GREEN HYDROGEN CONFERENCE PAPER

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Table of Contents

1. Executive Summary

The Green Hydrogen Conference organized by the Delegation of German Industry and Commerce in Ghana (AHK Ghana) as part of the AHK GhanaH2 project and a key part of the West African Clean Energy and Environment Trade Fair and Conference 2025 (WACEE'25), brought together government agencies, industry leaders, development partners, and academic institutions to discuss Ghana's emerging green hydrogen and green ammonia landscape. The presentations and panel dialogue collectively highlighted Ghana's strategic potential, ongoing pilot projects, policy developments, market prospects, and the challenges that must be overcome to position the country within the global hydrogen transition.

2. Presentation of the AHK Ghana Hydrogen Project (AHK GhanaH2)

Delivered by Mr. Caleb Caleb Kofi Sarpong, Project Manager at the Delegation of German Industry and Commerce in Ghana (AHK Ghana)

The Green Hydrogen Conference opened with a comprehensive presentation by Mr. Caleb Kofi Sarpong, Project Manager at the Delegation of German Industry and Commerce in Ghana (AHK Ghana). His address provided an in-depth overview of Ghana's emerging hydrogen landscape, focusing on renewable energy potential, opportunities for hydrogen integration, current market realities, and the structural challenges that must be addressed for hydrogen technologies to mature in the country.

Solar Potential and Renewable Energy Trends

Mr. Sarpong highlighted Ghana's strong natural potential for solar-based energy systems, with 2,500–3,000 hours of sunlight annually. Despite this significant resource, the country's installed grid-connected solar capacity remains low, reaching only 132 MW by 2023—a figure far below what its sunshine levels could support. This underdevelopment places Ghana behind global renewable energy expansion trends.

He referenced past international interventions that have shaped Ghana's renewable energy journey. The 2016 Power Africa initiative deployed mini-grids across island and lakeside communities, while Switzerland introduced off-grid solar systems in remote areas. The African Development Bank also continues to expand electrification programs inspired by these earlier works. These examples, he noted, provide valuable lessons for scaling new technologies such as hydrogen in similar remote communities.

The Case for Linking Solar and Hydrogen

Green hydrogen, according to Mr. Sarpong, offers a strategic solution to Ghana's energy challenges. It provides long-term energy storage, helping stabilize solar power, whose intermittency remains a major constraint. Hydrogen is particularly valuable for communities not connected to the national grid, offering a means to store excess solar power for use during low-generation periods.

He emphasized three factors supporting hydrogen's feasibility in Ghana: abundant sunlight, adequate water availability for electrolysis, and favorable climatic conditions. Contrary to public misconceptions, electrolysis does not require excessive water volumes, especially for decentralized systems suitable for Ghana's context. While large-scale centralized hydrogen

plants demand complex planning, smaller systems can operate efficiently without straining local resources.

Current Market Realities

Ghana has almost no domestic demand for pure hydrogen, with consumption focused on derivatives such as hydrogen peroxide. From 2020 to 2024, Ghana imported about 11.3 tonnes per year, mainly for textile processing, medical supply manufacturing, and some food industries. Local hydrogen production remains under 80 tonnes annually, making Ghana heavily reliant on imports. Nonetheless, emerging interest from partners in Singapore and Canada suggests future market growth as industrial needs expand.

Future Market Opportunities

Mr. Sarpong identified rural electrification as the most promising entry point for hydrogen deployment. Remote and island communities around Volta Lake, dependent on costly and polluting diesel generators, could transition to decentralized hydrogen-enhanced micro-grids. These systems would improve resilience, reduce fuel costs, and support long-term storage, helping close the remaining 11% national electricity access gap more sustainably.

Hydrogen Pilot Projects in Ghana

He presented three major pilot initiatives supported by German partners:

1. GH2GH Don Bosco System – a decentralized hydrogen model combining solar, batteries, electrolysis, storage, and a fuel cell.
2. SM4GH2 at KNUST – a smart hydrogen system integrating photovoltaic power, storage, electrolysis, and academic research.
3. Kwahu H2 Project by Enertrag Ghana – an ambitious 400–500 MW hybrid facility to produce hydrogen and derivatives.

Challenges and Recommendations

Hydrogen development faces barriers including the absence of a national hydrogen strategy, limited technical expertise, high capital costs, and lack of construction readiness. Standards for electrolysers and fuel cells are still being drafted.

Mr. Sarpong recommended stronger partnerships, community-level pilot programs, enhanced STEM and vocational training, and the creation of a clear national hydrogen strategy to attract investment and guide long-term development.

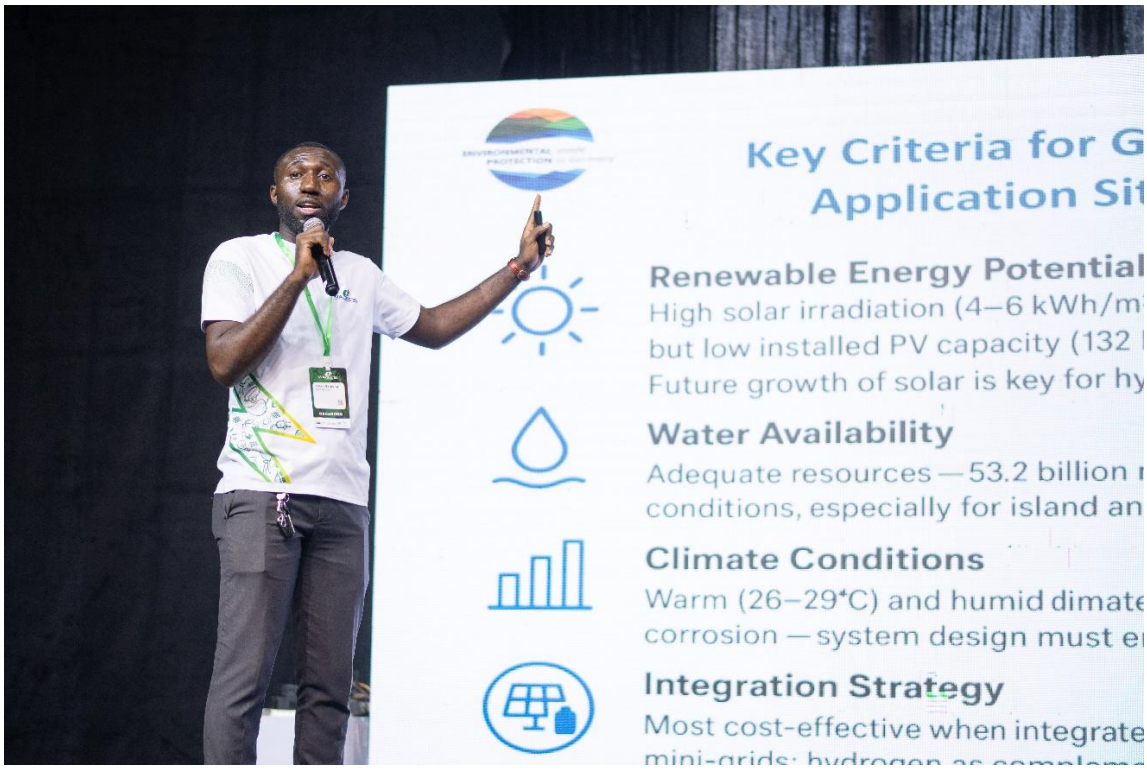

Figure 1. AHK Ghana H2 Study Presentation

3. Presentation of Green Hydrogen Projects in Ghana

KWAHU H2 - Delivered by Mr. Eric Yankah, Country Manager, Enertrag Ghana

Mr. Eric Yankah presented Enertrag Ghana's green hydrogen project in the Eastern Region, highlighting its 5,000-acre site designed to host 400 MW of solar and 100 MW of wind capacity feeding a large electrolyser. He stressed that success depends on market demand and infrastructure readiness, noting that feasibility studies show strong solar resources and viable wind speeds. Enertrag is evaluating two product pathways: producing hydrogen for conversion into green ammonia for fertilizer and industrial use or injecting renewable electricity into the national grid to support stability services. The project forms part of a broader effort to strengthen Ghana's renewable energy mix and industrial decarbonization. Mr. Yankah reaffirmed Enertrag's commitment as the project advances toward engineering and infrastructure negotiations.

GH2GH – Delivered by Mr. Jonas Plüschke, Research Associate, Hochschule Bochum /GH2GH Consortium

Mr. Jonas Plüschke, Research Associate at Hochschule Bochum and representative of the GH2GH consortium, presented the consortium's pilot project focused on demonstrating decentralized green hydrogen systems within renewable mini-grid environments in Ghana. The project is based at the Don Bosco Training Institute, where a hydrogen energy hub has been integrated into the school's existing mini-grid. The initiative combines demand-side

management, renewable energy integration, technical evaluation, and capacity building, with Don Bosco serving as both a host and long-term training partner.

Don Bosco currently generates a daily surplus of solar energy, much of which is wasted once battery storage is full. The project addresses this gap by converting excess solar energy into hydrogen through a 20-kW electrolyser, storing it in high-pressure tanks with a capacity of 1.2 MWh, and later reconverting it into electricity using a 10-kW fuel cell during low-solar periods. This system complements the facility's over 200 kW of solar PV and diverse battery chemistries, forming a robust hybrid mini-grid. A 3D visualization demonstrated how the hydrogen components integrate seamlessly through coordinated control systems.

Mr. Plüschke highlighted the system's technical complexities, noting the need for water purification due to Ghana's chlorinated tap water, efficient cooling for hydrogen drying, and precise coordination between electrolysis, storage, and reconversion. These engineering requirements illustrate that hydrogen deployment extends beyond equipment installation and demands careful operational planning.

Following installation, the consortium entered a comprehensive evaluation phase assessing system performance, operations and maintenance demands, and environmental impact relative to diesel generators, battery-only systems, and grid dependence. Social acceptance surveys in Tamale and Kumasi further explore community perceptions and potential business models.

Capacity building is central to the project. Don Bosco has hosted technical workshops supported by German hydrogen technology partners, training teachers, technicians, and students on hydrogen fundamentals and system operation. The local technical team now manages daily operations, ensuring sustained skill development.

Mr. Plüschke concluded that early results show strong promise for hydrogen-supported mini-grids across West Africa and reaffirmed the consortium's commitment to advancing decentralized hydrogen solutions.

SM4GH2 - Delivered by Mr. Michele Velenderic, CEO of Green Power Brains / Project Lead, SM4GH2 Consortium

Mr. Michele Velenderic delivered an in-depth presentation on the SM4GH2 project, highlighting the consortium's mission to advance green hydrogen skills development and renewable energy integration in Ghana. He began by introducing Green Power Brains, a company active since 2020 and specializing in solar solutions, hybrid energy systems, battery storage, and digitalization for energy technologies. He noted that the company recently strengthened its expertise through collaboration with Swiss partners, particularly in solar operations and sodium-ion battery storage. The SM4GH2 project, he emphasized, reflects years of work across Africa, including previous initiatives in Morocco, with a strong focus on workforce development as a foundation for successful hydrogen adoption.

Mr. Velenderic described the consortium structure: Green Power Brains leads project implementation and technical design, while KNUST serves as the primary academic partner contributing research expertise. A third partner supports technical training, capacity-building tools, and consulting. Together, they form a multidisciplinary team positioned to build Ghana's first robust hydrogen training ecosystem.

Funded by the SIFA (Skill for Africa Initiative), a programme between the African Union and KfW (German Development Bank), the project aims to equip Ghana with practical skills for the emerging green hydrogen economy. A central component is the development of a hands-on training facility at KNUST, envisioned as a distributed mini-grid supplying power to multiple campus buildings through solar technologies, smart meters, advanced battery systems, and hydrogen production units. Excess solar power will be used to generate hydrogen, later reconverted into electricity when required. A strong digitalization layer will link all system components, enabling real-time monitoring, simulation, and academic use.

KNUST, together with the Ghana Standards Authority, is developing a national curriculum covering renewable energy, hydrogen technologies, safety, and gender inclusion. Mr. Velenderic stressed the importance of aligning academia with industry needs to accelerate innovation.

The project has already completed its kickoff workshop, technical design work, and lecturer training. Installation of the 250-kW solar-hydrogen system is planned for 2026. Mr. Velenderic concluded by reaffirming the consortium's long-term vision: demonstrating visible, real-world hydrogen projects that make the technology accessible and practical for Ghana's energy future.

Figure 2. SM4GH2 Presentation

4. Presentation of the German–Nigerian Hydrogen Office

Delivered by Ms. Kristina Fuerst, Head of the German–Nigerian Hydrogen Office, GIZ Nigeria

Ms. Kristina Fuerst introduced the mandate of the German–Nigerian Hydrogen Office, established under Germany's International Climate Initiative (IKI) to advance green hydrogen as a central tool for global decarbonisation. The programme also promotes renewable energy expansion and energy efficiency, supporting sustainable development and strengthening international collaboration around hydrogen technologies.

She outlined two core goals:

1. Promoting green hydrogen to help countries meet their Paris Agreement commitments.
2. Diversifying energy economies, especially in nations heavily dependent on fossil fuels.

Using Nigeria as an example, she noted the country consumes nearly 100 megatons of hydrogen annually, primarily grey hydrogen derived from natural gas. Since oil accounts for up to 90% of Nigeria's export revenue, transitioning to green hydrogen offers a pathway for economic transformation and emissions reduction.

Ms. Fuerst described the Hydrogen Office network, which includes hubs in Nigeria, Kenya, Angola, Colombia, Ukraine, and Saudi Arabia. These offices share knowledge, conduct policy dialogue, provide technical consulting, coordinate sector assessments, and run capacity-building programmes. She highlighted a partner organization led by Ms. Lola Ade, which focuses on training women, youth, and professionals in green technology fields.

She then presented hydrogen potential in Nigeria, referencing a recent modelling study. Northern Nigeria records exceptionally high solar full-load hours—up to 2,000 hours annually—giving it a natural advantage for low-cost solar electricity. Solar generation costs could fall below 2.5 cents/kWh, enabling green hydrogen production at roughly $3.5/kg by 2030, far cheaper than projected European costs. These cost dynamics make Nigeria highly competitive for large-scale hydrogen production.

The Hydrogen Office is also supporting Nigeria in drafting a national hydrogen policy, involving ten government ministries. Early targets include 50% industrial emissions reduction by 2040 and positioning Nigeria as a hydrogen exporter by 2050. Infrastructure development—covering water treatment, electricity reliability, safety standards, and export logistics—is essential, alongside financial incentives such as subsidies or carbon pricing.

Ms. Fuerst stressed the critical need for workforce development, including technicians, engineers, and regulatory experts. Ongoing stakeholder engagements have already produced a draft policy and a three-phase implementation roadmap. She concluded by expressing confidence that Nigeria's strong solar resources, growing political commitment, and international partnerships position it well to build a competitive hydrogen industry.

5. Presentation of the GIZ PDP Green Ammonia Value Chain Study

Delivered by Mr. Michael Boateng, Managing Director, Blue Alliance

Mr. Michael Boateng delivered a comprehensive presentation on the GIZ PDP Green Ammonia Value Chain Study, examining Ghana's potential for green hydrogen and green ammonia production, their market opportunities, cost implications, and relevance to the wider energy transition. He began by outlining how green ammonia is produced: renewable electricity powers electrolysis to split water into hydrogen and oxygen, and hydrogen is then combined with nitrogen via the Haber–Bosch process. He emphasized hydrogen's broad applications across clean energy systems, referring to the "Power-to-X" concept, which allows hydrogen to be converted into multiple industrial products.

Discussing Ghana's context, Mr. Boateng highlighted the country's advantageous location in West Africa and its strong agricultural and mining sectors, both of which rely on fertilizer and explosives. While Ghana's fertilizer market is dominated by NPK blends, demand for ammonia-based products is expected to grow as agriculture and mining expand. The study projects national ammonia demand reaching 0.55 million tonnes by 2030, and 1.3–1.4 million tonnes by 2050, despite gaps in national statistics. He further noted ammonia's importance in mining and its export potential across Africa.

Figure 3. H2 Diplo Nigeria Presentation

Mr. Boateng compared Ghana's prospects with global trends, particularly Germany's use of ammonia in industrial processes. With global decarbonization accelerating, early adopters of green hydrogen stand to gain competitive advantages.

However, he underscored major challenges: Ghana lacks large-scale hydrogen infrastructure, coordinated policy frameworks, and sufficient renewable energy volume for industrial-scale production. High capital costs, taxes, and import duties also hamper investment. The study estimates that USD 11 billion would be needed to develop a competitive green hydrogen and ammonia industry.

He concluded by reinforcing the alignment between global clean-energy trends and Ghana's future needs, affirming the strategic importance of hydrogen and ammonia in upcoming industrial systems.

Figure 4. GIZ PDP Green Ammonia Value Chain Study Presentation

6. Panel Discussion: Green Hydrogen Policy Integration and Market Potential

The panel discussion, moderated by Ing. Louis Osei of the Project Development Programme (PDP) under the German Energy Solutions Initiative, brought together key experts to examine Ghana's emerging opportunities in green hydrogen and green ammonia. Panellists included Mr. Julius Nkansah-Nyarko (Energy Commission), Mr. Benjamin Struss (PDP), Mr. Eric Yankah (Enertrag Ghana), and Mr. Michele Velenderic (Green Power Brains). Their dialogue cantered on policy integration, technical and operational challenges, market readiness, workforce development, and long-term industrial potential.

Introduction and Objectives

Ing. Louis Osei opened the session by explaining PDP's overarching mission: to support renewable energy, energy efficiency, and hydrogen-related project development in Ghana. He emphasized that the discussion aimed to provide attendees with a comprehensive

understanding of green hydrogen technologies—their production, cost structures, regulatory implications, and practical applications across industry, transportation, and export-oriented value chains.

Understanding Green Hydrogen & Green Ammonia

Panellists began by outlining the fundamental processes behind green hydrogen production. Mr. Struss explained that green hydrogen is produced through electrolysis, which uses renewable energy from solar, wind, or hydro sources to split water into hydrogen and oxygen. When hydrogen is combined with nitrogen via the Haber-Bosch process, it forms green ammonia, a vital input for fertilizer production and various industrial applications.

Struss and Mr. Yankah stressed that hydrogen and ammonia qualify as "green" only if renewable electricity powers the entire production chain. They noted that Ghana's deployment of electrolysis technology faces challenges tied to local climatic conditions, especially the intermittency of solar and wind resources.

Technical and Operational Challenges

Yankah elaborated on Ghana's operational constraints. Electrolysers can operate optimally for only about eight hours per day due to renewable intermittency, which significantly reduces hydrogen output and increases production costs. The capital-intensive nature of hydrogen systems—especially electrolysers and storage—further complicates early-stage deployment.

Water availability, though sufficient nationally, requires careful management. Filtration and purification systems are essential when using river or non-potable water sources. The panel also introduced the idea of "shades of green," explaining that the environmental footprint varies depending on the renewable source and timing of electricity production.

Market Potential and Economic Considerations

Turning to economic feasibility, panellists acknowledged that green hydrogen in Ghana currently remains expensive, with early production costs estimated at $15/kg, much higher than the $3–$5/kg seen in markets benefiting from strong subsidies. This cost barrier limits domestic industrial uptake in the near term.

Given this, initial demand is expected to come from export markets, primarily Europe, where incentives for green products exist. Panellists identified potential local applications in fertilizer production, food processing, pharmaceuticals, and chemicals. Mr. Velenderic highlighted the importance of strong domestic and international partnerships to unlock investment, strengthen technical capacity, and facilitate market entry.

Policy and Regulatory Framework

Mr. Nkansah-Nyarko addressed Ghana's evolving policy environment. The Energy Commission, alongside other agencies such as the Ministry of Energy and the Ministry of Transport, is working to align national strategies with global best practices. Key policy measures include promoting local content participation, regulatory oversight for hydrogen projects, and integrating green hydrogen into future low-emission transport systems.

He emphasized the government's commitment to ensuring local equity participation, requiring investors to partner with Ghanaian entities and support human-capital development.

Opportunities for Youth & Capacity Development

A major theme throughout the discussion was the urgent need for capacity building. The panel stressed that Ghana will require a new generation of engineers, technicians, safety specialists, project managers, and financial experts to support the hydrogen sector. They encouraged young professionals to begin training early, noting that the long-term growth of hydrogen-based industries presents significant career opportunities.

Resource and Infrastructure Considerations

Panelists discussed resource requirements, noting that electrolysis needs roughly nine liters of water per kilogram of hydrogen. Ghana has adequate water resources for pilot and small-scale deployment, provided proper purification systems are used. Infrastructure—particularly for hydrogen storage and electricity storage—remains one of the most capital-intensive components and will require strategic site selection to optimize solar and wind yields.

Industrial Uptake & Export Readiness

Panelists agreed that Ghana's hydrogen sector is still nascent. Local demand remains limited, and early commercialization will depend on exports and strategic partnerships with international investors and technology providers. Target sectors include fertilizer production, pharmaceuticals, and food processing.

Key Takeaways

The discussion concluded with these main messages:

- Technical feasibility exists but is constrained by limited renewable hours and high costs.
- Economic viability will depend on subsidies, exports, and economies of scale.
- Policy integration is advancing, with strong emphasis on local participation.
- Human capital development is essential for scaling the sector.
- Collaboration (local and international) is critical for success.

The session ended with active networking among participants leading to the Networking event at the EU Ambassador's residence, reinforcing momentum for Ghana's green hydrogen journey.

Figure 5. Panel Discussion on green hydrogen Potential in Ghana

7. Networking Evening

After the various discussions at the Green Hydrogen Conference, the networking evening was hosted at the EU Ambassador's residence. Following welcome remarks by high-ranking dignitaries such as the German Ambassador and EU Ambassador, stakeholders from the conference mostly from the Ghanaian and Nigerian Energy Sector (such as development partners, project developers, solar companies and consulting companies) engaged in informal networking in a cocktail setting. The welcoming words from the German and EU Ambassadors underscored a unified commitment to a carbon-neutral future. Speakers from the conference including members of the working group (Don Bosco, Green Power Brains, Hochschule Bochum) were also invited to participate in the evening event. With the intellectual groundwork laid by the conference speakers and the personal connections forged during the evening, Ghana's green hydrogen economy received more momentum.

Figure 6. Welcome Remarks by German Ambassador at Cocktail Networking Event