



HYDROGEN
ENERGY

HYPHEN

Southern Corridor Development Initiative

**NAMIBIAN GREEN HYDROGEN
ROADSHOW DISCUSSION DOCUMENT**

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Version 1.0



Quiver Trees – Konkerboom Woud, Keetmanshoop Namibia
(Andreas Glockner)

Opportunity for Namibia

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Green Hydrogen and the SCDI

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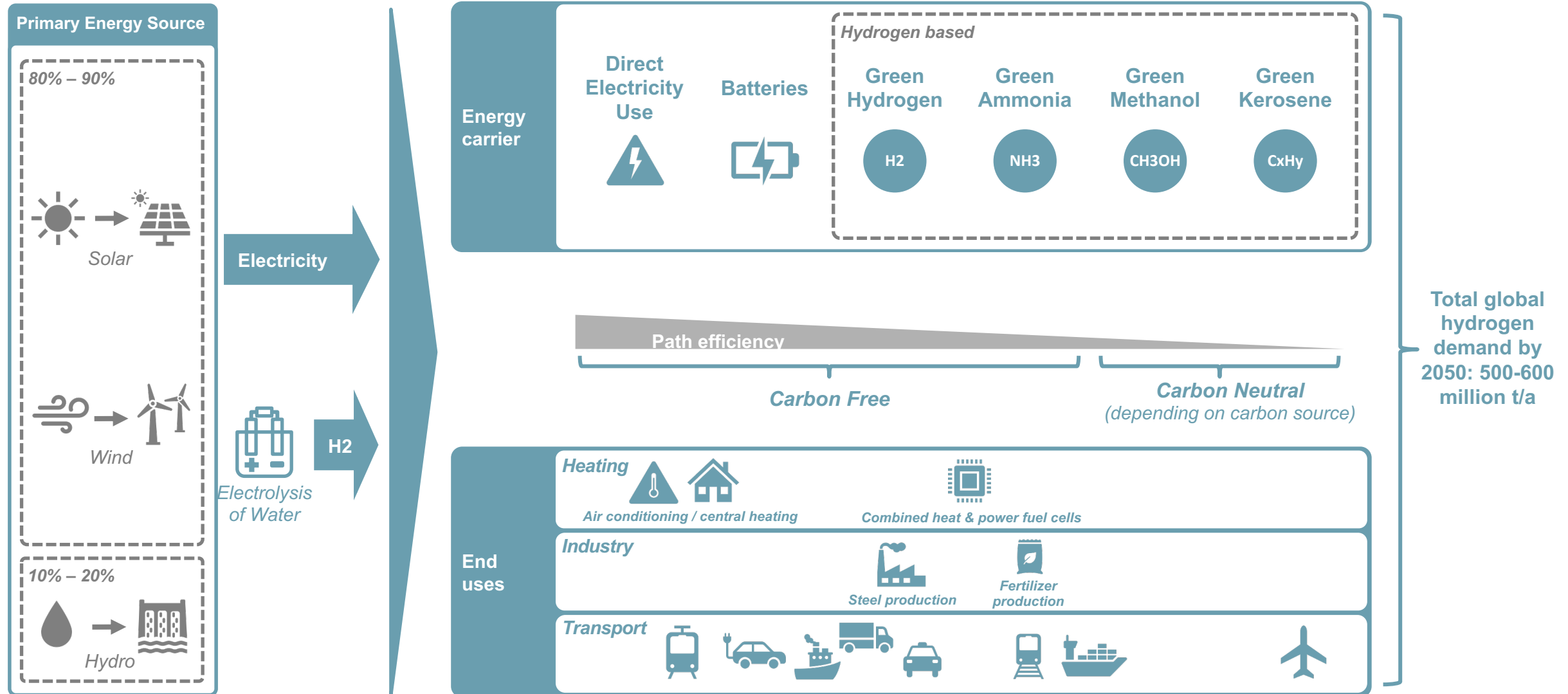
Partnering for success

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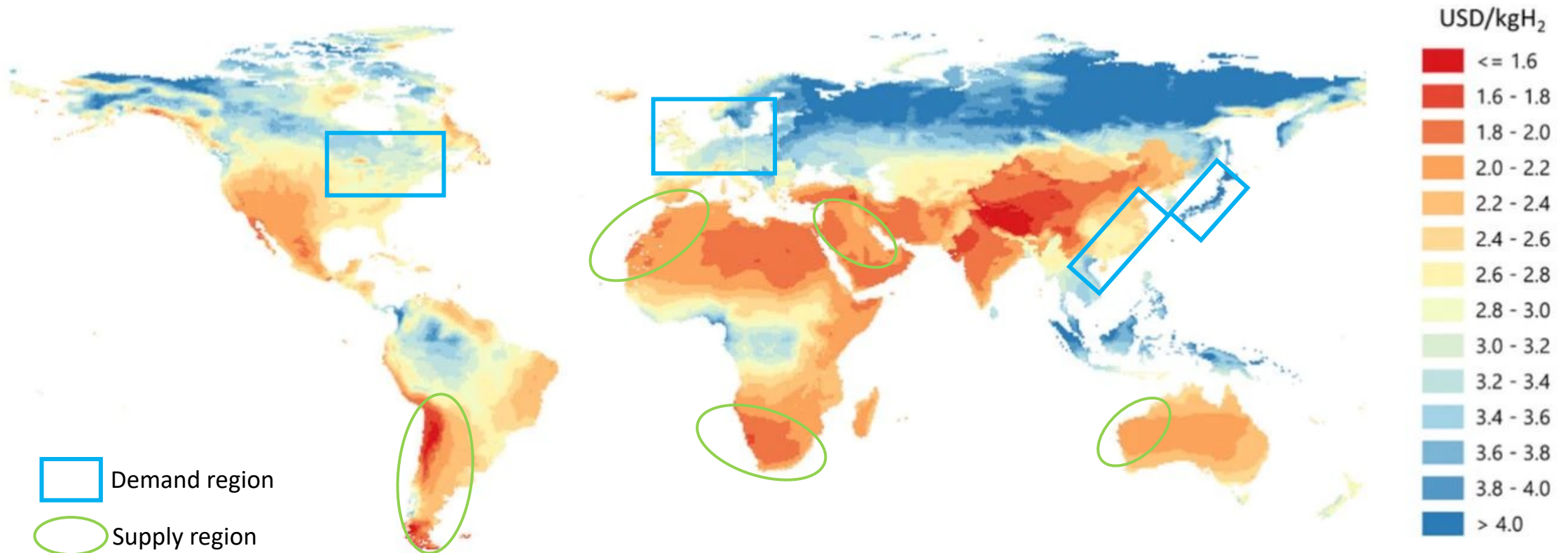


Oryx – Tsau // Khaeb National Park Namibia
(Alan Hendry)

Solar, Wind and Hydrogen = Future Energy System



Hydrogen costs from hybrid solar PV and onshore wind systems in the long term

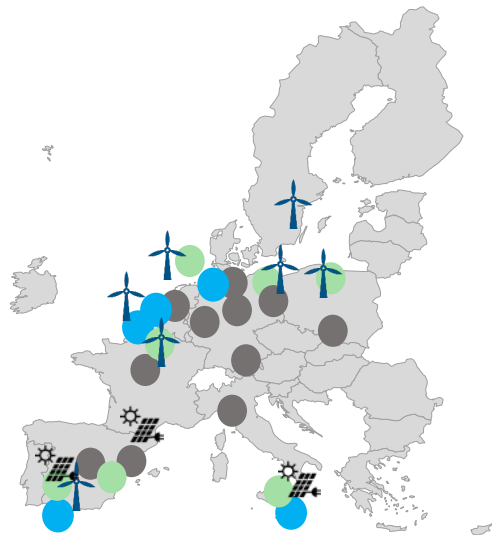


Namibia as a key supply hub for green-hydrogen products

Illustrative figure

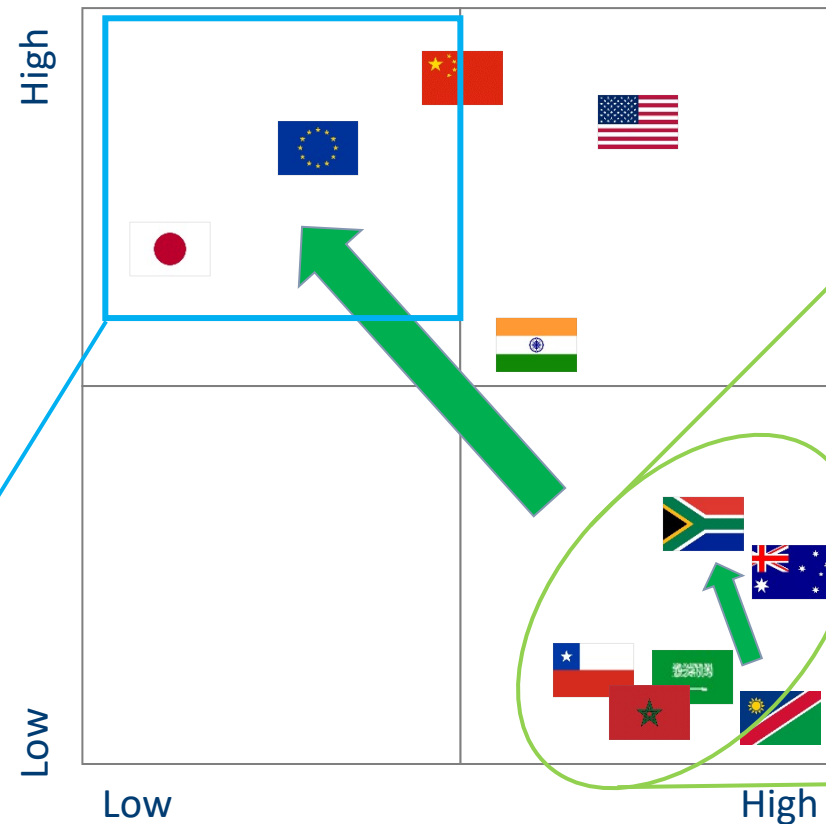


Import hubs



- Import hub
- Major off-taker
- Major production area

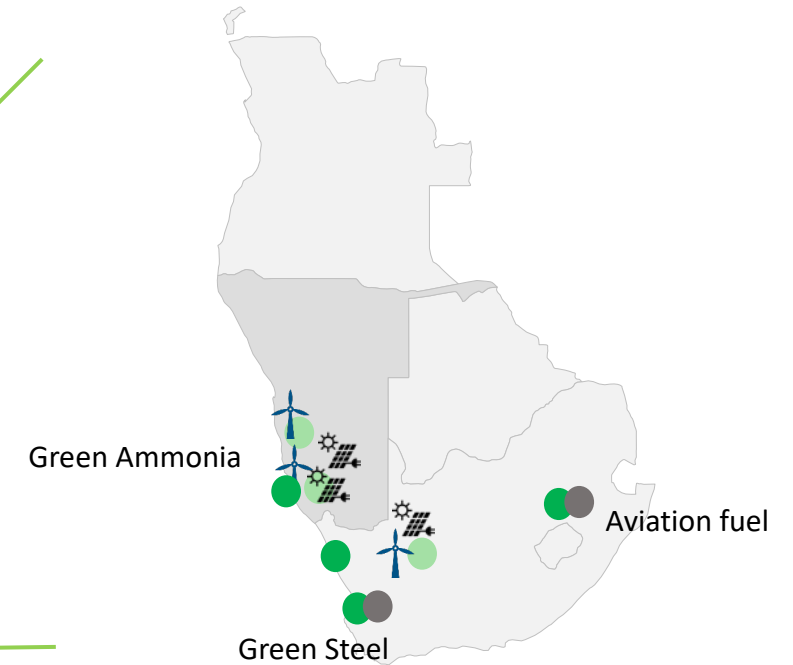
Hydrogen demand



Supply potential for low-cost hydrogen











Export hubs



- Export hub
- Major off-taker
- Major production area

> \$35 billion H2-based export potential for Namibia

	Composition	Use Case	Current Demand
 Green Ammonia	$H_2 + N_2 = NH_3$	Fertiliser 	Global demand: 170 Mt/a (H2: 30 Mt/a) Value ammonia: 100bn \$/a Namibian market share: 5% → 5bn \$/a export potential
 Green Methanol	$H_2 + CO_2 = CH_3OH$	Shipping Fuel 	Global demand: 500 Mt/a (H2: 90 Mt/a) Value ammonia: 300bn \$/a Namibian market share: 5% → 15bn \$/a export potential
 Green Steel	$H_2 + Fe_2O_3 = Fe + H_2O$	Zero Carbon Steel 	Global demand: 400 Mt/a (H2: 100 Mt/a) Value green H2: 150bn \$/a Namibian market share: 5% → 10bn \$/a export potential
 Green Kerosene	$H_2 + CO_2 = KEROSENE$	Aviation Fuel 	Global demand: 2 000 Mt/a (H2: 100 Mt/a) Value green H2: 150bn \$/a Namibian market share: 4% → 6bn \$/a export potential

Green-H₂ product requires >200,000 jobs in wind/solar alone



Potential End State

150 GW electrolyser

250 GW Wind/Solar PV

- 10 GW p.a. of new wind/solar PV and
- 5 GW p.a. electrolyser in perpetuity

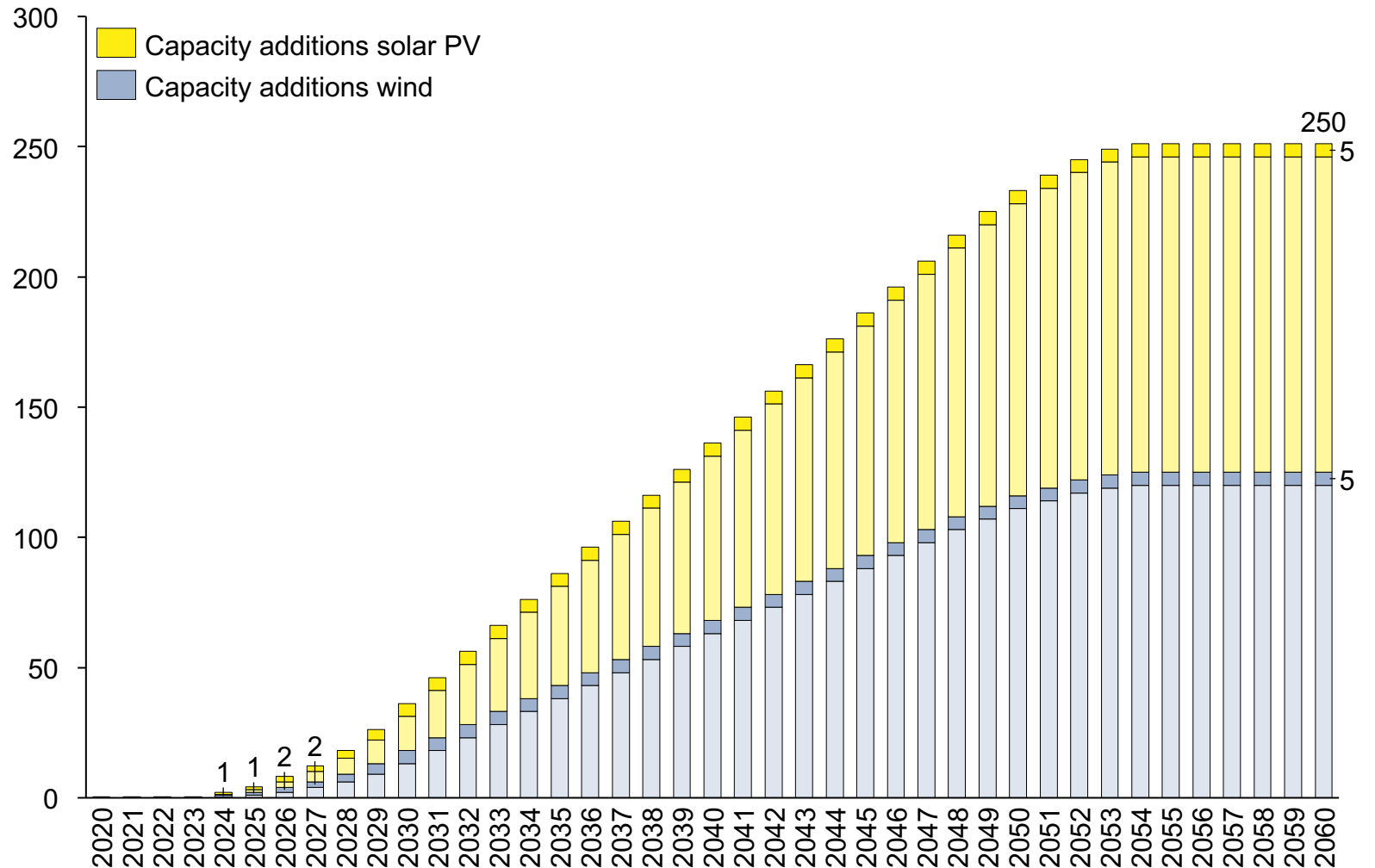
Namibia's domestic demand decarbonized in the 2020s

→ 10-15 Mt/a green-H₂-based export

→ > \$35 billion H₂-based export potential

→ > 200,000 permanent jobs

Total installed capacity in GW



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Tsau //Khaeb master plan – guiding principles



Minimising environmental impact - leveraging common user infrastructure to reduce environmental footprint and align to master planning, i.e. reducing need to build large transmission lines



Efficient infrastructure deployment - enable SCDI phase 1 and future projects to deliver lowest cost green H2. Bottom 25th percentile in the world cost curve delivered into Europe and potentially Asia



Common user infrastructure - enabling the sharing of CAPEX, economies of scale and paving the way for increased competition to the benefit of Namibia in subsequent SCDI land allocation rounds (ports, gas pipelines, water, electrical, other...)



Streamlining procurement – enabling faster, more robust, simpler and easier to assess future green H2 procurement rounds. i.e. technical requirements easier to define if based on a master plan end state



Supply-side risk mitigation – De-risking Namibia green H2 by creating multiple evacuation options through Port, rail and pipeline infrastructure



Regional integration – Strengthening of the Southern Africa Power Pool and broader economies through the supply of green electrons and molecules from the Tsau //Khaeb National Park into the SADC region

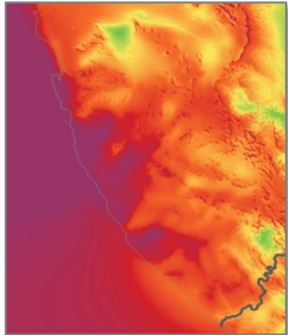


Sensitivity to park ecosystem – integration with the mining, tourism and community activities within the park and ensuring hydrogen / energy development minimises conflict as far as practically possible with existing stakeholder interests



Stakeholder alignment – Government, communities, Hyphen, and future developers all working towards a common master plan. Future developments would not be in competition with each other, rather future projects should build on the initial phases through partnerships / alignment, positioning Namibia as a major player in green hydrogen supply in the global economy

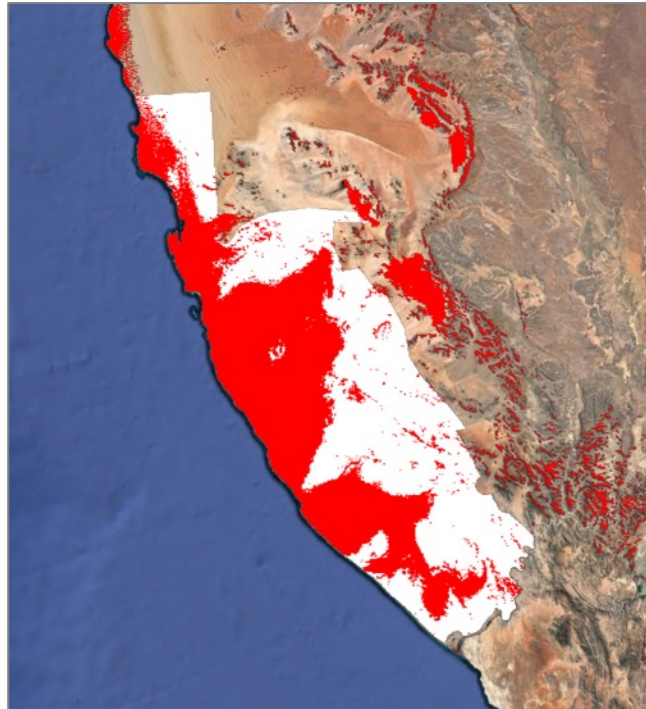
Optimal energy yield area



Global Wind Atlas



Global Solar Atlas (GHI)



Hyphen Calculation: Tsau / Khaeb National Park High Energy Yield Areas

- The Hyphen team have completed an initial desktop resource study on the high energy yield areas within the Tsau / Khaeb National Park

Environmental / Commercial Zoning Constraints



Tsau / Khaeb Park Zoning

- Managed Resource Use Zone
- Wildlife Management Zone
- Minimal Disturbance Zone
- Special Value Zone

Tsau / Khaeb Area Breakdown

Total Park Area (21,987 km ²)	
Managed Resource Use Zone (1,893 km ²)	8.6%
Wildlife Management Zone (10,140 km ²)	46.1%
Minimal Disturbance Zone (6,391 km ²)	29.1%
Special Value Zone (3,562 km ²)	16.2%

- The Hyphen team has used data from the Namibian Ministry of Environment and Tourism to create an environmental and commercial interests overlay to the Tsau / Khaeb National Park

Tsau //Khaeb proposed infrastructure end state (2050+)

Hydrogen Pipeline Backbone



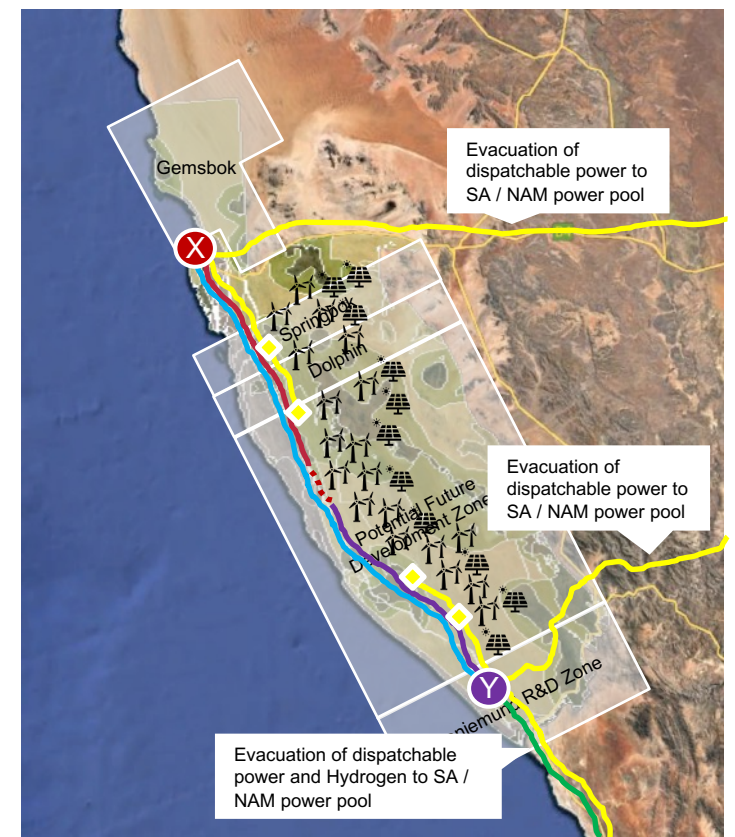
- A** Tsau //Khaeb H2 gas pipeline connecting Lüderitz and Oranjemund
- B** Namibia to South Africa regional pipeline connecting Oranjemund to Boegoebaai Port

Desalination & Water Pipeline Infrastructure



- X** Lüderitz desalination plant and pumpstation
- Y** Oranjemund desalination plant and pumpstation
- ▲** Offtake point **■** Line end

Fully developed Renewable Energy Capacity



- ◆** Combined power and Hydrogen facility
- Critical to minimising the environmental impact of the total development of the park will be to minimise the construction of transmission infrastructure. As such the proposal is for the Southern and Northern most parcels to be combined H2 and power production sites, with the central sites focussing on H2 only

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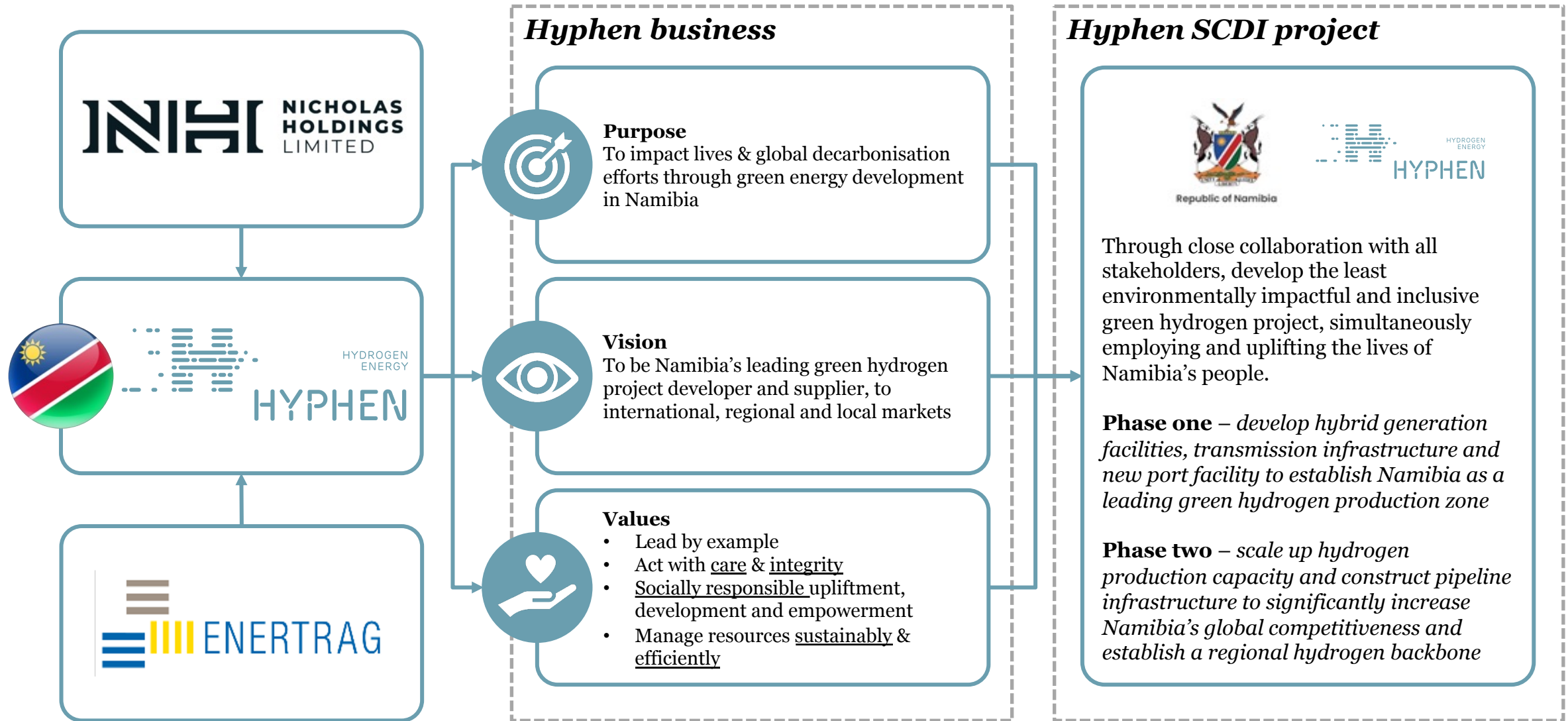
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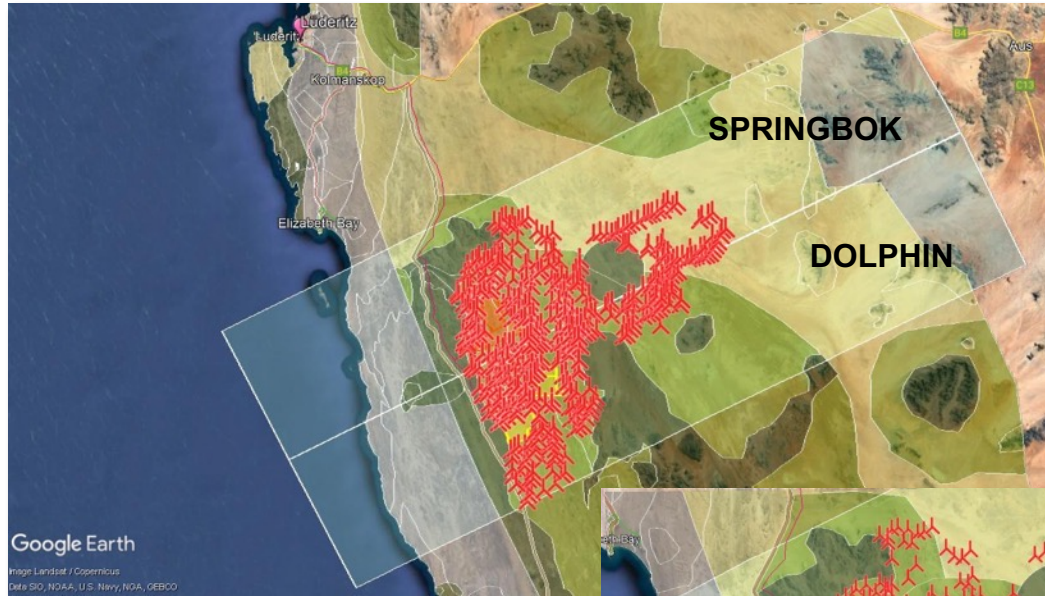
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Springbok and Dolphin Phase 1 & 2 Renewable Energy Layout

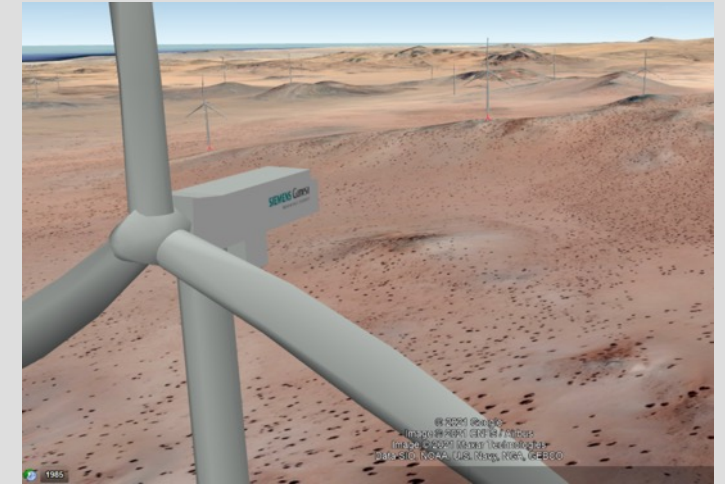


Special Value	No development zone as per environmental consultant guidance
Minimal Disturbance	This is a zone of no permanent development, but it does make allowance for renewable assets
Wildlife Disturbance	This is a zone of no permanent development, but it does make allowance for renewable developments.
Managed Resource	Same guidelines as minimal and wildlife disturbance zones.



Consideration for the sensitive environmental zones was key in designing the buildable area within the park. All special value areas were identified as non-buildable

Key insights



Wind capacity factor ~65% per annum

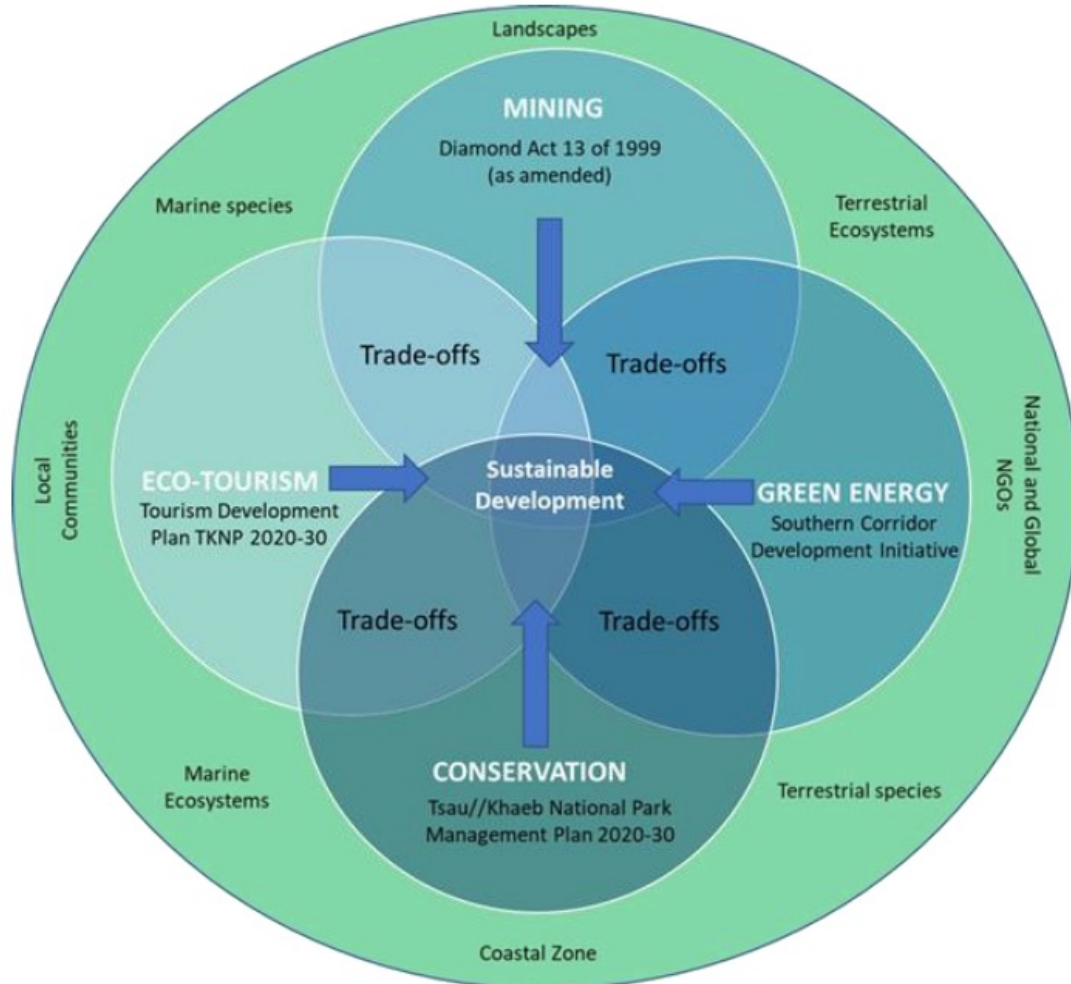
Wind turbine class 'S' identified in Namibia

A specific blade type, catering to these conditions, could be developed & locally manufactured as “Namibian Blades” – however this would only be possible if critical mass of turbines supply exists (GW scales over future extensions). Partnerships with wind turbine producers are to be initiated during the feasibility study phase (Vestas, ENERCON, Nordex as examples of locally producing companies if business case is large enough)

Environmental sensitivity is key



Minimising environmental impact – *Complex area, with many competing activities requires exceptionally sensitivity approach*



Phase #1: Pre EIA commencement planning

Task #1

Regulatory to identify all environmental & associated permits

Task #2

Consolidation of existing body of environmental sensitively knowledge of the project area

Task #3

Engagement with key stakeholders

Task #4

Site reconnaissance and consideration of logistics implications



Phase #2: Environmental permitting process

EIA #1

Environmental process for establishment of meteorological measuring equipment

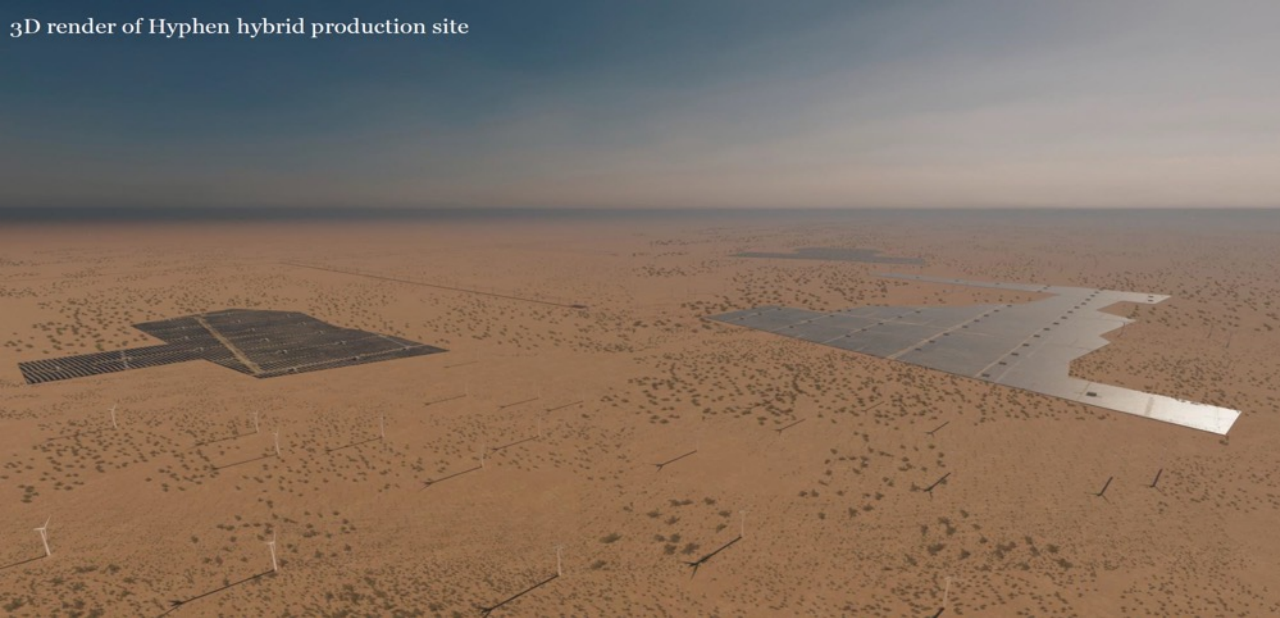
EIA #2

Environmental process for phase 1 of the project (2GW renewables and all common user infrastructure)

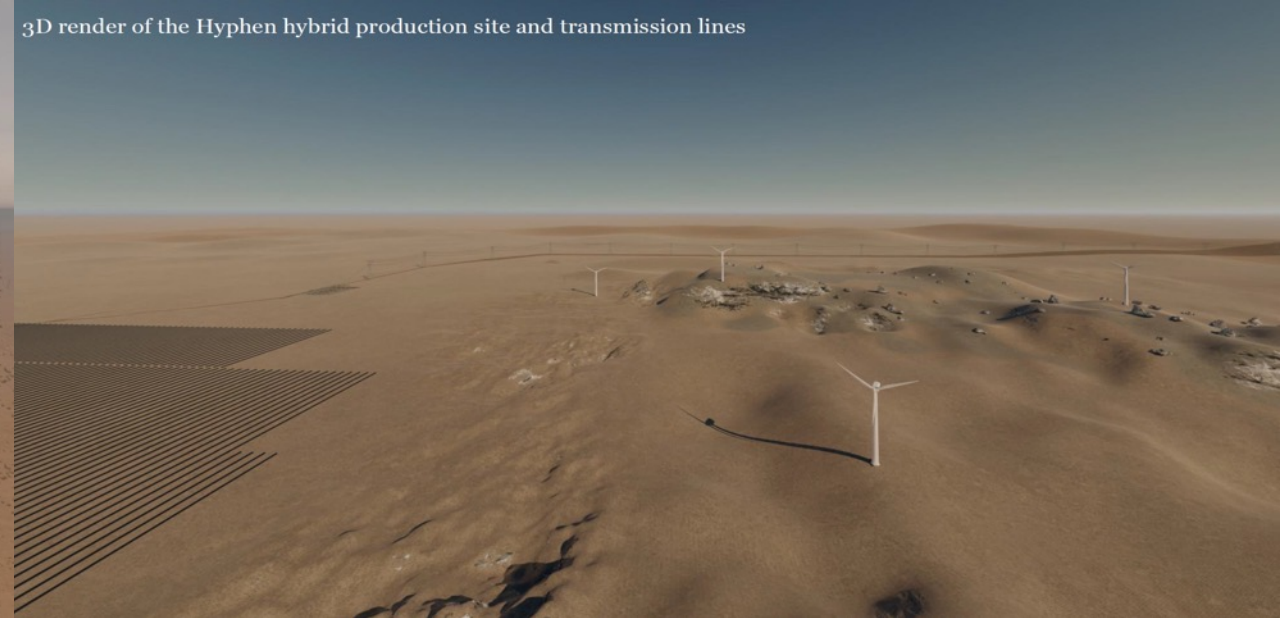
Site visualizations



3D render of Hyphen hybrid production site



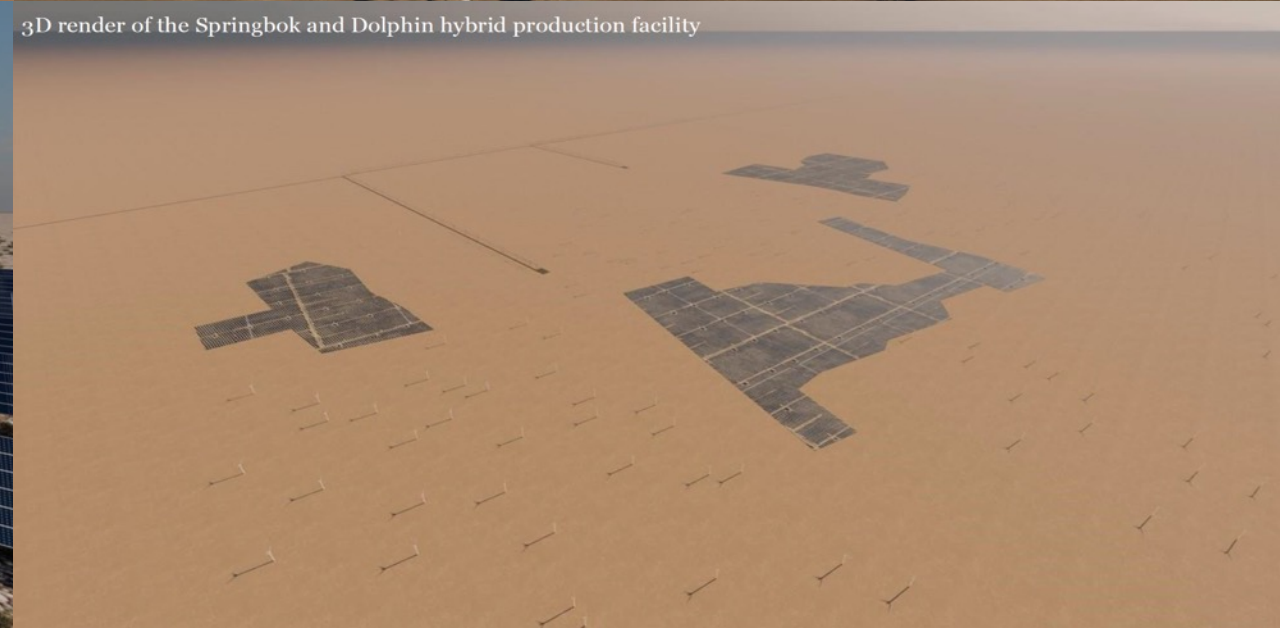
3D render of the Hyphen hybrid production site and transmission lines



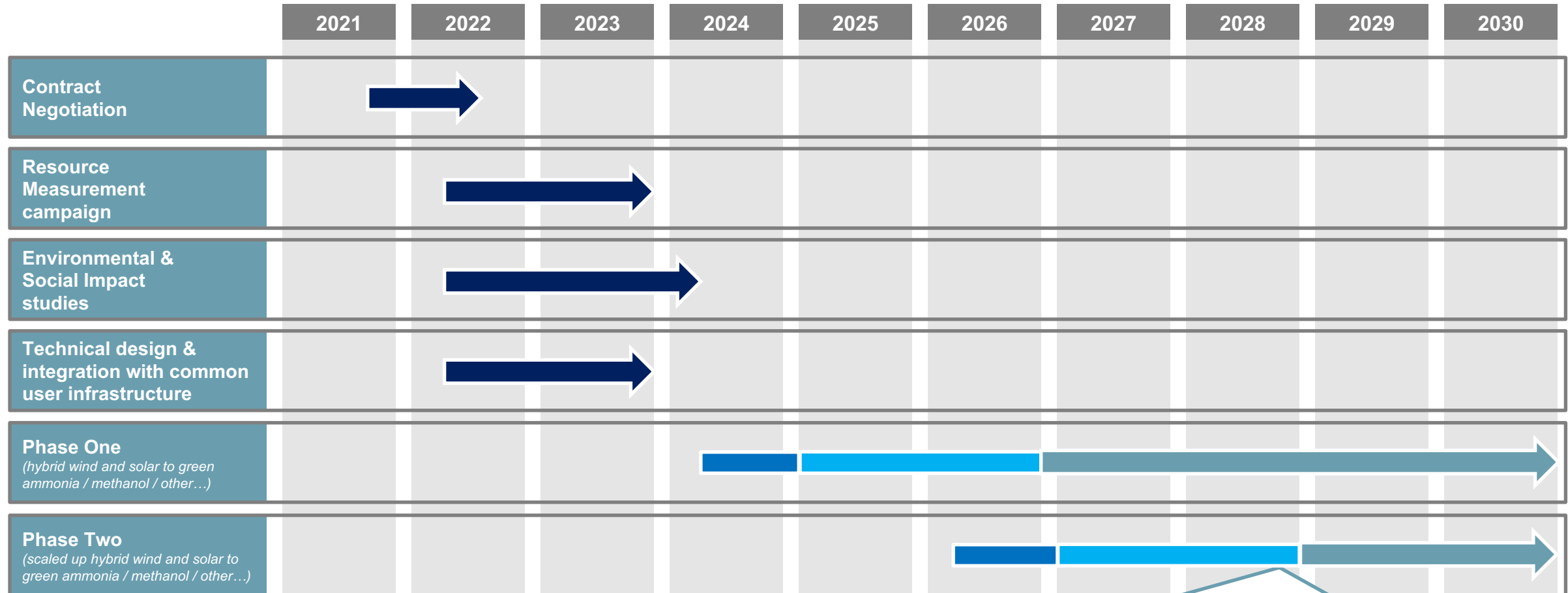
3D render of the Springbok hybrid production site



3D render of the Springbok and Dolphin hybrid production facility



Proposed Hyphen Project Timeline



Development Activity
 Construction
 Mobilisation
 Operations

Construction phases are staggered sequentially to ensure construction teams are utilised fully over the build phases without drops in workload. Thus, enabling maximum localisation opportunities and the de-risking of newly formed local construction companies

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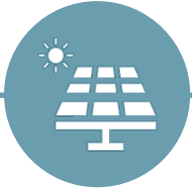
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Phase one & two

Installed capacity	5 GW renewables 3 GW electrolysis	
Total investment	USD \$9.4bn	\$
Green Hydrogen	300,000 t.p.a. (4m-5m tons CO2 avoidance p.a.)	H ₂ CO₂
Direct construction jobs	15,000 for 4-5 years	
Direct operational jobs	3,000 permanent jobs	



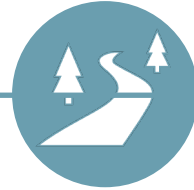
Energy

- Project will establish high voltage transmission lines (66kv / 132kv), substations and hydrogen pipeline infrastructure
- Electricity generation that is excess to the project requirements can be supplied either into the Southern Africa Power Pool or to NamPower, on terms to be agreed



Water

- Project will establish sea water desalination for water supply to the project
- Hyphen intends to over size the desalination plant to provide water supply capacity to Lüderitz
- Lüderitz demand to be established (current demand is 3,000m³ per day)



Roads

- Project will establish and maintain roads within the TKNP and Angra Point in order to access its facilities
- These roads will increase access to both these areas for tourism activities and will assist in driving tourism growth through increased access



Port

- Hyphen proposes the development of a new port
- The port has been designed and phased to enable the start of ammonia exports as a "Phase 0" of the port master plan
- The solution ensures maximum flexibility to maximise the port's development potential



Rail

- Traxtion, a Nicholas Holdings group company, leases locomotives to TransNamib
- Hyphen's value proposition includes the movement of hydrogen project cargo, hydrogen and dry bulk commodities by rail
- Various commercial models available to fund the upgrade of rail track required for these cargos



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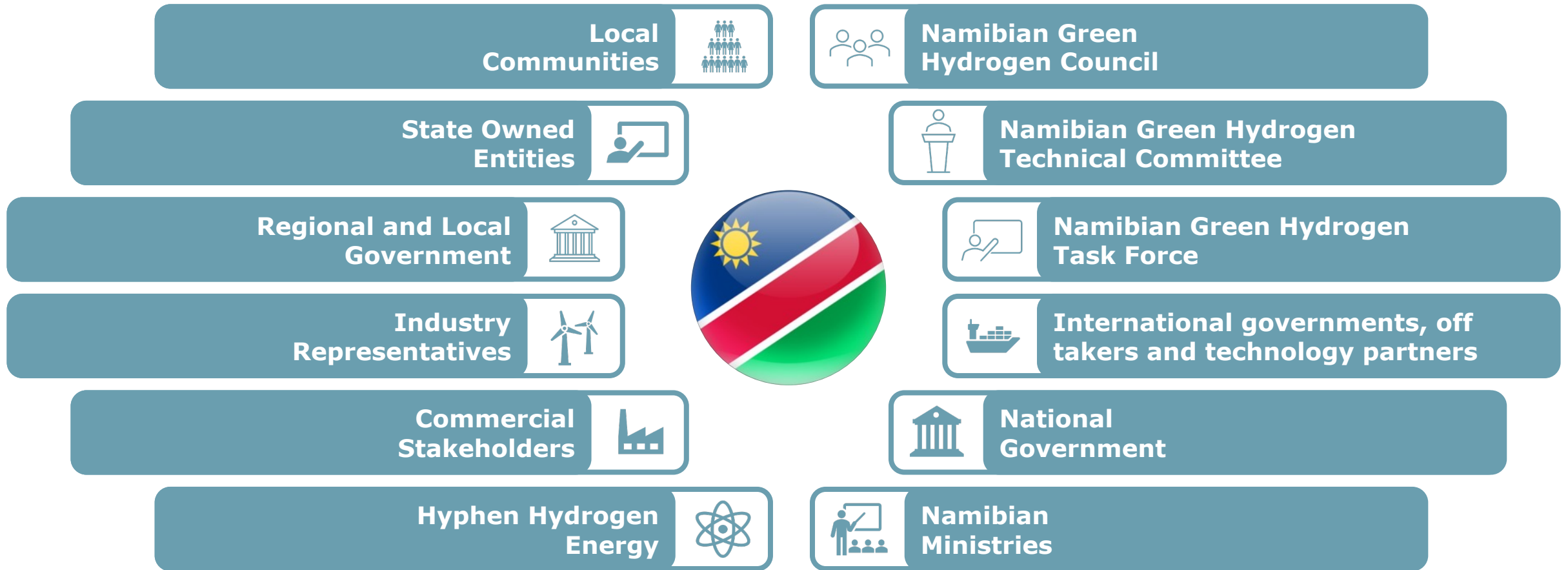
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