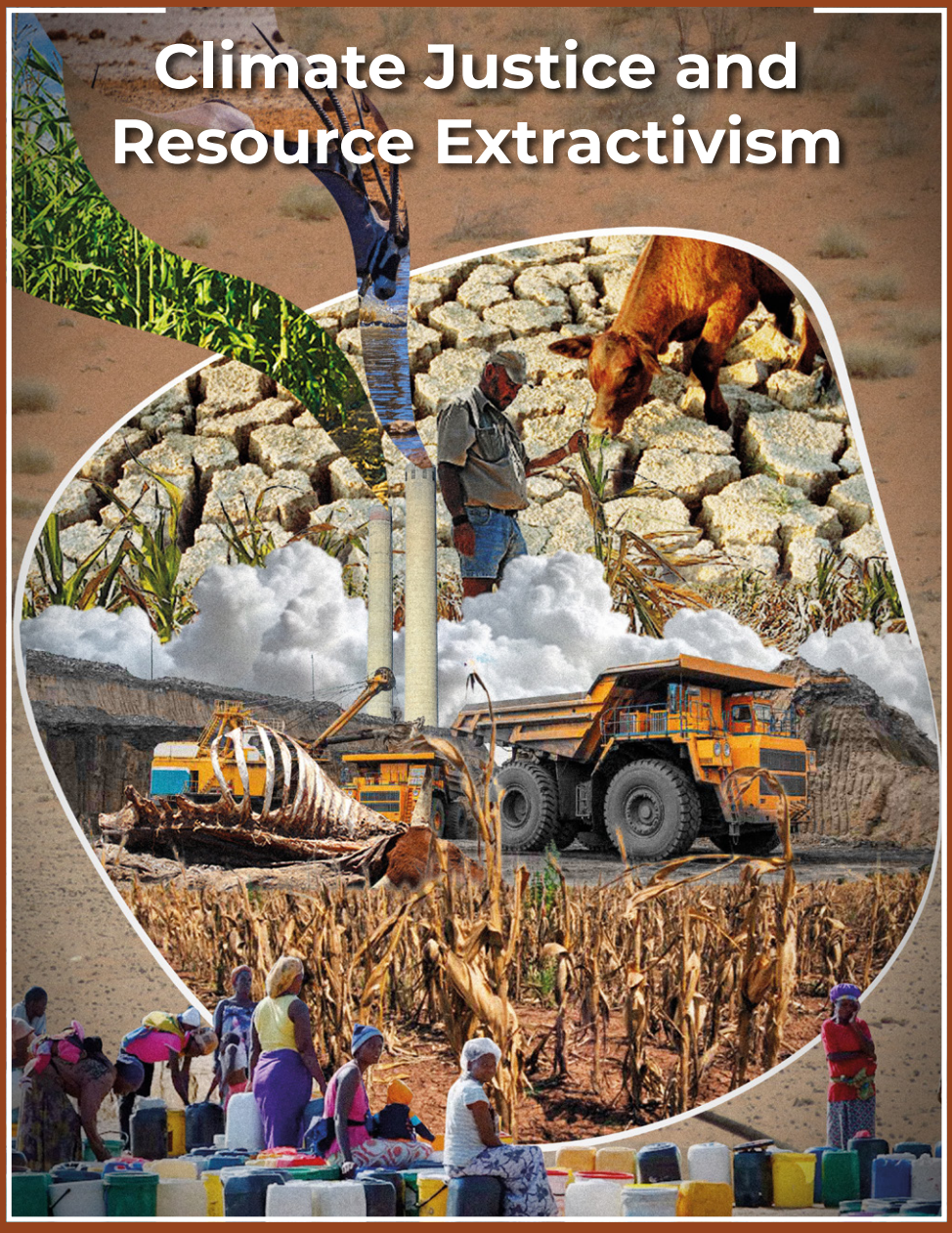
Volume 4

March 2025

Namibian Journal of Social Justice



Development for Whom? A Case Study of the Hyphen Hydrogen Project in Namibia.

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Abstract:

This paper examines the potential socioeconomic and environmental implications of Namibia's emerging green hydrogen economy, focusing on the Hyphen Hydrogen Energy project. Based on 18 months of research, including document reviews and over 60 interviews, it assesses anticipated benefits, risks, and stakeholders involved. Despite Namibia's renewable energy potential, findings indicate that primary gains may favour international corporations, with limited benefits to Namibian society. Opportunities for local job creation, value chains, and resolving Namibia's energy issues appear limited, while unique biodiversity is put at risk. The project's financing structure and lack of transparency raise concerns that it may perpetuate social inequalities, with Global North entities exploiting Namibia's natural resources for the sake of a "green" energy carrier. The study calls for stronger accountability and transparent planning processes to align Namibia's green hydrogen economy with the needs of its people, emphasising the role of civil society in advocating for equitable outcomes.

Shacks in Lüderitz. Source: Author

Keywords: green hydrogen; Hyphen; uneven development; Namibia; justice

Green hydrogen? We are still waiting.
Lüderitz resident in his early 20s

Introduction

Namibia stands at the crossroads of a global green hydrogen revolution that presents both remarkable opportunities and significant challenges. Within this context, stakeholders often adopt contrasting positions. On one hand, industrial and government representatives highlight Namibia's vast renewable resources as key enablers of economic and social upliftment, with the potential to address pressing national issues such as unemployment, poverty, inequality, and public debt (Amelang, 2023; Republic of Namibia, 2022a). In contrast, growing concerns about transparency, inclusivity, and uncertainties are being raised, particularly by non-profit organizations and civil society groups. For example, the Institute for Public Policy Research (IPPR, 2022) and various interviews conducted for this study highlight these issues, as reflected by the statement above. Activists and residents question whether the benefits of this emerging hydrogen economy will be equitably shared, or if the gains will disproportionately favour foreign entities, as has occurred in Namibia in the past.

This case study examines the socioeconomic and environmental implications of the Hyphen Green Hydrogen project, planned for the Tsau ||Khaeb National Park (TKNP) in southern Namibia, near Lüderitz Bay. Additionally, the paper shall present actionable entry points for various stakeholders, encouraging civil society, decision makers, industry leaders, and government entities to engage in critical reflection and active dialogue on green hydrogen. This engagement is vital both in Namibia and in Germany, a country heavily involved in promoting and funding Namibia's hydrogen initiatives.

Data Collection and Structure of this Paper

The analysis presented here is the result of extensive archival research of reports, documents, and scientific papers from industry, government, and academic sources, complemented by a three-month field study in Namibia. During that time, over 60 interviews—both semi-structured and field-based—were conducted with individuals of diverse ages, genders, occupations, residencies, and countries of origin. Moreover, participation in several conferences and symposia on green hydrogen developments provided firsthand insight into developments in towns like Lüderitz.

The following sections will briefly outline the political and legislative

background that shapes the hydrogen economy both globally and in Namibia, followed by an update on the current status of the Hyphen Green Hydrogen project. The main focus of this paper is to explore who stands to benefit from the hydrogen-related developments in Namibia, examining this question from various perspectives. The paper concludes by outlining opportunities that may present themselves with the new economy, as well as actionable steps that industry leaders, policymakers, and civil society can take to help realise these opportunities.

Political and Legislative Pressures Influencing the Hydrogen Economy in Namibia

In many countries of the Global North, green hydrogen is seen as a clean, sustainable, and affordable energy source for combatting climate change, particularly by replacing fossil fuels in sectors that are hard to decarbonise, in other words, where electrification is not feasible, such as some industrial activities, the mobility sector, aviation, and maritime shipping. Given that Germany creates a significant portion of its GDP from these sectors, the use of green hydrogen is highly attractive (United Nations Environment Programme, 2021; Merten & Scholz, 2023). Additionally, the Russian-Ukraine war has added greater urgency to the energy transition, resulting in efforts to replace reliance on cheap Russian oil and gas. Limited domestic production capacity has moved Germany towards prioritising imports, including from Namibia, a country considered ideal for green hydrogen production due to its abundant sun, wind and seawater renewable resources (Federal Ministry for Economic Affairs and Climate Action, 2024).

Namibia is facing substantial socioeconomic inequalities, with high unemployment and significant government debt (Bank of Namibia, 2022; Benonia, 2020; Melber, 2022). Additionally, a considerable portion of its electricity is imported, while half of the population lacks access to it (Brandt, 2022; Elston, 2022). Given the high electricity demands of hydrogen production, there is potential to reduce electricity imports if production facilities are oversized or configured to primarily feed electricity into the local grid. Regarding economic benefits, a key challenge lies in structuring projects to maximise Namibia's financial gains while ensuring that they remain attractive to developers. Given the described factors and the country's economic situation, the Namibian government has high hopes for the hydrogen economy to create numerous jobs, establish parts of the value chain domestically, boost national GDP, and address existing energy challenges (Republic of Namibia, 2022b).

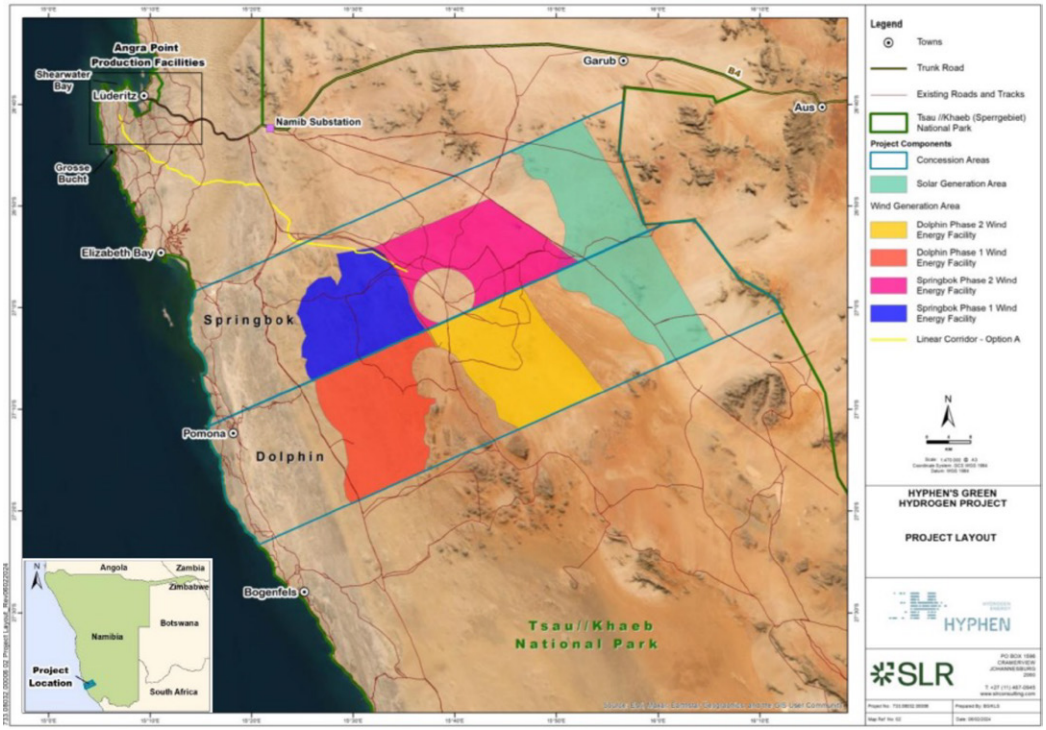
Green Hydrogen and the Current State of the Hyphen Project

Hydrogen is utilised in various forms today, playing a vital role across several industrial sectors. It is a key feedstock for the synthesis of ammonia, which is essential for chemical production and fertilisers, and is widely used in the petrochemical industry for fuel refining. Currently, the majority of hydrogen is derived from fossil fuels, particularly natural gas. However, hydrogen can also be produced through electrolysis, a process in which electricity is passed through water (mixed with a conductive substance) to separate water into hydrogen and oxygen. When the electricity used for electrolysis is sourced from renewable energy, the resulting hydrogen is commonly referred to as "green" hydrogen. As of 2019, the share of green hydrogen of the total global hydrogen production volume was less than 0.1% (International Energy Agency, 2019).

Green hydrogen production requires significant quantities of water. In arid regions like Namibia, where fresh water scarcity is a concern, seawater can be desalinated to serve as a feedstock. However, desalination is energy-intensive and generates brine—a concentrated salt solution—as a by-product, which may also contain hazardous chemicals. This brine is commonly discharged into surface ocean waters, although more costly alternatives exist for extracting minerals from brine (Collins, 2021; Schmidt & Frank, 2023).

As described above, Namibia has a significant interest in producing hydrogen. In this context, in 2021, the company Hyphen Hydrogen Energy was awarded the contract for the development of a large-scale hydrogen production facility to be located in the TKNP in southern Namibia, with an estimated investment volume of over USD 10 billion. The project is expected to create 18 000 jobs, with 90% of these positions to be filled by Namibians, with production originally planned to commence in 2027. According to Hyphen's plans as of October 2024, the projected start of production has been revised to 2029 (Hyphen Hydrogen Energy 2024). The investment, jointly raised by Hyphen (76%) and the Namibian government (24%), covers the development of wind and solar power plants, electrolysis facilities (to produce hydrogen), pipelines, a seawater desalination plant, and infrastructure such as roads and transmission lines (Hyphen, 2023b; Republic of Namibia, 2022a). Notably, this project is globally one of the first of its kind and scope. By 2031, it is expected to produce more than 350 000 tonnes of hydrogen annually. The entire concession area covers about 4 000 square kilometres within the park. Figure 1 provides an overview of the preliminary layout of the project.

Figure 1 *Preliminary layout of the Hyphen facilities within the TKNP*



Source: SLR Consulting (2024)

The designated renewable energy capacity includes 4 GW of wind power and 3 GW of solar power, which corresponds to around 600 wind turbines, and extensive fenced photovoltaic areas. According to preliminary plans from Hyphen, seawater will be pumped through pipelines from the Lüderitz Peninsula. Following desalination, it will be further transported to the electrolysis sites. The produced hydrogen will then be piped back to the peninsula where it will be synthesized into ammonia for international export by ship. Ammonia is widely regarded as the preferred hydrogen carrier for long-distance transport via ship, including by the German government (Federal Ministry for Economic Affairs and Climate Action, 2024). In addition to the infrastructure directly required for producing green hydrogen and ammonia, Hyphen has proposed supplying excess electricity to the country and providing potable water from desalinated seawater to Lüderitz and the settlement of Aus (Hyphen Hydrogen Energy, 2023c).

The project is currently in its "feasibility phase", which could extend until mid-2025. During this phase, Hyphen is tasked with assessing the technical, financial, environmental, social, and commercial viability of the project, while the government develops the fiscal and regulatory framework. Currently, Hyphen has installed sensors and meteorological masts to gather wind data in designated areas within the National Park. On the regulatory side, the Namibian government is expected to develop the Synthetic Fuels Act, which will provide the framework for regulating this new economic sector (Hyphen Hydrogen Energy, 2023b).

Mechanisms to Address Environmental and Socioeconomic Risks

The development of green hydrogen production facilities in Namibia in the TKNP comes with several environmental and socioeconomic risks. The Namibian Chamber of Environment (2024) has suggested labelling the hydrogen produced there as "red hydrogen" due to the potential threat of species listed on the IUCN (International Union for Conservation of Nature) Red List becoming extinct or endangered. Additionally, risks to marine biodiversity—including impacts from a new port, increased vessel traffic, brine discharge from desalination, and possible ammonia leaks—could negatively affect the fishing industry (also see "Benefits and Costs: Development for Whom?" section a) "Risk of job exclusion for locals" below).

Mechanisms do exist to partly manage these risks. As regulated in the Environmental Management Act (7 of 2007) (2012), an environmental clearance certificate is required for the construction of energy generation facilities; this certificate may also mandate an environmental impact assessment (EIA), a well-recognised tool for mitigating environmental and social risks on a project basis. It assesses the direct impacts, both positive and negative, of a specific project and proposes mitigation measures. An EIA also provides opportunities for stakeholders to raise concerns, for example during public consultation meetings. Stakeholders may register as Interested and Affected Parties to stay informed on EIA progress (Dalal-Clayton & Sadler, 1999).

For the Hyphen project, as of July 2024, an EIA was conducted only for the construction and placement of sensors and meteorological masts to collect data on wind characteristics in some areas of the TKNP (Blood & Moodaley, 2022). The formal EIA process for the entire Hyphen project has not yet commenced, with little information being shared with the public. SLR Consulting, an international sustainability consultancy,

is responsible for managing and coordinating the entire EIA process.

In May 2024, Green Hydrogen Commissioner James Mynupe announced that a Strategic Environmental and Social Assessment (SESA) would be conducted for the entire Southern Corridor Development Initiative, an area of about 14 000 km2 in southern Namibia that covers large parts of the TKNP where hydrogen developments shall take place (Ndjavera, 2024). This decision was announced shortly after the release of the report by the Namibian Chamber of Environment.

A Strategic Environmental Assessment (SEA) and Strategic Environmental and Social Assessment (SESA) assess broader, cumulative impacts of regional plans, outlines alternative project sites, and encourages public engagement. The duration of a SEA can vary significantly depending on complexity and data availability, sometimes taking only a few months (Dalal-Clayton & Sadler, 1999). However, given the absence of a prior SEA for the TKNP and other parts of southern Namibia, the process may extend significantly beyond the original timeline of the Hyphen project, similar to the 20-month SEA conducted for uranium mining in the Namib Desert from 2009 to 2011 (Republic of Namibia, 2011).

Benefits and Costs: Development for Whom?

a) Risk of job exclusion for locals

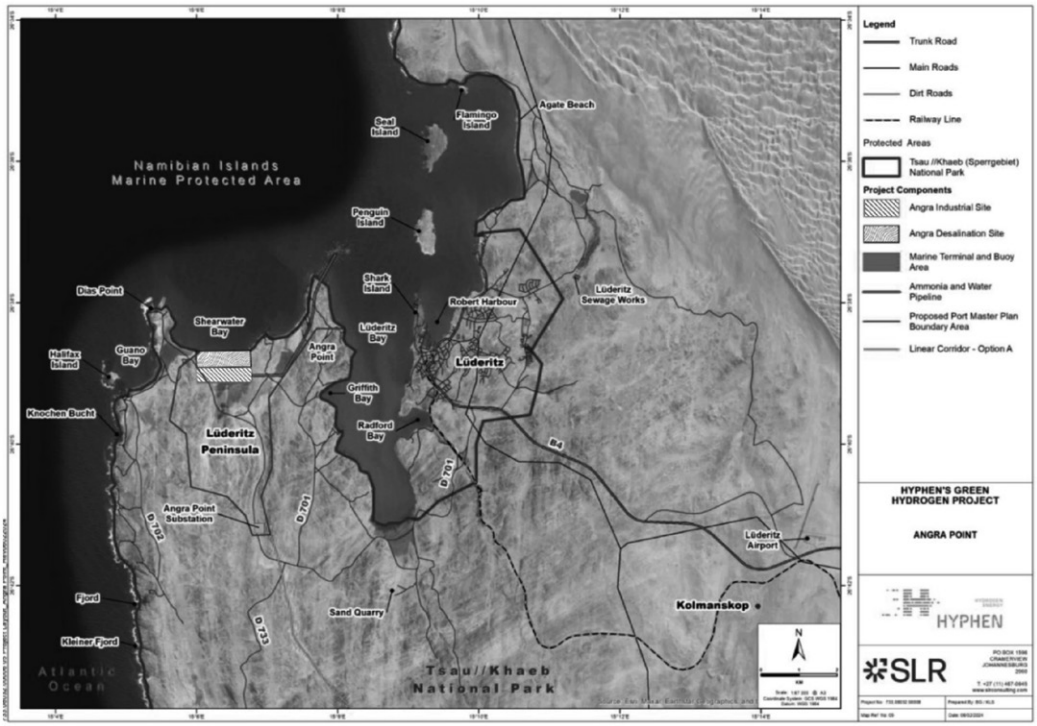
There is a significant risk that many job opportunities may be inaccessible to residents of Lüderitz and Namibia due to a lack of specialised skills within the country. Both residents and experts have expressed concerns that the necessary workforce does not currently exist in Namibia and would need to be imported, potentially leading to an influx of foreign workers in Lüderitz. This possibility was also mildly acknowledged by Hyphen's Head of Environment, Social, and Governance (Beukes, 2023).

One reason for the lack of the necessary skills is the limited availability of hydrogen-specific curricula from Namibia's higher education providers. Additionally, a gap exists between vocational education and training centres and universities, preventing many individuals from accessing university programmes due to missing qualifications and a lack of basic education (International PtX Hub, 2023). The high costs associated with tertiary education prevent many young people in Lüderitz and surrounding areas from pursuing higher studies, as highlighted by residents of Lüderitz and the settlement of Aus.

To address these gaps, Namibia has introduced skills development initiatives, including the Green Hydrogen Research Institute at the University of Namibia, partnerships with international institutions, and Youth for Green Hydrogen scholarships. Activists have raised concerns that these scholarships are unlikely to reach the underprivileged, marginalised, or uneducated populace, but will benefit those with existing status, wealth, or higher education.

Not only do the inhabitants of Lüderitz risk exclusion from emerging job opportunities, but they also face potential losses from the Hyphen project, particularly in the fishing industry. The discharge of brine into the ocean, potential ammonia leaks into the ocean, and increased large vessel traffic due to the construction of the new harbour on the Lüderitz peninsula, could have a significant negative impact on the marine environment and therefore threaten local fishing industries. This is particularly concerning given that the nearby nutrient-rich Benguela current supports the livelihoods of most Lüderitz residents. Figure 2 provides an overview of the planned facilities, offering a sense of the scale of the new harbour

Figure 2 *Planned new port location*



Source: own; adopted from SLR Consulting, 2024

zone where new entities will develop and where access will be restricted. Notably, this area is one of the few freely accessible coastal spaces along the entire southern coastline of Namibia.

Further in-depth research is necessary to understand the environmental and socioeconomic risks posed for the marine environment, but it is evident that these developments will inevitably have some kind of negative impact.

b) Electricity and water challenges

While acknowledging Hyphen's proposals to provide surplus electricity to Namibia and water to Lüderitz and the settlement of Aus, which are not mandated by the Namibian government, these suggestions do not effectively address the significant energy challenges and water shortages faced by Namibia. Electricity access would remain limited for most parts of Namibia, especially in rural areas, where 80% of the people without access to electricity reside (Brandt, 2022). The Hyphen plant could become an "energy island", as major investments and reforms would be necessary to allow the electricity it generates to reach remote areas and a wider population. An interviewee pointed out that in a best-case scenario, electricity could be provided to Lüderitz and Aus, but not to other areas in the country where it is also needed. It is also noteworthy that the planned renewable energy capacity of the Hyphen project could be approximately four times Namibia's entire electricity consumption of 2021 (GIZ, 2022; International Energy Agency, n.d.; author's calculations). Given the relatively small energy consumption of Lüderitz and Aus compared to national levels, the Hyphen project would not significantly improve access to electricity or reduce dependence on fossil fuel-based electricity imports from abroad.

Furthermore, as one of the driest countries in the sub-Saharan region, Namibia has faced several severe droughts in recent years (Liu & Zhou, 2021; Matthys, 2024). The water demand of Hyphen's planned electrolyser capacity to produce hydrogen could account for nearly 5% of all water consumed in Namibia in 2021 (Namwater, 2023; Schmidt & Frank, 2023; own calculations). Although the project uses seawater that will be desalinated and does not rely on Namibia's already limited groundwater resources, it will not help alleviate the country's problems associated with water scarcity and severe droughts.

c) Primary beneficiaries of the Hyphen project are abroad

The development of Namibia's hydrogen economy is predominantly driven by foreign companies that

control its entire supply chain, primarily originating from the Global North. Key beneficiaries include ENERTRAG, a German energy company and a member of the Hyphen consortium, which is probably involved in the planning and realisation of wind, solar, and electrolysis facilities. The second consortium member, and thus a main beneficiary, Nicholas Holdings, is an international investment firm registered in the British Virgin Islands, a known tax haven (GSL Law & Consulting, 2023). Generally, Hyphen outsources many critical advisory and planning tasks—from legal assistance and public relations, to environmental assessments and technical planning—to international companies from Austria, Germany, the USA, the UK, and South Africa (Hyphen Hydrogen Energy, 2023d, 2023e). According to the websites of these firms, most do not have local offices in Namibia.

Hyphen's "Socio-Economic Development Framework'" sets an objective to source 30% of its goods and services in Namibia (Hyphen Hydrogen Energy, 2023c). While Hyphen may undertake actions to reach this goal, implementing these measures could require a substantial amount of time, due to the significant lack of local expertise in Namibia. Consequently, foreign industries could dominate, for instance in wind blade production, where Hyphen has mooted the involvement of German or Danish companies (Hyphen Hydrogen Energy, 2021). Müller et al. (2022) and a social scientist specialising in green hydrogen whom I interviewed suggest that such developments could lead in Namibia to the establishment of an "enclave economy". This would result in the green hydrogen sector being disconnected from the domestic economy, reducing the likelihood of local economic spillovers.

The hydrogen that will be produced by the project is not intended for the Namibian market. If the current non-binding agreements between Hyphen and prospective clients are realised, all hydrogen produced in the project's first phase will be sold to countries in the Global North (Hyphen Hydrogen Energy, 2023a). Although Namibia's Green Hydrogen Council suggests potential domestic uses for hydrogen, such as in agriculture or mining (Republic of Namibia, 2022a), significant limitations restrict these prospects. These include inadequate infrastructure, scarce raw materials, and a lack of expertise. These factors also discourage industries from relocating to Namibia to produce hydrogen derivatives such as methanol, steel, and ammonia. As a result, Namibia's deeper integration into the hydrogen value chain will remain limited, with the country largely confined to exporting hydrogen rather than utilising it domestically (Eicke & De Blasio, 2022).

d) Financial risks associated with the project are significant

There are strong indications that the potential financial returns for the Namibian state are disproportionate to the financial risks it faces. In exchange for providing the land, the Namibian state is set to receive rent, royalties, taxes, and some revenue from hydrogen sales due to its project shares. Discussions are ongoing between Hyphen and the Namibian government about establishing a special economic zone in the Lüderitz region with reduced taxes on exported resources, as noted by a local politician from Lüderitz. Given this context, the 40-year concessional period granted to Hyphen to produce hydrogen, and own calculations of the potential financial reward, it is likely that Hyphen's profit will be significantly higher than Namibia's. This disparity is noteworthy, as Namibia is providing the land, and the natural resources – water, wind, and sun – necessary for green hydrogen production.

Namibia's 24% share of the overall project investment poses significant risks, potentially creating financial dependencies on other countries. From the overall investment of over USD 10 billion (Martin, 2023), the Namibian government would thus need to raise at least US$ 2.4 Bn, equivalent to NAD 44 billion (NAD 44 000 000 000). Due to limited capital available in the country, this share will likely be financed with foreign money, possibly through a loan by the European Investment Bank (2022) and by issuing green bonds (Gabor & Sylla, 2023). To incur new debt through foreign loans and bonds of such magnitude would double Namibia's overall foreign debt, presenting significant risks. These risks are particularly concerning if the hydrogen produced in Namibia is not as cost-competitive as hydrogen produced elsewhere, or if the expected demand for Namibian hydrogen falls short of expectations. In these scenarios, financial dependencies could arise as creditors would probably claim repayment, regardless of the project's success. Considering the nascent state of the global hydrogen economy, with the Hyphen project being among the first of its scale and with very limited prior experience to draw upon, concerns about the project's potential for limited success are well-founded. Additionally, the substantial financial commitment required from the Namibian government could divert necessary investments away from other critical sectors, such as healthcare and education, as noted by a social scientist interviewed during my research.

There are examples in other countries where similar financing models for pioneering energy projects have resulted in significant financial losses, borne primarily by the broader

public. One such example is a renewable energy project in Morocco, that employs Concentrated Solar Power (CSP) technology. The project has been financed with loans from international development banks and private investors, and is secured through guarantees by the Moroccan state. Since its inauguration in 2016, the project has incurred heavy annual losses, which are primarily borne by the Moroccan state and, ultimately, its citizens (Hamouchene, 2022).

In addition, global production capacity for essential components, such as electrolysers and wind turbines, must significantly increase to avoid long project delays (Martin, 2023). There is uncertainty about which companies and countries in the "great hydrogen race" (Eberhardt, 2023, p. 1) will gain access to these capacities first. A potential bottleneck for Namibia may be exemplified by the hydrogen production project of Cleanergy Solutions Namibia in Erongo Region, which is planned to start production by the end of 2024. One of its lead engineers reported a 1.5-year waiting time for the necessary electrolysers. For context, Cleanergy's electrolysis capacity will be 5 MW, roughly 0.2% of Hyphen's planned capacity.

Hyphen has indicated that it is working on how philanthropic investments through the project may benefit local communities in Namibia (Hyphen Hydrogen Energy, 2023c). At the time of writing this paper, no details have been made public.

e) Green hydrogen from Namibia: A case of neocolonialism?

The growing green hydrogen industry in Namibia raises concerns about neocolonialism, as historical patterns of exploitation might be repeated. In the past, this pattern was evident with natural resources such as diamonds and fish, particularly in Lüderitz. Today, it could be the wind, sun, and water that are harnessed to produce hydrogen. While this new industry has the potential to foster economic prosperity, it also brings with it significant risks, uncertainties, and concerns amongst residents, as described in the following section.

Under German colonial rule, Namibia was "developed" in accordance with colonial interests, prioritising the exploitation of resources such as diamonds, while only minimal compensation was provided to local workers. This systematic exploitation was also marked by acts of violence, forced expropriation, and ultimately, brutal atrocities, including genocide perpetrated against the Nama and Ovaherero peoples (Press, 2021).

While such coercive and violent measures are not being employed today, and land is not forcibly taken, some parallels between historical and modern practices persist. In both past and present contexts, the Nama people have had limited participation in decision-making and have received inadequate compensation for the use of their resources. While historically, these communities lost land with little restitution, today, they express concerns about being excluded from the hydrogen economy's development, including the Hyphen project, given the project's location. There is also concern that economic benefits may primarily flow to a private, partly German-owned company, backed by the German government, raising questions about fair compensation. As outlined earlier in this paper, there is concern that much of the economic value will not remain in Namibia, whereas potential financial risks could disproportionately impact Namibian society.

Such a scenario could widen the gap between Namibia and wealthier nations like Germany, which aim to benefit from an affordable and "sustainable" energy source, in this case, green hydrogen, for industrial decarbonisation, helping them to maintain global economic leadership.

Further research is needed to determine whether the production and export of hydrogen from Namibia to Europe could be considered a form of neocolonialism. However, there remains a striking resemblance to the conditions associated with practices of that time.

f) Lüderitz could face multiple socioeconomic challenges

The development of large-scale hydrogen production facilities in TKNP is expected to bring significant socioeconomic challenges to Lüderitz. The Hyphen project alone may draw 15 000 construction workers, effectively doubling the town's population. Additionally, workers from other sectors—such as construction for the new port, hospitality, and other tertiary industries—will likely move to Lüderitz. This influx will strain Lüderitz's already limited municipal systems for freshwater, electricity, and waste and wastewater management, which may struggle to meet the growing demand.

The development, which is anticipated to occur over a short period, may entail further consequences. Property prices in Lüderitz have already increased and are expected to rise drastically, as highlighted by local politicians, residents from Lüderitz, and a political analyst. Additionally, the demand for housing and services will increase administrative

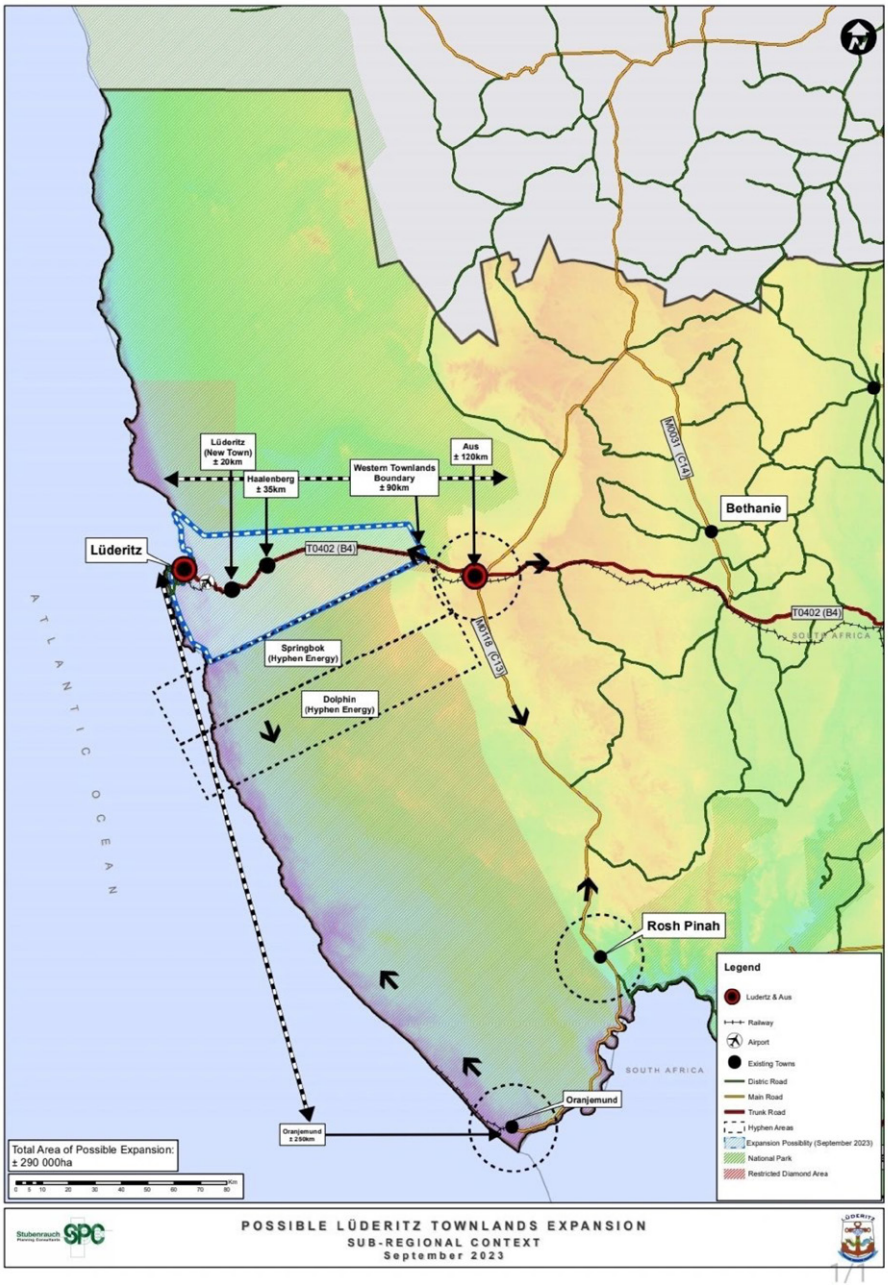
requirements in Lüderitz. This includes approving certain town developments, housing construction, and business establishments. Graham Hopwood, who spoke at the Regional Anti-Corruption Conference held in Lüderitz in May 2024, raised concerns that this could invite corrupt activities by companies to bypass bureaucratic processes. Some residents have noted that recent migrants to Lüderitz, primarily from other parts of Namibia, have had easier access to housing and property than long-term residents.

The Hyphen project may be the first of several potential hydrogen production projects in the TKNP (Hyphen Hydrogen Energy, 2022). Such further development would entail the construction of thousands of wind turbines, thousands of square kilometres of solar power facilities, the destruction of the entire TKNP, and an influx of many more people to Lüderitz. Furthermore, recent offshore oil discoveries near Lüderitz could also attract many people, necessitating additional services and infrastructure. The oil discoveries are substantial, potentially placing Namibia among the top 15 oil-rich countries in the world (Mining & Energy, 2024).

Residents also fear increased criminality and drug abuse with the anticipated influx of people. Individuals may arrive for job opportunities that may not materialise due to an oversupply of labour or insufficient specialised skills. They may remain in the town without employment, which could exacerbate pre-existing social problems.

To address these challenges, the Lüderitz town council has formed a planning group consisting of 40 members, focusing on expanding the town boundaries into so-called nodes. Despite not representing organic urban growth, nodes could have positive attributes regarding quality of life, as they may offer various opportunities for shops, housing, mobility, and entertainment in centralised areas outside the main town (Maher et al., 2018). The area inside the blue-white line in Figure 3 illustrates where such nodes could evolve, and how the town of Lüderitz could develop. This visualisation suggests that both the town and its surroundings could undergo significant changes, with the emergence of new urban centres at these nodes.

Figure 3 *Possible expansion of Lüderitz and context*



Source: Stubenrauch Planning Consultants (2023)

g) Challenges evolve through legislative deficiencies

Potential challenges in managing environmental and socio-economic risks stem from insufficient regulatory oversight and legislation in Namibia. As outlined earlier, environmental assessments offer mechanisms for managing such risks by assessing their severity and proposing mitigation strategies. However, limitations and loopholes can emerge in their application. Public engagement within SESA and EIA frameworks does not necessarily require the incorporation of concerns raised during consultation. Additionally, they may serve only as support for decision-making, and other factors, such as economic considerations, may outweigh environmental and social concerns (Kørnøv & Thissen, 2000). In Namibia, the Environmental Management Act does not explicitly refer to such an assessment, leading to ambiguity regarding the Act's implementation and stakeholder engagement.

Due to the described limitations, the effectiveness of the forthcoming SESA process will heavily depend on the commitment of the Namibian government and the involved companies to thoroughly assess the overall environmental and social impact. Hyphen's engagement with local communities has been limited, and the dissemination of information has fallen short of expectations. Although Hyphen operates within legal boundaries, this approach raises concerns about their genuine interest in thoroughly assessing impacts.

Additionally, a study by the German Federal Institute for Geosciences and Natural Resources and a Namibian consultancy identified a significant lack of coordination among Namibian ministries in performing their oversight duties. It noted that regulatory compliance monitoring would be a "rare occurrence", even within the Ministry of Environment, Forestry and Tourism with an officially designated Environmental Commissioner (Guillaneau, 2024). Historical instances such as hazardous manganese leaching during its transportation to Lüderitz reported by some locals, and unauthorised water drilling tests conducted by the Canadian company ReconAfrica in the Okavango River Delta in 2021 (Barbee & Neme, 2021; The Namibian, 2021) further illustrate these deficiencies and raise concerns about the potential for recurrence with Hyphen. Furthermore, the appeal process regarding the issuance of environmental clearance certificates is poorly regulated. This could cause potential delays due to unresolved issues.

The emerging hydrogen economy in Namibia requires various legislative changes. According to the Namibian Minister of Justice, at least nine different

laws will need to be amended (Kharas Media House, 2023). As reported by an expert during a community meeting in Lüderitz and as described in the Windhoek Observer (2022), Hyphen and other international companies seek to modify the Environmental Management Act to facilitate resource exploitation and maximise their financial benefits. Such influence could negatively impact both the environment and Namibian society, as their primary objective is financial gain.

Other prospective projects in the area, alongside the influence of Hyphen, are significant because the large-scale developments planned for the TKNP directly contradict the park's objectives: to "secure and increase landscape connectivity" and "protect and maintain biodiversity" (Republic of Namibia, 2020, p. 27). Additionally, "no new infrastructure is foreseen (…) except improvements to access control facilities, viewpoints and picnic sites" (ibid., p. 151). Consequently, amendments to the plan are inevitable, which poses a risk of the park's complete dissolution and the potential loss of its unique flora and fauna.

Global Marginalisation through Green Hydrogen: Namibia is not Alone

Concerns about the marginalisation of communities affected by green hydrogen projects are not unique to Namibia. Internationally, hydrogen production has faced criticism, with numerous examples of marginalised communities fearing adverse impacts from energy development, including green hydrogen. In some instances, civil society has successfully mounted opposition, advocating for more inclusive and just project developments. One relevant example is located just 20 kilometres from the Namibian border, in South Africa's Richtersveld Local Municipality, where the Northern Cape Green Hydrogen Hub is planned to be developed. This project, which includes large-scale wind and solar power installations, electrolysis facilities, and a deep-sea port, far exceeds the dimensions of Namibia's Hyphen project. The development of the Boegoebaai deep-sea harbour, in particular, has raised concerns among local communities and groups, such as the South African United Fishing Front and the indigenous Khoi and San peoples, who fear that they may be marginalised by these industrial advancements (Chief !Khaesen Maart, 2022; Lekalakala & Kalt, 2022). This situation closely mirrors that of Lüderitz in Namibia, where local fishermen fear the impact of green industrialisation on their livelihoods.

A similar scenario is unfolding in the Magallanes region of southern Chile, a remote area renowned for its unique flora and fauna. The region is seen as an

ideal location for producing electricity and hydrogen for international export, due to its extreme winds. However, the scale of the proposed wind and hydrogen production projects—comparable to Hyphen—has created fears of irreversible damage to unique ecosystems, including threats to migratory birds and cetaceans. Moreover, profound sociocultural changes are expected with this type of development, such as the shift from traditional sheep farming to renewable energy production for export. So-called "sacrifice zones" are areas where a high concentration of industrial activity is justified by a broader cause, in the case of southern Chile, "to decarbonise the entire world", as stated by the former Chilean energy minister. There is growing concern that such "sacrifice zones" could also emerge in the Magellanes region, as they have done in other areas of Chile. However, the true consequences of this approach are that profits and private interests take precedence over the well-being of local communities, their health, and the environment. This can lead to potentially catastrophic impacts on both the physical and mental health of the affected communities (Boyd, 2023; Opazo, 2023).

Opportunities and Entry Points

The aforementioned critique should not detract from opportunities associated with Namibia's abundant wind, solar, and ocean water resources. These resources hold the potential to foster socioeconomic prosperity in the form of job creation and GDP growth. While national parks may not be ideal locations, ample land is available for large-scale energy facilities. Moreover, if the demand for green hydrogen aligns with expectations, and the cost of hydrogen production is competitive, Namibia could generate substantial financial returns. Effective, timely legislation and inclusive governance can empower citizens to benefit directly from these revenue streams. In this regard, it may be important to prioritise national interests over international agendas and the objectives of major investors, as articulated by the Namibian energy expert Detlof von Oertzen (2024). This approach could enable Namibia to position itself as a key player in the international energy market without compromising the needs of its citizens.

Project developers, policymakers, and civil society can each take steps to advance these goals. Van Wyk (2024) suggests that developers engage communities early in the process, using clear and transparent communication in local languages to foster trust and awareness of both opportunities and risks. This approach aligns with governance principles such as transparency, accountability, the

provision of reliable data, and rigorous monitoring (Cremonese et al., 2023).

During the Regional Anti-Corruption Conference held in Lüderitz in May 2024, the IPPR suggested a more decentralised approach of revenue sharing between the central government and the hydrogen-producing regions. This approach could strengthen governance within local and regional institutions, address the actual needs of local populations, and lay the foundation for more inclusive and successful project implementation.

An alternative approach to enhance inclusiveness is to apply the Free, Prior, and Informed Consent (FPIC) principle in the development of infrastructure projects, such as hydrogen production facilities. Key FPIC components are:

- **Free**: Consent is given voluntarily, without coercion, intimidation, or manipulation.
- **Prior**: Consent is sought well in advance of the commencement of activities, allowing sufficient time for consultation and decision-making processes.
- **Informed**: All information related to the nature, scope, duration, and impacts of the project is provided to the affected communities in a way that is accessible and understandable.
- **Consent**: Affected communities have the right to give or withhold consent, and this decision must be respected by all parties involved.

These principles are incorporated in various internationally recognised agreements. Amongst the legally binding ones is Convention no. 169 of the International Labour Organization, 1989 (explained in International Labour Organization (2013)), which specifically addresses the rights of indigenous and tribal peoples. Article 6 mandates consultations with indigenous peoples through appropriate procedures, while Article 15 requires FPIC for any exploration or exploitation of resources on indigenous lands. However, Namibia has not ratified this convention. The Namibian government could be encouraged to become a signatory to it, and to incorporate appropriate participation and consultation processes in binding national law.

Lüderitz's urban development challenges and Namibia's skills shortage present opportunities for a holistic approach to workforce development across various sectors like energy, hospitality, and construction, while recognising that such capacity-building will take time.

Public participation remains crucial. The announcement of the Strategic Environmental Assessment for the Southern Corridor Development Initiative underscores the importance of an informed, knowledgeable, and critical society, and of engaging with politicians, attending public meetings, and raising concerns directly, to demonstrate public interest and help hold authorities accountable (see also section "Mechanisms to Address Environmental and Socioeconomic Risks" earlier in this article). It is also essential for individuals to understand their rights; consulting organisations such as the Legal Assistance Centre and the IPPR can provide insights into legislation, including the Environmental Management Act (7 of 2007), the Public Procurement Act (15 of 2015), and the Access to Information Act (8 of 2022). Concerns, including concerning corruption, can be reported through the IPPR's whistleblower portal or directly to the Anti-Corruption Commission of Namibia. Furthermore, building alliances within Namibia and internationally strengthens advocacy efforts. Collaborating with local organisations can significantly enhance public influence, particularly with upcoming legislation, such as the Synthetic Fuels Act and proposed amendments to the Environmental Management Act, which will be critical in shaping Namibia's socioenvironmental landscape. Finally, given Germany's involvement in the Hyphen project, German civil society could advocate for positive project impacts.

Conclusion and Recommendations

The findings of this paper suggest that the tangible benefits of large-scale hydrogen production projects, such as the Hyphen project, for Namibia and its population are likely to be limited. This conclusion is based on 18 months of extensive research, including a comprehensive review of reports, documents and scientific publications, and over 60 interviews. While Namibia has significant potential for energy production from wind and solar resources, with ample areas suited for electricity generation and hydrogen production facilities, the current situation strongly indicates that the primary beneficiaries will be foreign stakeholders.

As such, there are significant indications that the Hyphen project does not address Namibia's most pressing challenges. These include limited access to electricity, unemployment, and water scarcity. Furthermore, the financial risks associated with the project could place a substantial burden on the Namibian state and its citizens, while the financial gains may disproportionately favour the involved companies. The

situation may be exacerbated by non-transparent processes, a significant lack of information sharing, and Hyphen's potential influence on legislative changes. Employment opportunities for Namibians might be restricted to simple tasks, with many positions likely to be occupied by better-trained foreign workers. Additionally, Namibia currently seems to lack the capacity to develop industries connected to hydrogen production, such as fertiliser production or steel manufacturing based on green hydrogen.

Due to an enormous influx of people, the town of Lüderitz will face considerable challenges in developing infrastructure and providing essential services such as waste and sewage management, electricity, and housing. These pressures may also increase the risk of corruption. There is concern that historical injustices in Namibia could be repeated, benefiting actors from the Global North while offering minimal value and posing risks to local communities. Moreover, projects in the TKNP pose a substantial threat to unique flora and fauna. Combined with plans to build a new port in Lüderitz, both terrestrial and marine biodiversity could be severely affected, potentially also leading to negative socioeconomic impacts for the residents of Lüderitz.

All these factors strongly suggest that the broader value of projects like Hyphen for Namibia and its citizens remains very limited, potentially exacerbating social inequalities both within the country and in relation to other nations. The development associated with Namibia's green hydrogen economy does not appear to be primarily designed to serve the interests of Namibian society. Instead, it is driven by foreign companies and supported by national governments. For Germany, this pursuit responds to climate change legislation requiring the decarbonisation of its industries and geopolitical circumstances necessitating the reduction of dependence on Russian fossil fuels.

The Namibian government and the companies conducting social and environmental risk assessments must be held accountable. This accountability may entail transparent, holistic planning processes that prioritise Namibian societal needs—whether in the workforce and urban development in Lüderitz, protection of natural environments, or adherence to standards of ethical conduct such as the FPIC principles. In this regard, civil society and individuals must be well-informed, critical, and collaborative, working with various organisations to demand the fulfilment of rights and promises made by Hyphen and the Namibian and German governments.

Forming local and global alliances is essential for addressing the complex

challenges posed by emerging energy projects. Joining forces with individuals, groups, and NGOs can significantly amplify efforts to promote social justice.

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