



Republic of Namibia

GH2 Namibia PTX Pilot Projects Programme

Traction

Namibia's Green Hydrogen Overview

Annexure A

Draft Rev 1

20 Aug 2022



With its abundant, world-class renewable energy resources and increasing demand for green hydrogen worldwide, Namibia could be an early entrant in this new market.

Harambee Prosperity Plan II



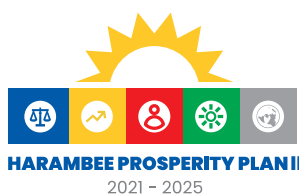
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GH2 Namibia PTX Pilot Projects Programme

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Background

In line with the goals of the Paris Agreement, the Government of the Republic of Namibia is pursuing the long-term goal of climate neutrality. With the updated Nationally Determined Contributions (NDCs), Namibia aims to reach carbon neutrality by 2050, and to further become a global net exporter and hub to produce Green Hydrogen and its derivatives.

In Namibia's view, only hydrogen produced using renewable energy sources – namely, Green Hydrogen – is sustainable in the long term. For this reason, the goal of the Namibian Government is to develop Green Hydrogen production capacities, promote a rapid market ramp-up and establish the corresponding value chains –both nationally and internationally. This will support local markets and local decarbonisation efforts, while generating employment for the Namibian people. As such, developing a Green Hydrogen industry will result in long-term pathways for economic recovery. As such, this pilot plant programme is linked to the ambitions articulated in the Harambee Prosperity Plan (HPPII).

Namibia has established a Green Hydrogen Partnership with Germany. The Namibian Government and the German Federal Ministry of Education and Research signed a Joint Communiqué of Intent (JCOI) which reserves funding for bilateral domestic Green Hydrogen pilot projects that are grounded in research.

This annexure is therefore a summary of the Namibian companies/institutions, in partnership with German companies/ institutions, that have been successfully selected for the available 30 million Euro grant funding.

Objectives of the programme

The grants provided under this directive are aimed at promoting international collaboration in the field of Green Hydrogen and its derivatives. With a specific focus on storage, transport, and the use of integrated application technologies. Therefore, the objectives of the grant funding programme are:

- i. to provide support for the necessary market ramp-up for Green Hydrogen industry;

- ii. to facilitate the creation of an international market for Namibian Green Hydrogen products through international partnerships;
- iii. to promote the research and development of the Green Hydrogen industry; and
- iv. to facilitate the creation of local employment in the Green Hydrogen industry.

Funding Guidelines

The funding arrangement will comprise of two modules:

Module 1: Projects

- Module 1 will fund companies/institutions that are systematically developing and promoting the sustainable production of Green Hydrogen and its derivatives. This includes projects dealing with the production, storage, transport and the integrated use of Green Hydrogen and its derivatives. This includes integrated projects that cover several value-added steps.
- Funding will be provided for technologies that make a decisive contribution to an early market ramp-up as well as preparatory or accompanying development, where applicable.

Module 2: Research Projects

- Module 2 will fund research projects that are designed to accompany projects funded in Module 1. This includes preparatory or accompanying research like material development, simulations, modeling, scientific analyses, and studies.

The PTX Pilot Projects

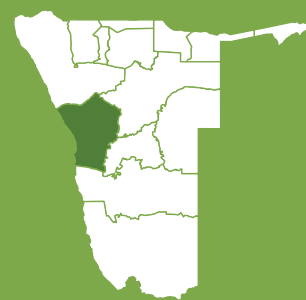
Pilot Project Profiles



Project 1

GH2 Namibia PTX Pilot Projects Programme

Project Name	Green Hydrogen Applications in the Port Environment
Location	Walvis Bay Port
Project Size	5 MW Electrolyser and H2 mobile refueller (945kg at 500bar)
Project Value	5.66 million EUROS
Project Partners	Cleanergy Solutions Namibia, CMB Germany GmbH & Co. KG, and Namport, UNAM



Project Overview

This demonstration project is an initiative of Cleanergy Solutions Namibia, CMB Germany GmbH & Co. KG and Namport to decarbonize port-logistics, reduce the port's carbon footprint, and use alternative fuels, i.e., hydrogen, which allows port operations to transition to low carbon operations. This will enable an ecosystem, built around Green Hydrogen. This project accelerates the adoption of hydrogen applications within Namibia, by tackling both the refueling infrastructure, and providing captive usage of hydrogen.

This will be the first application to use hydrogen as a fuel in Namibia. This project will be the first African port project to implement hydrogen powered tugboats and heavy-duty port equipment, as well as being the first port in Africa to supply green hydrogen for bunkering vessels and refueling equipment.

The project aims to boost the transition of the international port industry toward a low carbon and safe operation model. The main objective of this project is to demonstrate port a equipped with hydrogen technology, using locally produced Green Hydrogen as an energy independent, and low-cost fuel via innovative, and cost-effective solutions that will be ready for market adoption by the end of the project. The benefit of this project is directly linked to the Harambee Prosperity plan II.

The following are strategic targets of this project, which will be realized by Cleanergy Namibia & CMB Germany GmbH & Co. KG with support from Namport:

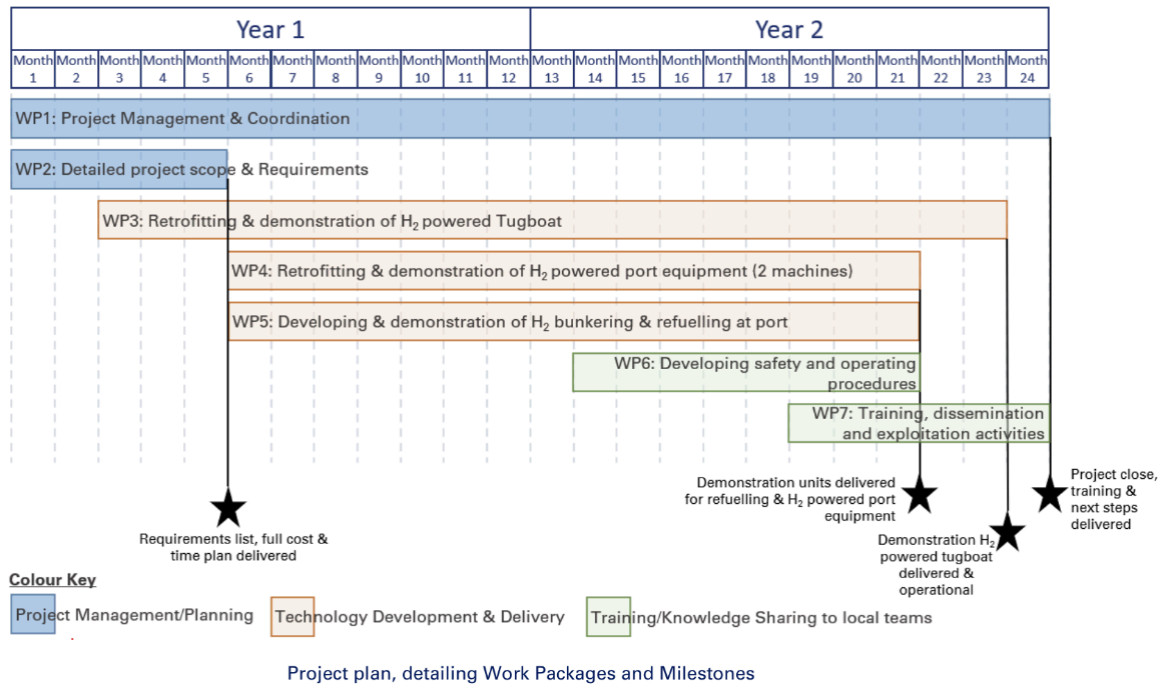
- To convert an existing tugboat to operate on hydrogen dual fuel technology
- To convert existing port equipment to operate on hydrogen dual fuel technology
- To develop Green Hydrogen bunkering and refueling infrastructure at the port
- To develop safety and operation procedures for use of hydrogen at ports
- To elevate the Germany-Namibia partnership, covering the whole value chain for Green Hydrogen and to promote the technological solutions proposed
- To increase public awareness towards Green Hydrogen
- To up-skill local work force to operate, service and repair hydrogen equipment
- To disseminate the project learnings through local educational institutes and publishing articles

Current Stage

Early feasibility is already performed showing the potential to use Green Hydrogen on port equipment.

Discussion ongoing with Namport and other port users for converting existing equipment into dual fuel systems.

Development Timeline (split per quarter)



Impact

Estimate no. Of jobs	Not Indicated
Unique Value	Transport - hydrogen usage at a port

Sustainable Development Goals (SDGs)



Contact Details

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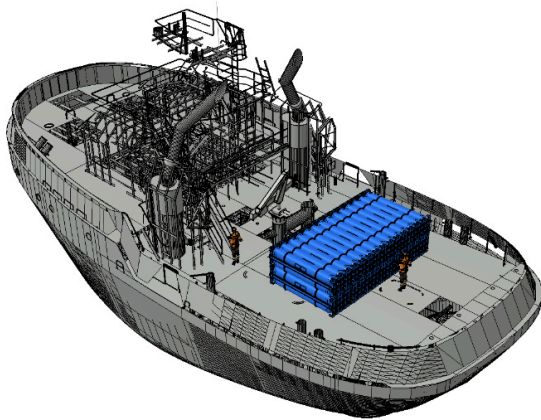
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Project Pictures



Feasibility to install 400kg H₂ storage at aft deck



Photo of Onkoshi, DAMEN ASD 2910 tugboat, taken on 30/03/22 at the Port of Walvis Bay

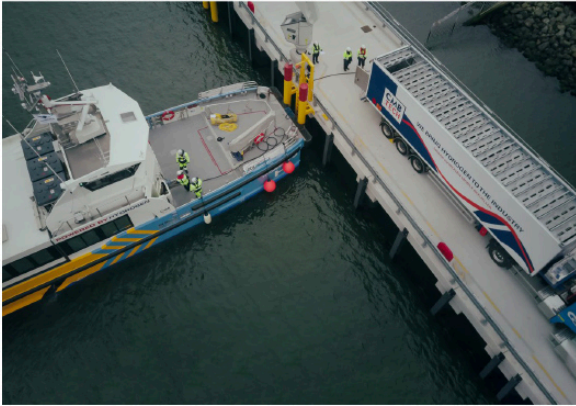


SPECIFICATION	
ENGINES	- MEDIUM SPEED BEHYDRO ENGINES
POWER	- 2X 2MW
H ₂ STORAGE	- 400KG
H ₂ PRESSURE	- 35MPa
CERTIFIED BOLLARD PULL AHEAD	- 65 TONNES
GROSSTONNAGE	- >500GT
AFTERTREATMENT	- EU STAGE V (SCR + PDF)



Examples of a port equipment operated in Walvis Bay which could be retrofitted with dual fuel technology

Project Pictures



CMB.TECH H2 tube trailer bunkering Hydrocat (H₂ dual fuel crew transfer vessel)

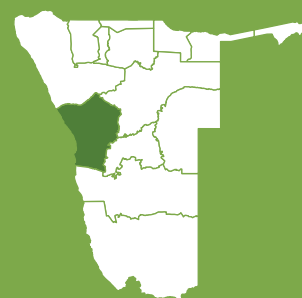


Hydrogen tube trailer bunkering/refuelling panel

The visualisation below shows the shore side mobile H₂ refueller with dual fuel truck alongside H₂ dual fuel port equipment (straddle carrier & gantry) as well as H₂ dual fuel tugboat:



Project Name	Hydrogen-Diesel Dual Fuel Locomotive Pilot Project Proposal for Namibia with Supporting Research Projects
Location	Walvis Bay to Kranzberg corridor in Namibia, through TransNamib
Project Size	50 locomotive fleet conversion to GH2 dual fuel
Project Value	7.63 million EURO
Project Partners	CMB.TECH, UNAM, Hyphen Technical, TransNamib, NGHRI, Nicholas Holding



Project Overview

The railways are a major consumer of energy in Namibia. Almost 11 million litres of diesel are consumed annually in this industry. With the TransNamib fleet due for an upgrade and upgrade funding being more readily at hand, an opportunity has arisen to combine the efforts in the Green Hydrogen Namibia drive by government with the railway sector in Namibia and implement a hydrogen off-take development project in one of the key industry sectors in the country. Thus, the idea of a hydrogen powered locomotive, using Namibian produced Green Hydrogen, took shape, and was proposed here.

This project aims to develop the first H2 Dual Fuel Locomotive (diesel-H2) in Africa. It builds on existing Green Hydrogen production and supply projects in Namibia, to create local off-take for the Green Hydrogen to be produced in the Western part of Namibia. This will be done through the utilization of Green Hydrogen in locomotives. Therefore, the project will consist of two converted locomotives (one retrofitted and the other re-powered) and their accompanying hydrogen fuel tender wagon and accessories.

The following major components to be developed, implemented during the course of the project to achieve the project goal:

1. 1x Locomotive converted for the use of H2 as fuel, using supervisory control methodology on the existing engine.
2. 1x Locomotive converted for the use of H2 as fuel, through repowering of the locomotive with a new rail engine that is H2-ready.

3. 2x H2 Valve Bank close to each locomotive engine with control valves, actuators, gauges, sensors, relief valves and cut off valves
4. 1x H2 fuel tender car, a modified flat-bed container wagon for transporting the 40ft, half height H2 fuel skids.
5. 2x 40ft half-height tube skids, with 8x Type 1 steel cylinder searchable to store H2 as compressed gas at > 200 bar.
6. Inter-vehicular connection for H2 fuel tender wagon

The project activities would include:

- Design and engineering, systems engineering
- Installation, modification, and assembly of components to vehicles
- Testing and commissioning of systems individually and on vehicles
- Homologation of locomotive consist
- In-service operation of the consist

Once these components have been designed, built, and assembled and tested individually, they will be combined as a system and tested collectively before being used as a unit to pull a train in-service. The planned location of the building and assembly of the locomotive and the consist will be Traxtion Rail Hub, Rosslyn, South Africa. The planned location of operational service of the locomotive will be the Walvis Bay to Kranzberg corridor in Namibia, through TransNamib.

Current Stage

- Concept

Development Timeline

Task / Activity	Duration	Timeline
Feasibility and Concept	1 Month	1 June 2022* - 1 July 2022
Mobilisation	1 Month	1 July 2022 - 1 August 2022
Design	3 Months	1 August 2022 - 1 November 2022
Building and Integrate Locomotive	3 Months	1 November 2022 - 1 February 2023
Test and Commission Locomotive	2 Months	1 February 2023 - 1 April 2023
Assemble Consist and Integrate to Locomotives	3 Months	1 April 2023 - 1 May 2023
Test and Commission Consist	1 Month	1 May 2023 - 1 June 2023
Dynamic Test and Commission of Consist	3 Months	1 June 2023 - 1 September 2023
In-Service Operation of Consist	3 Months	1 September 2023 - 1 Dec 2023
Total Consecutive time	18 Months	1 June 2022 - 1 December 2023

*Projected start date

Impact

Estimate no. Of jobs	Estimate no. of jobs: 10 – 15 direct jobs. For a 50 locomotive fleet conversion to GH2 dual fuel operation, the total future that this project can create in its roll-out phase is estimated to be 36 direct jobs and 160 indirect jobs, a total of almost 200 skilled jobs.
Unique Value	Hydrogen locomotives

Sustainable Development Goals (SDGs)



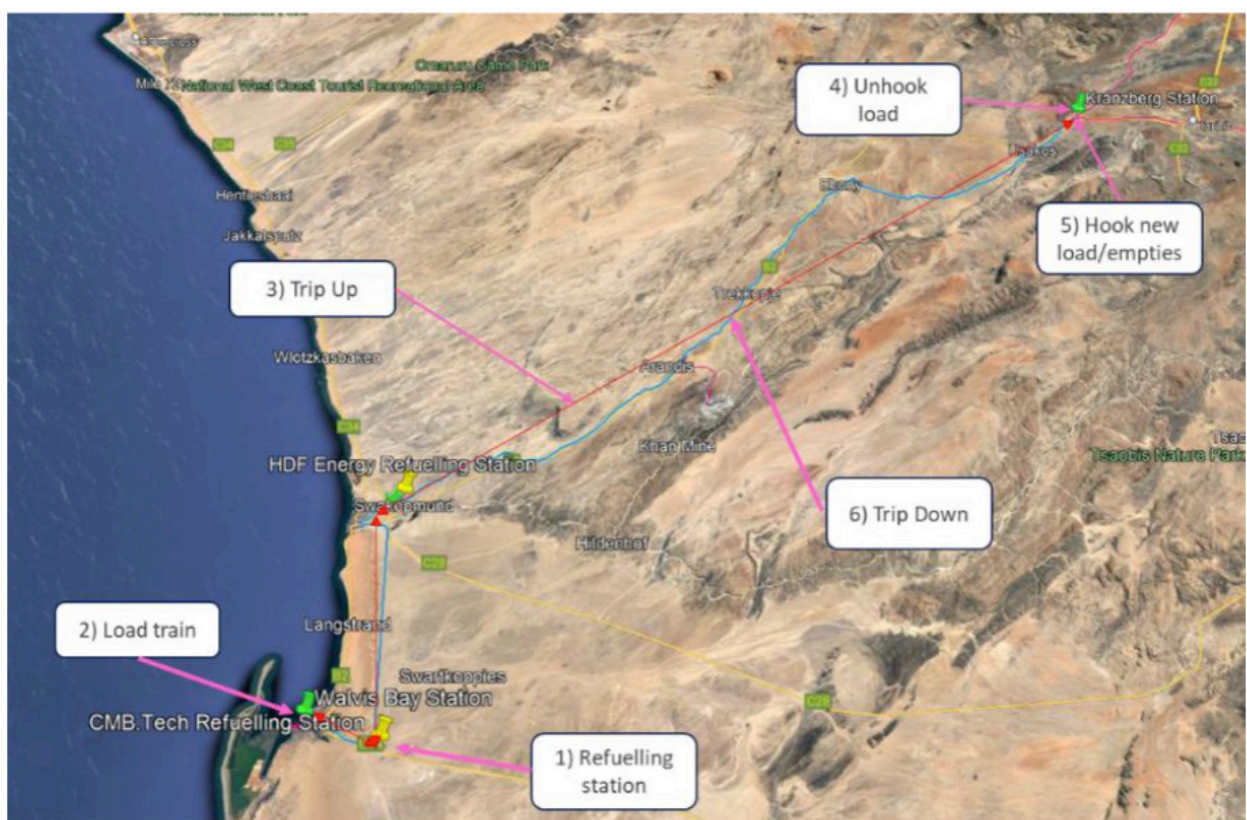
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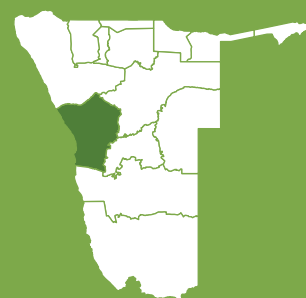
Project Pictures



Figure 3: Locomotive consist concept for the H2 DF Locomotive project



Project Name	Daures Green Village
Location	Erongo Region, Daures Constituency about 20km from Uis and 234km from Swakopmund
Project Size	Pilot phase producing 500kg of Anhydrous Ammonia per day. Subsequent phases with 350,000 tons of ammonia production per year
Project Value	15,1 million EURO (Phase 1)
Project Partners	Enersense Energy Namibia, Windwise, University of Stuttgart, NGHRI (UNAM) and various other providers



Project Overview

This project intends to develop Africa’s first Green Village that profiles Hydrogen use cases and interrogates the feasibility of the village on a semi-industrial scale. The project will be executed in a phased approach as follows:

- Phase 1 and 2:** Focusing proof of concept of production of green hydrogen and Anhydrous Ammonia as an efficient and widely used source of nitrogen fertilizer in agricultural green schemes.
- Phase 3 and 4:** Will focus on providing an industrial level production for local consumption and international export

The project will be based in the Daures Constituency in Uis in the Erongo region, where more than 30,000 hectares of land has been availed. Uis as a settlement provides significant opportunity for green hydrogen and green ammonia use. The presence of the Uis tin mine provides a potential commercial aspect and mining-industry decarbonization use case.

The Daure Green Village will be a first step to a larger Namibian research centre. The consortium commits that this project will ensure skill transfer and the development of a Namibian hydrogen value chain, both locally and internationally. The project consists of a Module 1 and 2 components.

Module 1 will realize the production of green hydrogen and anhydrous ammonia (NH₃) with various use cases, particularly focusing on the following:

- Sustainable production of green hydrogen based on renewable energies,
- Establish a green scheme program to be used by the local community making use of ammonia-based fertilizer
- Storage and transport of green hydrogen and green ammonia
- Integrated application technologies for the utilization of green hydrogen in agriculture, ammonia nitrate and cleaning detergents
- 5 no. 2.5 ha Center pivots powered by solar and Fuel Cells
- 15 no. 2 bedroom houses powered by solar and Fuel Cells
- Training center and warehousing powered by solar and Fuel Cells
- Solar and Fuel cell powered boreholes
- Complete off grid green Village
- Other site equipment powered by fuel cells

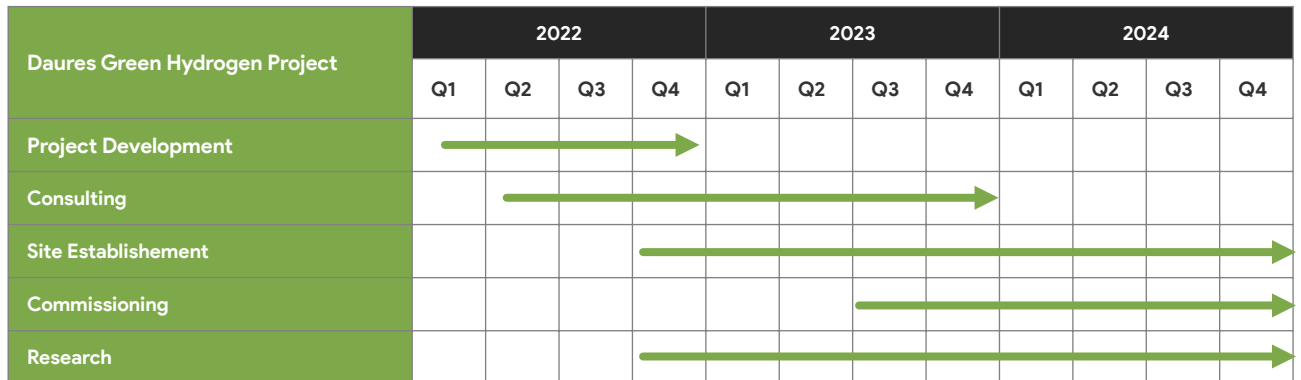
Module 2 will ensure the following developments, to ensure capacity building through education and research:

1. Research and collaboration on ammonia plant assembly
2. Research into fuel cell technology and multi-use-cases
3. Ammonia transportation with options to export to Zambia or Zimbabwe
4. Pilot use of Anhydrous Ammonia for Green Schemes in Namibia
5. Conversion of 2 no. Agriculture Tractors to Ammonia generator or Fuel cell tractors
6. Conversion of 10 no. 5kva Generators to Ammonia generators

Current Stage

- Solar energy yield assessment has been completed by Solargis (Direct Normal Irradiation of 2902) Long-term average yearly values calculated from time series (TS) representing 28 complete calendar years (1994-2021):
- wind energy yield assessment commissioned by GeoNet.
- EIA screening report completed with formal EIA to commence in August 2022.

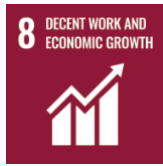
Development Timeline



Impact

Estimate no. of jobs	Pilot phase one will provide 20 to 30 jobs
No. of university interns	10 for 2 years
Unique Value	<ul style="list-style-type: none"> • Production of green hydrogen and Anhydrous ammonia (NH3) • Unlocking community-based agriculture with green hydrogen and ammonia • Potential for industrial level of green hydrogen and ammonia production

Sustainable Development Goals (SDGs)



Contact Details

Daures Green Hydrogen Consortium

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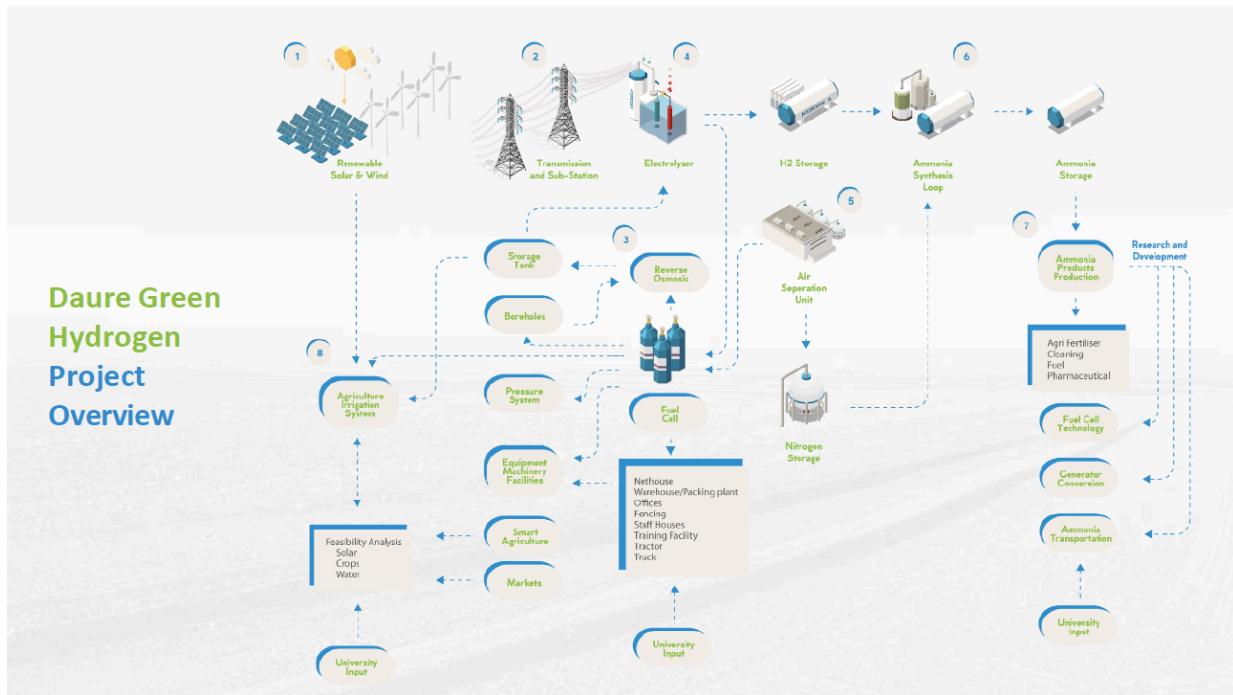
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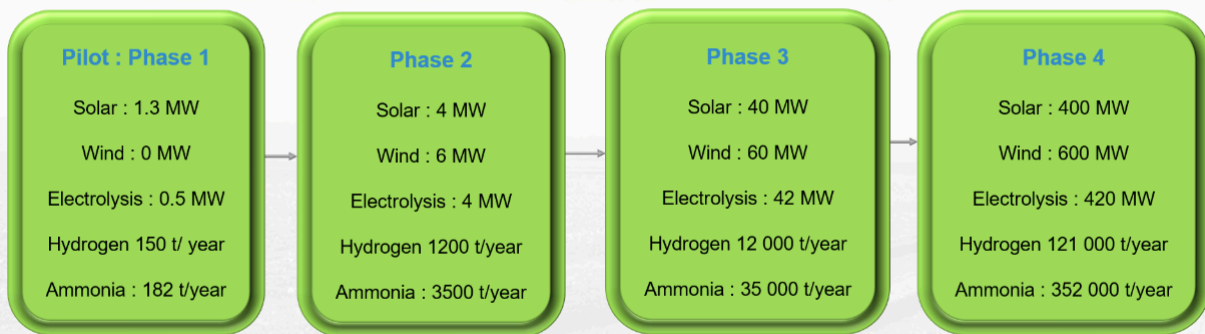
Project Pictures



Project Pictures

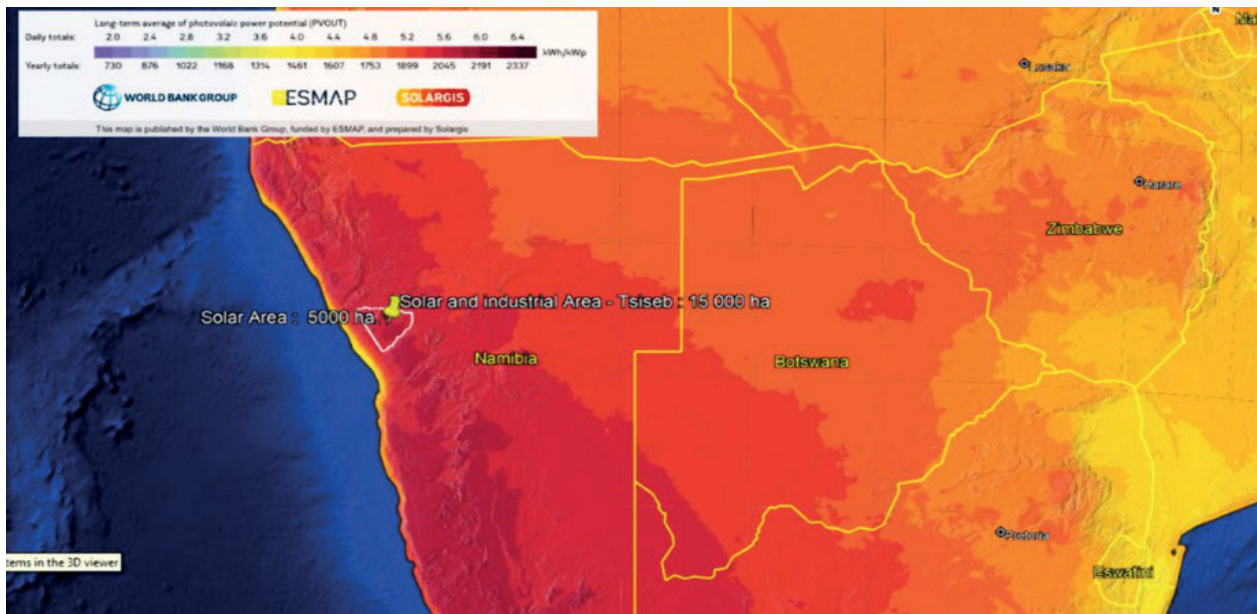
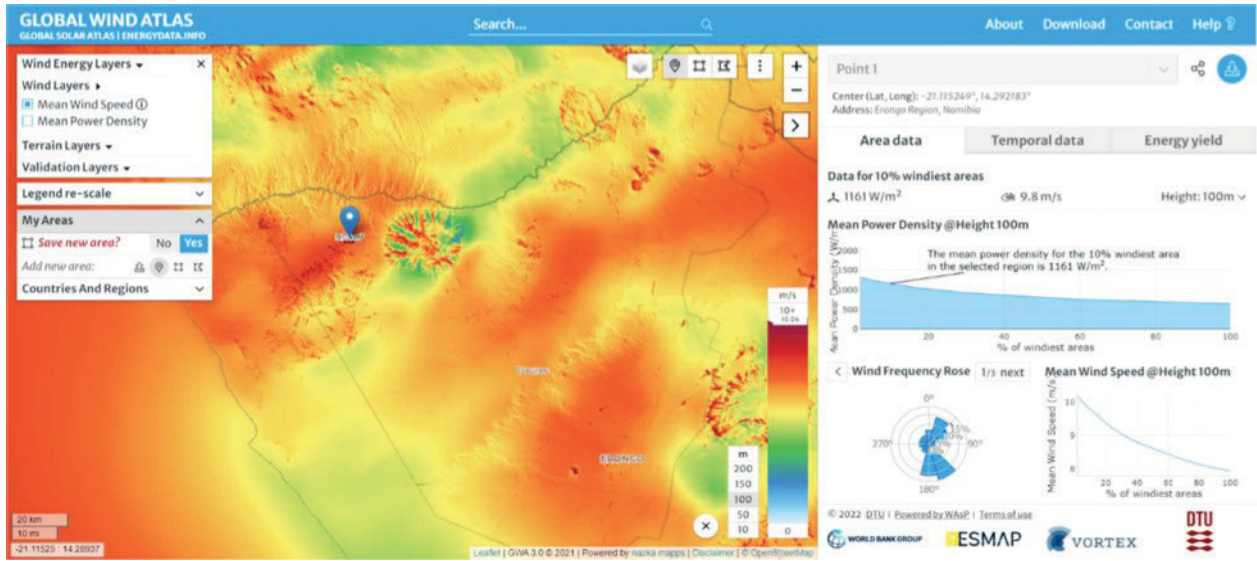


Daure Green Hydrogen Project Phasing

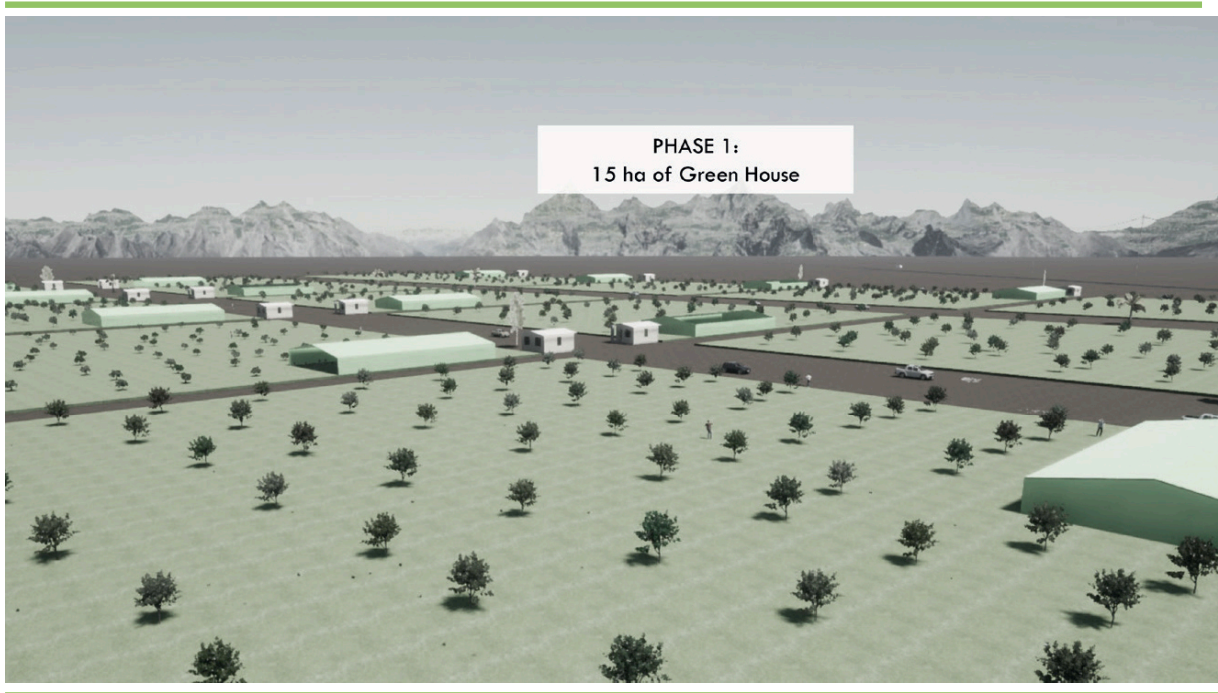


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Project Pictures



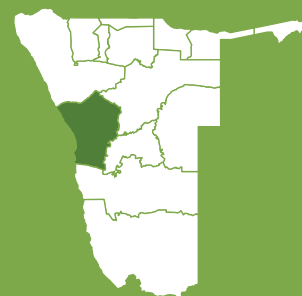
Project Pictures



Project 4

GH2 Namibia PTX Pilot Projects Programme

Project Name	H2-Pilot Plant / Refueling Station in Walvis Bay
Location	Walvis Bay
Project Size	5MW Electrolyser
Project Value	25 million EURO
Project Partners	CMB.TECH, Ohlthaver & List Group (JV = Cleanergy Solutions Namibia)



Project Overview

At the end of 2019, CMB.TECH started a project, called PV2Fuel, with the objective of producing ammonia at Gigawatt-scale. Feasibility studies were conducted which identified Namibia as one of the top 3 countries in the world with the best solar energy potential. The idea was to convert that energy into hydrogen and ammonia and create opportunities for the export of these products, the usage as a clean fuel and the conversion into green chemicals.

After performing an extended feasibility study in 2020, CMB.TECH partnered with Ohlthaver & List to continue the project. A Joint Venture "Cleanergy Namibia" has been founded to develop the project.

Cleanergy Namibia secured a land agreement for an area of 116 ha at the Port of Walvis Bay, to develop an ammonia factory including the required exporting facilities. The harbor site will be connected to a Gigawatt-scale solar park in Arandis, where the solar irradiation is one of the best worldwide. The project will start with a pilot project.

The plant will be situated near the airport of Walvis Bay and will consist of a 5 MW photovoltaic solar system, a 5 MW electrolyser and a H2-refuelling

station. The purpose of the plant is to test technologies, to develop offtake applications within the transport sector, mining sector and port activities and to facilitate technology transfer and skills development into Namibia. As such, the pilot plant will be used to establish a proof of concept to the Namibian people and the world at large, that a Green Hydrogen economy can be built for future prosperity of Namibia.

Building upon the lessons learned with the pilot plant, a second phase with a bigger commercial plant including ammonia production is planned.

Current Stage

- Concept and designs being finalised
- EIA commenced
- Land identified (near Walvis Bay)

Development Timeline (split per quarter)

- **Concept:** Complete
- **Approvals:** Final investment decision May 2022
- **Groundbreaking:** 4th quarter 2022
- **Completion of pilot plant:** End 2023
- **Commercial plant:** 2026/7

Impact

Estimate no. Of jobs	25-50 (pilot plant); > 1000 commercial plant and related industry
Unique Value	<ul style="list-style-type: none"> • actual green hydrogen production • hydrogen fuel stations / mobile refueling technology • facilitation of upskilling/learning/research (cooperation with UNAM, BAM, NIMT and others) • development of offtake applications

Sustainable Development Goals (SDGs)



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Project Pictures

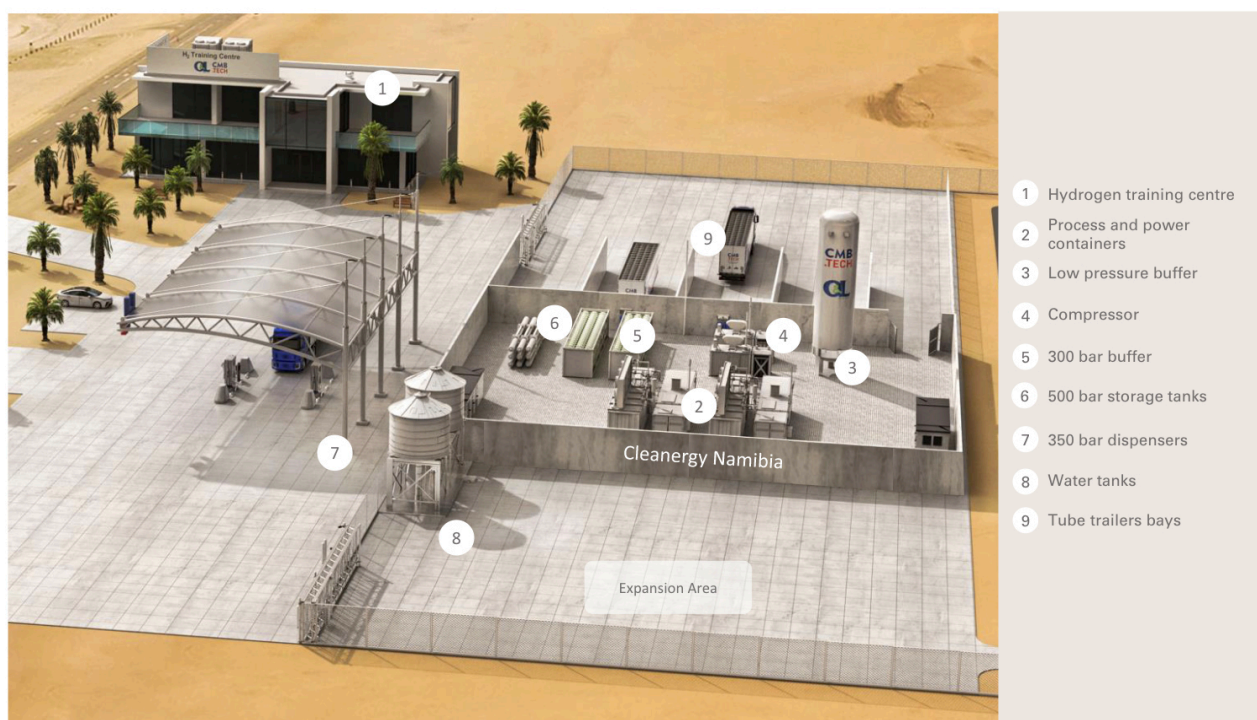
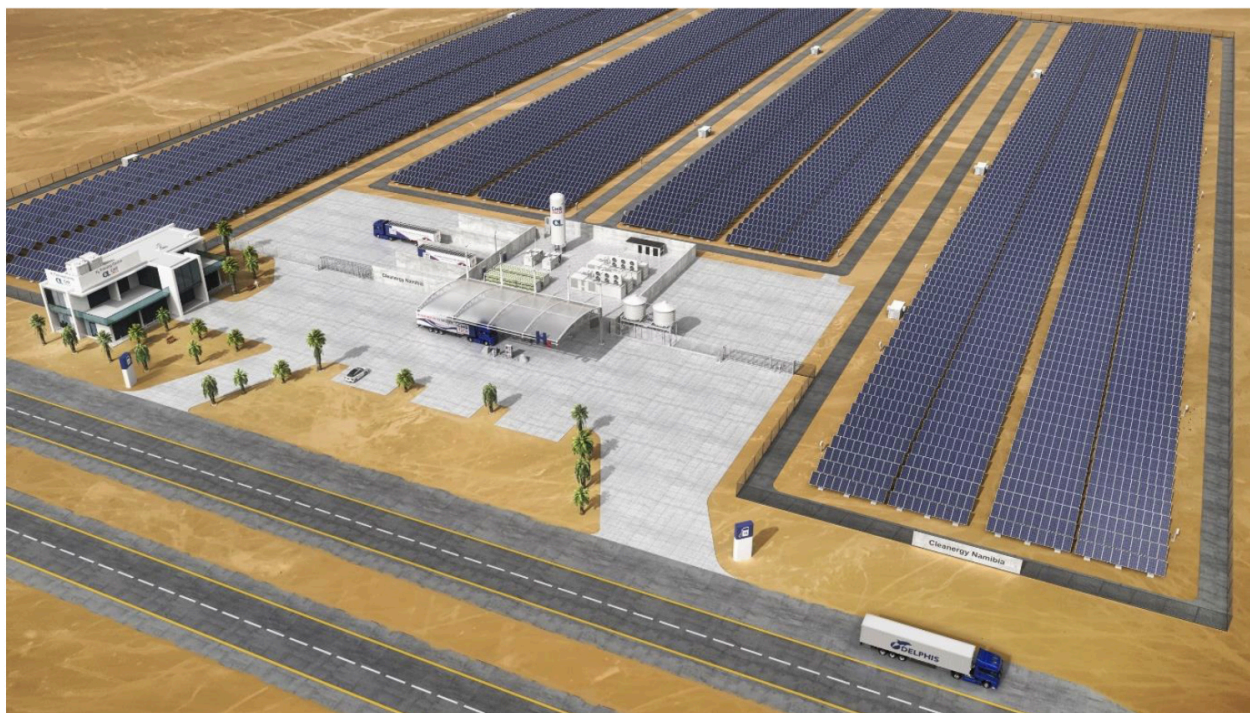


Figure 4: Hydrogen production zone



“Namibia’s world-class solar and wind resources give it a long-term competitive advantage in producing green hydrogen and green ammonia.”

The World Bank





Republic of Namibia

The Presidency

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