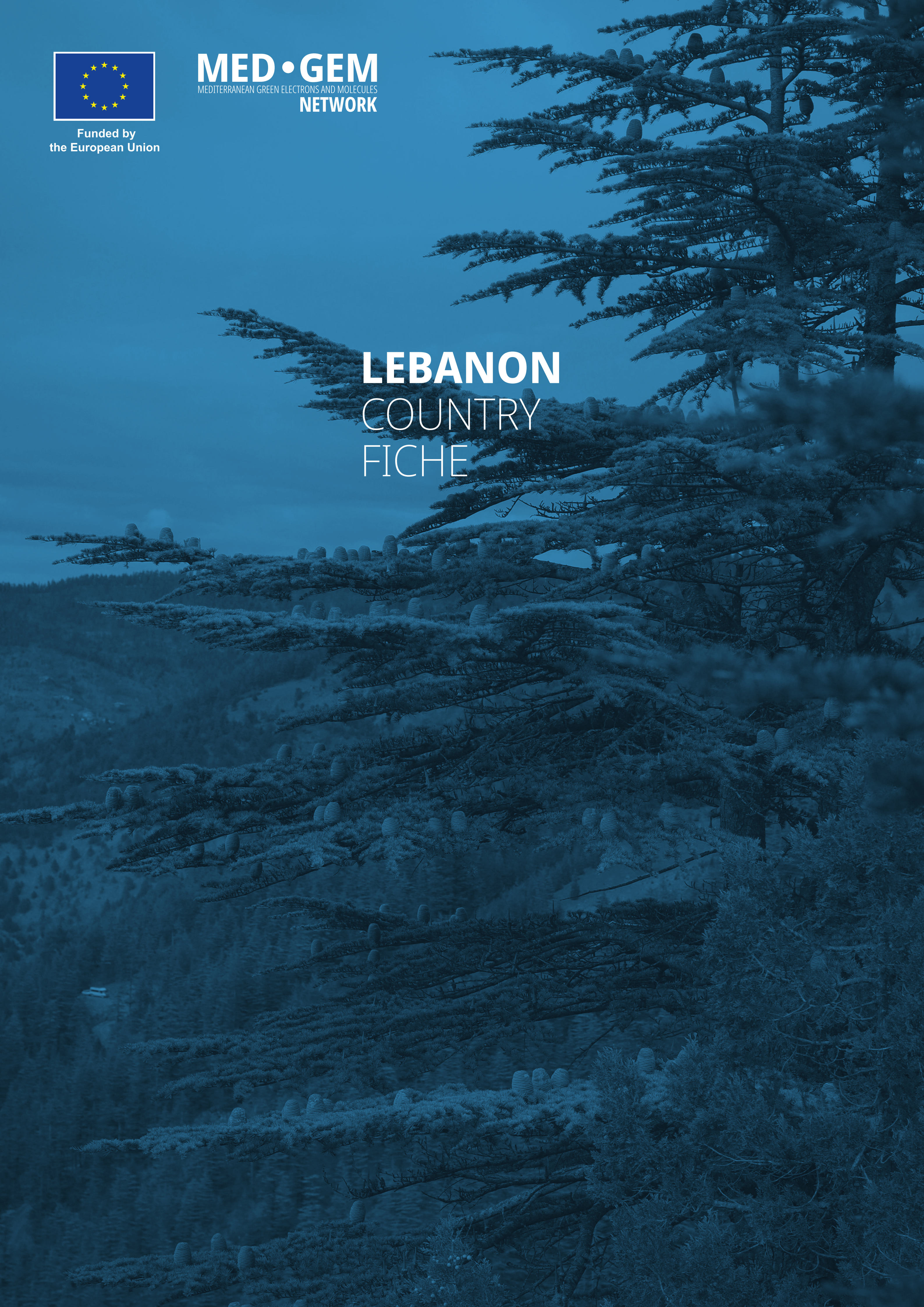

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MEDITERRANEAN GREEN ELECTRONS AND MOLECULES
NETWORK

LEBANON
COUNTRY
FICHE

List of Tables

Abreviations

AFNOR	Association Française de Normalisation
AGP	Arab Gas Pipeline
AIS	Air-insulated substation
AUB	American University of Beirut
BDL	Banque du Liban
BT	Technical Baccalaureate
CapEx	Capital expenditures
CSO	Civil Society Organizations
CSP	Concentrated Solar Power
DRE	Decentralized Renewable Energy Law
EBML	Eaux de Beyrouth et du Mont-Liban
EBRD	European Bank for Reconstruction and Development
EDL	Électricité du Liban
EDZ	Electricité de Zahlé
EE	Energy Efficiency
EoI	Expressions of Interest
EU	European Union
FA	Framework Agreement
FSRU	Floating Storage and Regasification Unit
GEM	Green Electrons and Molecules
GHG	Greenhouse gas
GH2	Green Hydrogen
GW	Gigawatt
H2	Hydrogen
HFO	Heavy Fuel Oil
IAB	Industry Advisory Board
IECD	Institut Européen de Coopération et de Développement
I-REC	International Renewable Energy Certificates
IRI	Industrial Research Institute
kW	Kilowatt
km	Kilometer
kV	Kilovolt
LAU	Lebanese American University
LCEC	Lebanese Center for Energy Conservation
LFPR	Labor Force Participation Rate
LT	Technical License
LU	Lebanese University
LVC	Local Value Creation
M	Million
MAR	Managed Aquifer Recharge
MCM	Million cubic meters
MED-GEM	Mediterranean Green Electrons and Molecules
MMT	Million metric tons
MoEW	Ministry of Energy and Water
MOU	Memorandum of Understanding
MV	Medium Voltage
MVA	Mega Volt Ampere
MW	Megawatt
NH3	Ammonia
O&M	Operation and Maintenance
OEA	Order of Engineers and Architects
PPA	Power purchase agreement
PPPs	Public-Private Partnerships
PtX	Power-to-X
PV	Photovoltaic
R&D	Research and Development
RE	Renewable Energy
RES	Renewable Energy Sources
RO	Reverse Osmosis
TA	Technical Assistance
T&C	Testing and Commissioning
TI	Technical Institute
ToT	Training of trainers
TVET	Technical and Vocational Education and Training
USJ	Saint Joseph University
WE	Water Establishment
WG	Working Groups
WWTP	Wastewater Treatment Plant

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Table of content

INTRODUCTION

BACKGROUND AND CONTEXT

The EU-funded MED-GEM Project, **supporting Green Electrons and Molecules' (GEM) development in the Southern Mediterranean Neighbourhood**, aims to: (1) Create and operate a sustainable Network in the Southern Neighbourhood region and (2) increase public awareness on the imperative need for an accelerated clean energy transition. The MED-GEM network is structured around four thematic components: (1) **Policy and Regulations**, (2) **Industry**, (3) **Infrastructure**, and (4) **Finance**.

Among the activities that MED-GEM has been mandated to initiate is the creation of an Industry Advisory Board (IAB) where the first IAB workshop was organized by the European Commission/DG NEAR through the MED-GEM Network on 20 December 2023 in Brussels. Accordingly, the workshop participants selected the following four topics as high priority topics that need to be addressed:

1. **Local value creation**
2. **Certification**
3. **Jobs, skills, and capacity building**
4. **Infrastructure**.

In summary, the first IAB meeting laid a foundation for collaborative efforts, addressing key challenges and leveraging opportunities for sustainable growth of the GEM industry across partner countries where it was agreed that the IAB will reconvene every 6 months, supplemented by Working Groups (WGs). One of the objectives of these WGs is to gather specific data in the partner countries on the current status, gaps, needs, challenges, opportunities, and future perspectives related to infrastructure, local value creation, jobs, skills, and capacity building across the whole RE and GH2 value chain. This was facilitated by preparing three questionnaires/surveys, one for each WG topic, that were shared with the partner countries to collect the required baseline information.

OBJECTIVE

Ultimately the aim of the country fiche is to provide recommendations and the needed technical assistance for activities, aiming for large-scale and speedy deployment of GEM technologies within the Southern Mediterranean Countries.

However, the objective of this interim country fiche at this stage is to present a first layer of analysis of the situation within the country with first key findings and recommendations in the aim of developing a final country fiche, including a gap analysis, by December 2024 which will put forward a thorough analysis of the situation on a local and regional level with recommendations on:

- How to make use of existing infrastructure (e.g. gas pipelines, ports, roads, etc.) along with the infrastructure needed for GH2 production, storage, transport, local use, and export (including new ports, roads, RE plants, desalination plants, etc.) based on local demand and export potential.
- The training, education, and apprenticeship programs needed along with the updated curricula and modern training equipment required to meet industry needs and provide the essential competences for the planned jobs to be created.
- Manufacturing components and systems for RE technologies and GH2 production systems, with the aim to add maximum value for the country.

This is in addition to potential complementing collaborations between partner countries and potential partnerships between Lebanon and EU stakeholders:

- Related to financing and shared/common infrastructure.
- At the level of sharing knowledge and human resources development.
- Related to financing and manufacturing opportunities.

CONTRIBUTORS

The MED-GEM Network is thankful to the National Focal Point (NFP), all the Industry Advisory Board (IAB) and working group (WG) members and contributors from Lebanon who dedicated their time and effort for the data collection and information gathering needed to prepare this report. The contributors are cited below:

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Table 1. List of contributors to baseline surveys

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EXECUTIVE SUMMARY

Historically, Lebanon has depended heavily on imported fossil fuels to meet its energy needs. The country lacks significant domestic fossil energy resources, particularly oil and natural gas, making it vulnerable to fluctuations in global energy prices and regional geopolitical tensions. The Lebanese energy sector has been underdeveloped due to years of civil unrest, wars, and lack of effective governmental policies. This has resulted in an aging and inefficient energy infrastructure that is unable to meet the demand of the population and the needs of the economy.

Lebanon currently faces a dire electricity crisis. The state-run electricity company, Électricité du Liban (EDL), is unable to provide consistent power to its citizens, leading to daily power outages that can last up to 16-18 hours. The national grid is outdated, plagued with technical issues, and operates far below its capacity due to lack of maintenance and investment. Additionally, the reliance on diesel generators to supplement the power supply has led to increased pollution and higher energy costs for households and businesses.

Amid these challenges, Lebanon's RE sector, while still in its nascent stages, presents significant potential for development and expansion, particularly from solar and wind sources and specifically as the country seeks solutions to its longstanding energy crisis. In response to these opportunities and challenges, Lebanon has set ambitious **RE targets**. The **National Renewable Energy Action Plan (NREAP**) aims for renewable sources to make up 30% of Lebanon's energy mix by 2030. This initiative is supported by both local and international entities, including the International Renewable Energy Agency (IRENA), which has collaborated with the Lebanese government to provide strategic guidance and technical support.

At the moment, Lebanon is planning to integrate GH2 into its energy landscape and further develop its RE sector, an effort led by the Lebanese Center for Energy Conservation (LCEC) - the country's national energy agency within the Ministry of Energy and Water (MoEW). The country currently has no national strategy, nor a roadmap related to green hydrogen. However, Lebanon being a partner country of the MED-GEM Network and with its support is working on developing a preliminary national roadmap for green hydrogen leading to a **national green hydrogen (GH2) strategy** with targets for the country. Therefore, as part of the country's planned strategy for GH2, Lebanon will be working on the development of the needed legal framework, infrastructure, and financial mechanisms for the production, storage, transport, use, and export of GH2.

When it comes to **natural resources**, Lebanon enjoys ample wind, solar and hydropower potential. Furthermore, there are huge prospects for GH2 development in Lebanon, due to land availability and the country's large coastline on the Mediterranean and its numerous rivers which enable easy access to water. However, no Expressions of Interest (EoIs) or Memorandums of Understanding (MOUs) for GH2 projects have been signed yet, as the country currently lacks a GH2 strategy and a regulatory framework to support the GH2 value chain. In addition to the country's economic situation is hindering the attraction of GH2 infrastructure investors. However, as mentioned above, the large potential of renewable energy sources (RES) in Lebanon, the easy access to water, and the availability of lands provide the country a promising potential for GH2 development. Once a GH2 strategy and the necessary legislation are in place, Lebanon could effectively leverage these resources to advance its GH2 initiatives.

To realize this potential, Lebanon should focus on several key actions: providing financial incentives for renewables and GH2 technologies, stabilizing the energy grid, establishing standards for GH2 production, allocating research funds, encouraging public-private partnerships (PPPs), enforcing eco-friendly practices, promoting international collaboration, and implementing monitoring and evaluation systems. These measures will help create a conducive environment for the growth of the GH2 sector and attract the necessary investment and expertise.

Lebanon's current **hydrogen demand** is present in the fertilizers industry, which uses decent amounts of imported grey ammonia. The country's potential hydrogen demand can be found in the cement and steel industries, as well as in power plants; mainly for burning hydrogen to be used as a heat source to generate power and for energy storage to accommodate for hourly/daily fluctuations and seasonal variations. Lebanon's potential for GH2 production to be set for export is also promising, and the country is eyeing exports to neighboring Arab countries, Turkey, and the EU. There is also an existing industry for RE parts and components in wind, solar PV, and solar thermal technologies, which provides an opportunity for further **local value creation** when it comes to integrating GH2.

The country's existing **infrastructure**, including highways, ports, and desalination plants provides a solid foundation for GH2 integration. Although Lebanon's grid connections and the Arab gas pipeline are technically ready and connected to Syria, they are not currently operational. However, the proximity of Lebanon's ports to the EU offers promising export opportunities. Furthermore, as mentioned, the country suffers from frequent power outages, and GH2 along with RE has significant potential in addressing this crucial issue.

The green energy sector in Lebanon currently employs around 14,000 people, of whom 5,000 are directly employed. This demonstrates the sector's significant role in job creation and its potential to further drive economic growth. Given the promising outlook for GH2, the potential for job creation is substantial. As the GH2 sector expands, it could provide numerous employment opportunities across various stages of the supply chain, from production and storage to distribution and maintenance. Lebanon's **workforce** has developed **knowledge, skills, and experience** in the green energy sector. However, there is a pressing need for advanced training on some critical areas such as energy storage, grid integration, hydropower, solar PV, solar CSP, and GH2 technologies.

SURVEY FINDINGS

LOCAL VALUE CREATION

JOBS, SKILLS AND CAPACITY BUILDING

INFRASTRUCTURE

SITUATIONAL ANALYSIS WITHIN THE COUNTRY

Local Value Creation

The purpose of the "Local Value Creation" chapter is to gather information about the current status of local value creation in manufacturing related to RE and GH2 within Lebanon as well as analyse and provide conclusions and recommendations. The input provided is valuable in assessing the baseline and guiding future initiatives and development plans on deepening and widening the value chain, encouraging local production, and nearshoring activities.

Background: H2 current consumption, and potential use

As this could be a good indicator and driver for the country's development plans on local value creation, sectors that presently use H2 and its derivatives were identified along with their current consumption to estimate the potential for local use of GH2 in the future when produced.

Current hydrogen usage and the potential for local GH2 use in different sectors		
Sector	Current consumption of H2 and its derivatives	Potential for local use of GH2 and its derivatives
Cement	Figures not available	Replacing the heat and electricity demand of industries in cement production
Steel	Figures not available H2 consumption is minimal as it is currently only used in the welding processes	Replacing the heat and electricity demand of industries in steel production
Fertilizers	112,500 kg per annum of imported grey ammonia	Replacing the imported ammonia quantities by local production

Table 2. Current hydrogen usage and the potential for local GH2 use in different sectors

Current Manufacturing Landscape: Major local industries and priority manufacturing activities

The current and existing major local industries and priority manufacturing activities that the country can build on and expand to integrate into the RE and GH2 value chains were identified and an overview was given by highlighting the sectors covered by these manufacturing activities, the products being manufactured by sector, the number of factories in each sector, as well as their market focus, be it local use or export.

Major local industries and priority manufacturing activities in the partner country			
Sector	**Products**	**Market focus (local use, export)**	**Number of factories**
Agrofood	Canned food, alcoholic beverages, non-alcoholic beverages, chips, olive oil	• 70% is for local use • 30% is for export	350 factories
Chemicals	Detergent, plastic products, pipes, cosmetics, pharmaceutical products	• 70% is for local use • 30% is for export	54 factories
Paper and Carton	Paper and carton	• 80% is for local use • 20% is for export	50 factories
Cables	Cables, electric wires for DC and AC use	• 90% is for local use • 10% is for export	7 factories
Cement	Cement and its derivatives	100% is for local use	15 factories
Steel	Steel and stainless steel	• 70% is for local use • 30% is for export	20 factories
Recycling	Recycling paper, plastic	The recycling done is 100% from locally collected paper and plastic	25 factories

Table 3. Major local industries and priority manufacturing activities in the partner country

Current Manufacturing Landscape: Existing manufacturing of components for RE technologies

The existing factories in the country that are involved in manufacturing components for RE technologies were looked at the products they manufacture by technology, the production capacity, the number of companies out there, as well as the quality assurance measures and quality control processes they have in place. Some of the RE components that were looked into by technology are:

1. For **Wind Energy** - Blades, nacelle, rotor, tower, gear box, generator, power cables, inverters, control systems, transformers, etc.
2. For **Solar PV** - PV cells, PV panels, inverters, batteries, racking equipment, electrical equipment, switchgear, performance monitoring system, power cables, mounting structures, accessories, etc.
3. For **Solar CSP** - Mirrors/Heliostats, Receiver, Heat Transfer Fluid (HTF), power block, control system, storage system (e.g. molten salt), etc.

It also touches upon the extent to which these RE manufacturing facilities cover the demand of the local market and what future plans exist for manufacturing RE components.

Existing factories involved in manufacturing RE components					
Technology	Products	Production capacity	Number of companies	Quality assurance measures	Quality control processes
Solar PV / Wind Energy	Cables (for solar PV and power)	Covers 80% of the local use	10 companies The largest market share is covered by **Liban Cables**	• Liban Cables has been ISO 9001 certified since 1997 • Yearly audits are conducted by AFNOR	Liban Cables has a QC system implemented at the factory on all raw material and manufacturing stages where a test certificate is issued for each drum of cables
Power Generation	Generators	Covers 80% of the local use	15 companies	Data related to QA measures is not available	Data related to QC processes is not available
Solar PV / Wind Energy	Transformers	Covers 30% of the local use	3 companies, 1 being: MATELEC	Data related to QA measures is not available	Data related to QC processes is not available
Solar PV / Wind Energy / Solar CSP	Control systems	Covers 20-30% of the local use	3 companies	Data related to QA measures is not available	Data related to QC processes is not available
Solar PV	Racking equipment	Covers 25% of the local use	10 companies	Data related to QA measures is not available	Data related to QC processes is not available
Solar PV / Wind Energy	Electrical equipment	Covers 30% of the local use	5 companies	Data related to QA measures is not available	Data related to QC processes is not available
Solar PV	Storage systems (Batteries)	Covers 10% of the local use	3 companies	Data related to QA measures is not available	Data related to QC processes is not available

Table 4. Existing factories involved in manufacturing RE components

In addition to other products such as: steel, aluminum, cement (for mounting structures and foundations), glass, copper, pipes, plastic, and the assembly of inverters, gearboxes, control and monitoring systems, and batteries.

As seen above, the RE manufacturing factories that work in cables (for solar PV and power), generators, and steel structures cover most of the demand of the local market while the remaining RE components manufactured locally mentioned in the table cover less than half of the market needs.

Current Manufacturing Landscape: Existing manufacturing of components for GH2 production systems

The existing factories in the country that are involved in manufacturing components for GH2 production systems were looked at the products they manufacture by technology, the production capacity, the number of companies out there, as well as the quality assurance measures and quality control processes they have in place. Some of the components for GH2 production that were looked into by system are:

- For **Electrolysers** - Electrolyte, anode and cathode compartments, electrodes, membrane, plates, etc.
- For **Water supply systems** - Pumps, pipes, reservoirs, etc.
- For **Water treatment systems** - Filtration, purification, deionization units, etc.
- For **H2 compression system** - Compressors, pipes, valves, etc.
  For **H2 storage systems** - Pressure vessels or tanks (for compressed H2 storage), cryogenic storage tanks (for liquid H2 storage), and solid-state storage materials (for solid-state H2 storage)
- For **Gas purification systems** - Gas purification unit (absorption or adsorption beds), purification materials, filters, and membranes, etc.
- For **Control and automation systems** - Programmable logic controllers (PLCs), sensors, and instruments for monitoring temperature, pressure, and flow.
- For **Cooling systems** - Heat exchangers, cooling water circulation system, etc.
- For **Safety systems** - Emergency shutdown systems, ventilation and gas detection systems, etc.
- For **Monitoring systems** - Instrumentation and sensors.
- For **Infrastructure for distribution and utilisation** - Pipelines or transportation systems for hydrogen distribution, storage tanks for temporary storage, and utilization equipment (fuel cells, hydrogen combustion systems).

It also touches upon the extent to which these GH2 manufacturing facilities cover the demand of the local market and what future plans exist for GH2 manufacturing.

Existing factories involved in manufacturing components for GH2 production					
Technology	Products*	Production capacity	Number of companies	Quality assurance measures	Quality control processes
Plumbing	Pipes	Covers 50% of the local use	20 companies	Data related to QA measures is not available	Data related to QC processes is not available
Plumbing	Filters	Covers 25% of the local use	10 companies	Data related to QA measures is not available	Data related to QC processes is not available
Plumbing	Tanks	Covers 75% of the local use	15 companies	Data related to QA measures is not available	Data related to QC processes is not available

Table 5. Existing factories involved in manufacturing components for GH2 production

These manufactured components cover 25% to 75% of the country's current local demand. However, Lebanon has no other existing factories that manufacture other components for GH2 production systems and no future plans in that regard yet.

** It is worth noting that these components produced in the above table are not manufactured for GH2 production purposes. However, these manufactured products could be used as components for GH2 production systems*

Future Perspectives: Overview of the development of manufacturing in RE locally within the country

This section gives an overview of: (1) the main **challenges or barriers** hindering the development of manufacturing in RE locally and (2) the **opportunities** for the growth of this sector within the country by looking into market trends, technological advancements, job creation, new product development, etc.

Renewable Energy (RE)	
Challenges / Barriers	**Opportunities**
• Some specific challenges exist in developing the necessary technology and expertise for RE • Cost of production mainly due to the high cost of electricity • Securing funding is difficult due the country's economic challenges	• Job creation in manufacturing, assembling, and recycling batteries due to the high demand attributed to the large additions of decentralized solar PV systems with storage in the Lebanese market • Environmental benefits due the recycling of these batteries • Increase in the energy security within the country and the opportunity to export green electricity in the long-term following the ratification of the DRE law which will potentially allow for the exponential growth of the RE market in Lebanon. It is worth noting that the DRE law allows peer-to-peer trading of electricity generated from RES having a capacity less than 10 MW

Table 6. Manufacturing in RE - Challenges and opportunities

Future Perspectives: Overview of the development of manufacturing in GH2 locally within the country

This section, similar to the previous one, gives an overview of: (1) the main **challenges or barriers** hindering or may hinder the development of manufacturing in GH2 locally and (2) the **opportunities** for the growth of this sector within the country by looking into market trends, technological advancements, job creation, new product development, etc.

Green Hydrogen (GH2)	
Challenges / Barriers	**Opportunities**
• Lebanon faces a significant challenge in developing the necessary technology and expertise for GH2 production. • Infrastructure for production, transport, and storage is lacking. • Access to finance especially the cost of CapEx is considerably high and challenging in the country's local context.	• The abundance of water and RES will remarkably increase the country's energy security especially in the electricity supply sector and will drastically decrease the country's dependence on fossil fuel imports • The promising potential of GH2 usage in Lebanon that is based on the large potential of RES will play a pivotal role in shifting the national energy mix and energy demand in the main industrial fields in the long term • The growth of the GH2 sector will allow Lebanon to be interconnected with Arab and European countries in the GEM sector, opening the door for better import/export opportunities for locally manufactured products needed to accelerate the clean energy transition in the Mediterranean area • Developing a **preliminary national roadmap for GH2 leading to a national GH2 strategy and regulatory framework** for the country based on the study conducted by MED-GEM to analyze the country's potential for GH2 and its derivatives (in terms of production, local use, and export)

Table 7. Manufacturing in GH2 - Challenges and Opportunities

Jobs, Skills, and Capacity Building

The purpose of the "Jobs, skills, and capacity building" chapter is to gather information about the existing jobs, skills, and capacity building covering the entire value chain of RE and GH2 within Lebanon as well as analyse and provide conclusions and recommendations. The input provided is valuable in assessing the baseline and guiding future initiatives on workforce development, skills enhancement, and capacity building to meet the demands of the evolving GEM industry landscape.

Jobs: Overview of the existing jobs in the clean/green technologies sector

The below table gives an overview of the country's workforce working in the clean/green technologies sector - number of people employed in the sector, percentage of the total workforce, and the existing jobs and occupations in major local manufacturing industries related to the sector.

Clean/green technologies sector (RE and GH2)	
Number of people employed*	**5,120** directly employed in RE sector **14,000** direct and indirect employees
Percentage of country's total workforce*	**2.25%** in the RE sector
Existing type of jobs in major local manufacturing industries related to the sector	
• Engineers • Technicians • Quality control experts • Safety control experts • Legal experts • Financial experts	

Table 8. Existing jobs in the clean/green technologies sector

** These figures are from 2022 where the labor force participation rate (LFPR) was 43.4% and the unemployment rate stood at 29.6%, indicating that less than half of the working-age population were either working or seeking employment and almost one-third of the labour force was unemployed.*

Skills: Overview of the status of the skill sets of the country's workforce in the RE sector by technology

A baseline on the existing expertise, skill sets, and competences in the RE sector that the country's workforce has was established along with a rating of these skills based on self-perception. Moreover, the skills gaps and in turn the skills needed in the RE sector were identified by technology: **wind energy**, **solar PV**, **solar CSP**, and **hydroelectricity**.

Wind Energy	
Skills Rating*	3
Existing Skills	• Engineering expertise (mechanical, electrical, and civil) • Legal, regulatory, and policy expertise • Financial expertise
Skills Gaps	• Site assessment and design • Construction works of wind farms • Field operations and maintenance
Skills Needs**	• Technical skills for site assessment and design of wind farms • Electricity integration best practices

Table 9. Status of skills in wind energy

Solar PV	
Skills Rating*	5
Existing Skills	• Expertise in decentralized solutions include system design, modeling, execution, T&C, and O&M covering engineering (electrical and civil) and technician expertise • Expertise in large scale solutions include regulatory, policy, legal, and financial expertise, particularly due to ongoing projects such as the 11 solar PV farm licenses. In addition to technical expertise which is primarily associated with the workforce having experience in such projects abroad
Skills Gaps	• O&M of large large-scale projects • Integration of solar farms to the grid, especially when addressing the intermittent and variable output of solar power and maintaining grid stability and control. *However, EDZ has been tackling this challenge, albeit on a smaller scale compared to EDL*
Skills Needs**	Development of grid code for large scale integration taking into consideration safety and technical requirements, grid impact assessment, digitalization and data analytics

Table 10. Status of skills in solar PV

Solar CSP	
Skills Rating*	2
Existing Skills	• Engineering expertise (mechanical, electrical, chemical, and civil) • Environmental impact assessment expertise
Skills Gaps	Execution, O&M, thermal energy storage technologies, control and dispatching ability
Skills Needs**	• Technical assessment and development of solar CSP projects • Thermal storage and their integration into the grid *for chemical, mechanical, and electrical engineers*

Table 11. Status of skills in solar CSP

** Rating of existing skills was based on self-perception and is to be interpreted accordingly. A scale of 1 to 5 was used, 1 being the lowest and 5 being the highest (Typical for all tables)*
*** Skills needs in terms of upskilling and re-skilling (Typical for all tables)*

Hydroelectricity	
Skills Rating*	4
Existing Skills	• Engineering expertise (mechanical, electrical, civil, and environmental) • Hydrology and water resource assessment • Grid integration
Skills Gaps	• Dam safety and structural expertise to ensure the integrity and stability of dams • Upgrading existing hydro turbines
Skills Needs**	• Dam safety, structural design, and best practices • Upgrading existing hydro turbines • Energy storage integration and control via pumped storage hydropower

Table 12. Status of skills in hydroelectricity

** Rating of existing skills was based on self-perception and is to be interpreted accordingly. A scale of 1 to 5 was used, 1 being the lowest and 5 being the highest (Typical for all tables)*

*** Skills needs in terms of upskilling and re-skilling (Typical for all tables)*

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Skills: Overview of the status of the skill sets of the country's workforce in the GH2 sector

A baseline on the existing expertise, skill sets, and competences in the GH2 sector that the country's workforce has was established along with a rating of these skills based on self-perception. Moreover, the skills gaps and in turn the skills needed in the RE sector were identified across the entire GH2 value chain (strategy / policy / regulatory frameworks, financing and funding, implementation of regulations, relevant technologies, GH2 production, GH2 storage, GH2 transportation, GH2 local use, GH2 export, and safety / hazard / risk).

GH2 value chain					
	Strategy / Policy / Regulatory frameworks	Financing and funding	Implementation of regulations	Relevant technologies	GH2 production
Skills Rating*	2	1	1	1	1
Existing Skills	Currently there is no GH2 industry/market that exists in the country, and hence the country's workforce has no expertise, skill sets, and competences across the whole GH2 value chain. However, upon the country's request, MED-GEM is conducting a study to analyze the country's potential for GH2 and its derivatives (in terms of production, local use, and export) to develop a preliminary national roadmap for GH2 leading to a national GH2 strategy and regulatory framework for Lebanon.				
Skills Gaps	The gaps cover the whole value of GH2 for both the public and private sectors				
Skills Needs**	• GH2 production, storage, and use (Advanced trainings) • Knowledge of best practices from countries with similar water and land resources potential • Re-skilling part of the country's workforce in the RE field, more specifically electrical, mechanical, civil, chemical, and petrochemical engineers to the GH2 production field				

Table 13. Status of skills set in the GH2 sector

** Rating of existing skills was based on self-perception and is to be interpreted accordingly. A scale of 1 to 5 was used, 1 being the lowest and 5 being the highest*
*** Skills needs in terms of upskilling and re-skilling*

GH2 storage	GH2 transportation	GH2 local use	GH2 export	Safety / Hazard / Risk
1	1	1	1	1

Capacity Building: Overview of the existing capacity building in the RE sector

The existing capacity building activities related to the RE sector in the country were looked into at the level of Technical and Vocational Education and Training (TVET), university level, and in the form of modular trainings and short courses.

This first table identifies the TVET institutes with existing updated vocational curricula, upgraded workshops equipped with modern training equipment, and on-the-job training related to RE that meet industry needs and specifies the existing curricula being used, the available training equipment, and the on-the job training opportunities presented.

Capacity building in the RE sector at the level of TVET			
TVET Institute	Existing Curricula	Available Training Equipment	On-the-job Training Opportunities
Institut Européen de Coopération et de Développement (IECD)	Training on solar PV systems: installation of components, protection devices needed, safety measures, and O&M. Future updates on the curricula may be applied	Solar PV panels, inverters, batteries, cables, etc.	Available: Every trainee is required to do a 15-day on-the-job training. IECD supports the trainees for 1 year in finding jobs following training completion
Industrial Research Institute (IRI)	Certified Training for Solar PV Technicians' program	All solar PV testing equipment	Not available
Tripoli Educational TI, Tripoli TI, Dekwaneh Educational TI	LT for RE Specialists	All technical training related equipment	Only practical sessions and exams are available

Table 14. Existing capacity building in the RE sector at the level of TVET

This second table identifies the universities with existing expanded engineering and non-engineering curricula with specialized courses and ongoing Research and Development (R&D) initiatives focused on RE as well as upgraded labs equipped with modern training equipment and internships related to RE that meet industry needs. It then specifies the existing curricula being used, the ongoing R&D initiatives, the available training equipment, and internship opportunities presented. It is worth noting that the existing curricula related to RE that were identified include engineering disciplines such as energy, electrical, electronics, process, industrial, mechanical, chemical, etc., and non-engineering disciplines such as finance, law, environmental management, etc.

Capacity building in the RE sector at university level				
University	Existing Curricula	R&D initiatives	Available Training Equipment	Internship Opportunities
LU / USJ	**Master Recherche en Energies Renouvelables** – Focusing on EE, wind energy, hydroelectric energy, solar energy, biomass energy, energy storage, RE projects assessment, and RE seminars	Not available *However, the master's degree includes thesis projects that form a solid base for R&D*	Not available.	Not available.
AUB / LAU	**Pro-Green Diploma** - focuses on RE, green buildings and water resources	Not available.	Not available.	Not available.

Table 15. Existing capacity building in the RE sector at university level

This last table gives an overview of the existing capacity building activities in the country in the form of modular trainings and short courses, theoretical and practical, to develop the necessary skills for RE as part of the continuous leaning, upskilling, and re-skilling of the country's workforce. These trainings identified cover technology specific and cross-cutting topics:

Technology specific such as:
- Design and implementation of RE projects.
- Panel, inverter, battery, etc. technology.
- Operation and maintenance of RE plants.

Cross-cutting such as:
- Health, safety and hazards.
- Legal aspects, regulations and permitting of RE projects.
- RE system components.

Capacity building in the RE sector in the form of modular trainings / short courses	
Practical training	Existing curricula
• Training by the IRI for electrical technicians on the installation of solar PV panels, electrical wiring of batteries, and safety measures. The training is both theoretical and practical and is essential for solar PV companies to be enlisted on the LCEC's list of recommended PV companies in Lebanon. • Short courses and modular trainings for RE, more specifically for solar PV developed and delivered by organizations like UNDP, UN-Habitat, USAID, PCPM, GIZ, and others as part of the capacity building components of their projects	• Several types of trainings proposed by the LCEC in the implemented projects for municipality members, CSO's and students, such as the Green City project, the BUILD ME Project where training programs were developed for engineers in the OEA in Tripoli, • Short trainings targeting specific type of audiences (industrialists, technical personnel) in collaboration with EBRD

Table 16. Existing capacity building in the RE sector in the form of modular trainings / short courses

Capacity building: Overview of the existing capacity building in the GH2 sector

The existing capacity building activities related to the sector of GH2 and its derivatives in the country were looked into at the TVET level, university level, and in the form of modular trainings and short courses.

This first table identifies the TVET institutes with existing updated vocational curricula, upgraded workshops equipped with modern training equipment, and on-the-job training related to GH2 that meet industry needs and specifies the existing curricula being used, the available training equipment, and the on-the job training opportunities presented.

Capacity building in the GH2 sector at the level of TVET			
TVET institute	**Existing curricula**	**Available training equipment**	**On-the-job training opportunities**
Zahle TI, Tripoli TI – Al Qobbeh, Ajaltoun TI	BT for Industrial Electricians	All technical training related equipment	Only practical sessions and exams are available
Hermel TI, Riyaq TI, Saida TI, Douma TI, Deir Amar TI, Zgharta TI, Tripoli TI – Al Qobbeh, Shohadaa Al Zrarieh and Seir Al Gharbiyeh TI, Arsal TI, Abdel Hadi Al Debes Preparatory TI, Shheim TI, Amlieh TI, Qortbawi TI – Adma, Zahle TI, Nabatieh TI, Sanayeh TI, Ajaltoun TI	BT for Industrial Mechanical Technicians	All technical training related equipment	Only practical sessions and exams are available
Bekaa TI, Manarah TI, Rashaya TI, Qob Elias TI, Majdal Anjar TI, Bar Elias TI, Saidoun TI, Saida TI, Zgharta TI, CIS Nabatieh, Adel Abdallah Osseiran TI, Hasbayya TI, Al Abrar TI, Bodnayel TI, Al Eqleem TI – Al Shouf, Barja TI, Shheim TI, Sanayeh TI, Baysour TI, Moaisrah TI, Al Dawsa TI, Meshmesh TI, Baytein TI	BT in Construction Techniques	All technical training related equipment	Only practical sessions and exams are available
Industrial Research Institute (IRI)	Certified Welders as per law 423/2002	All types of welding machines	Not available

Table 17. Existing capacity building in the GH2 sector at the level of TVET

This second table identifies the universities with existing expanded engineering and non-engineering curricula with specialized courses and ongoing R&D initiatives focused on GH2 as well as upgraded labs equipped with modern training equipment and internships related to GH2 that meet industry needs. It then specifies the existing curricula being used, the ongoing R&D initiatives, the available training equipment, and internship opportunities presented. It is worth noting that the existing curricula related to GH2 that were identified include engineering disciplines such as energy, electrical, electronics, process, industrial, mechanical, chemical, etc., and non-engineering disciplines such as finance, law, environmental management, etc.

Capacity building in the GH2 sector at university level				
University	**Existing curricula**	**R&D initiatives**	**Available training equipment**	**Internship opportunities**
All universities with engineering degrees	Undergraduate and post-graduate engineering curricula (mechanical, civil, electrical, industrial, chemical, and petrochemical) - **All contributing to the GH2 sector but nothing H2 specific**	Available in Master's and Ph.D programmes	Available depending on the university and the specialty	Not available.

Table 18. Existing capacity building in the GH2 sector at university level

Future perspectives: Overview of the skill sets and the types of trainings needed in the RE sector by technology

This final section "**Future Perspectives**" of the "Jobs, skills, and capacity building" chapter brings the attention back to the expertise, skill sets, and competences as well as the types of trainings needed by the country's workforce in the RE sector. Accordingly, the below tables identify the skills needed by topic across the entire RE value chain along with the types of trainings needed, be it theoretical or practical, in relation to the following technologies: wind energy, solar PV, solar CSP, and hydroelectricity, based on country's RE potential by technology.

Wind Energy	
Expertise / Skill sets / Competences	Types of trainings
• Development and design of on-shore and off-shore wind farms • Construction and O&M • Integration of wind farms to the national grid	• Advanced technical workshops regarding wind farms design, operations, grid interconnection requirements and best practices, and energy data analysis • Field visits and study tours to operational wind farms

Table 19. Skills and trainings needed in wind energy

Solar PV	
Expertise / Skill sets / Competences	Types of trainings
• Operation and integration of solar PV farms in the national grid • Design and implementation of large-scale storage systems • Development of a national grid code	• Advanced technical workshops and training of trainers (ToTs) on: - grid interconnection requirements and best practices - dispatchability and integration of storage systems - advanced modeling for large scale solar PV farms and storage systems within smart grids - national load profiles modeling based on smart meters • Field visits and study tours to dispatch centers and national control centers. • Training programs for technicians on the O&M of large-scale solar PV farms

Table 20. Skills and trainings needed in solar PV

Solar CSP	
Expertise / Skill sets / Competences	Types of trainings
• Development and design of CSP plants • Thermal storage systems characteristics and requirements • Integration of CSP plants in national grid along with other existing and operational RE plants	Advanced trainings on CSP plants and thermal storage modeling at this current stage

Table 21. Skills and trainings needed in solar CSP

Hydroelectricity	
Expertise / Skill sets / Competences	Types of trainings
• Structural safety • Pumped storage hydropower • Rehabilitation of existing hydropower plants • Options of upgrading existing hydropower turbines	• Advanced technical workshops • Training programs for technicians • Training of trainers (ToTs)

Table 22. Skills and trainings needed in hydroelectricity

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Future Perspectives: Overview of the skill sets and the types of trainings needed in the GH2 sector

Similar to above, this final section "Future Perspectives" of the "Jobs, skills, and capacity building" chapter brings the attention back to the expertise, skill sets, and competences as well as the types of trainings needed by the country's workforce but in the GH2 sector. Accordingly, the below tables identify the skills needed by topic across the entire GH2 value chain along with the types of trainings needed, be it theoretical or practical, based on the country's GH2 potential and the job's that can be created.

GH2 value chain	
Expertise / Skill sets / Competences	**Types of trainings**
Skills across the entire GH2 value chain: all stages of GH2 production, options of usage, transportation, and storage	• Basic and advanced workshops for engineers and technicians • Field visits and study tours to operational GH2 pilot projects (using solar farms as electricity source) • Training of trainers (ToTs)

Table 23. Skills and trainings needed across the GH2 value chain

Infrastructure

The purpose of the "**Infrastructure**" chapter is to gather information about the existing infrastructure within Lebanon, analyse, and provide conclusions and recommendations that the entire value chain of RE and GH2 can make use of. The input provided is valuable in assessing the baseline and guiding future initiatives and development plans on utilizing and expanding existing infrastructure as well as building new infrastructure to meet the needs of the evolving GEM industry.

Background: National H2 strategy, regulatory framework, infrastructure investments, and fiscal incentives

The country currently has no national strategy, nor a roadmap related to GH2. However, Lebanon being a partner country of the MED-GEM Network and with its support is working on developing a preliminary national roadmap for H2 leading to a national H2 strategy for the country. Accordingly, a study is being performed (under the MED-GEM TA) covering the following:

- Analysis of the current status of Renewables and H2 production and use.
- Analysis of the current status of H2 transport and storage
- Analysis and determination of future H2 demand in all the sectors of the economy
- Export opportunities for GH2
- Analysis of the production potential of GH2
- Analysis of the current technical and legal framework
- Proposal for new legislation needed for H2

Therefore, as part of the country's planned strategy for GH2, Lebanon will be working on the development of a legal framework and legislation needed for the production, storage, transport, use, and export of GH2.

Moreover, the country believes that GH2 development in Lebanon and the Mediterranean region needs a comprehensive strategy that includes setting realistic RE targets, providing financial incentives for renewables and H2 technologies, stabilizing the energy grid, establishing H2 production standards, allocating research funds, encouraging public-private partnerships (PPPs), enforcing eco-friendly practices, promoting international collaboration, and implementing monitoring and evaluation systems.

Regarding fiscal incentives or other support mechanisms to encourage building GH2 infrastructure, Lebanon has been approved for issuance of International Renewable Energy Certificates (I-REC) for electricity, and its local issuer is the Lebanese Center for Energy Conservation (LCEC). I-REC gives advantage for RE plants that could be used in producing GH2, where these certificates can be traded through an international platform to generate financial revenues. Thus, and in addition to the existing tax exemptions related to RE equipment, the I-RECs mechanism that helps quantify the reduction of GHGs is also an important incentive in this regard. The equipment used in the production of GH2 will be taken into consideration for tax exemptions in later stages.

As for the attraction of GH2 infrastructure investors and if there are any signed EoIs or MOUs, there is nothing in that regard yet as the country still has no H2 strategy / roadmap nor a regulatory framework covering the GH2 value chain. However, the large potential of renewable energy sources (RES) in Lebanon, the easy access to water, and the availability of lands allows the country to have a promising potential in GH2 once it has a GH2 strategy in place along with the needed legislation.

Background: Resources for GH2 production, current consumption, and potential use and export

The country's available local resources for RE generation and GH2 production in terms of solar and wind potential as well as the availability of land and water were highlighted in this section. Furthermore, the sectors that presently use H2 and its derivatives were looked at their current consumption and potential use of GH2 in the future when produced. In addition to that, the country's potential for GH2 export in terms of target markets and quantities that can be exported based on local supply and market demand were looked into.

Local resources available for GH2 production			
Solar energy potential	**Wind energy potential**	**Availability of land**	**Availability of water**
• The total potential peak power across the whole suitable area for solar installation (equivalent to 53% of Lebanon's area according to IRENA's report) is 182 GW • The annual average solar irradiation (as per the RE Outlook report) ranges between 1,520 kWh/m2 and 2,148 kWh/m2 per annum	• The total potential peak power across the suitable area for wind turbines installation is 6.23 GW • The wind speed at 100m ranges between 4.3m/s and 10.3m/s depending on the area	The Lebanese government owns a relevant share of the total landmass in Lebanon, where BDL for example owns around 43 million square meters	• 16 rivers, with a combined average flow of 2,151 MCM per annum • 225 km coastline

Table 24. Local resources available for GH2 production

Current H2 usage situation and potential for local GH2 use in different sectors		
Sector	**Current consumption of H2 and its derivatives**	**Potential for local use of GH2 and its derivative**
Cement	Figures not available	Replacing the heat and electricity demand of industries in cement production
Steel	Figures not available *H2 consumption is minimal as it is currently only used in the welding processes*	Replacing the heat and electricity demand of industries in steel production
Fertilizers	112,500 kg per annum of imported grey ammonia	Replacing the imported ammonia quantities by local production

Table 25. Current H2 usage situation and potential for local GH2 use in different sectors

Country's potential for GH2 export	
Target markets	**GH2 export potential**
• Neighboring Arab Countries and Turkey through road transportation or existing gas pipelines • European Union through maritime transportation or gas pipelines	As a result of law 318/2023 (DRE law), the potential of RE projects deployment in the next few years is large and will exceed the local consumption in terms of electricity and heat demand. Accordingly, all the excess can be potentially used to produce GH2 for export.

Table 26. Country's potential for GH2 export

Current Infrastructure Landscape: Status of existing infrastructure that the entire GH2 value chain can build on

The current and existing infrastructure that the country can build on and expand to integrate the GH2 value chain into were identified. The mentioned infrastructure comprises:

- **Transportation** - roads and highways, ports and harbors, land transportation.
- **Water** - water supply systems, desalination plants, water treatment plants.
- **Energy** - Power generation plants, transmission and distribution lines, gas pipelines, H2 pipelines, electricity interconnections.

Transportation		
Roads and highways	Ports and harbors	Land transportation
• The roads and highways are suitable for use • There are over 8,000 km of roads	• Beirut Port with 1.5 million TEU/year • Tripoli Port with 66,000 TEU/year	Trucks for H2 transportation are available and can be further developed.

Table 27. Status of existing transportation infrastructure

Water		
Water supply systems	Desalination plants	Water treatment plants
Water supply falls under the jurisdiction of four public Water Establishments (WEs): • WE of Beirut and Mount Lebanon • WE of North Lebanon • WE of Bekaa • WE of South Lebanon The total network length is around 20,000 km with 476 million m^3 per annum supplied	• Several brackish water RO desalination units with capacities ranging from 90 to 1,893 m3 per day were installed in Beirut between 1995 and 2009, to supply fresh water for industries, municipalities, and tourist facilities • A desalination plant having a flow rate of 5,000 m3 per day was also installed in Beirut in 2018	There are 268 WWTPs with a design capacity of 1,770,389 m3 per day, and actual treatment capacity of 292,918 m3 per day. If the operational WWTPs' function at maximum or design capacity, they will exceed by 30% the total wastewater volume generated.

Table 28. Status of existing water infrastructure

Energy				
Power generation plants	Transmission and distribution lines	Gas pipelines	H2 pipelines	Electricity interconnections
• 8 EDL Plants with a design capacity of 2,311 MW: - 2 Fuel Oil - 4 Gas Oil - 1 Hydro - 1 Biogas • 5 Independent plants with a capacity of 344 MW: - 4 Hydro - 1 Fuel Oil	The electrical grid is connected to all the potential areas that could feature a GH2 plant	The Arab Gas Pipeline (AGP) connecting Egypt with Syria and Lebanon which is 1,200 km long, out of which 32 km are within Lebanon, connecting the AGP to Deir Amar power plant (AGP was used in 2010 to import gas from Egypt and can be used for the same purpose today)	No existing H2 pipelines, but the existing gas pipeline can be assessed to determine whether it can be repurposed for H2 transport (import / export)	There is the Lebanese - Syrian Electric Interconnection which was used to import electricity from Syria before 2020 (the network is currently ready to import electricity from Jordan)

Table 29. Status of existing energy infrastructure

Future Perspectives: Plans or intentions to expand existing infrastructure to integrate the GH2 value chain

The plans or intentions to expand the existing infrastructure (same categories as mentioned in the above section - Transportation, Water, and Energy), to integrate the GH2 value chain were highlighted.

Transportation		
Roads and highways	Ports and harbors	Land transportation
• The preliminary study for rehabilitating the 80 km railway between Beirut and Tripoli (Coastal line) was completed within the Ministry of Public Works and Transport plans • The ongoing plans and reforms to improve the public transport sector – Pending securing funds	The renovation of the Port of Beirut. Pending the ongoing investigation and the country's financial situation.	Not determined yet

Table 30. Plan or intentions to expand existing transportation infrastructure

Water		
Water supply systems	Desalination plants	Water treatment plants
Plans to enhance and expand the existing infrastructure from the increase in revenues of the WEs through: • the increase of subscription rate to reach 70% by 2026 • the increase of collection rate to reach 80% by 2026 • A gradual yearly raise in tariff starting at around 1 MLBP in 2022 up to 3 MLBP in 2026	No plans yet	As per targets set by the MoEW in the 2010 national water sector strategy, there are plans to increase the reuse of treated wastewater from 0% in 2010 to 20% in 2015 and then to 50% by 2020 where 150 MCM per annum of treated wastewater could be used for irrigation by 2020, while another 100 MCM could be used for MAR

Table 31. Plan or intentions to expand existing water infrastructure

Energy				
Power generation plants	Transmission and distribution lines	Gas pipelines	H2 pipeline	Electricity interconnections
The MoEW plans to: • Decommission old plants using HFO-fired steam turbines and build gas-fired combined cycle power plants • Procure natural gas in a competitive manner through the utilization of a Floating Storage and Regasification Unit (FSRU) infrastructure	• Construction of a part of the 220kV South loop for supplying Beirut urban area, include a 220kV, 20km long Zahrani - Nabatieh overhead transmission line (carrying capacity of 1,140 MW), from the existing 220 kV Zahrani substation to a new AIS at Nabatieh (2x70 MW) • Reducing losses from 34% to 12% at the end of 2021 (as per plan, but still not achieved) along with the expansion and stabilization of the grid for the absorption of the planned new generation capacity	No expansion plans, but as per the agreement with Egypt which has not been put in effect yet, around 650 MCM of natural gas per annum will be channeled through the AGP, enabling the Deir Amar power plant to generate an average of around 400 MW of electricity. Note that in the future, if a dedicated extension of the AGP is constructed to connect Zahrani in the South, it could serve as an alternative supply route for natural gas	No plans yet	No plans yet

Table 32. Plan or intentions to expand existing energy infrastructure

Future perspectives: Plans or discussions to build new infrastructure to cover the GH2 value chain

This final section tackling the infrastructure landscape highlights any plans or discussions that the country has engaged in to build new infrastructure dedicated to cover the entire GH2 value chain as follows:

- **GH2 production:** Dedicated RE plants (wind energy, solar PV, solar CSP, and hydroelectricity), Water supply (water supply systems, desalination plants, and water treatment systems), Electrolysis facilities.
- **GH2 storage:** Compression systems (compressors), Storage facilities (pressure vessels / tanks, cryogenic storage tanks, and solid-state storage tanks).
- **GH2 transportation:** Compression systems (compressors), Transport system (pipelines and trucks).
- **GH2 local use (Integration infrastructure):** Industrial processes, Power generation, Transportation.
- **GH2 export (Transport system):** Roads and highways, Ports and harbors, Pipelines, Trucks.

GH2 production			
Dedicated RE plants*			
Wind energy	Solar PV	Solar CSP	Hydroelectricity
3 wind farms with a total capacity of 226 MW that will directly feed the national grid with electricity through PPAs	11 Solar Farms with a total capacity of 165 MW that will directly feed the national grid with electricity through PPAs	A feasibility study for a 70 MW project with 7.5 hours of thermal storage is being conducted. Based on the results a Go/no-go decision will be made	300 MW of hydroelectric power plants by 2030
Water supply			Electrolysis facilities
Water supply systems	Desalination plants	Water treatment systems	
No plans yet	As 1 of its pillars of its 5-year plan to ensure water supply in Beirut and Mount Lebanon, EBML plans to build: • 2 desalination plants in Choueifat and Bourj Al Barajneh near Beirut • Desalination plants for the wells that feed Greater Beirut *These desalination plants are not dedicated for GH2, but form a potential convenient asset for GH2 development in later stages*	No plans yet	No plans yet

Table 33. Plans or discussions to build infrastructures to cover GH2 production

As for the infrastructure needed for the remaining GH2 value chain (storage, transportation, local use, and export), **no plans have been determined yet**.

**It is worth noting that these planned RE plants are not dedicated for GH2 production. However, once the 30% RE target is reached and the gap is closed between demand and generation, the additional energy produced from these RE plants can be dedicated for GH2 production*

Situational Analysis within the Country

The objective of this section is to present a first layer of analysis of the situation within the country based on the information provided about Lebanon on: (1) local value creation, (2) jobs, skills, and capacity building, and (3) infrastructure regarding the RE and GH2 sectors in the form of a SWOT analysis to help us identify the related strengths, weaknesses, opportunities, and threats.

Local Value Creation

This SWOT analysis provides an overview of the internal strengths and weaknesses as well as external opportunities and threats facing the local value creation initiatives in manufacturing related to RE technologies and GH2 production systems within Lebanon.

SWOT Analysis	
Strengths	**Weaknesses**
• Human resources and expertise in the field of manufacturing RE and electrical components • Existing manufacturing facilities for RE components • Established local industries in chemicals, steel, cement, and fertilizers that could potentially use GH2 • Availability of ports in close proximity to the EU	• High cost of electricity • Frequent power outages • Limited opportunities for land border trade • Limited technology and expertise in GH2 production and CSP • Lack of existing manufacturing facilities for GH2 components • High production costs and large investments to manufacture some RE and GH2 components
Opportunities	**Threats**
• Growing global demand for RE and GH2 components presents export opportunities • Potential for job creation and economic growth through RE and GH2 industries • Cooperation with international partners to develop manufacturing capabilities of GH2 components • Development of a national strategy for GH2	• Economic situation in the country • Dependence on technology and expertise coming from abroad for manufacturing RE and GH2 components making imported components more competitive • Price competition with imported RE and GH2 components from more advanced markets with larger economies of scale

Table 34. SWOT Analysis - Local Value Creation

Jobs, Skills, and Capacity Building

This SWOT analysis provides a snapshot of the strengths, weaknesses, opportunities, and threats related to jobs, skills, and capacity building in the RE and GH2 sectors in Lebanon.

SWOT Analysis	
Strengths	**Weaknesses**
• Existing workforce of 5,000 - 14,000 in clean/green technologies sector • Existing expertise, skills, and competences in solar PV, hydroelectricity, and wind • Established capacity building programs at TVET institutes and universities • Workforce possesses good technical and practical knowledge	• Limited expertise, skills, and competences across the GH2 value chain • Limited theoretical and practical training opportunities in GH2 sector • Lack of widespread awareness in GH2 technology • Lack of expertise relating to CSP technology
Opportunities	**Threats**
• Integration of GH2 technology to create new job opportunities across the entire value chain • Upskilling and reskilling programs to address skills gaps in GH2 sector • Establishment of a GH2 training center to train the country's workforce • Potential for collaboration with international organizations and institutions for capacity building programs	• Rapid technological advancements may lead to skills becoming obsolete • Competition from other countries with more advanced workforce development programs • Brain drain due to immigration of professionals in the sector

Table 35. SWOT Analysis - Jobs, skills and capacity building

Infrastructure

This SWOT analysis highlights the internal strengths and weaknesses, as well as external opportunities and threats, relevant to Lebanon's infrastructure landscape for the RE and GH2 sectors.

SWOT Analysis	
Strengths	**Weaknesses**
• Abundant RE resources (solar and wind) • Availability of land near water resources, namely the Mediterranean coast and multiple rivers • Availability of ports in close proximity to the EU • Plans to build new RE plants of wind and solar energy	• Frequent power outages in the national grid • Limited current infrastructure for GH2 production, storage, and transportation • Grid and gas pipeline connections with Syria are technically ready, but not operational • Limited current local consumption and demand for GH2 • Absence of a master plan for infrastructure development related to the GH2 value chain
Opportunities	**Threats**
• Development of a national strategy for GH2 • GH2 could be a solution to the frequent power outages • Potential for significant GH2 production and export • Development of new infrastructure for GH2 value chain • Collaboration with international partners for technology transfer	• The country's economic situation • Technical and logistical challenges in GH2 production, storage, and transport • Regulatory and policy uncertainties • Competition from other countries in GH2 export markets

Table 36. SWOT Analysis - Infrastructure

CONCLUSIONS & RECOMMENDATIONS

GH2 Infrastructure Development

Capacity Building and Skills Development

Local Value Creation

GH2 Export and Local Use

Regulatory Framework and Fiscal Incentive

Overcoming Water Challenges

Lebanon, which benefits from good wind and solar resources, access to water, and the proximity of its ports to the EU, is planning to integrate GH2 into its energy landscape. Lebanon hopes to develop a national hydrogen strategy that would set targets, provide financial incentives, create regulations, and develop the skills of its workforce. In addition to several economic benefits resulting from the export of GH2 and its derivatives, the country has medium potential for local use of GH2 and its derivatives, such as in the fertilizers industry which uses decent amounts of imported grey ammonia. Furthermore, the country's potential hydrogen demand can also be found in the cement and steel industries, as well as in power plants; mainly for burning hydrogen to be used as a heat source to generate power and for energy storage to accommodate for hourly/daily fluctuations and seasonal variations. However, the country's economic situation has hindered GH2 and RE growth. According to this country fiche's findings and not based on priority, the following recommendations are suggested:

GH2 Infrastructure Development

- Initiate the development of a national green hydrogen (GH2) strategy with targets for the country - in progress with the support of MED-GEM.
- Production: Support foreign investors to explore GH2 opportunities and facilitate their feasibility studies.
- Transportation: Create opportunities for the private sector to establish or expand GH2 infrastructure in the country's ports and assess country's readiness for GH2 transportation through pipelines whether using blending, repurposing, or the construction of new pipelines.
- Storage: Construct GH2 storage facilities, including compression systems and storage tanks near the ports, to ensure safe and efficient GH2 storage.

Capacity Building and Skills Development

- Support the establishment of a training center equipped with modern equipment for practical hands-on training along with newly developed curricula and training modules covering the entire GH2 value chain.
- Collaborate with universities and academic institutions to incorporate GH2-related courses and research initiatives to bridge the existing skill gaps, if needed with external support (bilateral, multilateral agreements)
- Encourage partnerships between industries and educational institutions to facilitate on-the-job training opportunities for students and professionals.
- Provide theoretical and practical hands-on trainings for the Lebanese workforce in wind energy, large-scale solar PV, hydroelectricity, energy storage, and grid integration.
- Raise awareness of pupils about technology and societal matters and developing interest of younger generations for sectors such as hydrogen. Actions in this area could be teaching teachers some ground knowledge about hydrogen so that they feel comfortable integrating certain awareness raising activities in class.
- Propose external support to academic entities which could take the form of agreements for common courses and degrees with participation of external experts fostering the transfer of knowledge and expertise in the country.
- Define what type of training equipment is needed for training hydrogen specialists to prioritise investment for training infrastructure. Hydrogen Europe could support and provide more information on this in the coming months as this is something that they are trying to explore in the International Partnership for a Hydrogen Economy.
- The recognition of certificates/diploma in continuous education: Implementing recognised training standards to guarantee a certain quality of training on essential topics linked to hydrogen, such as safety which would be a much welcome development by industry stakeholders.

Local Value Creation

Developing local manufacturing capabilities for Green Hydrogen (GH2) involves strategic planning and strong collaboration framework. Indeed, GH2 manufacturing is a long-term endeavor, and collaboration across sectors is essential. By combining local expertise, international knowledge, and targeted policies, Lebanon can build a robust manufacturing ecosystem for some specific GH2 components. Here are some recommendations that could be further fine-tuned to fit Lebanon's context:

Assess Existing Industrial Base:

- Identify industries in Lebanon that can potentially contribute to GH2 manufacturing. These may include existing facilities in chemicals, steel, cement, and fertilizers.
- Evaluate their capacity, expertise, and willingness to integrate GH2 production or components.

Capacity Building and Training:

- Invest in training programs to upskill the local workforce. Focus on GH2-specific skills, such as electrolyzer assembly, hydrogen storage, and quality control.
- Collaborate with technical institutes, universities, and vocational schools to develop specialized GH2 courses.

Public-Private Partnerships (PPPs):

- Foster partnerships between the government, private sector, and research institutions. PPPs can pool resources, share risks, and accelerate GH2 manufacturing.
- Encourage private companies to invest in GH2-related R&D and production facilities.

Incentives and Grants:

- Offer financial incentives, grants, and tax breaks to companies willing to establish GH2 manufacturing units. These incentives can offset initial costs.
- Prioritize GH2-related projects in national funding programs.

Technology Transfer and Licensing:

- Collaborate with international companies or research centers experienced in GH2 manufacturing.
- Explore technology transfer agreements or licensing arrangements to access proven GH2 production methods.

Cluster Development:

- Create GH2-focused industrial clusters. Co-locate manufacturers, suppliers, and service providers to enhance collaboration and knowledge sharing.
- Leverage existing industrial zones or establish new ones specifically for GH2.

Quality Standards and Certification:

- Develop local standards for GH2 components and systems. Ensure compliance with international norms.
- Establish certification bodies to verify product quality and safety.

Supply Chain Integration:

- Map the GH2 supply chain, from raw materials to final products. Identify gaps and opportunities.
- Encourage local suppliers to specialize in GH2-related components (e.g., pipelines, compressors, storage tanks, water treatment).

Research and Innovation Hubs:

- Establish research centers or innovation hubs focused on GH2. These hubs can facilitate collaboration, prototyping, and testing.
- Encourage cross-disciplinary research involving materials science, engineering, and renewable energy.

Regulatory Support:

- Streamline permitting processes for GH2 manufacturing facilities.
- Ensure environmental regulations align with GH2 production and storage.

Awareness Campaigns:

- Educate investors, entrepreneurs, and the public about the economic and environmental benefits of GH2 manufacturing.
- Showcase success stories and highlight the potential for job creation.

For the three analyzed work streams, the following complementary recommendations are highlighted in addition to the specific recommendations provided:

GH2 Export and Local Use

- Collaborate with neighboring countries in the region and the European Union to establish or expand export infrastructure, leveraging existing free trade agreements, and ensuring harmony of policies and regulations.
- Assess the potential demand in heat-intensive industries, such as the cement and steel industries, as well as the transportation sector, including heavy-duty transportation and aviation, and the fertilizers industry as potential off-takers in the future.
- Conduct assessment on the techno-economics of using GH2 as a seasonal storage for electricity to improve grid stability and reduce power outages in the national grid.

Regulatory Framework and Fiscal Incentives

- Conduct an analysis on the current legal framework as well as on the legal and regulatory steps needed to streamline the development of the GH2 market, including a new legislation needed for across the entire GH2 value chain - in progress with the support of MED-GEM.
- Provide financial incentives, such as tax breaks, to RE and GH2 projects to incentivize companies seeking to invest in Lebanon's energy sector.
- Offer fiscal incentives and support to potential industries to encourage them to transition to GH2 usage.

Overcoming Water Challenges

- Explore opportunities related to the technical and economic feasibility of using treated wastewater to produce GH2, and business models for co-sharing a water facility with a GH2 developer.

Notes

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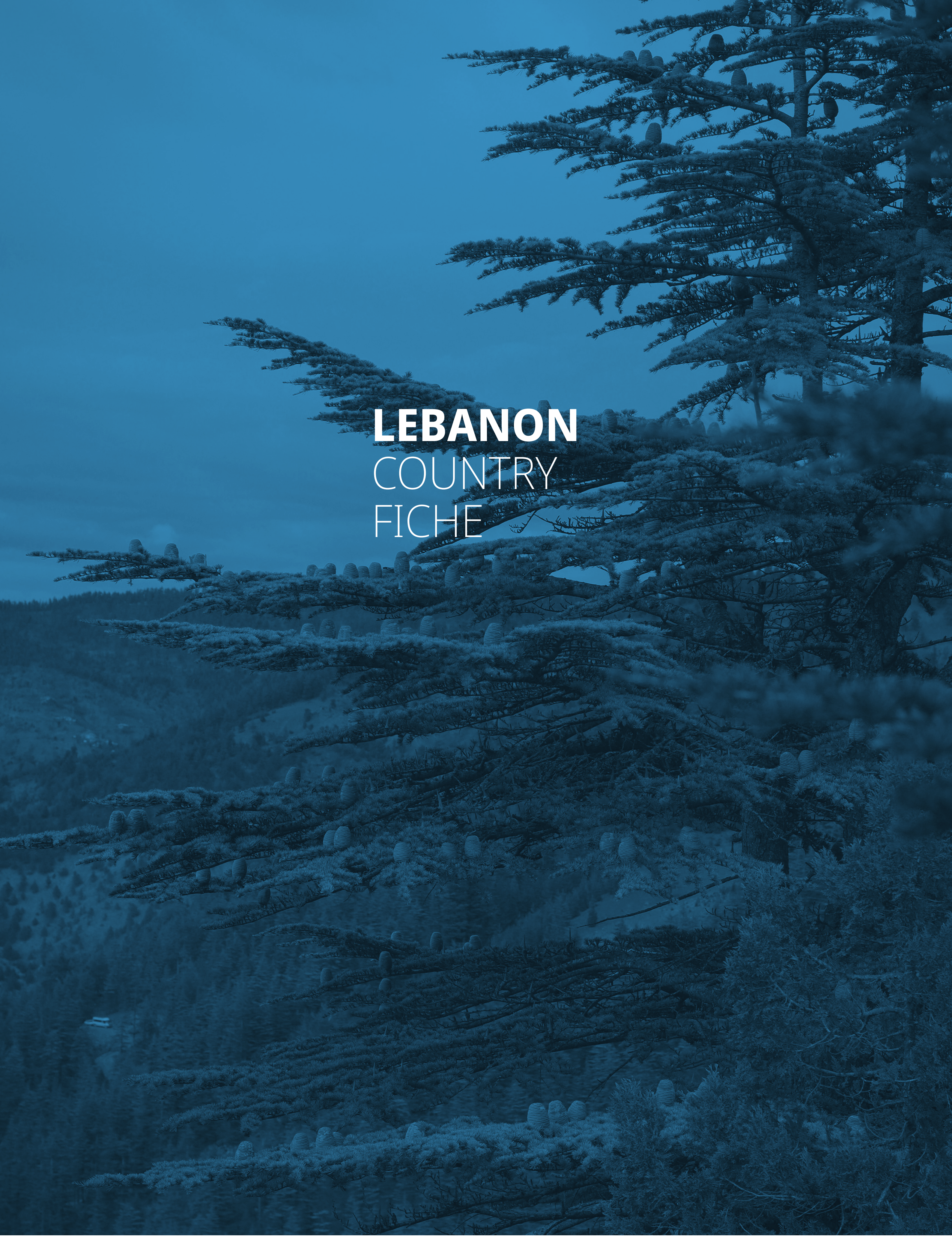

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