A Green Revolution

A Socio-Economic Perspective on Renewables and Hydrogen in the MENA Region
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A Green Revolution: A Socio-Economic Perspective on Renewables and Hydrogen in the MENA Region

Executive summary

Since 2009 the industry network, Dii Desert Energy, together with public and private stakeholders, has been paving the way for a fast energy transition in MENA. This transition involves a transformation of the regional energy system to not only become carbon emission free on an economic basis but also improve energy security. It also implies integrating the regional system into the emerging global clean energy markets. This energy transition would only be fair and be making sense if the people, local industries and natural environment would durably benefit. In the end energy supply shall, thus, become a pillar of sustainability and prosperity. This underscores the importance of socio-economic considerations in Dii’s ‘think tank’ activities as we navigate the complexities of the energy transition.

The MENA region, despite its current heavy reliance on fossil fuels, has been a relatively late and slow starter in the energy transition. However, it has the best cards to become the world’s largest and most economic ‘clean energy powerhouse’, thanks to its superior solar and wind resources and abundant space. The region already hosts renewable energy projects at record low cost. Since around 2015, solar and wind energy production has been generally ‘in the money’. As a consequence, energy investments are shifting from ‘fossil to ‘renewable’, with some actors investing in carbon capturing infrastructure. The rising pressure to reducing emissions and encouraging additional revenues from ‘green certificates’, are expected to further accelerate the transition. While hydrogen currently still requires government support, it is expected to further reduce emissions and improve system efficiencies in the long run and, eventually, become economically viable without subsidies.

How will this benefit the people and the natural environment?

Dii’s first study on the Economic Impact of Desert Power in 2013 marked the beginning of our journey in understanding the socio-economic implications of renewable energy in the MENA region. A decade later, in 2023 we have asked our partners again how they judge the socio-economic benefits. They agree that the green power markets have been evolving well and that the first tangible hydrogen projects are emerging. However, expected socio-economic benefits such those deriving from localisation have not fully materialized. We recognize that socio-economic assessments and outlooks in the region are a balancing act between optimism, needed to bring a major change in motion, and realism, which helps ‘keeping feet on the ground’ and avoiding deception. Our study critically reviews the socioeconomic advancements of the energy transition in the MENA region, including economic diversification and overall social and environmental benefits. Furthermore, it offers perspectives for the future, outlining potential trajectories and opportunities in the evolving energy landscape.

Keywords

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Highlights

The MENA region has seen significant socioeconomic advancements over the past decade, including a powerful start transitioning to renewable energy, economic diversification and infrastructure development. Each country, however, faces its own unique set of challenges and opportunities within these broader trends.

The MENA region is making significant advancements in renewable energy, with over 200 operational projects over 5 MW and a renewable energy (solar and wind) installed capacity of approximately 27 GW. In the hydrogen space, since 2020 a surge in activities has yielded 98 announced projects as of May 2024, most of which are for producing hydrogen from renewable energy sources.

Government policies and initiatives are crucial in shaping the adoption and expansion of renewable energy projects. The MENA region is still subject to incentives for renewable energy projects, focusing on indirect subsidies, from tax incentives to quotas. However, grace to outstanding solar and wind conditions most installations are already able to produce at competitive costs.

Job opportunities are a crucial socioeconomic factor in renewable energy and hydrogen projects. The ongoing global energy transition offers the chance to create new jobs and it presents a unique opportunity to advance gender equality.

The shift towards renewable energy, hydrogen and derivatives will generate substantial economic benefits, stimulate local manufacturing and supply chain development, and enhance energy security. This transition also offers solutions to expand energy access and affordability, especially in off-grid and remote areas.

Water scarcity in the MENA region is a significant challenge. The massive additional water desalination capacities required for green hydrogen projects can also serve communities for agriculture and other developments.

The “in-country value” (ICV) concept promotes sustainable industrial growth and human resources development by utilizing local renewable energy resources. Localization efforts are often confronted by bankability considerations. The focus could be initially on the assembly part of the value chain, moving to manufacturing of components at a later stage.

Striking the right balance with a nuanced approach - where export ambitions coexist with local needs including energy intensive industries - will ultimately define the region’s success in green hydrogen. However, global market competition, financial factors and policy challenges remain.

Technology transfer and capacity building are crucial for the successful deployment and sustainability of clean energy solutions. This involves exchanging knowledge, expertise and technology, as well as enhancing the skills and capabilities of local stakeholders.

Socio-Economics
Introduction

Desert Energy acts as a market enabler, bridging the gap between governments and private sector. Following our mission, we aim to catalyze the deployment of renewable energy projects in MENA. Our vision extends beyond energy itself, encompassing various aspects of societies: their prosperity, resilience, and shared benefits. Our core objectives intersect with socio-economics.

Local Benefits: Energy transition extends beyond power plants and transmission lines. It reaches schools, hospitals, and local businesses. It creates jobs, empowers entrepreneurs, and elevates communities—nurturing a sustainable ecosystem.

No Emissions: Our commitment to a world without emissions aligns with socio-economic progress. By transitioning to clean energy, we can reduce health risks, enhance air quality, and create jobs, directly impacting the well-being of communities.

Lowest Costs: Socio-economics thrive on efficiency. By pursuing cost-effective solutions, we can increase energy affordability. As costs decrease, opportunities multiply, fostering economic growth and prosperity.

Energy Security: Energy security empowers nations. By harnessing the desert’s abundant sunlight, we bolster energy independence, reduce reliance on imported fossil fuels, and strengthen socio-economic stability.

Socioeconomic factors: soft factors or key priorities?

Socioeconomic factors influence the development, implementation, and impact of projects. For projects across the emission-free value chain, such as renewable energy installations or sustainable transportation initiatives, socioeconomic elements often become underestimated key success factors. Early integration into project planning, development, and evaluation, can foster sustainable and inclusive growth while transitioning to a low-carbon future for the MENA region.

How much socioeconomic factors matter in projects is increasingly seen as a key issue. There have been critical views and concerns on extractivism and neo-colonial practices related to green hydrogen projects1. Nowadays, there is more awareness of the need to steer these projects away from exploitative models towards fairer and more sustainable ones. As a result, there is more attention to how these initiatives can benefit local communities economically in the first place, reduce negative impacts, and promote inclusive growth.

Traditionally, value in project delivery has been defined in terms of cost, time, and scope. However, this perspective is evolving to include broader socio-economic and environmental factors. The “From Ambition to Reality” (FATR) thought leadership series identifies moving from ‘economic’ to ‘social-economic-environmental’ as one of the five shifts necessary to address project delivery challenges. This recognizes that projects, particularly in sectors like energy and infrastructure, have far-reaching impacts that extend beyond their immediate objectives. They can contribute to societal goals such as sustainability, inclusivity, and resilience.

Governments face a significant challenge in designing national renewable energy (RE) programs to maximize socio-economic impact. They must balance environmental goals with job creation, local ownership, and skills development. In addition, fostering inclusive participation, localizing supply chains, addressing land rights, and accurately measuring impact are crucial. Socio-economic factors play a pivotal role in qualifying project benefits, including employment, GDP, training, and living standards. By acknowledging the importance of these factors, governments and stakeholders can ensure that energy transition projects (renewables, green hydrogen and derivatives, electric mobility, etc.) contribute to environmental sustainability and bring positive social and economic outcomes for the communities involved.

2 From Ambition to Reality - Worley

Emphasizing the integration of regional systems into the emerging global clean energy markets is crucial, therefore the transformative power of market instruments should not be overlooked. Instruments such as carbon pricing and renewable energy certificates can potentially steer the economic trajectory towards sustainable growth. They can incentivize the adoption of renewable energy sources, foster innovation in hydrogen technologies, and ultimately, drive a market-led transition to a low-carbon economy for the benefit of the stakeholders involved.

As the focus shifts from technology demonstrations to the establishment of sustainable emission-free value chains, socioeconomic factors take on a crucial role. This shift presents a significant growth opportunity for all countries capable of establishing these value chains competitively. Socioeconomic factors that are important in the context of the energy transition are:

Cost and Affordability: Projects that can provide affordable energy solutions or reduce overall costs while minimizing greenhouse gas emissions are more likely to be successful and scalable. As renewable energy is already cost-competitive in the MENA region, the focus could be shifted towards supporting early-stage, non-cost competitive technologies. This support could help these technologies scale up and bring costs down, making them more competitive in the long run. Additionally, targeted support for vulnerable consumers is crucial, especially where the energy transition results in overall higher costs.

Economic development: Market dynamics, investor confidence, and financial incentives can drive the growth of low emission projects. A favourable business environment, supportive policies, and access to capital play a crucial role in attracting private investments and fostering innovation.

Employment and Job creation: Renewable energy installations, sustainable infrastructure or energy efficiency retrofits, have the potential to create new jobs and contribute to local economic development. Workforce training and development programs can enhance job opportunities and help communities transition to green economies, especially in the MENA region that can count on a skilled workforce from the oil and gas industry.

Energy Access and Energy Poverty: Deployment of renewable energy technologies can provide affordable energy access, particularly in remote or underserved areas where traditional energy infrastructure may be lacking or costly to implement, for example through microgrids. Supportive policies and measure that address the affordability and accessibility of clean energy options for low-income communities can bring significant socio-economic and health benefits.

Social Acceptance and Community Engagement: Projects in the emission-free value chain often require community support and engagement. Public perception, awareness, and acceptance of renewable energy sources or sustainable practices can significantly influence the project’s implementation and long-term viability.

Social Equity, Health and Environmental Justice: Addressing socioeconomic disparities and ensuring that vulnerable or marginalized communities are not disproportionately affected by the transition to a low-carbon economy is a key priority. Emission-free projects can have positive health and environmental impacts by reducing air pollution. Moreover, the transition to renewable energy presents an opportunity for job creation and promoting gender equality. The traditionally male-dominated energy sector can integrate policies to encourage more women to join the workforce, thereby fostering diversity and inclusivity.
The MENA region has witnessed several key socioeconomic developments over the last decade. Some general trends can be identified across the region; however, it is important to note that each country has unique socioeconomic challenges and opportunities.

- **Sustainable Development Goals (SDGs):** The MENA region tried aligning with the United Nations’ Sustainable Development Goals. Countries have implemented strategies and policies to address poverty, inequality, gender empowerment, environmental sustainability, and other development objectives outlined in the SDGs.

- **Renewable Energy Transition:** The MENA region has made significant progress in transitioning towards renewable energy sources. Countries like the United Arab Emirates, Egypt and Morocco have invested heavily in solar and wind energy projects. This shift has contributed to reducing carbon emissions and led to job creation and economic diversification.

- **Economic Diversification Efforts:** Many countries in the MENA region have embarked on economic diversification initiatives to reduce their dependence on oil and gas revenues e.g. Saudi Arabia’s Vision 2030, Oman’s Vision 2040. Investing in renewable energy is one example, but other sectors such as tourism, finance, manufacturing, and technology benefitted as well.

- **Infrastructure Development:** The MENA region has witnessed significant infrastructure development, including the construction of new cities, airports, ports, and transportation networks. These projects have improved connectivity, facilitated trade, and attracted foreign investment, contributing to economic growth and development. For example, Egypt’s New Administrative Capital project involves the construction of a new city east of Cairo, aiming to alleviate population congestion in the capital and spur economic development.

- **Entrepreneurship and Innovation:** There has been a growing emphasis on fostering entrepreneurship and innovation in the MENA region. Governments and organizations have implemented various initiatives to support startups and small businesses, including incubators, accelerators, and funding programs e.g. Oasis500 in Jordan or the newly launched Mega Green Accelerator®. In the UAE, Dubai Angel Investors (DAI), a member-led micro-venture capital (VC) firm, invests in early-stage technology companies with high growth potential. This has resulted in a vibrant entrepreneurial ecosystem and the emergence of successful startups in sectors like e-commerce, fintech, and healthcare.

- **Social Reforms:** Several countries in the MENA region have implemented significant social reforms over the past decade. The region has also witnessed efforts to improve education, healthcare, and social welfare systems. For example, Saudi Arabia lifted the ban on women driving and introduced reforms to enhance women’s participation in the workforce. Similarly, the Bahraini government has implemented policies to promote gender equality, including anti-discrimination laws and initiatives to support women’s entrepreneurship and leadership roles in various sectors.

- **Youth Empowerment and Employment:** With a significant youth population, youth empowerment and employment have become key priorities in the MENA region. Governments and organizations have implemented initiatives to enhance skills training, entrepreneurship opportunities, and job creation for young people. For example, in Tunisia the government and the UN created a Multi-partner Trust Fund® to tackle the challenge of youth unemployment.

Multiple organizations, both international and regional, track socioeconomic development around the globe and specifically within the MENA region by collecting data and providing indicators. For instance, organizations like the World Bank, the United Nations Development Programme (UNDP), and regional bodies such as the Arab Monetary Fund and the Arab Development Funds routinely gather data on various socioeconomic indicators to monitor progress and identify areas for improvement. A collection of socio-economics indicators can be found in the Annex 2.

**Socioeconomic impacts**

For renewable and hydrogen projects to be sustainable in the long run, they should align with the principles of a just transition meaning that they should not only be environmentally friendly but also socially equitable. In areas where access to basic needs like electricity, clean water, employment, clean air, and education can be challenging, large-scale projects must not worsen these issues but contribute to solving them.

**Employment generation and labour market effects**

Job opportunities are generally considered as the most important socioeconomic factor, particularly in discussions surrounding in-country value, localization, and local content requirements. In the context of renewable energy and the development of a truly sustainable industry, efforts should be made to consider job opportunities from a broader perspective than solely within the construction or manufacturing industry. A strategy that extends beyond the project-to-project basis and focuses on building a sector, such as providing job opportunities in the energy industry, would be beneficial. It can be argued that low-skilled jobs, often filled by foreign workers, contribute little or no skill transfer to the host country, especially in the long term. On the other hand, the maintenance of energy projects offers longer-term employment prospects and can contribute to developing a skilled domestic workforce within the country.

The IRENA Renewable Energy and Jobs database (update 2023) offers valuable insights into the renewable energy job market in the MENA region (Figure 1). According to it, approximately 53,000 individuals are currently employed in the renewable energy sector within the MENA region. Among the countries considered, Jordan stands out as a significant contributor, accounting for nearly 30% of the renewable energy jobs in the region. In terms of technology distribution, solar photovoltaic (PV) leads the sector, employing around 24,000 individuals. This is indicative of the region’s abundant solar resources and the growing global demand for solar PV technology. Following solar PV, solar heating and cooling technologies employ approximately 12,000 individuals.

**Figure 1:** MENA region renewable job analysis based on the IRENA Renewable Energy and Jobs database (update 2023).

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While it is clear that the development of the hydrogen economy will create jobs, it is crucial to approach this topic with caution and realism. The hydrogen sector, like any emerging industry, has its share of challenges and uncertainties. Moreover, it is important to note that job creation in this sector can vary greatly depending on the project and its stage. For instance, jobs linked to the construction phase are often temporary.

A recent study conducted by Dii Desert Energy and Roland Berger on the “Potential for Green Hydrogen in the GCC region” estimates that the emergence of the hydrogen economy and the localization of value chain activities offer diverse job prospects requiring various skills and expertise. With the GCC countries poised to become key players in the hydrogen ecosystem, two scenarios are proposed. An aggressive scenario estimates a volume production of 80-100 Mt for annual revenue in the order of 120-200 bln USD. In the conservative scenario, a volume of 50-70 Mt is envisaged, leading to 70-140 bln USD in annual revenue. According to those two scenarios, it is projected that the region could generate between 400,000 to 900,000 direct and indirect job opportunities by 2050 in only three GCC countries (Figure 2).

The Regional Network in Energy for Women in the MENA Region (RENEW MENA) hosted by the World Bank aims to boost women’s role in energy providing access to role models, mentorship and building confidence. The Energy2Equal, an initiative launched in 2019 by the International Finance Corporation (IFC), in partnership with the Government of Canada, has for five years worked to increase women’s participation in the renewable energy sector in Africa. Active at a global level, the Women in Renewables Alliance (WIRA) is a network of professional women in the renewable energy sector, committed to promoting and advocating for greater gender equality and diversity in the transition to clean energy.

However, it’s important to note that while progress is being made, challenges remain. Continued efforts are needed to ensure that women have equal opportunities to participate and thrive in the renewable energy and hydrogen sectors. This includes addressing cultural and societal norms, providing equal educational opportunities, and implementing policies that promote gender equality in the workplace.

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The MENA region possesses immense renewable energy potential, particularly in solar and wind resources, which, if harnessed effectively, can generate substantial economic benefits. By developing large-scale renewable energy projects, countries can meet their clean energy needs and export the generated excess electricity and green hydrogen to neighbouring regions, creating new revenue streams.

The deployment of renewable energy projects and the development of hydrogen infrastructure present significant avenues for economic expansion. Investment in renewable energy installations, such as solar and wind farms, promotes job creation and stimulates local manufacturing and supply chain development. Moreover, establishing hydrogen production facilities and associated value chains offers prospects for technology innovation, research, and development, thus driving economic diversification.

Furthermore, the shift towards renewable energy and hydrogen offers an opportunity for MENA countries to reduce their dependence on fossil fuels. By diversifying their energy mix and embracing cleaner alternatives, these nations can mitigate the risks associated with volatile oil markets and position themselves as leaders in the global energy transition.

It is also worth noting that the deployment of renewable electricity and clean hydrogen production also impact research activities for renewable energy systems. Establishing research centres across the MENA region can bring important benefits in terms of knowledge building, driving technological advancements and supporting policy decisions.

Reshaping jobs in renewables for gender equality

The renewable energy and hydrogen sectors in the MENA region present significant opportunities for women to enter the historically male-dominated energy industry. As these new sectors grow, they are creating a wide range of jobs across the value chain offering women the chance to engage in meaningful work that contributes to the fight against climate change and the transition to a sustainable economy.

Many organizations and governments in the region are recognizing the importance of gender diversity and are implementing policies to encourage more women to enter these fields. For instance, training programs are being developed to equip women with the necessary skills, and initiatives are being launched to promote women’s leadership in the energy sector.

Economic growth and diversification

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Energy access and affordability

The transition towards renewable energy and hydrogen offers promising solutions to expand energy access and enhance affordability in the MENA region. By harnessing abundant solar and wind resources, countries can deploy decentralized renewable energy systems to reach off-grid and remote areas, thereby improving energy access for underserved populations.

As renewable energy technologies have become the most cost-competitive form of electricity generation and hydrogen production processes become more efficient, the overall cost of energy generation and distribution is expected to decline further. This, in turn, can alleviate the financial burden on households and businesses, making energy more affordable and accessible to all.

However, addressing energy access and affordability challenges requires a comprehensive approach that integrates policy interventions, regulatory frameworks, and financial mechanisms. Governments must prioritize investments in renewable energy infrastructure, establish supportive policies for private sector participation, and implement targeted subsidy programs to ensure equitable access to clean energy solutions. Furthermore, capacity-building initiatives and community engagement efforts are essential to empower local communities and enable them to actively participate in the energy transition process.
Environmental sustainability and public health

Environmental sustainability and the social factors described above, plays a crucial role in renewable energy projects, as they can either enable success or inhibit development. It is essential to assess both social and environmental constraints early in the planning process, as they encompass various components such as site selection, land availability, presence of nature reserves, flood-prone regions, etc. The impacts of projects, particularly mega-projects, should be assessed and possibly mitigated beforehand.

Water: opportunities and challenges

Water scarcity is a significant challenge in the MENA region, exacerbated by rapid population growth, urbanization, and climate change. Water desalination, the process of removing salt and other impurities from seawater or brackish water to produce potable water, has emerged as a solution to address water scarcity in and regions. With its extensive coastline, the region has heavily invested in desalination infrastructure to supplement traditional freshwater sources that can also be used to cater to communities for agriculture and other developments. Furthermore, ammonia production from electrolysis produces large quantities of clean water as a by-product that can be reused to green some of the desert areas in favour of local communities.

However, water desalination is considered to have one of the greatest environmental impacts and is often under scrutiny due to reasons such as the consumption of very large quantities of energy and water, the use of chemicals, and the discharge of brine back into the environment. These impacts can be mitigated by exploring options such as brine recirculation, optimizing the chemicals utilized and selecting sites for plants that are already industrialized to minimize environmental disruption. For example, NEOM has taken a Zero Liquid Discharge (ZLD) approach for brine aiming at a sustainable water management and treatment. It is that are already industrialized to minimize environmental disruption. For example, NEOM has taken a Zero Liquid Discharge (ZLD) approach for brine aiming at a sustainable water management and treatment. It is

Another success story comes from ACWA Power, which achieved an impressive 87% reduction in energy consumption in desalination since 2009.17 They underwent three phases to achieve this:

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<td>Transitioned from thermal coupling to seawater reverse osmosis (SWRO), reducing Specific Power Consumption (SPC) from 22 kWh/m³ to 6.5 kWh/m³.</td>
<td>Improved design and operations, lowering SPC to below 4 kWh/m³.</td>
<td>Despite rising energy prices, ACWA Power maintained SPC at only 3 kWh/m³ through design shifts, membrane analysis, and big data analytics.</td>
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Masdar launched a renewable energy desalination pilot programme to research and develop energy-efficient, cost-competitive desalination technologies powered by renewable energy between 2015 -2017. The programme's results found that one of the most promising solutions was solar-powered reverse osmosis, a technique where salt water is purified through membranes. This method proved to be up to 75 per cent more energy efficient than the thermal desalination technologies used in many countries.

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Renewable Energy vs Hydrogen socio-economic impacts

When examining the socio-economic impacts of renewable electricity and hydrogen projects, they are often viewed as a single entity. However, it’s important to note that there are unique considerations that can be made.

Developing an integrated hydrogen project is typically more complex than a standalone wind or solar project. Wind and solar projects consist of a single element- such as a PV solar array or wind turbines. In the case of hydrogen, renewable energy production is only the first stage of a multifaceted process that involves other elements such as water desalination, electrolysis, storage and conversion. Furthermore, hydrogen projects have a longer temporal duration. For example, an ammonia production facility has a project lifespan of 50 years, whereas solar and wind facilities typically require repowering after 25 years to sustain renewable energy production.

The requirement for a more complex infrastructure and the extended duration of on-site operations offers better chance to build a robust economy centred around hydrogen facilities. This could materialize as the establishment of new cities, the creation of more stable and long-term employment opportunities, with also positive effects on health and well-being of workers. Notably, fly-in, fly-out (FIFO) and drive-in, drive-out (DIDO) work practices, common in oil&gas industry but also during the construction phase of renewable projects, have demonstrated adverse impacts on mental health. A study commissioned in 2018 by Western Australia government18 revealed that “one third of the 3000 FIFO workers in Western Australia surveyed experience high or very high levels of psychological distress, as measured on an extensively validated scale”.

Moreover, longer-lasting projects offer increased opportunities to attract more elements of the supply chain. This presents an optimal chance to streamline the supply chain, even down to the equipment level, thereby increasing in country value.

Challenges and opportunities

In country value and Localization

The concept of “in-country value” (ICV) originated in the oil and gas industry, particularly in countries – such as those belonging to the MENA region - where natural resources significantly contribute to their economies. Other countries pursue Local Content Regulations and Local Content Policies as described later in the study, which are often different in nature and may sometimes lead to non-compliance issues with the World Trade Organization (WTO). The idea behind ICV revolves around two main objectives: a sustainable and balanced industrial growth and human resources development.

By utilizing abundant renewable energy resources within their borders, countries can attract energy-intensive industries and promote re-industrialization, job creation, and technology transfer. Many countries are using complementary solar and wind profile to service quasi baseload requirements of several heavy manufacturing industries. This approach intends to increase in-country value and to reduce reliance on pure export-oriented models. However, each country has its unique situation, and it remains to be seen if this trend finds traction. Furthermore, in hard-to-abate sectors where electrification is a complex process and pilot projects are underway, hydrogen is regarded as a potential alternative but still at the early stages of development.

Closely related to ICV, in the context of renewable energy projects, localization refers to identifying and implementing strategies to develop and deploy renewable energy systems in specific regions or communities, considering their diversity and unique characteristics. Strategic investment decisions within the industrial sector should align with the local context to maximize benefits for the community and the environment, while considering potential risks and challenges. Investing in renewable energy industries necessitates the fulfillment of certain fundamental prerequisites:

The existence of substantial, consistent, and committed demand projections.

The presence of a competitive advantage within the industrial hub.

The implementation of policies that support and safeguard local manufacturing.

Crucially, the provision of cash and non-cash incentives and facilitators.

Policy and Regulatory Frameworks

Clear and consistent policies, along with incentives and support measures, are necessary to encourage local manufacturing and attract investment in the renewable energy sector. In Turkey, due to very low feed-in-tariffs, many non-reasonable offers were submitted in response to tenders. Lack of a strict selection procedures of the bidders in the pre-qualification process resulted in a high number of projects that were never realized.

Despite these challenges, there are efforts in the MENA region to promote local manufacturing of renewable energy equipment. Some countries have started taking steps to establish manufacturing facilities, develop renewable energy supply chains, and provide incentives for domestic production. These initiatives will ultimately strengthen the local supply chain.

Localization is not limited to manufacturing and can also be applied to service companies. Bureau Veritas, a global leader in testing, inspection, and certification services, for example that has offices and laboratories across the MENA region, employing more than 4500 employees. These local offices serve as hubs for coordinating operations within specific countries, leveraging on the knowledge and understanding of the local context, regulations, and client needs. Additionally, local entities are also signing contracts for projects within the country, thus ensuring agility and responsiveness.

Lack of substantial local markets

Limited local markets can pose challenges for sustained production and economies of scale. Despite the region’s potential, solar and wind equipment market remains relatively nascent. The demand is not yet at a scale that fully supports large-scale local manufacturing. Encouraging local adoption and creating a vibrant market within the MENA region is essential to overcome this hurdle and foster sustainable industries.

Global Market Competition

The global market for solar and wind equipment is highly competitive, with established manufacturers dominating the market. Especially on core technologies, there is a general debate whether it is worth trying to enter the market alongside major producing countries (e.g. China) with a strong and deep competitive advantage. However, there are opportunities within specific components of the value chain. For example, towers for wind turbines have low market entry barriers, and there are high advantages to manufacturing them domestically due to the high cost of shipping such large components. Similarly, assembly of solar panels and wind turbines can also be a good candidate for domestic production. On the other hand, higher-value added components, such as advanced electronics or precision-engineered parts, can be trickier to compete with global suppliers due to the high level of technical expertise and capital investment required.

Financial and Investment Factors

Establishing manufacturing facilities for solar and wind equipment requires significant investments in infrastructure, technology, research and development, and skilled labor.

Technological Dependence

The MENA region has relied on importing solar and wind equipment from established manufacturing hubs, primarily in Europe, China, and other parts of Asia. Localizing the supply chain requires technology partnerships to transfer the knowledge and intellectual property, which is not always an easy arrangement.

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Global Market Competition

The global market for solar and wind equipment is highly competitive, with established manufacturers dominating the market. Especially on core technologies, there is a general debate whether it is worth trying to enter the market alongside major producing countries (e.g. China) with a strong and deep competitive advantage. However, there are opportunities within specific components of the value chain. For example, towers for wind turbines have low market entry barriers, and there are high advantages to manufacturing them domestically due to the high cost of shipping such large components. Similarly, assembly of solar panels and wind turbines can also be a good candidate for domestic production. On the other hand, higher-value added components, such as advanced electronics or precision-engineered parts, can be trickier to compete with global suppliers due to the high level of technical expertise and capital investment required.

Financial and Investment Factors

Establishing manufacturing facilities for solar and wind equipment requires significant investments in infrastructure, technology, research and development, and skilled labor.

Technological Dependence

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Local vs export

MENA region has the potential to become a global powerhouse and can leverage green hydrogen as a catalyst for industrial growth. Historically, regions with abundant and low-cost energy sources have attracted industrial investments. As MENA countries try to reduce their usual reliance on oil and gas, green hydrogen is a powerful driver for this transition. Strikes the right balance with a nuanced approach - where export ambitions coexist with local needs - will ultimately define the region’s success. Attracting investment is crucial for creating new hydrogen economies and investment decisions will largely be based on export consideration. As such, export-oriented projects can kickstart the industry, while local utilization ensures sustainability and resilience.

The interaction between export and local use is complex and diverse factors come into play, including energy security, economic diversification, and environmental impact. Recent developments show a global shift from export models toward the use of hydrogen for the creation of local markets and as a catalyst for green industrialisation. This is also due to the introduction of Carbon Border Adjustment Mechanism (CBAM) introduced by the European Union. The CBAM imposes tariffs on carbon-intensive goods manufactured outside the EU, aiming to create a level playing field for European businesses by reducing the competition they face from foreign actors. In fact, this introduces energy related carbon content as a cost factor in the equation. Therefore, it acts as a catalyst for decarbonization - or better - emission reduction, of local industries to remain or become competitive in the European market.

The UAE’s National Hydrogen Strategy published in 2023 focuses on local production and use of low-emission hydrogen to boost domestic industries before considering exports. Hydrogen trade is seen more as a long-term plan than an immediate one, different from the original 2030 goals set by the EU. These targets helped to start a global discussion on hydrogen, especially in the Global South, but now the attention is on finding ways for local industrialization. Countries like Oman, Mauritania, and Morocco are using their low-cost local wind and solar energy access—not only for direct energy export but for re-industrialization, aiming to create more value in-country through zero-emission energy projects instead of relying only on exports. This is becoming a global trend with Malaysia, Indonesia and Viet Nam following the same approach. The European Commission president, Ursula von der Leyen highlighted this during a green hydrogen roundtable in Mauritania in February 2024, suggesting that hydrogen can help establish a green steel industry in a country that is today mostly exporting iron as a raw ore.

There is also an emerging focus on the opportunities associated with embedding value chains for derivatives and commodities. For instance, instead of exporting raw ammonia, countries could consider manufacturing and exporting value-added products like fertilizers.

Green Hydrogen to drive sustainable industrial development

A recent study from UNIDO, IRENA and ISDS on “Green Hydrogen for sustainable industrial development” discusses the rising prominence of Green Hydrogen (GH2) as a clean and renewable energy carrier with the potential to deliver low-cost and low-emission hydrogen production while enabling industrial decarbonization. This report highlights four essential components: prioritizing local utilization of green hydrogen, aligning initiatives with national goals, commencing with smaller scale projects, and adopting a phased approach to production and application. By adhering to this, green hydrogen production can effectively contribute to sustainable development, technological progress, and job creation in developing nations.

The early stages of any new industry, including the green hydrogen sector, are often characterized by high upfront costs and low profit margins. This is due to the significant investments required for research and development, infrastructure, and market development. If any profit is made, it could be utilized to further improve and expand the green hydrogen projects themselves. This could involve enhancing the efficiency of the electrolysis process, expanding production capacity, or investing in new technologies that could reduce costs in the long run.

Technology transfer and capacity building

As countries in the region seek to adopt and implement clean energy solutions, the transfer of technological know-how and the development of local capabilities play a vital role in ensuring successful deployment and long-term sustainability.

Technology transfer involves the exchange and adaptation of knowledge, expertise, and technology from developed nations to developing countries. In the context of renewable energy and hydrogen, this transfer encompasses various aspects, including the design, manufacturing, installation, operation, and maintenance of renewable energy systems and hydrogen infrastructure.

Capacity building, on the other hand, refers to the process of enhancing the skills, knowledge, and capabilities of individuals, institutions, and organizations to effectively engage in renewable energy and hydrogen-related activities. This involves training programs, education initiatives, skill development workshops, and institutional strengthening efforts aimed at empowering local stakeholders to participate actively in the clean energy transition. The following concrete actions can facilitate the transfer of capabilities:

- **Re-skilling and Training Programs**
  - By investing in education, training, and research and development (R&D) initiatives, countries can cultivate a pool of local talent equipped with the necessary expertise to drive innovation, drive technological advancements, and address the unique challenges and opportunities associated with renewable energy and hydrogen deployment.

- **Collaboration between Industries**
  - Encourage collaboration between traditional energy companies and clean energy companies to facilitate knowledge exchange and transfer of expertise. This can involve joint research and development projects, partnerships, or knowledge-sharing platforms to bridge the knowledge gap and facilitate the transfer of skills.

- **Policy Supports**
  - Certain policy supports such as funding for training programs, tax credits, and complementary regulatory frameworks can promote the development of the clean energy sector.

- **Industry Associations and Networks**
  - Collaboration between governments, academia, research institutions, industry players, and international partners is essential to facilitate technology transfer and capacity building efforts in the MENA region. Public-private partnerships, knowledge-sharing platforms, and joint research initiatives can promote collaboration, foster innovation, and leverage resources to accelerate progress towards a sustainable energy future.

- **Leveraging Existing Infrastructure:**
  - Utilize the existing infrastructure and expertise of the O&G industry for the development of clean energy projects. For example, repurposing offshore oil platforms for offshore wind farms or utilizing existing pipeline networks for transporting hydrogen or carbon capture and storage.
The two tables below provide the current overview of climate and green energy targets set by countries in North Africa (Table 1) and Middle East (Table 2). For each country, it includes targets for achieving Net Zero emissions and Greenhouse Gas (GHG) reduction, targets and strategies for renewable energy and hydrogen.

As the MENA region has a well-developed oil & gas industry, it is possible to leverage on the existing expertise to drive the growth and adoption of renewable energy technologies. By capitalizing on existing knowledge and infrastructure, while also investing in the development of new skills and technologies, countries can expedite the transition to a more sustainable and resilient energy system. However, it's essential to acknowledge the potential risk of job cannibalism. Job cannibalism refers to the scenario where employment opportunities in one industry are negatively impacted by the growth of another industry.

In the transition from the oil & gas industry to renewables, this risk manifests through redundancies, skill mismatches, and regional disparities, particularly in O&G-dependent communities. To mitigate these risks, proactive measures are essential, including investment in transition programs, diversification of regional economies, strengthening social safety nets, and implementing just transition policies. By addressing these challenges head-on, stakeholders can ensure a smoother and more equitable transition, minimizing the negative impacts on affected workers and communities while maximizing the opportunities presented by the renewable energy sector.

Policy and regulatory framework

Government policies and initiatives are crucial in shaping the adoption and expansion of renewable energy projects worldwide. Despite ongoing efforts, resolving the complexities surrounding renewable energy policy frameworks remains a challenge for nations across the globe. These frameworks and incentives must be meticulously crafted with a strategic approach, accounting for unique local and regional competitive advantages and long-term objectives.

Numerous countries worldwide are undertaking ambitious initiatives aimed at promoting renewable energy adoption. Notable examples include the Investment Tax Credit (ITC) and Production Tax Credit (PTC) in the United States, the European Union’s Green Deal, and India’s Production Linked Incentives. These initiatives serve as benchmarks for nations seeking to emulate successful models and implement effective policies within their own jurisdictions.

The MENA region have actively engaged in comprehensive research and analysis, benchmarking international initiatives to develop their own incentives and enablement mechanisms for renewable energy projects. With abundant and cost-effective renewable resources, governments in the MENA region are beginning to recognize their potential to play a pivotal role in the global energy transition, by helping western countries e.g. Europe, to undergo a transformation that has been so far underestimated. Specifically, global considerations about use and trade of green hydrogen, reflect a strategic shift that emphasizes local utilization and a more detailed approach to global supply chains. These concerns can be articulated through three primary perspectives:

- Green hydrogen has the potential to become a trade commodity and possibly transform entire economies in countries such as Mauritania. However, while export may be an attractive source of foreign exchange revenue, countries should pursue extending the local value chain, serve both local and export demand and in general try to create maximum local value. This viewpoint considers the intricate challenges involved in creating a worldwide hydrogen market. These challenges encompass the need for infrastructure development, achieving cost competitiveness, and establishing suitable regulatory frameworks. Countries must ensure that green hydrogen can be effectively produced and utilized at the local level, in addition to global trade.

- In the Global North, especially in Europe, there is an increasing willingness to consider relocating portions of the value chain to take advantage of the potential of green hydrogen. For instance, the concept of producing direct reduced iron (DRI) for the steel industry using green hydrogen is now being openly discussed. As for the MENA region, this shift presents a significant opportunity that could enable the region to become a key player in the global energy market.

The two tables below provide the current overview of climate and green energy targets set by countries in North Africa (Table 1) and Middle East (Table 2). For each country, it includes targets for achieving Net Zero emissions and Greenhouse Gas (GHG) reduction, targets and strategies for renewable energy and hydrogen.

### Table 1: Comprehensive overview of North Africa’s climate and green energy goals: Net Zero, GHG Reduction, Renewable Energy, and Hydrogen

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<th>Country</th>
<th>Renewable Energy Goals</th>
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<th>Hydrogen Strategy</th>
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### Table 2: Comprehensive overview of Middle East’s climate and green energy goals: Net Zero, GHG Reduction, Renewable Energy, and Hydrogen

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<th>Country</th>
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A full list of references for national strategies and roadmaps can be found in the Bibliography section.

Source for GHG Emissions: [https://data.worldbank.org/indicator/EN.ATM.GHGT.KT.CE].
The road toward clean energy systems requires generally effective government guidance and support on the one hand and appropriate market structures and mechanisms on the other hand. Although the ‘public policies - market pull’ balance is not the focus of this report, industry policy and market approaches are highlighted. In the context of kicking off the hydrogen market there may not be something like one single ‘best balance’ between industry policy and market pull, but a gradual migration from strong policies and government support in the beginning, toward ever more effective market instruments and market pull to reach maturity may be anticipated. For example, industrial policies to set the strategic direction and to kick off with initial support to the nascent hydrogen industry and, when the industry is getting more mature, stronger reliance on a competitive landscape for clean energy products to take it from there. Once emission prices have become a dominant factor and a higher percentage of ‘green’ in energy off-take is being encouraged the market will, thus, accelerate the energy transition.

**A competitive landscape for projects**

Before discussing whether it is better to subsidize the production or off-take side of renewable energy and green hydrogen, it should be highlighted that the primary focus for governments should be on creating a competitive landscape for these projects. Additionally, we must recognize that in most of the MENA region, subsidies for renewable energy projects have been limited, therefore they are unlikely to be a primary driver for future developments.

However, when analysing energy subsidies from a broader perspective, it is worth noting that, according to the IMF, fossil fuel subsidies amounted to $7 trillion in 2022 and are projected to increase to more than $8 trillion by 2030. These substantial subsidies reduce the costs of fossil fuel production and use, which can create challenges for renewable energy and green hydrogen projects in terms of competitiveness. Therefore, while direct subsidies for renewable projects may be limited, the indirect impact of fossil fuel subsidies is a crucial factor to consider in the development of renewable energy and green hydrogen in the region.

Governments should play a proactive role in assisting developers to create projects that are not only profitable and competitive but also economically viable and sustainable. This involves establishing clear and supportive regulatory frameworks, providing financial incentives, investing in infrastructure, and protecting research and innovation. By doing so, governments can accelerate the development of the green hydrogen industry and ensure its long-term sustainability and success. It is fundamental to recognize that sustainability not only benefits the planet but also has positive financial implications. In the case of green hydrogen, it is important to recognize that the value chain extends beyond its production alone. Clean hydrogen should be integrated into downstream products such as green fertilizers, green steel, green fuels, and chemicals to maximize its penetration and leverage.

That said, in this historical context where the hydrogen market is in a nascent phase, it could be beneficial to incentivize renewable energy producers rather than off-takers. This approach can facilitate the localization of green hydrogen production, promoting sustainable development and innovation within the industry. By incentivizing local production, countries can stimulate economic growth, create jobs, and reduce their reliance on imported energy. Furthermore, these incentives can attract much-needed investment into the sector, providing the capital necessary for the development of new green hydrogen projects.

In any case, striking the right balance between incentivizing supply and demand is crucial in the development of the green hydrogen sector. In areas where international regulations and coordination are still being established, it might be beneficial to initially set up quotas on the off-take side to stimulate demand and market growth. Conversely, in sectors where a robust regulatory framework is already in place, such regulations can naturally stimulate demand by setting standards that encourage the use of cleaner energy sources.

This is the case for example of shipping where International Maritime Organization (IMO) sets requirements for emissions reduction that are globally applicable. In such cases, the regulatory pressure to reduce emissions can drive demand for green hydrogen, reducing the need for additional off-take incentives.

Finally, it is important to reiterate that the debate over hydrogen ‘colours’, particularly concerning its development, should be set aside in favour of prioritizing the emphasis on accelerating the commercialization of hydrogen and its by-products.

- An Intergovernmental Declaration of Intent on Mutual Recognition of Certification Schemes for Hydrogen and Hydrogen Derivatives. This covers more than 80% of the anticipated future global market for hydrogen and its derivatives.
- An ISO methodology that offers a global standard for assessing the greenhouse gas (GHG) emissions of hydrogen pathways on a life-cycle analysis basis.

**Prioritizing industrial policies**

Another angle suggests that the right legal framework for government action should prioritize industrial policies over market-driven approaches in the context of green hydrogen development. Given the global nature of climate change and the need to reduce carbon emissions, concerted and directed efforts that go beyond individual market actions are required. Industrial policies enable governments to set ambitious decarbonization targets and implement the necessary measures to achieve these goals.

This perspective originates from the fact that with green hydrogen technology still in its early stages, it necessarily involves substantial initial investment in new and innovative technologies. As such, in the absence of an established market, the private sector may not be ready yet to make the necessary investments in research and development due to the high risk and long-term horizons involved. In contrast, industrial policies allow for targeted investments in technology development, infrastructure, and capacity building, accelerating the maturation of green hydrogen industries.

Furthermore, the shift to a hydrogen economy involves complex systemic changes across multiple sectors, including energy, transmission, and manufacturing. Industrial policies can facilitate a coordinated development across these sectors, ensuring that progress in hydrogen production is matched by advancements in hydrogen storage, distribution, and end-use applications.
Conclusions

This study highlights the significant socioeconomic advancements in the MENA region over the past decade, with a focus on the transition to renewable energy and economic diversification.

Key findings include:

→ Although the sense of urgency is still hardly felt among the population, undeniable climate change effects, energy price shocks and ever louder voices of influencers impact awareness and acceptance.

→ Government strategies, targets, support and plans are now commonplace throughout the MENA region, albeit with different intensity and with different socioeconomic impacts.

→ The MENA region can be proud of over 200 operational renewable energy projects with a capacity of approximately 27 GW (April 2024).

→ A first major hydrogen project has passed FID and the number of announced ‘no or low’ net emission hydrogen projects in the region is increasing swiftly.

→ The shift from (often still subsidised) fossil energy supply towards unsubsidised renewable energy (including initially subsidised hydrogen), is expected to enhance energy security, lowering cost of supply and facilitating access to energy. In addition, this transition opens up new avenues for local manufacturing, attracting (energy intensive) industries and therefore creating local employment opportunities.

→ The popular concept of “in-country value” (ICV) promotes sustainable growth and development by utilizing local renewable energy resources.

→ Energy transition in the region is not strictly about ‘local only’ or ‘predominantly export’. Instead, it is about achieving a balance in clean(er) supply and demand, including attracting energy intensive industries, within the region and eventually in the global energy market context for the benefits of stakeholders involved.

→ The Middle East has the potential to boost local industries using hydrogen and related guarantees of origin, carbon credits, or carbon content factors such as the EU’s Carbon Border Adjustment Mechanism (CBAM). These related ‘virtual elements’ will offer additional value to the region.

→ The region is generally in deficit of local technology expertise, education and training facilities for building human capacity. Therefore, intensified technology transfer and cooperation for capacity building are crucial for the successful deployment and sustainability of clean energy solutions.

→ Other factors mentioned by our partners include geopolitical and policy stability, effective regulatory measures, reduced bureaucracy, market transparency, competitiveness and bankability. However, we believe that the momentum of the emerging clean energy and circularity ‘revolution’ is already unstoppable. The required acceleration may come from stronger regulations, in particular offering more effective market instruments taking the possibilities and limitations of cultures into consideration. The study is in that sense hosting various recommendations such as more effective emission reduction policies, uncovering the true market value of renewables, increased energy wasting awareness and so on.

We are confident that the observed socio-economic challenges can and will be overcome and that the enormous potential of energy from the deserts will benefit society and nature.

Country Focus

EGYPT

| Egypt22 | GDP  
(in billion USD, 2022) | GDP per Capita 
(in USD, 2022) | Unemployment Rate 
(2023) | FDI, net inflows 
(% of GDP, 2022) |
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Egypt has embarked on a transformative journey in the renewable energy and green hydrogen sectors, supported by a strong and strategic focus on sustainable development and a deep commitment to creating a competitive environment for energy companies. This journey is enhanced by Egypt’s exceptional solar and wind resources, an established regulatory framework and political stability, which together secure Egypt’s position as a leading force in the renewable energy field.

The Egyptian government has implemented various initiatives to boost renewable and green hydrogen projects, creating a competitive environment for companies. Among these initiatives is the Golden License, the direct engagement with multilateral financing institutions like the European Bank for Reconstruction and Development (EBRD) to ensure bankability of projects and the support of the Sovereign Fund of Egypt (TSFE) as a key stakeholder for developing the right environment to attract Foreign Direct Investment (FDI). These institutions can provide necessary financial support, technical assistance, and risk mitigation measures that can make renewable energy and green hydrogen projects more attractive to private investors.

Moreover, Egypt’s political stability, in contrast to the challenges faced by other African nations, offers a conducive environment for long-term investments. As a result, Egypt is today at the forefront of not only MoUs but also binding framework agreements with international partners as part of the country’s efforts to attract foreign investments into renewables.

Egypt is drawing international investment and gaining support from various development funds. In February 2024, the government disclosed a significant agreement with the United Arab Emirates aimed at developing a prime segment of its Mediterranean coastline. This deal is expected to inject $35 billion into the financially strapped nation over the ensuing two months. Additionally, in March 2024, the World Bank declared its commitment to providing Egypt with $3 billion following a deal with the International Monetary Fund (IMF).

22 https://databank.worldbank.org/source/world-development-indicators#
In March 2024, the European Union (EU) and the Arab Republic of Egypt established a Strategic and Comprehensive Partnership. This partnership aims to deepen shared stability, peace, and prosperity. It recognizes Egypt’s geo-strategic role and emphasizes values such as equity, mutual respect, and trust. The areas of cooperation include political relations, human rights, and regular summits for enhanced dialogue.

The Golden License
The Egyptian government offers a comprehensive approval, known as the Golden License, for the setup, operation, and management of a project. This scheme includes various incentives and is granted to companies that contribute to sustainable development or set up a partnership between the private sector and the State in public utilities and infrastructure, new and renewable energy, roads and transportation, ports, telecommunications, and information technology. The scheme is part of Egypt's efforts to confront its economic crisis. It has been granted to several projects, including those in green hydrogen, electric cars, infrastructure, seawater desalination, and renewable energy.

Green Hydrogen
The green hydrogen projects in Egypt are being developed under the umbrella of the framework agreements signed with the key Egyptian Sponsors: Egyptian Electricity Transmission (EETC), the Sovereign Fund of Egypt (TSFE), the New and Renewable Energy Authority (NREA) and the Suez Canal Economic Zone (SCZONE). Most of the green hydrogen projects in Egypt are planned in the industrial area of Ain Sokhna, managed by the SCZONE. Concentrating green hydrogen projects in the same area, can lead to significant cost savings and efficiency gains. Shared service solutions implemented by the government, like water desalination facilities, transmission lines, and air separation units for nitrogen, can reduce the upfront capital expenditure (CAPEX) for companies setting up their hydrogen projects. This can shift a significant portion of their costs from CAPEX to operational expenditure (OPEX), making the projects more financially viable. This approach also fosters a collaborative ecosystem that can accelerate the development and deployment of green hydrogen technologies. It is a great example of how industrial policies can play a pivotal role in fostering the growth of green hydrogen industries.

AMEA Power, the largest renewable Independent Power Producer (IPP) in Egypt with experience in both, wind and solar technologies, stands as a prime example of successful progression in the green hydrogen sector. The company is at the forefront of developing a 1 GW electrolyzer green hydrogen project in Egypt aimed at producing 68,000 tons of green hydrogen by 2028 at a competitive cost, leveraging Egypt’s excellent solar and wind resources. Starting with the signing of an MoU in April 2022, AMEA Power has rapidly advanced, completing a feasibility study in 2023, and progressing with the ‘Pre-FEED/FEED’ studies in 2024. Other few developers have also entered into binding agreements with the Egyptian sponsors and will be progressing with the engineering phase, similarly to AMEA Power.

In Morocco, the energy transition (investments by 2030) would generate ~28,000 net jobs per year, i.e. ~9% of Morocco’s current estimated annual shortfall of 300,000 jobs. Key areas of progress over the last decade include:

- Promotion of sustainable development goals: Morocco's ambition is to exceed the 52% mark for renewable energy in its energy mix by 2030, a target that is likely to be reached as early as 2025;
- Renewable capacity increased from 1,969 MW in 2009 to 4,067 MW by the end of 2021, made up of 20% solar, 36% wind, 32% hydro and 11% STEP;
- Increased investment in renewable energy projects: cumulative investment in solar and wind power in Morocco between 2010 and 2020: ~$9.1 billion, with a peak in 2018 of $3.1 billion.

Beyond the energy sector, Morocco’s success in creating an automotive industry from scratch is noteworthy. This industry now employs thousands of people and has generated exports totalling $13 billion over the last decade.

Water desalination is a strategic priority for the Kingdom of Morocco and well addressed by the government with a desalination project under development in Casablanca and two further calls for tender's expected in the next months. The primary challenge lies in financing smart desalination projects and establishing an effective regulatory framework. Currently, the cost of desalinated water exceeds its selling price, necessitating a reassessment of tariffs and more efficient allocation of subsidies. The regulatory framework could streamline procedures for granting authorizations and concessions, enabling smoother project implementation.
The main opportunities can be found in several key areas. They not only address water scarcity challenges but also contribute to Morocco’s broader goals of advancing renewable energy adoption and fostering innovation in clean technology industries.

1. **Desalination Projects Potential**
   Morocco aims to achieve an objective of producing 1 billion cubic meters of desalinated water by 2050. This ambitious goal presents significant opportunities for investment and development in desalination infrastructure to meet the growing demand for freshwater.

2. **Renewable Energy Integration**
   By coupling desalination with renewables such as solar or wind power, Morocco can reduce reliance on fossil fuels, decrease carbon emissions, and promote environmental stewardship.

3. **Desalinated Water for Green Hydrogen Production**
   Utilizing desalinated water in the electrolysis process for hydrogen generation aligns with Morocco’s commitment to green energy initiatives and fosters the development of a sustainable hydrogen economy.

The OCP Group, the world’s largest phosphate-based fertilizer producer, has announced a partnership to build solar plants to power its operations, reducing its carbon footprint and greening its fertilizer production. This is part of OCP’s $13 billion Green Investment Program, which aims to increase its green fertilizer production and transition its operations to green energy by 2030. The transition to green fertilizers and renewable energy has significant socio-economic implications for Morocco. The green investment program is expected to create 25,000 direct and indirect jobs as well as contributing to Morocco’s food security and agricultural sector.

JESA has established a significant presence in Africa, notably in Morocco, through its focus on innovation and sustainability. Since its inception in 2010 as a joint venture between OCP and Worley, JESA has experienced substantial growth, expanding from a modest team of 50, with a significant expatriate presence, to over 4,000 employees, with the majority being local talent. This expansion underscores the commitment to developing local expertise and supporting the economies in which they operate. For example, JESA has undertaken a series of initiatives to promote local content and enhance in-country value:

- **Local Workforce Development**
  JESA prioritize hiring and training individuals from within the communities where it operates and actively invests in the future of local hires through comprehensive training and mentorship programs.

- **Promoting Local Content**
  A dedicated “Ecosystem” division within the supply chain department ensures that projects feed into the local economy, enhancing the capabilities of local industries and contributing to a sustainable energy ecosystem.

- **Establishing a Center of Excellence**
  JESA is actively addressing challenges in scaling up power-to-x (PtX) deployment by leveraging local talent for project execution and operations & maintenance (O&M) requirements in Morocco. JESA plans to establish a Center of Excellence to foster the development of a local knowledge base to drive the PtX industry in Morocco. The overarching objective is to contribute to the establishment of a sustainable ecosystem in Morocco, revitalizing the labor market and supporting the country’s position as a global hydrogen hub.

The Morocco Offer, published on the 11th March 2024, is a strategic initiative by the Kingdom of Morocco aiming to position the country as a competitive player in the emerging field of green hydrogen. This incentive-driven offer covers the entire value chain of the green hydrogen industry, whether for the domestic market, export, or both. The Morocco offer covers six topics:

- **Scope:** it applies to integrated projects ranging from electricity generation through renewable energies and electrolysis to the conversion of green hydrogen, ammonia, methanol, and synthetic fuels.

- **Land Mobilization:** Public land of 1 million hectares has been identified with high potential for green hydrogen. A phased approach is proposed to allocate land to projects in order to maintain the flexibility required to be able to adapt to changed related to an emerging sector such as green hydrogen.

- **Infrastructure:** As additional infrastructure will be required for the development for the green hydrogen sector, the Moroccan Offer outlines the responsibilities of the different government authorities.

- **Incentives:** Green hydrogen integrated projects will be subjected to incentive measures for investors as well as tax and custom incentives.

- **Investor Selection:** The Moroccan offer describes the process for selecting investors and concluding contracts with the State.

- **Sector Governance:** It outlines the framework for green hydrogen sector governance. In particular, MASEN will be the focal point for potential investors.


OMAN

The Green Energy Oman (GEO) project\(^42\) relied on a local firm, HRM Consultants, to run the environmental study. The choice of a local company was purposely made believing that they would identify potential social and environmental issues due to their inside knowledge of the country. The idea has been proven to be successful, for example boundaries of the project were traced to exclude from the beginning a natural reserve and camel race tracks that were important for the local communities. Early engagements with the communities, a proper communication strategy together with the creation of local jobs greatly helped the social acceptance of the GEO project.

Worley’s team in Oman, backed by global subject matter experts (SMEs), has successfully executed scopes for several of the planned green hydrogen projects in the country. Worley is actively enhancing local capabilities and developing Omani engineers by undertaking project work within Oman’s borders, while also extending support to projects beyond the country’s boundaries. The overarching goal is to lead all green hydrogen initiatives for Oman directly from within the country, thereby optimizing the In-Country Value (ICV) generated. Worley collaborates closely with strategic suppliers to integrate the supply chain with these projects and explores avenues to establish a robust supply chain within Oman. This strategic approach aims to further amplify the ICV for the green hydrogen projects in Oman.

Oman’s advanced stance in the green hydrogen sector sets a strong foundation for future developments. Oman has laid the groundwork for a thriving green hydrogen industry. The Vision 2040 Oman\(^44\) was launched in Jan 2021 and sets the blueprint for sustainable growth in the country. It is built upon four pillars: a society of creative individuals, a competitive economy, responsible state agencies, an environment with sustainable components. The policy proposed for the energy transition program foresees to reach a share of 30% electricity from renewable energy by 2030, 39% in alternative energy by 2040 and net zero by 2050.

At the end of 2022, the government launched Hydrom as orchestrator for green hydrogen development in the country, tasked to meet the production target for green hydrogen is 1 mtpa by 2030. The first three deals – part of the first public auction – have been signed the 2nd June 2023, for a total investment of over $20 billion\(^45\). The large-scale development green hydrogen has the double objective of establishing new revenue streams from export and decarbonizing the domestic energy use as well as the hard-to-abate sectors.

In country value is at the core of Vision 2040 and it is defined by the government as “total spending retained in-country that can benefit business development, contribute to human capability development, and stimulate productivity in Oman’s economy”. The concept was initiated in the 2010s within the oil and gas industry to engage with communities and create value while benefiting from government commitment. Originally the focus was mainly on short-term objectives such as ensuring that procurement and services were provided by skilled Omani people, but today Oman is shifting towards long-term ICV. This implies promoting the development of small-medium size companies, development of training institutions and investments in fixed assets. The objective is to create a truly sustainable economy and to incentivize development of local capability and workforce. There is currently a strong emphasis on training and knowledge transfer as well as ensuring that ICV is cross-sectorial and not only derived from the oil & gas industry\(^46\). As an early starter in the green hydrogen space, Oman could capitalize on the investments made across the entire value chain to train Omani and ultimately become an exported of this knowledge.

\(^{43}\) https://open.spotify.com/episode/0aMpNrQxc2xCSgVBuHMGst
\(^{44}\) https://lcgpa.gov.sa/en/LocalContent/Pages/default.aspx
\(^{45}\) https://www.oman2040.om/mahawer-en.html

SAUDI ARABIA

In Saudi Arabia, renewable energy projects have a local content requirement (LCR), defined by The Local Content & Government Procurement Authority, as the total expenditure in the Kingdom of Saudi Arabia through the participation of Saudi components\(^47\). For instance, in the third round of the Kingdom’s National Renewable Energy Program (NREP), which includes four Solar PV projects with a combined generation capacity of 1,200 MW, the projects carry a minimum requirement of 17% local content\(^48\). The percentage of LCR is expected to reach 30% in the next few years. Emphasis has been placed on supply chain management, critical metals, and minerals, with certain instances involving the establishment of explicit targets and objectives.

\(^{47}\) https://pswsa.gov/sa/en/LocalContentProjectsdefault.aspx
\(^{48}\) https://databank.worldbank.org/source/world-development-indicators/
\(^{49}\) https://geo.om/
Starting from the initial projects tendered in 2017, the establishment of renewable energy frameworks and the implementation of local content policies proved somewhat discouraging. Despite efforts to strike a balance between levelized cost of electricity (LCOE) and local content, renewable energy policies conveyed the perception of an aggressively competitive market, leaving no room for margins for local manufacturers. In fact, despite the limited volume of projects tendered in Saudi Arabia up until 2022, in comparison to major markets such as the US, Europe, Japan, and even China, the LCOEs announced in Saudi Arabia were globally the lowest. The narrow profit margins sent a signal that would not incentivize investors to undertake investments. Furthermore, even if investors were willing to take the risk and invest in developing the industries and supply chain, it would prove highly unfeasible and unsustainable.

A noteworthy development in the Saudi Arabian landscape is the emergence of a novel approach to industrialization. Policies such as “Made in Saudi” and “Localization” signify a new stage preceding the “Local Content” Policies. This new approach entails the initial transfer of industrial capabilities through basic assemblies. Local Content, on the other hand, adopts an accounting-based approach aimed at precisely quantifying (and essentially auditing) the amount of expenditure made locally in dollar value. Consequently, it is not solely concerned with product development but encompasses the entire supply chain, including upstream stages, as well as metals and minerals. Localization, conversely, focuses on fulfilling the demand. Therefore, if the demand for solar panels or wind turbines amounts to 5GW per year, securing these products through assembly facilities still holds significant industrial and socio-economic value. Additionally, in many instances within the renewable energy industry, sophisticated industries typically follow mastery of the initial monotonous assembly process.

Nextracker has emerged as a successful example of market entry through localization in Saudi Arabia. Their journey began with the Sakaka project, where they collaborated with three local suppliers to produce steel components for their solar trackers. Following the success of this initial venture, Nextracker expanded its production capacity. Today, the local steel manufacturing capability that was developed is not only a part of Nextracker’s global supply chain but also contributes to the development of the clean energy workforce. Saudi Arabia has become a significant production hub for Nextracker, with its products being exported to the GCC region, notably the UAE, and even as far as the Eastern United States. This success story underscores the potential of localization in the renewable energy sector.

Building local capabilities

The geographical distribution of renewable energy projects in Saudi Arabia predominantly favours remote areas. Notable examples of such projects include the Sakaka PV project (300MW), and the Duomat Al Jandal wind energy project (400MW). These projects are strategically situated in border regions characterized by limited industrial and commercial activities. Consequently, the inhabitants of these regions experience a shortage of employment opportunities, compelling them to relocate to major urban centers. However, the proximity of the renewable energy initiatives to the regions facilitated the recruitment, education, and training of individuals from the same region, thereby contributing to the development of those areas.

Prominent international suppliers, such as Nextracker, played a pivotal role in delivering training and certification programs to the local workforce, augmenting their skills and capabilities. Moreover, numerous collaborative initiatives were established between local and international training institutes, as well as nearby universities and institutions in the Sakaka and Duomat Al Jandal regions. These concerted efforts resulted in renewable energy assuming the role of a catalyst for economic development in these remote areas, fostering the emergence of a specialized talent pool dedicated to the renewable energy sector.

TUNISIA

Tunisia cannot count on big reserves of oil & gas and it is currently producing a small parts of its energy needs. The country has abundant solar resources, particularly in the south, and has the potential to boost its renewable energy capacity. For this reason, the Tunisia has made a strategic choice to focus on green energy, aiming to fulfill 30% of its energy needs from renewable sources. The government has also launched initiatives to tackle youth unemployment and promote sustainable development.

However, challenges remain, including the need to reduce administrative constraints to attract developers and to address energy subsidies. The last decade has seen all envisaged large projects remain unrealized. A new impulsion was observed at the beginning of May 2024 with the announcement of the award of two PV solar plants in the governorates of Gafsa and Tataouine.

ELMED Project

The ELMED project is a planned bi-directional power exchange link between Italy and Tunisia. It’s a 600MW capacity project that will be the first direct current connection between Europe and Africa. The construction of the 220km long connector will entail an investment of around €850m. The project will be developed by Italian electricity transmission system operator Terna and Tunisian state-owned electricity and gas utility company STEG. Construction work on the project may start in 2024, with completion expected in 2028.

The ELMED project is expected to have a transformative impact on Tunisia’s energy sector and economy. It will enhance Tunisia’s energy security, integrate renewable energy sources, reduce carbon emissions, and make the power sector more financially viable. The project also positions Tunisia as a regional hub for renewable energy by connecting its power grid to the European network. The construction and maintenance of the project are likely to create jobs, contributing to the local economy. In the long run, it could enable Tunisia to export electricity to other North African countries. The project has been included in the list of ‘European Projects of Common Interest’.

Further information:

52 https://databank.worldbank.org/source/world-development-indicators#
United Arab Emirates was the first country in the region to sign the Paris Agreement and adopt a NetZero target. In 2006, the UAE government established Masdar (its official name is Abu Dhabi Future Energy Company PJSC) as pioneer and first-mover in renewable energy. The recent restructuring of its shareholding, effective from December 2022, created a joint venture formed by the Mubadala Investment Company, Abu Dhabi National Energy Company PJSC (TAQA) and Abu Dhabi National Oil Company (ADNOC). By solidifying the UAE’s position as a frontrunner in the global green hydrogen economy, Masdar assumes a pivotal role in shaping the energy landscape and in driving the UAE’s ambitious Net Zero by 2050 strategic initiative.

The UAE host the largest single-site solar park in the world, the Mohammed bin Rashid Al Maktoum Solar Park. The park combines photovoltaic (PV) solar panels and Concentrated Solar Power (CSP) technologies, and it is operated under the Independent Power Producer (IPP) model. The Dubai Electricity and Water Authority (DEWA) is strategically developing the MBR Solar Park in multiple phases to fulfil the Dubai Clean Energy Strategy 2050 and the Dubai Net Zero Emissions Strategy 2050 and achieving 100% clean energy production capacity by the year 2050. The MBR Solar Park is projected to have a remarkable production capacity of 5,000 megawatts (MW) by 2025, with a total investment of AED 50 billion.

Since 2006, Masdar itself has invested in many solar and wind power projects in emerging markets to provide access to affordable clean electricity to millions of households. The electricity generation capacity of Masdar’s projects, which are either fully operational, under development or secured, is over 20 GW, enough to power over 5.25 million homes. Altogether, they displace nearly 30 million tonnes of carbon dioxide per year, equivalent to removing 6.5 million cars off the road.

Masdar promotes multiple initiatives to fulfil its socioeconomic objectives and reflect key priorities, namely promoting cross border and international partnerships, exchange of knowledge and ideas, encouraging innovation and empowering women in the field of sustainability.

Abu Dhabi Sustainability Week
Since 2008, Abu Dhabi Sustainability Week (ADSW) has grown to become one of the largest platforms of its kind in the world. Working with its public and private partners, ADSW hosts a series of events that welcome heads of state, policymakers, business leaders and technology pioneers, providing them with a global platform to forge partnerships, share knowledge, showcase innovation and outline strategies for delivering climate action.

Zayed Sustainability Prize
The Zayed Sustainability Prize global award recognizes organizations for their impactful, innovative, and inspirational sustainable solutions across five distinct categories:

- Health
- Food
- Energy
- Water
- Global High Schools

Since 2008, its global network of 96 winners has positively impacted the lives of 378 million people – powering 53 million homes with clean energy, providing 216,000 women and new-borns with safe healthcare and providing nutritious food to 2.3 million people globally.

Empowering Women
The Women in Sustainability, Environment and Renewable Energy (WiSER) platform, is an impact focused Masdar platform dedicated to inspiring women and girls to play an active role in addressing global sustainability challenges.

WiSER convenes decision-makers, experts, opinion formers and youth role models from across the sustainability sector to promote new thinking, viable solutions, and lasting collaboration to empower present and future generations of female sustainability leaders.

WiSER strives to position women and girls of all nationalities as drivers of change and innovation, while ensuring that their voices are heard across the sustainability debate – whether on issues of policy, technology, or business.

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Chiara Aruffo
Director of Research
Dii Desert Energy

Cornelius Matthes
CEO
Dii Desert Energy

**Authors**

**Bibliography**


AHDB (online) “Green fuels for the agricultural sector – ammonia, hydrogen and methane”.

Al Yemni Faisal (2020). 1st IEF-IRENA Seminar on Renewable and Clean Energy Technology Outlooks

Pages: 1-7; https://doi.org/10.1093/ce/zkae012

AstroLabs (online) The Mega Green Accelerator Program
https://astrolabs.com/themegagreenaccelerator/

https://astrolabs.com/themegagreenaccelerator/


BloombergNEF & Climate Investment Funds (2021) 2030 Morocco Roadmap: Multiplying the Transition; Market-based solutions for catalyzing clean energy investment in emerging economies.

Collins L. (online) ‘Make green iron and steel from hydrogen and export them to Europe’, EU president tells Mauritania, Hydrogen Insight, February 9th, 2024. 

Mohammed bin Rashid Al Maktoum Solar Park (website). 

Dii Desert Energy (2013), Desert Power 2050: Perspectives on a Sustainable Power System for EUMENA. 

Dubai Angel Investors 
https://www.dubaiangelinvestors.me/

Energy2Equal Africa (online) “Empowering women in Africa’s renewable energy sector”. 

ESMA, European Rating Platform (ERP) and RADAR database 
https://registers.esma.europa.eu/publication/searchRegister?core=esma_registers_radar

European Union (online) Carbon Border Adjustment Mechanism. 

European Union (online) Joint declaration on the Strategic and Comprehensive Partnership between The Arab Republic of Egypt and the European Union, March 17, 2024. 

https://open.spotify.com/episode/8aMvyMrOncw3CJgyi8urKMGst

General Authority for Investments and Free Zones, Egypt (2022) “Golden License Guidebook”. 
https://www.investingegypt.gov.eg/Pact%20sheets/Golden%20License%20Guidebook.pdf

Green Energy Oman (GEO) 
https://geo.ae/

Human Development Reports (website). Human Development Index. 


IRENA (2021) “Decarbonising end-use sectors: Practical insights on green hydrogen”. 

UNIDO (2023). “COP28 Presidency marks the launch of flagship initiatives to unlock the climate and socio-economic benefits.”

UNIDO, IRENA, & IDOS (2024), Green hydrogen for sustainable industrial development: A policy toolkit for developing countries.

UN General Assembly (2015) Transforming our world: the 2030 Agenda for Sustainable Development, A/RES/70/1

Women in Renewables Alliance (website)
https://www.womeninrenewables.org/overview

UN (website) The 17 SDG Goals
https://sdgs.un.org/goals

World Bank. (2022). World Development Indicators
https://databank.worldbank.org/source/world-development-indicators

UNIDO (2023), “COP28 Presidency marks the launch of flagship initiatives to unlock the climate and socio-economic benefits.”

UNIDO, IRENA, & IDOS (2024), Green hydrogen for sustainable industrial development: A policy toolkit for developing countries.

UN General Assembly (2015) Transforming our world: the 2030 Agenda for Sustainable Development, A/RES/70/1

UN (website) The 17 SDG Goals
https://sdgs.un.org/goals

Women in Renewables Alliance (website)
https://www.womeninrenewables.org/overview

World Bank. (2022). World Development Indicators
https://databank.worldbank.org/source/world-development-indicators

UNIDO (2023), “COP28 Presidency marks the launch of flagship initiatives to unlock the climate and socio-economic benefits.”

UNIDO, IRENA, & IDOS (2024), Green hydrogen for sustainable industrial development: A policy toolkit for developing countries.

UN General Assembly (2015) Transforming our world: the 2030 Agenda for Sustainable Development, A/RES/70/1

UN (website) The 17 SDG Goals
https://sdgs.un.org/goals

Women in Renewables Alliance (website)
https://www.womeninrenewables.org/overview

World Bank. (2022). World Development Indicators
https://databank.worldbank.org/source/world-development-indicators

Women in Renewables Alliance (website)
https://www.womeninrenewables.org/overview


Worley (online) From Ambition to Reality series.

Van Son, P., Isenburg, T. (2023) Sun, Wind and Desert: MENA, the upcoming Clean Energy World Champion. 229
https://www.amazon.com/Sun-Wind-Desert-MENA-upcoming-Champion-ebook/dp/B0CQ2QQG57

National strategies and roadmaps

North Africa

https://www.me.gov.dz/recherche/plan-national-climat/

https://www.energy.gov.dz/Programme%20de%20développement%20de%20l'énergie%20renouvelable

https://www.energy.gov.dz/Stratégie%20Nationale%20de%20Développement%20de%20l’Hydrogène

Egypt (2023) National Determined Contribution.
https://unfccc.int/sites/default/files/NDC/2022-06/Egypt%20Updated%20First%20Nationally%20Determined%20Contribution%20Updated%202023.pdf

Lybia (2023) Strategy for Renewable Energies and Energy Efficiency 2023-2035
https://ilea.blob.core.windows.net/assets/imports/events/173/Libia_RE_National_Plan.pdf

https://unfccc.int/sites/default/files/NDC/2022-06/CDN-actualisé%202021_%20Lybia.pdf

https://unfccc.int/sites/default/files/NDC/2022-06/Moroccan%20updated%20NDC%202021%20_Fr.pdf

https://unfccc.int/sites/default/files/NDC/2022-06/Moroccan%20updated%20NDC%202021%20_Fr.pdf

https://www.mem.gov.ma/lt/rapports/attachments/16%Feuille%20de%20route%20%20hydrogene%20vert.pdf

https://www.mem.gov.ma/lt/rapports/attachments/16%Feuille%20de%20route%20%20hydrogene%20vert.pdf
Morocco (2024) Morocco Offer
https://www.cg.gov.ma/en/node/11710

https://unfccc.int/sites/default/files/NDC/2022-10/Sudan%20Updated%20NDC-12102021.pdf

Tunisia (2022) Strategy of Carbon Neutral and Resilient Development to Climate Change at the 2050 Horizon.

https://unfccc.int/sites/default/files/NDC/2022-06/Tunisia%20Update%20NDC-french.pdf

Tunisia (2013) Stratégie Transition Énergétique

Tunisia (2023) H2Vert.TUN - Green hydrogen strategy
https://www.environnement.gov.tn/mediatheque/bibliothèque-du-telechargement/t,ameosfilemanager%20action%2Ddownload&tx_ameosfilemanager%20controller%2DExplore%2FSite&tx_ameosfilemanager%2Dfile%2DID=1864&hash=3e3ca51969a9f4f901f0ce543ef7477

Morocco (2024) Morocco Offer


Tunisia (2022) Strategy of Carbon Neutral and Resilient Development to Climate Change at the 2050 Horizon.


Tunisia (2015) Plan Solaire Tunisien

Tunisia (2013) Stratégie Transition Énergétique

Tunisia (2023) H2Vert.TUN - Green hydrogen strategy

Middle East

Bahrain (2023) Bahrain National Energy Strategy

https://unfccc.int/sites/default/files/NDC/2022-06/UPDATED%20NDC%20MISSION%202050%20JORDANS.pdf

Jordan (2021) LongTerm Low-carbon and Climate Resilient Strategy (LTS) for Jordan


Kuwait (2021) National Determined Contribution
https://epa.gov.kw/Portals/0/PDF/KuwaitINDCFN.pdf

Oman (2022) National Carbon Neutral Strategy

Oman (2022) Vision 2040 document

Oman (2019) Adaptation & Mitigation to Climate Change 2020-2040

Oman (2022) Green Hydrogen in Oman
https://hydrom.om/events/hydromlaunch/221023_MEM_E.pdf

Qatar (2021) Qatar National Climate Change Plan

Qatar (2021) National Environment and Climate Change Strategy (QNE)

Qatar (2008) Qatar National Vision 2030

Saudi Arabia (2021) National Circular Carbon Economy Program
https://www.cce.org.sa/ Pages/Home.aspx

United Emirates Arab (2023) UAE Energy Strategy 2050


United Emirates Arab (2015) UAE Green Agenda

United Emirates Arab (2023) National Hydrogen Strategy 2050
Renewable energy resources in the MENA Region

The MENA region is experiencing a significant shift towards renewable energy and hydrogen. Dii Desert Energy monitors advancements in solar and wind energy and has created over the years a unique database that provides special insights into these projects. The MENA H2 tracker is the latest addition to this collection, providing detailed information about the status of these projects, their scale, and the organizations involved.

Renewable Energy Projects

The Renewable Energy Database by Dii Desert Energy is a comprehensive resource that tracks solar photovoltaic, wind and CSP projects in the MENA region with a capacity of more than 5 MW (Table 3). As of April 2024, the region has over 230 operational projects, with 25 in the construction phase. Additionally, more than 130 projects are currently in development, and more than 120 have been announced (including green hydrogen related projects).

Egypt is at the forefront with the highest number of operational projects (93) and the highest total number including projects in construction or earlier phase of development. Morocco has the strongest pipeline of projects in construction and development (33 in total), whereas Oman has the highest number of projects announced (22) mainly related to low emission hydrogen projects.

Table 3: Summary table and graph of solar and wind projects in the MENA region by development phase. Source: Dii Desert Energy Renewable Energy Database.

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<td>31</td>
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<td>8</td>
<td>3</td>
</tr>
<tr>
<td>Total</td>
<td>530</td>
<td>243</td>
<td>27</td>
<td>127</td>
<td>129</td>
</tr>
</tbody>
</table>

Renewable Energy Installed Capacity

The MENA region has a current renewable energy installed capacity of almost 27 GW (Table 4 and Figure 3). Looking at the regional distribution, UAE emerges as a leader with 5.9 GW installed capacity, followed by the Egypt (3.7 GW) and Saudi Arabia (3.1 GW). It is worth noting that UAE has achieved more installed capacity than Egypt with fewer than half the projects. This is largely due to the impact of the mega-project Mohammed bin Rashid Al Maktoum Solar Park (MBR Solar Park), which significantly contributes to the UAE’s renewable energy capacity.

Table 4: Summary table and graph of solar and wind installed capacity in the MENA region by technology. Source: Dii Desert Energy Renewable Energy Database.

<table>
<thead>
<tr>
<th>Total RE Energy</th>
<th>PV Solar(on grid)</th>
<th>CSP</th>
<th>Wind</th>
</tr>
</thead>
<tbody>
<tr>
<td>Algeria</td>
<td>423</td>
<td>388</td>
<td>25</td>
</tr>
<tr>
<td>Egypt</td>
<td>3680</td>
<td>1770</td>
<td>20</td>
</tr>
<tr>
<td>Iraq</td>
<td>3</td>
<td></td>
<td>3</td>
</tr>
<tr>
<td>Jordan</td>
<td>2601</td>
<td>1987</td>
<td></td>
</tr>
<tr>
<td>Mauritania</td>
<td>217</td>
<td>80</td>
<td></td>
</tr>
<tr>
<td>Morocco</td>
<td>2695</td>
<td>297</td>
<td></td>
</tr>
<tr>
<td>Oman</td>
<td>732</td>
<td>675</td>
<td>7</td>
</tr>
<tr>
<td>Saudi Arabia</td>
<td>3131</td>
<td>2610</td>
<td></td>
</tr>
<tr>
<td>Tunisia</td>
<td>500</td>
<td>255</td>
<td></td>
</tr>
<tr>
<td>UAE</td>
<td>6055</td>
<td>5352</td>
<td></td>
</tr>
<tr>
<td>Others*</td>
<td>7211</td>
<td>6582</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>27248</td>
<td>19999</td>
<td></td>
</tr>
</tbody>
</table>
Hydrogen projects in the MENA region

The MENA region witnessed its initial hydrogen project announcements in 2020, signaling a significant shift in the energy sector. Since then, the momentum has accelerated, with 98 projects now in the pipeline as of May 2024. Notably, over 90% of these projects focus on green hydrogen, while the remaining 10% fall under the category of 'blue' hydrogen, which involves fossil-based production methods, including Carbon Capture Utilization and Storage (CCUS).

Egypt, with its 29 announced hydrogen projects, currently leads the way. These developments are mainly due to a series of Memorandum of Understanding (MoUs) signed during COP27, which took place in Sharm El Sheikh in 2022. It is important to remark that the hydrogen landscape is dynamic, and we can expect rapid evolution.

Planned Electrolyzers capacity

The hydrogen market in MENA is, thus, in an early stage of development. Project data (e.g. renewable energy use, electrolyzers, annual production) are not always publicly available or credible yet. Looking for example at announced Electrolyzer capacities, the range covers a wide spectrum from a few hundreds of MW up to 35 GW (!) for the biggest projects announced in Mauritania.

Largest Green H₂ projects to be built in Oman, Mauritania and Egypt

Largest known green H₂ projects by electrolyzer capacity [GW]

20 largest projects (>1 GW) are powered by a combined ~156 GW of electrolyzer capacity.
Human Development Index (HDI)

The Human Development Index (HDI)\(^{56}\) was introduced in 1990 by the United Nations Development Programme (UNDP) as a measure of human development. It provides a comprehensive view of a country's progress beyond economic factors alone, aiming to capture the overall well-being and quality of life of its citizens. The HDI takes into account three fundamental dimensions of human development:

- a long and healthy life measured in terms of life expectancy at birth
- knowledge measured in terms of years of education
- decent standard of living measured in terms of gross national income (GNI) per capita

The HDI for the Arab countries (as depicted in Figure 5) exhibits a distribution both above and below the global median (represented by the dashed black World line in the graph). Countries such as Qatar, Bahrain, UAE and Kuwait surpass the global average, indicating higher levels of human development. Conversely, Djibouti, Sudan and Yemen fall below the global median, suggesting lower levels of human development. It's important to note that there has been a general increase in HDI across all countries over the years, with the exception of countries like the Syrian Arab Republic, Yemen, and Lebanon, where political instability has hindered progress.

World Developments Indicators

The World Bank's World Development Indicators (WDI) database\(^{57}\) is a comprehensive source of data and indicators covering various socioeconomic aspects. It encompasses a wide range of topics, including poverty, income inequality, education, health, and economic development, providing valuable insights into global development trends.

The analysis of key indicators from the WDI database, such as the “adjusted net national income per capita” (Figure 6), defined as the gross national income minus consumption of fixed capital and natural resources depletion, or labor-related indicators (Figure 7), reveals significant variations across the MENA region. These disparities underscore the need for a nuanced approach, wherein each country is analyzed individually. A thorough understanding of the unique socio-economic factors and challenges specific to each country would enable the development of tailored policy interventions and strategies for sustainable development.

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\(^{57}\) https://databank.worldbank.org/source/world-development-indicators
Worldwide Governance Indicators

The Worldwide Governance Indicators (WGI) are a set of indicators developed by the World Bank to assess the quality of governance in countries worldwide. These indicators aim to provide a comprehensive view of governance and help identify areas that require attention to reform. Among the indicators included in the WGI are political stability, government effectiveness, regulatory quality, and control of corruption. Estimates for 2022 for ten major countries in the MENA region are provided below, measured in units of a standard normal distribution, i.e. ranging from approximately -2.5 to 2.5 (Figure 8).

Sovereign credit ratings

Sovereign ratings refer to assessments by credit rating agencies to measure the creditworthiness, and thus financial stability, of a national government or its issued debt instruments. Below, we report the latest ratings as of April 2024 assigned by the “Big Three” credit rating agencies: S&P Global Ratings, Moody's and Fitch. It’s important to note that not all MENA countries are rated; for example, Algeria does not have a rating. Additionally, some countries are rated only by certain agencies, such as Tunisia. It’s also crucial to highlight that ratings equal to or below BB+ (or Ba1 for Moody’s) are considered speculative or non-investment grade. In the MENA region, only Qatar, Saudi Arabia, and the UAE are therefore perceived as less risky investments.
A Green Revolution

A Socio-Economic Perspective on Renewables and Hydrogen in the MENA Region