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REFORM SECRETARIAT

Government of Jordan / World Bank

"Jordan: Options for Legal and Regulatory Frameworks for Green Hydrogen Production, Use and Exports"

Policy Note

by
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QED consulting

WATSON FARLEY & WILLIAMS

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GLOSSARY

ADC	Aqaba Development Company
ALARP	As Low As Reasonably Practicable
ASEZ	Aqaba Special Economic Zone
ASEZA	Aqaba Special Economic Zone Authority
CGH2	Compressed GH2
CUI	Common Use Infrastructure
ECA	Export Credit Agency
EMRC	Energy and Minerals Regulatory Commission of Jordan
FID	Final Investment Decision
GA	Green Ammonia
GH2	Green Hydrogen
GH2 derivatives	Green Ammonia, Green Methanol and other Green Hydrogen Derivatives
GM	Green Methanol
GoJ	Government of Jordan
HGV	Heavy Good Vehicles
H2	Hydrogen
Jordan	The Hashemite Kingdom of Jordan
LCOE	Levelised Cost of Electricity
LCOH	Levelised Cost of Hydrogen
MEMR	Ministry of Energy and Mineral Resources
MIGA	Multilateral Investment Guarantee Agency, part of the World Bank Group
NDCs	Nationally Determined Contributions
NEPCO	National Electric Power Company of Jordan
RE	Renewable Electricity
Report	This Final Report
ROI	Return on Investment
SOE	State-Owned Entity
SPV	Special Purpose Vehicle

1 INTRODUCTION

1.1 BACKGROUND

Jordan has developed a 2033 Economic Modernization Vision and 2030 Energy Strategy that focuses on sustainability and the green economy driven by its Nationally Determined Contributions (NDCs) that promote emission reductions and capitalise on its strategic regional location and excellent renewable resources (both wind and solar). In support of the country's energy diversification objectives, and in line with Pillar 9.1 of Jordan's Five-Year Reform Matrix (Energy Sector Policy and Governance – Diversification), developing the country's green hydrogen (GH2) economy has become a strategic focus of the Government of Jordan (GoJ).

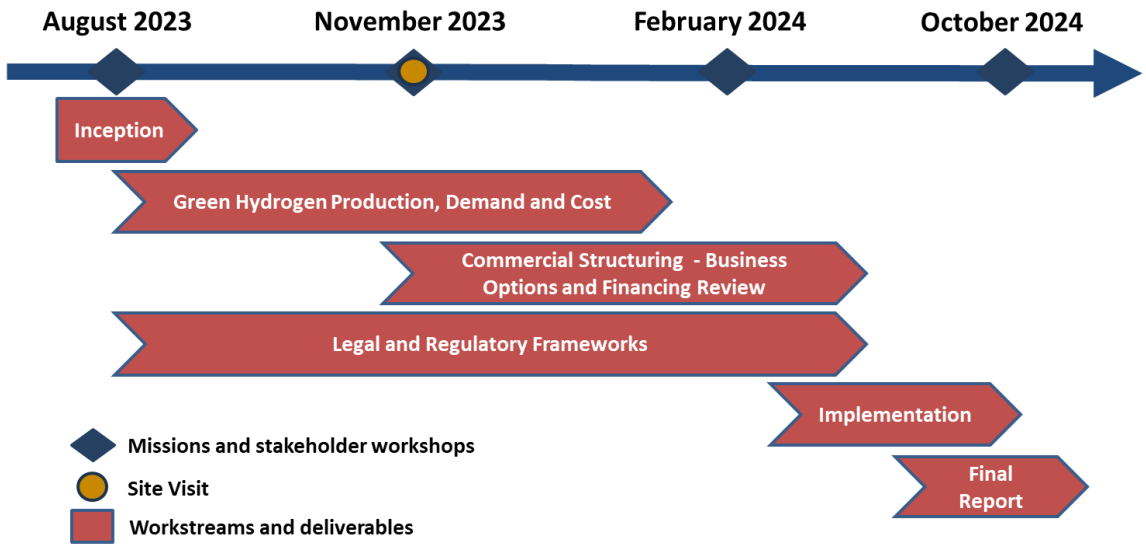
A key requirement for the successful development of a new GH2 sector is the development and implementation of a legal and regulatory framework which clearly addresses GH2 and within which the necessary investments can take place. In support of this, a study was undertaken over 2023-2024 by Quality Energy Developments Consulting Limited and Watson, Farley & Williams LLP (the Consultant) on the legal and regulatory framework required for the development of the GH2 sector in Jordan, working closely with the Jordanian Ministry of Energy and Mineral Resources (MEMR) and supported by the World Bank.

This Policy Note provides the key findings and recommendations of the study. The study was conducted in full engagement with sector key stakeholders and potential investors. This included government entities and municipalities, investors in GH2 developments and signatories of Memoranda of Understanding (MoUs) in Jordan. Engagement was facilitated through four workshops held in Amman, meetings with the Aqaba Development Company (ADC) and a site visit to the Aqaba Special Economic Zone (ASEZ), where the GH2 export projects are planned to be located.

1.2 STUDY OBJECTIVES AND STRUCTURE

The study assessed the technical and economic considerations for a GH2 sector in Jordan (both for local demand and export projects) which informed the key parameters for the desired legal and regulatory framework required for GH2 sector development. This included assessments around potential demand and the scale of GH2 projects, potential locations and requirements for supporting infrastructure (power and water) and the business model options with their relative pros and cons as well as associated risks. The analysis undertaken mapped the current legal and regulatory framework and provided recommendations on how best to address gaps in existing legislation and requirements for new legislation specific to the GH2 sector. The study also proposed short and medium term implementation roadmaps covering the legal/regulatory, technical and commercial/financial development of the sector, from the perspective of both GoJ and investors in the sector.

Project timeline and structure



2 AREAS OF ANALYSIS AND ASSESSMENT

2.1 GREEN HYDROGEN PRODUCTION, DEMAND AND COST

The cost of renewable power is a key input in the cost of GH2 production. There are strong solar conditions across most of Jordan and particularly in the Aqaba and surrounding area. Wind conditions are also good in the areas to the north and east of Aqaba. The production of GH2 from combined solar (during the day) and wind (at night) is likely to be the most cost-effective option. High capacity factors for renewable power generation projects indicate that Jordan has the potential to produce GH2 and consequently green ammonia (GA) or green methanol (GM) at internationally competitive tariffs. In 2022, the average capacity factor for wind power was 32% (1,748GWh generated from 622MW capacity) and for solar was 26% (2,222GWh generated from 958MW of capacity). Tariffs range between JD 42-120/MWh (¢$5.9-16.8/kWh) for solar, and between JD 68-85/MWh (¢$9.5-11.9/kWh) for wind, with more recently developed projects being at the lower end of these ranges. The production of GA brings benefits of larger scale GH2 transport and storage for exports. The production of GM requires carbon imports or direct air capture and hence is more challenging. We refer to GA through, but the same may also apply to GM or even green kerosene.

Local demand for GH2 in Jordan includes demand from existing sectors where grey hydrogen is currently being used, e.g. fertilizer, crude oil refining, glass, steel, pharmaceuticals, chemicals and edible oils manufacturing. Local production is expected to take place close to the end user markets in Amman and Zarqa. In addition, demand from emerging sectors, e.g. transportation (shipping, municipal, Heavy Good Vehicles) and potentially residential and commercial heating and power storage, may materialise post-2030. GH2 and GA production for export will be located in ASEZ with close proximity to the port in Aqaba and to benefit from the incentives of the special economic zone. Export industries producing goods such as fertilizer and steel are also assumed to be located at ASEZ in the Heavy Industrial Area. Production of GH2 products for export rather than exporting the GH2 or GA adds more value for Jordan.

The scale of GA exports will be dependent on the attractiveness of Jordan as a GH2 production and export location. Currently there is strong interest, with MOUs signed from more than 10 major investors in GH2 and GA export projects. We undertook economic modelling to estimate a levelized tariff for renewable power generation and separately for GH2 production. Assuming capacity factors of 27% for solar, and then 35% for wind to the East of Amman and 45% for wind in the South of Jordan, the cost of power from an integrated wind and solar project is estimated to be $44/MWh closer to Amman and $38/MWh closer to Aqaba in the Base Case. Adding the costs of transmission, this gives an estimated renewable electricity supply price into the electrolyser plant of around $45/MWh in Aqaba and $50/MWh in Amman in the Base Case. Costs can be lower if wind and solar Capex costs continue to drop. In a Low Cost scenario, given higher capacity factors for wind, cost of power generation is estimated between $17-22/MWh compared with $29/MWh for solar. Consequently, the addition of wind brings down the overall levelized cost of electricity (LCOE) for projects closer to Aqaba to around $22/MWh. Whilst the addition of wind power may not lead to a lower LCOE for projects closer to Amman, the additional wind power during non-solar hours will nevertheless lead to higher electrolyser plant utilisation and reduce the cost of GH2 production. GH2 and GA production for export is assumed to be based on renewable power supply independent of the existing NEPCO grid in order to meet EU green certification requirements (note the EU requires new build of renewable power supply for green hydrogen certification). However, for GH2 domestic use we assumed less stringent green certification with use of the existing power network and with grid excess power supply to GH2 in off peak periods to provide cost savings with increased electrolyser plant utilisation (90% versus ~70% without excess grid supply).

For domestic users, the decision to produce GH2 onsite versus purchasing GH2 from a GH2 distributor would mainly depend on land availability for the GH2 plant (including safe exclusion zones), the ability to finance the GH2 plant and the cost of GH2 distribution versus distribution of power. Where possible, it is better for a customer to generate their own renewable power by wheeling it through the existing network and producing GH2 onsite. In case of aggregated GH2 production and distribution to multiple consumers, GH2 distribution by pipeline can be lower cost compared to GH2 trucking. Where a group

of customers already exists; e.g in an industrial area, developing a GH2 pipeline network may be a good option.

For exports, a key technical consideration is the limited availability of land at ASEZ and export loading infrastructure in the port of Aqaba. This dictates the need for developing Common Use Infrastructure (CUI) for use among different GH2 developers for the transmission of renewable power from outside ASEZ to the GH2 electrolysers in ASEZ as well as for clean water supply and the transmission of GH2/GA by pipeline to shared ship loading facilities. This factor influenced the design of the project commercial and market structure, and consequently, the GH2 legal/regulatory framework required.

2.2 COMMERCIAL STRUCTURING

We assessed project structure options and commercial aspects of GH2 project development in Jordan.

Project Structuring

The options considered were based on the following building blocks of the supply chain:

1. **Production** of renewable power and clean fresh water (inputs to the GH2 plants);
2. **Transmission** of renewable power and clean water to the GH2 plants;
3. **Processing/electrolysis** of water and renewable power to produce GH2 and GH2 derivatives; and
4. **Storage** and **transportation** of GH2 or GH2 derivatives to the point of sale (locally or exports).

Export Market Model Options

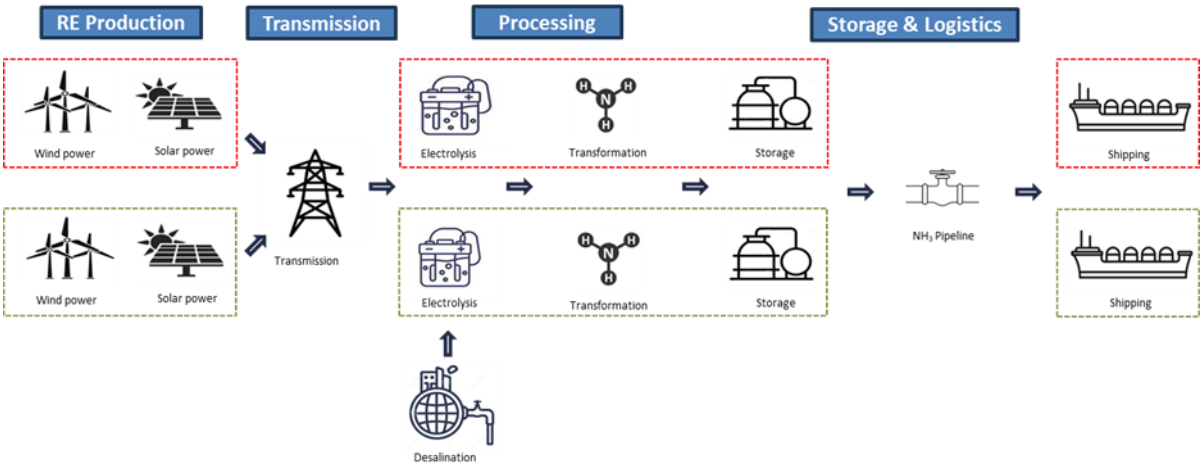
Some key issues are common to all export project options. These include water availability (the provision of clean fresh water from desalination facilities), supply of renewable power to GH2 plants, port facility/export loading access and meeting the GH2 standards of target markets.

The three export models assessed were:

- **Model A:** A non-integrated model with CUI and GH2/GA production at ASEZ;
- **Model B:** A fully integrated model covering the full value chain from renewable power production to the point of GH2/GA exports with GH2/GA production at ASEZ; and
- **Model C:** A model where the GH2 plants are co-located at the renewable power site outside ASEZ and the GH2 is transported by pipeline to GA plants at Aqaba Heavy Industrial Area.

Of the three primary export models that were considered, Export **Model A** was selected by MEMR as the preferred model (Base Case).

Export Model A – Base Case



Export Model A Key Features:

- Renewable power projects owned by GH2 project developers or independent power producers selling directly to GH2 developers.
- Power transmission through dedicated CUI powerlines. Ownership through a state entity or a privately owned Special Purpose Vehicle (SPV). Operator may also be independent of SPV.

- Seawater extraction, desalination, processing and distribution of clean water and the disposal of saline post-processing through a separate entity operating within Aqaba. Could be owned and operated through a government entity or a private sector SPV.
- Multiple GH2 project developers each with their own GH2 electrolyser plant. Developers may or may not also own the renewable power facilities supplying the GH2 plants. The GH2 developers are responsible for development and operation of GA production and storage.
- Current land and infrastructure constraints necessitate one GA pipeline for transportation to the port ship loading facilities. The ownership of this pipeline system may be private or a government entity but in any case CUI.

Domestic Market Model Options

The three models assessed for the domestic market were:

- **Model D:** On Site GH2 Production;
- **Model E:** GH2 Distribution by Truck; and
- **Model F:** GH2 Distribution by Pipeline.

It should be noted that unlike for the export market, the primary model options considered to meet domestic demand in Jordan are not mutually exclusive, so that multiple options could be adopted (e.g. produced on-site or at a regional hub and delivered to end consumers).

In terms of green certifications, GoJ may decide that the green certification specifications required for exports to EU markets, for instance, do not need to be applied fully to domestic consumption allowing developers to optimise production by utilising existing power and water networks and excess power supply in off peak periods. This will help in reducing costs to Jordanian consumers.

Contractual Arrangements

We assessed the key contractual agreements required for power generation and CUI along the GH2 value chain for both GH2 export and domestic projects. They comprised the commercial and regulatory relations between each of the building blocks of the value chain with other parties including contractual relation, flow of money, licensing, and the potential role of GoJ in case it decided to participate (e.g. in land lease, CUI ownership / operatorship).

Financing – International Examples

The financing of major infrastructure projects, including as envisaged for GH2 in Jordan, not only requires a well-planned and executed project, but also a facilitating environment in which large scale investments can be made. Jordan has an established track record of such projects in the energy and water sectors.

In terms of international examples of GH2 projects, whilst there are a limited number of major scale GH2 projects which are under construction or in operation to date, some projects have recently taken FID and can provide helpful learnings to Jordan. In the examples provided below, the role of the government in progressing GH2 developments has been highlighted.

- **Saudi Arabia:** In Saudi Arabia, the state is heavily and directly invested in the development of the NEOM project.
- **Namibia:** The Namibian government's stake in the Hyphen project is via an SOE. The sector is also supported by favourable government policies.
- **Chile:** In Chile, a state supported fund for GH2 projects has been established, this is supporting project and sector level development.
- **Australia:** In Australia, a fund which is supported by the state is helping to facilitate financing of GH2 developments both locally and for export.
- **Egypt:** In Egypt, various government entities are partners in different proposed GH2 projects.
- **Oman:** In Oman, the government is developing the CUI required for GH2 projects along the value chain.

Risk Assessment

The range of risks which will impact the development and operation of GH2 projects in Jordan – and which will be of focus for potential investors/lenders – include those relating to regulations,

competition, costs, environmental issues as well as sector expansion. The applicability of many of the risks identified, as well as how they are best managed or mitigated, is partially dependent on the preferred business model adopted for GH2 sector development. The key risks identified, and potential mitigation measures associated with the selected model, were discussed for both the export and domestic markets. The risks assessed included the risk of low/delayed return on investment (ROI) on the CUI, high cost of CUI for early movers, project-to-project risk during development and operation (assuming a non-integrated market model), lack /delay of clear policy and regulatory framework, low cost-competitiveness and country risk.

2.3 LEGAL AND REGULATORY FRAMEWORK

The legal and regulatory framework assessment mapped out the existing legal, regulatory, institutional and financing framework in Jordan against what may be necessary to ensure the successful development of the GH2 sector. This included recommending the adoption of international best practices for such regulation as well as identifying the key pre-requisites and amendments required.

One action already taken to support the development of the GH2 sector was the establishment of a hydrogen task force by way of Council of Ministers resolution in August 2023. This task force is called the National Committee for Hydrogen. The objectives of the Committee are to discuss, plan and approve all GH2 related activities in Jordan, including strategies, plans, regulations, signing memoranda of understanding with interested parties, amongst others. The Committee will play a pivotal role in guiding the development of relevant legal and regulatory frameworks.

The key recommendations for each element of the GH2 chain for both export and domestic projects are outlined below. MEMR's preferences have been taken into account regarding the optimal market model for the sector in Jordan whilst also allowing for variations to this structure to emerge.

Area – Export Market	Recommended Actions
Land	MEMR: Provide Land Use List for potential RE generation sites for GH2 production
Regulatory Regime	Establish transparent Third Party Access regulations for CUI **Short Term**: Expand powers of Energy and Minerals Regulatory Commission of Jordan (EMRC) to GH2 chain coordinated with Aqaba Special Economic Zone Authority (ASEZA)/ADC, Ministry of Environment, and WAJ; **Long Term:** Establish "super regulator"
Electricity	Amend Electricity Laws to allow: RE generators to sell power to GH2 producers and other buyers via independent transmission lines, ownership and operations of independent transmission/distribution lines as CUI, make electricity storage licensable activity, allow for bylaw to be enacted
GH2 and Derivatives	**Short term:** Seek to amend Petroleum Products Law to cover GH2 and derivatives, or enact GH2 bylaw under Petroleum Products Law to cover GH2 and derivative activities (potentially including activities such as transportation, although depending on scale of activity, may be possible to address through licensing). **Long term:** Whilst not recommended now as will be time consuming and potentially impractical to implement, the potential requirement or benefit of a GH2 "Super" Law could be reassessed in the long-term.
Environmental, Health & Safety	Amend Environmental Regulations to govern GH2 value chain, draw on international best practice to develop the national guidelines.

Technical Standards and Certificates for GH2 Export	Need certification for the entire GH2 value chain from independent accredited body. A national champion entity might take the lead to coordinate with international certifiers and ensure compliance with national standards and codes. Certificates will be an essential element of the enabling framework.
Government role: Take and Support	Develop specific aspirations for GoJ take. Confirm GoJ support, including for CUI.
Area – Domestic Market	**Recommended Actions**
GH2 use of distribution network	Enact new Natural Gas Law (or similar) with GH2 included
Technical Standards and Certificates for GH2 domestic use	Update Standard Specifications and Technical Rules issued by Standards and Meteorology Corporation

2.4 IMPLEMENTATION

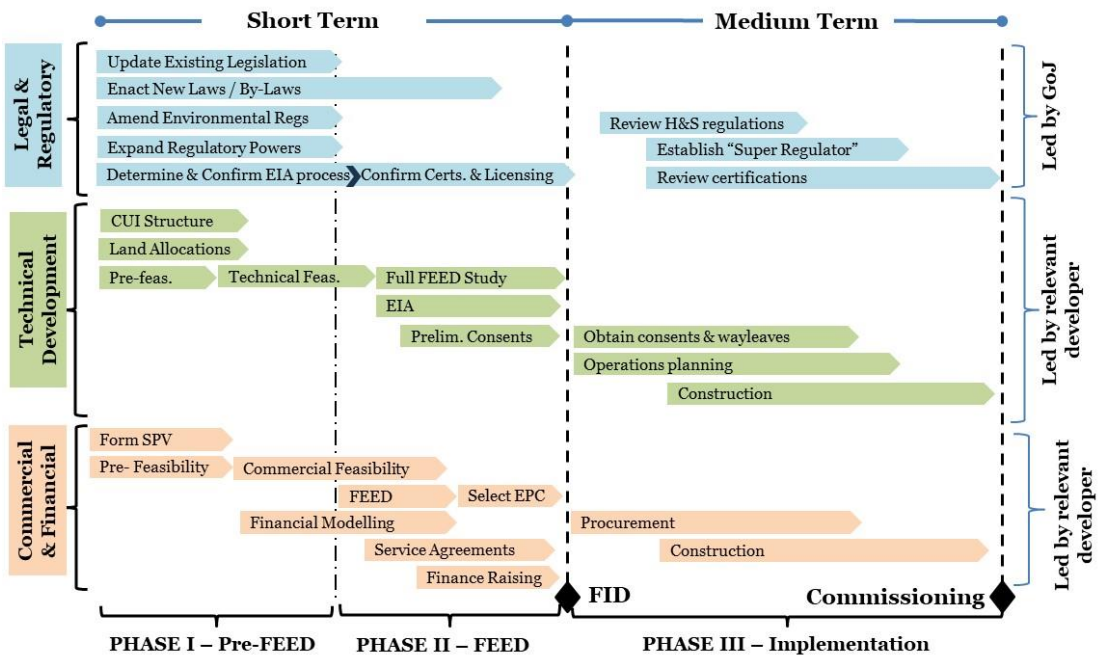
With the GoJ's role mainly focused on facilitating the development of the GH2 sector, GH2 developers will take responsibility for the planning and implementation of their own projects. However, GoJ inputs into the implementation process must at least reflect the anticipated drivers, needs and constraints of the overall development of GH2 projects, even with a degree of uncertainty at this time.

With this in mind, we have developed an outline development plan for the anticipated first wave of GH2 projects in Jordan to be brought onstream around 2030. While the expansion of the GH2 sector beyond the first wave is also addressed, it is done at a higher level as much of the work required for sector initiation will not need to be repeated.

Drawing on the work undertaken during this assignment, the outline development plan is informed not only by international best practice for the development of a new energy sector, but also by the specifics of what will be required in Jordan, including the Base Case Model A for export projects.

With the focus on the Short and Medium Term, the summary plan is depicted in the diagram below.

GH2 sector development – summary timeline



The implementation plan considers the following key points:

(i) The plan assumes a timeline of approximately five (5) years to progress these initial projects from the current status (pre-feasibility) through detailed project development, FID and construction. The plan considers the key elements which constitute the critical path for GH2 sector development.

(ii) The plan considers the three primary areas of development activity, being Legal & Regulatory, Technical and Commercial & Financial. Whilst the GoJ will be primarily responsible for the Legal & Regulatory aspects, should it decide to invest, it will also bear responsibility for developing elements of CUI along the GH2 value chain (as per Model A – Base Case). The GoJ's role will either be direct (potentially through a SOE) or through participating in SPVs which might be formed for that purpose. It is assumed for the purpose of this analysis that the GoJ may potentially participate in the SPVs indicated (some SPVs will be comprised of GH2 developers).

(iii) We consider this five (5) year plan to encompass the Short and Medium Term actions from a GoJ perspective. These periods are then categorised into three phases, reflecting GH2 project and CUI development milestones.

(iv) Phase I in the Short Term is the pre-FEED (Front End Engineering Design) stage with Phase II moving from FEED to FID. The Medium Term moves from post-FID to end of construction and project commissioning. The Short Term will require a high concentration of effort from GoJ in the Legal & Regulatory sphere in particular in order to facilitate all other areas of development. The Long Term actions will relate to those activities after the first wave of projects are in operation, including both the maintenance of effective regulatory control over the established projects and the further expansion and development of the GH2 sector.

(v) It is helpful to understand that whilst FID remains the primary decision point in respect of any such infrastructure development project, the developers are likely to adopt some form of 'Gate' process whereby senior management will review the status of the project during the earlier stages of development before committing to the next level of development budget. Specifically, we would expect the private developers to have a 'Gate' decision point after project feasibility but prior to entering into major FEED contracts, as these will represent an investment commitment of several million USD.

Short Term Actions

Legal and Regulatory

The priority legal and regulatory actions the GoJ will need to consider in the Short Term to ensure the timing of GH2 sector development does not slip are outlined below.

By H1 2025: Confirm legal and regulatory framework and GoJ role.

- Establish GoJ role / potential incentives for investors (direct state participation (e.g. in CUI))
- Begin development of fiscal policy for GH2 sector (e.g taxes and incentives)
- Begin drafting and enactment of new /amended legislative provisions (implement GH2 legal and regulatory framework)
- Undertake clarification (expansion where relevant) of regulatory roles

From 2025+: Maintain momentum on GH2 sector development.

- Draft legislative amendments / new legislations
- Amend / complete and enact regulatory roles
- Develop operating licences and certifications
- Determine and confirm EIA process

Technical, Commercial and Financial

GoJ actions regarding technical and commercial tasks, will be dependent on the decision of the GoJ with regards to potential equity participation (e.g. CUI). For reference, the essential technical and commercial actions to be completed if they were to invest directly are noted below.

By H1 2025: Prepare essential studies

- Technical: Complete CUI Masterplan study
- Technical: Confirm CUI structure and allocate land
- Commercial: Move to form SPV(s)
- Technical and Commercial: Prepare for and undertake CUI pre-feasibility and full feasibility studies

From 2025+: Project Implementation

- Technical and Commercial: Undertake FEED study/studies
- Technical: Confirm process and requirements for EIA
- Technical: Prepare to issue preliminary consents
- Commercial: Undertake financial modelling for CUI
- Commercial: Undertake service agreements for CUI
- Commercial: Seek to raise financing for CUI

Medium Term Actions

Legal and Regulatory

- Enact gas pipeline networks legislation
- Review of health and safety regulation
- Establish "Super Regulator"
- Review certifications against latest/developing export requirements

Technical, Commercial and Financial

- Technical: Obtain consents and wayleaves
- Technical: Operations planning
- Technical: CUI Construction
- Commercial: Procurement for CUI and Construction of CUI

Long Term Actions

Legal and Regulatory

No new legal and regulatory undertakings are anticipated to be needed in the Long Term beyond those related to the regulation of new GH2 project which commission in this period.

Technical, Commercial and Financial

The technical activities, workstreams and undertaking required in the Long Term will be those related to capacity expansion of CUI along the GH2 value chain.

The primary commercial activity required in the Long Term is expected to be securing commercial agreements with new GH2 developers. These will mirror those required in the development stage of the sector.

For the technical and commercial developments, the expansion of infrastructure as opposed to development of new infrastructure should mean time and task savings for expanded CUI capacity.

3 CONCLUSIONS

Jordan is well placed to become a significant player in the GH2 sector, providing products both for export and for the domestic market

- The solar and wind conditions in Jordan provide a good basis for new GH2 sector developments.
- Jordan has a strong track record of facilitating private sector investment in the energy sector.
- The existing regulatory framework requires amendments to provide a robust basis for investment in the sector.

GH2 sector development is on target, but is at risk of slipping.

- At present, project development in the GH2 sector in Jordan remains consistent with timeframes in the GH2 Roadmap that envisage the first major projects being commissioned by around 2030.
- However, timelines will become tighter as 2025 progresses and the need for GoJ decisions on the key questions highlighted in this analysis (i.e. GoJ participation, drafting and enactment of legislative amendments, and regulatory support) is critical.

The implementation of a full regulatory framework must be prioritised.

- The full regulatory framework will support the realisation of benefits including foreign investment, economic and job growth, national energy and climate strategy targets, as well as improvements in Jordan's trade balance and tax revenue.
- Continued positive GoJ activity on legislative amendments will reduce developer uncertainty and enable investment. However, failure to progress on legal enactments will undermine the route to FID for projects and developers.
- In an uncertain global market for GH2, Jordan's ability to adopt and implement transparent and streamlined regulatory and approval processes can help maximise its competitive positioning and growth opportunities.