THE STRATEGIC ROLE OF GREEN HYDROGEN IN GERMANY'S INTERNATIONAL ENERGY POLICY: A SOUTH AFRICAN CASE STUDY

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AUTHOR'S DECLARATION

I, the undersigned, **Kathrin Langewald**, candidate for the MA degree in International Public Affairs, declare herewith that the present thesis is exclusively my own work, based on my research and only such external information as properly credited in notes and bibliography. I declare that no unidentified and illegitimate use was made of the work of others, and no part of the thesis infringes on any person's or institution's copyright. I also declare that no part of the thesis has been submitted in this form to any other institution of higher education for an academic degree.

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ABSTRACT

Green hydrogen is widely acknowledged to be a driver of global decarbonization in industrial processes. Globally, countries are positioning themselves on the demand and supply side of the emerging value chain. With the German recognition for large-scale market development and import dependence, this thesis explores how green hydrogen is driving German-South African Energy Relations and its implications for the "International Energiewende" as a soft power resource (Quitzow and Thielges 2020). With the help of six expert interviews, I analyze how the case of South Africa illustrates the dilemma of pursuing geostrategic goals of import security and market development while simultaneously promoting climate change mitigating efforts in existing energy frameworks.

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LIST OF ABBREVIATIONS

AA	German Foreign Affairs Ministry
AHK	German Chamber of Commerce
BMU	German Ministry of Environmental Affairs
BMWK	German Ministry for Economic Affairs and Climate Action
BMZ	German Federal Ministry for Economic Cooperation and Development
CBAM	Carbon Border Adjustment Mechanism
DMRE	Department of Mineral Resources and Energy (South Africa)
DSI	Department of Science and Innovation (South Africa)
ENW	Energiewende Narrative
EU	European Union
gH2	Green Hydrogen
GIZ	German Development Cooperation Agency
HSRM	Hydrogen Society Roadmap South Africa
IDC	Industrial Development Corporation (South Africa)
JET- P	Just Transition Partnership
KfW	German Development Bank
MEC	Minerals Energy Complex
MLP	Multi-Level Perspective
NHS	Germany's National Hydrogen Strategy
PGM	Platinum Group Metals
PtX	Power-to-X
SDG	Sustainable Development Goals

CHAPTER 1 – INTRODUCTION

“Germany wants to establish a strategic green hydrogen partnership with South Africa – and Africa at large – for mutual benefit. This partnership must boost sustainable economic development in Africa and supply Germany and the EU with additional clean energy. Another beneficiary of this partnership would be the world’s climate as less CO2 is emitted into the atmosphere.” (Dr. Martin Schäfer 2021)

This quotation by the German ambassador to South Africa, Lesotho, and Eswatini comes from the third renewable green hydrogen webinar, held in 2021 in South Africa. It emphasizes the perceived contribution of green hydrogen (gH2) in German-South African energy relations, reflecting both its centrality to and the international dimension of Germany’s energy transition, known as the Energiewende.

Germany's Energiewende is a significant element of its international policy and a frequent subject of academic discourse. Scholars have called for Germany to take an active role in global climate protection (Messner and Morgan 2013; Tänzler and Wolters 2014; Quitzow 2013) and have assessed its strategies and leadership on the global stage (Röhrkasen and Westphal 2012; Steinbacher and Röhrkasten 2019; Quitzow and Thielges 2020). Steinbacher (2019) explores Germany's interactions with various partner countries in the realm of renewable energy, focusing on the effectiveness of its leadership in transferring renewable energy policies. Similarly, Quitzow and Thielges (2020) discuss Germany's international energy partnerships, framing them as a form of "soft power" in contrast to traditional "hard power" concepts rooted in fossil energy policies. More recently, scholarly attention has centered on the development of global gH2 value chains within Germany's international Energiewende and the geopolitical implications of its international policy strategies (Nunez and Quitzow 2023; Quitzow, Nunez,

and Marian 2024). However, the implications of Germany's efforts to build a global value chain and ensure supply security with its partner countries remain underexplored.

Therefore, this thesis investigates how gH2 influences German energy cooperation with South Africa and its implications for Germany's Energiewende Narrative (EWN) as a soft power resource (cf. Thielges and Quitzow, 2020). Through the lens of soft and hard power, I examine the strategies employed to promote future imports and market development, while South Africa's coal-dominated economy and its wider socio-technological environment serve as an entry point for assessing German engagement in South Africa. Using qualitative interviews, this case study explores the dynamics between national energy policies and global market strategies, emphasizing the role of gH2 within the larger framework of global energy transitions.

The thesis is structured as follows: the next chapter examines Germany's international Energiewende and highlights the role of gH2. This is followed by a discussion on South Africa's Minerals-Energy Complex (MEC) and its connection to German gH2 cooperation. Chapter four introduces my abductive case study approach, while chapter five explores the hydrogen factor in German-South African energy relations. The final chapter summarizes the findings and discusses their implications for German international energy policy.

CHAPTER 2 – GERMANY'S GREEN HYDROGEN DIMENSION IN PROMOTION OF THE INTERNATIONAL ENERGIEWENDE

Germany's Energiewende aims for a CO2-neutral energy system by focusing on renewable energies, energy efficiency, and phasing out coal and nuclear energy, which should also ensure energy security and affordability (BMWi, n.d.)[1]. To promote these national objectives, the Energiewende is also a cornerstone of its Foreign Energy Policy, targeting global climate goals and promoting renewable energy technologies through significant investments (AA 2019a). With gH2 as a newly emerging "key element" in energy transition (BMWK, n.d.-a), this thesis assumes a geostrategic shift in its international Energiewende dimension, recognizing Germany's import dependence and the need for large scale market development.

2.1 Germany's Energiewende Leadership

Considered internationally as a role model — a concept known as the "lead market effect" — Germany uses its economic significance to encourage other nations to follow its example (Westphal 2012; Quitzow, Röhrkasten, and Jänicke 2016, 11). However, the global success of the energy transition and demand for renewable energy technologies hinges on the overall international movement towards sustainability. Only if successfully integrated into broader environmental and foreign policy, technical innovation can become a competitive advantage (Quitzow 2013).

Therefore, the Foreign Affairs Office (AA) highlights the role of renewables as a means to reduce dependency on fossil fuels, thus enhancing energy affordability and their advantage for economic growth (AA 2019b). Quitzow and Thielges (2020, 9-10) argue that the international dimension of the energy transition, including its emphasis on energy independence and

[1] The Ministry for economic affairs and climate (BMWK) formerly BMWi

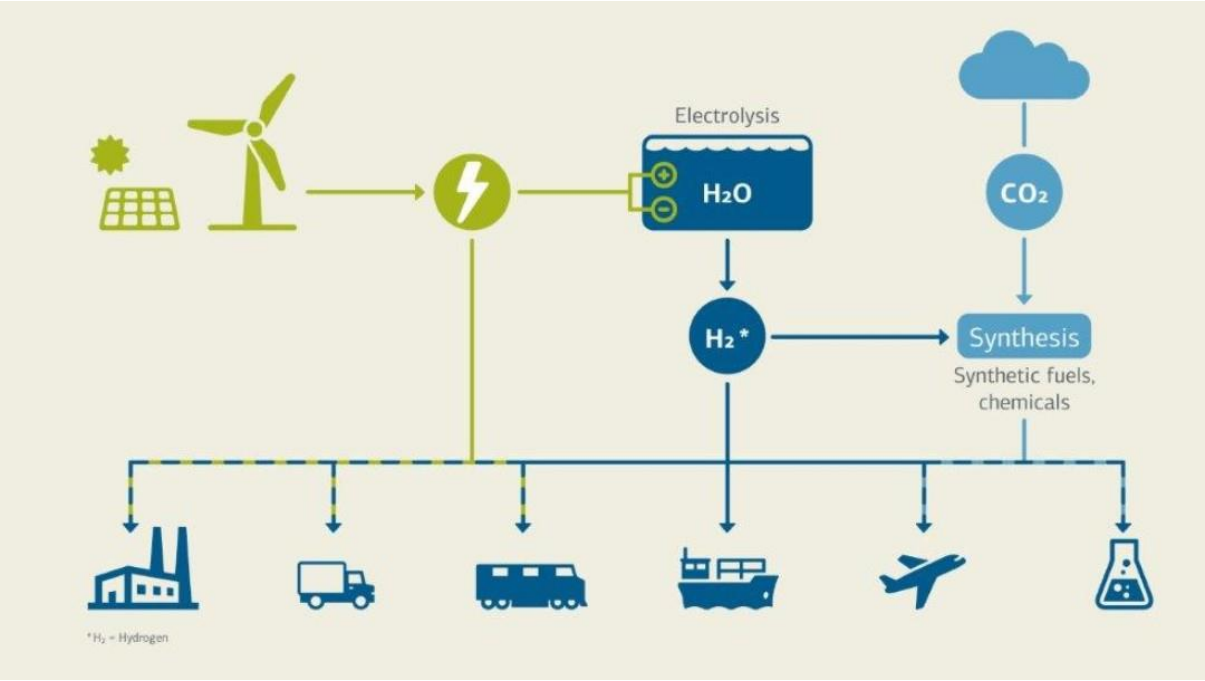
affordability, acts as a solution to multiple interrelated challenges such as climate change, economic growth, and innovation. This narrative enables Germany to leverage its energy transition as a soft power resource.

To promote the Energiewende internationally, Germany has developed bilateral and multilateral frameworks with countries in the Global South and fossil fuel-reliant economies. Since the 1970s oil crisis, renewable energies have been integral to German development cooperation, promoting energy independence and addressing political, economic, and social challenges in line with Sustainable Development Goal (SDG) 7 (Steinbacher and Röhrkasten 2019, 205; BMZ, n.d.). Energy partnerships and dialogues aim to advance the international energy transition by fostering cooperation with target countries on energy, climate change, and its market economy frameworks, including export opportunities and innovation (Quitzow and Thielges 2020; AA 2019c). Germany has also played a key role in establishing the International Renewable Energy Agency and the Renewable Energy Policy Network for the 21st Century, which disseminate knowledge and updates on renewable energy (Quitzow, Röhrkasten, and Jänicke 2016). This strategy is not only intended to meet global climate targets but also helps Germany develop global markets for environmentally friendly technologies and to enhance its own transition goals.

2.2 The Role of Green Hydrogen in the International Energiewende

The publication of the National Hydrogen Strategy (NHS) is the missing puzzle piece in Germany's energy transition, addressing challenges beyond the decarbonization of the electricity sector (see Figure 1) through the use of renewable energies (BMWK, n.d.-a). In addition to establish the regulatory framework and continuing the energy transition, the NHS envisages 38 measures intending to ensure Germany's competitiveness and security of supply (BMWi 2020).

Figure 1: Production and Use of Green Hydrogen and PtX Products



Source: KfW Development Bank (n.d. -a)

Despite gH2's potential in industrial sectors, it is not yet competitive with fossil resources. To address this, Germany aims to accelerate the international market for gH2 and Power-to-X (PtX) products, leveraging economies of scale to reduce costs. This strategy sees Germany's technological leadership in gH2 and PtX as a chance to stimulate its own economy through technology exports. At the same time, Germany acknowledges not to meet its hydrogen needs domestically, thus emphasizing the import of hydrogen and PtX-products. Consequently, the NHS focuses on importing hydrogen from countries with abundant renewable energy resources.

This approach is assumed to promote climate protection in partner countries while fostering sustainable growth. It also aims to establish new supply chains and trade relationships, creating a win-win scenario aligning with the EWN.

2.3 Hypothesis 1: Soft and Hard Power Resources in the international Hydrogen Dimension

To investigate the impact of gH2 on the ENW, I will apply concepts of hard and soft power understood as a resource. Nye defines power as "the capacity to do things, but more specifically in social situations, the ability to affect others to get the outcomes one wants" (Nye 2021, 2)[2]. Hard power is derived from a realist understanding of power, where one actor compels another to abandon its preferences through payment and coercion (Nye 2011, 11). In contrast, Nye introduces the concept of soft power, which views power as the ability to attract and persuade others (Nye 2005, 5). The two concepts are distinguished based on the degree of voluntarism (Nye 2021, 8), or more simply, the use of both push and pull factors in the exercise of power (Nye 2021, 6).

2.3.1 Soft Power Resources and Means

Soft power on the one hand is rooted in a behavioural understanding of power (Nye 2021, 6), emphasizing its social nature, which unfolds between counterparts on voluntary behaviour. In contrast to hard power, preferences are shaped through the attraction of culture, values and ideas (Nye 2021, 8). In the context of Energy Transition the ‘lead market effect’ (Quitzow, Röhrkasten, and Jänicke 2016, 11) and the EWN constitute such ideas (cf. Thielges and Quitzow 2021), promoting Germany’s international leadership ambitions in hydrogen through win-win scenarios.

Germany’s efforts to disseminate its ideas and values regarding electricity generation and energy efficiency involve development cooperation and partnerships as key strategies.

[2] I acknowledge, that the classification of international policy and its instruments in terms of hard and soft power is conceptually not a purely resource-based exercise. However, this would exceed the capacity of the thesis, wherefore the assessment of gH2 on the EWN and its policy will be based by the prevalence of national interests and how these are promoted (cf. Ohnesorge, 2021, 112; Nye, 2004, 68).

Institutions such as the German Development Cooperation (GIZ) transfer expertise to partner country ministries (Steinbacher and Röhrkasten 2019, 205), while Energy Partnerships leverage high-level dialogue and policy learning to bolster the energy transition (Thielges and Quitzow 2021, 16). Conceptually, soft power often manifests as public diplomacy, which, if effectively used, builds long-term relationships to strengthen policies and cultural exchange (Nye 2005). Supporting gH2 in partner countries like South Africa can build on Germany's legacy of promoting Energiewende based on mutual interests and voluntary measures.

2.3.2 Hard Power Resources and Means

Hard power on the other hand is fundamentally rooted in the idea that states possess various material resources that they can leverage (Nye 2021, 3) against the preferences of others. Germany has critical interests in energy security and market development. Hence, it has launched economic incentives like the H2Global auction model to secure hydrogen imports, providing investment certainty and ensuring the rapid deployment of hydrogen production facilities and related supply chains (H2Global Stiftung, n.d.). However, prioritizing export market creation may conflict with designing longer value chains, potentially hindering socio-economic development in partner countries (Quitzow et al. 2023, 11), thus its development goals. The H2UPPP instrument was launched to establish pilot projects in partner countries using German and European technologies (BMWK, n.d.-b). Recognizing the immaturity and high cost of gH2 technologies, these support initiatives carry economic risks given uncertain demand for gH2 (Quitzow et al. 2023, 11). Hence, Germany could potentially use its economic clout to promote hydrogen and gain prioritized access to South Africa's gH2 market, possibly against South African interests.

In addition to the direct use of resources, there are more nuances to the notion of hard and soft power. Goldthau and Sitter (2015) differentiate between targeted and untargeted exercises of

power. Joining the European Union (EU) energy market is seen as an attractive prospect, constituting an untargeted form of soft power, whereas prescribing access terms, such as through standards, might verge on coercion when targeted at specific entities (Goldthau and Sitter 2015, 16). An example of this "soft power with a hard edge" is the Carbon Border Adjustment Mechanism (CBAM) under the "European Green Deal" and "Fit-for-55" package. It encourages green supply chains by restricting access to the EU market through CO2 pricing (Maat 2022). While this regulation promotes climate protection, it may coerce countries and firms seeking to export to the EU to adhere to its sustainability standards. This could affect export-dependent countries concerning their financial stability. Such an understanding of CBAM aligns with Nye's definition of hard power, which involves involuntary changes in behavior through structural manipulation (Nye 2021, 7-9).

From this perspective arises a threefold challenge to the promotion of gH2. Firstly, to strict standards could jeopardize Germany’s climate ambitions if countries struggle to meet European criteria. Secondly, such measures could hinder the sustainable market development approach and import ambitions (Quitzow et al. 2023, 11). Thirdly they potentially undermine the EWN as a soft power resource. To handle this trade off carefully will be a difficult task.

H1: Green hydrogen has an impact on the Energiewende Narrative as a soft power resource.

CHAPTER 3 – LOCATING GREEN HYDROGEN IN THE WIDER ECONOMIC CONTEXT OF SOUTH AFRICA

As highlighted in the previous chapter, the NHS recognizes that Germany cannot meet its own needs wherefore a global market approach is deemed necessary. Under the geopolitical implications of a global market approach, the cooperation with today's fossil fuel exporting and dependent countries is highlighted as crucial concern to convert their supply chains for the use of renewables and the production of gH2 (BMWK 2020, 8). Furthermore, Germany's role in shaping the global energy transition is influenced by the preferences of powerful recipients and the disruptive impact of these efforts (cf. Steinbacher 2019, 141). Therefore, this chapter is concerned with the systemic role of gH2 promotion in a coal dominated economy such as South Africa.

3.1 The Minerals Energy Complex in the South African Economy

Largely shaped by its apartheid legacy, the MEC dominated South Africa's energy and economic landscape over a long period of time. Coined by Fine and Rustomjee (1996) the MEC describes the political-economic relations around coal and mining. They identified rich coal mineral resources, cheap labor from the black population and therefore cheap electricity as the preconditions for the emergence of energy-intensive industries that formed the backbone of economic growth in South Africa. As shall be seen, the MEC continues to play a central role in the economy.

The MEC comprises core sectors, which, on the one hand, exhibit strong interconnections among themselves and weaker connections to other industries on the other. Fine and Rustomjee (1996) identified various core sectors of the MEC based on its input-output linkages compared to non-MEC sectors.

Table 1: The Interdependence of the MEC input/output linkages 2010

MEC subsector	Share of inputs from MEC sectors (% of total)	Share of output to MEC sectors (% of total)
Coal mining	26	90
Gold and uranium ore mining	55	5
Other mining	23	77
Coke and refined petroleum products	88	18
Basic chemicals	77	60
Other chemicals and man-made fibers	67	37
Plastic products	68	30
Non-metallic minerals	73	8
Basic iron and steel	82	59
Basic non-ferrous metals	91	59
Metal products excluding machinery	70	41
Machinery and equipment	63	53
Electricity gas and steam	53	47
Non-MEC manufacturing	23	6

Source: Ashman, Fine, and Newman (2013)

The strong interconnection arising from these sectors indicates that "64.4% of productive inputs into the MEC sectors come from the MEC core itself and 53.0% of output from MEC sectors goes back into the MEC core as inputs" (Ashman, Fine, and Newman 2013, 8), suggesting that MEC sectors operate relatively autonomously from other sectors.

The formation of the MEC has supported the development of state-owned enterprises, providing public infrastructure and the continuous supply and demand for coal. Transnet, a

state-owned company, developed the country's rail, port, and pipeline systems (Eberhard, 2010, 20), primarily serving the mining industry's needs (Montmasson-Clair 2015, 21). Eskom and Sasol (a former state-owned enterprise) are the biggest coal consumers. Eskom produces and distributes electricity, while Sasol's coal-to-liquid synthetic fuel plants reduce dependence on international oil prices (Eberhard 2011, 6).

Historically, the MEC's contribution to the Gross Domestic Product has remained in the range of 20-30% (Ashman, Fine, and Newman 2013, 10), while the tertiary sector increasingly gained importance and non-MEC manufacturing declined (Montmasson-Clair 2015, 22). The MEC accounts for 60% of foreign currency earnings (Ibid.). Despite its economic significance, employment in the MEC is relatively low compared to other sectors and has been declining with corresponding effects on the high unemployment and inequality in the country (Ashman, Fine, and Newman 2013, 11).

3.2 The Minerals Energy Complex in Transition

The concentration on these core sectors has led to a specific structure with relatively closed couplings and various social functions. However, in recent decades, the MEC has experienced internal and external transformative pressure:

Firstly, the energy sector is in crisis with planned electricity shortfalls, known as loadshedding. These arise from aging infrastructure, mismanagement, and capacity constraints (Baker, Newell, and Phillips 2014). Eskom, the state-owned electricity producer, has struggled to meet increasing demand, resulting in significant economic damage to the mining sector, estimated at R2 billion (124 million euros) per day in 2008 (Lawrence 2020, 72).

Secondly, the mining sector has declined, as indicative by dropping employment and production numbers (Robinson and Croll 2018). Challenges relate to Eskom and Transnet

include their mismanagement and decaying infrastructure (Eberhard, 2011, 21). Furthermore, platinum metals' (PGMs) role in the automotive industry is expected to decline (McClelland 2014, 236), signifying the sector reliance on global commodity prices for its main export goods.

Thirdly, as one of the largest CO2 emitters, the country faced increasing environmental pressures, creating a window of opportunity for renewable energy technologies. The Copenhagen Climate Accords and technological advancements in renewable energies led to a Renewable Energy Feed-in Tariff and its subsequent initiative the Renewable Energy Independent Power Producer Procurement Programme, which paved the way for renewable energy interests (Morris and Martin 2015, 49-52). This split the energy industry into two segments: one featuring Independent Power Producers and another where Eskom remains the primary electricity provider (Ting and Byrne 2020, 11).

3.3 Hypothesis 2: Regime Driven Sustainability Transition

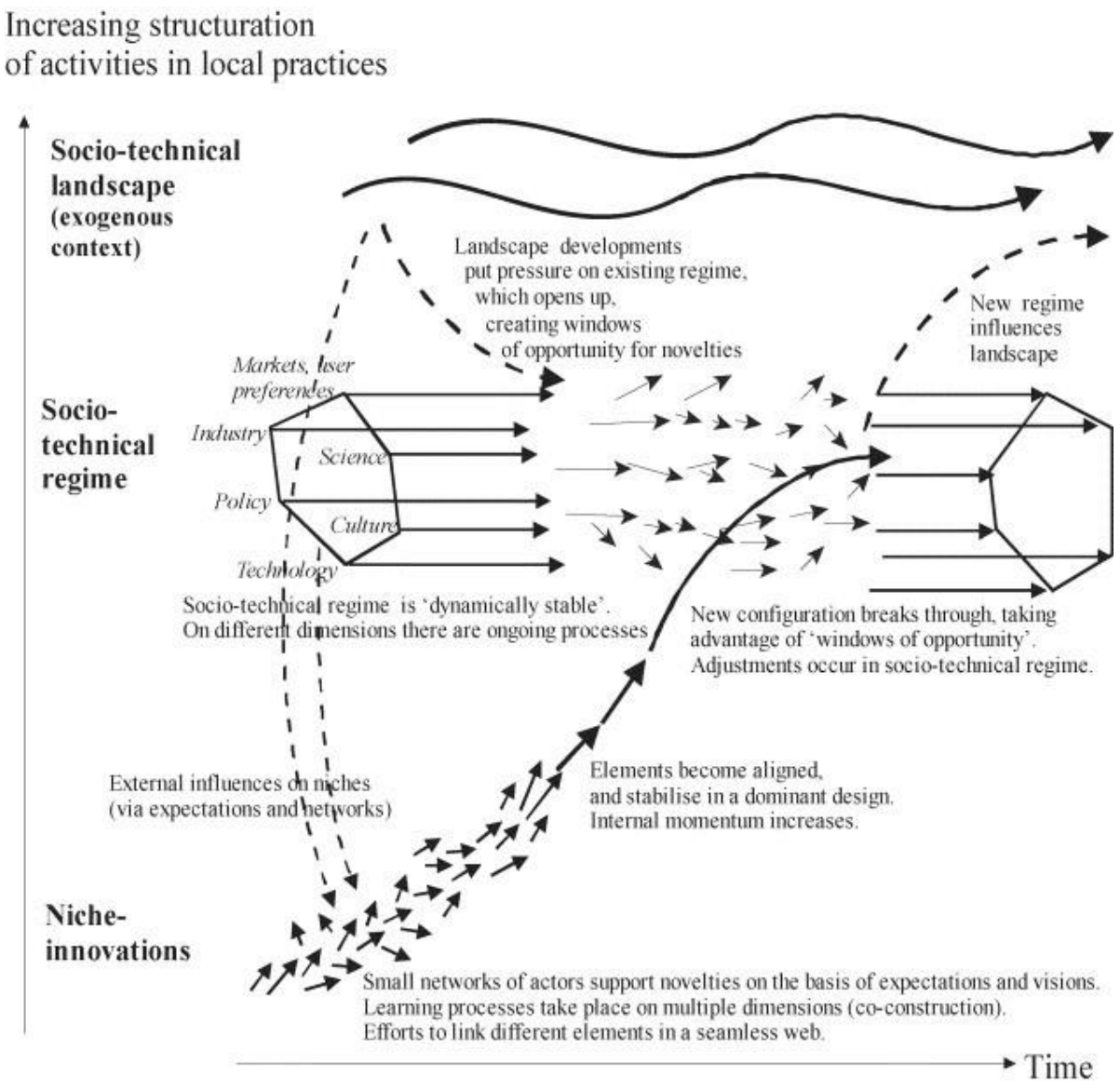
Amidst internal and external pressures to the MEC and prevailing societal challenges, South Africa released its Hydrogen Society Roadmap (HSRM) to drive sustainable development. This leverages its abundant solar and wind resources, the world's largest PGM deposits crucial for gH2 technologies and expertise in the Fischer-Tropsch process. Research on sustainability transitions attempts to explain these processes of change in systems characterized by environmental problems (Frank W. Geels 2004). The South African economy exemplifies such a socio-technological system where actors, technologies, and rules interact to provide societal functions (cf. Verbong and Geels 2007) particularly in energy-intensive industries spanning from electricity to transport with a focus on export (see 3.1.). However, transitioning to greener production methods is challenging due to entrenched structures and lock-in mechanisms favouring fossil energy (Unruh 2000). Therefore, I want to assess the potential of Germany's international gH2 dimension for socio-technological change within the MEC.

3.3.1 The Multi-Level Perspective

Geels' (2002; 2004) Multi-Level Perspective (MLP) framework, with its three interacting dimensions (see Figure 2), offers a comprehensive view of transition processes. The MLP posits that innovations, such as gH2 technologies, initially develop in niches, supported by a small number of actors (cf. Verbong and Geels 2007, 1026) like renewable entrepreneurs and research promoting the use of PGM in fuel cell development (cf. DSI 2021). These niches relate to socio-technical regimes characterized by established actor constellations who develop common belief systems, norms, rules, and structures (Geels and Schot 2007, 400). Regime actors are part of the larger socio-technological system, which in the South African case refers to the MEC, with its established industries such as chemicals, steel, and mining and entrenched infrastructure networks, supply chains and export orientation. Socio-technical regimes are embedded in broader, less malleable landscape dynamics, including trends like globalization and climate change (Geels 2004, 913) exerting transformative pressures. [3]

[3] Due to the more global and external characteristics of landscape pressures, I do not consider this category explicitly in my analysis. I am more interested in the German interaction within the South African context.

Figure 2: Multi-Level Perspective on Transitions



Source: Geels and Schot (2007, 401)

In the MLP, regimes and niches are similar in structure, comprising actor networks with shared rules but differ in size and stability (Geels and Schot 2007, 402). Regimes typically dominate niches, dictating rules and stifling change to protect material interests and market control, leading to only incremental innovations (Markard and Truffer 2008, 599). Consequently, transitions are seen as niche-driven, eventually replacing existing regimes when landscape pressures are sufficient (Köhler et al. 2019, 5).

3.3.2 The Minerals Energy Complex in the GH2 Economy

Recent literature highlights regime actors' active role in socio-technical change. For example, (Berggren, Magnusson, and Sushandoyo 2015) see the borders between niches and regimes blurring, as regimes may provide for well-integrated strategies to promote innovations. This "re-configuration" pathway involves regimes adopting incremental changes across sectors (Geels and Schot, 2007, 411). The MEC, in comparison, is even contributing to the hydrogen value chain by supplying crucial inputs like carbon and mineral resources and has a legacy in in the provision of infrastructure, including electricity transmission lines, gas pipelines, and storage facilities (cf. DSI, 2021). Thus, the HSRM makes clear that gH2 and derivatives align seamlessly with existing technology, infrastructure, and key actors within the MEC, positioning it as a transitional solution. Therefore, the MEC should be addressed in Germany's international hydrogen dimension as point for departure for transition.

H2: The MEC is crucial to the international dimension of German hydrogen goals in South Africa

To navigate this transformation, I leverage the socio-technological transitions framework and conceptualizations of niche and regime structures in the MLP as guiding tools, for a more nuanced understanding of the context and the targeted approach by which Germany promotes its international gH2 agenda.

Table 2: Analytical Framework Multi-Level Perspective

Level	Changes in Actor Networks	Changes in Production through Technology	Changes in guiding Rules
Niche	Trying to get support from powerful actors	Building niche momentum through strategic learning	Changes in regulative rules cognitive routines and behavioral norms through new expectations
	The building of social networks		
Regime	Supporting Regime market entrants	Supporting incremental changes in the production pathway	Stabilization of existing regulative rules; cognitive routines and behavioural norms
	Supporting Institutional Entrepreneurs at the Regime level	Supporting wide scale niche deployments at the regime level; changes in the production lines	

Source: Own illustration; based on Geels and Raven (2007), Geels and Schot (2007), Kern (2012), Markard and Truffer (2008), Schwabe (2024) and Verbong and Geels (2007)

The MLP framework examines German institutions' support mechanisms in South Africa on various dimensions, including changing actor networks, technological transformations, and alterations in guiding rules. Based on that, this analysis identifies potential transformation pathways induced by the MEC.

CHAPTER 4 – METHODOLOGY

This methodological chapter lays out my exploratory case study approach to investigate the strategic role of gH2 within the EWN and its promotion in South Africa in relation to the MEC. To pursue this goal, the previous chapters have discussed gH2 in the light of its impact on the EWN as soft power resource as well as the usefulness of the MLP to familiarize myself with the policy implications within the MEC structures.

4.1 Research Design

With my research question, I want to understand the strategic role of gH2 in German international energy policy, but also how it is promoted. This question is explored as countries globally are trying to position themselves in this newly emerging market. With my interest in this current phenomenon (Yin 2014, 10), I followed Brinkman's (2014) assessment of abductive reasoning in qualitative research, interpreting a series of events within their context and incorporating new information and perspectives. Accordingly, I formulated initial expectations regarding hydrogen as puzzle piece within the respective country contexts. These expectations are "surprising" due to the normative aspects of energy transition and the emergence of vested interests in energy security. The German-South African energy relationship presents a unique case (Rohlfing 2012) because of the longstanding cooperation in renewable energy. With the MEC central to energy-related decision-making in South Africa (Baker, Newell, and Phillips 2014), this relationship provides a fruitful ground for investigating the role of gH2 in the context of entrenched fossil fuel interests and German international energy policy.

4.2 Data Collection and Analysis

My case study builds on six expert interviews that were conducted between December 2023 and February 2024, supplemented where necessary by existing research and reports. This combination of sources is considered useful to triangulate information about the properties of energy transition on the ground. The interviewees were purposefully selected based on their occupation in German implementing institutions such as GIZ, German Development Bank (KfW) and German Chamber of Commerce (AHK) and their experience in the energy field and knowledge on gH2. One interview was conducted with a South African Institution as background material to assess my own assumptions regarding the role of German institutions in South Africa in the energy field and development of gH2 value chains. Each interview, lasting approximately one hour, was conducted online, transcribed, and coded via MaxQDA. Participants were informed about the confidentiality and anonymity of their responses.[4]

Table 3: Interview Partners

Institution	Interview Style	Number of Interviews	Interview Code
German Chamber of Commerce (AHK)	Expert Interview	1	AHK
German Development Agency (GIZ)	Expert Interview	3	GIZ 0-2[5]
German Development Bank (KfW)	Expert Interview	1	KfW
Industrial Development Cooperation, National Bank South Africa (IDC)	Background Interview	1	/

Source: Own research

[4] For data protection reasons, the interviews are not attached to the thesis.
[5] GIZ 0: this interview was conducted in June 2022; therefore, the questions and answers deviate from the other interviews, but are nonetheless considered relevant to answer my research question and coded accordingly.

The interview guide is built on two parts. First, questions were developed in order to capture possible shifts in German EWN implementation according to the perceived prevalence of national interests and its instruments (cf. Ohnesorge 2020, 112). Furthermore, a comparative approach for energy transition (renewable energy and energy efficiency only) and gH2 was applied in order to capture differences, with the publication of the NHS as a time marker. Second, with regard to its implementation in South Africa, I was particularly interested in actor network composition, technological production pathways, and rules and institutions due to the promotion of hydrogen, as identified by the MLP to steer transitions (see Appendix 1). After transcription, I developed a coding scheme (see Appendix 2-3) according to criteria of qualitative content analysis (cf. Mayring 2022), integrating new codes when deemed necessary. Specifically, the dimension of power was initially identified and theoretically integrated only later. The content detailing German initiatives in promoting gH2, pertinent to the MLP, was evaluated for its niche and regime properties in conjunction with the literature in chapter 3.3.2.

My methodology's main limitations are that the selection of interview partners mostly reflects the assumptions of German implementation agencies within the context of South Africa and are subjective in nature. Therefore, assessments of shifts in the EWN as a soft power resource are limited due to lack of reciprocity such as through legitimacy, which is inherent to the relational assumption of soft power (cf. Ohnesorge, 2021, 112). Besides, generalizability outside the South African context is restricted.

CHAPTER 5 – THE STRATEGIC PROMOTION OF THE ENERGIEWENDE AND THE GREEN HYDROGEN FACTOR

Germany has been actively involved in renewable energy and energy efficiency measures in South Africa for many years, primarily through various GIZ projects and KfW's financial assistance (GIZ 2; GIZ 1; KfW, AHK). Analogous, Germany now has become a key player in the development of South Africa's gH2 value chain (AHK).

Table 4: German Implementing Institutions

Implementing Institution	Projects/Programmes	Ministry	Role
German Chamber of Commerce (AHK)	H2UPPP	BMWK	Individual business consulting services; Support for the utilization of various German funding programs
	Export Initiatives	BMU [b]	
German Development Cooperation (GIZ)	International PtX Hub	BMWK	Technical, market-related, and political expertise; Capacity building and learning; Dialog and Networking
	H2.SA	BMZ	
	German-South African Energy Partnership	BMWK	
German Development Bank (KfW)	JET-P	BMZ	Concessional financing in the form of loans or credits
	PtX Growth Fund [a]		

Source: Own research; a: KfW Development Bank (n.d.-b), b: NOW GmbH (n.d.)

Under the JET-P framework, Germany, and several international partners, support South Africa in its endeavors to decarbonize its economy and phase out coal. Central to Germany's involvement is also the provision of financial assistance aimed at fostering a gH2 economy (Cassidy and Quitzow 2023, 20; The Presidency 2023, 178). Additionally, Germany is the primary provider of technical assistance to South Africa regarding hydrogen (Cassidy and Quitzow 2023, 21). This includes projects implemented by GIZ, such as the International PtX

Hub, commissioned by the German Federal Ministry for Economic Affairs and Climate Action (BMWK) with works to identify sustainable PtX value chains for climate change mitigation (International PtX Hub, n.d.); the H2.SA project, financed by the German Federal Ministry for Economic Cooperation and Development (BMZ), which aims to improve the investment conditions for gH2 in South Africa (GIZ, n.d.); as well as the Energy Partnership, financed by the BMWK, with the aim to ensure political dialogue between Germany and South Africa on energy issues (GIZ n.d.- b; Cassidy and Quitzow 2023, 21). The AHK implements the investment program H2UPPP led by GIZ to identify local value chains (giz, n.d.-b) and is responsible for promoting foreign trade in the field of hydrogen. These institutions work synergistically, with KfW providing substantial financial support and GIZ contributing to the strategic framework. While KfW and GIZ operate at macro and meso levels, focusing on the public sector, AHK operates at the micro level, advising companies directly (AHK). Together, these three institutions are pivotal in Germany's international hydrogen dimension.

5.1 Prevalence of National Interests

The EWN is not only promoted as a response to global crises such as climate change, but also presented as a motor for economic growth. The conducted interviews reinforce the notion that Germany's support for renewable energies in South Africa addresses critical social challenges such as energy security and poverty alleviation (GIZ 1). GIZ emphasizes environmental, social, and economic factors geared towards benefiting the broader population. KfW prioritizes infrastructural financing, focusing on decentralizing the energy system. Meanwhile AHK highlights foreign trade, technological solutions, and export initiatives related to energy security and economic decarbonization. Collectively, these efforts aim to develop local value chains from a socio-economic perspective, underscoring Germany's engagement in South Africa.

Given its limited domestic production capabilities and subsequent reliance on imports, a vital aspect of the NHS lies in Germany's hydrogen ambitions on the international stage. One interviewee delineates the evolution of German interests in gH2 promotion across three key dimensions:

“At the beginning, German efforts were clearly focused on climate protection. The question was how to reduce CO2 emissions by using hydrogen products, PtX products, etc. The COVID-19 pandemic changed this, and Germany now looked at green hydrogen as one of the growth paths that could lead to some kind of reindustrialization. [...] In addition, since Russia's war of aggression against Ukraine, there has also been a new component on the German side, namely energy security. Prior to this event, energy security was not an issue.” (GIZ 1)

Although hydrogen aligns with the broader international energy transition, it also underscores Germany's increasing focus on energy security. Several interviewees stress that particularly considering recent geopolitical events Germany's commitment to address the global climate crisis and security concerns (GIZ 1) has led to increased financing for hydrogen projects within bilateral energy frameworks (GIZ 1, AHK, KfW).

The promotion of gH2 value chains reflects coordinated cooperation between Germany and South Africa (AHK). There is a growing awareness of the necessity of energy transition, driven by the prospects of gH2 (GIZ 2). Mutual interests include importing and exporting gH2 and potential green reindustrialization (GIZ 1).

Germany also prioritizes social and environmental criteria to mitigate risks associated with developing the hydrogen value chain in South Africa (GIZ 0; KfW). For example, GIZ focuses on local economic value creation and capacity building (GIZ 0), while KfW mobilizes financial resources for decarbonization, job creation, and coal phase-out projects (KfW). A common

goal is empowering the private sector to enhance its competitiveness in the global hydrogen economy.

National interests play a significant role in assessing hydrogen's impact on the energy transition as a soft power resource (cf. Ohnesorge 2019, 112). The interviews suggest promoting gH2 aims to create a "win-win situation" focused on decarbonization and economic recovery. Efforts involve close coordination with South African partners to ensure alignment with ongoing energy crisis mitigation and socio-economic value generation. Despite the energy security dimension as a hard power motive, gH2 primarily supports the EWN of sustainable development as a soft power resource.

5.2 Channels of Influence

On the one hand, the interviewees emphasize that gH2 continues previous renewable energy and energy efficiency efforts (GIZ 2, AHK), supporting the EWN. Through the provision of technical, market, and policy expertise (GIZ 1), GIZ addresses diverse needs identified in previous dialogue formats (GIZ 2). Therefore, capacity building measures, such as those introduced within the South African-German Energy Program, promote institutions and reform processes for the uptake of renewable energy technologies (GIZ 2). Expertise is also disseminated through commissioned studies and workshops on renewable energy additionality, ensuring hydrogen production does not hinder electricity sector decarbonization (GIZ 0). From a soft power perspective, GIZ leverages its institutional roots for agenda-setting (Nye 2021, 7), as it influences decision-making by framing topics in workshops. Furthermore, GIZ emphasizes dialogue and consensus-building activities to share knowledge among stakeholders (GIZ 2). The Energy Partnership facilitates technical exchanges and cooperation between political representatives through various formats, such as study trips and workshops (Thielges and Quitzow 2020, 13-14). This strengthens the energy transition narrative of the hydrogen

economy in South Africa (cf. Thielges and Quitzow 2020, 17), as one interviewee noted regarding the inclusion of gH2 in Jet-P conditions under German suggestions (KfW). The AHK supports businesses by offering consulting services, facilitating funding access, and providing networking opportunities with decision-makers (AHK). Ultimately these persuasive efforts build on the long-term relationship between South Africa and Germany in the field of energy (cf. Nye 2004, 8) with the goal to promote the market development of gH2 within the broader values of climate change and sustainable development.

On the other hand, South Africa is under pressure from the EU's legal framework for climate and energy to decarbonize its economy (AHK). CBAM incentivizes South Africa to produce gH2 to reduce export products' carbon content and to remain competitive through creating new value chains (Maimele 2023). Under these structural conditions, the EU shapes South Africa's regulatory and economic environment, pushing production process changes (cf. Nye 2021, 8). However, the nascent market for gH2 requires substantial upfront investments (KfW). Considering this, the NHS and the provision of Covid-19 stimulus funds create demand and investment certainty for the South African gH2 economy (KfW, GIZ 0). In addition, the H2Global initiative intends to provide funding for large-scale industrial investments to bolster the market and to secure energy imports (AHK). With JET-P and the funds provided by KfW, the South African government can improve its borrowing capacity and investment climate for gH2 (National Treasury Republic of South Africa 2022), as South Africa grapples with budget deficits and public debt since the Covid-19 recession. KfW typically provides concessional financing, with funds allocated to South African institutions under KfW oversight (KfW). KfW's provision of financial resources increasingly involves policy-related development loans tied to energy market reforms (KfW, GIZ 2). Infrastructure projects focus on export and port development (The Presidency 2022, 97). Both measures aim to attract foreign investors (KfW). Germany's financial support aligns with the EU's broader regulatory ambitions to promote

sustainable value chains and South Africa's need for capital market access. Shaping South Africa's economic transformation and export orientation reflects an element of structural manipulation. However, Germany's influence on the institutional and economic context in which it cooperates with South Africa is limited. Following that, Germany's actions in promotion of the hydrogen factor in the EWN are based on persuasion and attraction, rather than on payment and coercion (Nye 2021, 8). [6]

Overall, the soft power approach in developing a gH2 economy in South Africa gears toward Germany's EWN. The outlined combination of strategic communication of gH2 with the infrastructural and capacity development programs aims to boost the market ramp-up. Tied to this are the provision of sustainability criteria and the outlook of importing hydrogen and PtX products in future. However, some interviewees have expressed their doubts considering the effectiveness of this approach. For example, Sasol got support from the German government under the H2Global funding mechanism to produce sustainable aviation fuels with the aim to export its products to Germany (SASOL 2021). Therefore, considering the EU Renewable Energy Directive 2, sustainable carbon sources will be required. But from a technological point of view, the company will not be able to transition its whole production processes accordingly (AHK). Consequently, the export focus in South Africa is currently shifting away to other destinations such as South Korea and Japan (KfW). This example illustrates how the promotion of gH2 is currently interfering with the advancement of the EWN. Germanys involvement in South Africa is supporting its goal of the global development of gH2 value chains and respective export initiatives. But conflict arises with EU regulations fostering climate mitigation efforts and competitiveness of European industries. Measures like CBAM coupled with unrealistic certification requirements could deter South African industries from export to

[6] I acknowledge, that Germany has significant influence on EU decision making processes. However, a discussion on Germany's position regarding CBAM would exceed the scope of my thesis.

Europe and Germany. Thus, the German soft power approach potentially clashes with European hard power measures. There is a risk that a successful yet under-targeted promotion of gH2 in South Africa could undermine the ENW by failing as much to support climate ambitions as the goal of import security.

5.3 Changes in the Composition of Actors, Networks and Social Groups

By examining the strategic orientation of the international hydrogen dimension, this first part looks at German efforts on the promotion of different stakeholder networks in South Africa's gH2 value chain. The MLP assumes that technological niches and socio-technical regimes have similar structures but differ in size and stability and are clearly differentiated from each other. Measures to back the gH2 niche are targeted at existing MEC structures, through the support of institutional entrepreneurs, the stimulation of supply and demand, as well as by gaining support from powerful actors and the promotion of niche networks.

5.2.1 Support for Institutional Entrepreneurs

In South Africa, institutional entrepreneurs are mainly political actors advocating for gH2 to drive economic growth and reduce coal dependence. These actors, including the presidency and several ministries, play a central role in transforming existing regimes, allowing deviations from previous energy paths. At the same time, these political partners are responsible for German implementing institutions. Support services provided by German institutions include, for example, capacity building in the form of workshops on regulations and standards, as well as market-based aspects that bring together both policymakers and private sector actors (GIZ 0). Most importantly, the Presidency, taking patronage for strategic infrastructure and investment decisions, coordinates various ministries (GIZ 0). With the emergence of gH2, South Africa made the strategic choice to anchor hydrogen development under the Presidency

(AHK), with a central role taken by the Minister of Electricity who worked previously in the presidential acceleration unit for Infrastructure South Africa and continues to oversee the issue in his current role (GIZ 2).

5.2.2 Support of New Market Entrants

South Africa's nascent gH2 market require stimulation of the demand side (GIZ 1, GIZ 2, GIZ 0) and supply side (GIZ 1), allowing established players and new market entrants to form a common network. Support includes feasibility studies, training, workshops, and funding advice (GIZ, n.d.). New market participants include MEC actors like the steel company ArcelorMittal (GIZ 0) and Anglo American with hydrogen-powered mining vehicles (Anglo American 2022), and Transnet, which has to adapt to the new conditions (KfW). However, established players, like the petrochemical companies SASOL and PetroSA also support the niche development (GIZ 2), aiming to transition from grey to gH2 (KfW, GIZ 0). New players on the supply side are renewable energy companies with significant interest in putting their electricity molecules into value (AHK, GIZ 0).

5.2.3 Niche Support from Powerful Actors

Niche technologies can also gain traction through support from powerful actors (cf. Kern 2012, 303). In South Africa, many have had bad experiences with international companies failing to keep their development promises (KfW). Key measures for their involvement include training courses and information events (GIZ 2) for communities, NGOs, and trade unions, strengthening discourse and building societal support (GIZ 1). Another group consists mainly of JET-P partners as most of them are largely reluctant to support gH2 (Cassidy and Quitzow, 2023, p. 20), except for the Netherlands, Denmark and Japan (GIZ 1). Collaboration with development banks, such as the European Investment Bank and World Bank, mobilizes funding and ensures financial security for international investors, as they strengthen South

Africa as a business location (KfW). Overall, the support of these actors is crucial to increase the credibility of gH2 technologies in South Africa.

5.2.4 Building Networks

The MLP suggests that niche technologies break through primarily by networks facilitating exchanges between companies, decision-makers, and researchers (Geels and Raven 2007, 67). German implementing institutions play a key role in connecting these groups and coordinating efforts (AHK) that is crucial due to the lack of a dedicated hydrogen interest group (GIZ 0, GIZ 2). Activities include matchmaking events such as the South African GH2 Summit, largely financed and organized by GIZ (KfW), which allows niche developers in the field of hydrogen production to build networks with the demand side. Developers range from smaller local start-ups that are already producing gH2 to various international technology providers active in consortia, such as Enertrag together with Sasol, Bambili or Energie (GIZ 0). These efforts indicate that the market is still nascent, with the gH2 technologies network being internationally and systematically expanded across different industrial sectors.

5.3 Changes in Technological Pathways

In addition to stakeholder networks, the MLP framework highlights the technological dimension, embedded in niches and regime structures, driving the dissemination and innovation of technologies (Verbong and Geels 2007; Geels and Raven 2007). This section assesses Germany's contribution to the emergence of new production systems using gH2 technologies (cf. Markard and Truffer 2008, 599). Production processes, such as in the MEC sectors, aim to utilize gH2 technologies within their established applications, while niche-level innovations lead to new uses through learning processes.

5.3.1 Changes in Production Process

Hard-to-abate sectors are increasingly recognizing the role of green molecules in their decarbonization efforts, beyond the energy transition in the electricity sector. For example, the mining sector is investing in mini-grid installations to avoid the costs of loadshedding and to respond to international market incentives, such as those from the EU (GIZ 2). By focusing, e.g. on sustainable water usage in the development of a gH2 value chain, the AHK conceives strategies to link the hydrogen and mining sectors, converting former burdens into sustainable value (AHK). Furthermore, companies like Transnet are not only needed to connect important hubs such as mining areas with corresponding ports, but explore the use of gH2 for decarbonization themselves (InfraCo Africa 2023). Notwithstanding, financial support is challenging due to profitability concerns (KfW). Thus, activities in sectors like mining focus on incremental innovations supporting decarbonization which does not result in changes in the final product.

5.3.2 Changes in Production Line

Changes in production lines also emphasize decarbonization but lead to different end products, where hydrogen technologies are integrated into production processes. For instance, many renewable energy project developers are looking into mini-grid applications, using electrolyzers to make use of their additional molecules (AHK). GH2 is also gaining value in sectors already using grey hydrogen, such as the petrochemical industry, including companies like Sasol and PetroSA, which produce synthetic fuels. As a result, the German government's H2Global initiative has provided Sasol with purchase guarantees for sustainable aviation fuel exports (SASOL 2021). These initiatives demonstrate gH2's potential to generate green products within existing regimes, aiming to mainstream hydrogen technologies and develop large-scale applications.

5.3.3 Strategic Learning: Commercialization and Capacity Building

At the niche level, strategic learning is crucial to promote new production processes and build capacity for the emerging gH2 market. GIZ collaborates with scientific networks to develop skills and conduct studies on niche technologies, such as desalination (GIZ 2, GIZ 0). Accompanying, KfW offers non-repayable loans (KfW). The South African government has designated nine catalytic hydrogen projects (SIPS, n.d.), whose pilot characteristics are aimed at pooling resources and facilitating learning processes. These are indirectly financed by KfW through IDC development loans (KfW). Altogether, this demonstrates how German implementation organizations support decarbonizing existing production processes, developing new product lines, and promoting niche developments.

5.4 Changes in Guiding Rules

Finally, rules form the behavioral frameworks in which technologies and actors operate. These include not only formal regulations such as legislation, but also a variety of cognitive expectations about market developments or normative rules of conduct (Verbong and Geels 2007; Geels and Raven 2007). With Germany's support for "renewable energy additionality", it seeks to transform these existing frameworks.

5.4.1 Regulative Rules

GH2 is currently addressed through national strategies like the HSRM and the GH2 Commercialization Strategy, which set targets for hydrogen use, including exports and local consumption (GIZ 1). The strategies were developed in close consultation with German stakeholders and formulated according to common goals (AHK). Germany supports the principle of additionality for renewable energies, ensuring that resources designated in current energy legislation are not diverted to gH2 production (GIZ 0). This is in line with recent

regulatory changes, allowing for increased private renewable energy installations (GIZ 2). Such topics are discussed within training courses and workshops about regulations, codes and standards tailored for ministries, officials, and the private sector (GIZ 0). Additionally, KfW is using policy-based loans to support the reform of the energy market from a centralized to a decentralized system, enabling large-scale hydrogen production (KfW). Despite the lack of integration of gH2 into South Africa's existing regulatory framework (GIZ 1), new regulatory frameworks are emerging. Thus, support mechanisms reinforce ongoing changes in the overall energy system.

5.4.2 Normative Rules

Normative discussions focus on the transition from coal to renewable energies, shaped by concerns about energy security and the impact on local communities and existing coal sector jobs (KfW, AHK, GIZ 1,2,0). The JET-P agreement has prompted warnings against a neo-colonial agenda from the Global North, amplifying fears about the responsibility of international actors and skepticism about public money being used for export investments (AHK; GIZ 2). The Department of Mineral Resources and Energy (DMRE) and its current minister, a former trade union leader of the coal industry, reinforce these sentiments by remaining focused on coal, and opposed to renewable energy efforts (AHK, KfW, GIZ 0).

Despite this, South Africa faces high unemployment of over 30%, especially among young people (AHK), with gH2 offering a partial solution. Developing a gH2 economy under the principle of additionality could create projected 20,000 additional jobs by 2030 (cf. DSI 2021) without threatening existing coal jobs (GIZ 0). To establish a suitable Technical and Vocational Education and Training system, GIZ collaborates with universities, aiming to provide skilled workers for maintenance and promote human capital for innovation (GIZ 1, GIZ 0).

Furthermore, implementing international environmental and social standards is crucial to minimize local community disruption. Information dissemination by German implementing institutions intend to prevent resource conflicts (GIZ 1, KfW) and inform about job opportunities (GIZ 0). Thus, gH2 is expected to drive sustainable development independent of exports.

5.4.3 Cognitive Rules

Since 2008, South Africa is experiencing recurring power outages, which have stunted economic growth (AHK) and shaped the cognitive perception of energy-related issues (GIZ 1, GIZ 2, GIZ 0, AHK; KfW). The energy crisis has heightened demand for electricity from all sources, prompting companies like Anglo American to invest in mini-grid systems powered by hydrogen (GIZ 2). These market-driven solutions are more prevalent in regions severely affected by loadshedding (GIZ 2). Although the current regulatory framework lacks sufficient market incentives, the development of a hydrogen economy serves as a possible catalyst to developing a decentralized energy system more immune to power outages.

Finally, the expansion of the gH2 economy is also based on the conviction that in a CO2-free world the market for coal will decline (GIZ 1). The cooperation in the Energy Partnership, initially represented by the disinterested DMRE, and now headed by the presidency (AHK, KfW), displays this changing mindset. GIZ has made a significant contribution to this shift during a delegation trip to Brussels. The Presidency, the Department of Science and Innovation (DSI), and the Department of Trade, Industry and Competition engaged with the topic, while the DMRE remained in the background during the visit (KfW). This has fostered increased cooperation between German institutions and the Presidency, which has provided necessary attention to the country and indicates high expectations of the hydrogen market. However, many uncertainties remain, due to the lack of projects in the final development phase and

because gH2 is not yet competitive with fossil fuel alternatives, challenging investor confidence (GIZ 1, KfW).

CHAPTER 6 – CONCLUSION AND DISCUSSION

GH2 emerged as a cornerstone of Germany's energy transition with the goals to mitigate climate change and to decarbonize its industry and mobility sector. Germany's recognition of its import dependence and the need for large-scale market development emphasize the international orientation of the NHS. With this thesis, I investigated how the perceived necessity for hydrogen imports and global market development in the NHS influences Germany's efforts in South Africa, and its implications for international EWN as a soft power resource.

The promotion of gH2 in South Africa is a continuation of the EWN as a soft power resource. Efforts to stimulate gH2 are driven by its environmental benefits and as a strategic tool for economic growth and reindustrialization – therefore creating a "win-win" narrative for both South Africa's and Germany's own energy security. The narrative is supported under soft power tactics such as the long-term cooperation measures of capacity building, provision of expertise, and dialogue to foster policies and to increase gH2s legitimacy. But given the European Green Deal and its implementation of CBAM, economic incentives also show coercive elements with regard to the development of an export market in South Africa.

These measures are leveraged against South Africa's coal dominated economy and its reliance on MEC sectors for public services and export earnings. As this regime structure is under significant economic, environmental, and social pressure for greener production methods, German agencies support the architectural reconfigurations of the MEC through the promotion of gH2 technologies. In close cooperation with the Presidency, Germany forms a private sector alliance linking MEC sectors with green technology providers. Technologically, these initiatives aid in decarbonizing hard-to-abate sectors, introducing new product lines, and fostering incremental innovations within MEC sectors. The associated changes along

technological trajectories and actor-network compositions are stimulated under the principle of renewable additionality, emphasizing the potential for a decentralized energy system, job creation, as well as energy security.

However, the results also indicate that the EWN is insufficient in terms of climate targets and securing hydrogen imports. German support measures do promote the MEC's business model, especially through the establishment of export structures for the global hydrogen value chain. Nevertheless, the technological prerequisites and the necessary standards for exporting to European markets have not yet matured sufficiently. Given the structural conditions established by the EU under CBAM and instruments like H2Global, the goal of future imports is not adequately assured. Consequently, South Africa is targeting other sales markets in Asia in the medium term, thereby thwarting the establishment of a hydrogen market aligned with European climate goals.

In conclusion, the success of the international hydrogen dimension of German energy policy faces a dilemma, between sustainability and import security. To address this, future research should focus on enhancing sustainability standards and effectively designing international energy policy to address this challenge.

APPENDICES

Annex 1: Interview Guideline

Dimensions	Content	Questions
1) Energy Transition	Queries about personal experiences with various measures taken by Germany in South Africa.	• In your experience, how has Germany participated in the energy transition in South Africa? • Did you observe any changes in Germany's engagement in South Africa, especially since the publication of the National Hydrogen Strategy?
	Understanding the working procedure of German implementing institutions	• Could you describe your institution's key strategic objectives in the context of South Africa's energy transition? • What instruments does your institution use to support the energy transition in South Africa? • Referring to the two questions asked above, do you think anything has changed in terms of goals or instruments since green hydrogen is on the agenda?
2) Multi-Level Perspective	Understanding actor composition and target groups	• Could you describe the stakeholder groups you work with? • Why are these actors relevant to your organization?
	Understanding the relevance of green hydrogen promotion in South Africa and its perception	• How do you assess the role of hydrogen in South Africa's decarbonization plans compared to other technologies? • In your opinion, how has the public perception of renewable energies developed after the promotion of green hydrogen?

Source: Own illustration

Annex 2: Energiewende Narrative as a Power Resource Coding Scheme

Category	Description/Definition	Sub Code	Anchor Example	Coding Rule
1) Prevalence of interest	The prevalence of (national) interest as understood as what an actor declared as vital for the promotion of (global) public goods. (cf. Ohnesorge, 2021, 112)	1.1) Prevalence of national interest energy transition	E.g.: Pursuit of the SDGs, climate change, technological export	Subjective assessment of German national interests with regard to renewable energies and energy efficiency in South Africa
		1.2) Prevalence of national interest gH2	E.g.: Climate change, reindustrialization, German energy security; technological export	Subjective assessment of German national interests with regard to green hydrogen in South Africa
		1.3) Prevalence of institutional interest energy transition	E.g.: Climate change, sustainability, South African energy security and accessibility; foreign trade; infrastructure	Subjective assessment of institutional interests with regard to energy transition in South Africa
		1.4) Prevalence of institutional interest gH2	E.g.: Climate change, economic competitiveness, just energy transition;	Subjective assessment of institutional interests with regard to green hydrogen in South Africa
2) Means to achieve its goals	The ways and means by which an actor seeks to achieve its stated goals in energy policy (cf. Ohnesorge, 2021, 112).	2.1) Means to achieve its goals Energy Transition	E.g.: Study tours, studies, vocational training, institution building, concessional financing, development of business cases	Description of mechanisms in support of energy efficiency and renewable energy

		2.2) Means to achieve its goals gH2	E.g.: Study tours, studies, concessional financing, development of business cases	Description of mechanisms in support of green hydrogen
3) Change indicators	All aspects that describe certain shifts in a political program or decision relevant to the promotion of green hydrogen (cf. Ohnesorge, 2012, 111)	3.1) Change indicator interests	E.g.: Covid 19; Ukraine war	Subjective assessment of temporal changes and evolution of national interests
		3.2) Change indicator means	E.g.: National Hydrogen Strategy; increased funding	Subjective assessment of temporal changes and evolution with an impact on the use of different means
Inductive Category				
4) German South African relations	The way in which German South African interactions are framed including the perception of German presence in South Africa	4.1) Germany's role in renewable energy	E.g.: Bilateral programs, technical and financial support	Subjective assessment of Germanys relevance in the promotion of energy transition in South Africa
		4.3) Germany's role in green hydrogen	E.g.: National Hydrogen Strategy, different projects and programs, JET-P; private sector involvement	Subjective assessment of Germanys relevance in the promotion of a green hydrogen economy in South Africa
		4.3) Role of implementing institution	E.g.: Years of activity; focus of activity	All passages highlighting the presence of German institutions in South Africa
		4.4) Shared interests between	E.g.: The creation of export markets; shared commercial interests	All passages describing alignment of German South African interests in the field of energy

	Germany and South Africa		
	4.5) Nature of cooperation between Germany and South Africa	E.g.: Mutual learning; adaptation of cooperation in the field of energy;	All passages describing the nature of German South African cooperation in the field of energy

Source: Own illustration; based on Ohnesorge (2021, 112) for categories

Annex 3: Multi-Level Perspective on Sustainability Coding Scheme

Category	Description	Sub-Code	Definition	Anchor Example	Coding Rule
1) Actors Networks	The way how the promotion of green hydrogen activities influences the actors and network compositions	1.1) Regime: Institutional Entrepreneurs	Supporting institutional entrepreneurs such as individuals or groups who proactively seek to initiate and drive transformation at the regime level (c.f. Schwabe, 2024, 3)	E.g.: Government bodies and regional governments promoting actively the hydrogen agenda	Cases of individuals and institutions which initiated gH2 and its agenda proactively
		1.2) Regime: New Market Entrants	Reconfiguration of the socio-technological system (cf. Kern, 2012, 306; Geels and Schot, 2007, 411)	E.g.: Promotion of established sectors in the emerging hydrogen market	Cases interested in the application of gH2 and potential demand up-takers
		1.3) Niche: Powerful Actor Support	Trying to get support from powerful actors' groups for niche developments (cf. Kern, 2012, 303; Geels and Schot, 2007, 405)	E.g.: Communities which show reluctance towards the promotion of green hydrogen or investors	Cases which are skeptical, not aware or need to be convinced
		1.4) Niche: Network Building	Providing space for the interactions between niche actors and the building of social networks (cf. Geels and Raven, 2007, 67)	E.g.: Information and market development events	Actions to promote network building among project developers niche project developers
2) Technology	The extent to which the promotion of green hydrogen technologies can lead	2.1) Regime: Change in Production Process	Incremental changes in technological production pathway (cf. Kern, 2012, 305), with no changes in the final product (cf.	E.g.: Advising companies how to use green hydrogen (technologies) and providing synergies	Cases where the use of hydrogen and its derivatives promote path dependent production

	to innovative production pathways		Markard and Truffer, 2008. 599)		pathways; indirect use of hydrogen (technologies)
		2.2) Regime: Change in Product Line	Supporting the wide scale deployment of niche innovations (cf. Kern, 2012, 305); with changes in the final product (cf. Markard and Truffer, 2008, 599).	E.g.: Subsidizing the direct adoption of hydrogen (technologies)	Cases where green hydrogen is directly implemented at the regime level
		2.3) Niche: Strategic Learning	Building niche momentum through activities that help the development of technical and strategic learning (cf. Kern, 2012, 303; Geels and Raven 2007)	E.g.: Proactive R&D calls and research accelerators	Cases with research and developmental characters
3) Rules	The way promotion of green hydrogen can indicate its role in promoting different rules towards behavioral change	3.1) Regime Rules	Stabilization of existing regulative rules; cognitive routines and behavioral norms (Geels and Schot, 2007, 403)	E.g.: Regulative: integration of hydrogen into existing legislation Normative: Concerns about job losses and environmental degradation Cognitive: Green hydrogen benefiting export purposes;	Cases defending the status quo of the old system through the use of green hydrogen

			extractivism and big projects	
	3.2)Niche Rules	Changes in regulative rules cognitive routines and behavioral norms through the articulation of new expectations (Geels and Schot, 2007, 402; Geels and Raven, 2007, 67)	E.g.: Regulative: principles of additionality and regulatory reform Normative: Discussions on the transition from coal to renewable energies Cognitive: Perception of green hydrogen as a potential new sales market	Cases promoting change in the rule sets through the use of green hydrogen

Source: Own illustration; based on Geels and Raven (2007), Geels and Schot (2007), Kern (2012), Markard and Truffer (2008), Schwabe (2024) and Verbong and Geels (2007) for sub-codes

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