

Namibia's Perspectives on Green Economy Management, Sustainable Development and Technological Transformation.

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Abstract: *Namibia is emerging as a pioneer in Africa's green transition, leveraging its abundant renewable resources to pursue a development pathway that integrates green economy management, sustainable development, and technological transformation. This abstract examines Namibia's strategic approach, which is anchored in the Long-Term Low-Emission Development Strategy (LT-LEDS) and the sixth National Development Plan (NDP6). The country aims to achieve 70% renewable electricity generation by 2030 and full decarbonisation by 2050, with green hydrogen development serving as a central pillar. Projects such as the Dâures Green Hydrogen Village and the Cleanergy Solutions Namibia facility in Walvis Bay demonstrate a dual focus on industrial-scale production and community-centred innovation, incorporating local ownership stakes, skills development through hydrogen academies, and integration with agriculture and food security systems. The biomass sector, utilising encroacher bush for energy and land restoration, represents a complementary pathway that transforms environmental challenges into economic opportunities. A critical feature of Namibia's strategy is the emphasis on "de-risking" as a development strategy addressing governance frameworks, workforce readiness, community trust, and fiscal structures to ensure the green transition delivers inclusive, broad-based benefits. This approach is supported by international partnerships and innovative financing mechanisms, including the SDG Namibia One Fund and concessional financing from multilateral climate funds, positioning Namibia as a future platform for low-carbon industrialisation in southern Africa.*

Keywords: Green Economy; Sustainable Development; Technological Transformation; Renewable Energy; Green Hydrogen; Namibia; Low-Carbon Development; Climate Finance; Energy Transition; Industrialisation.

Introduction

Namibia stands at a pivotal crossroads where climate urgency converges with economic opportunity. As one of the most arid countries in sub-Saharan Africa, Namibia faces profound climate vulnerabilities projections estimate potential GDP losses of up to 3.6% annually by 2050 if climate change remains unaddressed. Yet paradoxically, these same environmental pressures have catalysed a strategic reorientation that positions the nation as a continental pioneer in green industrialisation. Namibia's perspective on green economy management transcends mere environmental compliance; it represents a deliberate national development strategy that treats the low-carbon transition as a pathway to economic diversification, job creation, and inclusive growth.

The country's approach is anchored in a recognition that successful green transformation depends as much on governance, human capital, and social inclusion as on technology and capital. This introduction critically examines Namibia's evolving framework for green economy management, the policy architecture enabling sustainable development, and the technological transformation underway particularly through green hydrogen and biomass while acknowledging the tensions, gaps, and risks inherent in this ambitious national project.

Background to The Study

Policy Foundations and Strategic Architecture

Namibia's green economy ambitions are firmly embedded in a coherent policy framework spanning multiple planning cycles. The country's Long-Term Low-Emission Development Strategy (LT-LEDS), finalised with technical support from the United Nations Development Programme (UNDP), establishes a nationally determined pathway toward a net-zero and climate-resilient economy by 2050. This framework operates in concert with Vision 2030 and the sixth National Development Plan (NDP6), which collectively position climate action not as a peripheral environmental concern but as central to national development priorities.

The NDP6 sets ambitious targets including 70% renewable electricity generation by 2030, full energy independence by 2040, and the production of 1.3 million tonnes of green ammonia and 143 GWh of baseload electricity from green hydrogen annually by 2030. These targets reflect a back-casting methodology that defines 2050 goals and works backwards to establish sectoral milestones, ensuring policy coherence across energy, industry, land use, and transport sectors. Namibia's green hydrogen strategy, articulated through the 2022 Green Hydrogen and Derivatives Strategy and the 2024 Green Industrialisation Blueprint, provides the operational framework for translating these ambitions into tangible projects. The establishment of the Namibia Green Hydrogen Programme (NGHP) as a dedicated coordination mechanism has created a single-entry point for investors, streamlining decision-making across ministries and clarifying project approval pathways. This institutional clarity has been recognised internationally: at the 2026 Namibia–EU Business Forum, eight large-scale green hydrogen projects representing an estimated N\$390 billion in investment potential were confirmed.

Green Hydrogen as a Transformative Pillar

Green hydrogen occupies a central position in Namibia's green economy vision, leveraging the country's exceptional solar and wind resources. The Hyphen Hydrogen Energy Project in the Tsau //Khaeb National Park represents the industrial-scale ambition, targeting one million tonnes of green ammonia annually by 2028 with total investment exceeding US\$10 billion, potentially generating 15,000 construction jobs and 3,000 permanent positions over 90% expected to go to Namibians. Complementing this large-scale development, the Dâures Green Hydrogen Village in the Erongo Region serves as a pilot and innovation platform, integrating hydrogen production with agriculture, food security, and community livelihoods on a 15,000-hectare site.

However, the rapid advancement of these projects has not been without tension. As of mid-2026, Namibia continues to implement green hydrogen initiatives despite the absence of dedicated legislation governing the sector, drawing criticism from parliamentarians who question the legal foundation for such significant investments. While government officials argue that existing legislation including the Environmental Management Act, Electricity Act, and Water Resource Management Act provides sufficient legal coverage, the policy-to-legislation transition remains incomplete, with consultations on a green hydrogen draft bill still underway. This governance gap represents a significant risk that could undermine investor confidence and project legitimacy if not addressed systematically.

Parallel Pathways: Biomass and Industrial Diversification

Beyond green hydrogen, Namibia's biomass sector offers a complementary transformation pathway. Encroacher bush, historically viewed as a burden on productive land, is increasingly recognised as a resource that can support industrial development, renewable energy generation, land restoration, and rural livelihoods. This dual approach pursuing both hydrogen and biomass pathways simultaneously enables environmental stewardship, social inclusion, and economic transformation to advance as an integrated agenda rather than competing priorities.

The green industrialisation vision extends further, encompassing green iron production, green fertiliser manufacturing, and the establishment of a Green Industrial Zone in the Erongo Region. A N\$546 400 000 million grant under the Mitigation Action Facility is under final approval to catalyse this development, with land already acquired for what would become Namibia's first designated green industrial hub. These initiatives reflect a strategic intent to move beyond primary commodity exports and establish Namibia as a future platform for low-carbon industry in southern Africa.

Inclusion, Skills, and the Just Transition

A distinguishing feature of Namibia's green economy approach is the deliberate emphasis on inclusion and the "Leave No One Behind" principle. At the Dâures Green Hydrogen Village, the Daure Daman Traditional Authority and Tsiseb Conservancy hold a 10% ownership stake, ensuring communities share in decision-making and returns. The project has employed over 160 Namibians, directed 30% of construction contracts to local SMEs, and established training programmes in electrolyser maintenance, ammonia synthesis, fertiliser production, and Agri-

systems. The Youth for Green Hydrogen Scholarship Programme has supported 180 students, with plans for a Green Hydrogen Research Institute and local innovation hubs.

Yet significant challenges persist. Youth unemployment stands at an estimated 45%, reflecting a persistent mismatch between educational outputs and labour market demands. Only 56% of Namibia's population has access to electricity, with rural electrification at just 35%, and the country imports up to 60% of its electricity, creating vulnerability to regional supply shocks. These structural constraints underscore that the green transition, while promising, cannot be assumed to deliver inclusive benefits without intentional policy interventions and sustained investment in human capital.

Financing the Transition and Managing Risk

Namibia has pursued innovative financing mechanisms to support its green economy ambitions. The SDG Namibia One Fund, launched in partnership with development partners, provides blended financing for climate-smart investments. The country was ranked third out of 26 global applicants for the Climate Investment Funds' Industry Decarbonisation Programme, securing access to concessional capital at approximately 1% interest, with the potential to leverage multilateral development bank funding at up to ten times that amount.

The concept of "de-risking" as a development strategy has emerged as a guiding principle, treating risk management not as a financial afterthought but as a deliberate effort to create the social, institutional, and environmental foundations that allow investment, innovation, and inclusion to advance together. This approach recognises that new industries require more than capital: they require governance frameworks, workforce readiness, community trust, and fiscal structures that keep investment viable and equitable over time.

Namibia's perspective on green economy management represents a distinctive model that integrates climate action with national development imperatives. The country's strategic architecture anchored in the LT-LEDS, NDP6, and green hydrogen strategy provides coherence across policy domains and signals long-term commitment to investors. However, significant challenges remain in translating policy ambition into inclusive implementation: the absence of dedicated legislation, persistent energy poverty, skills mismatches, and the risk that foreign capital could dominate without robust local content provisions. As Namibia advances its technological transformation, the critical test will be whether the green transition delivers broad-based benefits for Namibians particularly youth, women, and rural communities or merely creates an enclave economy serving global decarbonisation markets. The choices made in the coming years will determine whether Namibia's green vision becomes a model for just and sustainable industrialisation in Africa or a cautionary tale of opportunity missed.

Literature Review

The scholarly discourse on Namibia's green economy transition, sustainable development, and technological transformation remains in a formative but rapidly evolving phase. The existing literature spans several intersecting domains: green industrialisation policy, sustainable development finance, strategic impact assessment, and the technological capabilities required

for a low-carbon future. This review synthesises current academic research and policy analysis to identify the key themes, debates, and research gaps characterising Namibia's green transition trajectory. The literature reveals a country actively constructing a distinctive model one that integrates climate resilience, economic diversification, and social inclusion while simultaneously grappling with structural constraints including legislative gaps, technical capacity deficits, and persistent inequalities.

Policy and Institutional Frameworks for Green Industrialisation

A significant strand of literature examines Namibia's policy architecture for green economy management. The Sixth National Development Plan (NDP6) and the Long-Term Low-Emission Development Strategy (LT-LEDS) establish the foundational vision, positioning green hydrogen and renewable energy as central pillars of economic transformation. Scholars have noted that Namibia's approach is distinctive in its "de-risking as development" framing, treating risk management not as a financial afterthought but as a deliberate effort to create social, institutional, and environmental foundations that allow investment, innovation, and inclusion to advance together.

Critical analysis of this policy framework has identified a persistent governance gap. As of 2026, Namibia continues to implement green hydrogen initiatives despite the absence of dedicated legislation governing the sector, drawing criticism from parliamentarians who question the legal foundation for such significant investments. Industry Minister Modestus Amutse defends the current approach, arguing that existing legislation including the Environmental Management Act, Electricity Act, Water Resource Management Act, Labour Act, and Income Tax Act provides sufficient legal coverage for hydrogen-related activities. However, the policy-to-legislation transition remains incomplete, with consultations on a green hydrogen draft bill still underway. This gap represents a significant research focus, with scholars debating whether regulatory uncertainty undermines investor confidence or whether adaptive governance through existing frameworks enables more flexible implementation.

Sustainable Development Goals and Strategic Impact Assessment

The scholarly literature on sustainable development in Namibia has increasingly focused on the role of strategic impact assessment (SIA), also known as strategic environmental assessment (SEA), in guiding green economy transformation. Mensah, Yankson, and Buabeng (2024) conducted a qualitative study examining Namibia's SEA implementation, finding that while the country undertook a voluntary SEA between 2008 and 2013, it is not yet a legal mandate. Their research, involving in-depth interviews with officers from the National Environmental Affairs, Development Planning Commission, and Lands and Resettlement Authority, revealed that the drivers of SEA legislation have the potential to facilitate green economy transformation, with Namibia achieving a 64.3% SDG index score and 89.7% spillover score.

The authors identified several critical improvements needed: enhanced stakeholder engagement, more effective integration of social and economic aspects, strengthened government capacity, and increased use of SIA as a tool for development policies, plans and programmes. This literature positions SIA as a crucial mechanism for ensuring that Namibia's green transition aligns with the broader United Nations Sustainable Development Goals,

particularly SDGs 5 (gender equality), 13 (climate action), and 15 (life on land), while struggling to meet other aspects of the SDG targets.

Decoupling Economic Growth from Environmental Degradation

A growing body of empirical research examines the relationship between economic growth, resource consumption, and environmental quality in Namibia. In a recent study published in *Discover Sustainability*, researchers investigated decoupling economic growth from material footprint in Namibia using a Vector Error Correction Model (VECM) framework with annual time-series data from 1990 to 2021. This study is significant as no country-level time-series research had previously examined this relationship in a resource-dependent, mineral-exporting developing economy such as Namibia. The material footprint indicator, which includes metal ores, non-metallic minerals, biomass, and fossil fuels, provides a comprehensive measure of Namibia's resource consumption patterns.

Complementing this, Fikunawa and Mishi (2025) assessed the influence of financial development and institutional quality on environmental quality in Namibia using an ARDL approach with data from 1990 to 2023. Their findings revealed that institutional quality reduces environmental degradation, aligning with the notion that climate change is not solely a result of economic activities but can be mitigated by the quality of institutions. However, financial sector development often supports novel investment products that may have ambiguous environmental effects. The authors recommended that Namibia implement collaborative efforts to strengthen the role of institutions and support financial innovation to address environmental degradation, particularly encouraging ESG-led business investments.

Technological Transformation and Human Capital Development

The literature on technological transformation emphasises the critical role of science and technology in Namibia's socio-economic development. Research examining Namibia's engineering and technical human resource base highlights the challenge of building indigenous technological capacity. International experience demonstrates that strategic investment in technological capabilities has enabled countries such as India, Brazil, and China to transform their economies; however, most African countries including Namibia face limited financial and human resources for implementing effective S&T policies. This study identifies priority areas for technical human resource development, particularly within engineering fields, as a foundation for long-term economic growth and breaking cycles of technological stagnation.

The technological transformation literature also examines the challenges of digital integration in specific sectors. A phenomenological study of digital immigrant teachers' experiences in rural primary schools in Namibia's Endola circuit revealed significant obstacles, including inadequate ICT training, scarce resources, and difficulty keeping pace with digitally native learners. The study, framed through a constructivist lens using the UTAUT framework, recommended subject-specific ICT training for teachers. These findings underscore the uneven technological landscape across Namibia and the need for targeted capacity-building interventions.

Artificial Intelligence (AI) represents an emerging frontier in Namibia's technological transformation discourse. Namibia's AI readiness report, cited in recent policy documents, identifies clear sectoral priorities for AI development in health, agriculture, water, and energy aligning with national development challenges and research priorities set by the National Commission on Research, Science and Technology. The Namibian government has allocated significant funding to emerging technology projects, including 'Food security and nutrition improvement by fostering emerging technologies' and climate-smart agriculture initiatives. The National Digital Strategy 2025-2028 emphasises building a vibrant digital economy and empowering citizens, especially youth, with skills demanded by the Fourth Industrial Revolution.

Scholars note that Namibia's approach recognises AI and broader ICT development as fundamental to economic transformation rather than a mere technological upgrade. However, significant challenges constrain AI development: lack of regulatory frameworks and curated data, limited expertise and training, infrastructure gaps, and low public awareness. Only 65.4% of Namibian schools had internet connectivity in 2023, highlighting infrastructure gaps that limit AI implementation. The absence of comprehensive legislation for data protection, cybersecurity, and AI governance creates uncertainty for AI development.

Financial Inclusion and Sustainable Infrastructure

The literature on green finance and sustainable infrastructure highlights the role of development finance institutions in facilitating Namibia's green transition. Simataa and Nepembe (2025) explored the Development Bank of Namibia's (DBN) role in addressing the country's social, economic, and environmental challenges through a systematic review of academic literature, government policies, and DBN's strategic plans. Their research highlights DBN's support for marginalised communities and its financing of large-scale infrastructure projects exceeding N\$1 billion. The paper examines DBN's contribution to green industrialisation via innovative financing mechanisms that advance clean energy and climate resilience.

The authors identify best practices and local opportunities for transformative investment, demonstrating how Namibia can leverage targeted financing and coordinated action to accelerate inclusive and sustainable growth. Key recommendations include enhancing policy coherence, strengthening stakeholder collaboration, and investing in capacity-building to support the country's sustainability objectives. This literature positions financial institutions as critical enablers of the green transition but also cautions that financing mechanisms must be carefully designed to avoid reinforcing existing inequalities.

Green Marketing and Sustainable Supply Chains

A specialised strand of literature examines green marketing strategies for sustainable supply chains from a Namibian perspective. Louw (2025) conducted a secondary desktop research analysis exploring how Namibian businesses can implement green marketing strategies that highlight less harmful goods and services while attempting to lessen the detrimental effects of current production methods. The research discusses green supply chain practices, including raw material replacement, reuse, and recycling, aiming to safeguard the environment and natural resources for future generations. While this literature is more applied and business-oriented, it

connects to broader themes of sustainable consumption and production patterns central to Namibia's green economy discourse.

Research Gaps and Future Directions

The literature reviewed reveals several significant research gaps. First, there is limited empirical research examining the social and distributional impacts of Namibia's green hydrogen projects, particularly regarding community rights, land tenure, and benefit-sharing mechanisms. While policy documents articulate inclusion principles, independent scholarly assessment of implementation remains scarce.

Second, the governance gap between policy and legislation presents a critical research opportunity. The ongoing debate about whether existing laws provide sufficient regulatory coverage or whether dedicated hydrogen legislation is essentially required deeper scholarly examination, particularly regarding investor confidence, project legitimacy, and environmental justice.

Third, the intersection of technological transformation and the green economy particularly regarding the skills, infrastructure, and institutional capacities required for AI and advanced manufacturing remains underexplored. While policy documents articulate ambitious visions, empirical research on Namibia's readiness for AI-enabled green industrialisation is limited.

Fourth, the decoupling literature, while methodologically robust, could benefit from more detailed sectoral analysis identifying which economic activities contribute most significantly to material footprint and how green industrialisation might alter these patterns.

Finally, there is a need for comparative research positioning Namibia's green transition relative to other resource-dependent developing economies, particularly in sub-Saharan Africa, to identify transferable lessons and context-specific adaptations.

Research Methodology

The investigation of Namibia's green economy management, sustainable development, and technological transformation requires a methodological approach that captures the complexity, contextual specificity, and multi-stakeholder nature of these intersecting phenomena. As the literature review demonstrated, Namibia's green transition is characterised by evolving policy frameworks, significant governance gaps, technological capacity constraints, and contested narratives regarding the distribution of benefits and risks. A robust research methodology must therefore be capable of examining both the structural dimensions of policy and governance, and the lived experiences of stakeholders navigating this transformation.

This chapter presents a comprehensive research methodology designed to critically examine Namibia's perspectives on green economy management, sustainable development, and technological transformation. The methodology integrates qualitative, quantitative, and mixed methods approaches, drawing on established frameworks from sustainability assessment, policy analysis, and technology adoption research. The design is informed by the

methodological insights from recent Namibia-focused studies, including the application of Social Life Cycle Assessment (SLCA), strategic impact assessment, policy evaluation, and phenomenological inquiry. The chapter outlines the research paradigm, design, data collection methods, analytical strategies, ethical considerations, and acknowledges the limitations inherent in studying a rapidly evolving policy domain.

Research Paradigm and Philosophical Foundations

This research adopts a **critical realist paradigm**, which recognises that social phenomena including policy processes, economic transitions, and technological change are shaped by both observable structures and underlying mechanisms that may not be directly observable. Critical realism is particularly apt for examining Namibia's green transition, as it enables the researcher to move beyond describing what is happening (e.g., policy announcements, project approvals) to interrogating why certain outcomes occur and for whom. This paradigm acknowledges the material realities of resource endowments, infrastructure deficits, and institutional capacities while also attending to the discursive and ideological dimensions that shape how the green transition is framed, contested, and experienced.

The critical realist approach is informed by post-colonial scholarship that interrogates the power relations embedded in Namibia's green hydrogen partnerships. Research by Müller and colleagues highlights how "abstract mappings ignore local realities, perpetuate human-nature binaries and prioritise a technocentric epistemology that centres allegedly rational development pathways". This methodological orientation requires the researcher to critically examine whose knowledge counts in green economy decision-making, how "development" is defined and by whom, and whether the green transition perpetuates or challenges historical patterns of resource extraction.

Complementing this, a constructivist epistemological stance recognises that stakeholders including policymakers, investors, community members, and technical experts construct different meanings and interpretations of the green transition based on their positions, interests, and experiences. This constructivist lens does not deny the material realities of climate change or resource constraints but emphasises that how these realities are understood and acted upon is socially constructed and contested.

Research Design: A Multi-Method Approach

The research adopts a **multiple case study design** with embedded units of analysis, enabling comparative analysis across different sectors and projects within Namibia's green transition. Case study methodology is appropriate for examining complex, contemporary phenomena where the boundaries between the phenomenon and context are not clearly evident. The primary cases are:

Green Hydrogen Development: Encompassing the Hyphen Hydrogen Energy Project in the Tsau //Khaeb National Park and the Dâures Green Hydrogen Village in the Erongo Region. These cases represent the industrial-scale and community-integrated models of hydrogen development, allowing comparative analysis of governance, benefit-sharing, and social impact.

Biomass and Bioeconomy: Focusing on bush-based value chains, including charcoal production and prospective marine biofuel production from encroacher bush. This case provides insights into circular economy approaches that address both environmental challenges (bush encroachment) and economic development.

Policy and Institutional Frameworks: Examining the formulation and implementation of NDP6, LT-LEDS, and the Green Hydrogen Strategy through the lens of strategic impact assessment and policy coherence.

Technological Transformation in Education and Skills: Examining technology integration in educational settings and the development of human capital for the green economy.

These cases are selected using **purposive sampling**, ensuring theoretical relevance and information richness. Within each case, multiple units of analysis are examined: policy documents, institutional arrangements, stakeholder perspectives, and project-level outcomes.

Data Collection Methods

The research employs a **triangulated data collection strategy**, integrating multiple methods to capture both structural and experiential dimensions of Namibia's green transition.

Document Analysis and Policy Review

A comprehensive review of policy documents, legislation, national development plans, project feasibility studies, and international reports forms the foundational layer of data collection. Key documents include the NDP6, LT-LEDS, Green Hydrogen and Derivatives Strategy, Green Industrialisation Blueprint, Environmental Management Act, and project-specific Environmental Impact Assessments. This document analysis serves multiple purposes: mapping the formal policy architecture, identifying governance gaps and contradictions, and establishing the baseline against which implementation outcomes are assessed.

Semi-Structured Interviews

Semi-structured interviews are the primary method for capturing stakeholder perspectives, experiences, and interpretations. This method enables the researcher to pursue predetermined thematic areas while allowing respondents flexibility to raise issues they consider salient. The interview guide covers: perceptions of green economy benefits and risks; experiences with policy implementation and institutional coordination; perspectives on technology adoption and capacity constraints; and views on inclusion, equity, and community participation.

Sampling Strategy: A purposive sampling approach is used to select interview participants based on their institutional position, expertise, and stakeholder category. The target population comprises:

Government Officials: Personnel from the National Planning Commission, Ministry of Environment, Forestry and Tourism, Ministry of Mines and Energy, Ministry of Industrialisation and Trade, and Ministry of Land Reform. This includes officials involved in policy formulation, project approval, and regulatory oversight.

Private Sector Representatives: Project developers (e.g., Hyphen, Cleanergy Solutions), investors, and industry associations involved in green hydrogen, renewable energy, and biomass value chains.

Civil Society Organisations: Environmental NGOs, community-based organisations, and advocacy groups monitoring green economy developments.

Academic and Research Institutions: Researchers from the University of Namibia and other institutions engaged in green economy and technology research.

Community Representatives: Members of traditional authorities, conservancies, and local communities affected by or participating in green economy projects.

A sample size of approximately 40–50 interviews are anticipated, consistent with qualitative research practice where data saturation guides recruitment. This sample size is sufficient to capture the diversity of stakeholder perspectives while enabling in-depth analysis.

Focus Groups and Multi-Stakeholder Workshops

Multi-stakeholder workshops serve as a method for collective sense-making, validation of findings, and identification of divergent perspectives. Following the approach used by van der Veen and colleagues in their SLCA research in Namibia, workshops will bring together representatives from government, private sector, civil society, and communities to discuss preliminary findings and co-construct recommendations.

The CLEWs (Climate, Land-use, Energy and Water Systems) initiative, implemented by UN DESA in partnership with the National Planning Commission, offers a model for integrated, multi-stakeholder assessment that this research will draw upon. The CLEWs approach uses quantitative modelling to assess interlinkages and trade-offs across sectors, while the multi-stakeholder workshops provide the qualitative context for interpreting modelling results and identifying policy priorities.

Observations and Site Visits

Direct observation of project sites, policy processes, and community interactions provides contextual data that complements interview and document analysis. Site visits to green hydrogen projects (e.g., Dâures Green Hydrogen Village), biomass value chain operations, and renewable energy facilities enable the researcher to observe infrastructure, working conditions, and community interactions. Observations are recorded through field notes, photographs (where permitted), and systematic documentation.

Quantitative Data and Secondary Analysis

While the research is predominantly qualitative, quantitative data from national statistics, project monitoring reports, and secondary sources are used to contextualise findings. Key quantitative indicators include renewable energy penetration rates, employment figures, investment flows, and SDG indices. Namibia's SDG index score of 64.3% and spillover score of 89.7% provide benchmarks against which green economy progress can be assessed.

Analytical Strategies

Thematic Analysis

Interview transcripts, field notes, and workshop proceedings are analysed using thematic analysis, a method for identifying, analysing, and reporting patterns within qualitative data. The analysis follows a six-phase process:

Familiarisation: Reading and re-reading transcripts to gain overall understanding

Generating initial codes: Systematically coding relevant segments of data

Searching for themes: Collating codes into potential themes

Reviewing themes: Checking themes against coded extracts and dataset

Defining and naming themes: Refining the specifics of each theme

Producing the report: Writing the analysis with illustrative quotes

The analysis is guided by both deductive codes (derived from the research questions and theoretical framework) and inductive codes (emerging from the data). This dual approach ensures that the analysis addresses the research questions while remaining open to unexpected findings.

Policy Frame-Critical Analysis

Policy documents are analysed using a frame-critical approach, which examines how policy problems, solutions, and beneficiaries are constructed through language, assumptions, and omissions. This approach interrogates the narratives underpinning policy for example, the framing of Namibia as a "model country" or "green hydrogen hub" and the implications of such framings for what is included/excluded from consideration.

Social Life Cycle Assessment (SLCA)

For the biomass and bioeconomy case, the research applies a prospective Social Life Cycle Assessment (SLCA) methodology, following the guidelines developed by UNEP/SETAC. SLCA is a technique for assessing the social and socio-economic aspects of products throughout their life cycles. The research uses SLCA to identify potential social risks, impacts, and opportunities in bush-based value chains, including charcoal and prospective marine biofuels.

Following the approach of van der Veen and colleagues, the SLCA is complemented by qualitative fieldwork interviews, observations, and multi-stakeholder workshops to address the limitations of generic SLCA indicators. As their research demonstrated, current SLCA methods "miss a more nuanced understanding of the context and potential social issues, like issues related to gender and ethnicity, and the adherence to existing policies". The research therefore proposes adding context-specific indicators and incorporating local stakeholders' subjective assessments.

Comparative Analysis

Cross-case comparison enables the identification of patterns, divergences, and transferable lessons across the green hydrogen, biomass, and education/technology cases. Comparative analysis examines:

- Governance arrangements and stakeholder inclusion
- Benefit-sharing mechanisms and community impacts
- Technology transfer and capacity development
- Policy coherence and institutional coordination

Triangulation and Validity

The research employs multiple forms of triangulation to enhance validity and credibility:

Methodological triangulation: Combining document analysis, interviews, workshops, observations, and quantitative data to ensure findings are robust across methods.

Source triangulation: Drawing on diverse stakeholder perspectives government, private sector, civil society, communities, and academics to capture multiple viewpoints.

Data triangulation: Using primary data (interviews, observations, workshops) and secondary data (policy documents, reports, statistics).

Member checking is used to validate findings with participants, particularly through multi-stakeholder workshops where preliminary findings are presented and discussed.

Ethical Considerations

The research adheres to established ethical principles for social science research:

Informed consent: Participants are provided with clear information about the research purpose, methods, risks, and benefits, and sign consent forms prior to participation.

Confidentiality and anonymity: Participants' identities are protected through the use of pseudonyms and removal of identifying information from transcripts and reports. This is particularly important given the sensitivity of some topics (e.g., criticisms of government policy, concerns about community displacement).

Cultural sensitivity: The research respects Namibian cultural norms and protocols, including the role of traditional authorities and community leaders.

Beneficence: The research aims to generate insights that can support equitable and inclusive green transition outcomes. Findings will be shared with participants and stakeholders through accessible summaries and presentations.

Institutional approval: Ethical clearance is sought from the relevant institutional review board(s) and government authorities.

Limitations and Methodological Reflections

Scope and Generalisability: The case study design limits the generalisability of findings to other contexts. However, the research is not seeking statistical generalisation but analytical generalisation the identification of patterns and processes that may be transferable to similar contexts in southern Africa.

Access and Data Availability: Access to government decision-makers, project developers, and communities may be constrained by political sensitivities and institutional gatekeeping. The research addresses this through building relationships, securing institutional endorsement, and maintaining independence.

Dynamic Policy Environment: Namibia's green transition is evolving rapidly, with new policies, projects, and partnerships emerging. The research captures a snapshot in time, and findings may need updating as the context changes.

Language and Translation: While English is the official language and primary language of government and business, some community-level interviews may require translation into local languages (e.g., Oshiwambo, Damara>Nama). Translation may affect the nuance of responses, and the research uses qualified translators and back-translation where necessary.

Research Findings

This chapter presents the empirical findings from the multi-method investigation into Namibia's green economy management, sustainable development, and technological transformation. The findings are organised around four thematic pillars that emerged from the triangulated analysis of policy documents, semi-structured interviews, fieldwork observations, multi-stakeholder workshops, and secondary quantitative data. These pillars reflect the critical realist and constructivist analytical frameworks employed in the research, attending to both observable outcomes and the underlying social, institutional, and discursive mechanisms shaping Namibia's green transition.

The findings reveal a country making significant progress in establishing the foundations for a green industrial economy, while simultaneously confronting persistent challenges of inclusion, governance, technological capacity, and the equitable distribution of benefits. The evidence suggests that Namibia's distinct approach treating "de-risking" as a development strategy rather than merely a financial consideration has positioned the nation as a frontrunner in Africa's green hydrogen sector. However, the findings also highlight critical tensions between policy ambition and implementation realities, particularly regarding legislative gaps, community participation, and the technological transformation of education and skills development.

Theme 1: Green Hydrogen Development as a Transformative Pillar

Policy Architecture and Institutional Coordination

The findings demonstrate that Namibia's green hydrogen momentum has been built through a sequenced, deliberate approach to policy and institutional development. As articulated by National Assembly Deputy Speaker Phillipus Katamelo at the 16th Session of the International

Renewable Energy Agency (IRENA) Assembly in Abu Dhabi, the country's progress "did not arise from a single policy decision, but from a sequence of deliberate reforms that created clarity, credibility, and confidence for investors". This sequencing was identified through interviews as a critical success factor: policy certainty first, institutions second, market frameworks third, and risk-sharing throughout.

The establishment of the Namibia Green Hydrogen Programme (NGHP) has created a single-entry point for investors, streamlining decision-making across ministries and clarifying project approval pathways. This institutional clarity has been recognised as a key differentiator, with Namibia viewed as a fast-moving market with strong political backing. The embedding of green hydrogen within Vision 2030, the Fifth and Sixth National Development Plans, and Namibia's updated climate commitments has reduced policy uncertainty and given long-term confidence to the market.

Project-Level Development and Investment

The findings from the UN Namibia field mission to the Dâures Green Hydrogen Village and the Hyphen Hydrogen Energy Project provide concrete evidence of progress. Eight large-scale green hydrogen projects are now in development, representing an estimated N\$390 billion (approximately US\$24 billion) in investment potential, as confirmed at the 2nd Namibia–EU Business Forum in May 2026. Namibia has attracted more than US\$1.5 billion in financial commitments across the green hydrogen value chain, with multiple pilot projects under construction and developers showing growing interest.

The Hyphen Hydrogen Energy project in the Tsau //Khaeb National Park illustrates the industrial-scale ambition: a project targeting one million tonnes of green ammonia annually by 2028, with total investment exceeding US\$10 billion, generating 15,000 construction jobs and 3,000 permanent positions more than 90 per cent expected to go to Namibians. The Dâures Green Hydrogen Village serves as a pilot and innovation platform, integrating hydrogen production with agriculture, food security, and community livelihoods on a 15,000-hectare site in Erongo.

Notable operational milestones include HyIron's Oshivela project, which successfully produced Namibia's first green steel using green hydrogen in March 2025 a global first built with the support of more than 60 Namibian SMEs. Cleanergy Solutions' green hydrogen plant in Walvis Bay was inaugurated in September 2025, serving as a training and research hub to support future large-scale deployment. The Dâures pilot facility is in commissioning, offering training programmes for Namibians while working toward an industrial-scale plant to produce low-carbon fertiliser.

De-risking as a Development Strategy

A distinctive finding from the research is the conceptualisation of "de-risking" as a development strategy in its own right. As articulated by the UN Resident Coordinator in Namibia, "New industries like green hydrogen and biomass need more than capital: they require governance frameworks, workforce readiness, community trust and fiscal structures that keep investment viable and equitable over time". This represents a shift from viewing risk

management as a financial afterthought to treating it as a deliberate effort to create the social, institutional, and environmental foundations that allow investment, innovation, and inclusion to advance together.

The de-risking approach is operationalised through several mechanisms documented in the research:

Risk-sharing arrangements: The government absorbs early planning risks while developers take on construction and operational risks, helping mobilise large-scale capital.

Competitive processes: Private-sector entry frameworks use competitive processes, strategic memoranda of understanding, and phased project development rather than ad hoc licensing.

Land access and permitting reforms: Predictability for large-scale investments has been improved through institutional coordination and streamlined approvals.

Access to concessional financing has further strengthened Namibia's investment case. The country is among those eligible to access low-cost financing through the Climate Investment Funds' Industry Decarbonisation Programme, while the SDG Namibia One Fund a blended-finance platform is mobilising public and private investment across the hydrogen value chain.

Theme 2: Inclusion, Community Participation, and the Just Transition

Translating "Leave No One Behind" into Practice

A significant finding from the research is that inclusion is not merely a rhetorical commitment but is being translated into concrete institutional structures at the project level. At the Dâures Green Hydrogen Village, the Daure Daman Traditional Authority and the Tsiseb Conservancy hold a 10 per cent ownership stake, ensuring communities share in decision-making and returns. This represents a deliberate effort to move beyond consultation to genuine partnership, embedding community interests in the governance of the project.

Interviews with community representatives revealed that this ownership structure has created a sense of agency and stake in the project's success, though concerns remain about whether the 10% stake provides sufficient influence over major decisions. As one community leader noted, "We are at the table, but we need to ensure our voice is heard when difficult choices are made." Employment and local procurement demonstrate measurable inclusion outcomes:

- Over 160 Namibians have been employed at Dâures, including more than 30 from the local constituency
- 30 per cent of construction contracts have been directed to local small- and medium-sized enterprises
- More than 60 Namibian SMEs supported the HyIron Oshivela project

The research found that these figures, while promising, represent early-stage achievements. Scaling inclusion to the industrial-scale Hyphen project will require deliberate policy interventions to ensure local content provisions are maintained as project size increases.

Skills Development and Human Capital

The research identified skills development as a critical enabler and potential constraint. A training programme developed with the UN Industrial Development Organization (UNIDO)

under its Accelerate-to-Demonstrate (A2D) Facility supported by a US\$5 million UK-funded grant builds skills in electrolyser maintenance, ammonia synthesis, fertiliser production, and Agri-systems, with priority places for young people from marginalised communities. The Dâures project also holds a Memorandum of Understanding with the World Food Programme (WFP) for potential offtake of agricultural produce and fertiliser, anchoring energy production within local food security systems.

The Cleanergy Solutions plant serves as a training and research hub, supporting future large-scale deployment. Collectively, these initiatives aim to address a critical challenge: the need to develop a workforce capable of supporting a sophisticated green industrial sector. However, interviews with government officials and training providers revealed persistent concerns about the mismatch between educational outputs and industry needs a theme explored further in Theme 4.

Agricultural Integration and Food Security

A distinctive finding from the research is the integration of green hydrogen with agriculture and food security. At Dâures, the integration of hydrogen production with fertiliser production and agricultural offtake creates a model where energy production supports food security rather than competing with it. This addresses a significant concern in the global south: that large-scale renewable energy projects may displace agricultural land or divert water resources from food production.

The Dâures model demonstrates how:

- Low-carbon fertiliser production can reduce dependence on imported fertilisers
- Agricultural produce can be off taken from local farmers, creating market linkages
- Water and energy systems can be integrated to support both industrial and agricultural needs

Theme 3: Biomass From Environmental Challenge to Economic Opportunity

Bush Encroachment as a Resource Opportunity

The research findings confirm that Namibia's biomass sector offers a parallel pathway to green industrialisation, transforming an environmental challenge into an economic opportunity. Bush encroachment affects approximately 45 million hectares roughly a third of the country causing soil infertility, biodiversity loss, and groundwater depletion. This challenge disproportionately affects rural livelihoods: over 70% of the Namibian population directly or indirectly depends on agriculture, and reduced grazing capacity can lead to poverty and food insecurity.

The most established value chain from encroacher bush is charcoal production, with an annual production of over 200,000 tonnes. Commercial farmers produce charcoal on their land, often using the manual labour of migrant workers, which is then processed and exported to Europe. However, the research found that communal farmers are currently prohibited from participating in this commercial value chain due to a moratorium placed by the government because of concerns about unequal benefit sharing and overexploitation, which might result in worse bush encroachment.

Social Life Cycle Assessment Insights

The Social Life Cycle Assessment (SLCA) conducted on Namibia's bush-based value chains provides critical insights into the social dimensions of biomass development. The research, part of a larger multi-stakeholder and multi-disciplinary project to design inclusive and sustainable biofuels for the marine industry, found that while SLCA is a useful method to quantify some social impacts and identify social risks in the value chain such as labour conditions and existing policies current SLCA methods "miss a more nuanced understanding of the context and potential social issues, like issues related to gender and ethnicity, and the adherence to existing policies" .

Key findings from the SLCA research include:

Land tenure complexity: Namibia's three-tier land tenure system commercial land (privately owned, average 7,000 ha, typically European descendants), communal land (state-owned, managed by traditional authorities, covering 38% of the country and accommodating half the population), and resettlement land (acquired by government for previously disadvantaged communities) creates different capabilities and challenges for farmers.

Common-pool resource dynamics: The bush that grows on communal land is a common-pool resource, with different tribes having unique characteristics, agricultural practices, beliefs, and customs. This complicates benefit-sharing arrangements and requires culturally sensitive governance mechanisms.

Indicator gaps: Current SLCA methodologies are inadequate for capturing "softer social impact categories, such as gender and ethnicity-related social norms, which are not easily captured by general indicators". The research recommends adding context-specific indicators to the risk assessment and incorporating local stakeholders' subjective assessments.

Stakeholder engagement imperative: The research "advocate[s] for incorporating local stakeholders' subjective assessments" because "engagement with local stakeholders during the SLCA process is essential, not only to receive feedback on the important subcategories, but also to assess and rank those subcategories".

Biofuel Potential

The research identifies significant potential for expanding biomass value chains. Current utilisation of 1.85 million tonnes of bush is only 1% of the total available biomass. New value chains with larger market demand such as biofuels for the shipping sector could substantially increase utilisation while providing rural livelihoods and restoring land. However, the research cautions that new value chains could impose new social risks and negative social impacts, underscoring the importance of thorough social assessment.

The techno-economic and environmental assessment of biofuel production from encroacher bush confirms the technical feasibility of converting bush biomass to biofuels through hydrothermal liquefaction (HTL) and hydrotreatment upgrading. This analysis provides evidence that the biomass pathway is not merely an environmental remediation strategy but a viable industrial development pathway.

Theme 4: Technological Transformation and Educational Capacity

Technological Readiness and Infrastructure Gaps

The research findings reveal a significant gap between the technological ambitions of Namibia's green industrialisation and the current state of technological infrastructure and human capital. While Namibia has a well-developed ICT policy implemented since 1999, with the Ministry of Education establishing five development levels to measure progress in ICT implementation, the reality on the ground shows substantial disparities.

A study of e-learning implementation in six selected secondary schools in the Khomas Region found that while teachers and students recognise benefits including convenience of time and place, ease of contact between teachers and students, and greater confidence in adopting e-learning significant challenges persist:

Limited computer and internet access: This was identified as a primary constraint, with insufficient infrastructure preventing effective e-learning implementation.

Lack of technical support: Both students and educators complained about inadequate technical support, undermining confidence in e-learning platforms.

Lack of enthusiasm and training: Lack of training, poor awareness of programmes, and poor infrastructure were identified as contributing factors to the failure of e-learning implementation.

Teacher competency: ICT literacy training alone does not guarantee teachers can effectively integrate technology; subject-specific ICT training is needed.

Digital Immigrant Teachers in Rural Schools

A phenomenological study of digital immigrant teachers' experiences in rural primary schools in Namibia's Endola circuit, Ohangwena region, provides rich qualitative insights into technology integration challenges. Thirteen public rural school teachers were purposively selected for semi-structured interviews and classroom observations.

The thematic analysis revealed:

Advanced digital skills in learners: Teachers encountered learners with digital literacy that sometimes exceeded their own, creating a dynamic where traditional teacher authority was challenged.

Transformed roles: Teachers experienced shifts in their professional roles, moving from knowledge transmitters to facilitators and guides.

Evolving beliefs: Teachers reported changes in their beliefs about teaching and learning as they experimented with technologies.

Experimentation: Teachers engaged in self-directed experimentation with technologies, often despite limited institutional support.

Challenges identified included inadequate ICT training, scarce resources, and difficulty keeping pace with digitally native learners. The study recommends subject-specific ICT training for teachers, addressing a key gap in current professional development approaches.

E-Learning Benefits and Constraints

A mixed-methods study on e-learning teaching in Grade 8 Computer Studies found that the key benefits of e-learning included convenience of time and place, greater degree of trust in adopting e-learning as a teaching and learning instrument, and ease of contact between teachers and students. However, these benefits were constrained by inadequate infrastructure, limited technical support, and lack of training.

The research identifies several contributing factors to the failure of e-learning implementation in schools:

Lack of awareness: Students and parents are unaware of e-learning platforms and their effectiveness

Technological hurdles: Limited financial resources, staff technical capabilities, and e-learning technology expenses hinder adoption

Skills gaps: Inadequate computer skills, unreliable internet connections, and weak internet signals hinder effective e-learning deployment

The study recommends that the Ministry of Education introduce mandatory e-learning courses into the curriculum for all learners, and that stakeholders' opinions and suggestions including teachers and education officers be taken into account when e-learning is introduced in schools.

Implications for Green Economy Skills

The technological transformation findings have direct implications for Namibia's green economy ambitions. The green hydrogen and biomass sectors require a workforce with technical skills in electrolyser maintenance, ammonia synthesis, fertiliser production, Agri-systems, and advanced manufacturing. The current educational system, with its infrastructure deficits and teacher training gaps, may not be adequately preparing learners for these opportunities.

Interviews with government officials revealed growing awareness of this challenge, with efforts underway to align educational curricula with green economy needs. The Youth for Green Hydrogen Scholarship Programme and the establishment of hydrogen academies represent steps in this direction, but the scale of the challenge is substantial given the existing infrastructure and capacity constraints in the education system.

Cross-Cutting Findings: Governance and Financing Legislative and Regulatory Gaps

A significant finding from the research is the governance gap between policy and legislation. While Namibia has developed comprehensive green hydrogen strategies and roadmaps, dedicated legislation governing the sector remains absent. The government argues that existing legislation including the Environmental Management Act, Electricity Act, Water Resource Management Act, Labour Act, and Income Tax Act provides sufficient legal coverage for

hydrogen-related activities. However, the policy-to-legislation transition remains incomplete, with consultations on a green hydrogen draft bill still underway.

This governance gap presents both risks and opportunities. On one hand, regulatory uncertainty could undermine investor confidence and project legitimacy if not addressed systematically. On the other hand, the current adaptive governance approach through existing frameworks may enable more flexible implementation, allowing lessons from pilot projects to inform future legislation. The research suggests that the balance between flexibility and regulatory certainty requires careful calibration.

Financing Mechanisms and International Partnerships

The research findings highlight Namibia's success in mobilising innovative financing mechanisms. The SDG Namibia One Fund, launched in partnership with development partners, provides blended financing for climate-smart investments. Namibia was ranked third out of 26 global applicants for the Climate Investment Funds' Industry Decarbonisation Programme, securing access to concessional capital at approximately 1% interest, with the potential to leverage multilateral development bank funding at up to ten times that amount.

International partnerships have been instrumental:

Germany: The GreeN-H2-Namibia project, a collaboration between DECHEMA and ISOE funded by the German Federal Ministry of Education and Research, has produced three reports on Power-to-X technologies, water infrastructure, and brine valorisation.

European Union: Eight large-scale green hydrogen projects confirmed at the Namibia–EU Business Forum.

United Kingdom: US\$5 million grant supporting the UNIDO Accelerate-to-Demonstrate Facility.

United Nations: Multiple agencies FAO, ILO, UNDP, UNICEF, UN Women, and WFP are jointly implementing "Agri-Systems Transformation through Biomass Processing for Decent" programmes.

Water Infrastructure and Resource Constraints

The GreeN-H2-Namibia project's report on water infrastructure in the ||Kharas Region highlights a critical resource constraint. Lüderitz and Aus are emerging as focal points for Namibia's green hydrogen ambitions, but water availability is a significant limiting factor. The report compiles scattered data from diverse stakeholders into one coherent analysis, giving decision-makers a clearer basis for planning water infrastructure in the face of uncertainty.

Uncertainties include:

- Whether hydrogen workers' families will relocate
- What skills exist locally
- The readiness of infrastructure
- How industrial development will actually unfold over time

The report develops scenarios for future water demand built on transparent assumptions, underlining the advantages of a modular approach to water infrastructure. This allows investments to grow with demand, meeting current and near-term needs without holding back other industries or urban growth, while keeping flexibility for larger green hydrogen projects. The report on brine valorisation explores opportunities as desalination expands to support the green hydrogen sector. Market opportunities could be in sodium chloride, soda ash, sodium bicarbonate, and longer-term recovery of magnesium and lithium, suggesting that a high-value, circular brine economy could be integrated with desalination and green energy hubs.

Synthesis: Key Findings Summary

The research findings reveal a Namibia making substantial progress in establishing the foundations for a green industrial economy, while facing significant challenges in translating policy ambition into inclusive implementation. The key findings are:

Strategic Policy Sequencing: Namibia's success in green hydrogen development stems from deliberate policy sequencing: policy certainty first, institutions second, market frameworks third, and risk-sharing throughout.

Concrete Inclusion Mechanisms: The 10% community ownership stake at Dâures, local procurement targets, and skills development programmes demonstrate that inclusion is being operationalised, not merely rhetorically endorsed.

Parallel Transformation Pathways: Green hydrogen and biomass development advance complementary transformation pathways, addressing environmental challenges (climate change, bush encroachment) while creating economic opportunities.

Social Assessment Gaps: Current social impact assessment methods are inadequate for capturing the nuanced social realities of Namibia's complex land tenure system and ethnic diversity, highlighting the need for context-specific indicators and community engagement.

Education-Technology Mismatch: Namibia's technological transformation ambitions face significant constraints from educational infrastructure deficits, teacher training gaps, and limited digital access, which may undermine green economy skills development.

Governance Gaps: The absence of dedicated green hydrogen legislation presents ongoing governance challenges, with the policy-to-legislation transition incomplete.

Resource Constraints: Water availability and infrastructure development are critical constraints requiring modular, scenario-based planning.

Innovative Financing: Namibia has successfully mobilised concessional and blended financing, positioning itself as an attractive destination for green investment

Recommendations

Based on the empirical findings and analysis of Namibia's green economy transition, this chapter presents a comprehensive set of recommendations across the intersecting domains of governance, inclusion, technological capacity, and sustainable development. These recommendations are structured to address the critical gaps identified in the research while building on Namibia's demonstrated strengths and comparative advantages.

The recommendations are organised around five thematic areas, reflecting the key challenges and opportunities identified in the findings: (1) Governance and Institutional Strengthening, (2) Inclusive Development and Benefit Sharing, (3) Skills Development and Human Capital, (4) Technological Transformation and Digital Infrastructure, and (5) Sustainable Finance and Investment Climate. Each recommendation is grounded in the empirical evidence and aligned with the analytical insights from the research.

Theme 1: Governance and Institutional Strengthening

Recommendation 1.1: Enact Dedicated Green Hydrogen Legislation

The research findings confirm a significant governance gap: while Namibia has developed comprehensive green hydrogen strategies and roadmaps, dedicated legislation governing the sector remains absent. This policy-to-legislation transition represents a critical vulnerability that could undermine investor confidence, project legitimacy, and the enforcement of shared value and corporate accountability principles.

Recommendation: The Government of Namibia should expedite the finalisation and enactment of the green hydrogen draft bill currently under consultation. This legislation should:

- Establish clear regulatory frameworks for project approval, environmental oversight, and operational standards
- Codify benefit-sharing mechanisms, local content requirements, and community participation rights
- Create comprehensive investor and financier protections to support large-scale financing
- Ensure alignment with international standards while maintaining Namibia's sovereignty over its resources

As Nanyemba (2025) argues, shared value and corporate accountability are "crucial in cementing the foundation of an environmentally sustainable green hydrogen market" and are "fundamental principles to ensure that foreign-owned companies operating in Namibia's green hydrogen sector align their operations with environmental, social, and ethical requirements". Without dedicated legislation, these principles remain aspirational rather than enforceable.

Recommendation 1.2: Strengthen Inter-Ministerial Coordination and Governance Structures

The findings identified significant delays in project implementation due to complex permitting processes, fragmented approval pathways, and inadequate inter-ministerial coordination. As the Namibia Green Hydrogen Association (Nam GHA) noted, "Delay in sector maturity is caused by slow market demand development and the speed of execution in project permitting

and approval processes, including land access, servitudes, EPLs, permits, licences, and export infrastructure"

Recommendation: Establish a high-level inter-ministerial coordination and governance structure, reporting directly to Cabinet, to oversee the implementation of projects outlined in Namibia's National Development Plan 6 (NDP6) . This structure should:

- Streamline approval processes for strategic projects
- Provide a single-entry point for investors, reducing bureaucratic complexity
- Monitor implementation progress and address bottlenecks proactively
- Ensure policy coherence across energy, industry, land use, and transport sectors

The Nam GHA recommended that "Governance structures must be in place to support project developers and expedite approvals for strategic projects" . This aligns with the research finding that successful green industrialisation depends as much on governance and institutional capacity as it does on technology and capital.

Recommendation 1.3: Address Policy and Regulatory Complexity in Renewable Energy

The research found that policy and regulatory complexity in the renewable energy sector represents a significant barrier to investment, including a prolonged permitting process for renewable energy projects. Additionally, Namibia's fiscal regime remains less competitive than that of other countries developing green hydrogen industries.

Recommendation: Undertake a comprehensive review and simplification of renewable energy permitting processes, including:

- Benchmarking Namibia's fiscal regime against international competitors to create a globally attractive investment environment
- Reducing permitting timelines through streamlined administrative procedures
- Establishing clear and predictable land access frameworks for renewable energy projects
- Creating a fiscal regime that "enables Namibian projects to compete internationally while fairly compensating Namibia for the establishment and operation of the industry"

Theme 2: Inclusive Development and Benefit Sharing

Recommendation 2.1: Scale and Codify Community Ownership and Benefit-Sharing Mechanisms

The research findings from the Dâures Green Hydrogen Village demonstrate that community ownership and benefit-sharing can be effectively operationalised at the project level. The 10% community ownership stake held by the Daure Daman Traditional Authority and Tsiseb Conservancy, the employment of over 160 Namibians (including more than 30 from the local constituency), and the direction of 30% of construction contracts to local SMEs provide a replicable model.

Recommendation: Codify community ownership and benefit-sharing requirements into law and policy frameworks, ensuring that:

Namibia's Perspectives on Green Economy Management, Sustainable Development and Technological Transformation.

- All large-scale green economy projects include mandatory community ownership stakes (minimum 10%)
- Local content requirements (minimum 30% of contracts to local enterprises) are enforceable
- Employment targets for local communities are established and monitored
- Benefit-sharing mechanisms are transparent, accountable, and subject to independent review

As the UN Resident Coordinator noted, ensuring "that communities are active participants in transformation, not passive observers" requires deliberate policy intervention.

Recommendation 2.2: Strengthen Agricultural Integration and Food Security Linkages

The Dâures model demonstrates the potential for integrating green hydrogen production with agriculture and food security through low-carbon fertiliser production and agricultural off take. The Memorandum of Understanding with the World Food Programme (WFP) for potential offtake of agricultural produce and fertiliser anchors energy production within local food security systems.

Recommendation: Expand agricultural integration as a core component of green economy development:

- Develop a national framework for integrating green fertiliser production with agricultural development
- Establish market linkages between green hydrogen projects and local agricultural producers
- Ensure that water and energy planning considers both industrial and agricultural needs
- Support community-based agricultural enterprises that can supply and benefit from green economy projects

This approach addresses the concern that large-scale renewable energy projects may displace agricultural land or divert water resources from food production, particularly important in Namibia's water-scarce context.

Recommendation 2.3: Address Energy Poverty as a Development Priority

The research found that only 56% of Namibia's population has access to electricity, with 75% in urban areas and only 35% in rural areas. Namibia imports up to 60% of its electricity, creating vulnerability to regional supply shocks. Energy poverty has profound social implications: "students can't study or access digital learning, clinics struggle to power essential equipment, and households rely on polluting fuels like kerosene and firewood".

Recommendation: Treat energy access as a core component of the green transition, not a separate or secondary concern:

- Prioritise renewable energy deployment in underserved rural areas
- Integrate off-grid and mini-grid solutions where grid expansion is not cost-effective
- Ensure that green hydrogen projects contribute to domestic energy security, not solely export markets
- Develop financing mechanisms specifically targeting rural electrification

As the UNDP analysis notes, "the decisions made today will shape the future of the country in international partnerships, attracting investment, and access to technology". Energy access decisions are central to this future.

Theme 3: Skills Development and Human Capital

Recommendation 3.1: Implement the Energy Sector Skills Strategy with Urgency

The research identified skills development as a critical enabler and potential constraint for Namibia's green transition. The Energy Sector Skills Strategy, developed jointly by the Namibia Investment Promotion and Development Board (NIPDB) and the International Labour Organization (ILO) using the internationally recognised Skills for Trade and Economic Diversification (STED) methodology, provides an evidence-based roadmap for identifying future workforce needs and aligning education, training and labour market systems with industry demands.

Recommendation: Accelerate implementation of the Energy Sector Skills Strategy with clear milestones and accountability:

- Align education and training curricula with industry skill requirements
- Establish industry partnerships for work-based learning and apprenticeships
- Create financing mechanisms for skills development targeting marginalised communities
- Monitor and evaluate skills development outcomes against industry needs

As Jessica Hauuanga, Executive for Investor Experience at NIPDB, stated, "Our responsibility is to ensure that every dollar invested translates into structural transformation for Namibia's economy. Capital is mobile, but sustainable development must be local. That means building the skilled workforce our industries need so that Namibians are at the centre of this transformation".

Recommendation 3.2: Address the Youth Employment Challenge

Namibia faces a persistent youth unemployment crisis, with nearly 42% of young people not in education, employment, or training. The green economy offers significant employment potential: green hydrogen projects could contribute US\$2 billion annually to GDP and create 30,000 direct jobs, with an additional two to three times that number indirectly once the industry becomes fully operational.

Recommendation: Develop targeted youth employment programmes linked to green economy opportunities:

- Expand the Youth for Green Hydrogen Scholarship Programme and similar initiatives
- Create youth entrepreneurship programmes focused on green economy value chains
- Establish mentorship and internship programmes linking young Namibians to green economy employers
- Ensure that skills development programmes reach young people in marginalised and rural communities

The African Development Bank's Country Strategy Paper (CSP) for Namibia includes a Skills for Youth Employability and Entrepreneurship Project (US\$315.3 million) to equip young Namibians with the technical and entrepreneurial skills needed for jobs in emerging sectors,

including green energy, ICT, logistics, and value-added industries. This should be leveraged and expanded.

Recommendation 3.3: Strengthen Technical and Vocational Education for Green Industries

The research identified persistent concerns about the mismatch between educational outputs and industry needs. While the education system has made progress in ICT implementation, significant infrastructure deficits and teacher training gaps constrain the development of a workforce capable of supporting sophisticated green industrial sectors.

Recommendation: Reform technical and vocational education to meet green economy demands:

- Integrate green economy skills into technical and vocational education curricula
- Invest in training facilities and equipment for renewable energy, hydrogen, and related technologies
- Provide subject-specific ICT training for teachers
- Establish partnerships between educational institutions and green economy employers
- Create clear career pathways linking education to green economy employment

Theme 4: Technological Transformation and Digital Infrastructure

Recommendation 4.1: Address ICT Infrastructure Gaps in Education

The research found significant gaps between Namibia's technological ambitions for green industrialisation and the current state of technological infrastructure and human capital. A phenomenological study of digital immigrant teachers in rural primary schools identified challenges including inadequate ICT training, scarce resources, and difficulty keeping pace with digitally native learners. E-learning implementation in secondary schools faces similar constraints, including limited computer and internet access, lack of technical support, and inadequate teacher competency.

Recommendation: Invest strategically in ICT infrastructure for education:

- Prioritise internet connectivity for schools, recognising that only 65.4% of schools had internet connectivity in 2023
- Provide adequate hardware and software resources for teaching and learning
- Establish technical support systems for educational institutions
- Ensure that infrastructure investments reach rural and marginalised schools

This is essential not only for educational outcomes but for preparing the workforce required for Namibia's green economy ambitions.

Recommendation 4.2: Integrate AI and Emerging Technologies into Education and Training

The research exploring the significance of Artificial Intelligence (AI) in teacher education at Namibian universities found that AI has a transformative role in higher education, with diverse applications and benefits for teaching. However, significant challenges hinder AI integration: technological limitations, inadequate training, cultural resistance, funding constraints, and infrastructure disparities.

Recommendation: Develop a comprehensive AI and emerging technology strategy for education and workforce development:

- Integrate AI skills into teacher education curricula
- Develop specialised courses in AI and related technologies
- Invest in faculty development for AI competencies
- Foster industry partnerships to align education with technology sector needs
- Engage policymakers to address technological and ethical challenges

Mutelo (2025) emphasises that "strategic investments, capacity building, and ensuring equitable access" are essential for successful AI integration, and that "continuous professional development is crucial for equipping educators with the necessary AI skills, promoting inclusivity, and addressing concerns about equity and creativity".

Recommendation 4.3: Develop Technological Capacity for Green Industry

Namibia's reliance on imported advanced technology limits its ability to capture value, and "without strong local participation, foreign companies may dominate key engineering and construction roles".

Recommendation: Build indigenous technological capacity for green industries:

- Invest in research and development for green economy technologies
- Establish technology transfer agreements with international partners
- Develop local manufacturing and maintenance capabilities for renewable energy and hydrogen technologies
- Create innovation hubs and incubators for green economy start-ups
- Support Namibian enterprises to participate in green economy value chains

UNIDO's work under the GEF 8 Global Clean Hydrogen Programme Namibia Child Project and the Accelerate to Demonstrate Facility focuses on strengthening industrial capacity, promoting local value addition, facilitating technology transfer, and demonstrating practical applications of clean hydrogen technologies. This work should be expanded and sustained.

Theme 5: Sustainable Finance and Investment Climate

Recommendation 5.1: Strengthen Innovative Financing Mechanisms

Namibia has demonstrated success in mobilising innovative financing mechanisms, including the SDG Namibia One Fund and access to low-cost concessional financing through the Climate Investment Funds' Industry Decarbonisation Programme. However, the high cost of capital in comparison to developed countries remains a significant barrier to investment.

Recommendation: Expand and strengthen innovative financing mechanisms:

- Scale up the SDG Namibia One Fund and similar blended-finance platforms
- Enhance Namibia's eligibility and access to international climate finance
- Develop financial instruments specifically for green economy projects in water-scarce, high-risk contexts
- Address currency fluctuation risks that pose challenges for long-term investment and planning

- Create financing mechanisms for local enterprises to participate in green economy value chains

Recommendation 5.2: Align Investment with Industrial Development

The research found that Namibia faces a critical choice between green hydrogen and fossil fuel development pathways. Based on the assessment of Namibia's current structural challenges and industrial policy experience, Andreoni (2025) advances "nine concrete and feasible policy recommendations clustered around three areas state capacity development, sectoral development interventions, investments in social and environmental drivers" .

Recommendation: Develop a coherent investment strategy that prioritises green industrialisation and addresses the following:

- Breaking into the global economy through strategic participation in green value chains
- Linking up into value chains while linking back into the domestic economy
- Keeping pace with technological change
- Avoiding "enclave" investments that do not generate broad-based development benefits
- Creating intermediate pathways through "new industrial policy and mixed sectoral prioritisation strategies"

Recommendation 5.3: Address Water Infrastructure Constraints

The research identified water availability as a critical constraint for green hydrogen development, particularly in the ||Kharas Region where Lüderitz and Aus are emerging as focal points. The GreenN-H2-Namibia project's report on water infrastructure highlights uncertainties including whether hydrogen workers' families will relocate, what skills exist locally, the readiness of infrastructure, and how industrial development will unfold over time.

Recommendation: Adopt a modular, scenario-based approach to water infrastructure planning:

- Invest in desalination capacity with a modular approach that allows investments to grow with demand
- Explore opportunities for brine valorisation to create circular economy benefits
- Integrate water infrastructure planning with green energy and industrial development
- Ensure water planning addresses both industrial needs and community water security
- Develop water infrastructure that "meets current and near-term needs without holding back other industries or urban growth, while keeping flexibility for larger green hydrogen projects"

These recommendations provide a comprehensive roadmap for advancing Namibia's green economy management, sustainable development, and technological transformation. They are grounded in the empirical findings of this research and aligned with the strategic frameworks already established by the Government of Namibia, including the Long-Term Low-Emission Development Strategy (LT-LEDS), NDP6, and the Green Industrialisation Blueprint.

The successful implementation of these recommendations requires whole-of-government and whole-of-society alignment. As the LT-LEDS emphasises, this is "not just a technical document. It is a policy shift that requires whole-of-government and whole-of-society alignment". The recommendations also require a concerted effort from development partners, the private sector, and civil society to ensure that Namibia's green transition delivers broad-based, inclusive, and sustainable development.

The critical test for Namibia will be whether the green transition delivers benefits for Namibians particularly youth, women, and rural communities or merely creates an enclave economy serving global decarbonisation markets. The recommendations presented here are designed to ensure that Namibia's green vision becomes a model for just and sustainable industrialisation in Africa.

Conclusion

Namibia's pursuit of green economy management, sustainable development, and technological transformation represents one of the most significant economic reorientation efforts in Africa. The evidence suggests a clear and ambitious vision, yet the conclusion that emerges is one of cautious optimism: Namibia has positioned itself as a potential continental leader, but whether this translates into inclusive, sustainable prosperity depends on closing persistent gaps between policy and implementation, governance and practice.

The Strategic Foundation: A Country Ready to Lead

Namibia's foundational advantages are compelling. With some of the world's best solar and wind resources, the country has attracted eight large-scale green hydrogen projects representing an estimated N\$390 billion (approximately US\$24 billion) in investment potential. This resource endowment is complemented by sophisticated policy architecture, including the Green Hydrogen Strategy of 2022, the Green Industrialisation Blueprint, and integration into the sixth National Development Plan (NDP6). The UN has characterised Namibia as "uniquely positioned to lead in green industrialisation," noting that the country's ambition is to become "a future platform for the low-carbon industry in southern Africa".

The Dâures Green Hydrogen Village exemplifies the integrated model Namibia aspires to combining hydrogen production with agriculture, food security, and community livelihoods on a 15,000-hectare site. Crucially, the project demonstrates tangible inclusion mechanisms, with the Daure Daman Traditional Authority and Tsiseb Conservancy holding a 10% ownership stake, over 160 Namibians employed, and 30% of construction contracts directed to local SMEs. This reflects a deliberate attempt to translate the "Leave No One Behind" principle into concrete economic participation.

The Implementation Gap: Risks and Barriers

Despite these ambitions, a substantial implementation gap exists. By late 2024, the green hydrogen sector had created only 400 mostly temporary jobs far below projections of 180,000 to 250,000 new jobs within five years. The Hyphen Hydrogen Energy project, targeting one million tonnes of green ammonia annually by 2028, has faced delays due to a worldwide

shortage of electrolyser units and slow market demand. As the Namibia Green Hydrogen Association (Nam GHA) has acknowledged, "delay in sector maturity is caused by slow market demand development and the speed of execution in project permitting and approval processes". Regulatory uncertainty compounds these challenges. Despite government assertions that existing laws are sufficient, dedicated green hydrogen legislation remains absent, with a draft bill still in consultation. The National Council's oversight report identified that "Namibia lacks important regulations and legislation to regulate the green hydrogen industry," including frameworks for local content, incentives, and occupational health and safety. This legal vacuum creates uncertainty for billion-dollar investors requiring long-term stability to secure financing. Infrastructure constraints represent another critical barrier. Producing 15 million tonnes of green hydrogen annually Namibia's 2050 target would require 750 terawatt hours of renewable energy generation, compared to only 1.33 terawatt hours generated in 2020. Grid capacity remains insufficient, with the National Council noting that "projects are willing to transmit all the solar power they generate onto the national grid, but at present, this is not possible". Port infrastructure, transmission lines, and logistics networks require estimated public investments of US\$15 billion. As the National Planning Commission's Director General Kaire Mbuende has emphasised, stakeholders must address "structural barriers such as grid capacity, water supply, logistics requirements, regulatory readiness, and infrastructure constraints".

Technology as Enabler and Challenge

Digital transformation presents a parallel narrative of potential constrained by capacity. While Namibia helped shape the global Digital Compact and has signed partnerships to accelerate digital inclusion, significant gaps remain. The UN-MTC partnership focuses on human development, access to public services, economic resilience, and smart growth, but faces challenges of reach and equity. Research on Namibia's National Spatial Data Infrastructure reveals that while a solid institutional base exists, "application to real-time monitoring and inter-sectoral data sharing remains uneven". Similarly, studies on ICT integration in education show that while teachers have positive perspectives, operational challenges such as time-consuming device setup and limited school connectivity hinder progress.

Skills development represents a cross-cutting challenge. The National Council's oversight report found that "Namibia's skills market is simply not able to deliver what the green hydrogen industry requires," with logistics, transport, and technical services unable to meet sector demands. The youth unemployment rate of approximately 45% reflects a mismatch between education system outputs and labour market needs. The Katutura Science Centre initiative, while promising, underscores the need for accessible STEM education and practical skills development to bridge the digital divide. As the UN has argued, "a just transition requires deliberate investment in people, skills and participation enabling women, young people and vulnerable groups to become active contributors to emerging green value chains, not bystanders".

Conclusion: Towards a De-risked Transition

The evidence points to a central insight: Namibia's green transformation requires treating risk management as an integrated development strategy rather than a financial afterthought. As the UN has articulated, "new industries like green hydrogen and biomass need more than capital:

they require governance frameworks, workforce readiness, community trust, and fiscal structures that keep investment viable and equitable over time”. The establishment of the SDG Namibia One investment platform and access to US\$250 million through the Climate Investment Funds' Industry Decarbonisation Programme demonstrate growing recognition that financing must be accompanied by institutional capacity.

The Namibian experience offers three critical lessons for green economy transitions in developing contexts. First, policy ambition must be matched by regulatory and institutional readiness: without dedicated legislation, coordination mechanisms, and permit streamlining, momentum stalls. Second, infrastructure and skills are co-requisites for industrialisation: grid capacity, port expansion, and workforce development must advance alongside project development. Third, inclusion is both a moral imperative and a practical necessity: community ownership, local content, and equitable skills access build the legitimacy that sustains projects through market fluctuations and political cycles.

Namibia's green economy and technological transformation vision represents a paradigm shift from viewing climate action as a burden to recognising it as an opportunity for industrialisation and inclusive development. Yet the gap between ambition and execution remains significant. For Namibia's transformation to succeed, the country must move from planning to implementation with urgency, coordinate across ministries and sectors, invest in both digital and energy infrastructure, and ensure that the benefits of the green transition reach all Namibians not just investors and policymakers. As the Namibian government has affirmed, the objective is not to "merely export raw materials" but to "industrialise, create value locally, generate employment, and support Namibian enterprises”. Delivering on this promise will define Namibia's sustainable development trajectory for decades to come.

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