Green Hydrogen in Oman
Growing momentum for Energy Transition including Hydrogen export in Oman

- Hydrogen Economy feasibility study
- Establishment of National Hydrogen Alliance (Hy-Fly)
- Incorporation of HDO
- BoD Approval of HDO’s strategy & rebrand
- Kick-off of Energy Transition Policy & Legal Framework projects

2021
- Aug '21: Royal Directives for Hydrogen

2022
- Jun '22: Tender for Energy Transition Policy & Legal Framework projects
- Sep '22: Announcement of Net Zero Target 2050
- Oct '22: Official launch of Hydrogen Oman

Set the required strategy, policies and legal framework
Allocate lands for green Hydrogen
Establish a Directorate General for Clean Energy & Hydrogen
Establish a company to develop the Hydrogen sector
Objectives of the presentation

01 Present Oman's ambition in green hydrogen

02 Showcase the roles in the Omani hydrogen value chain

03 Present Hydrogen Oman

04 Outline the green hydrogen tender parameters and process
H\textsubscript{2} today fully fossil-based, but significant low-carbon hydrogen penetration and growth to come in next decades

Global hydrogen production (Mtpa)

Global Hydrogen Market

Strong market momentum, with 900+ projects in pipeline

Only 1% of the announced projects at a mature stage

$\approx 200$ Mtpa

green hydrogen production expected by 2050

1. Hydrogen-derivative fuels are normalized to hydrogen equivalent. 2. Production technology split & grey production volume taken from IEA SDS global hydrogen production forecast (last updated in Sep 2020) in SDS scenario; Green & blue volumes based on BCG Global H\textsubscript{2} demand tool; Note: scenario used SDS = Sustainable Development Scenario

Source: IEA; Irena; BCG Global H\textsubscript{2} Demand Model – Feb 2022 (updated for RePowerEU latest announcements)
25+ countries have released hydrogen ambition

Key learnings from low-carbon H₂ country strategies

Decarbonizing industry as first priority
Most actionable change in the short-run is replacing grey H₂ in industry with low-carbon H₂

Targets and policies centered around supply
Supply targets being set (e.g., X GW of electrolyzers by 2030), while demand support largely lacking

Creation of hydrogen clusters
Large demand clusters can springboard H₂ industry via economies of scale & sector coupling synergies

Growing international cooperation
Bilateral agreements allow for knowledge sharing and de-risking national hydrogen investments
Japan, Korea and Western Europe likely importers of low-carbon H₂ due to limited renewable potential

<table>
<thead>
<tr>
<th>Region</th>
<th>Market conditions to supply</th>
<th>Key import market?</th>
</tr>
</thead>
<tbody>
<tr>
<td>North America</td>
<td>Favorable PV and wind, cheap gas, CCUS potential</td>
<td>Likely exporter</td>
</tr>
<tr>
<td>South America</td>
<td>Favorable PV and wind</td>
<td>Likely exporter</td>
</tr>
<tr>
<td>Africa</td>
<td>Favorable PV and wind</td>
<td>Likely self-sufficient</td>
</tr>
<tr>
<td>Middle East</td>
<td>Favorable PV and wind, cheap gas, CCUS potential</td>
<td>Likely exporter</td>
</tr>
<tr>
<td>Oceania</td>
<td>Favorable PV and wind, CCUS potential</td>
<td>Likely exporter</td>
</tr>
<tr>
<td>India</td>
<td>Favorable renewables potential</td>
<td>Uncertain</td>
</tr>
<tr>
<td>China</td>
<td>Favorable renewables potential, large investments</td>
<td>Uncertain</td>
</tr>
<tr>
<td>Japan</td>
<td>Limited natural resources and renewables potential</td>
<td>Likely major importer</td>
</tr>
<tr>
<td>South Korea</td>
<td>Limited natural resources and renewables potential</td>
<td>Likely major importer</td>
</tr>
<tr>
<td>Rest of Asia</td>
<td>Fragmented smaller markets, favorable RE potential</td>
<td>Likely self-sufficient</td>
</tr>
<tr>
<td>Western Europe</td>
<td>Limited RE and CCUS potential particularly DE and NL</td>
<td>Likely major importer</td>
</tr>
<tr>
<td>Rest of Europe</td>
<td>More favorable renewables potential</td>
<td>Likely self-sufficient</td>
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</tbody>
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1. Hydrogen-derivative fuels are normalized to hydrogen equivalent. Note: scenario used SDS – Sustainable Development Scenario
Source: IEA World Energy Balances; IEA WEO 2021; GlobalData; Nexant
Oman has 5 strategic objectives to move into Green H₂

- Ensure energy security on a national and International level
- Diversify the local economy, onshore the supply chain, forward connect industries and create local long-term jobs
- Decarbonize the country to safeguard a sustainable future for incoming opportunities
- Create a Green H₂ sector with a competitive LCOH for export markets and attractive for Foreign Direct Investments
- Support innovation and ensure capabilities development for Oman
3 zones in Central/South Oman have been chosen to develop Green H₂

Areas for Renewables across Oman

- **Total renewable land area**
- **Industrial or commercial ports**
- **Wind capacity factor (%)**
- **Solar irradiation** (kWh/m²)

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**Zones**

- **Duqm**
- **Dhofar**
- **Al-Jazir**

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1. Highest wind potential areas mapped at 200m
Source: Global Wind Atlas, Global Solar Atlas

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1. Global Horizontal Irradiation (GHI)
Source: Global solar atlas, Global wind atlas (July '22)

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**Total renewables available land for H₂**
~50,000 km²
Equivalent to ~25 Mtpa of H₂ or 500 GW of renewables
Oman has ambitious production targets until 2050, to cover both export and local demand – scope of Phase A of tendering is to fulfil 2030 ambition.

Green H₂ production ambition for Oman in 2030-50 (Mtpa)

Scope of Phase A of tendering

- 1.0 - 1.25 Mtpa for 2030
- 3.25 - 3.75 Mtpa for 2040
- 7.5 - 8.5 Mtpa for 2050

Includes exports mainly to Europe and Asia, and local Omani demand.

Electrolyzer capacity¹ (GW)

- 8-10 for 2030
- 35-40 for 2040
- 95-100 for 2050

Renewables capacity¹,² (GW)

- 16-20 for 2030
- 65-75 for 2040
- 175-185 for 2050

¹. Approximate values for Duqm. Oman ². Includes 25% buffer over Renewables needed for electrolyzers to account for Balance of plant load (which includes NH₃ synthesis loop, Storage tanks for H₂/NH₃, other auxiliary facilities load). Assumption: Sustainable Development Scenario (2°C). Source: Team analysis

~30% of available land for green H₂ required to fulfill target.
Cumulative investments by 2050 required in Oman Green H₂ Economy

~$140B
~OMR 54B

Investments required in solar panels, wind turbines, electrolyzers, derivative synthesis, storage, transport, water desalination, etc.
Oman plans massive capacity installation and investments in the green $H_2$ sector by 2050

- **~300M** Solar panels
- **~10K** Wind turbines
- **~5,200** Electrolyzers
- **~180GW** Renewable capacity
- **~100GW** Electrolyzer capacity
- **~70k** New permanent jobs, of which ~17k are managerial

Main assumptions: 540W per solar panel; 3.5MW per wind turbine; 200MW per electrolyzer module
# Key project parameters have been defined

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Detail</th>
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</thead>
<tbody>
<tr>
<td>Duration</td>
<td>• 47 years from project development and land sub-usufruct award</td>
</tr>
<tr>
<td>Oman take</td>
<td>• Land lease (floor of 20 bz/m² ≈ 0.05 USD)</td>
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<td></td>
<td>• Base royalties (floor of 5% in kind) and surplus royalties</td>
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<td></td>
<td>• Corporate tax applies</td>
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<td>• Equity stake 20% for Government owned entity</td>
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<tr>
<td>Incentives</td>
<td>• Developers can expect incentives as reduced land fees to 20bz/m² which are further discounted during development stages by up to 100%</td>
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<tr>
<td>Scope</td>
<td>• Integrated project to produce Green H₂ derivatives (includes Renewables generation, H₂ production, derivatives conversion, off-take)</td>
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<td>• Common infrastructure to be tendered separately</td>
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<tr>
<td>Conditions</td>
<td>• No committed off-take of electricity/connection to grid</td>
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<tr>
<td></td>
<td>• Unused land to be given back to Government</td>
</tr>
</tbody>
</table>

Further details will be disclosed in the RFQ, bidders can propose more.
Objectives of the presentation

01 Present Oman's ambition in green hydrogen

02 Showcase the roles in the Omani hydrogen value chain

03 Present Hydrogen Oman

04 Outline the green hydrogen tender parameters and process
Four different roles to drive the Hydrogen economy in Oman, performed by different Omani entities

<table>
<thead>
<tr>
<th>Roles</th>
<th>Policy maker &amp; Regulator</th>
<th>Orchestrator</th>
<th>Infrastructure</th>
<th>Developer</th>
</tr>
</thead>
<tbody>
<tr>
<td>H₂ value chain</td>
<td>Country Strategy &amp; policies</td>
<td>Tender, land &amp; infrast. mgmt</td>
<td>Transport &amp; Storage</td>
<td>Financing</td>
</tr>
<tr>
<td></td>
<td>Regulations</td>
<td>Off-take coordination</td>
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<td>Renewable / power systems</td>
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<td>H₂ production</td>
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<td>Derivatives</td>
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<td></td>
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<td>Shipping</td>
</tr>
</tbody>
</table>

**Omani entities involved**
- Policy maker & Regulator: Ministry of Energy and Minerals
- Orchestrator: Hydrogen Oman
- Infrastructure providers: OQ Alternative Energy, Networks, Marafiq

Hydrogen Oman

Downstream orchestrator: Hydrogen Oman

International developers + OQ Alternative Energy

Hydrogen sector connects with many industries and current Omani companies
Thank you