs, and exclusion from international climate finance and governance mechanisms" (Ibid.).

Morocco itself stands to benefit from a major boost in the role of renewables in their domestic energy mix. Morocco is a recognised leader in Northern Africa for technical research and development into renewable energy and green hydrogen, and the growing sector has stimulated a new market for domestic servicing and manufacturing jobs. However, this new job market also shows unequal distribution of benefits: in the Western Sahara, the vast majority of the jobs taken by Moroccan settlers are more technical positions and require a certain standard of expertise and education (Terrapon-Pfaff et al. 2017). Training opportunities are not easily available in local communities, and as a consequence, it reinforces patterns of labour displacement and migration seen in fossil fuel industries. Local communities (for example, Sahwari people) are more often displaced from land and resettled in refugee camps.

Renewable energy projects for hydrogen production are likely to lead to additional distributional conflicts due to the royal family's control over national resources. The Moroccan Agency for Sustainable Energy has ties to the royal family, who co-owns the Noor solar power plant and plays a major role in land acquisition. This is a common practice of green grabbing that takes place in postcolonial/neocolonial contexts (Haddad et al. 2022).

5.3.2 Recognition Justice

Based on available documents from the German-Morocco partnership, the Moroccan National Energy Strategy, and National Hydrogen Strategy, there is no specific attempt for the inclusion of affected communities or of local knowledge. Available data on hydrogen projects and Morocco's climate reports (for example, their UNFCCC Nationally Determined Contribution) disregards political borders along the Western Sahara and treats the whole region within the Moroccan borders (Western Sahara Resource Watch 2021). This artificially reduces Morocco's emissions per capita rates, due to the depressed energy usage of Western Sahara populations, and inflates their potential for renewable energy generation (Lo 2021).

Additional problematic claims arise about the "extractivism" of renewable energy: energy companies argue they are not physically removing natural resources to capture wind and solar energy. However, solar and wind farms require water, space, and have been used to generate energy and improve efficiency for other extractive industries in the region, for example phosphate mining for fertiliser production (Western Sahara Resource Watch 2021). More importantly, they are also promoting capitalist modes of accumulation through colonialism and occupation while denying the needs of local communities (Allan et al. 2021).

Green hydrogen projects are subject to manipulative narratives, from community projects led by energy companies (i.e. Siemens' sponsored tree plantings, waste bin instalment) to large-scale sustainable

development and climate leadership for Moroccans (Western Sahara Resource Watch 2021). These all undermine and distract from problematic power imbalances, entrenched colonial occupation, and forced displacement of local and indigenous communities in Western Sahara.

5.3.3 Procedural Justice

New and projected hydrogen projects are iterative of several other large scale infrastructure projects in the region, which enable unsustainable and illegal forms of extractivism from Western Sahara. Beyond renewable energy complexes, exploitative industries in Western Sahara include industrial agriculture projects (i.e. plantations and greenhouses), desalination and wastewater treatment plants, phosphate mining, oil exploration and drilling, and large scale fishing operations (Sahrawi Arab Democratic Republic 2021). Oil licences were granted by the Kingdom for exploration purposes in Western Sahara, and have not resulted in commercially viable oil reserves (Ibid.). However, this demonstrates Morocco's pursuit of domestic energy independence and royal profit-making over the desire to transition to a sustainable energy system. These initiatives stand to benefit the Moroccan monarchy and other ruling elite, who in large part own the companies involved. They also additionally serve international business interests (such as those of multinational energy companies and financial institutions) and to some extent benefit development agencies (such as the GiZ), who are charged with implementing such partnerships on the ground. In the context of such activities by the powerful stakeholders that disregard the needs of the local populations and marginalised groups, renewable energy projects fortify Morocco's exploitation of Western Sahara's natural resources.

What might be expected elements of procedural justice, for example participatory planning, stakeholder consultation, FPIC (free, prior, and informed consent), and even environmental and social impact assessments, are not easily implemented in an undemocratic monarchical system, especially in the context of Morocco. In the case where the monarchy and royal family hold such power, it would be hard to imagine a truly inclusive and participatory process where "representative entities of the local population [are] included in the decision process" (Hess and Ribeiro 2016). In Article 36 of the kingdom's constitution, it forbids "conflicts of interest [and] all practises contrary to the principles of fair and free competition" (Western Sahara Resource Watch 2021). This is completely undermined, as there are immediate conflicts of interest when the governor, regulator, military, and judicial leader is also a major company owner in the large scale and lucrative energy market (among others) (Ibid.). Thus, the reality of the Moroccan context indicates that, despite the constitutional monarchy system, the high level of power imbalance in the current structure hinders a meaningful fulfilment of the procedural justice aspect of hydrogen development in Morocco.

Nevertheless, the European Union and the United Nations have made important decisions regarding the military occupation in Western Sahara. In 2016, the EU court ruled that Western Sahara territories are separate and distinct from Morocco. In the same year, the UN Human Rights Commission made a similar ruling, and concluded that Morocco required the full consent of the people in Western Sahara before implementing developmental and infrastructure projects (Ibid.). Interestingly, the EU was involved in both the prosecution and defence of its bilateral trade and fisheries agreements. In September 2021, the EU Court of Justice found the EU's approach to Moroccan trade agreements to be in violation of Western Sahara's rights to self-determination and sovereignty. While parties involved in the agreements argued that they engaged in "stakeholder consultation" with the "local populations" to determine how these projects could stand to benefit them, the EU Court found the vague language inadequate and required explicit consent from the Polisario, the UN-recognised representation of the people of Western Sahara (Ibid.). While this is a milestone victory for the Sahrawi people, its impact remains questionable, as large-scale infrastructure projects are still slated to be built for Moroccan energy export to countries such as Germany. As illustrated in this example, participatory processes may only be an attempt to "check the box" rather than to truly consider the needs of the affected population.

5.3.4 Other Aspects

Environmental sustainability of the hydrogen projects have not been fully or transparently assessed. For example, desalination plants are planned to be built for the production of green hydrogen, yet questions arise regarding access to the distribution of the produced fresh water, particularly for smallholder farmers and local communities (Baumann 2021). The Kingdom of Morocco is already struggling with freshwater shortages, which have been subject of local conflicts (Ibid.). Large greenhouses owned by the king and French-Moroccan conglomerates have been blamed for draining underwater wells in Western Sahara, further exacerbating water shortages (Sahrawi Arab Democratic Republic 2021). Furthermore, "concentrating solar power" (CSP) technology used in the Noor solar project under the Moroccan Agency for Solar Energy has been criticised for being extremely expensive and water-intensive (Foroudi 2021). Illegal land grabbing from the Western Sahara is only increasing under the need for more land with favourable conditions. Although the exact figures differ, it seems that solar power and desalination plants will continue to be established en masse over the conflicted areas (Sahrawi Arab Democratic Republic 2021).

Finally, the global need for renewable energy is in conflict with the need to protect the rights and dignity of marginalised groups in Morocco and Western Sahara. These two will likely continue to conflict as long as the current governance arrangements stay in place. The Moroccan authorities seem to be focused on expanding their renewable energy production and on promoting public-private partnerships with energy companies. This strategy is in part based on pressure from the EU, UN, and financial institutions, among others, to meet renewable energy targets, but is coming at a cost to creating truly sustainable and just energy regimes.

5.3.5 Additional Dimensions

Additional dimensions of environmental justice were not included in our framework, but could prove beneficial to further studies on the issue. Appreciative justice, for example, could help recognise and evaluate the historical legacies of colonialism and fossil fuel extractivism, which have enabled the formidable power imbalances and exploitation between actor groups witnessed today. There is an additional need to address the broader international and geopolitical contexts of the region, which could illuminate possible pathways for restorative justice. This aligns with our general scepticism of the capacity of hydrogen partnerships to mitigate complex conflicts related to land use and colonial occupation. The recognition and, importantly, follow up, from international authorities such as the UN and EU Court of Justice can support the people of Western Sahara and the Sahrawi Arab Democratic Republic to access international governance bodies on their own terms.

5.4 Case-specific Mitigation and Governance Options

This section highlights key problems under a hydrogen partnership with Morocco and proposes possible mitigation policies. The aforementioned challenges discussed in 2.3.2 Environmental Justice have been summarised under six main problems with mitigation options suggested for each. The summary of the policies can be shown below in Table 7 and is further elaborated upon in this section. Although these are possible options for policy-makers, it should be noted that further research would be necessary to consider the feasibility of these options, such as by considering historical precedents in international agreements or cooperation in other fields.

Table 7: Summary of mitigation policies within the Moroccan context

Problem	Problem description	Policy option
Discrepancy in objectives, values and capacities between Germany and Morocco	The undemocratic authority of the royal family and ruling elites over Morocco's system of governance, the country's relatively low resource capacity, and its stage in the energy transition are starkly different from Germany's situation. This may lead to an unfair outcome which further exacerbates human rights issues in Morocco and the importation of unsustainable yet "clean" hydrogen into Germany.	Use "soft power" diplomacy to steer Morocco towards more democratic and socially just energy governance regimes that are in line with Germany's values Cooperate with the EU to develop trade regulations and certification schemes to ensure that hydrogen imported from Morocco has been produced in a socially just and democratic manner Provide further investments and technological support to enhance Moroccan democratic institutions and energy production
Continuation of fossil fuel system power structures	The Morrocan ruling elite, by securing international investments, have generated profits from renewables in an undemocratic manner reminiscent of the country's colonial history. Renewable energy production has simultaneously degraded the socio-ecological foundations of the country and threatened the water access and land security of marginalised groups, particularly in occupied areas of Western Sahara. The increasing reliance on renewables in Morocco may lead to a case of the "resource curse" and lead to dependence on hydrogen importing countries like Germany, reminiscent of the country's current dependence on fossil fuels imported from other countries.	Formal acknowledgement of the harmful legacies of colonial structures and fossil fuel systems in Morocco Use diplomatic avenues to push Morocco towards a more equitable and democratic energy production system. This could entail the demand for increased participation of local stakeholders in planning processes, more equitable distribution of energy revenues, or development of public institutions to fight against corruption
Geopolitical conflict	The Germany-Morocco hydrogen partnership could deteriorate over the conflict surrounding the recognition of territory held by the Polisario Front and the Sahrawi Arab Democratic Republic.	Include recognition of the Sahrawi territory as a prerequisite to any hydrogen partnership with Morocco Mandate the inclusion of the Sahrawi and other local stakeholders in hydrogen planning processes
Loss of traditional culture and livelihoods	RE and hydrogen projects' expansion impact the nomadic lifestyle of the Sahrawi people	International pressure through EU institutions and civil society organisations to recognize traditional culture and livelihoods
Uneven distribution of benefits	Green hydrogen and RE projects stand to benefit the monarchy of Morocco, business and political elites, and international business interests	Ensure economic participation of various stakeholders (SMEs, local communities, labour market, etc.) to guarantee a fair distribution of benefits. Knowledge transfer through trainings and research for the local population

Uneven distribution of risks	Local communities are disproportionately impacted by potential risks of hydrogen projects and the associated RE projects necessary to produce hydrogen energy.	Unbiased environmental risk assessments Hydrogen technology such as Salt Water Disposal plants to be used to mitigate water scarcity across the country

5.4.1 Discrepancy in Objectives, Values, and Capacities of Partnering Countries

One of the key challenges for two countries seeking to form a sustainable energy partnership is that they may differ greatly in their objectives, values, and capacities. For example, Germany's position as a liberal democracy and the values associated with that system of governance can be quite different from those of its energy partners. In Morocco, a constitutional monarchy in which the monarch controls much of the state's policies and resources, there are significant concerns about the protection of basic democratic freedoms such as secure land rights. The situation in the Western Sahara territory is a prominent example of this problem. Morocco has implemented development projects, including for renewable energy, by taking land in the occupied territory of Western Sahara, sometimes referred to as the Sahrawi Arab Democratic Republic (Blenkinsop and Eljechtimi 2021). These projects have been implemented without the proper consent and consultations of the people in the occupied territory, breaking European Union and international law (Ibid.). These illegal land grabs by the government of Morocco have increased as more land is necessary to meet the rising demand for more renewable energy projects (Baumann 2021). Further exacerbating the problem is that hydrogen production requires a high intensity of water. Already experiencing a water shortage, Morocco has increasingly turned to desalination plants; but in order for the final hydrogen product to be considered "green hydrogen" and a desirable product for importing countries such as Germany, these desalination operations will need to be powered by renewable energy (Ibid.). This places further pressure on the land and contributes to a worsening situation of human rights, particularly for the Sahrawi people in the occupied territories within Western Sahara.

The challenge of human rights in Morocco extends to freedom of speech. While Morocco has seen an emergence in environmental NGOs and other civil society organisations, the state has used its authority to keep them away from environmental issues considered "politically sensitive," such as renewable energy production (Heinrich Böll Stiftung 2016). Instead, they have been pressured by authorities to stick to less politically problematic issues, such as garbage collection and tree planting (Ibid.). This situation is exemplified by the history of the Moroccan Coalition for Environmental Justice. Originally founded as a diverse alliance of associations, trade unions and civil society to denounce Morocco's environmental injustice, it was co-opted by the government and became an unofficial propaganda body of the Moroccan state (Yousfi 2016; Thomas 2016). This silencing of critical voices conflicts with the freedom of speech (Meinungsfreiheit) principles of Germany's liberal governance system.

While Germany values the liberalization of markets, Morocco has provided little opportunity for private businesses to enter the renewables market (Baumann 2021). In fact, a legal basis has not been developed for businesses, communities, and private households to feed any surplus energy into the grid (Ibid.). The government lacks the political will to enable this liberalisation and democratisation of renewables because it would cut into their control of the market (Ibid.). These issues of corruption in Morocco's renewable energy strategy stem from the power of the monarchy. The king of Morocco is "not only the political, judicial, military, and religious leader of the country, he is also a businessman, controlling companies that operate in large-scale and lucrative markets" (Western Sahara Resource Watch 2021).

The objectives of Germany and its partnering countries may differ greatly due to their position in the energy transition. Germany's goal for the *Energiewende* is focused on a wide-scale renewable energy transition, which completely replaces fossil fuels. This strategy is reliant on energy imports and partnership development with countries such as Morocco (Steinbacher 2015). Meanwhile, Morocco is more focused on development or expansion of its energy system - the major goal is rather energy independence, job creation, and industrial policy (Ibid.). Morocco is far behind Germany in phasing out fossil fuels and increasing renewable energy production, creating a mismatch of objectives and capacities in a potential hydrogen partnership (Baumann 2021). Morocco's high dependence on imported fossil fuels, combined with its low capacity for technology manufacturing, makes it dependent on foreign manufacturers to help establish its energy infrastructure (Schinke and Klawitter J. 2016; Ahsan et al. 2021).

From the German perspective, there are some policy options which could address these discrepancies between the two partnering countries. First, Germany could utilise "soft power" methods to steer Morocco towards more democratic and socially just energy governance regimes, which better reflect its values (Quitzow and Thielges 2020). Germany could use its position of leadership and strength in the international community to present the case to Morocco that in the long run, it will benefit from respecting territorial sovereignty, protecting freedom of speech, and democratising energy markets (Ibid.). Next, Germany can cooperate with the EU to develop trade regulations and certification schemes to ensure that hydrogen imported from Morocco has been produced in a socially just and democratic manner. The race to produce green hydrogen for export may also lead to a "race to the bottom" for producing countries like Morocco, who may be forced to lower their sustainability standards in order to lower production costs and sell the lowest priced green hydrogen (Heinemann and Mendelevitch 2021). Germany could help Morocco to produce more sustainable hydrogen by providing further investments and technological support, particularly if the Moroccan government expresses its interest in promoting more democratic principles. Considering Morocco is a developing nation whose primary ambition is economic growth and development, Germany cannot expect Morocco to transition to renewable energy as quickly as Germany can. However, Germany could support Morocco in building a governance system that will ultimately be more sustainable and socially just.

5.4.2 Continuation of Fossil Fuel System Power Structures

The transition to renewable energy promises to bring about a more sustainable future, but there are concerns over whether this can be achieved simply by substituting fossil fuels with renewables. Many experts believe that the energy transition is fundamentally a political struggle, and therefore decarbonisation cannot be a success without also confronting and challenging the dominant systems of energy power, which generated so much harm to socio-ecological systems in the fossil fuel era (Burke and Stephens 2018). The strategy of "renewable energy by any means necessary" could lead to many of the same problems which plagued the fossil fuel era (Ibid.).

In the case of Morocco, the ruling elite have treated the global demand for renewables as an opportunity to generate profits in the name of protecting the environment (Heinrich Böll Stiftung 2016). Many companies involved in green energy projects in Morocco have been linked to environmental degradation, such as the Société Nationale d'Investissement (SNI) holding company (Ibid.). The SNI, whose largest shareholder is the Moroccan royal family, is branded as a leader in sustainable development in Morocco, especially in wind energy (Ibid.). However, its subsidiaries have been involved in pollution disasters such as the contamination of aquifers, which have led to ongoing conflicts with the local population over water resources (Ibid.). Relatedly, the wind parks in occupied Western Sahara "provide energy for Morocco's exploitation of non-renewable resources" (Western Sahara Resource Watch 2021). For example, almost the entire phosphate industry in the Western Sahara territory is controlled by a Moroccan-owned company that runs on

wind energy (Ibid.). The removal of Sahrawi people from their land and the disruption of their traditional ways of life in order to make way for these renewable energy projects is reminiscent of the long history of extractivism and exploitation of communities under fossil fuel and colonial power structures (Baumann 2021).

Furthermore, one of the main elements of fossil fuel power structures, the intervention of large international investors in developing nations for the purpose of exporting energy to more industrialised nations, is being reproduced in the Moroccan context (Ibid.). The large solar power plants and wind farms in Morocco have been funded primarily by international development banks, such as the German KfW (Ibid.). Meanwhile, Moroccan civil society institutions have criticised these projects as being planned without their consent and as offering few local jobs (Ibid.). The royal family's economic stake in land grabs for the purpose of green development projects appears to be a manifestation of neocolonialism.

One of the considerations for Germany when creating a partnership is whether it will lead to a "resource curse" as has been observed in many oil-producing countries (Ahsan et al. 2021). If hydrogen becomes an increasingly important source of income and job creation in Morocco, the welfare of its people could become increasingly dependent on importing countries like Germany (Ibid.). Furthermore, as these projects would be co-financed and co-owned by international investors and the Moroccan state, there is a concern about misappropriation of funds by the Moroccan government away from key areas such as social programs, education or healthcare to make way for renewable energy production (Ibid.).

From Germany's end, there are a few policy options that may help to remediate these persistent power structures and form a more sustainable hydrogen partnership with Morocco. First, there could be a formal acknowledgement of the harmful legacies of colonial structures and fossil fuel systems. As a former colony itself, Morocco inherited a system with gross power imbalances both within the country and in comparison to other countries such as Germany, who have benefited directly or indirectly from colonial power structures. These power imbalances have to be recognised in the formation of a hydrogen partnership in order to assess whether the energy generated is actually "clean," or whether its production will contribute to further social instability in exporting countries. In this sense, Germany can use diplomatic avenues to push Morocco towards a more equitable and democratic energy production system. This could entail increased participation of local stakeholders in planning processes, more equitable distribution of energy revenues, or development of public institutions to fight against corruption.

5.4.3 Geopolitical Conflict

Operating within the international governance system, hydrogen partnerships must consider the geopolitical implications of such international agreements. These partnerships may generate or reinforce conflicts in partner countries. In the Moroccan case, there is the issue of the recognition of the Sahrawi Arab Democratic Republic and their territorial sovereignty. In 2021, Germany faced a diplomatic crisis with Morocco after "adopting a negative position on the question of Morocco's sovereignty" over Western Sahara (Sanz 2021a). The incident led to a recall of the Moroccan ambassador in Berlin and an announcement by the Moroccan Ministry of Foreign Affairs accusing Germany of "hostile acts" which would be "detrimental to the higher interests of the Kingdom" (Sanz 2021b). This situation led to a temporary halt to the hydrogen agreement between the two countries, directly threatening Germany's plan to achieve eventual carbon neutrality (Ibid.). The refusal by Morocco to cede any diplomatic ground to the demands of the Sahrawi Arab Democratic Republic should force Germany to consider whether this hydrogen partnership is truly in the best interest of its national energy transition strategy. The exclusion of the Sahrawi Arab Democratic Republic from international processes of climate governance and climate finance at the request of the

Moroccan state is a humanitarian and geopolitical problem which will not go away easily and needs to be considered under the Germany-Morocco hydrogen partnership (Democracy Now 2021).

Germany can consider several policy options to potentially move forward with a less diplomatically-problematic hydrogen partnership with Morocco. For example, the partnership could include provisions that recognize the Sahrawi territory and mandate the inclusion of the Sahrawi and other local stakeholders in planning processes.

5.4.4 Loss of Traditional Culture and Livelihoods

Moroccan energy development projects seem to hold the trend of impacting the Sahrawi's nomadic lifestyle by forcing them to move away from occupied territories. Therefore following the discussion of the current geopolitical conflict (as mentioned above), policies aiming to maintain the Sahrawi's heritage and rights have to be entrenched in deeper political dynamics that would have to be discussed on an international level including the European Court of Justice. Mitigation options that could preserve the locals' traditions can be explored through Social Impact Assessment that include participatory processes. Moreover, civil society organisations can increase international awareness through social media and campaigns in order to pressure the Moroccan government to ensure that the Sahrawi's rights are maintained.

5.4.5 Uneven Distribution of Benefits Livelihoods

As mentioned in 5.3.1 Distributional Justice, the development projects under Morocco's energy strategy are dominated by entities that are allegedly linked to the monarchy and political elites. Therefore economic participation should be enabled within hydrogen production and transportation to ensure that the benefits of the projects are reaped across various groups of the society. According to an Oeko-Institut study, this should happen on two levels. First, small and medium businesses should be given a chance to operate in the new energy sector. Moroccan SMEs might be currently lacking the required expertise to produce required parts such as PV panels, wind turbines, electrolysis, desalination plants, power lines, etc.. However, future agreements should tackle this through knowledge transfers in order to allow the sector to decentralise. Moreover, economic participation is enabled through creation of permanent jobs beyond manual work, which is possible through technical and vocational training (Heinemann and Mendelevitch 2021, p.26).

It is worth noting that the Moroccan strategy stresses on the establishment of a fair industry for national stakeholders as well as citizens. Detailed actionable plans to ensure justice are still not available. However, it states that there is a plan to *"strengthen university-industry-research-coordination"*, which shows commitment to a socially beneficial project (Maroccan Ministry of Energy Transition and Sustainable Development 2020). The strategy also aims at creating industrial clusters to develop hydrogen and infrastructure technologies along with training of human resources (Ministry of Energy, Mines and Environment 2021). Finally, communities hosting parts of the hydrogen value chain or those that are in near REs plants should participate in respective financial gains (i.e., cheaper electricity prices), which might secure the long-term acceptance of hydrogen plants.

5.4.6 Uneven Distribution of Risks

The impacts of hydrogen production and its infrastructure are not yet available or made public, which raises the question of to what extent are those projects environmentally sustainable. A group of factors come into place when implementing hydrogen projects and the associated RE projects, such as land use change and overexploited water resources, which can have disproportionate risks on local communities. In order to assess these risks, Environmental and Sustainability Risk Assessments should be conducted, independent from the interference of stakeholders who claim economic interests in the projects (Heinemann and Mendelevitch 2021, p.5). Assessments must be both technical (involving scientific experts) and participatory (involving local stakeholder groups). The Ministry of Energy, Mines, Water and Environment in Morocco is responsible for both energy and mining as well as environmental sustainability. Therefore, under the partnership agreement, Germany should push for third parties to conduct the assessment in order to maintain neutrality. Hydrogen technology benefits should be diffused into other sectors to help elevate environmental pressures. For example, technology arising as a result of hydrogen production such as the Salt Water Disposal (SWD) plants should be used in order to relieve water scarcity pressures from the local communities. Therefore, future agreements should ensure that fresh water produced can also be navigated to benefit smallholder agriculture and households. Moreover, the price of water and electricity should be monitored, and measures are to be put in place to avoid an increase in prices due to hydrogen production (Ibid.).

6 Options for Action

The previous section described the findings of potential environmental justice challenges from the case study of a German-Morocco hydrogen partnership. Based on those case-specific findings, we address our research objective in this section by abstracting insights that could be generalised to other potential hydrogen partnerships with other producing and exporting countries, especially from the Global South.

The following policy-relevant end-products could be formulated from our research: First, a preliminary criteria list to assess hydrogen partnerships, and second, a policy instrument toolbox that is available to policy makers to mitigate risks identified from the assessment.

6.1 Criteria List for Hydrogen Partnerships

From our case study findings, the Hess and Ribeiro 2016framework proved to be helpful as a starting point. However, additional criteria were identified based on the study that would supplement the existing list.

The main goal of the criteria list is to assess if a potential partnership will create more challenges for environmental justice or to exacerbate the problem, a very important element to consider as green hydrogen projects have a tendency to sidestep potential conflict due to the perceived “inherent value” of the projects (i.e. the assumption that green hydrogen is beneficial for the society so it should be promoted and resistance would be seen as going against the “common good”).

Based on our study, the following is a preliminary compilation of the criteria checklist for hydrogen partnerships, with additions/modifications from the original framework indicated with asterisks(*). The additional criteria were added from the case findings, some of which were modified from items from Sovacool and Dworkin 2015. A cursory attempt to compare and consolidate these two frameworks is described in 10.2 Appendix 2 – Selection of Frameworks, however it is not added here because of time and resource constraints to analyse it in detail, hence only criteria identified through the case study was added here.

Table 8: List of relevant criteria for hydrogen partnerships

Dimensions	Relevant Aspects
Distributional Justice	What are the purposes of the project? What will the energy produced serve for? How much of it will be exported to other regions and how much will be used in the region? Which policies can be applied to secure a socially and economically positive contribution of energy production to the local region? Who/which groups of people will primarily be affected negatively by the project (including its possible supply chain)? Do they belong to already environmentally and socially discriminated groups? What can be done to protect them and include them in the benefit sharing? *Which communities will possibly benefit and which will be negatively affected by the project? *(this is already originally in the Hess framework but has been reordered here from 'Other Aspects' because it addresses cost and benefits distribution)* Does the project include fundamental conflicts on the mode of appropriation of nature (with indigenous or traditional populations)? What can be done to approach this conflict within the project? Will the project possibly lead to further distributional conflicts on the use of natural resources? What can be done to secure the fair distribution of natural resources? Should multiple purposes be considered in the project? How can the benefits of these purposes be distributed in a just manner? *What is the percentage of generated revenue that stays in the area where hydrogen is produced? *Do potential accident zones disproportionally affect marginalised and/or low-income communities? *Are people being forced to migrate away from their traditional lands?
Recognition	Which people and populations will be affected by the project (considering physical and livelihood displacement, direct and indirect impacts) -> Definition of the proper territorial scale to ensure recognition. Is recognition of all (directly and indirectly) from the project affected people possible? What has to be done to ensure this? Are there special cultural or traditional populations affected by the project, whose particular socioeconomic conditions and cultural needs have to be taken into account? Does the project involve religious and/or spiritual conflicts? *Do the activities in connection with an energy facility negatively impact other economic activities that were prevalent in the area before the facility was built?

Procedure	Definition of the proper territorial scale for impact studies (if water resources are affected: river basin) IEIA: Are there other important projects/socioeconomic transformations occurring or planned in the area that have to be taken into account? Allocate the IEIA before the decision making Is a differentiated consultation process of indigenous and tribal peoples necessary? If yes, how can it be approached? How can representative entities of the local population be included in the decision process? Is the project likely to lead to attempts of political manipulation? What can be done to avoid this? *Is the allocation of energy revenues transparent? *Is hydrogen production contingent on the support of a partner country's government with a history of corruption issues? *Have all local stakeholders been consulted, particularly those who stand to lose the most from hydrogen generation projects?
*Appreciative Justice	*What role do historical legacies of colonialism and fossil fuel extractivism play in the power imbalances and exploitation between actor groups witnessed today? *What are the broader international and geopolitical contexts of the region and how do they inform potential pathways for restorative justice?
Other aspects	Which community capabilities are at stake? Can a functioning of all communities with the project be secured or is there a realistic chance to achieve this outcome? Are there traditional populations and/or communities with special demands? If yes, which are these demands? How can they be addressed? Is there an incommensurability of values involved in a possible conflict situation? *Does the partner country comply with the International Labour Organisation's Core Labour Standards? *Has the partner country failed to protect human rights such as the right to protest, access to clean drinking water, access to energy, indigenous rights, etc.? *Will a proposed hydrogen project lead to a "lock-in" of carbon intensive infrastructure? *To what extent does hydrogen production rely on the physical infrastructure systems inherited from hydrocarbon production/transportation (e.g. pipelines, diesel trucks, etc.)?

This is not an exhaustive list and further research should be conducted to:

1. **Fine-tune the criteria list for assessments**
    a) Generally, the questions can be fine-tuned to be more specific to hydrogen and also to reduce redundancies between the questions to yield a more manageable list of mutually exclusive criteria (to the extent possible, given the interrelation of certain items)
    b) Additional resources such as the assessment frameworks mentioned by Fredershausen et al. 2021 should be reviewed to ensure no component is missing. In particular, the criteria list from Sovacool and Dworkin 2015 should be further incorporated, as they include temporal and technological aspect missing in the Hess framework (for more details, see 10.2 Appendix 2 – Selection of Frameworks)
    c) The criteria list can be further fine-tuned by testing it out in more applications (e.g. with different potential hydrogen partnerships)
2. **Formulate assessment methodology, scales of assessments/scoring, decision threshold for deciding on a partnership, etc.**
    a) The current qualitative list is a helpful starting point but needs to be further operationalize to be used as a meaningful component of the process to evaluate hydrogen partnerships
    b) In particular, the guidelines published by UNEP for a Social Life Cycle Assessment of Products and Organisations (Benoit Norris. et al. 2020) may provide a starting point that can be integrated into the life cycle approach already prevalent in hydrogen assessment literature
3. **Integrate these criteria into a holistic sustainability assessment, rather than as a separate "environmental justice" component**
    a) An assessment tool is only useful if it is used. As mentioned by (Fredershausen et al. 2021), the social sustainability component of hydrogen production is often overlooked. This could be addressed by creating a comprehensive assessment tool that incorporates technological feasibility along with the environmental, economical and social sustainability (including energy justice perspectives) components. This tool should then be used to evaluate potential hydrogen partnerships to assess potential risks. The categorisations by Sovacool and Dworkin 2015 or Fredershausen et al. 2021 offer potentials to move beyond the environmental justice dimensions and towards a more holistic and integrated approach

6.2 Policy Instruments Toolbox

The assessment provides a starting point for a partnership, not an 'end grade'. It should be viewed as a risk assessment - the risk of exacerbating environmental justice through the partnership. As a partner, Germany can work with the exporting/producing countries to develop mitigation plans to address the issues highlighted / identified through the assessment as part of the negotiations of partnerships. Here are some policy instruments available in the German policy maker's toolbox identified through the case study and supplemented by literature review.

Table 9: Policy instruments Toolbox

Policy Instruments Toolbox
Conduct unbiased Environmental Risk Assessments/ Social impact assessment including sustainability and EJ criteria
Cooperate with the EU to develop trade regulations and certification schemes to ensure that hydrogen imports have been produced in a socially just and democratic manner (with special attention paid to local water security)
Provide further investments and technological support for sustainable hydrogen infrastructure (focus on water efficiency)
Formal acknowledgement of the harmful legacies of colonial structures and fossil fuel systems in partnering countries
Provide vocational and technical training for local stakeholders, including transfer of know-how to take part in the labour market opened by the hydrogen economy
Enhance involvement of local companies (SMEs) and education and research centers in the hydrogen production and transportation process
Formalise land tenure rights so that revenues could potentially be generated for local communities from lending their land for hydrogen projects
Strengthen (and enforce) current environmental protection laws to avoid misuse of water resources and biodiversity loss
Develop mechanisms to share financial gains with communities hosting parts of hydrogen value chain
Shape narratives/discourses by utilising "soft power" methods to steer international energy partners towards more democratic and socially just energy governance regimes which better reflect these values
Development/research of policy instruments for partnership agreements related to hydrogen

This is not an exhaustive list. Further research should be conducted to build upon the list given the characteristics of hydrogen partnership, e.g. cross-border technological development, infrastructure development, etc.

If the risk cannot be reduced through policy instruments as part of the partnership, then the producing country may not be a suitable partner for Germany. Measurements and monitoring process, thresholds for acceptance, among other factors, will need to be further defined.

7 Discussion

7.1 Limitations of the Study

There are considerable limitations of this study. Grunwald 2019 as summarised by Späth 2022 listed the following quality criteria of Technology Assessments: grounded anticipation of future, comprehensiveness, participation, and transparency. Adequate fulfilment of the first two criteria are constrained by our methodological and scoping limitations (detailed below). It was also not possible to be inclusive in participation due to time and resource constraints, although we have tried to include information from multiple sources where possible. With regards to transparency, please refer to our Methodology and Appendix, in particular 10.3 Appendix 3 – Reflections on Positionality.

7.1.1 Scoping Limitations

Due to the time frame of the project, not all elements that are important for a complete overview of future hydrogen policy could be considered. For example, other production methods of hydrogen, such as blue, would also have to be considered - their potential use as a bridging technology and the associated risks. The dynamism of the development of hydrogen technology and its emerging narratives could also not be adequately explored, which may give a false impression of a system that is not as dynamic as it actually is.
Our assumptions (2.2 Scoping the Project) need to hold in order for the future scenario to be feasible. However, these assumptions are based on a cursory understanding of the field from the limited research timeline, therefore there might be important elements that were missed in our understanding of the system and its assumptions.

These limitations may affect the quality of our project with regards to comprehensiveness and grounded anticipation of the future.

7.1.2 Data Limitations

From a data perspective, we had to operate under certain limitations, both due to the tight time frame and data availability. For example, the social aspects of hydrogen are not well studied (Fredershausen et al. 2021). Among the sources found, many are from organisations that tend to be politically left-wing. Overall, environmental/energy justice is a concept that tends to come from a left-leaning perspective. English-language sources were used almost exclusively for the study. Only a few German-language articles and no French/Arabic-language articles were consulted.

Additionally, some of the official partnership reports were not publicly accessible, and we had to rely on official communication channels from participating organisations and governing bodies or media outlets reporting on the agreement. Furthermore, due to the novelty of the green hydrogen partnership, developments such as the temporary suspension of the agreement, and possible impacts of the COVID-19 pandemic, were not studied in detail, particularly because there are few peer-reviewed studies to rely on.

7.1.3 Methodological Limitations

Due to time constraints, we relied on the existing, but relatively broad energy-justice framework of Hess & Ribeiro 2016 to structure our research into the German-Moroccan partnership. This may have prompted us to focus more on few, albeit prominent, forms of injustices, such as impacts on local communities from land use change and forced displacement. A more focused framework for energy-related infrastructure

projects may have led us to assess other issues and thus come up with other policy instruments (e.g. electricity pricing, energy tariffs, impacts along the entire value chain, especially on the transport and consumption side). Our focus was almost explicitly focused on production-side and land use changes. We were not able to comparatively analyse the other major approach to frameworks in energy justice by Sovacool and Dworkin 2015 and the synthesis attempt by Heffron and McCauley 2017. To our knowledge, there are few applications of the various frameworks available, especially on international relations.

We were also only able to conduct literature review in the timeframe, which limited the insights we could gain.

7.2 Avenues for Further Research

The aim of further research would be to expand the framework and adapt it to the analysis of international partnerships. For this, a review and comparative analysis of the frameworks listed in Fredershausen et al. 2021 and Heffron and McCauley 2017 would be useful. This would be followed by compiling a list of criteria and conducting informational interviews with experts to gather feedback and adjust accordingly. To fit it to hydrogen partnerships, a more thorough, in-depth literature review on hydrogen partnerships and other expert interviews are necessary. Feedback should also be gathered from appropriate stakeholders such as policy makers, policy analysts, scientists, researchers, governmental agencies, industry actors, environmental activists and so on.

The resulting framework could be used to explore other potential hydrogen partnerships. If needed, it could also be adapted to other future energy forms. In addition to studies of countries with obvious room for improvement in social justice, such as Morocco, a comparison with relatively developed economies such as Norway would be interesting.

8 Conclusion

From the study, we found it to be crucial to incorporate environmental justice as a perspective when assessing potential hydrogen partnerships. This perspective brought to light certain issues that were not adequately addressed if only looking at it from a technological and economical perspective. Therefore, it is necessary to add the lens of environmental justice to the agenda when looking into potential partner countries. The question needs to be raised: What impact will this hydrogen partnership have in exacerbating environmental justice issues? In the case of Morocco, several red flags have been identified through the assessment and sufficient mitigation options must be developed if the partnership agreement should be continued.

As next action steps, we recommend that policy makers:

1. Formulate a comprehensive and holistic assessment criteria list for potential hydrogen partnerships
   The one provided above can serve as a starting point, but research should be done to include additional components such as technological and environmental components (e.g. distance to Germany, potential for renewable energy generation, environmental impact analysis, etc.)
2. Ensure assessments are conducted prior to starting hydrogen partnership talks (or at least as part of the negotiations)
   A preliminary scorecard beyond the hydrogen production and export potential should be taken into consideration when assessing potential hydrogen partnerships

8.1 Open Questions

Some questions were raised as part of this study that were beyond the scope to answer, but need to be considered.

8.1.1 Limitations of International Hydrogen Partnerships

To what extent can international hydrogen partnerships advance environmental justice in the producing countries? These partnerships are limited by many factors, not least the sovereignty of the producing countries, but also in the form of the partnerships (i.e. not just binding trade agreements) as well as the stakeholders involved (not just governments but also private sector/industry actors). Many national-level energy policies contribute to environmental injustice, but it may not be possible / appropriate to influence national energy policies through a hydrogen development partnership.

8.1.2 Role of Partnerships

More broadly, what is the role of international partnerships in promoting sustainable development and environmental justice? To what extent should Germany aim to "enforce" its ideas of "justice and democracy" on the producing countries through a hydrogen trade partnership? Is it democratic for a Global North country with considerable wealth and resources to attempt to "democratise" its partner country through conditions, incentives and penalties in partnerships? To what extent is this exacerbating a Global North-South power dominance? Are there alternatives that would be more just, such as reducing its own energy consumption instead of outsourcing the cost of clean energy production abroad?

8.1.3 To Partner or Not to Partner: What is the "Right" Decision?

If a potential partnership is found to be risky, is it better to "do a little good" by entering a "risky partnership" or is it better to not refuse to enter any "risky partnership" (but then have no leverage to create change)? Germany or the EU are not the only partners interested in hydrogen technologies (green or otherwise). For example, in the case that Germany chooses not to partner with Morocco due to the social risks involved with the local population, that does not prevent Morocco from forming partnerships with other countries for whom that is not a concern. Without any partnership, there is naturally no leverage for Germany to influence or improve the lives of the local population. However, does this possibility to improve the conditions of the producing country (e.g. the chance of influencing Morocco to embrace more democratic ideals) outweigh the possibility of exacerbating environmental justice challenges in the producing country?

These are fundamental questions that could not be addressed in our report but merit consideration from German and EU policy-makers when exploring potential hydrogen partnerships.

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10 Appendix

10.1 Appendix 1 – Search Strategy

This section roughly outlines the keywords / search terms used during the literature review and search for data. Generally the platform used is through a search engine or through Google Scholar. A snowball method is often used to find additional related resources. Abstracts were scanned to determine relevance to the topic. We did not record the number of articles found and disregarded due to lack of time and because this is not a study reviewing the state of the literature.

Table 10: Keywords /Search Terms

Concepts	Keywords / Search Terms
Environmental Justice Framework	Energy justice; Energy justice framework; Environmental justice; Justice dimensions; Social sustainability; Energy transition
Potential policy instruments	Policy instruments/recommendations energy justice; Bilateral partnerships energy justice
Environmental challenges of hydrogen production	Hydrogen technology gap; hydrogen health impacts; hydrogen water consumption; Societal impacts
German-Morocco Hydrogen Partnership Case Study	National Energy Strategy; Western Sahara conflict; Morocco-Germany; Sahrawi Arab Democratic Republic, Occupied and Liberated Territory; Extractivism; Marginalization; Green Grabbing; Green hydrogen agreements, partnerships; Environmental assessment; Greenwashing; Renewable Energy Infrastructure

10.2 Appendix 2 – Selection of Frameworks

10.2.1 Assessment Framework / Criteria List

A preliminary literature search did not yield many results regarding frameworks to structure the formulation of criteria for assessing hydrogen partnerships from an environmental justice lens. Three frameworks were regarded as promising and were considered:

1. Seven-dimension energy security-justice framework from Hancock and Wollersheim 2021 (Table 11)

Table 11: Seven-dimension energy security-justice framework (Hancock and Wollersheim 2021, p.7)

Dimension	Underlying Values	Components
1. Availability	Self-sufficiency, resource availability, security of supply, independence, imports, variety, balance, disparity. Focus on security of supply and/or domestic production of critical materials for RE technologies.	- Security of Supply and Production - Dependency/Diversification
2. Affordability	Cost, stability, predictability, equity, justice, reducing energy poverty	- Price Stability - Access and Equity - Decentralization - Affordability
3. Technology Development and Efficiency	Investment, employment, technology development and diffusion, energy efficiency, stockholding, safety and quality	- Innovation and Research - Safety and Reliability - Resilience - Efficiency and Energy Intensity - Investment and Employment
4. Environmental and Social Sustainability	Stewardship, aesthetics, natural habitat conservation, water quality and availability, human health, climate change mitigation, climate change adaptation. Social sustainability, human rights, human (individual) security, Sustainable Development, positive outcomes for communities.	- Land Use - Water - Climate Change - Pollution - Human Security
5. Regulation and Governance	Transparency, accountability, legitimacy, integrity, stability, resource curse, geopolitics, free trade, competition, profitability, interconnectedness, security of demand, exports. Foreign policy, international relations, international treaties.	- Governance - Trade and Regional Interconnectivity - Competition and markets - Knowledge and Access to Information - Geopolitics/Foreign policy
6. Just and ethical socio-technical energy transitions	Values are identified by applying Cherp and Jewell's [68] three key questions: - Security for whom? - Security for which values (and interests)? - Security from what threats?	- The politics, governance and ethics of risk and vulnerability. - Identifying what is being protected in the way energy security is being framed and in whose interests. - Identifying just and ethical socio-technical energy transitions.
7. Supranational Carbon mechanisms	- Level playing field for domestic products/imports on carbon emissions - Non-voluntary import carbon-cost equalization fee - Incentivizing lower carbon emission fuel/energy production by trading partners [carbon diplomacy]	- Border levy/tariff on carbon emissions in supply chain to combat climate change [i.e., global insecurity]. - Carbon/emissions certification scheme with broader international remit.

2. Examples of justice considerations in clean energy policy design and implementation based on Zhou and Noonan 2019- framework included later
3. Model of an Environmental Justice Protocol to be Applied in Energy Projects by Hess and Ribeiro 2016

The first framework by Hancock and Wollersheim 2021 was deemed to be too broad and difficult to operationalize. The second by Zhou and Noonan 2019 were more about policy options and not assessment of environmental justice aspects, thus the third by Hess and Ribeiro 2016 was deemed to be most suitable.

Subsequently during the research, an additional framework by Sovacool and Dworkin 2015 was found. This framework of investigation is focused on the application of energy justice. It is divided into eight principles, and thus takes a different approach (Sovacool and Dworkin 2015). In the emerging field of energy justice, Heffron and McCauly attempt to synthesise these two approaches and therefore developed the concept of "restorative justice," an adjunct to the three dimensions of justice.

Although we were not able to consolidate the approaches of the different frameworks in our assessment approach for the case study, these concepts provided a background of understanding for other sections of the report.

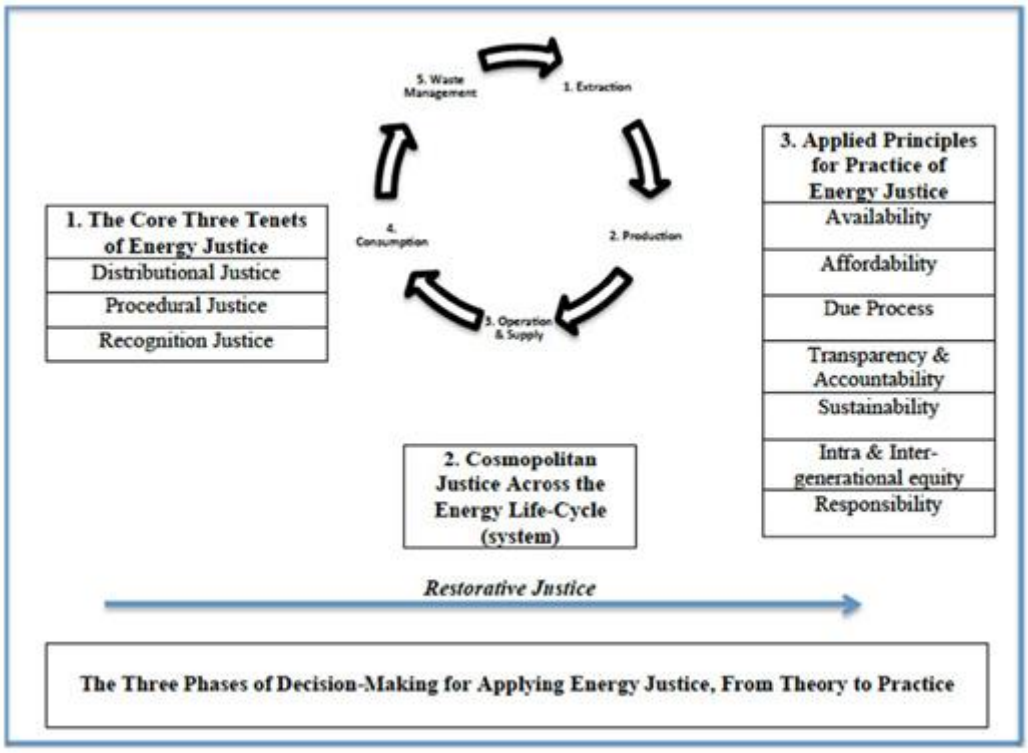

Figure 2: The energy justice conceptual framework (Heffron and McCauley 2017)

Due to time constraints it was not possible to conduct a detailed comparative analysis of the different frameworks and assessment tools to create a comprehensive framework.

However, a cursory comparative analysis of the Sovacool and Dworkin 2015 checklist compared with the Hess and Ribeiro 2016 framework yielded some findings as briefly outlined below.

Generally the three dimensions of environmental justice (distributional, recognition, procedure) were also covered in the Sovacool and Dworkin, although the categorizations of Temporal, Economic, Geographic, Sociopolitical, Technological) may prove to be an easier structure to work with for policy-makers or other stakeholders in assessments. For example:

Table 12: Similarities between the justice dimensions and the aspects according to Sovacool and Dworkin 2015

EJ Dimension	Aspect from Sovacool & Dworkin	Question
Distributional	Geographic	What is the percentage of generated revenue that stays in the area where hydrogen is produced?
Distributional	Economic	Does switching to a more sustainable energy mix disproportionately affect poor members of the society?
Distributional	Temporal	Does a country's energy policy interfere with its responsibility to aid victims of climate change?
Distributional	Temporal	Will construction of an energy facility exacerbate environmental damage?
Distributional	Temporal	Does a decision to subsidise a certain energy industry add to the cost of externalities?
Distributional	Economic	How does energy affect the distribution of wealth in a country?
Distributional	Technological	Do potential accident zones disproportionally affect low-income communities?
Procedural	Sociopolitical	How transparent is the allocation of energy revenues?
Procedural	Sociopolitical	To what extent does an energy company rely on the support of the central government known for its questionable governance methods?
Procedural	Sociopolitical	Does the legal and regulatory regime of a country whose economy is dependent on export of oil and gas provide for meaningful participation of its citizens in the decision-making process related to energy matters?
Procedural	Geographic	Do the activities in connection with an energy facility negatively impact other economic activities that were prevalent in the area before the facility was built?
Procedural	Technological	Have appropriate consultations taken place on the national and, if appropriate, international levels to ensure societal acceptance of accident risk?

Temporal and dynamic components were lacking in the Hess and Ribeiro 2016 framework (a limitation also mentioned by the authors), which are crucial components when dealing with climate change as well as technological solutions to it (e.g. hydrogen), as these issues have long temporal span and decisions made today need to reflect considerations of the future. For example:

Table 13: Temporal and Dynamic components of energy justice (Sovacool and Dworkin 2015)

Aspect	Question	Hydrogen Example
Temporal	Does a decision to build energy infrastructure account for the physical risks posed by climate change?	If hydrogen plants are built close to the coast for offshore wind power and shipping routes and proximity to H20 input, will they be affected by rising sea level? Will drought or other water supply risks from climate change jeopardise hydrogen productions in the particular site?
Temporal	Does an energy-related decision account for regulatory risks associated with climate change?	Will the decision to expand hydrogen markets and its development be jeopardised by an artificially low price (from international agreements to ensure hydrogen competitiveness) that would make the recuperation of capital costs difficult?
Economic	To what extent does the construction of an electrical generation facility account for volatility of oil and gas prices?	This applies if hydrogen transportation requires oil to function (e.g. if using fossil-fuel based long-haul trucks). This can also be modified to be more general of a question by replacing "oil and gas prices" to prices of input

Comparison with the Sovacool & Dworkin framework also highlighted some gaps in the Hess & Ribeiroro framework in specificities of the technology and direct impact on the environment (the Hess & Ribeiroro framework focuses more on human aspects). For example:

Table 14: Potential environmental impacts of energy (Sovacool and Dworkin 2015)

Aspect	Question	Hydrogen Example
Geographic	Does an electrification plan include support for distributed generation and development of micro-grids?	To what extent will development of hydrogen production infrastructure affect this?
Technological	Does a proposed technology lock out low-carbon solutions?	Does the "reliance" on importing green hydrogen reduce incentives to increase production potential from renewables in Germany (e.g. due to resistance to wind turbines by the local population?) or to pursue sufficiency? What "guarantees" should exporting countries have in the case that low-carbon solutions were developed and they were left to foot the bill of developing expensive green hydrogen infrastructure that is no longer required?

However, the Sovacool and Dworkin checklist also includes many very specific questions that are not relevant for hydrogen partnerships in general, for example:

Table 15: Non-relevant aspects of the Sovacool and Dworkin checklist (Sovacool and Dworkin 2015)

Temporal	Does a plan to build a nuclear waste storage facility provide for long-term risk mitigation measures?
Temporal	Does the cost of owning and operating a motor vehicle fully reflect the external cost caused by air pollution?

Economic	Does the mix of electric generation facilities match the actual demand?
Economic	What is the full price of military presence in oil producing regions?
Geographic	Does a proposal to mine coal include a plan to repair necessary infrastructure, decommission unneeded infrastructure, remediate the affected environment, and ensure sustainable economic growth after extraction activities have ended?
Technological	Does a fossil fuel-centric project require a multibillion-dollar investment that would take decades to repay?
Technological	What is the horizontal distribution of energy efficiency capacity?
Technological	What is the vertical distribution of energy efficiency An energy efficiency program targeting generation facilities capacity?
Technological	Does a technological solution intended to improve reliability reach the end user regardless of her income level?

Table 16: Summary Overview of Comparison and potential mapping

HESS (2016) FRAMEWORK		SOVACOOL & DWORKIN (2015) FRAMEWORK	
Dimension	**Relevant Aspect**	**Aspect**	**Question**
Distributional Justice	What are the purposes of the project?		
	What will the energy produced serve for? How much of it will be exported to other regions and how much will be used in the region?		
	Which policies can be applied to secure a socially and economically positive contribution of the energy production to the local region?	Economic	Does switching to a more sustainable energy mix disproportionately affect poor members of the society?
	Who/which groups of people will primarily be affected negatively by the project (including its possible supply chain)? Do they belong to already environmentally and socially discriminated groups? What can be done to protect them and include them in the benefit sharing?	Temporal	Does a country's energy policy interfere with its responsibility to aid victims of climate change?
	Does the project include fundamental conflicts on the mode of appropriation of nature (with indigenous or traditional populations)? What can be done to approach this conflict within the project?	Temporal	Will construction of an energy facility exacerbate environmental damage?
	Will the project possibly lead to further distributional conflicts on the use of natural resources?	Geographic	What is the percentage of generated revenue that stays in the area where hydrogen is produced?

	What can be done to secure the fair distribution of natural resources?	Economic	How does energy affect the distribution of wealth in a country?
	Should multiple purposes be considered in the project? How can the benefits of these purposes be distributed in a just manner?		
Recognition	Which people and populations will be affected by the project (considering physical and livelihood displacement, direct and indirect impacts) -> Definition of the proper territorial scale to ensure recognition.	Technological	Do potential accident zones disproportionately affect low-income communities?
	Is it possible to recognize all people possibilty affected by the project (directly and indirectly)? What has to be done to ensure this?		
	Are there special cultural or traditional populations affected by the project, whose particular socioeconomic conditions and cultural needs have to be taken into account?		
	Does the project involve religious and/or spiritual conflicts?		
Procedure	Definition of the proper territorial scale for impact studies (if water resources are affected: river basin) IEIA: Are there other important projects/socioeconomic transformations occurring or planned in the area that have to be taken into account?	Geographic	Do the activities in connection with an energy facility negatively impact other economic activities that were prevalent in the area before the facility was built?
	Allocate the IEIA (integrated environmental impact assessment) before the decision making? – transport infrastructure, production RE, water usage, etc. -doesnt have to be quantified but qualitatively/illustratively described!!		
	Is a differentiated consultation process of indigenous and tribals peoples necessary? If yes, how can it be approached?		
	How can representative entities of the local population be included in the decision process?	Sociopolitical	Does the legal and regulatory regime of a country whose economy is dependent on export of oil and gas provide for meaningful participation of its citizens in the decision-making process related to energy matters?
	Is the project likely to lead to attempts of political manipulation? What can be done to avoid this?	Sociopolitical	To what extent does an energy company rely on the support of the central government known for its questionable governance methods?

		Sociopolitical	How transparent is the allocation of energy revenues?
		Technological	Have appropriate consultations taken place on the national and, if appropriate, international levels to ensure societal acceptance of accident risk?
Other Aspects	Which community capabilities are at stake?		
	Which communities will possibly benefit and which will be negatively affected by the project?		
	Can a functioning of all communities with the project be secured or is there a realistic chance to achieve this outcome?		
	Are there traditional populations and/or communities with special demands? If yes, which are these demands? How can they be addressed?		
	Is there an incommensurability of values involved in a possible conflict situation?		
		Temporal	Does a decision to build energy infrastructure account for the physical risks posed by climate change?
		Temporal	Does an energy-related decision account for regulatory risks associated with climate change?
		Temporal	Does a decision to subsidise a certain energy industry add to the cost of externalities?
		Economic	To what extent does the construction of an electrical generation facility account for volatility of oil and gas prices?
		Technological	Does a proposed technology lock out low-carbon solutions?

10.2.2 Policy Option Framework / Structure

The following frameworks were used in an attempt to come up with potential policy options in a systematic way.

1. Examples of justice considerations in clean energy policy design and implementation:

Table 17: Examples of justice considerations in clean energy policy design and implementation (Zhou and Noonan 2019)

General Category	Policy Instruments	Policy Design Options	Energy Justice Tenets
Regulatory	Utility regulation	Electricity prices	Distributive
		Siting of energy infrastructure	Distributive; procedural
	Mandatory targets and quotas	Target setting	Distributive
		Penalty	Distributive
		Redistribution of penalty funds	Distributive
		Opt-out options	Recognition
		Eligibility of technologies and systems	Distributive
	Net metering or distributed generation compensation rules	REC ownership	Recognition
		Buy-back prices	Distributive
		Eligibility of technologies and systems	Distributive
	Interconnection standards	Application information and procedures	Procedural
		Agreement form	Procedural
		Eligibility of technologies and systems	Distributive
Financial	Loans, grants, tax credits, rebates, and feed-in tariffs	Eligibility and selection criteria	Distributive
		Payment levels	Distributive
		Eligibility of technologies and systems	Distributive
		Program caps	Distributive
		Funding options	Distributive
Government provision	Supply	Quality, prices of energy supplied	Distributive
		Where, how to extract fuel	All
	Procurement	Procurement training and assistance	Procedural; recognition
		Privilege for women or minority-owned businesses	Distributive
Information and education	Labels, public information campaigns	Information dissemination	Procedural
		Target group selection	Recognition

2. Energy justice decision-making tool:

Table 18: Energy justice decision-making tool (Sovacool and Dworkin 2015)

Principle	Explanation
Availability	People deserve sufficient energy resources of high quality
Affordability	All people, including the poor, should pay no more than 10 percent of their income for energy services
Due process	Countries should respect due process and human rights in their production and use of energy
Good governance	All people should have access to high quality information about energy and the environment and fair, transparent, and accountable forms of energy decision-making
Sustainability	Energy resources should not be depleted too quickly
Intragenerational equity	All people have a right to fairly access energy services
Intergenerational equity	Future generations have a right to enjoy a good life undisturbed by the damage our energy systems inflict on the world today
Responsibility	All nations have a responsibility to protect the natural environment and minimize energy-related environmental threats

3. Categories of social sustainability based on an extensive literature review based on Fredershausen et al. 2021

- Health and safety considers all aspects of human physical integrity. Emissions are only considered in this category if their impact on human health is apparent from the indicator (e.g., human toxicity potential) and a focus of the respective paper.
- Social security addresses all aspects of individual economic security and prosperity.
- Culture and community considers all aspects of culture and social interaction.
- Prospects, well-being, and individual development address aspects such as discrimination, exploitation, transparency and recognition, education, training, and personal advancement.

10.3 Appendix 3 – Reflections on Positionality

As Grunwald 2019 posits, the object of Technology Assessment is "the societal meaning assigned to new technology" (p. 101). As briefly touched upon in the Overview section, this is heterogeneous with regards to hydrogen technology and its potentials in combating climate change. We recognize and acknowledge that within the project group, there is a tendency towards techno-scepticism and a critical approach towards the ecological modernization narrative of hydrogen technologies. This tendency informs the normative orientation of our technology assessment.

In addition, our disciplinary backgrounds also influence our perspectives within the study. This is summarised below:

Table 19: Authors background

Author	Currently Enrolled Master's Program	Educational Background (Bachelor's)
Angela Tatiana Molano	Masters in Environmental Governance	Bachelor in Anthropology
Arturo Martinez	Masters in Environmental Sciences	Bachelor in Environmental Engineering.
Daniela Gargya	Masters in Environmental Governance	Bachelor of Science in Ecology and Environmental Sciences
Jonas Pfistner	Masters in Environmental Sciences	Bachelor of Science in Environmental Sciences
Moeen Khan	Masters in Environmental Governance	Bachelor of Science in Political Sciences and Media Studies
Nora Demitry	Masters in Environmental Governance	Bachelor of Arts in Economics
Pablo Nuñez	Masters in Environmental Governance	Bachelor of Arts in Environmental Studies and Political Science
Sophia McRae	Masters in Environmental Governance	Bachelor of Arts in History and Environmental Humanities
Yourui Yeo	Masters in Environmental Governance	Bachelor of Arts in Economics and Organizational Studies

10.4 Appendix 4 – Acronyms of the Different Stakeholders

This table describes the stakeholders depicted in the stakeholder mapping in Figure 1.

Table 20: Acronyms of the stakeholders

ACRO-NYMS	MEANING
BMZ	German Federal Ministry for Economic Development and Cooperation
BMWi	German Federal Ministry of Economic and Energy
BMU	The German Federal Ministry for the Environment, Nature Conservation and Nuclear Safety
AA	The German Federal Foreign Office
IRENA	The International Renewable Energy Agency
COP NDCs	COP: Conference of the Parties NDC's: Nationally determined contributions
CIP	Climate Investment Platform
AMEE	The Moroccan Agency for Energy Efficiency
SEFA	Sustainable Energy Fund for Africa
MASEN	Moroccan Agency for Sustainable Energy
MEME	Moroccan Ministry of Energy, Mines and Environment
IRESEN	Research Institute on Solar Energy and New Energies
ONEE	Moroccan National Office of Electricity and Drinking Water
FENELEC	National Federation of Electricity and Renewable Energies
SIE	Energy Engineering Company
ESCO	Energy Service Company
CLASP	Coalition for Sustainable Energy Access initiative
MCCJ	Moroccan Coalition for Climate Justice
EBRD	European Bank for Reconstruction and Development

10.5 Appendix 5 – Primary Contributions by Author

Table 21: Primary Contributions by Author

Angela Tatiana Molano	• Overview: Case study
Arturo Martinez	• Stakeholders Mapping • Presentation formatting • Morocco-German context • Existing/emerging hydrogen cooperation
Daniela Gargya	• Executive summary • Overview EJ criteria in hydrogen partnerships • Key takeaways - policy toolbox
Jonas Pfistner	• Overview: Environmental & Energy justice • Limitations of the Study / Avenues for Further Research • Formatting
Moeen Khan	• Overview: Hydrogen partnerships • Hydrogen Economy: Environmental Justice Challenges • Report compilation
Nora Demitry	• Mitigation policies 4-6
Pablo Nuñez	• Mitigation policies 1-3
Sophia McRae	• Case Study: Environmental Justice Assessment • Report Proofreading and minor contributions to Methodology and Limitations
Yourui Yeo	• Introduction - Background and Motivation, Scoping the Project • Options for action - Criteria List • Coordination of the project and structuring of the content • Report compilation