Sector Analysis Jordan

Green Hydrogen & Ammonia: Industrial Applications, Market Potential, and Strategic Opportunities

Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH

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TABLE OF CONTENTS

List of figures

List of tables

Currency units

JOD	Jordanian dinar
USD	United States dollar

Currency units and conversion rate as of 21.01.2025

EUR 1 = JOD 1.3620
JOD 1 = EUR 0.7342

EUR 1 = USD 0.9661
USD 1 = EUR 1.0351

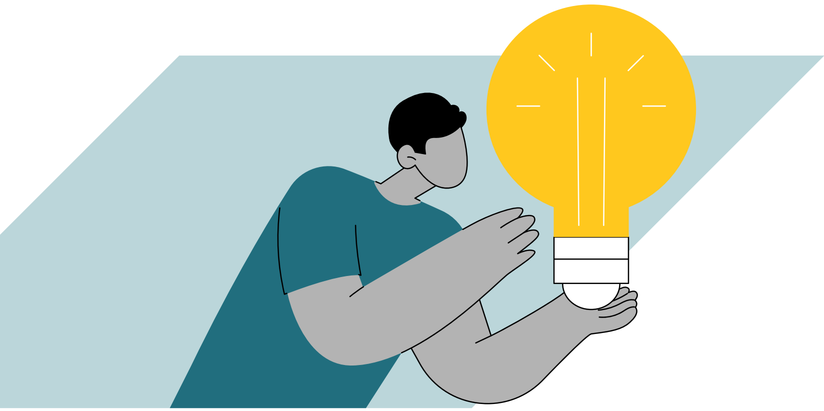
Source: Exchange-Rates.org, 2024

Technical units

bbl	Barrels (plural)
GW	Gigawatt
GWh	Gigawatt hour
k	Thousand
KTPA	Thousand tonnes per annum
Mt	Million tonnes
MTPA	Million tonnes per annum
MW	Megawatt
MWh	Megawatt hour
PJ	Petajoule (10^3 TJ)
TJ	Terajoule (10^12 joule)

Abbreviations/acronyms

A2D	Accelerate-to-Demonstrate
AAWDCP	Aqaba-Amman Desalination and Conveyance Project
ADC	Aqaba Development Corporation
AEC	Alkaline Electrolysis
AEMEC	Anion Exchange Membrane Electrolysis Cell
AHK	Deutsche Auslandshandelskammer (engl., German Chambers of Commerce Abroad)
AN	Ammonium nitrate
AS	Ammonium sulphate
ASEZA	Aqaba Special Economic Zone Authority
ASU	Air Seperation Unit
ATR	Autothermal reforming
BCC	Al-Baha Company for Caustic and Chlorine
BDO	1,4-Butanediol
BMWE	Bundesministerium für Wirtschaft und Energie (BMWE) / German Federal Ministry for Economic Affairs and Energy (BMWE)
C_6H_{12}	Cyclohexane
CAN	Calcium ammonium nitrate
CCS	Carbon Capture and Storage
CHP	Clean Hydrogen Partnership
CO	Carbon monoxide
CO_2	Carbon Dioxide
DAC	Direct air capture
DAP	Diammonium phosphate
DRI	Direct reduced iron
EBRD	European Bank for Reconstruction and Development
EU	European Union
GEF	Global Environment Facility
GH_2	Green Hydrogen
GHF	Green Hydrogen Trust Fund
GHI	Global Horizontal Irradiance
GIZ	Deutsche Gesellschaft für Internationale Zusammenarbeit (engl., German Society for International Cooperation)
H_2	Hydrogen
H_2O_2	Hydrogen peroxide
H_2Uppp	International Hydrogen Ramp-up Program
HB	Haber-Bosch
HBr	Bromine, hydrogen bromide
HCl	Hydrochloric acid
HTU	Al Hussein Technical University
IEA	International Energy Agency
IJC	Indo Jordan Chemicals Company
JAFCCO	Jordan Abyad Fertilisers and Chemicals Company P.S.C
JBC	Jordan Bromine Company
JCI	Jordan Chamber of Industry
JIEC	Jordan Industrial Estates Company
JIFCO	Jordan India Fertiliser Company
JKB	Jordan Kuwait Bank
JPMC	Jordan Phosphate Mines Company
JPRC	Jordan Petroleum Refinery Company
KEMAPCO	Arab Fertilisers & Chemicals Industries
LCOA	Levelized Cost of Ammonia
LCOH	Levelized Cost of Hydrogen
MAP	Monoammonium phosphate
MCA	Multi-criteria assessment
MCFP	Modern Company for Fertiliser Production
MEMR	Ministry of Energy and Mineral Resources, Jordan
MIGA	Multilateral Investment Guarantee Agency
MoU	Memorandum of Understanding
MTBE	Methyl Tertiary Butyl Ether
N_2	Nitrogen
NCI	National Chlorine Industries
NEPCO	National Electric Power Company
NH_3	Ammonia
NJFC	Nippon Jordan Fertiliser Company
PDP	Project Development Programme
PEMEC	Proton Membrane Electrolysis Cell
PPA	Power Purchase Agreement
PPP	Public Private Partnerships
PtX	Power-to-X (anything)
PV	Photovoltaic
R&D	Research and Development
RE	Renewable Energy
SME	Small and medium-sized enterprises
SOEC	Solid Oxide Electrolysis Cell
UAN	Urea ammonium nitrate
UNIDO	United Nations Industrial Development Organization
USAID	United States Agency for International Development



ENERGY SOLUTIONS – MADE IN GERMANY
The German Energy Solutions Initiative

The German Energy Solutions Initiative of the German Federal Ministry for Economic Affairs and Energy (BMWE) aims to globalise German technologies and expertise in climate-friendly energy solutions.

Years of promoting smart and sustainable energy solutions in Germany have led to a thriving industry known for world-class technologies. Thousands of specialised small and medium-sized enterprises (SMEs) focus on developing renewable energy systems, energy efficiency solutions, smart grids, and storage technologies. Cutting-edge energy solutions are also built on emerging technologies such as power-to-gas, fuel cells, and green hydrogen. The initiative's strategy is shaped around ongoing collaboration with the German business community.

The initiative creates benefits for Germany and the partner countries by:

- boosting global interest in sustainable energy solutions
- encouraging the use of renewables, energy efficiency technologies, smart grids, and storage technologies, while facilitating knowledge exchange and capacity building
- enhancing economic, technical and business cooperation between Germany and partner countries

THE PROJECT DEVELOPMENT PROGRAMME (PDP)

PDP is a key pillar of the German Energy Solutions Initiative and is implemented by the Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH. It connects development cooperation with private-sector engagement and supports climate-friendly energy solutions in selected developing and emerging countries, enabling local businesses to adopt solutions in energy efficiency, electricity and heat supply, and hydrogen, while facilitating market access for German solution providers.

Developing and emerging economies offer promising business potential for climate-friendly energy solutions but also pose challenges for international business partners. The PDP team works closely with local industries to develop financially viable projects by providing technical expertise, financial guidance, and networking opportunities.

It identifies project leads, collects and analyses energy consumption data, and assesses projects from both a technical and economic perspective. This includes outlining the business case, calculating payback periods, and evaluating profitability. Companies can then choose to finance projects using their own funds or explore leasing and other financing options. PDP provides cost-free advice to local companies and connects them with German solution providers for project implementation.

Additionally, by offering training, organising reference project visits, and publishing studies on the potential of climate-friendly solutions and on navigating regulatory frameworks, the programme supports market development and fosters private-sector cooperation.

Executive summary

GREEN HYDROGEN FOR JORDAN'S C&I SECTOR

This Green Hydrogen sector analysis aims to assess the potential for green hydrogen development in Jordan, providing a foundation for future projects. This analysis is part of a series to offer market insights and support pre-development efforts to generate both local and international interest in the green hydrogen economy.

The analysis explores the feasibility of introducing green hydrogen into Jordan's commercial and industrial sectors, evaluating specific use cases and providing techno-economic estimates for stakeholders – particularly companies based in Germany. The objective is to identify viable opportunities, address key challenges, and outline a pathway for green hydrogen integration that aligns with Jordan's broader energy and industrial development goals.

Jordan possesses an exceptional renewable energy potential that can be harnessed for green hydrogen production. The country's high solar radiation and strong wind corridors create a strong foundation for developing a large-scale hydrogen economy. The country's diverse industrial base, especially in Aqaba, including sectors such as fertiliser production and refinery, presents substantial opportunities for green hydrogen applications. Additionally, Jordan's strategic location and well-developed trade networks position it as a potential hub for hydrogen/ammonia exports and ammonia-based fertiliser to Europe and Asia, further strengthening its long-term market potential.

Zusammenfassung

GRÜNER WASSERSTOFF FÜR DEN C&I-SEKTOR JORDANIENS

In der vorliegenden Sektoranalyse wird das Entwicklungspotenzial grünen Wasserstoffs in Jordanien bewertet und damit eine Grundlage für zukünftige Projekte mit grünem Wasserstoff geschaffen. Die Analyse ist Teil einer Studienreihe, in der Marktinformationen bereitgestellt und Vorentwicklungsmaßnahmen unterstützt werden, um sowohl das lokale als auch das internationale Interesse an der grünen Wasserstoffwirtschaft zu wecken.

Untersucht wird vor allem, inwieweit grüner Wasserstoff in den jordanischen Gewerbe- und Industriesektor (C&I-Sektor) integriert werden kann. Dabei werden Anwendungsfälle bewertet und techno-ökonomische Abschätzungen für relevante Akteure bereitgestellt – insbesondere für Unternehmen mit Sitz in Deutschland. Ziel dessen ist es, tragfähige Geschäftsmöglichkeiten zu identifizieren, zentrale Herausforderungen aufzuzeigen und einen Fahrplan für die Integration von grünem Wasserstoff zu skizzieren, der mit Jordaniens energie- und. industriepolitischen Zielen vereinbar ist.

Jordanien verfügt über ein außergewöhnliches Potenzial bei den erneuerbaren Energien, das für die Produktion grünen Wasserstoffs genutzt werden kann. Die starke Sonneneinstrahlung sowie große Windkorridore bilden eine solide Grundlage für den Aufbau einer großskaligen Wasserstoffwirtschaft. Die breit aufgestellte Industrie des Landes – insbesondere in Aqaba mit Sektoren wie Düngemittelproduktion und Raffinerien – bietet vielfältige Einsatzmöglichkeiten für grünen Wasserstoff. Darüber hinaus ist Jordanien durch seine strategische Lage und gut ausgebaute Handelsverbindungen als Exportdrehscheibe für Wasserstoff, Ammoniak und ammoniakbasierten Dünger nach Europa und Asien prädestiniert – ein weiterer Faktor, der die langfristige Marktperspektive stärkt.

Green hydrogen could play a pivotal role in Jordan's energy transition by:

- **Supporting industrial decarbonisation:** Integrating green hydrogen/ammonia into processes such as fertiliser production, oil refining, and steel and cement manufacturing to reduce carbon emissions.
- **Enhancing energy security:** Diversifying the energy mix and reducing reliance on fossil fuels through the adoption of hydrogen-based solutions.
- **Facilitating export opportunities:** Leveraging existing infrastructure and trade relationships to position Jordan as a regional leader in green hydrogen exports.

BUSINESS OPPORTUNITIES FOR GERMAN SOLUTION PROVIDERS

Jordan's evolving energy landscape presents several business opportunities for German SMEs, particularly in renewable energy, electrolysis, industrial applications, and infrastructure development. Key advantages include:

- **Renewable energy potential:** Jordan leads the region in renewable energy installation, providing capacity for large-scale green hydrogen production, with plans for an economic zone to boost related manufacturing.
- **Strategic export position:** Jordan's proximity to Europe and the Aqaba port's expansion make it optimal for exporting hydrogen, ammonia, and fertilisers.

Grüner Wasserstoff könnte bei Jordaniens Energiewende eine zentrale Rolle spielen:

- **als Beitrag zur Dekarbonisierung der Industrie:** Integration von Wasserstoff bzw. Ammoniak in Prozesse wie die Düngemittelproduktion, Ölraffination sowie die Stahl- und Zementherstellung zur Reduzierung von CO_2-Emissionen
- **zur Stärkung der Energiesicherheit:** Diversifizierung des Energiemixes und Verringerung der Abhängigkeit von fossilen Brennstoffen durch den Einsatz wasserstoffbasierter Lösungen
- **bei der Ermöglichung von Exportchancen:** Nutzung der Infrastruktur und der Handelsbeziehungen, um Jordanien als regionalen Vorreiter beim Export grünen Wasserstoffs zu positionieren

GESCHÄFTSMÖGLICHKEITEN FÜR DEUTSCHE ANBIETER VON LÖSUNGEN

Jordaniens Energielandschaft ist im Wandel und bietet deutschen KMU vielfältige Geschäftschancen – insbesondere in den Bereichen erneuerbare Energien, Elektrolyse, industrielle Anwendungen und Infrastrukturentwicklung. Zu den wichtigsten Standortvorteilen gehören:

- **Potenziale erneuerbarer Energie:** Jordanien zählt zu den Ländern der Region, die den Ausbau erneuerbarer Energien maßgeblich voranbringen, und bietet damit Kapazitäten für die großskalige Produktion grünen Wasserstoffs. Eine geplante Wirtschaftszone soll die damit verbundene Industrieproduktion weiter stärken.
- **strategische Exportlage:** Die geografische Nähe zu Europa und der Ausbau des Hafens von Aqaba machen Jordanien zu einem attraktiven Standort für den Export von Wasserstoff, Ammoniak und Düngemitteln.

- **Industrial integration opportunities:** Jordan's strong fertiliser industry, reliant on imported ammonia, can transition to green hydrogen, reducing imports and supporting other sectors like refinery and steel.
- **Government support:** Jordan's Draft National Green Hydrogen Strategy and active national committee aim to establish competitive hydrogen and ammonia projects, enhancing Jordan's regional clean energy leadership.
- **International partnerships:** Jordan has signed multiple MoUs with international firms targeting substantial green ammonia production, supported by significant renewable energy and desalination investments.

CHALLENGES ON THE PATH TO A HYDROGEN ECONOMY

While the potential is significant, Jordan faces several hurdles:

- **Regulatory challenges:** While Jordan has taken commendable steps toward enabling green hydrogen development — including the draft Green Hydrogen Strategy and proposed amendments to the gas law — there remains a need to enhance and operationalize the regulatory framework. Clear, dedicated regulations and implementation mechanisms will be essential to attract investment, ensure competitiveness, and facilitate market development.

- **Potenziale für industrielle Integration:** Die starke Düngemittelindustrie ist bislang auf importiertes Ammoniak angewiesen. Dies bietet Möglichkeiten für die Umstellung auf grünen Wasserstoff – mit positiven Effekten auch für weitere Sektoren, zum Beispiel Raffinerien und Stahl.
- **Politische Unterstützung:** Die geplante Nationale Wasserstoffstrategie und ein aktives nationales Komitee unterstreichen den politischen Willen in Jordanien, wettbewerbsfähige Wasserstoff- und Ammoniakprojekte zu entwickeln und Jordaniens Rolle als Vorreiter für saubere Energien in der Region auszubauen.
- **internationale Partnerschaften:** Jordanien und internationale Unternehmen haben Absichtserklärungen unterzeichnet, die auf umfangreiche Produktionsprojekte für grünes Ammoniak abzielen – flankiert von bedeutenden Investitionen in erneuerbare Energien und Meerwasserentsalzung.

HERAUSFORDERUNGEN AUF DEM WEG ZUR WASSERSTOFFWIRTSCHAFT

Trotz des großen Potenzials steht Jordanien vor mehreren Herausforderungen:

- **regulatorische Hürden:** Jordanien hat wichtige Schritte für die Förderung grünen Wasserstoffs unternommen – etwa durch die Entwurfsfassung der Nationalen Wasserstoffstrategie und die geplanten Änderungen des Gasgesetzes. Dennoch muss der regulatorische Rahmen weiter konkretisiert und in die Praxis umgesetzt werden. Klare, dedizierte Regelungen und Umsetzungsmechanismen sind entscheidend, um Investitionen anzuziehen, Wettbewerbsfähigkeit zu sichern und die Marktentwicklung zu fördern.

- **Technical and environmental challenges:** Green hydrogen production in Jordan faces water scarcity, requiring desalination investment. Infrastructure expansion, including ports and renewable energy, is crucial for sector support.
- **Economic challenges:** High initial costs in developing green hydrogen infrastructure, electrolysers, and renewable energy sources necessitate strong public-private collaboration and low-cost financing to achieve commercial viability in Jordan.

WHY JORDAN MATTERS FOR GREEN HYDROGEN

Jordan's vast renewable energy resources, industrial potential, and strategic location create promising opportunities for green hydrogen/ammonia development. However, regulatory uncertainties, along with environmental and economic challenges, must be carefully navigated.

German companies that engage early, leveraging their expertise and fostering collaborations, can play a pivotal role in shaping Jordan's green hydrogen future, driving both commercial success and sustainable development.

- **technische und ökologische Herausforderungen:** Der Produktion grünen Wasserstoffs in Jordanien steht Wasserknappheit entgegen, was Investitionen in Meerwasserentsalzung erforderlich macht. Zudem ist der Ausbau der Infrastruktur – insbesondere in den Häfen und im Bereich der erneuerbaren Energien – von zentraler Bedeutung für die Entwicklung des Sektors.
- **wirtschaftliche Herausforderungen:** Die hohen Anfangsinvestitionen in Wasserstoffinfrastruktur, Elektrolyseure und erneuerbare Energiequellen erfordern eine enge Zusammenarbeit zwischen öffentlichem und privatem Sektor sowie den Zugang zu günstiger Finanzierung – nur so wird die wirtschaftlich tragfähige Umsetzung in Jordanien möglich.

WARUM JORDANIEN FÜR GRÜNEN WASSERSTOFF RELEVANT IST

Jordaniens umfangreiche Ressourcen an erneuerbaren Energien, das industrielle Potenzial und die strategische Lage des Landes sind vielversprechend und bieten Chancen für die Entwicklung von grünem Wasserstoff und Ammoniak. Gleichzeitig erfordern regulatorische Unsicherheiten sowie ökologische und wirtschaftliche Herausforderungen eine sorgfältige Steuerung.

Deutsche Unternehmen, die frühzeitig aktiv werden, ihr Know-how einbringen und Partnerschaften aufbauen, können eine entscheidende Rolle bei der Gestaltung der Wasserstoffzukunft Jordaniens übernehmen – und dabei sowohl ihren wirtschaftlichen Erfolg als auch die nachhaltige Entwicklung vorantreiben.

1

Outline of the current context

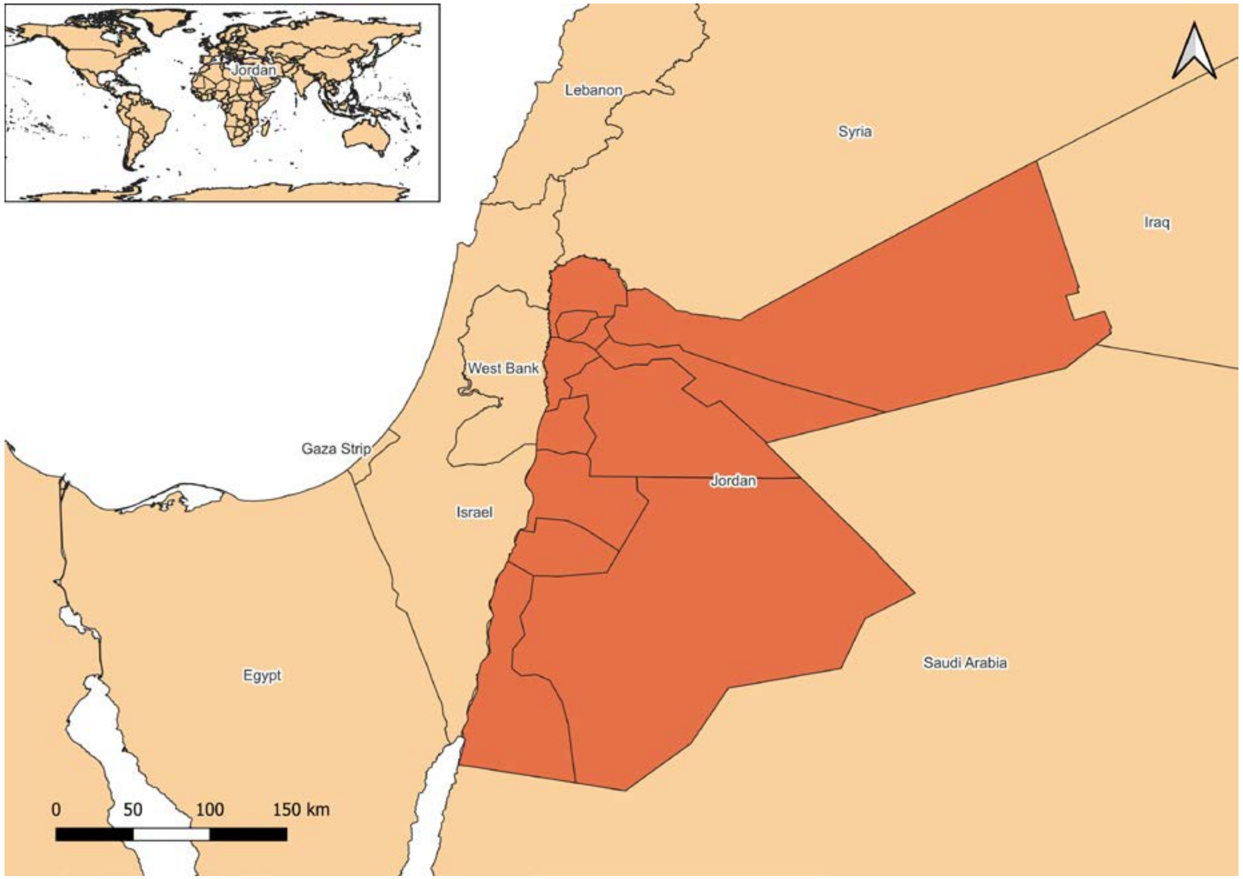
Jordan's move towards hydrogen and ammonia production marks a strategic shift in its energy sector, leveraging its strong solar and wind resources to produce green hydrogen. This reduces dependence on fossil fuel imports, boosts energy security, and opens economic opportunities through exports to Europe and Asia. The initiative positions Jordan as an emerging player in the global green energy market.

This section provides an overview of the energy landscape in Jordan for hydrogen/ammonia development. The section also includes an overview of the legislative and regulatory framework as well as key activities undertaken by the government in the green hydrogen space.

1.1 General country information

The Hashemite Kingdom of Jordan is located in the Middle East (see Figure 1), covering an area of approximately 89,794 km² (Statistisches Bundesamt, 2024). It has access to the Red Sea via the Gulf of Aqaba. The country has a population of about 11.4 million as of 2023 (World Bank, 2025). Jordan's economy is primarily driven by tourism, chemicals, textiles, agriculture, and mining. Jordan's GDP reached USD 51 billion in 2023, equating to USD 4,456 per capita (World Bank, 2025).

FIGURE 1. Location of Jordan



Source: Authors' own compilation, Fichtner (2025) based on (OpenStreetMap, 2025)

1.2 National energy sector analysis

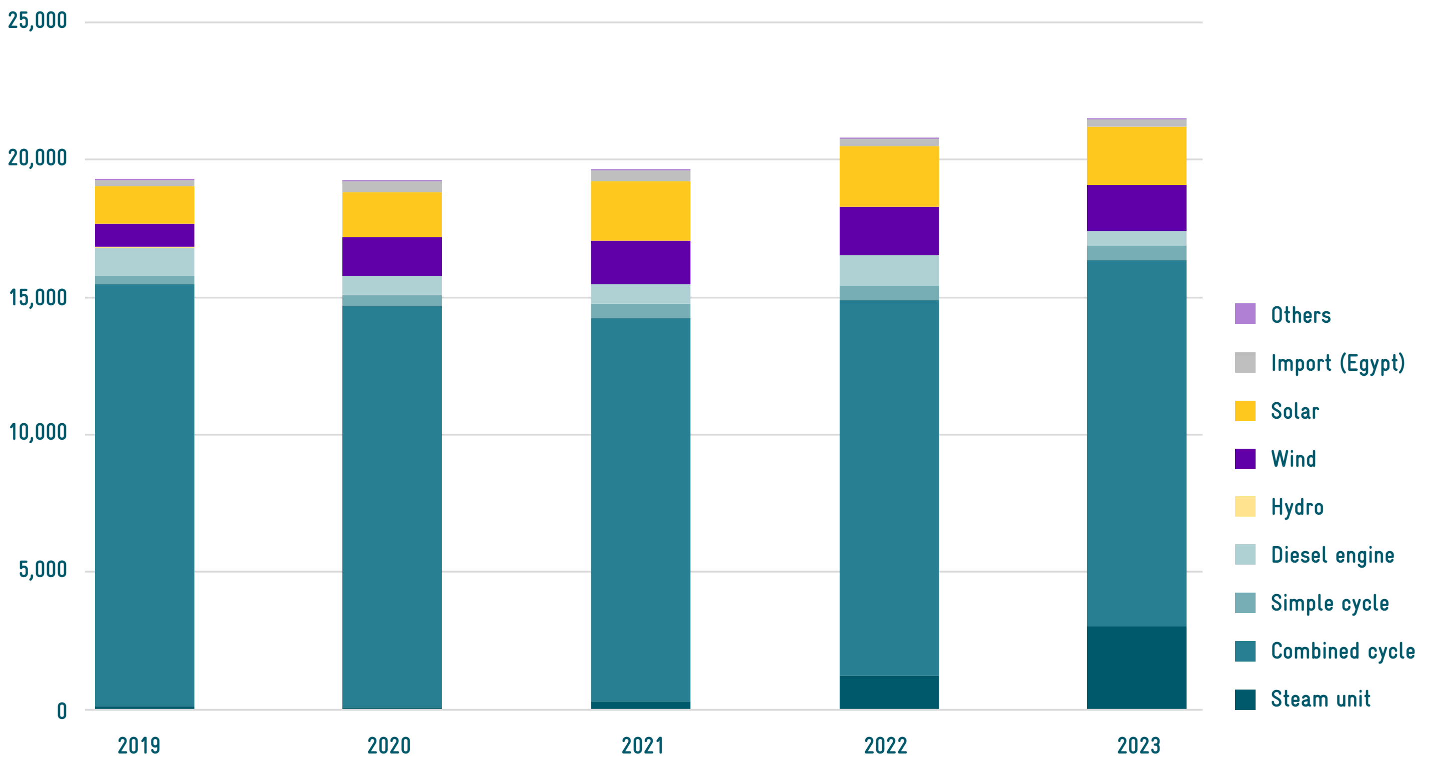
This section introduces the historical development of Jordan's energy sector up to the present day, with a focus on renewable energy penetration and development.

1.2.1 Evolution of the energy sector to the present

Jordan's energy sector has undergone significant transformations over the past few decades, particularly in the development and penetration of renewable energy sources. Historically, Jordan has heavily relied on imported oil and natural gas to meet its energy needs. Roughly 68% of its electricity is generated by natural gas (NEPCO, 2024). However, the country's lack of domestic fossil fuel resources and the volatility of global oil prices pushed Jordan to explore alternative, sustainable energy solutions, marking the onset of the renewable energy era.

The exploration of renewable energy in Jordan began in earnest in the early 2000s, when the government started to implement policies aimed at diversifying its energy sources. Solar and wind energy have been at the forefront of Jordan's renewable energy push. The country enjoys abundant sunlight and favourable wind corridors, which are conducive to the development of solar and wind farms. In the last five years, the amount of electricity generated by renewable energy increased from 2,236 GWh (2019) to 3,813 GWh (2023), growing at an annual rate of 14% (NEPCO, 2024). The promising deployment and favourable resources of renewable energy are significant factors in the path towards the rollout of green hydrogen/ammonia.

FIGURE 2. Evolution of electricity generation by source in Jordan since 2019 (in GWh)



Source: Authors' own compilation, Fichtner (2025) based on (NEPCO, 2024)

As shown in Figure 3, in 2022 the industrial sector accounted for 26% of final energy consumption (IEA, 2024a). The main sources of energy used by industry in Jordan are electricity (39%), natural gas (22%), heavy fuel oil (15%), diesel (12%), and coal (11%) (MEMR, 2024a).

Energy infrastructure

The transmission network in Jordan is operated by NEPCO. In total, NEPCO operates 5,889 km of transmission lines (NEPCO, 2024) (Wuppertal Insitut, 2021). Jordan has upgraded its transmission system with smart grid technologies to handle the variability of renewable energy. However, limited grid capacity still restricts expansion. To address this, NEPCO launched the Green Corridor project to expand the grid in the south, enabling greater integration and transfer of renewable electricity to key demand areas (AFD, 2025).

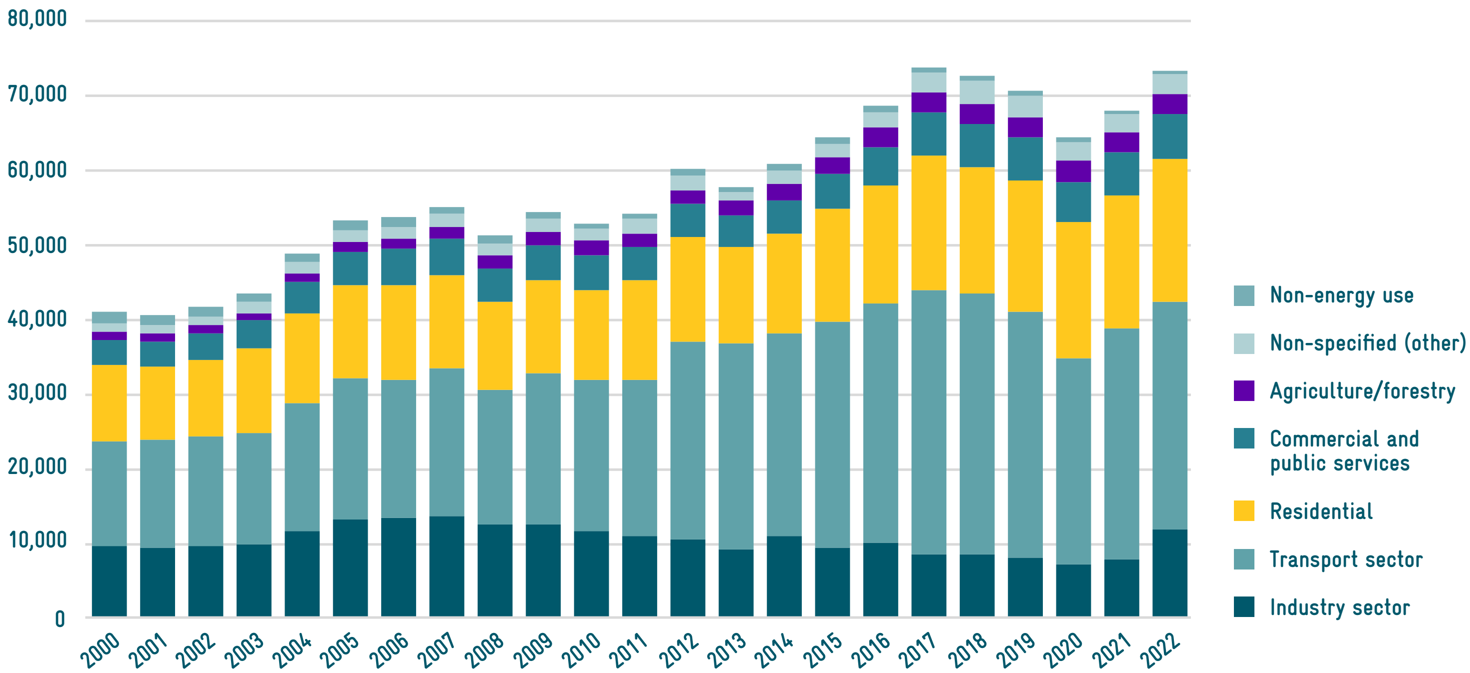
1.2.2 Forecasted evolution of the energy sector

Jordan's energy sector is poised for continued growth and evolution. The Energy Strategy to 2030 estimates that primary energy demand will reach 137 TWh by 2030 (117 TWh in 2020), and electricity demand 19.7 TWh by 2030 (17.7 TWh in 2020). Particularly in the realm of renewable energy, the country has set ambitious targets and initiatives to enhance its energy self-sufficiency and sustainability. By 2030, Jordan aims to increase the share of renewable energy in the total primary energy mix from 11% (2020) to 14%, and from 21% (2020) to 31% in electricity generation (MEMR, 2020).

Several anticipated developments are key to achieving the transition to the green economy:

- Green hydrogen production
- Energy storage solutions
- Enhanced grid infrastructure and smart grids
- Regulatory and policy enhancements

FIGURE 3. Evolution of final energy consumption by sector in Jordan since 2000 (in GWh)



Source: Authors' own compilation, Fichtner (2025) based on (IEA, 2024a)

1.3 Legislative and regulatory framework

Figure 4 shows the overview of Jordan's renewable energy legislative and regulatory framework, highlighting key laws and directives supporting the energy transition and key initiatives supporting Jordan's green hydrogen development.

FURTHER INITIATIVES

National Committee for Green Hydrogen
Established in 2023

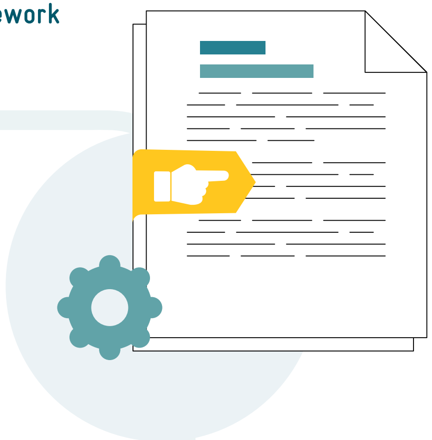
Economic Modernization Vision
Integrates green hydrogen as a strategic priority

Achievements Report of the Ministry of Energy and Mineral Resources for the Economic Modernization Vision 2024
Highlights progress in reducing energy sector costs and advancing renewable energy initiatives in Jordan

Public Consultations by USAID ESSA
Stakeholder engagement for refining the National Green Hydrogen Strategy

EBRD - ILF Consulting Engineers Feasibility Support
Provides consulting for project development, focusing on environmental, technical, and economic aspects

FIGURE 4. Overview of Jordan's renewable energy legislative and regulatory framework



POLITICAL FRAMEWORK

Jordan has established a comprehensive legislative and regulatory framework to enable its renewable energy transition.

Renewable Energy and Energy Efficiency Law No. 13 (amended by Law No, 12, 2024)
Promotes renewable energy development and energy efficiency improvements

Investment Environment Law No. 21 (2022)
Facilitates investment by providing fiscal and administrative incentives for energy and infrastructure

Directive for Connecting Renewable Energy Facilities
Outlines cost and technical requirements for connecting renewable energy facilities to the distribution system

General Electricity Law No. 64 (2002)
Regulates electricity licensing and operations in Jordan

Public Electricity Draft Law (2024)
Updates regulations for electricity generation, distribution, and renewable energy integration

Energy and Minerals Regulatory Commission (EMRC) Law No. 8 (2017)
Establishes EMRC as the regulatory authority for energy projects

The Aqaba Special Economic Zone Law No. 32 (2000, amended)
Governs economic activities within ASEZA, including renewable energy and green hydrogen projects

Environmental Impact Assessment (EIA) Bylaw No. 69 (2020)
Ensures sustainable project development and environmental protection

Source: Authors' own compilation, Fichtner (2025)

2

Industrial applications of hydrogen/ammonia

This section provides a general overview of today's and future potential hydrogen uses, before a more detailed view of Jordan is presented. As this study is focusing on local GH_2 production and consumption, no logistical limitations have been considered. In a large-scale environment, the hydrogen supply chain still lacks maturity in intercontinental transport options (see section 2.3).

2.1 Hydrogen uses and most common downstream products

Hydrogen can be produced through different processes according to the energy source and technology used, as summarised in the following table. The hydrogen used to cover the current demand comes almost exclusively from the processing of fossil fuels (natural gas and coal) through methane reforming and coal gasification.

TABLE 1. Production methods of hydrogen

Production process	Energy source	Technology options	Products	CO_2 emissions
Methane reforming	Natural gas	• Steam methane reforming (SMR) • Autothermal reforming (ATR)	H_2, CO, CO_2, N_2	• High CO_2 emissions • Potential combination with CCS to reduce CO_2 emissions
Coal gasification	Coal	• Gasification/reaction with O_2 and steam at high pressure and temperatures	H_2, CO, CO_2, N_2	
Methane pyrolysis	Natural gas	• Thermal decomposition at high temperatures without O_2	H_2, CO, CO_2	
Biomass gasification	Biomass	• Heating with limited oxygen	H_2, CO, CO_2	• Low to zero CO_2 emissions
Electrolysis	Electricity	• Electrolysis (AEC, PEMEC, SOEC, AEMEC)	H_2, O_2	• CO_2 emissions depend on electricity source • Low to zero for renewable energy sources

CCS	carbon capture and storage
AEC	alkaline electrolysis cell
PEMEC	proton exchange membrane electrolysis cell
SOEC	solid oxide electrolysis cell
AEMEC	anion exchange membrane electrolysis cell

Source: Authors' own compilation, Fichtner (2025)

2.1.1 Introduction to hydrogen-based products

Hydrogen is a key component of the global energy and industrial landscape, with similar applications worldwide. The data presented in this section reflects the global context of hydrogen and is location-independent.

Hydrogen demand reached 97 MTPA in 2023, when the largest consumers of hydrogen were refining (44%), ammonia production (33%), and methanol production (17%). Some 5% of hydrogen is used for direct reduced iron (DRI) in the iron and steel sector and small amounts are used in other segments such as glassmaking, electronics, and metal processing, accounting for 1 MTPA or 1% of current global hydrogen demand (IEA, 2024b).

Other minor current uses of hydrogen include aerospace, as a propellant, and energy storage for balancing renewable energy supply and demand.

1 In refineries, hydrogen is required for hydrocracking and hydrotreating, but it is also generated, mainly during catalytic reformulation: 18 kg of hydrogen/tonne of crude oil (Fuel Cells and Hydrogen Observatory, 2021).

TABLE 2. Current uses of hydrogen

Current uses	Main processes/products	Specific requirements
Refining[1]	• Hydrocracking, hydrotreating and desulphurisation	• Depends on refinery complexity and oil quality: 8–14 kg H_2/tonne refined product
Ammonia	• Fertiliser production • Chemical production: e.g. nitric acid, amines, explosives • Refrigeration	• Stochiometric: 178 kg H_2/tonne ammonia
Methanol	• Fuel: methyl tertiary butyl ether (MTBE) • Solvent • Antifreeze • Chemical feedstock: e.g. formaldehyde, acetic acid	• Stochiometric: CO_2 hydrogenation: 189 kg H_2/tonne methanol CO hydrogenation: 126 kg H_2/tonne methanol
Chemical industry	• Oxo alcohols	• Depends on olefin, process and product, stoichiometrically between 10–30 kg H_2/ tonne oxo alcohol
	• Fatty alcohols	• Depends on production process and product, stoichiometrically between 10–20 kg H_2/ tonne fatty alcohol
	• Hydrogen peroxide (H_2O_2)	• Stochiometric: 59 kg H_2/tonne H_2O_2
	• Cyclohexane (C_6H_{12})	• Stochiometric: 71 kg H_2/tonne cyclohexane
	• Hydrochloric acid (HCl)	• Stochiometric: 55 kg H_2/tonne HCl
	• Caprolactam	• Depends on the production process, between 30–50 kg H_2/tonne caprolactam

Current uses	Main processes/products	Specific requirements
Chemical industry	• Phenol production[2] • Acetone production via hydrogenation of isopropyl alcohol • 1,4-Butanediol (BDO) • Fine chemicals and pharmaceuticals as reducing agent	• Depends on the production process, between 10–30 kg H_2/tonne phenol • Stochiometric: 34 kg H_2/tonne acetone • Stochiometric: 23 kg H_2/tonne BDO • Depends on processes and products
Iron and steel	• As reducing agent in direct reduced iron (DRI) • As reducing atmosphere in annealing process in steel roll mills	• Depends on iron ore quality: ~60 kg H_2/tonne steel
Glass	• Glass melting as reducing agent to improve quality • Specialty glasses to control optical properties • Alternative fuel or furnaces to replace e.g. natural gas	• As reducing agent: 0.4 kg H_2/tonne float glass
Electronics	• Chemical vapour deposition, mainly e.g. for semiconductor manufacturing and LED production • Reduction agent	• 45–90 kg H_2/tonne semiconductor
Food industry	• Hydrogenation of oils (fats) and fatty acids	• Depends on oil/fat, required product and process: 5–100 kg H_2/tonne unsaturated fat processed
Metal processing	• Pure or in a mixture as shielding gas for welding processes	• Depends on process

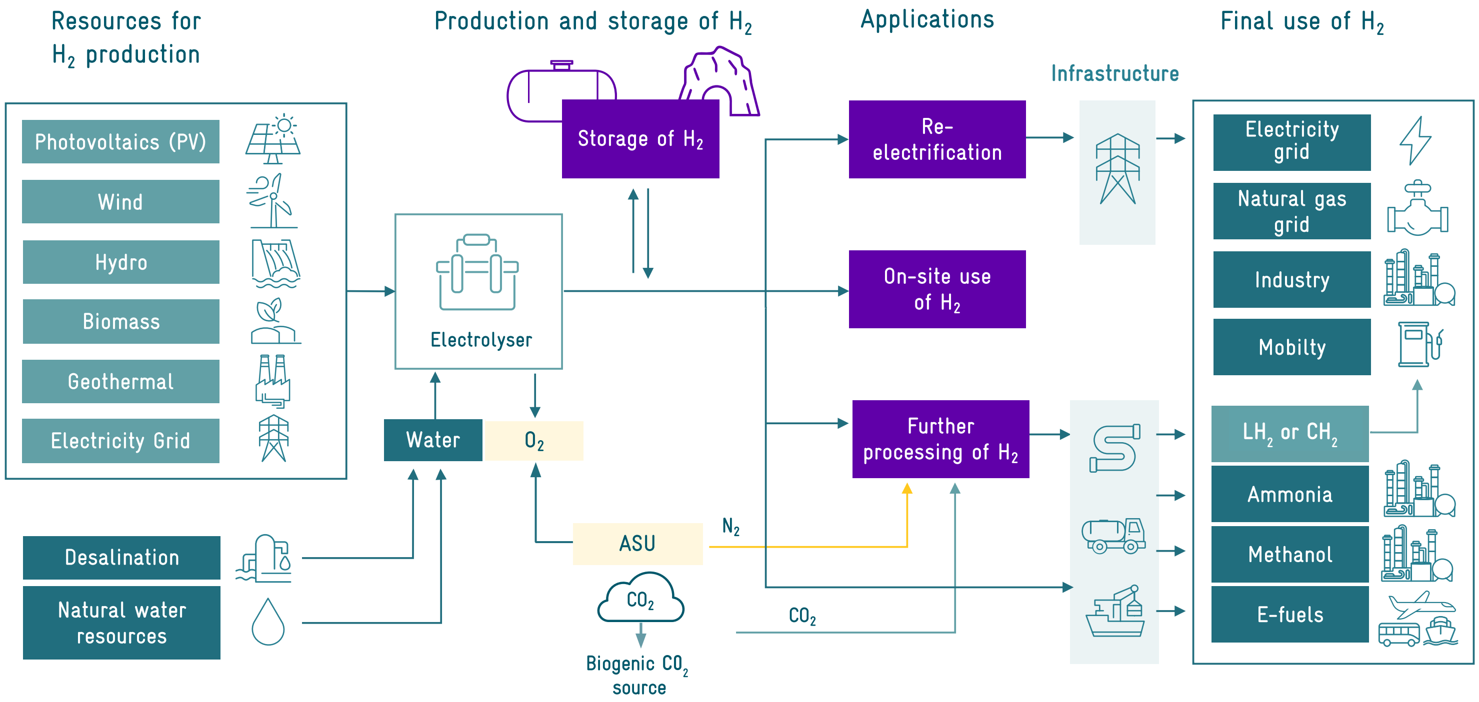
2 The most common production process for phenol and acetone is the cumene process. This process does not require hydrogen directly, but it can be required for refining acetone (removal of impurities).

Source: Authors' own compilation, Fichtner (2025) based on (Bressan, L. et al., 2009), (Fuel Cells and Hydrogen Observatory, 2021), (Wasserstoff Kompass, 2022), (Semiconductor Digest, 2018)

While demand for hydrogen has been concentrated in refining and some industrial applications, the adoption of clean hydrogen in new applications will play a key role in the energy transition. This will include the replacement of current hydrogen demand with green hydrogen produced via electrolysis (as shown in Figure 5), for example, but also new areas of use such as mobility (road, air, and maritime transport), electricity generation, production of synthetic fuels (e-fuels), and high-temperature heat generation, among others. The switch from conventional production processes to electrolysis for hydrogen generation will require additional feedstocks for derivatives production, including a nitrogen source for ammonia production and a sustainable CO_2 source for methanol and synthetic fuel production.

These applications provide a first indication of how green hydrogen might be used in the future. Which applications gain traction will largely depend on possible alternative technologies with which hydrogen will have to compete, on national and international decarbonisation targets and commitments, and on available energy sources in the individual countries.

FIGURE 5. Value chain of potential applications of green hydrogen



Storage: In tanks or geological.

H_2	Hydrogen
LH_2	Liquefied hydrogen
CH_2	Compressed hydrogen
ASU	Air separation unit

Source: Authors' own compilation, Fichtner (2025)

2.1.2 Ammonia and fertilisers

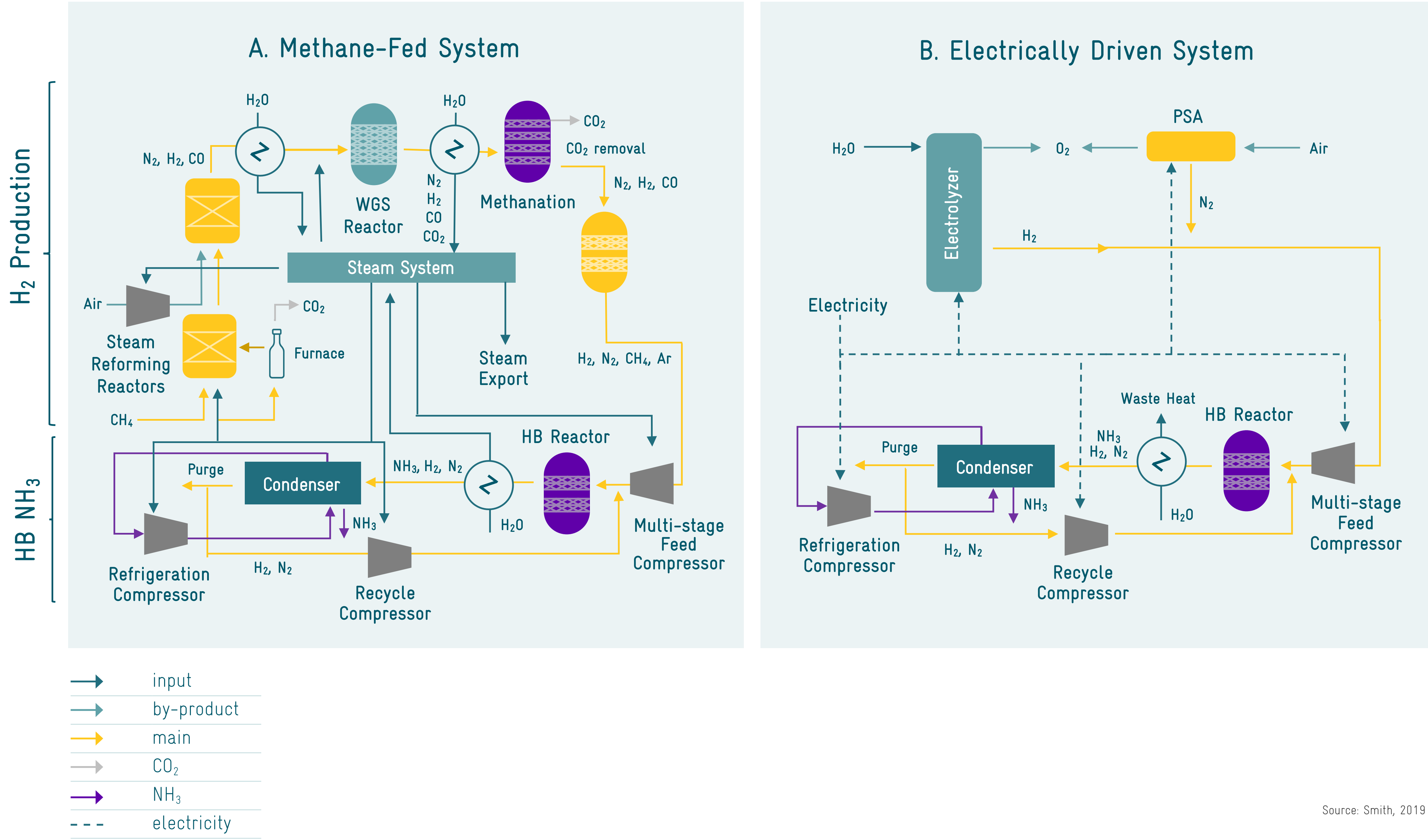
Ammonia production is the second-largest use of hydrogen, accounting for 33% of total hydrogen demand. Ammonia is a key precursor in the industry and is mainly used for nitrogen-based fertilisers (around 70-80%), and other industrial applications such as plastic and explosive production.

Ammonia is synthesised via the Haber-Bosch (HB) process, in which hydrogen (H_2) reacts with nitrogen (N_2) to form ammonia (NH_3) under high pressures and high temperatures. A schematic of the conventional HB process, as well as a green hydrogen-based process, is shown in Figure 6. The green ammonia option is an electrically driven system; it requires an external source of nitrogen (e.g. from air through an air separation unit, ASU), and the compressors that are steam-driven in the conventional process are mainly electrically driven.

Ammonia is a key ingredient in nitrogen fertilisers and, as such, critical for crop growth. The following table presents an overview of some commonly used fertilisers.

It should be noted that the production processes of some of the fertilisers require a carbon source, which needs to be sustainable in order to obtain green fertilisers. Possible solutions are direct air capture (DAC), carbon capture and use (CCU) from unavoidable industrial sources, or biomass treatment processes. Globally, only a few industrial or commercial-scale projects are currently available for sustainable carbon sourcing.

FIGURE 6. Schematic of conventional (A) and green (B) Haber-Bosch process



Source: Smith, 2019

TABLE 3. Key nitrogen fertilisers

Fertilisers	Production process	Specific H_2 requirement (stochiometric)	Global production [MTPA]
Ammonia (NH_3)	Haber-Bosch process $N_2 + 3H_2 \rightarrow 2NH_3$	177 kg H_2/t NH_3	145
Urea	NH_3 and CO_2 from HB fed into a high-pressure reactor (or urea reactor) $2NH_3 + CO_2 \rightarrow CH_4N_2O + H_2O$	100 kg H_2/t urea	234
Ammonium nitrate (AN)	Neutralisation process in which NH_3 (gas) is mixed with HNO_3 (liquid) in neutraliser $NH_3 + HNO_3 \rightarrow NH_4NO_3$	40 kg H_2/t AN	45
Calcium ammonium nitrate (CAN)	Blending of AN (solution) with limestone (calcium carbonate) in a mixing unit and granulation of product $NH_4NO_3 + CaCO_3 \rightarrow Ca(NO_3)_2 + NH_4 + CO_2 + H_2O$	50 kg H_2/t CAN	13
Urea ammonium nitrate (UAN)	Mixing solutions of urea and AN and dilution with water	7 kg H_2/t UAN	23
Ammonium sulphate (AS)	By-product of caprolactam production (raw material for nylon) $2NH_3 + H_2SO_4 \rightarrow (NH_4)_2SO_4$	50 kg H_2/t AS	30
Diammonium phosphate (DAP)	Reaction of NH_3 with phosphoric acid and posterior granulation $H_3PO_4 + 2NH_3 \rightarrow (NH_4)_2PO_4$	46 kg H_2/t DAP	28
Monoammonium phosphate (MAP)	Reaction of NH_3 with phosphoric acid and posterior granulation $H_3PO_4 + NH_3 \rightarrow NH_4H_2PO_4$	26 kg H_2/t MAP	29

Source: Authors' own compilation, Fichtner (2025). Global annual production in 2022 based on (Statista, 2024) and (Chemanalyst, 2023)

2.2 National overview of hydrogen/ammonia

This section provides some background on the current and future demand for hydrogen/ammonia within Jordan.

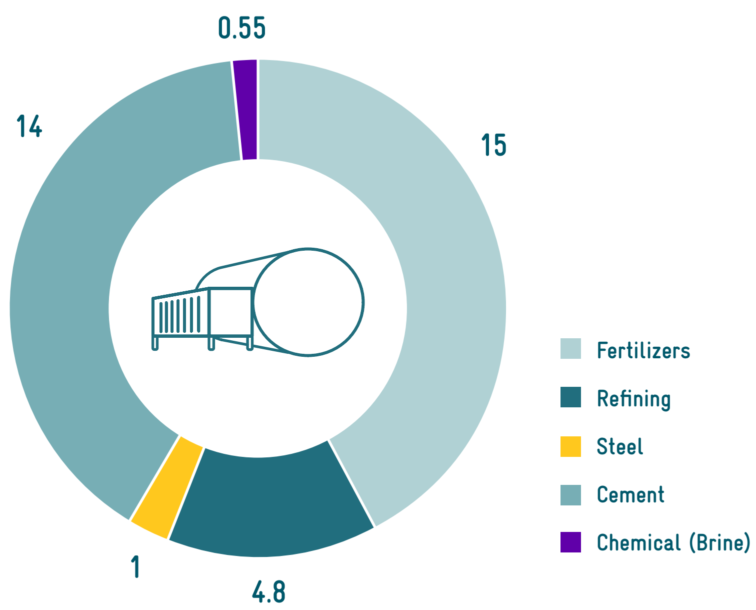
2.2.1 Overview of the national industry

Current hydrogen consumption in Jordan is limited, and mostly occurs in the refinery and chemical industry (hydrogen bromide, caustic and chlorine production) where hydrogen is obtained from its own by-products or SMR facilities. The estimation of realistic future hydrogen/ammonia demand broken down by industry, energy and transportation sectors is based on published reports, statistics, known production capacities of main industries, typical hydrogen consumption ratios per unit of final product, and the assumption of continuous full-load operation of the plants. Consequently, the estimation represents the maximum theoretical hydrogen demand in Jordan, though actual annual demand is likely to be lower.

Looking at future local GH_2 off-takers in Jordan, the fertiliser and refinery industries emerge as prime candidates for green hydrogen integration due to their economic significance and higher technical feasibility. Conversely, despite potential benefits, the steel and cement industries face economic barriers; the high costs associated with hydrogen infrastructure and production undermine their feasibility compared to conventional fuels

Further details of the potential hydrogen/ammonia demand in the various industry sectors are given in the following sections.

FIGURE 7. Estimated future potential local hydrogen-equivalent demand in Jordan by sector (in KTPA)



Source: Authors' own compilation based on public presentation of Assessment of the Number of Potential Jobs and Skills Needs by Prof. Lutfi Al-Sharif, HTU and (MEMR, 2023).

2.2.2 The fertiliser industry

Looking at the value chain of ammonia in Jordan (quantities, source, import channels, storage, means of transport within Jordan, final consumers), the fertiliser industry is the largest industrial player.

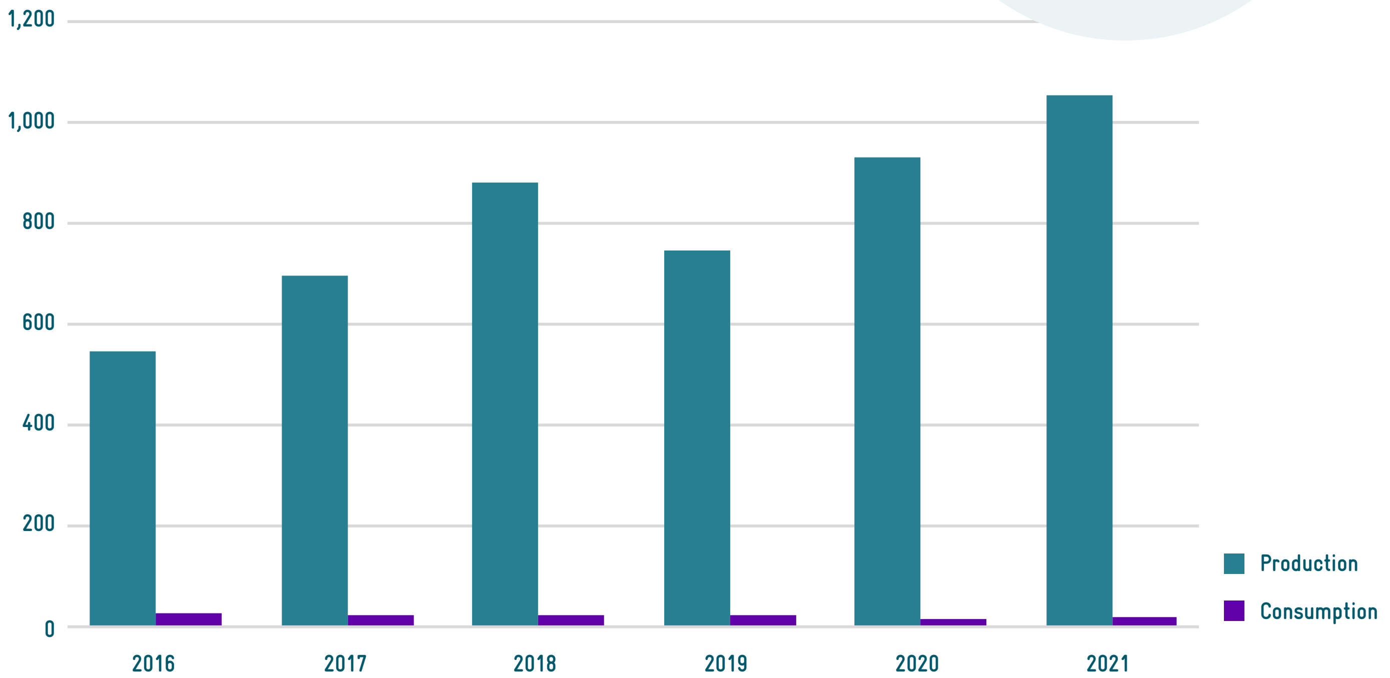
Jordanian fertiliser is among the products for which demand is increasing as it supports the industrial and agricultural sectors, which play an essential role in enhancing and improving food security and supporting agricultural outputs, both plant and animal. This has contributed to the development of these industries and the establishment of pilot projects.

Production/consumption

Figure 8 shows the domestic consumption and production of fertiliser. Jordan's fertiliser industry is export-oriented. Due to Jordan's large reserves of phosphate and its potash fertiliser industries, Jordan uses ammonia as feedstock mainly for the production of potassium nitrate (NOP), diammonium phosphate (DAP), mixed nitrogen, phosphorus, and potassium (NPK), sulphuric acid, and phosphoric acid. Total fertiliser production was 1,055 KTPA in 2021 (MEMR, 2023). A fertiliser is considered high-end if its production involves costly inputs like ammonia or hydrogen. By this measure, Jordan's fertiliser qualifies as high-end, making the industry a key potential off-taker for green ammonia and hydrogen.

The domestic demand for fertiliser was around 20 KTPA in 2021, around 2% of the production capacity. Therefore, domestic demand is not considered to be the main off-taker of the future green ammonia business.

FIGURE 8. Fertiliser production and consumption in Jordan (in KTPA)



Source: Authors' own compilation, Fichtner (2025) based on (MEMR, 2021), (FAO, 2025a), (FAO, 2025b)

Most ammonia used for fertiliser production in Jordan is imported, with 248,145 tonnes imported in 2022 (WITS, 2025). JPMC is the sole importer of ammonia in Jordan and supplies other companies with ammonia via an ammonia pipeline. Transitioning to onsite green ammonia production could significantly reduce import dependency, stabilise market prices, and enhance the sustainability of fertiliser production.

The imported ammonia is utilised by 13 fertiliser companies primarily clustered near the Port of Aqaba, where KEMAPCO, JMPC, JIFCO, and NJFC are the major players. Table 4 shows the main fertiliser players with their production capacity and ammonia demand in Jordan.

NOP	Potassium nitrate
DAP	Diammonium phosphate
NPK	Nitrogen phosphorus and potassium fertiliser
MAP	Magnesium ammonium phosphate
NPS	Nitrogen phosphorus and sulphur fertiliser

3 JIFCO, IJC, and JAFCCO are subsidiaries of JPMC. The production amount is counted accordingly.

TABLE 4. Main fertiliser plants in Jordan

Company	Location	Status	Fertiliser type and production capacity [KTPA]	Ammonia demand [KTPA]
Arab Fertilizers & Chemicals Industries (KEMAPCO)	Aqaba	Current	NOP: 175	Ammonia: 37
Jordan Phosphate Mines Company (JPMC)[3]	Aqaba	Current	DAP: 674 Phosphoric acid: 272 Sulphuric acid: 920	Ammonia: 110
Jordan India Fertiliser Company (JIFCO)	Eshidiya	Current	NPK7 & DAP5: 276	Ammonia: 60
Indo Jordan Chemicals Company (IJC)	Eshidiya	Current	Phosphoric acid: 326	No direct ammonia use
Nippon Jordan Fertilizer Company (NJFC)	Eshidiya	Current	DAP5, MAP, NPK, NPS: 349	Ammonia: 70
Modern Company for Fertilizer Production (MCFP)	Sahab (Amman)	Current	NPK7: 6	Ammonia: 1
Jordan Abyad Fertilizers and Chemicals Company P.S.C (JAFCCO)	Al Abiad	Current	Potassium sulphate: 80 Triple super phosphate: 65 Dicalcium phosphate dihydrate: 12 Calcium chloride: 55 Phosphoric acid: 54 Sulphuric acid: 132 Hydrochloric acid: 100	No direct ammonia use
Alanfal Fertilizers	Al-Muwaqqar (Amman)	Current	NPK7: Not available	Not available

Source: Authors' own compilation, Fichtner (2025) based on public presentation of Assessment of the Number of Potential Jobs and Skills Needs by Prof. Lutfi Al-Sharif, (KEMAPCO, 2025), (JPMC, 2025a), (IFFCO, 2025), (JPMC, 2025b), GIZ

2.2.3 The refinery industry

Jordan's only refinery, operated by JPRC, processes around 36,000 barrels per day (approx. 1,787 KTPA) and uses 4.8 KTPA of hydrogen for hydrocracking and desulphurisation, produced from naphtha. A planned expansion could double capacity and increase hydrogen demand by up to 9.6 KTPA, though future demand is uncertain due to competition from imports. Table 5 outlines the refinery's location, capacity, and hydrogen needs (MEMR, 2023).

TABLE 5. Main refinery plants in Jordan

Company	Location	Status	Capacity [kTPA]	Hydrogen demand [kTPA]
Jordan Petroleum Refinery Company (JPRC)	Zarqa	Current	Diesel, gasoline, jet fuel, LPG, fuel oil: 1,787	4.8
		Expansion		9.6

Source: Authors' own compilation, Fichtner (2025) based on (MEMR, 2023), GIZ

Note: Data on hydrogen demand to be verified by data which will be provided by MEMR)

2.2.4 The chemical industry

Jordan's by-product hydrogen comes mainly from JBC, BCC, and NCI—used internally, unclear, and vented, respectively—highlighting opportunities for better use and decarbonisation (see Table 6). Meanwhile, Jordan's organic chemical industry remains limited, with heavy reliance on imports, including 9,695 metric tons of hydrogen peroxide in 2019 from key suppliers such as Germany, France, the USA, Italy, and Switzerland (WITS, 2025).

TABLE 6. Main chemical plants in Jordan

Company	Location	Status	Capacity [kTPA]	Hydrogen demand [kTPA]
Jordan Bromine Company (JBC)	Safi	Current	Bromine, hydrogen bromide (HBr), other derivatives: 115	0.5
Al-Baha Company for Caustic- Chlorine Industry (BCCI)	Zarqa	Current	NaOH: 30 Chlorine: 25	30 (hydrogen as by-product, not demand)
National Chlorine Industries (NCI)	Amman	Current	Sodium hydroxide: 18	Unavailable (hydrogen as by-product, not demand)

Source: Authors' own compilation, Fichtner (2025) based on (U.S. Geological Survey, 2024) and public presentation of Assessment of the Number of Potential Jobs and Skills Needs by Prof. Lutfi Al-Sharif, GIZ

2.3 Industry clusters and enabling infrastructure

Jordan aims to harness green hydrogen and ammonia through robust infrastructure, industrial zones, and strategic investments. The Aqaba Special Economic Zone plays a central role, offering tax incentives, port access, renewable energy, and desalinated water (MEMR, 2024).

Electricity and water infrastructure

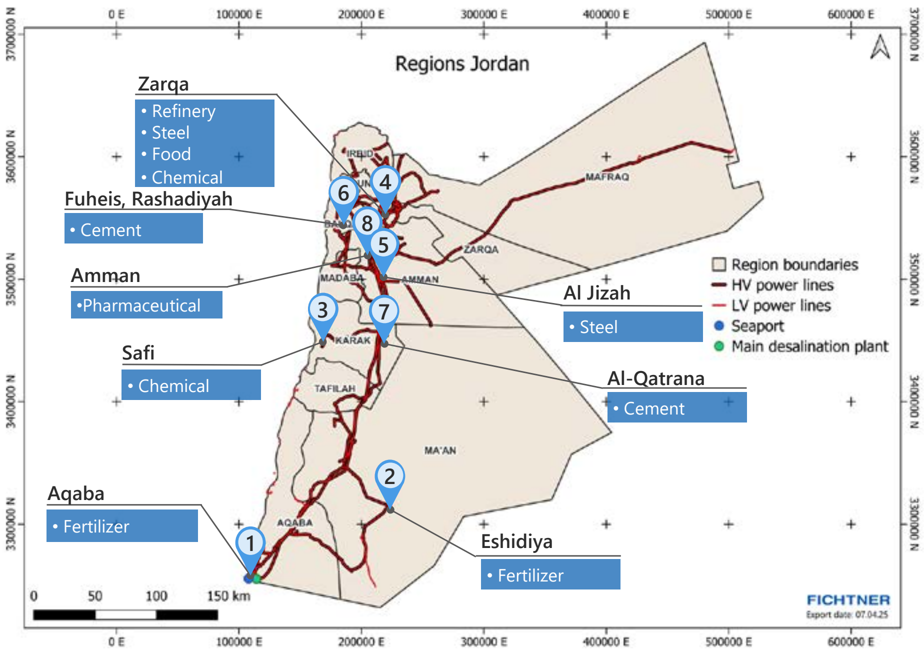
Jordan has enhanced its electricity and water infrastructure to support green hydrogen production. NEPCO is improving grid resilience and smart energy management to ensure reliable, renewable power for electrolysis. On the water side, projects like the Aqaba-Amman Desalination and Conveyance Project (AAWDCP) secure sustainable water supplies, while recycling systems in industrial zones reduce freshwater use, supporting responsible hydrogen production.

Industry clusters

Jordan's industrial zones, managed by the Jordan Industrial Estates Company (JIEC), offer a favourable setting for green hydrogen and ammonia production. Strategically located for renewable energy access, these estates host around 35% of the country's medium to large industries—870 out of 2,502 facilities (ESSA, 2023). Jordan has nine operational public industrial zones, with five more in development, alongside several private zones managed by JIEC. The planned green ammonia and hydrogen plant in Aqaba strengthens industrial capacity, while KaMP offers further opportunities to integrate green hydrogen production with existing industries, enhancing efficiency and sustainability.

FIGURE 9. Overview of infrastructure and industry cluster

Industrial Clusters



Key Companies

	Company	[kTPA]
1	**Arab Fertilizers & Chemicals Industries** (KEMAPCO)	175
	Jordan Phosphate Mines Company (JPMC)	700
2	**Jordan India Fertilizer Company** (JIFCO)	498
	Nippon Jordan Fertilizer Company (NJFC)	300
3	**Jordan Bromine Company** (JBC)	115
4	**Jordan Petroleum Refinery Company** (JPRC)	1,787
	Jordan Steel Group (JOST)	610
	Al-Baha Company for Caustic and Chlorine (BCC)	55
	Jordan Vegetable Oil Industries Co	37
5	**United Iron**	350
6	**Lafarge Jordan Cement**	4,000
7	**Modern Cement and Mining Company**	1,800
8	**Hikma Pharmaceuticals,**	-
	Jordanian Pharmaceutical Manufacturing Co.	-

Source: Authors' own compilation, Fichtner (2025) based on (KEMAPCO, 2025), (JPMC, 2025a), (IFFCO, 2025), (JPMC, 2025b), (MEMR, 2023)

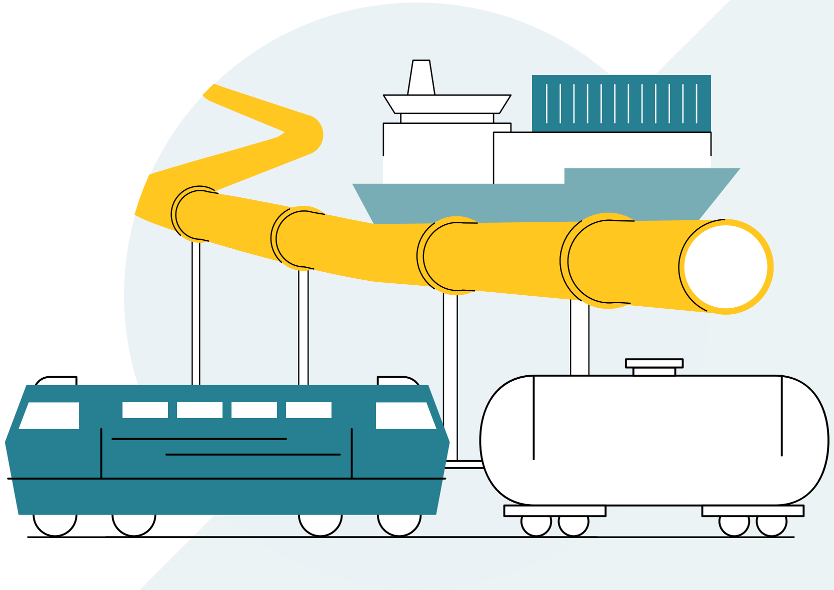
Transport, ports, and export infrastructure

Jordan's strong road network connects industrial zones to key logistics centres, supporting domestic and export transport of hydrogen and ammonia. Planned rail projects aim to cut logistics costs and emissions. Logistics zones in Al Quweira and JIEC-managed estates offer strategic support for hydrogen supply chains.

The Port of Aqaba, Jordan's only seaport, is central to its green hydrogen and ammonia export plans. It is being upgraded to handle larger volumes, with existing ammonia facilities expandable for increased exports. Future hydrogen terminals will help Jordan access European and Asian markets. ASEZA offers investment incentives and fast-tracked approvals for hydrogen-related projects.

Gas, oil, and ammonia infrastructure

Jordan's energy infrastructure, including the Arab Gas Pipeline and Zarqa refinery, supports future hydrogen use and transport. Expanding hydrogen storage and distribution is vital for industrial growth. Green ammonia, backed by a strong fertiliser sector, serves both domestic needs and exports. Aqaba's bunkering capacity positions Jordan as a regional low-carbon fuel hub.



3

Green hydrogen/ammonia potential in Jordan and use cases

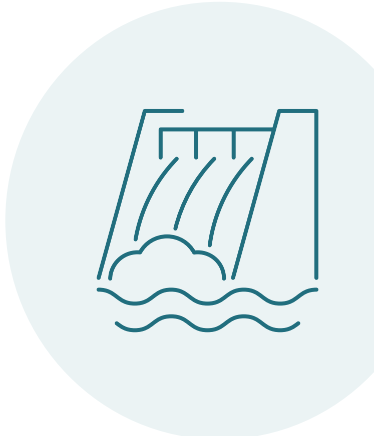
Jordan has the potential to become a major producer of green hydrogen, leveraging its renewable energy resources and strategic geographical location. With significant domestic hydrogen demand in fertiliser and oil refining, as well as proximity to major international markets in Europe, Jordan is well-positioned to develop a competitive hydrogen industry

3.1 Hydrogen/ammonia potential within the country

Jordan possesses exceptional renewable energy potential, which can be harnessed for green hydrogen production. The country's high solar radiation and strong wind corridors create a strong foundation for developing a large-scale hydrogen economy.

- **Solar resources:** Jordan's solar energy resources are abundant, particularly due to its geographical location, which offers high solar irradiance. Global horizontal irradiance (GHI) levels in the country lie within a range of approximately 2,000-3,000 kWh/kWp, with the highest values observed in the eastern desert regions. This makes areas such as Ma'an and the Mafraq Governorate prime locations for solar power plants, facilitating the nation's shift towards renewable energy.
- **Wind resources:** Wind resources in Jordan are moderate, especially in the northern and western highlands, where average wind density can reach about 900 W/m^2. Locations like the Tafila region have become significant for wind energy development, hosting several large wind farms that capitalise on these consistent wind patterns to generate electricity, supporting Jordan's energy diversification goals.

Jordan faces significant water scarcity, ranking among the world's driest countries with approximately 61 cubic metres of water available per person annually in 2021 (The Ministry of Water and Irrigation, 2023). The main water sources in Jordan are groundwater, surface water and reclaimed water. Around a quarter of Jordan's renewable freshwater from aquifers and rivers originates from neighbouring countries (The Ministry of Water and Irrigation, 2023). The challenge is heightened by the high water demand for hydrogen production. To address this, Jordan is increasingly investing in desalination technologies, particularly in the Aqaba region, where desalinated water could potentially support hydrogen production through electrolysis. This approach seeks to create a sustainable water source for industrial uses while conserving the limited freshwater resources for domestic and agricultural needs, ensuring a balanced approach towards resource management and industrial development.



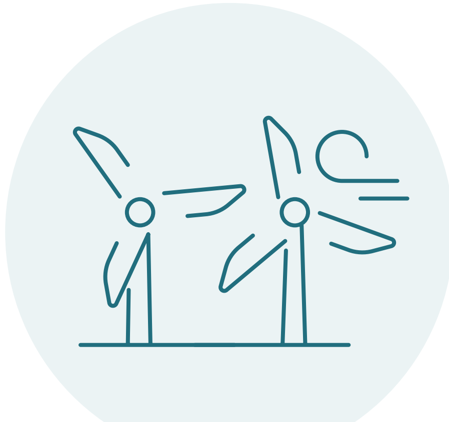
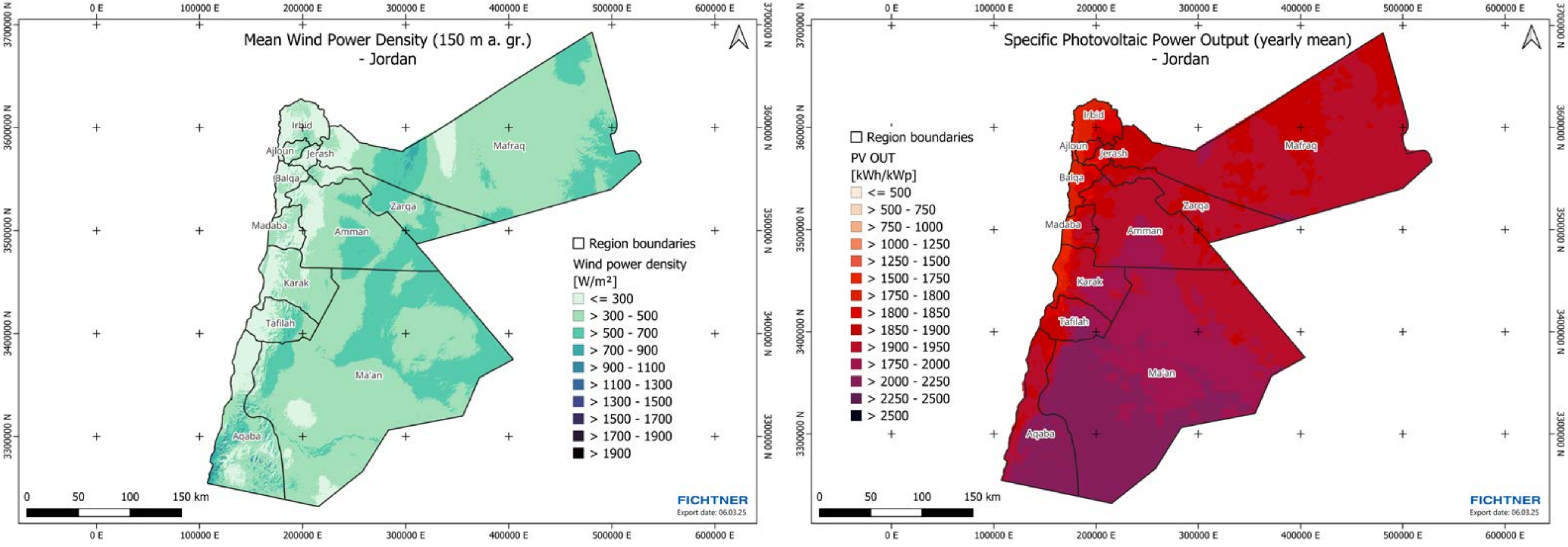


FIGURE 10. Mean wind power density and specific photovoltaic power output

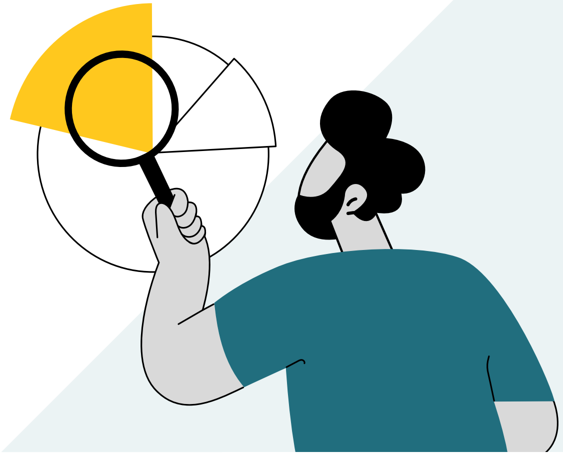


Source: Authors' own compilation, Fichtner (2025) based on (Global Wind Atlas, 2025)[4]

Source: Source: Authors' own compilation, Fichtner (2025) based on (Global Solar Atlas, 2025)[5]

4 Data obtained from the Global Wind Atlas version 3.3, a free, web-based application developed, owned, and operated by the Technical University of Denmark (DTU). The Global Wind Atlas version 3.3 is released in partnership with the World Bank Group, utilising data provided by Vortex, using funding provided by the Energy Sector Management Assistance Program (ESMAP). For additional information: https://globalwindatlas.info

5 Data obtained from the Global Solar Atlas 2.0, a free, web-based application developed and operated by Solargis s.r.o. on behalf of the World Bank Group, utilising Solargis data, with funding provided by the Energy Sector Management Assistance Program (ESMAP). For additional information: https://globalsolaratlas.info



3.2 Potential use cases

Jordan's diverse industrial landscape presents several promising opportunities for integrating green hydrogen, particularly within the chemical, fertiliser, steel, and oil-refining sectors. These applications can be segmented into small-scale and large-scale use cases, each with specific considerations regarding electrolyser capacities and sector-specific hydrogen consumption patterns.

Small-scale use cases – bromine (electrolyser capacity: 1+ MW)

Small-scale green hydrogen projects serve industries with moderate hydrogen demand or decentralised production needs. These setups prioritise on-site or near-site generation to minimise logistics costs and seamlessly integrate with existing processes. Electrolysers will then be typically powered by local wind or solar PV plants, supported by battery energy storage or hydrogen storage to manage fluctuations in electricity supply and hydrogen demand. In most cases, the hydrogen is consumed directly on -site, ensuring efficiency and reliability.

Typical small-scale applications include electronics, specialty glass production, welding processes, and the food industry – either for hydrogenation or as protective gas in food packaging. However, based on the analysis of the last section, hydrogen use in the food industry is very limited: Jordan has implemented a ban on the use of partially hydrogenated oils (PHOs) specifically in dairy products from 2017. Jordan Vegetable Oil Industries Co. produces vegetable ghee from palm oil. The use of hydrogen in hydrogenation in Jordan is limited. The glass industry mostly processes float glass. One key potential application in Jordan is in the brine industry.

The most promising small-scale use case in Jordan is in the bromine industry. Bromine production necessitates the use of a brine electrolyser for its production processes. Consequently, an electrolyser has been installed at the JBC site. Annually, JBC generates approximately 0.5 KTPA of hydrogen as a by-product through the brine electrolyser operations. It is estimated that a 1 MWe electrolyser can produce a maximum of 0.15 KTPA of hydrogen if the electrolyser operates at full load, categorising JBC within the small-scale use case involving a comparatively small electrolyser.

The business strategy does not involve the installation of new electrolysers; rather, it includes updating the existing power sources to renewable options, such as photovoltaics (PV), wind turbines, or green electricity from the grid with PPA contracts. The production facility, located in Safi, possesses ample space suitable for the development of renewable power infrastructure.

Furthermore, in this business case the cost mainly lies in the upgrading of power sources in comparison with normal green hydrogen projects, entailing investment in both the electrolyser and renewable power sources. This strategic decision not only enhances operational efficiency but also supports sustainability by integrating renewable energy sources into the production process.

Large-scale use cases – ammonia and fertiliser production (electrolyser capacity: 10 MW and above):

Large-scale green hydrogen projects serve industries with high and continuous hydrogen demand, maximising economies of scale through larger electrolyser installations and the utilisation of optimal wind and solar resources.

These projects typically feature large renewable energy facilities paired with nearby large-scale electrolysers, supported by infrastructure for electricity transmission, water supply, wastewater management, and hydrogen storage and transport to off-takers or ports. Extensive hydrogen storage is essential either to balance production fluctuations without disrupting downstream processes or to accommodate the periodic nature of maritime transport for export-oriented projects.

Unlike smaller-scale projects, large electrolysers are housed in dedicated buildings, as containerised solutions are more common for smaller installations. In some cases, desalination units may be required to ensure a sustainable water supply, depending on local availability.

Typical large-scale applications include ammonia and fertiliser production, chemicals (including methanol), and crude oil refining. In the future, iron & steel and cement may also emerge as major hydrogen consumers. In Jordan, the key potential application for large-scale green hydrogen is fertiliser production.

Ammonia is a key ingredient in most nitrogen fertilisers. Jordan produces a large amount of nitrogenous fertiliser, such as NOP and NPK. Despite the robust demand for ammonia, ammonia is imported into Jordan, making it dependent on imports. Switching to green hydrogen reduces the carbon footprint and increases the supply security of ammonia.

Established producers like KEMAPCO and JPMP in Aqaba, JIFCO, IJC, and NJFC in Eshidiya, and other smaller companies like MCFP in Sahab, JAFCCO in Al Abiad, and Alanfal in Al-Muwaqqar, are already using ammonia. The Port of Aqaba can potentially enable the export of green ammonia.

The global market for lower-carbon fertilisers is growing, driven by sustainability trends. Implementing green fertiliser production can enhance Jordan's competitiveness in agricultural exports, aligning with increasing demand for sustainably sourced products.

Techno-economic calculations of ammonia use cases (fertiliser industry)

The bromine industry might only require renewable energy facilities, but not hydrogen production. It is therefore expected that the production of green ammonia, which will be used to produce fertiliser, will be the main use case of hydrogen in Jordan.

To provide a preliminary indication of techno-economic feasibility for projects of varying scales, four different scenarios have been assessed for ammonia use in Aqaba, where good solar potential is available and off-takers are located. The four selected cases consider the following variables: production size, renewable electricity generation option, and financial support.

For these selected cases, the analysis examined the levelised cost of hydrogen and ammonia. Different electrolyser sizes are used to meet the demand targets. The main results of these four cases are summarised in Table 7. These results are based on exemplary renewable profiles at the location (Lat. 29.37354, Long. 35.00805). It should be noted that the results may vary significantly if industries are chosen in other parts of the country, for instance with different wind resources nearby, or if utility-scale projects with significantly larger component sizing are planned.

6 Price difference between LCOA proposed case and LCOA grey

TABLE 7. Techno-economic calculations for ammonia use cases

Case	Small-scale NH_3 (wind & PV)	Large-scale NH_3 (wind & PV)	Small-scale NH_3 (PV only)	Small-scale NH_3 (wind & PV) optimistic
Demand (H_2) [tonnes/a]	45	450	45	45
Demand (NH_3) [tonnes/a]	270	2,700	270	270
Installed RE capacity [MWp]	PV: 1.9 Wind: 0.5	PV: 8.3 Wind: 6	PV: 2.4	PV: 1.9 Wind: 0.5
Electrolyser size [MW]	0.8	6.3	0.9	0.8
Weighted average cost of capital (WACC) [%]	7.8	7.8	7.8	7.8
Ammonia price increase above inflation [% p.a.]	2%	2%	2%	3%
CO_2 emission price [USD/tCO_2]	0	0	0	110
Capex subsidies [million USD]	0	0	0	2.2
Total investment [million USD]	5.4	34.8	5.4	3.4
LCOA grey [USD/kg]	0.70	0.70	0.70	0.88
LCOH proposed case [USD/kg]	8.65	8.83	9.27	2.2
LCOA proposed case [USD/kg]	2.02	1.79	2.13	0.77
Excess RE sales [GWh]	1.3	5.23	1.21	1.3
Oxygen sales ['000 tonnes]	0.36	3.2	0.36	0.36
Project IRR [%]	1.5	0.9	0.7	9.5
Net present value (NPV) [million USD]	–1.8	–12.4	–1.9	0.6
Finance gap[6] [USD/kg]	1.3	1.1	1.4	–0.1

Source: Analyses performed by GIZ (2025), EUR 1 = USD 1.1

The complete assumptions, sizing, cost breakdown, financial parameters, and results are detailed in Annex 2: Techno-economic calculations. Based on the results presented in Table 7, the following can be concluded:

- **Production size:** Comparing the first two cases, the 'large-scale NH_3 (wind & PV)' scenario presents the lowest green LCOA at USD 1.79 per kg, making it more competitive relative to the alternatives.
- **Resource utilisation via various RE technologies:** The analysis reveals that wind resources at the selected location are favourable for effective electricity generation , as indicated by the lower LCOH and LCOA for green hydrogen in the 'small-scale NH_3 (wind & PV)' case compared to the 'small-scale H_2 (PV only)' case.
- **Financial feasibility of usual cases:** If the last, optimistic case is excluded, the NPV is negative across all three cases, and the 'small-scale NH_3 (wind & PV)' scenario offers the highest return at 1.5%. With the local prices for grey ammonia being significantly lower than those for green hydrogen, none of the projects can generate ammonia at lower cost and thus all projects have a financial gap. The 'large-scale NH_3 (wind & PV)' case has the smallest financial gap at USD 1.1 per kg of ammonia, highlighting its potential for large-scale implementation. This remaining gap might be closed by leveraging the funding mechanisms as described in section 2.
- **External funding:** The optimistic case assumes subsidies and a higher market price for ammonia. Given this optimistic market trend, the project NPV is positive at USD 0.6 million with a negative finance gap, i.e. the green ammonia is competitive.

Overall, and under current assumptions, the results show the general rationale of larger projects being more cost-efficient than small-scale projects. Nevertheless, they also require higher initial investment and are therefore associated with greater risk in terms of changing market developments. The LCOA is still not enough in either small- or larger-scale ammonia cases to compensate for this and reach a positive NPV. It is therefore clear that these projects are not economically feasible in the short term without intensive funding.

It is important to note that the aforementioned options provide an estimate of potential green hydrogen and ammonia costs; however, cost evaluations should be conducted on a project-by-project basis as factors such as the local renewable profile and the required industry's offtake profile (the analysis in Table 7 is based on a constant profile) can significantly influence the levelised cost, particularly due to their impact on the sizing of the electrolyser and storage system required. This effect is smaller for ammonia than hydrogen as the former has significantly lower storage costs. Additionally, securing an off-taker for the produced oxygen can be challenging, as revenue from the sale of this by-product generally does not justify investment in extensive transport infrastructure. The calculation further assumes that the full amount of renewable electricity generated can be sold to the industry attached for a price of USD 99/MWh. It is likely that the industries will be interested in purchasing the otherwise curtailed renewable electricity, but this might not always be the case, and without the sale of excess renewables, implementation of battery storage might become an option. In certain scenarios it may also be feasible to derive additional benefits from using the electrolyser's waste heat for applications such as industrial pre-heating processes and to conclude a PPA with other more stable renewables sources.

3.3 Analysis of hydrogen production potential

For hydrogen/ammonia production to take place on a large scale, the alignment of renewable energy resources, water availability, export infrastructure, and regulatory frameworks is essential. Bearing these factors in mind, Aqaba region is considered to be the most promising location for large-scale ammonia production due to its exceptional solar resources, low land-use conflicts, closeness to port, and major desalination plants. These factors contribute to competitive production costs, reinforcing Jordan's potential as a global green hydrogen exporter.

Conversely, small-scale hydrogen projects require proximity to industrial end-users to minimise transportation costs and ensure economic viability. Industrial hubs in northwestern Jordan, such as Zarqa, provide strategic locations thanks to their existing energy and water infrastructure and direct access to industries with hydrogen/ammonia demand. Leveraging these established clusters can reduce capital expenditure requirements and accelerate project deployment.

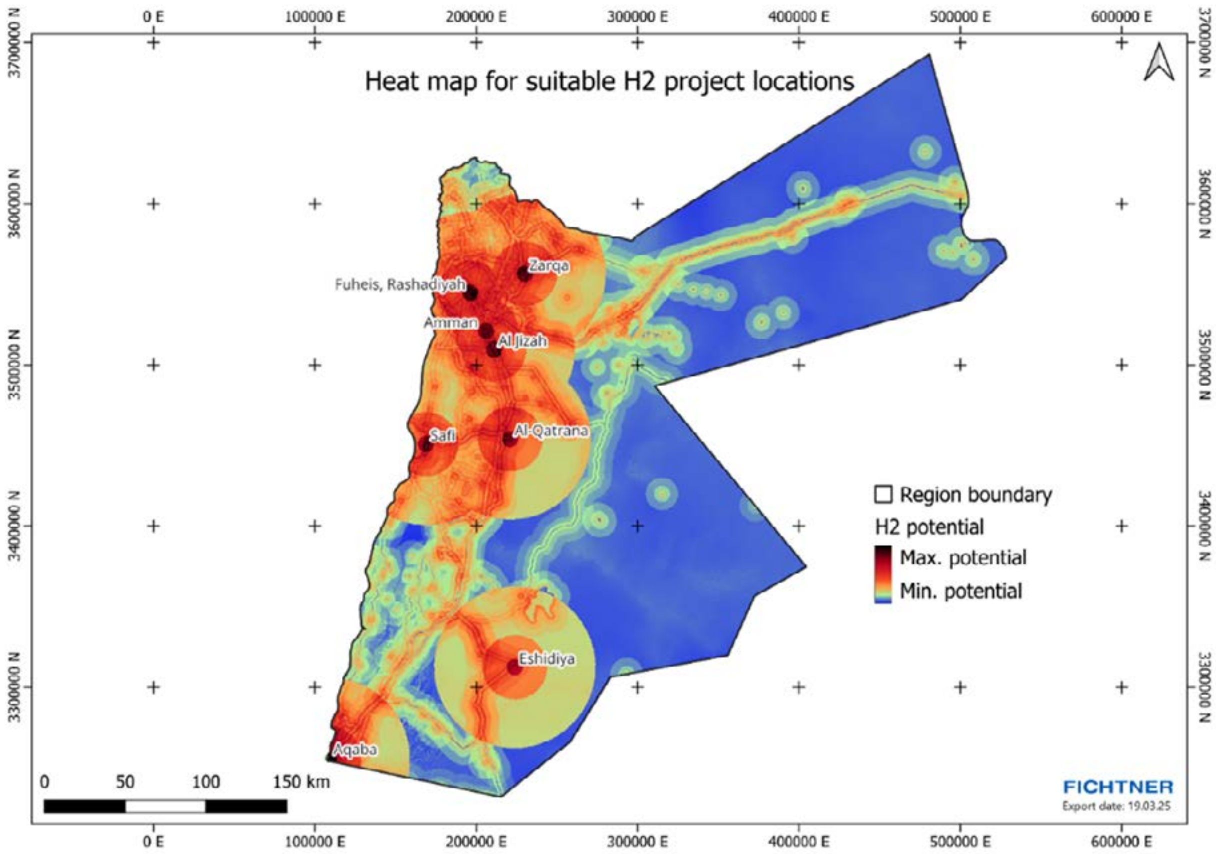
Jordan's existing export and transport infrastructure further strengthens its hydrogen market potential. With direct access to the Red Sea through the Port of Aqaba, and a strategic position as a transit route between Europe and Asia, Jordan is well placed to export hydrogen or its derivatives to neighbouring markets. In the long term, the nation's existing natural gas pipelines (as part of the Arab Gas Pipeline) and possible new corridors could be repurposed or adapted to carry hydrogen, reducing the need for entirely new infrastructure and facilitating both domestic and international transport routes.

3.4 Multi-criteria assessment for small-scale hydrogen projects

A multi-criteria assessment (MCA) was conducted to identify optimal sites for small-scale hydrogen projects, evaluating factors such as renewable energy potential (solar and wind), proximity to industrial clusters, water availability for electrolysis, and access to existing energy and transport infrastructure. Criteria were scored based on thresholds such as distance to off-takers, grid connectivity, water sources, roads, and ports, with industrial proximity given the highest weighting, followed by grid access, renewable resource quality, and water. Transport links were also considered to assess export feasibility. The results, shown in Figure 11, highlight high-potential zones in red—ideal for early project development—while blue areas reflect greater challenges

Hotspots are mainly in the north-west, Eshidiya, and Aqaba, driven by existing infrastructure and industrial demand. The north-west stands out for its dense off-taker presence and mature infrastructure, although large-scale wind and solar projects may face land constraints. Eshidiya is attractive for its strong fertiliser industry, while Aqaba is central to future green hydrogen plans due to its proximity to off-takers, ample land, and its role as Jordan's only export port.

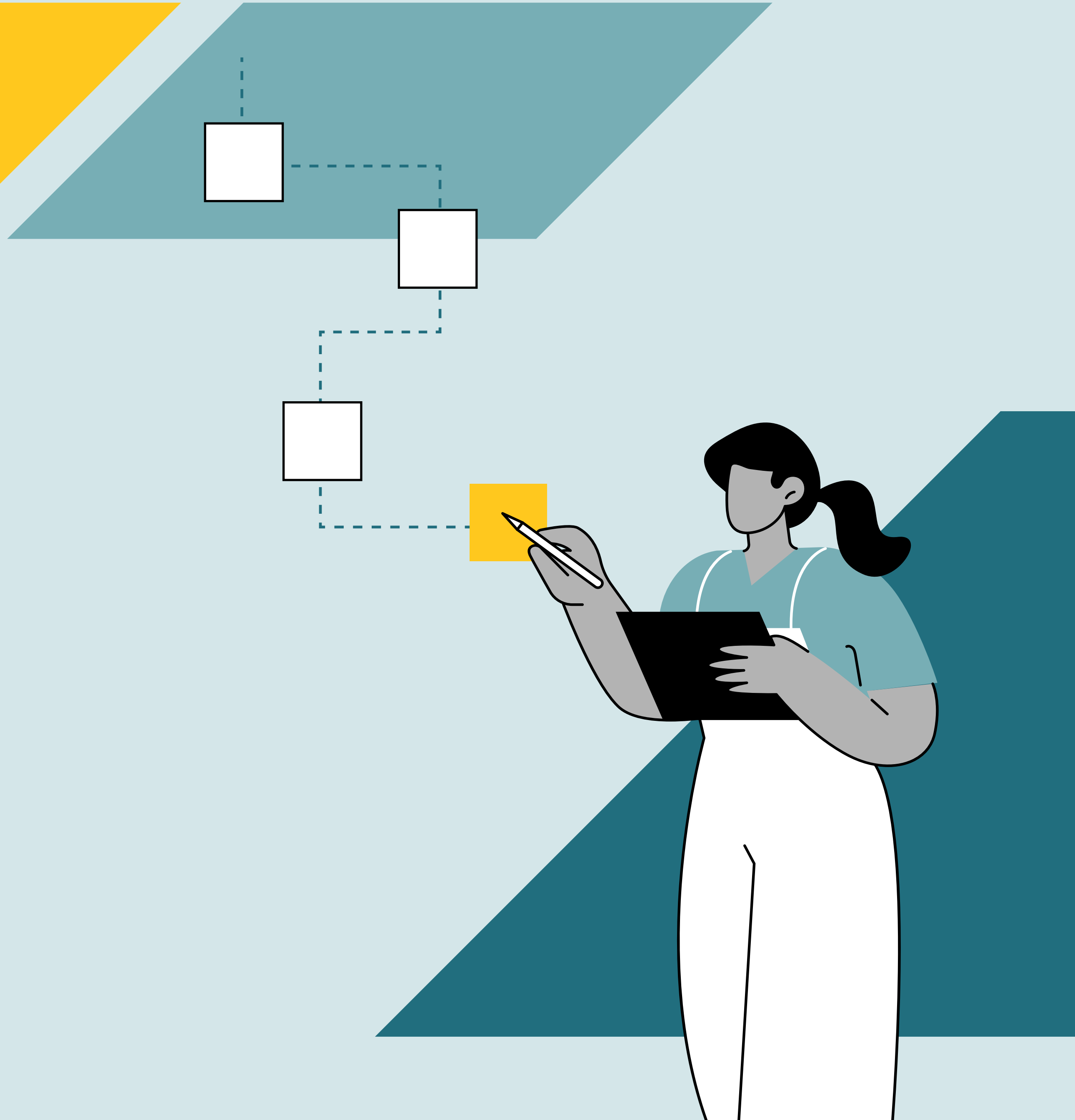
FIGURE 11. Heat map indicating potential for green hydrogen projects



Source: Authors' own compilation, Fichtner (2025)

4

The way forward



4.1 Opportunities and supporting frameworks

With the country's abundant renewable energy sources, its strategic position in the Middle East with proximity to the European hydrogen demand market, the existing port structures in Aqaba, and the country's richness in mineral resources, Jordan is well positioned to progress the country's ambitions to become a regional hub for green hydrogen/ammonia for export, but also to develop local market options, especially in the fertiliser sector. Also, for export, the production of green hydrogen products such as fertiliser would add more value for Jordan than exporting green hydrogen/ammonia.

FIGURE 12. Key enablers and opportunities for green hydrogen development in Jordan

Renewable energy potential
Jordan leads the region in renewable energy installation, providing capacity for large-scale green hydrogen production, with plans for an economic zone to boost related manufacturing.

Job creation and economic growth
Opportunities are presented for domestic economic growth with investments in renewable energy, water supply, and transport infrastructure benefiting both industry and surrounding communities. It is estimated that 65,000 job opportunities can be created in the green hydrogen supply chain.

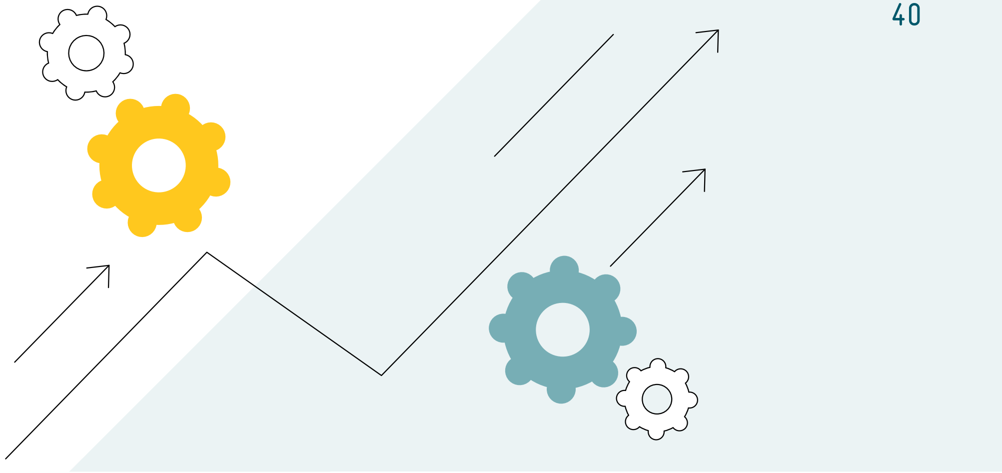
Strategic export position
Jordan's proximity to Europe and the expansion of Aqaba's port make it ideal for exporting hydrogen, ammonia, and fertilisers.

Industrial integration opportunities
Jordan's strong fertiliser industry, reliant on imported ammonia, can transition to green hydrogen, reducing imports and supporting other sectors such as refinery and steel.

Environmental benefits
Development of green hydrogen projects aligns with Jordan's commitments to its Nationally Determined Contributions (NDCs) under the Paris Agreement.

Government support
Jordan's Draft National Green Hydrogen Strategy and active national committee aim to establish competitive hydrogen and ammonia projects, enhancing Jordan's regional clean energy leadership.

International partnerships
Jordan has signed multiple MoUs with international firms targeting substantial green ammonia production, supported by significant renewable energy and desalination investments.



4.2 Challenges and considerations

Despite the opportunities, Jordan faces economic, technical, and regulatory challenges that must be addressed for sustainable growth across sectors. Although they are already progressing, the key framework conditions in Jordan are still under development, including a dedicated regulatory framework, the establishment of financial incentives, and the expansion of necessary infrastructure and renewable energy production capacity. Such global challenges, common to all emerging hydrogen markets, highlight the need for targeted policies and investment to further support sector development in Jordan.

- **Regulatory challenges:** While Jordan has established a comprehensive legislative and regulatory framework to enable its **renewable energy transition**, a comprehensive regulatory framework for **green hydrogen** is not yet developed. Clear policies and regulations are needed to accelerate the development of the sector, to facilitate investments and commercial structuring, to optimise infrastructure, and to ensure competitive and predictable pricing for hydrogen production. Jordan's existing regulatory environment has already been assessed. Specific suggestions for adopting existing and/or providing additional policies and regulations have been identified from this evaluation and are set out in a policy note published by MEMR (Government of Jordan/World Bank, 2025). In this context, the recently approved drafts of the Electricity and Gas Laws are expected to enhance regulatory clarity by empowering the Energy and Minerals Regulatory Commission to issue licences for green hydrogen projects and oversee independent generation, storage, and related activities, thereby supporting investment promotion and market development (Jordan News, 2025).
- **Technical and environmental challenges:** Green hydrogen production requires significant water resources for electrolysis. Jordan's water scarcity, which requires investment in desalination infrastructure, is one of the main challenges to development of the green hydrogen sector from a technical and environmental and, consequently, an economic perspective. It is crucial to build a green hydrogen industry in such a way that it will not negatively affect water security. Various feasibility options for water supply are currently under discussion. In addition, the necessary infrastructure including port infrastructure and renewable energy generation capacity must be expanded. MEMR is thinking about developing common-use infrastructure for GH_2 projects that can serve as a backbone for the projects slated for implementation in Jordan (EBRD, 2024). Alternative private or private-public initiatives to develop the necessary infrastructure are under discussion. Technical solutions will be linked to the development of the regulatory framework.
- **Economic challenges:** Developing the green hydrogen sector, including electrolysers, water desalination, renewable energy, and infrastructure, involves substantial upfront costs. Strengthening collaboration between the private and public sector to develop cost-competitive projects together with low-cost financing will be crucial to ensure that green hydrogen projects in Jordan achieve commercial viability.

4.3 Green hydrogen financing opportunities

The green hydrogen sector requires substantial financial investment to overcome high initial costs and infrastructure challenges. Several funding mechanisms exist to address this, as described below with selected examples:

German instruments for investment in the international market

- **H_2Global** (H_2Global Stiftung, 2025): A reverse auction-based mechanism to support green hydrogen market development, offering 10-year purchase agreements. No project size or investment limitations; non-EU hydrogen producers can participate, meeting EU sustainability standards.
- **PtX Development Fund** (KfW, 2025): Set up by the German Government and KfW Group. Provides non-reimbursable grants for large-scale projects in emerging economies, with no specific investment thresholds. Eligible countries include Brazil, Colombia, Egypt, India, Kenya, Morocco, and South Africa (PtX Development Fund, 2025). As of now, Jordan is not listed among the eligible countries. However, eligibility criteria and target countries may evolve in future funding rounds.
- **International Hydrogen Ramp-up Programme (H_2Uppp)** (BMWK, 2025) Supports early-stage public-private partnerships for pilot projects, with a minimum public contribution of EUR 100,000 and total project costs of at least EUR 200,000. Companies must contribute at least 50%. Applications are currently open until March 2025 (PtX Hub, 2025), though the overall programme is expected to continue until 2026 (BMWK, 2024).
- **UFK Untied Loan Guarantees** (UFK-Garantien.de, 2025): Provides loan guarantees to reduce political and economic risks in target countries. Green hydrogen projects may be eligible if they align with Germany's energy strategy.

European instruments for investment in the international market

- **Green Hydrogen Trust Fund (GHF)** (European Investment Bank, 2025): The European Investment Bank (EIB) established this fund to support large-scale green hydrogen infrastructure projects and to provide strategic advice and capacity building to developing countries. Jordan is currently among the eligible countries receiving funding.
- **Clean Hydrogen Partnership (CHP)** (European Union, 2025) primarily supports the development and commercialisation of clean hydrogen technologies. No fixed limitations on project size or investment, but large, impactful projects are prioritised. Eligible countries are EU member states and countries associated to Horizon Europe, which Jordan currently is not (European Comission, 2024). It may therefore participate only through specific agreements/joint projects with EU member countries.
- **European Bank for Reconstruction and Development (EBRD)** (EBRD, 2025): The GEFF program supports Jordan's transition to a green economy by providing a USD 90 million credit line to partner financial institutions. These institutions, in turn, offer financing to small and medium-sized enterprises (SMEs) and individuals for sustainable energy and resource efficiency investments. The goal is to enhance competitiveness and profitability through the adoption of high-performance technologies and practices. The goal is to enhance competitiveness and profitability through the adoption of high-performance technologies and practices.

Multilateral instruments

- **MIGA (Multilateral Investment Guarantee Agency)** (MIGA, 2025): Offers political risk insurance and credit guarantees for hydrogen investments in developing countries, with a focus on projects with significant developmental impact. There is no strict minimum investment amount, but larger projects, especially those aligned with national development priorities, are likely to be prioritised. MIGA funds investments into a developing member country made by investors located in any MIGA member country. Jordan is one of the countries eligible for funding, together with 181 other countries (World Bank Group).

- **Global Environment Facility (GEF)** (Green Climate Fund, 2025): Provides grants and concessional loans for renewable energy projects, including green hydrogen, to achieve decarbonisation and environmental goals.

- **World Bank Loans** (World Bank, 2023): The World Bank promotes the implementation of renewable energies including hydrogen through various programmes and initiatives. In 2023, for example, the bank stated that it had approved USD 1.6 billion in funding for renewable hydrogen loans in that year.

- **United Nations Industrial Development Organization (UNIDO) Accelerate-to-Demonstrate (A2D) Facility** (UNIDO, 2024) is dedicated to accelerating the commercialisation of innovative climate solutions in developing countries. It focuses on providing grant funding to support the implementation and operation of demonstration projects, for example for clean hydrogen and industrial decarbonisation projects. The programme supports pilot demonstration projects in developing countries, tests innovative production methods, validating efficiency and feasibility in real-world applications, and utilises grant funding and knowledge sharing to maximise clean hydrogen's potential.

- **Jordan Kuwait Bank (JKB)** (Jordan Kuwait Bank, 2025): The Renewable Energy Project Financing Product of JKB provides financing for renewable energy projects (solar and wind) in collaboration with the Central Bank of Jordan. The maximum loan amount is four million Jordanian dinars.

Private finance

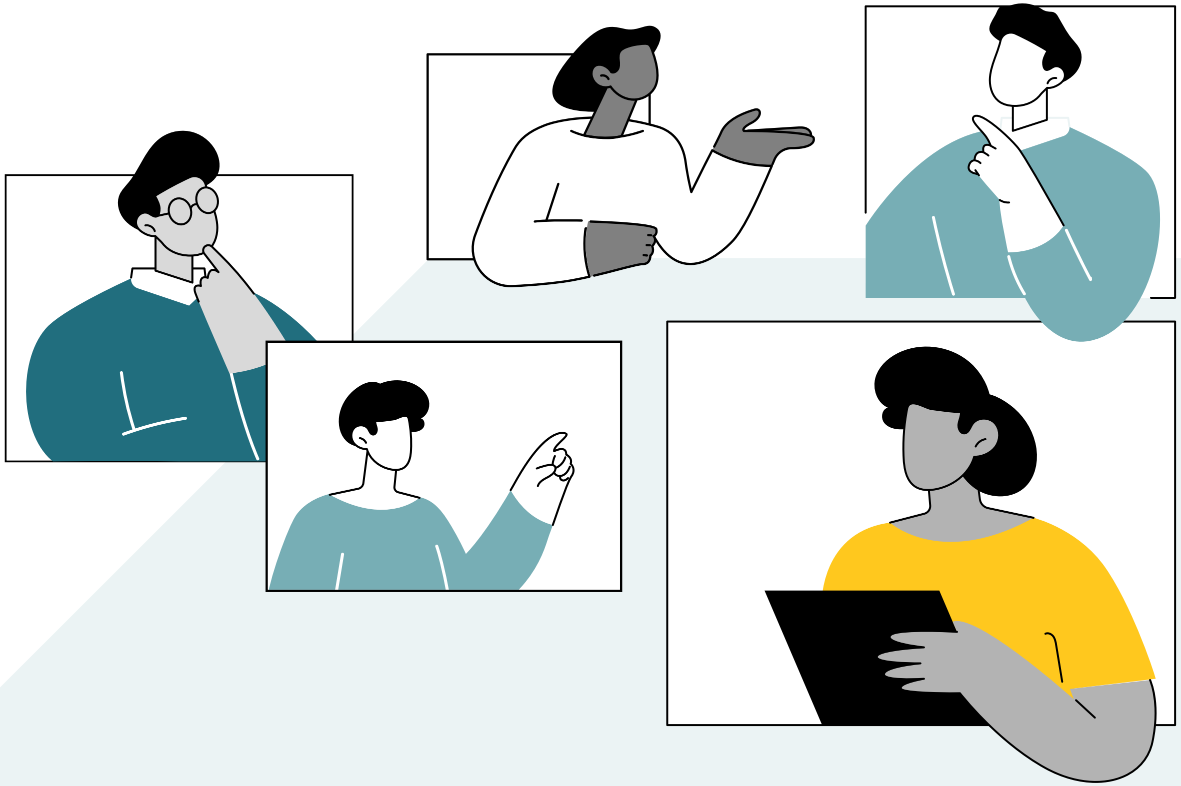
- **Hydrogen One Capital** (HydrogenOne, 2025): A private venture fund specialising in direct or indirect investments in hydrogen infrastructure and technology.

- **Breakthrough Energy Ventures (Breakthrough Energy, 2022):** Through various programmes, Breakthrough Energy supports cutting-edge research and development by investing in companies with clean products to accelerate the clean energy transition.

- **Green Bonds:** These bonds are fixed-income financial instruments designed to fund sustainable projects such as renewable energy or clean transportation. Different standards can be applied, two of the most common being the Green Bond Principles issued by the International Capital Market Association (ICMA, 2025) and the Climate Bond Standards (Climate Bonds, 2025).

4.4 Stakeholder mapping and institutional overview for green hydrogen development

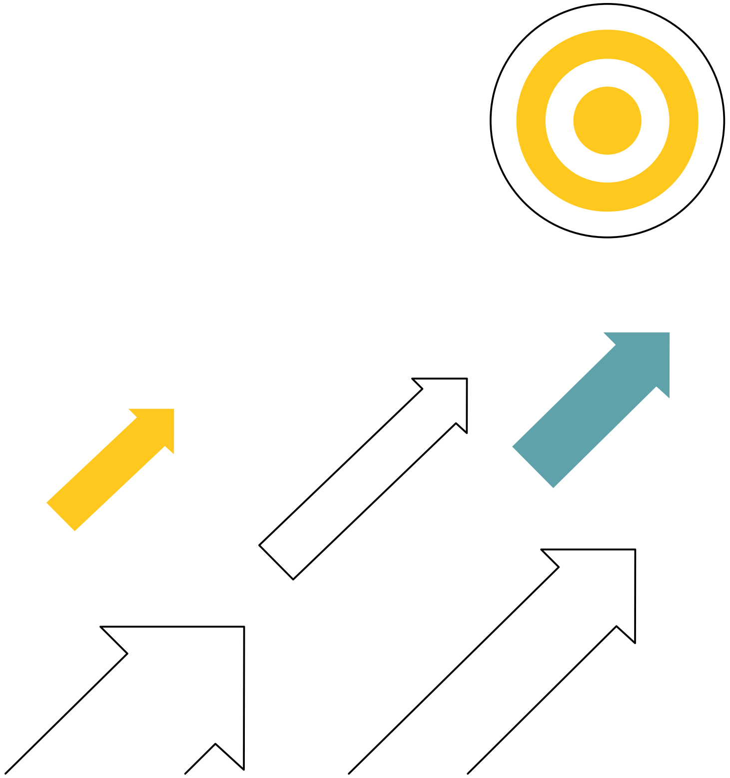
The development of Jordan's green hydrogen sector will require the collaboration of stakeholders, including government ministries, regulatory agencies, academic institutions, private sector players, non-governmental organisations, and international partners. Each plays a crucial role in shaping the policy landscape, advancing pilot projects, and establishing regulations to support hydrogen adoption. A National Committee for Green Hydrogen, chaired by the MEMR, has been established in Jordan to foster this process. Its tasks are to follow up on the preparation of the national strategy for green hydrogen, follow up on the preparation of legislation and studies regulating it, evaluate investment opportunities in this field and approve procedures related to them (Jordan News Agency, 2023). A comprehensive list of all stakeholders and players relevant to green hydrogen and ammonia production in Jordan is annexed to this report.



4.5 Next steps for German companies

Jordan offers substantial opportunities for German companies in the green hydrogen sector, bolstered by its renewable energy potential, strategic location, port infrastructure, and increasing government focus on green hydrogen/ammonia sector development.

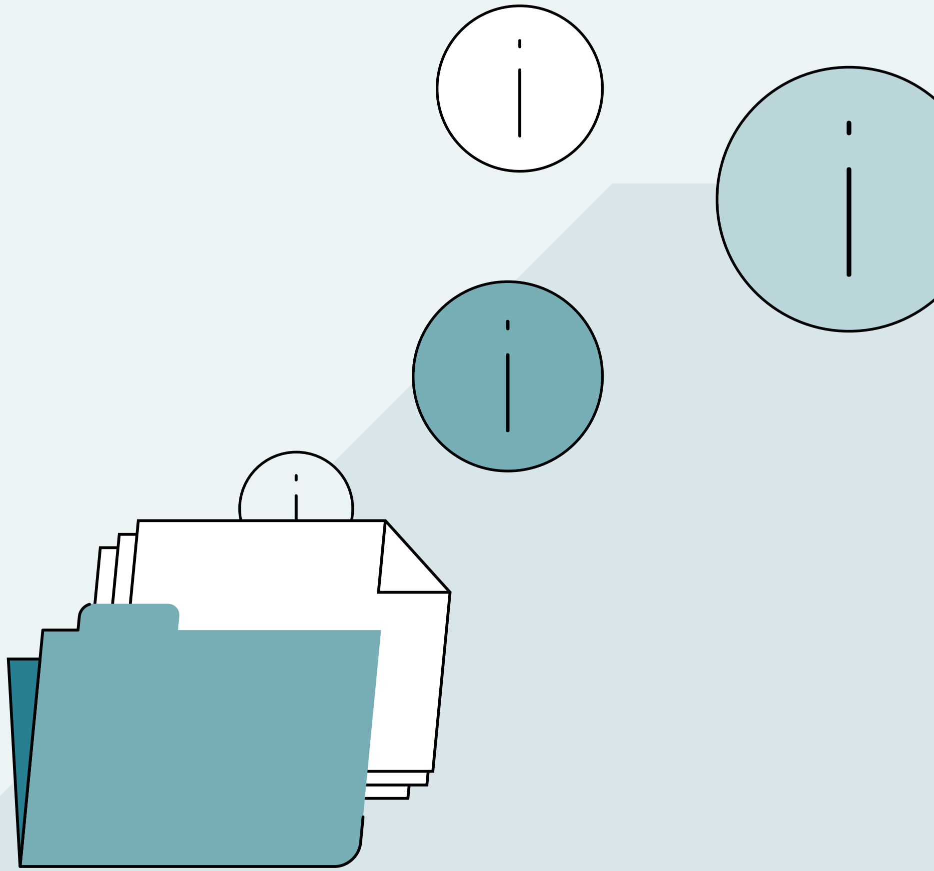
For German companies looking to participate in Jordan's green hydrogen market, the following next steps are recommended:



1. Engage with local stakeholders: Partner with Jordanian government bodies such as the Ministry of Environment and Mineral Resources (MEMR) and Aqaba Special Economic Zone Authority (ASEZA) and local industries (renewable energy, fertiliser, refinery) to stay informed on the latest policies, incentives, and investment opportunities as well as on the development status of common-use infrastructure for green hydrogen projects in Jordan.
2. Leverage funding mechanisms: Explore financial instruments like H_2Global and the Green Hydrogen Trust Fund (GHF), as well as multilateral funding from the World Bank and EBRD, to reduce investment risks and support infrastructure development.
3. Assess market viability, export opportunities, and infrastructure: Take advantage of Jordan's vast renewable energy potential, strategic location, and port infrastructure to position the country as a competitive exporter of green hydrogen especially to the European market. Identify opportunities to play a role in establishing green hydrogen/ammonia projects for export and in key sectors (e.g. fertiliser, refinery). Consider pilot projects to build local demand bearing in mind the potentially upcoming common-use infrastructure in Jordan.
4. Monitor regulatory developments: Stay updated on developments regarding Jordan's National Green Hydrogen Strategy and the evolving regulatory landscape, incentives, and carbon taxes that might increase the competitiveness of green hydrogen projects.
5. Participate in pilot and R&D projects: Collaborate with local universities, research institutions, and private companies on hydrogen technologies to improve efficiency and scalability.

By taking these steps, German companies can position themselves at the forefront of Jordan's green hydrogen market, contributing to the country's transition to a more sustainable energy future while capitalising on the emerging opportunities.

Annexes



Annex 1 Stakeholder mapping and institutional overview

TABLE 8. Key stakeholders for hydrogen development in Jordan

Stakeholder	Role related to hydrogen
PUBLIC – Member of the National Committee for Green Hydrogen	
Ministry of Energy and Mineral Resources (MEMR)	Leading the National Committee for Green Hydrogen.
MEMR in Jordan is responsible for developing policies, regulations, and infrastructure to support the growth of green hydrogen and ammonia, driving the country's energy transition towards sustainability and clean energy.	Manages and protects natural and ecological resources, regulates environmental standards. Ensures that projects in various sectors of economy meet environmental criteria and sustainability standards.
Ministry of Finance	Plays a role in budgeting and securing or providing guarantees and financial resources for green hydrogen and ammonia development projects and governs public-private partnerships (PPP) through the PPP Unit.
Ministry of Investment	Plays a role in attracting investments, including for green hydrogen and ammonia projects, and facilitating investor relations in Jordan.
Ministry of Planning and International Cooperation	Coordinates planning and development efforts and ensures that green hydrogen and ammonia projects align with national goals, integrating international cooperation for funding and technology.
Energy and Minerals Regulatory Commission (EMRC) (ministry)	Regulates energy sectors, including green hydrogen, ensuring compliance with energy laws, standards, and licences for green hydrogen and ammonia production projects.
Ministry of Water and Irrigation	Ensures that water resources, which are crucial for green hydrogen production, are sustainably managed in the development of related projects.
Land and Space Department (ministry)	Responsible for managing land use, including the development of infrastructure for green hydrogen and ammonia projects.
Aqaba Special Economic Zone Authority (ASEZA) (governmental authority)	Responsible for overseeing the development and regulation of the Aqaba Special Economic Zone, promoting investment, facilitating infrastructure development, and supporting sustainable projects, including those related to green hydrogen and ammonia production.

Stakeholder	Role related to hydrogen
PUBLIC – others	
Ministry of Industry and Trade	Responsible for regulating and developing the industrial and commercial sectors to enhance the national economy. Established in 1952, the Ministry's mandate includes formulating policies that promote industrial growth, regulating internal and external trade, and improving the competitiveness of Jordanian products in international markets.
National Electric Power Company (NEPCO) (transmission company)	Ensures the integration of green hydrogen into Jordan's energy grid, overseeing the storage, transmission, and distribution of electricity generated from renewable energy sources.
ADC (Aqaba Development Corporation) (government-owned company)	Plays a role in facilitating large-scale infrastructure projects, including those related to green hydrogen and ammonia, within the Aqaba Special Economic Zone, by developing necessary land and facilitating investments.
Jordan Chamber of Industry (JCI)	Represents Jordan's industrial sector and advocates for policies that support the development of green hydrogen and ammonia. It fosters industry collaboration, supports capacity building, and attracts investment to promote green energy projects in Jordan.
ACADEMIA	
German Jordanian University (GJU)	Cooperation with International PtX Hub for capacity building: joint research, innovation, and course development in green hydrogen/PtX, including R&D projects and faculty exchanges. (PtX Hub, 2025a)
Al Hussein Technical University (HTU)	Cooperation with International PtX Hub for capacity building: hands-on training for hydrogen/PtX applications, boosting technical capacity and industry readiness among students and staff. These efforts are critical in building skills for green hydrogen and ammonia production. (PtX Hub, 2025b)
German Energy Academy in Jordan	Provides specialised training, capacity-building programmes, and research collaboration on green hydrogen and ammonia technologies, aiming to advance Jordan's technical expertise and workforce in these fields. (GEA, 2025)

Stakeholder	Role related to hydrogen
DONORS	
Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH (German Development Agency) **(donor)**	Capacity building and project pipeline development for hydrogen initiatives. Facilitating policy dialogues and developing a regulatory framework for green hydrogen and ammonia projects. Building local expertise, strengthening academic-industry synergy, and engaging diverse stakeholders through training, research, and workshops related to green hydrogen and ammonia, positioning Jordan as a regional hub for sustainable hydrogen and PtX technologies. (GIZ Jordan, 2024)
International PtX Hub	Implemented by GIZ on behalf of the German Federal Ministry for Economic Affairs and Climate Action (BMWK). Leveraging renewable energy potentials for job creation and economic growth (PtX Hub, 2025c). Financed by the International Climate Initiative (Internationale Klimaschutzinitiative, IKI), the International PtX Hub is a contribution to the German National Hydrogen Strategy of 2020.
World Bank Group	Supporting the Government of Jordan in reviewing the legislative and legal framework governing the green hydrogen industry and its derivatives in Jordan, and providing proposals to update this framework to attract foreign investments in the hydrogen and ammonia sectors. (Government of Jordan/World Bank, 2025)
European Bank for Reconstruction and Development (EBRD)	Financing feasibility studies for the Government of Jordan and renewable energy infrastructure for green hydrogen and ammonia projects. Provides consulting services on technical, environmental, and economic aspects of hydrogen and ammonia initiatives in Jordan. Supporting Jordan in the development of a green hydrogen production hub in the Aqaba Special Economic Zone (EBRD, 2024).
United States Agency for International Development (USAID)	Technical support for the Government of Jordan on developing the Draft National Green Hydrogen Strategy for Jordan. Due to the political change, USAID will not play an active role in supporting the hydrogen strategy/project as before.

Stakeholder	Role related to hydrogen
PRIVATE/NGO	
Aqaba Terminal Companies	Responsible for handling and processing the import, export, and storage of hydrogen and ammonia, and ensuring the necessary infrastructure for green hydrogen exports and imports is in place at the Aqaba port.
Jordanian Oil Transport Company (JOTC) **(public-private partnership)**	Can play a role in the logistics and transportation infrastructure for green hydrogen and ammonia, including distribution and storage.
EDAMA Association (NGO)	Membership-based organisation that represents private sector developers, companies, off-takers, and banking institutions, with a focus on advocating for investments and promoting the efficient economic use of renewable energy solutions, including green hydrogen and ammonia, in Jordan. By fostering collaboration between stakeholders, EDAMA works to attract investments, drive policy reforms, and ensure the economic feasibility of green energy projects. It also supports capacity building through training and workshops, helping to develop a skilled workforce for the renewable energy sector, thereby contributing to the growth and sustainability of the green hydrogen and ammonia markets in Jordan. (EDAMA, 2025)

Source: Authors' own compilation, Fichtner (2025)

Annex 2 Techno-economic calculation

TABLE 9. Techno economic calculations: Main parameters

Parameter	Value	Description
Cost of debt	5%	Annual interest rate on debt financing
Cost of equity	10%	Required return on equity capital
Inflation rate	2.5%	Annual general inflation in the country
Equity/debt gearing	20%	Capital structure ratio
WACC	6%	Weighted average cost of capital
Grace period	1 year	Period for the construction of the plant on the loan being given
Grid price increase above index/ inflation rate	0%	Increase in the price of the grid above inflation
Hydrogen price increase above index/inflation rate	2%	Increase in the price of hydrogen above inflation
Oxygen price	USD 0.17/kg	Price per kg of oxygen sold
Hydrogen price	USD 5.78/kg	Average price of grey hydrogen per kg in the country (obtained in gas tanks)
Ammonia price	USD 0.46/kg	Average price of grey ammonia per kg in the country
Corporate tax rate	20%	Direct tax levied on the income or capital of corporations
Depreciation scheme	Linear	Systematic way to account for the decline in value of an asset over its useful life
Wind – specific investment cost (for around 1 MW)	USD 1,735/kW	
PV – specific investment cost (for around 1 MW)	USD 752/kW	

Parameter	Value	Description
Wind – specific investment cost (for around 10 MW)	USD 1,388/kW	
PV – specific investment cost (for around 10 MW)	USD 578/kW	
Cost of grid electricity	USD 0.10/kWh	Cost of electricity purchased from the grid
Ammonia synthesis unit costs (for large-scale cases)	USD 1,458/TNH_3	Ammonia unit cost per tonne of annual ammonia capacity
Ammonia synthesis unit costs (for small-scale cases)	USD 2,525/TNH_3	
Air separation unit cost	USD 168/TN_2	Air separation unit cost per tonne of annual nitrogen capacity

Source: Analyses performed by GIZ (2025)

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