

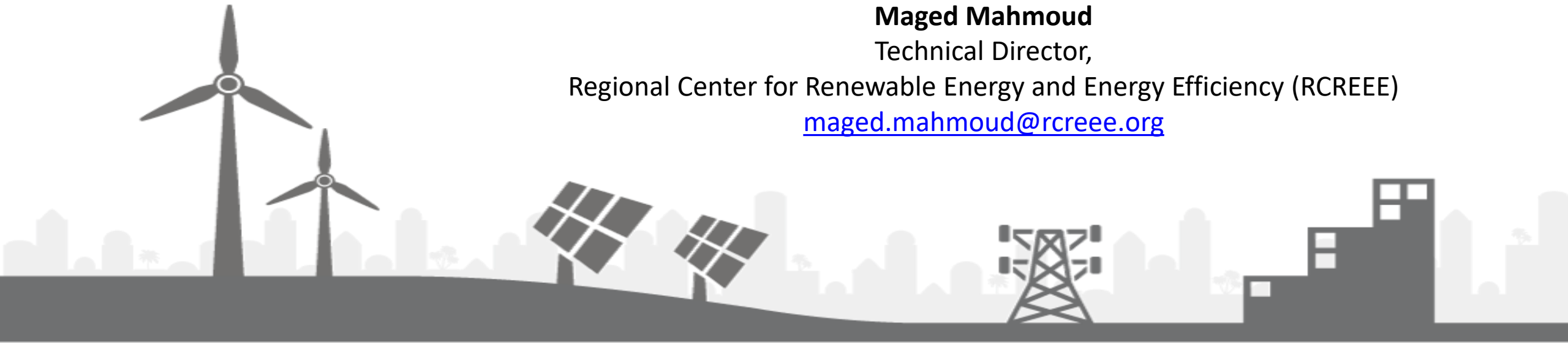
Prospects and Challenges of Green Hydrogen in the Arab Region: Readiness of Sustainable Energy Programs

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RCREEE

Regional Center for Renewable Energy and Energy Efficiency
المركز الإقليمي للطاقة المتجددة وكفاءة الطاقة



July, 2021

RCREEE – Who we are

*“We, the Regional Center for Renewable Energy and Energy Efficiency, are the **strategic partner** for the **Arab countries** driving **energy transition** for the **prosperity of all our people**.”*



Work in the Pan-Arab Region...
know how to navigate your way



Intergovernmental Organization with 17 Member States



The technical arm of the League of Arab States



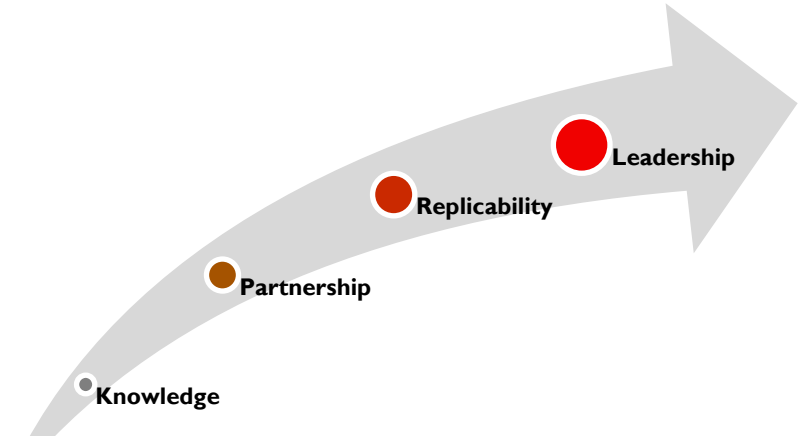
A leader in clean energy policy dialogues, strategies, technologies, investments promotion, and capacity development



The first regional renewable energy and energy efficiency center across the world



Secretariat in Cairo, Egypt with regional antennas and a pool of short-term experts



• Sustainable
Energy Policies
and Technical
Support

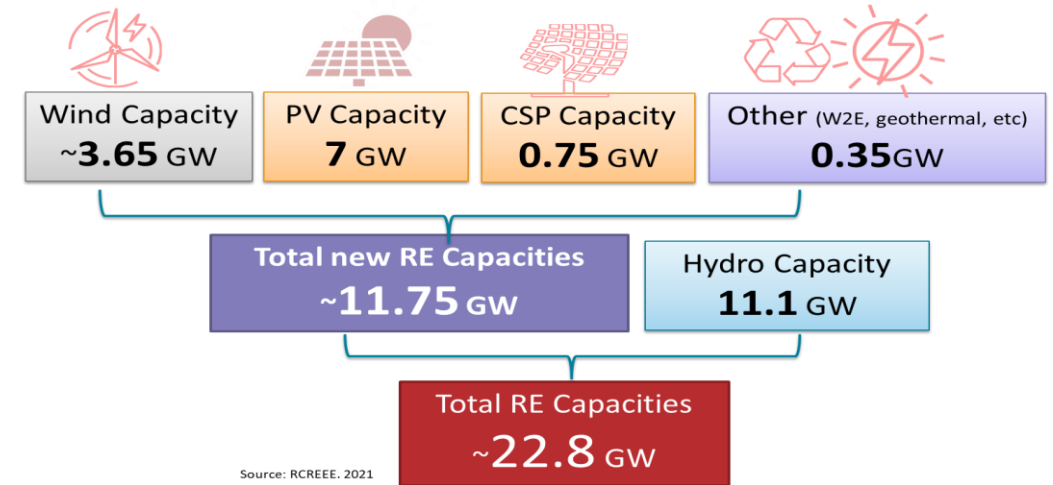
Energy Market
Research and
Knowledge
Management

Sustainable
Energy
Investments
Promotion

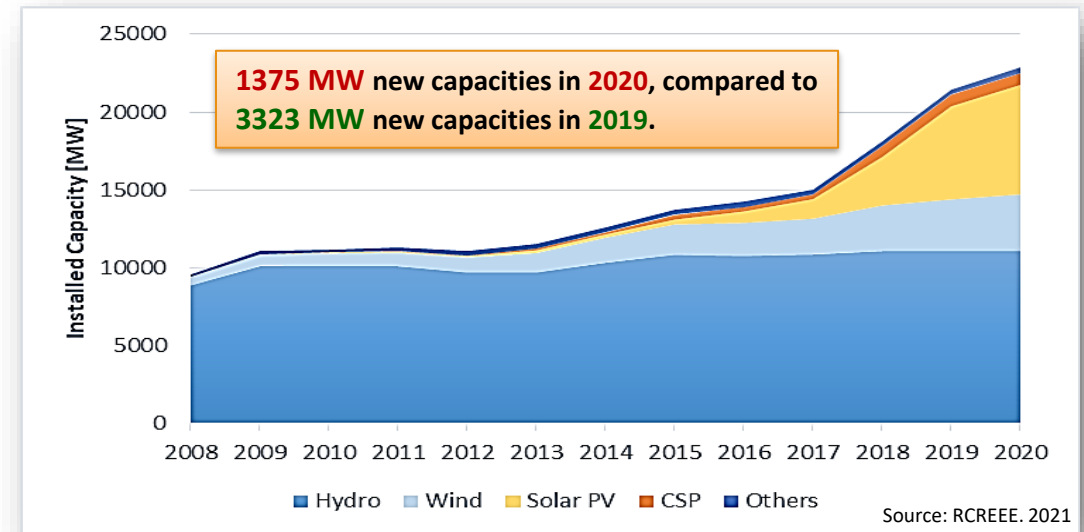
Socio-Economic
& Environmental
Assessments

Renewable Energy in the Arab Region

- ❑ The renewable energy (RE) in the Arab region is becoming **a mainstream**, particularly in the power sector.
- ❑ **Investments** in Arab countries over the past decade **in solar and wind** projects exceeded **17 billion USD**.
- ❑ There is **clear commitment** to embrace strong forward thinking policies and capture the immense value of the RE business and cross-border interconnections.
- ❑ Several **RE support policies** and **financial instruments** have proven to be effective region. Examples are competitive bids and auctions for utility scale projects, resulting in a **competitive RE electricity prices**.
- ❑ Such prices are possible because of the excellent solar and wind energy **resources**, backed by **some concessional finance** coupled with **policy measures to reduce the various risks** and encourage investments.



RE in the Arab Region: Operational Capacities as of Dec. 2020 [RCREEE, 2021]



Policies for Mobilizing RE Investments in Arab Countries

- The preferred policy option for **utility scale projects** in the region is the public **competitive bidding** and lately the process is adapted towards “**Auctions**” in many countries.
- **Feed-in tariffs are phasing out** for utility scale projects towards auctioning and bidding
- The adoption of **direct proposal submission** proved to be successful for the development of large-scale RE projects in some countries.
- **FiT and net metering** are emerging for **decentralized** RE systems.

Competitive Bidding and Auctioning

- **At least 12 countries**

Direct Proposal Submission

- **3 countries**

Feed-in Tariffs

- **2 countries**

Net Metering

- **9 countries**

EPC Contracting

- **More than 17 countries**

Sustainable Energy Finance and Investment

- ✓ **Around 70%** of Arab countries have **public financing** channels and funds for SE projects
- ✓ International **funding institutions** are active in the region (WB, KfW, AFDB, EIB, IFC, EBRD, JICA, etc.)
- ✓ **At least Four** countries created **state-backed private sector companies** to invest in RE projects, such as Masdar in **UAE** and Masen/SIE in **Morocco**, SKTM in **Algeria** and lately **Libya**
- ✓ **10** countries directed **national petroleum companies** to launch investment programmes in RE, such as **Algeria, Bahrain, Egypt, Kuwait, Morocco, Qatar, Saudi Arabia, Syria, Tunisia and UAE**
- ✓ **Public private partnerships** and **corporate sourcing** of RE (captive markets) are getting increasing interest.
- ✓ **Egypt, Lebanon and Morocco** issued **green bonds** to help to finance the country's development of clean technologies. The Arab's first corporate **green Sukuk** was launched in **UAE**

RE Targets in the Arab Countries



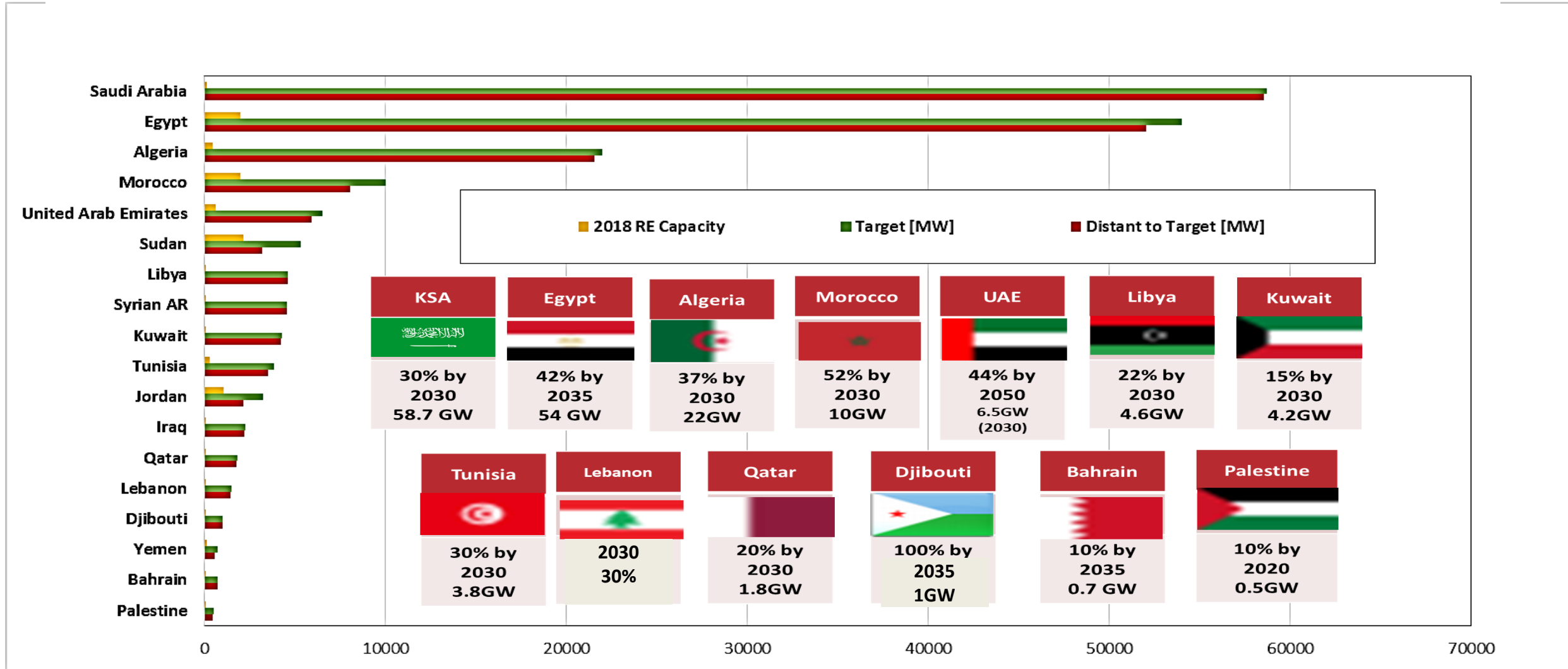
> 190 GW

Announced targets by 2035

Renewable energy business opportunities throughout the Arab region... estimated at over 30% of the global solar and wind growth!



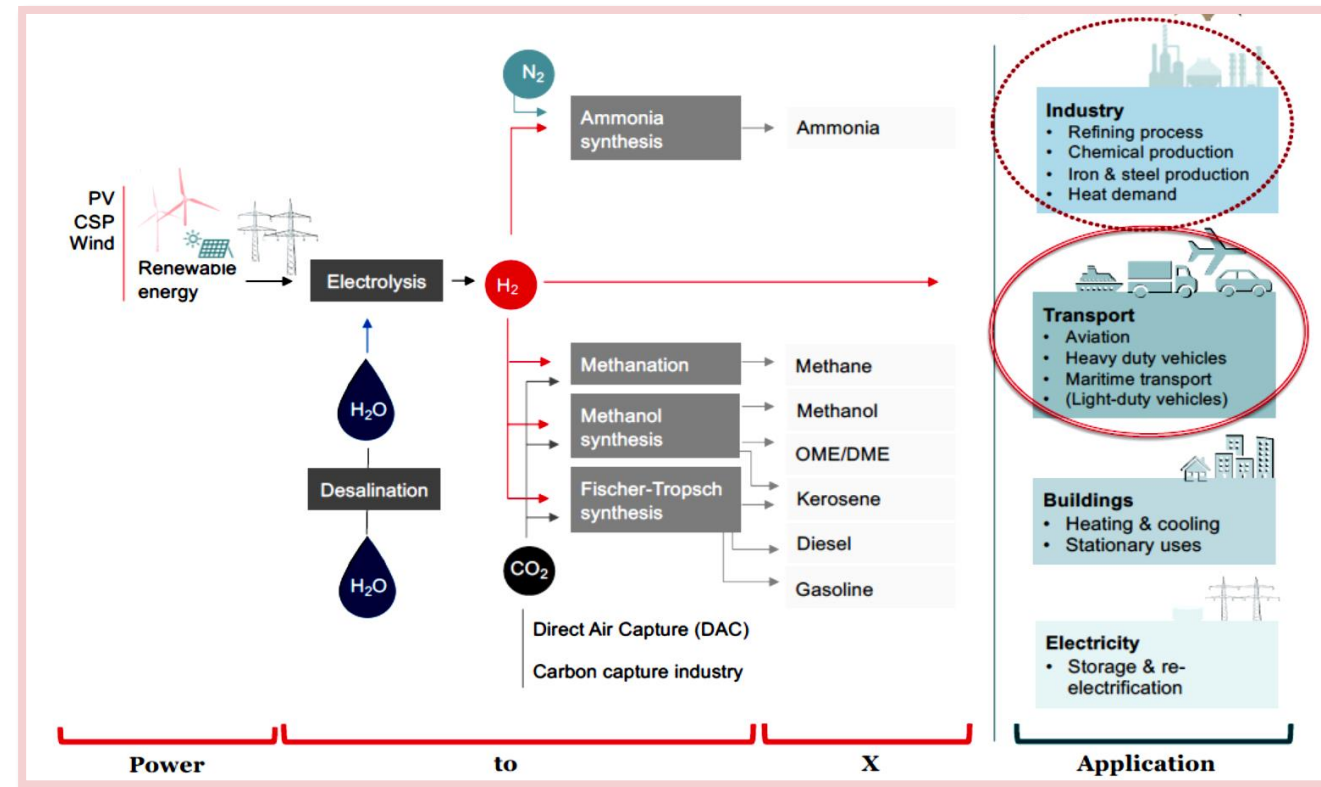
RE Targets in the Arab Region



Source: RCREEE- AFEX , 2019

Green Hydrogen and Power-to-X: A Near future opportunity?

- Some countries are facing the challenge of the surplus RE and conventional generation and therefore need to envisage solutions to accommodate for the available generation capacities.
- Among different solutions, a movement towards **green hydrogen projects and P2X** that relies on renewables' electricity is emerging in **[UAE, KSA, Morocco, Egypt, Tunisia, Algeria, Oman and Mauritania.](#)**
- The green hydrogen traction offers long-term opportunities to the Arab **countries to integrate higher shares of renewable energy** into the grid, **export renewable energy to third countries** worldwide, **decarbonize sectors** which are often difficult to decarbonize such as **transport, oil and gas, steel, mining, etc.**



Viebahn P. et al, The MENA-Fuels Project Presentation", 2020, <https://www.wupperinst.org/en/p/wi/p/s/pd/789/>

Green Hydrogen Production is Old in the Arab Region!!

- **Since 1960 Green Hydrogen** was produced **in Egypt** by the Egyptian Chemical Industries Company (KIMA) in Aswan, where electricity produced from the **Aswan hydro power plant** to produce **hydrogen in electrolyzers** (37000 m³/h) which is then used with Nitrogen to produce **Ammonia** (400 Ton/day).
- The **factory was rehabilitated in 2019 to rely on natural gas instead of electrolyzers** and increasing its production capacity by several folds!!



Would Green Hydrogen Promise a Success Story for the Arab- MENA Region? similar to RE or Better? → Most Probably! (1/2)

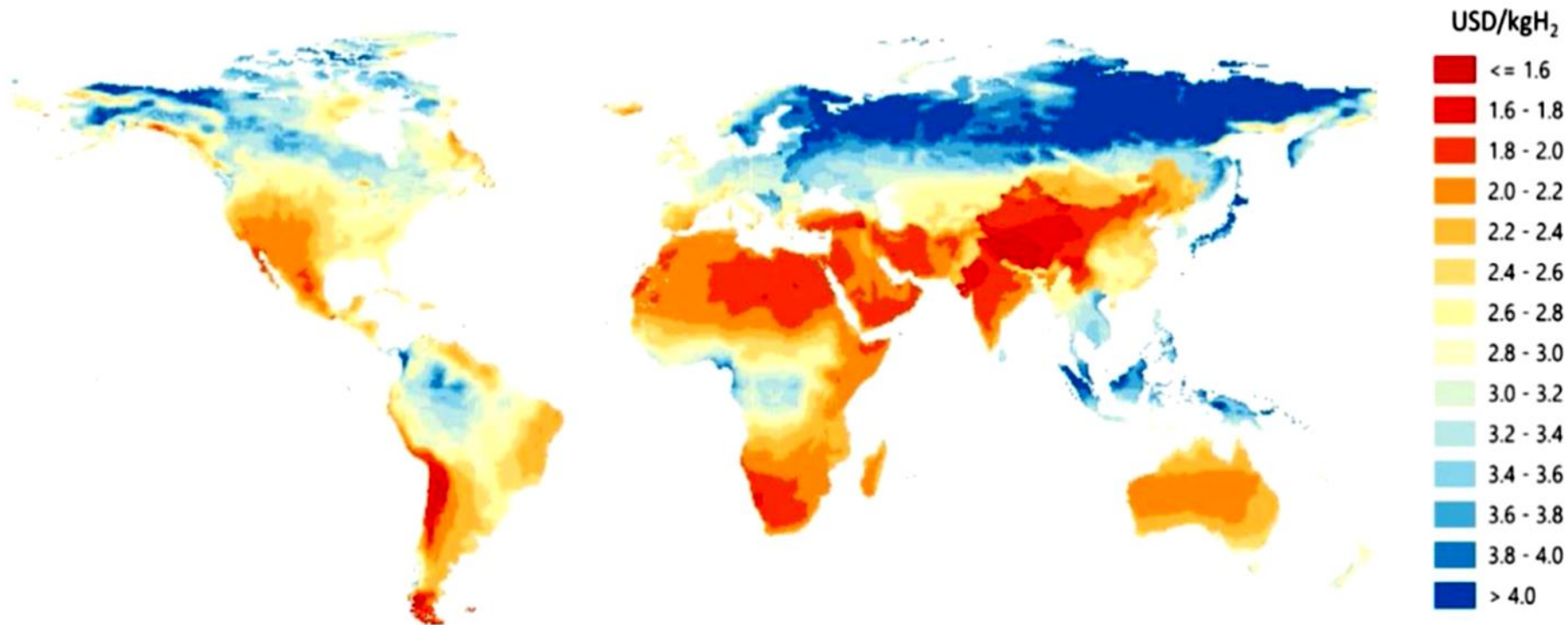
- Excellent solar and wind potential
- Available **low cost land** for RE projects and H₂ facilities
- Relatively **low cost of capital/PPPs/concessional finance**
- Existing **industrial capacity**
- National, regional and **global growing markets**: Hydrogen exists mostly in refineries, steel factories and petrochemical facilities. It could be used in ammonia, methanol, steel, food and glass production, and possibly cement and aluminum. Also, for applications in electricity generation, transport and others.
- **New jobs** and mainstreaming **climate actions**
- **Pipeline-transported hydrogen is feasible in some countries, especially North Africa**, given the existing NG infrastructure nationally and with Europe, **whether in pure form, or blended into natural gas**.
- A number of suitably-located salt deposits exist in the region in which caverns could provide low-cost buffer storage of hydrogen.

Geographical proximity to neighboring expanding “green” markets is a key factor.

E.g. The EU hydrogen strategy was published in July 2020, setting a target of 40 GW of electrolyzers installed within its borders by 2030 and another 40 GW of capacity imported from other producers, mainly North Africa and Ukraine.

Would Green Hydrogen Promise a Success Story for the Arab- MENA Region, similar to RE or Better? → Most Probably (2/2)

- Green hydrogen costs are projected to fall from US\$ 3.5-7.5/kg in 2020 to US\$ 1.6-2.2/kg by 2030.



Hydrogen costs from renewable energy (solar PV and onshore wind systems) in the long-term
Source: IEA, "The Future of Hydrogen", June (2019)

Facing Challenges (1/2)

- Arab countries are considered amongst the **most exposed and least resilient** to an EU carbon pricing scheme.
- The EU's potential **carbon border tax** could **cut the profits from exports of oil, steel, and wood** pulp by 10-65%, impacting both EU and non-EU producers of goods.
- This could encourage increased production of **H₂-derived materials to reduce the carbon footprint of energy-intensive materials exported to Europe.**

- Water electrolyzers currently have an efficiency of 60-81% and require around **9 liters of water to produce 1 kgH₂.**
- The cost of **water is less than 2%** in the overall business case.
- **Freshwater access may become an issue in water-scarce or water-stressed areas,** meaning desalinated seawater will likely be required in the Gulf.
- Current electrolyzers require desalinated water, though **new generations are under development that could work with salt water.**

- Liquid hydrogen transport is costly, while liquid organic hydrogen carrier's gravimetric density is relatively low and the supply chain is complicated.
- Thus, **the ammonia value chain appears the most practical and cost-effective approach to transporting MENA hydrogen over long distances**, and this is the approach being pursued by KSA and Morocco.

Facing Challenges (2/2)

- Given the early stage of the industry, Arab countries should consider
 - including green (blue) hydrogen in the revision of national sustainable energy strategies and action plans as well as in the Nationally Determined Contributions (NDCs) for the Paris Agreement
 - adopting supportive policy instruments and awareness-building, starting with policy-making constituency
 - building collaboration on technologies
 - coordination on harmonizing regulations and standards,
 - developing low-carbon green products pricing/carbon pricing mechanisms, with links to other “carbon” pricing schemes (e.g. European ETS), to create business opportunities to expand the hydrogen market.
- Green hydrogen investors need to start by initiating and developing projects themselves, in partnership with state actors and strategic investment vehicles.

More R&D investments need to be allocated to:

- strengthen technology expertise,
- drive cost reductions in electrolyzers,
- create an infrastructure network, and
- refine export business models.

Examples of policy instruments:

- Double auction model for green hydrogen supply contracts (cover for the difference between green H₂ production price and the highest willingness to pay for it)
- Carbon contracts for difference in industry;
- Quota for aviation;
- Auctions for CHP plants;
- Financial and fiscal incentives for decarbonized materials;

This should be accompanied by regulations that ensure:

- Sustainable renewables growth,
- appropriate infrastructure investment,
- system integration,

Food for Thoughts (1/2)

- ❑ Current Arab RE targets were mostly set few years ago when green hydrogen was not yet featured of the global energy equation.
- ❑ Green hydrogen facilities require competitive RE electricity with high capacity factors.
 - ❑ Would excess renewable generation be sufficient to cover the power demands for significant production of green hydrogen and synthetic fuel production?
 - ❑ Should current RE plans be revised?
 - ❑ Or, would the lower demand on electricity due to subsidy reform programs and energy efficiency gains give a room for pondering?
- ❑ The required policy support for green hydrogen at the EU level is anticipated to cost €10-24 billion per year, **how much Arab countries are willing to provide?**

- ❑ Is there a fast-track for Arab countries?
- ❑ Which applications for H₂ are of priority for decarbonization?
 - ❑ Steel industry,
 - ❑ Feed stock (ammonia, chemicals)
 - ❑ Long-haul aviation
 - ❑ Maritime shipping
 - ❑ Long-term storage for variable RE backup.
 - ❑ District heating and cooling (?)
- ❑ Which use cases are controversial and of less priority?
 - ❑ Short-haul aviation and shipping
 - ❑ Light duty vehicles (green hydrogen fuel cells versus battery-electric vehicles)
 - ❑ Low temperature heat for industries and buildings
 - ❑

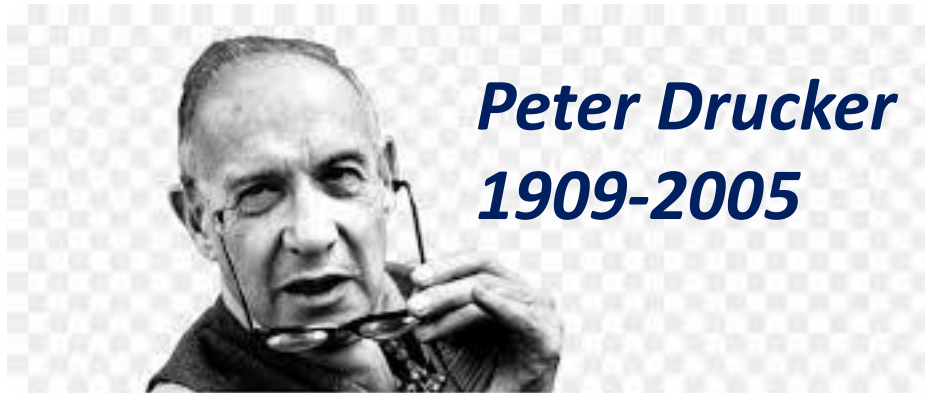
Food for Thoughts (2/2)

- ❑ In the present 2020s decade, CO₂ market prices may not be sufficiently high to trigger a quantifiable demand for green hydrogen, **large quantities of lower-cost blue hydrogen will be needed at least in the medium term.**
- ❑ **Blue hydrogen “alignment/competition with?” green hydrogen**, e.g. Aramco first blue ammonia shipment to Japan in September 2020 and ADNOC new plans (Blue hydrogen is seen as the natural fit for oil/NG producers!)
 - ❑ Low cost of NG
 - ❑ Ease of carbon capture, use and storage (CCUS)
- ❑ Green hydrogen could become cheaper than ‘blue’ hydrogen as technology improves and **carbon pricing (?)** is increasingly adopted.
- ❑ **Negotiation with the off-takers of hydrogen-derived materials** (likely ammonia and steel) for export **should start** to trigger a suitable **“captive market”** and **innovate suitable business models.**
- ❑ Given recent discussions/developments on nuclear power in EU, Arab and globally, is there any possibility that **yellow hydrogen would be on the table at a certain point!** How green hydrogen industry would react?

- ❑ Would hydrogen be high enough on the agenda of Arab oil and gas companies?

- ❑ With EU carbon neutrality goals up to 2050 potential off-takers will be lined up:
 - ❑ e.g. the steel or heavy transport industries are evaluating where to source in the mid- and long term the big amounts of green inputs through market mechanisms.

“The best way to predict your future ...
is to create it.”



Thank You

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