



Economic Sector - Energy Department
League of Arab States

Energy Transition in the Arab Region: The Role of Hydrogen

OAPEC Workshop: Hydrogen and its role in the energy Transition

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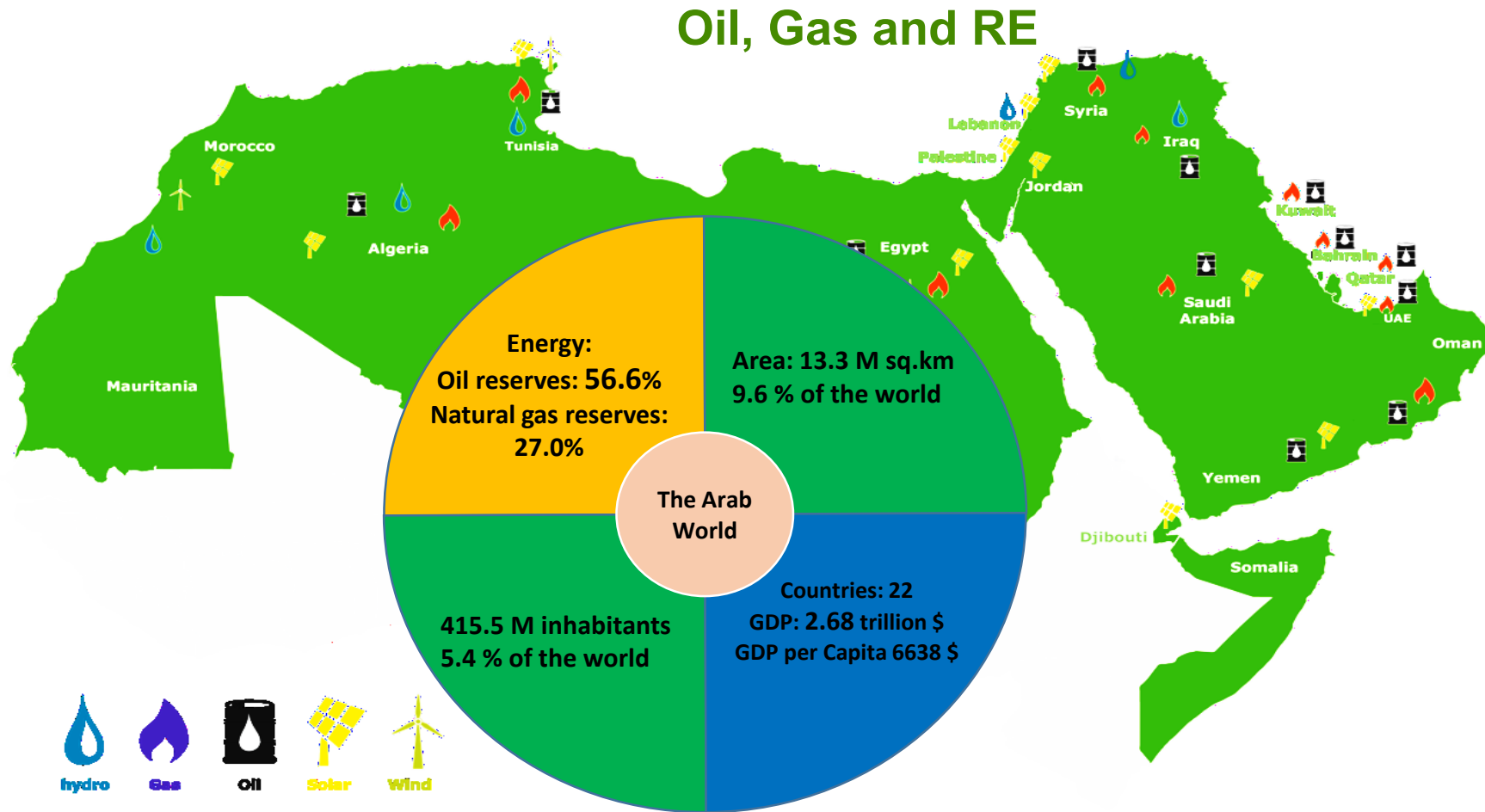


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Introduction to the energy system in the Arab region



The most important energy indicators for the year 2020



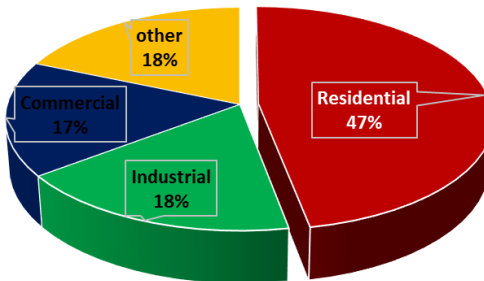
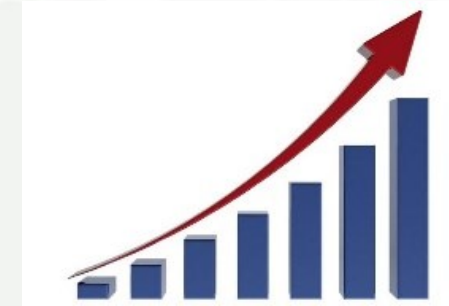


The most important energy indicators for the year 2020



- PAN-Arab Countries Installed capacity over **288 GW**

- **1,137,644** GWh energy produced in 2017



Customer consumption,

- 46% Residential,
- 18% Industrial,
- 17% Commercial,
- 19% Other

- More than **212, 500 km** Transmission Network



- **~190 GW** Renewable energy announced by 2035



The most important energy indicators for the year 2020

The most important characteristics of the energy system in the Arab region are:

- ☐ Heavily dominated by fossil resources
- ☐ Production of energy is not market-driven and infrastructure is public
- ☐ Fossil resources are the main drivers for the most Arab countries' economies
- ☐ Interconnection with neighbor countries
- ☐ Political support for an ambitious energy transition

In this regard, the Arab Sustainable Energy Strategy 2030 was adopted by the Arab Ministerial Council for Electricity's Executive Bureau resolution at its thirty-fourth session (Cairo: 22/11/2018)



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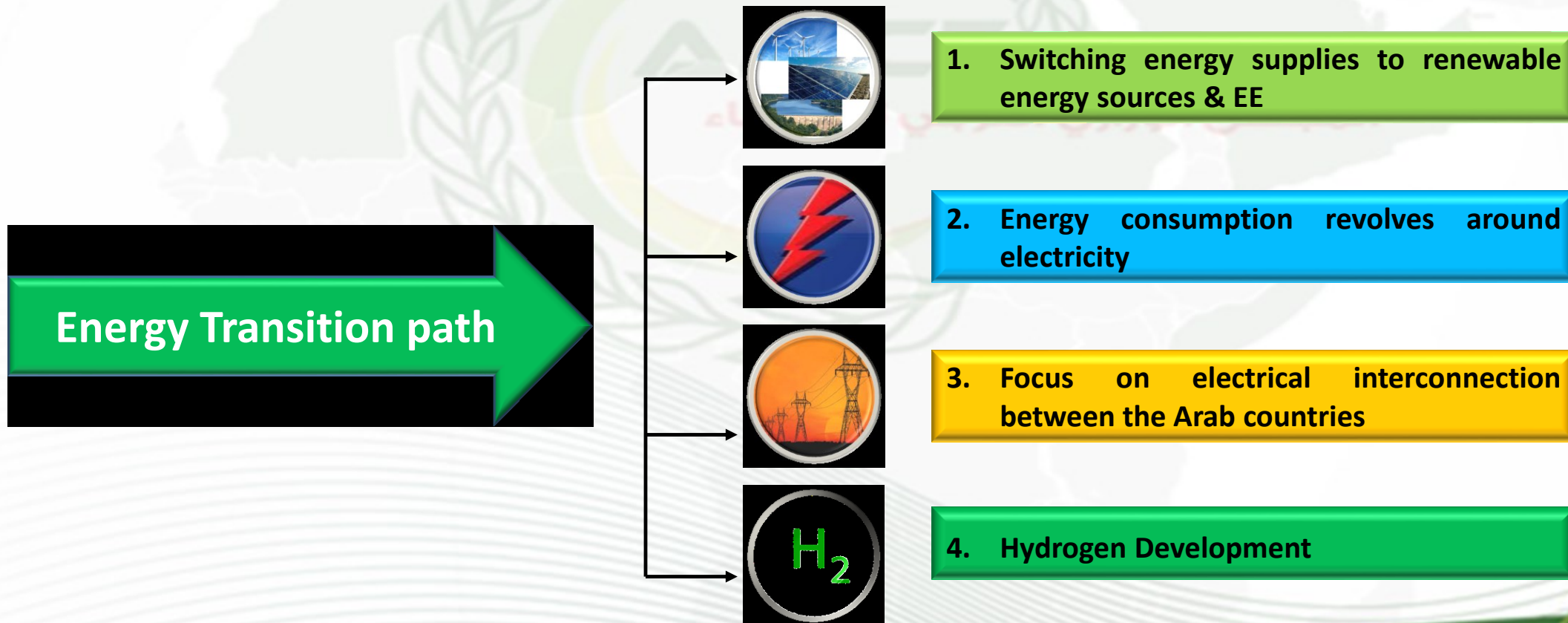
Energy transition in Arab Region





Energy transition in Arab Region: The main pillars

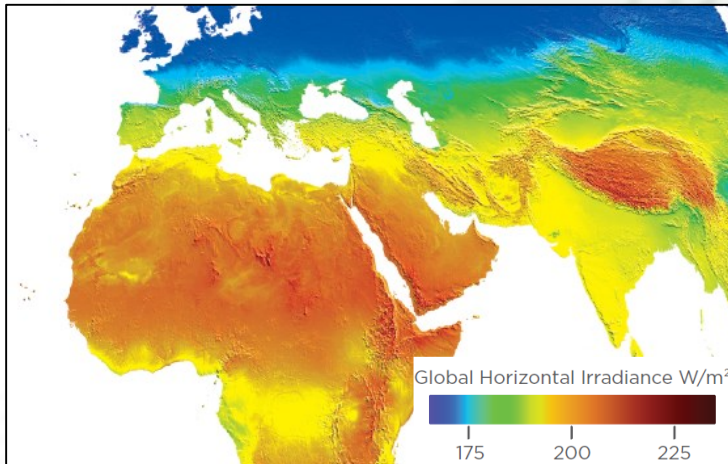
The Arab region has an excellent location and abundant energy resources. The economic development of the petroleum exporting countries depends mainly on the petroleum industry, while the non-petroleum exporting countries depend mainly on agriculture and their economic structure is relatively undiversified. Sustainable energy development in the Arab region is of great importance for the energy transition in the world





1. Switching energy supplies to renewable energy sources & EE (1/3)

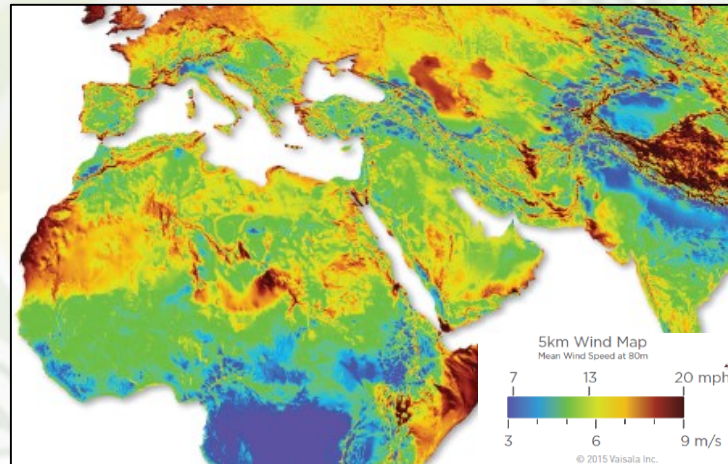
- ❑ The development of clean energy on a large scale is to be accelerated in order to achieve a diversified and clean energy supply. A region with significant renewable energy potential to meet operational goals.



SOLAR RESOURCES: GHI UP TO 2500 KWH/M²

0.40%
RE

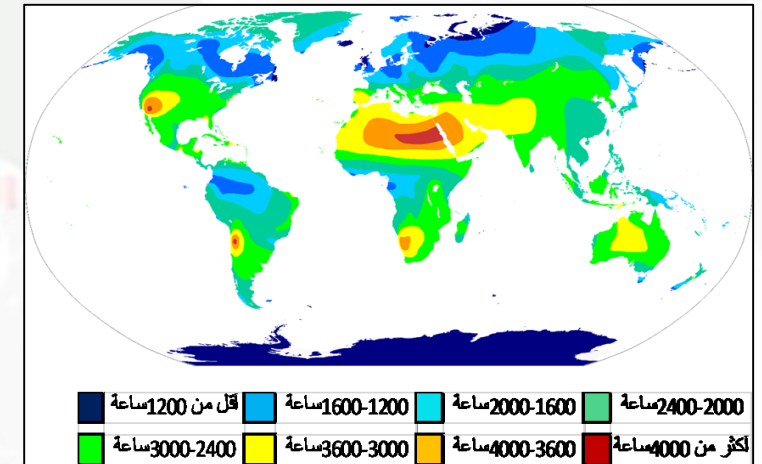
2014



WIND RESOURCES: HIGH WIND POWER POTENTIAL IN ARAB REGION

7.7%
RE

2020



THE ARAB REGION HAS THE HIGHEST SUNSHINE HOURS IN THE WORLD ~ 3900 h

≥ 12.8%
RE

2030



1. Switching energy supplies to renewable energy sources – 2/3

Installed
Capacity

2018



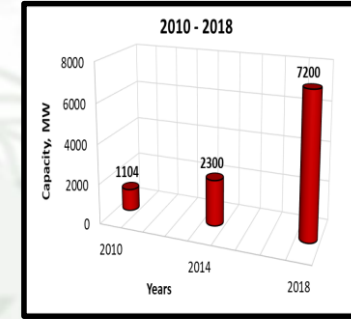
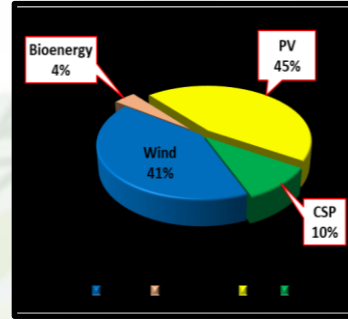
720 MW

3240 MW

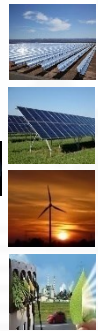
2952 MW

288 MW

6%



2014



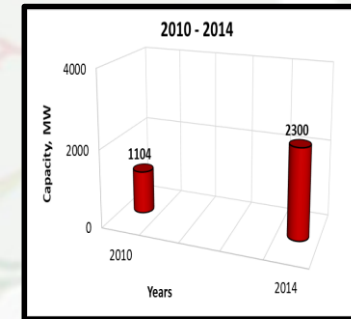
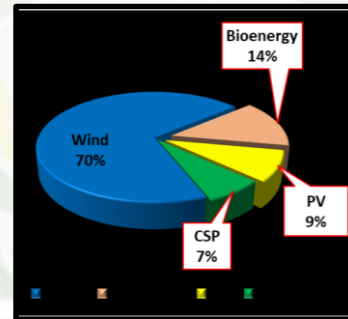
161 MW

207 MW

1610 MW

322 MW

0.4%



2010



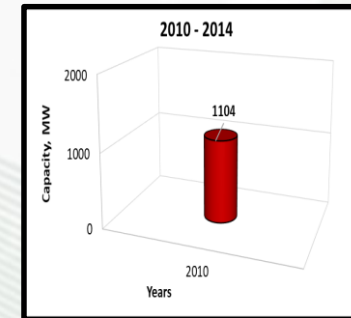
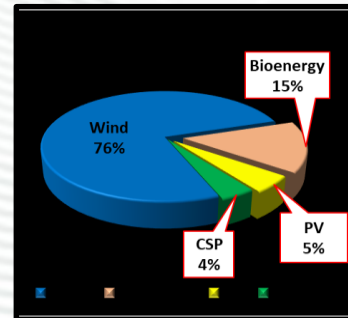
44 MW

55 MW

840 MW

165 MW

< 0.15%



Penetration Rate

Market transformation from wind to PV technologies



1. Switching energy supplies to renewable energy sources & EE- 3/3

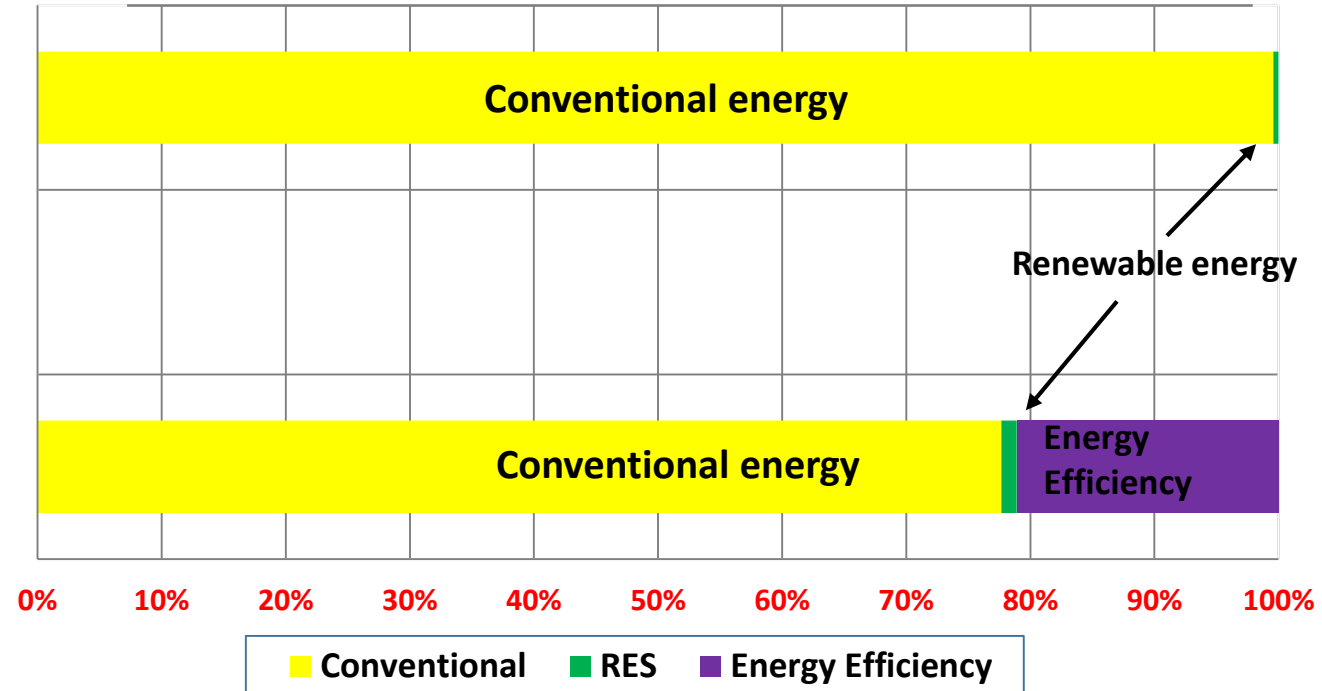
2014

سيناريو الحالة الاعتيادية
Baseline scenario-BAU

2030

سيناريو التطور المستدام للطاقة
Sustainable Energy
Development Scenario (SED)

The Arab Strategy for Sustainable Energy



Stabilized energy demand through increased energy efficiency and circular economy measures while maintaining economic growth



2. Energy consumption revolves around electricity

- ☐ By 2050, electricity would be the main energy carrier with over 50% (direct) share of total final energy use – up from 21% today.
- ☐ By 2050, 90% of total electricity needs would be supplied by renewables followed by 6% from natural gas and the remaining from nuclear.
- ☐ By 2050, 30% of electricity use will be dedicated to green hydrogen production and hydrogen and its derivatives such as e-ammonia and e-methanol.
- ☐ Hydrogen and its derivatives together will account for around 12% of total final energy use. To produce this, almost 5 000 GW of hydrogen electrolyser capacity will be needed by 2050, up from just 0.3 GW today.
- ☐ Electrification of end-use sectors, with the increased use of electricity in buildings, industry and transport

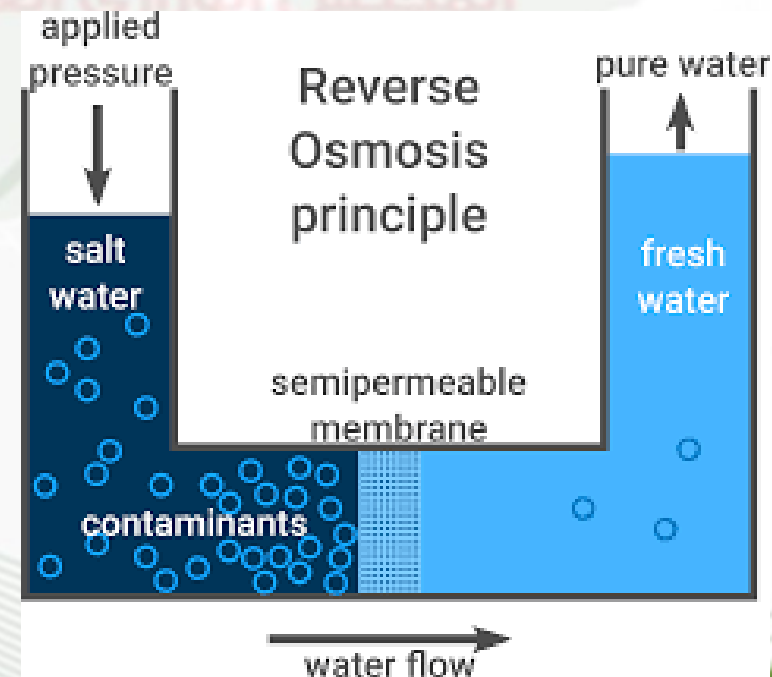


2. Energy consumption revolves around electricity

❑ A promising field of electricity use in Arab region is water desalination:

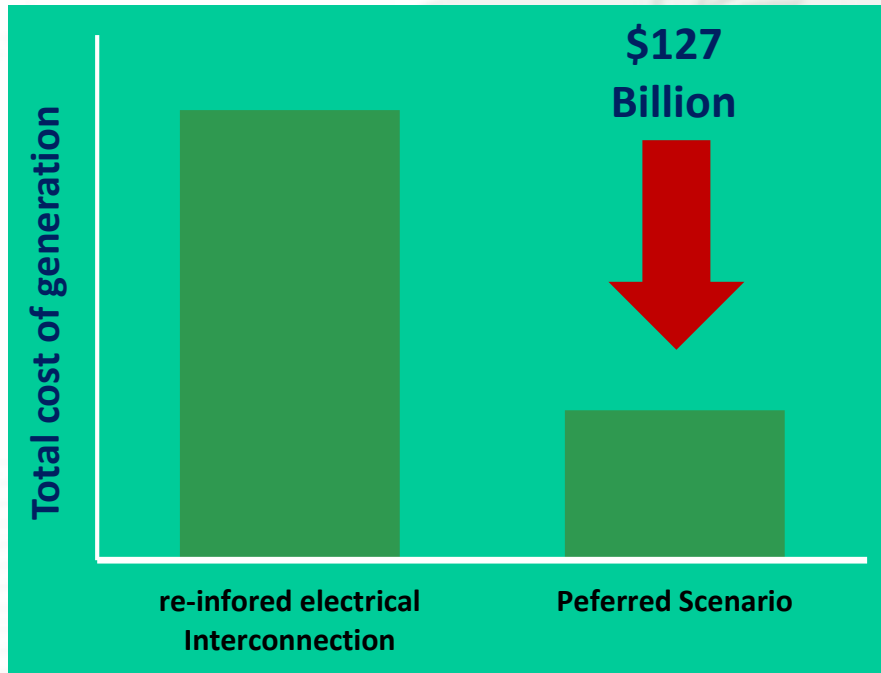
A combination of clean power generation and water desalination is being developed to meet freshwater needs. The expansion of solar power generation and its combination with desalination technology can effectively reduce energy consumption and investment costs

- Reverse osmosis water desalination technology can significantly reduce energy consumption.
- The large-scale development and application of reverse osmosis equipment will be completed in the entire region



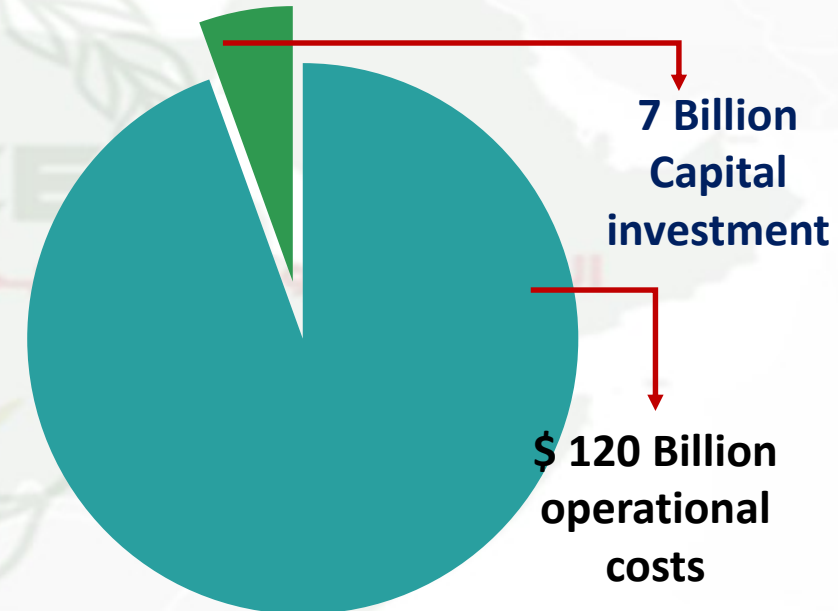


Generation cost expected savings 2012-2030



Present value (PV) of
saving is \$ 35 Billion

Disbudded
as follows



Plus an additional \$ 11 Billion in Reduction
of emissions of harmful gases



3. Focus on electrical interconnection between the Arab countries

Requirements for Establishing the PAEM Market

Legal and Legislative Frameworks

- ☐ Memorandum of Understanding ✓
- ☐ General Agreement ✓
- ☐ Market Agreement ✓
- ☐ Arab Grid Code (in progress) ✓

Institutions

- ☐ Market Committees (Regulatory and Advisory, Market Systems Operators)
- ☐ Market Secretariat
- ☐ Market Facilitator

Infrastructure

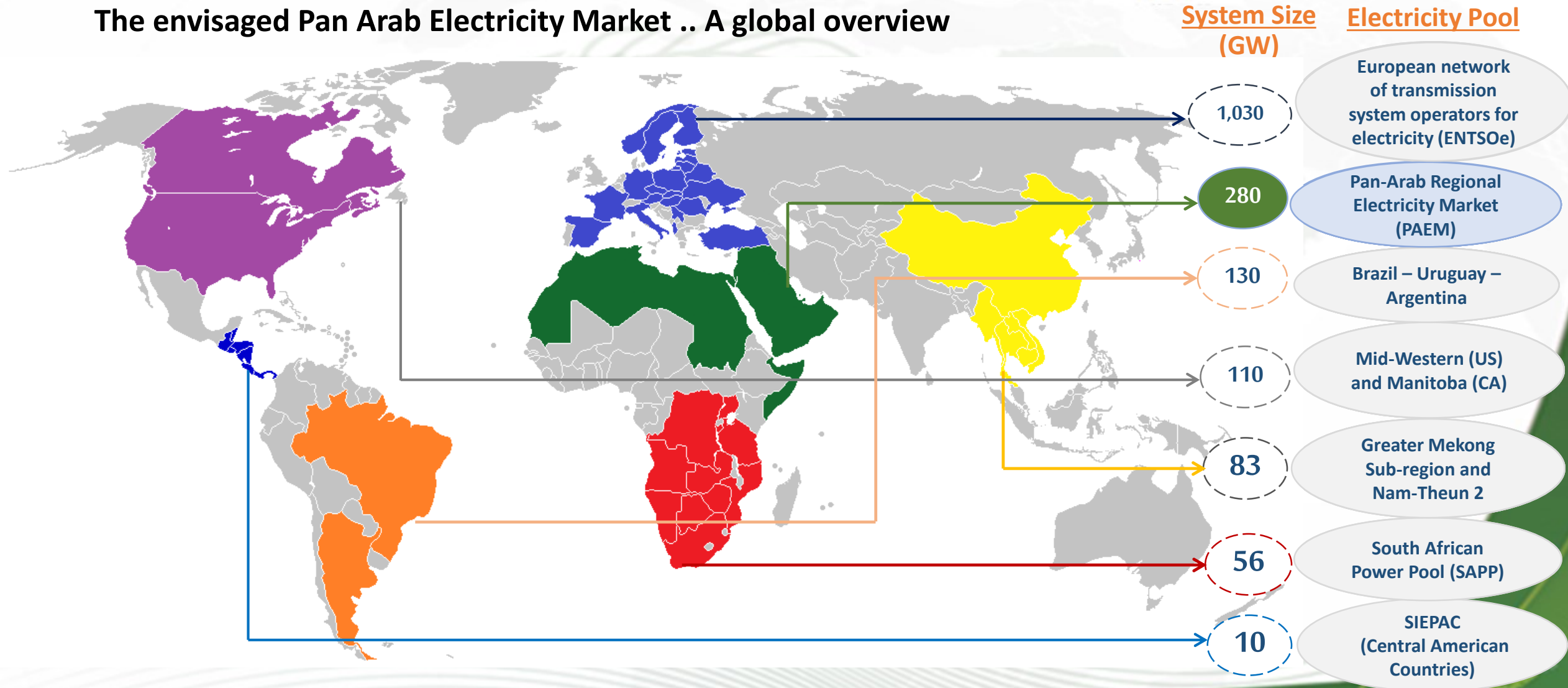
- ☐ Existing on Ground Projects

3. Focus on electrical interconnection between the Arab countries



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The envisaged Pan Arab Electricity Market .. A global overview





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Hydrogen Development



4. Hydrogen Development



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The main types of hydrogen



- ☐ Depends on fossil fuels
- ☐ It contradicts the goals of environmental protection
- ☐ Carbon dioxide is produced as a by-product



- ☐ Depends on fossil fuels
- ☐ An advanced version of the gray type
- ☐ Carbon capture and storage for other uses



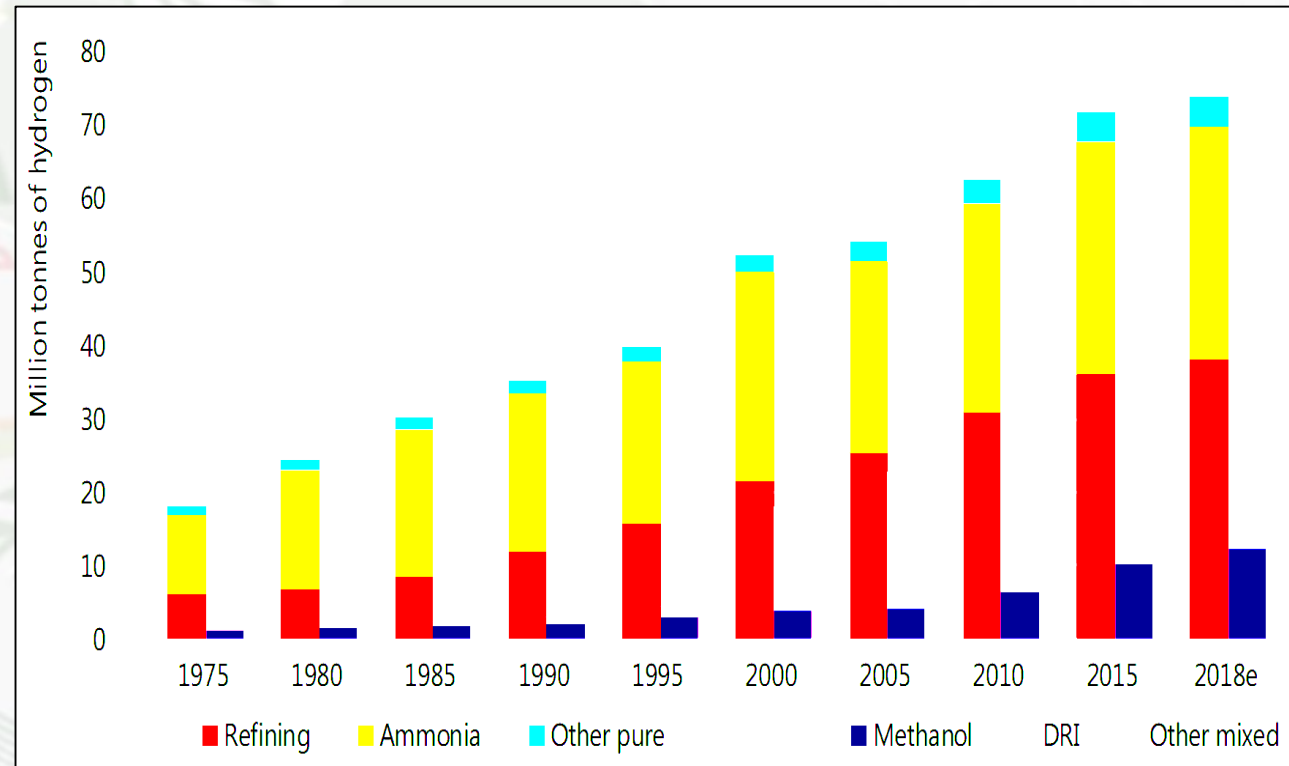
- ☐ It is extracted by separating the components of water
- ☐ Produces oxygen as a byproduct
- ☐ It is based on electrolysis in an environmentally friendly manner



Hydrogen Production

Hydrogen market is big today but not in the energy sector

- ❑ The world annually produces 70 million tons of pure hydrogen, the largest part of which is used in oil refining and ammonia processing for fertilizers
- ❑ An additional 45 million metric tons is used in impure form in the industry without pre-separation from other gases.
- ❑ 100% of current hydrogen needs are covered with fossil fuels, emitting 830 Mtons CO₂/yr

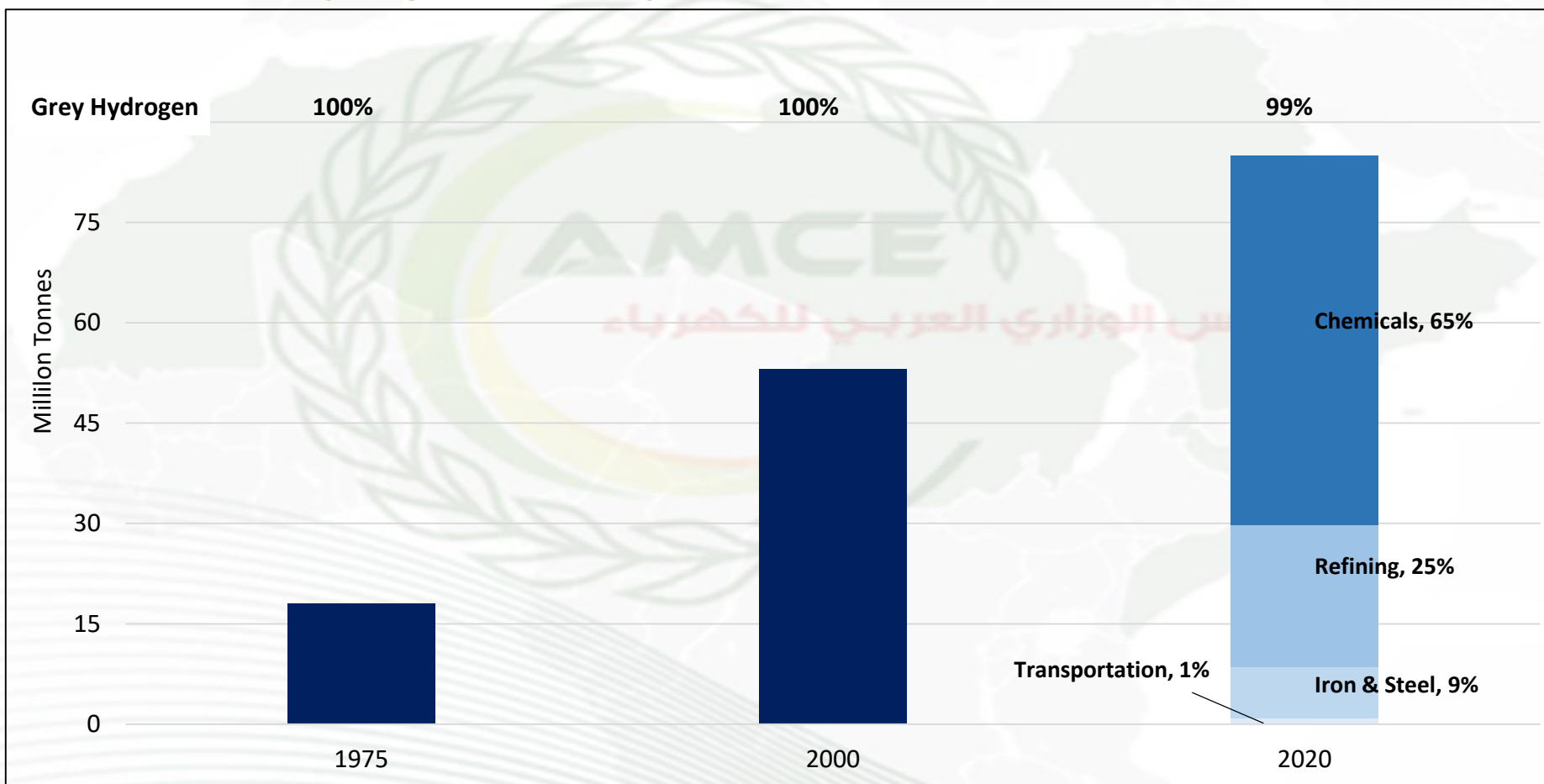


Hydrogen Production



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Historical hydrogen demand by application [m MT, 1975 – 2020]

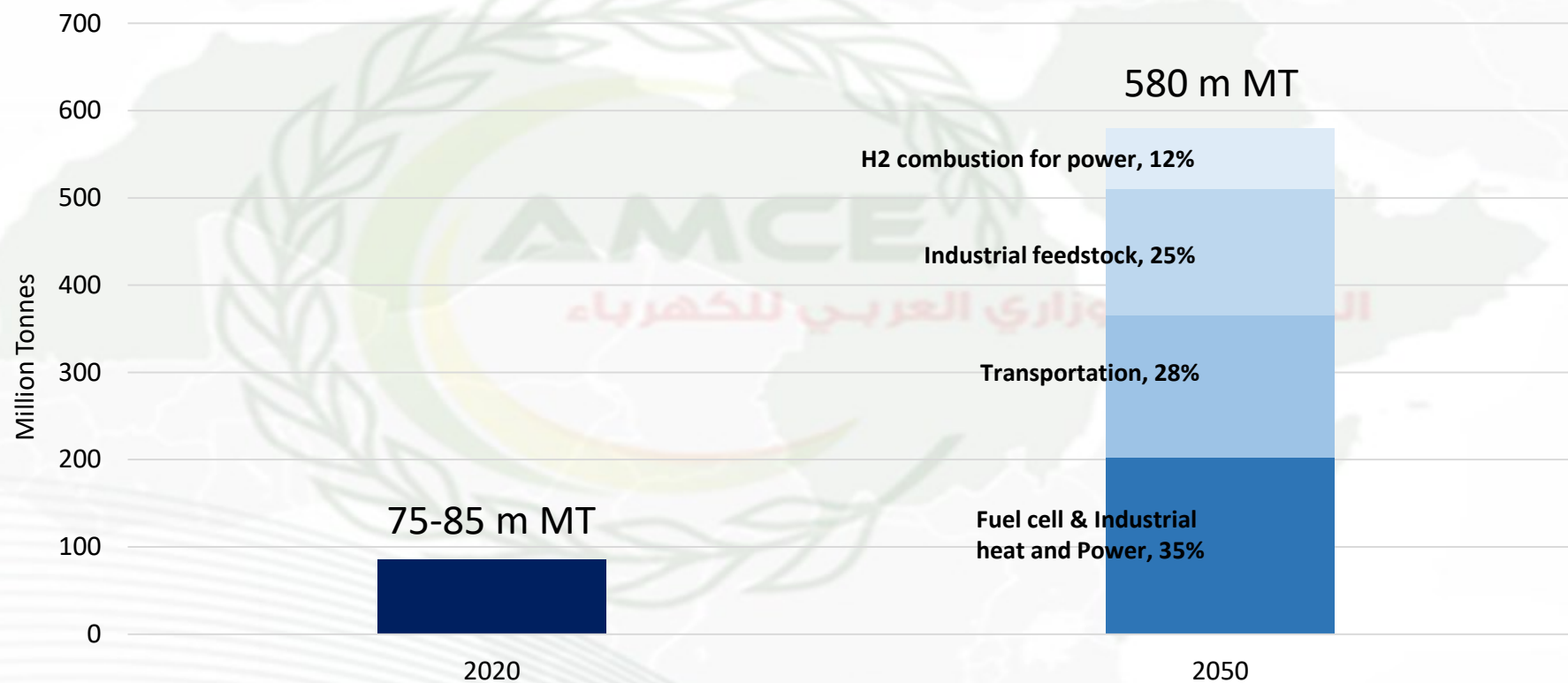


Hydrogen Production



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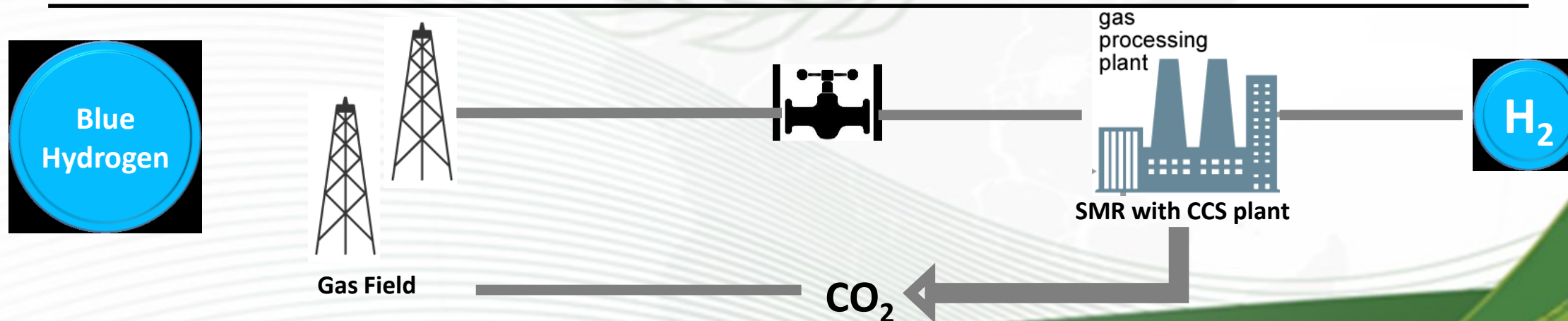
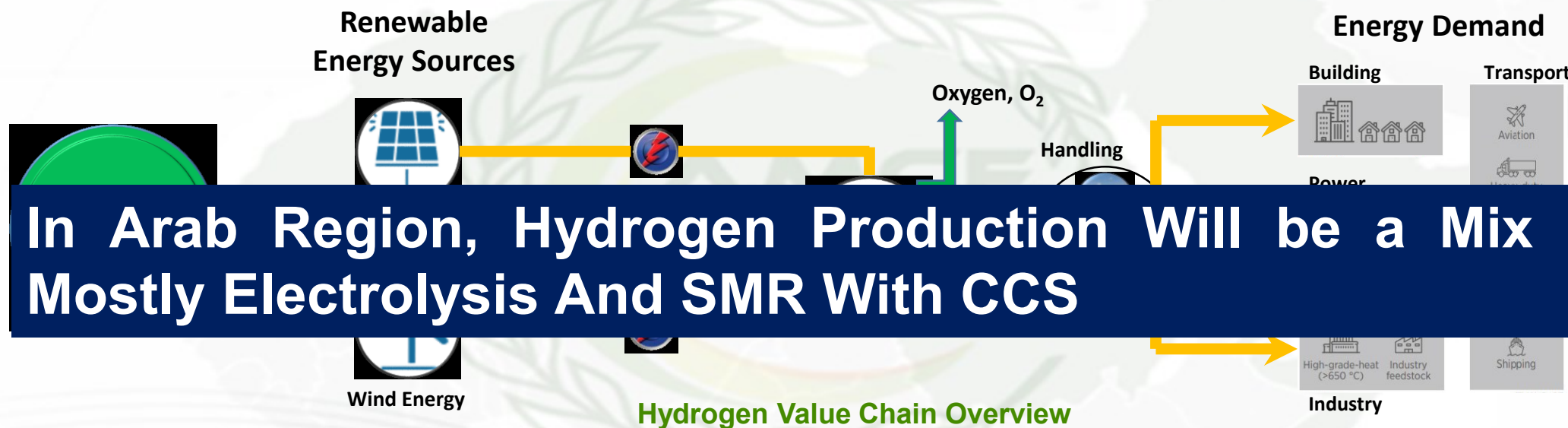
Global hydrogen demand forecast [m MT, 2019-2050]



4. Hydrogen Development



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4. Hydrogen Development

Green Hydrogen: Stabilizing the Power Market

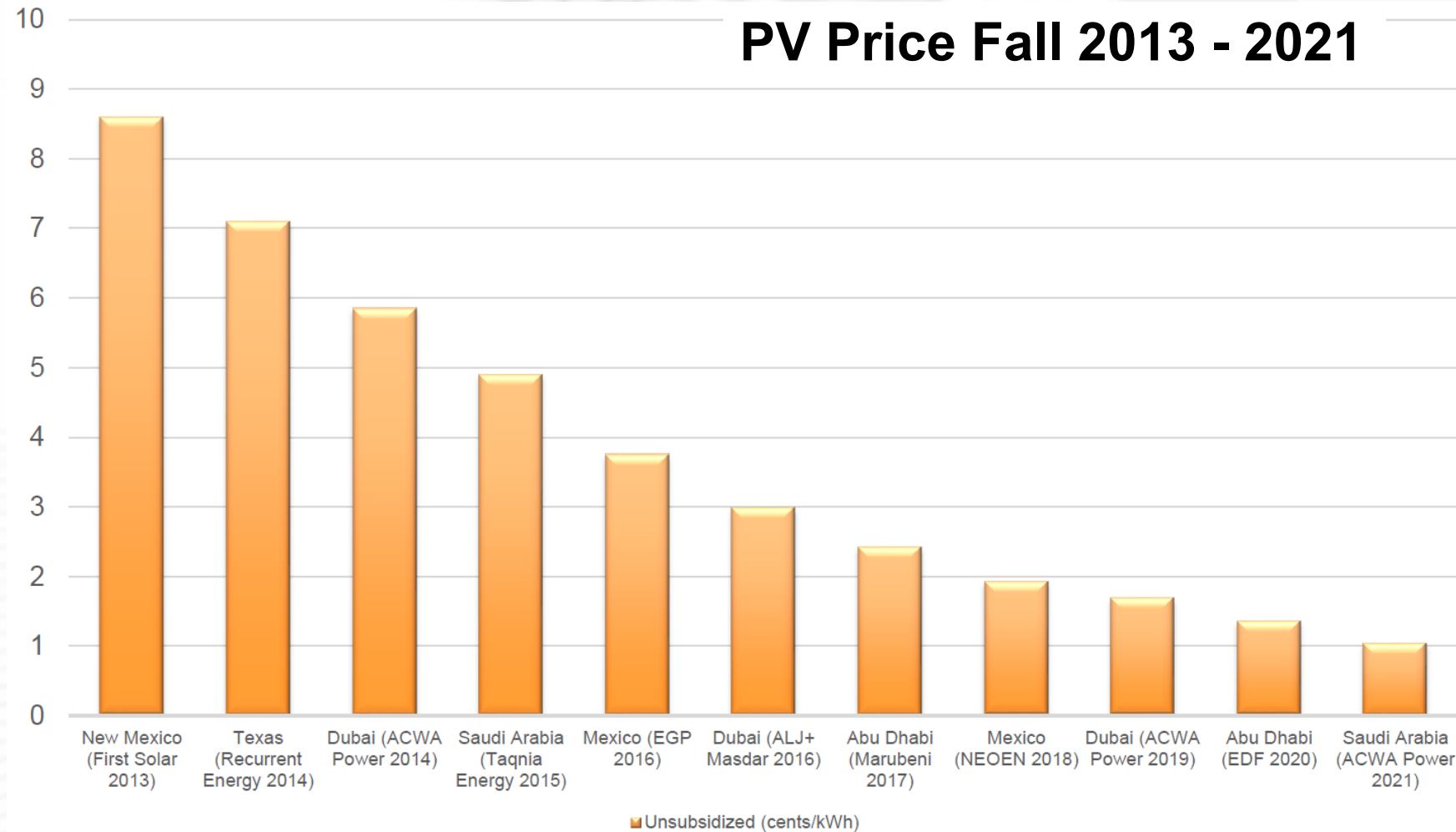


- ❑ Hydrogen produced with excess solar PV and wind power can be stored for later use – as a fuel for transport, industry and other sectors.
- ❑ Hydrogen production can be used as a ‘smart’ load to increase power system flexibility and help to decarbonize the overall economy.
- ❑ **Hydrogen from renewable electricity has great potential.** The cost of generating renewable energy in Arab Region is low. The use of excess electricity from large power grids in combination with a large amount of renewable energy to generate hydrogen in times of low network load, further improving plant utilization and reducing costs Green hydrogen is enormous



4. Hydrogen Development

Massive drop in prices for unsubsidized PV systems, led by the Middle East





4. Hydrogen Development

Local (on-site) use of RE energy provides a solution to increasingly loaded electricity grids

With the increase in installed capacities of renewable energy ...



It makes electricity grids increasingly under pressure



The solution: local use of green electricity to generate hydrogen

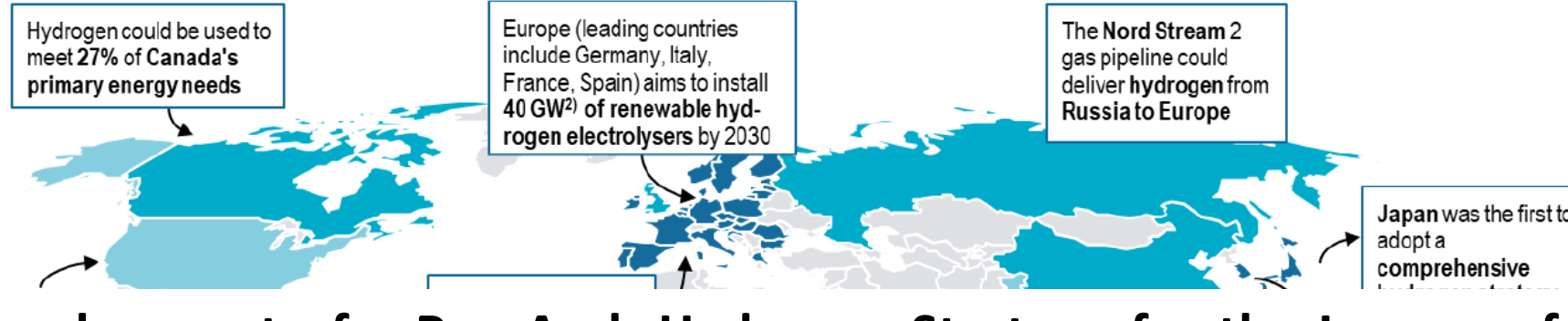




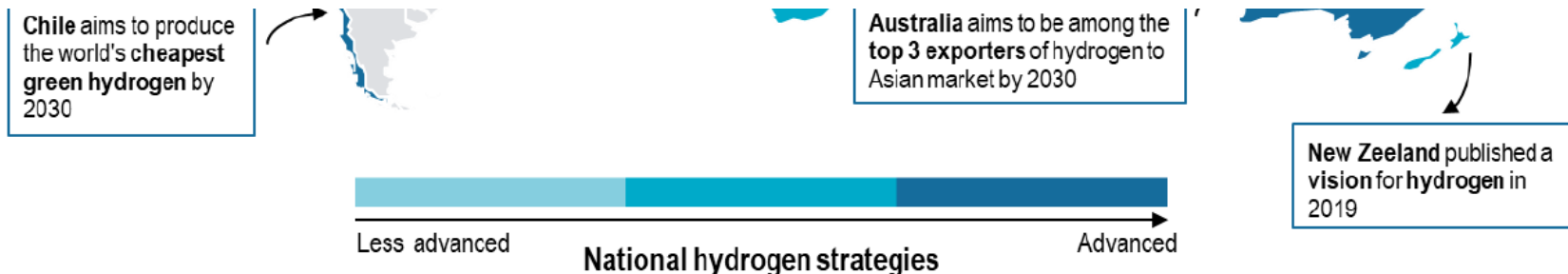
4 Hydrogen initiatives in the Arab Region



Hydrogen potential development around the world [2020]



- Development of a Pan Arab Hydrogen Strategy for the League of Arab States.
- The Strategy and the Roadmap will be ready by the end of 2021.



1) Eurasia Group, International Energy Agency; Bloomberg

2) The 2x40 GW initiative of the European industry association Hydrogen Europe aiming to invest in 2x40 GW hydrogen infrastructure, half of which should be deployed inside the EU and half in the Ukraine and Northern Africa

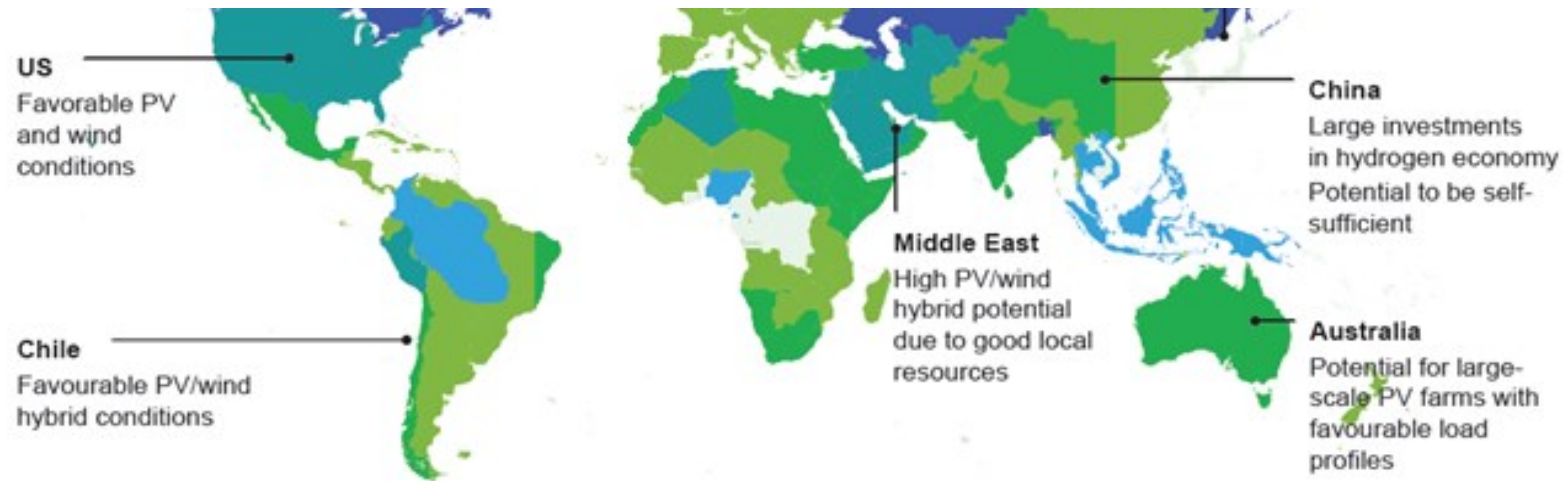
Best source of low-carbon hydrogen in different regions



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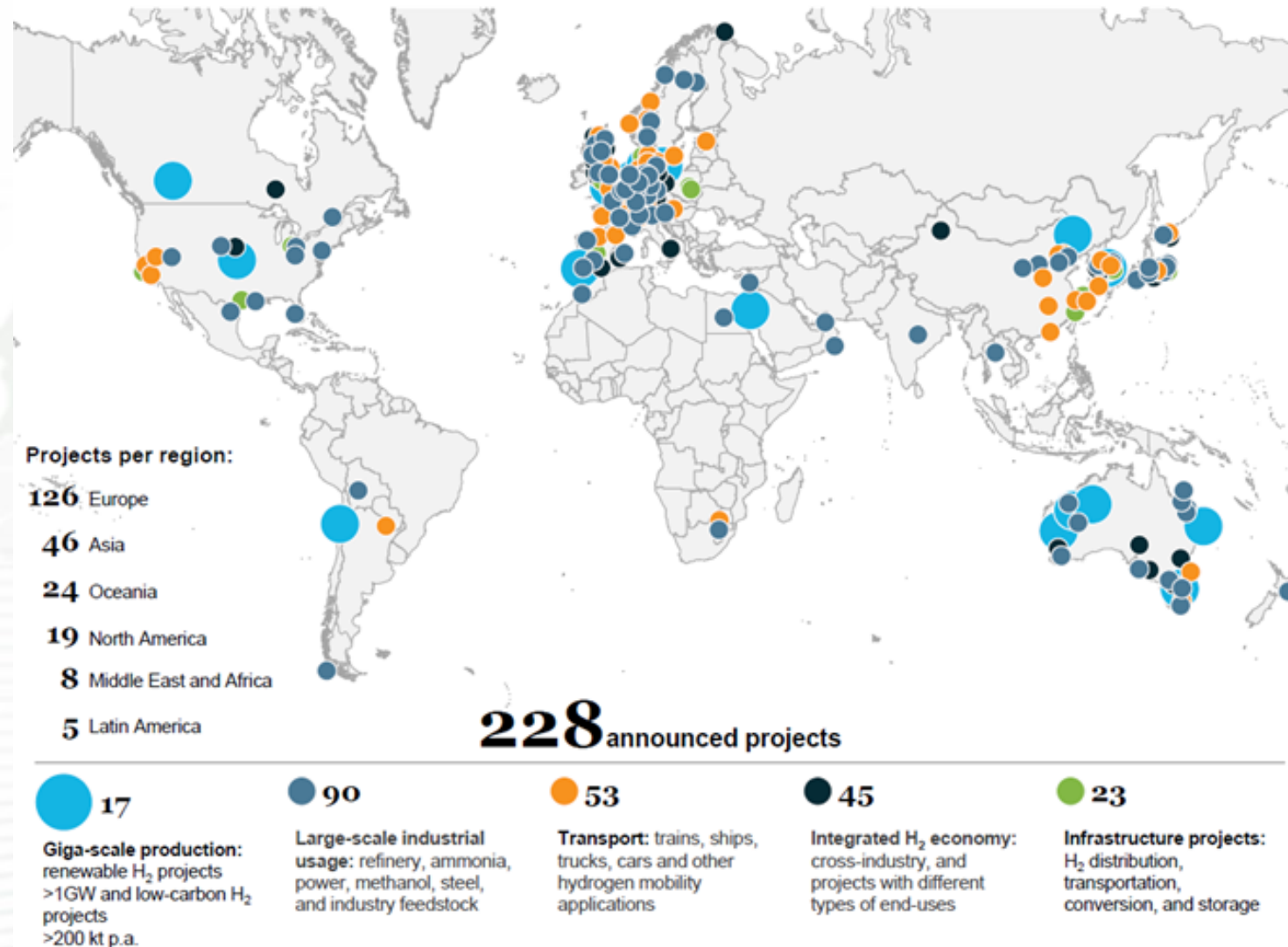
The Arab region is at the top of the list of the best regions for the production of green hydrogen and blue hydrogen



SOURCE: IEA; McKinsey



Global hydrogen projects



LNG / Hydrogen Synergies



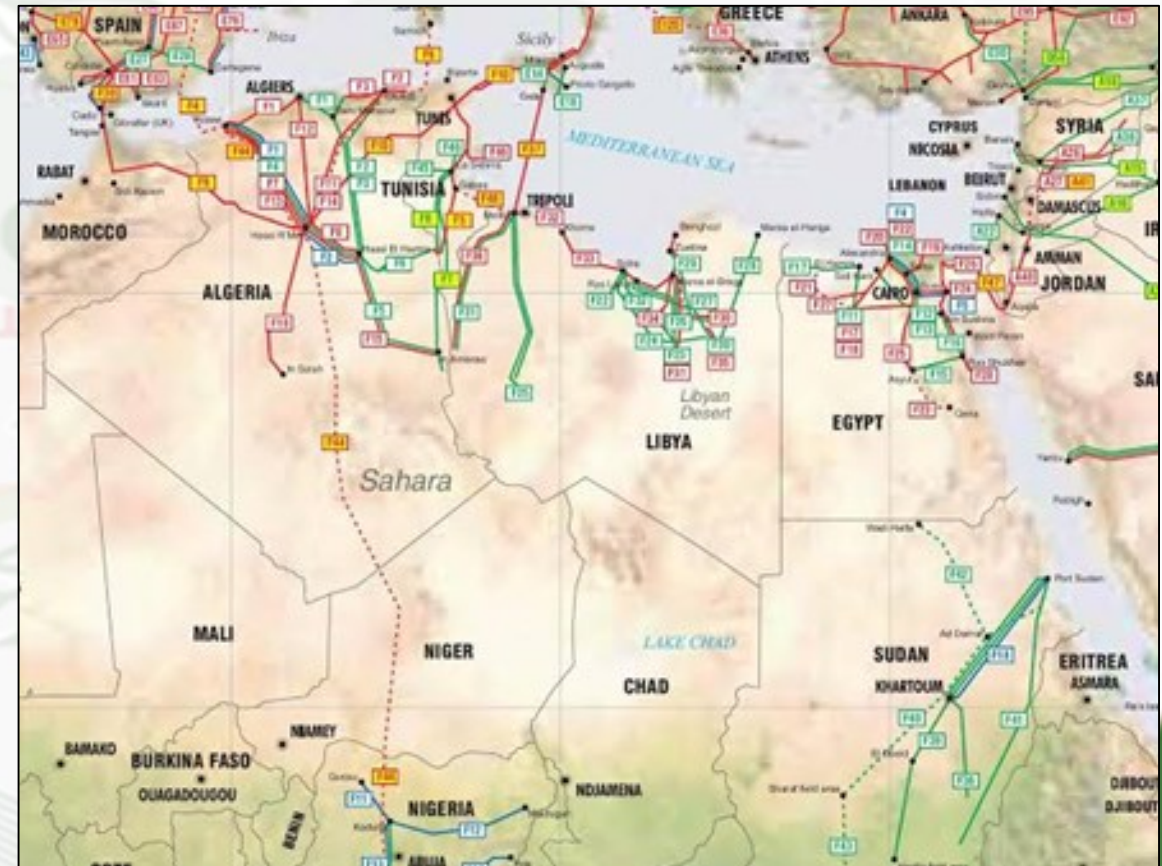
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□ A great opportunity in the Arab region to export hydrogen on a large scale

□ Green hydrogen can be transported using the existing natural gas grid.

□ Italy could become vital hydrogen hub between North Africa and Europe:

- The Italian government aims to install 5 GW of electrolyzers by 2030. The EU strategy foresees 46 GW by 2030.



North Africa Pipelines Map



LNG / Hydrogen Synergies

Potential hydrogen imports for selected region:



Europe: Potential hydrogen imports of **100+ m MT** due to the lack of renewables



Belgium: Potential import of **~25 m MT**



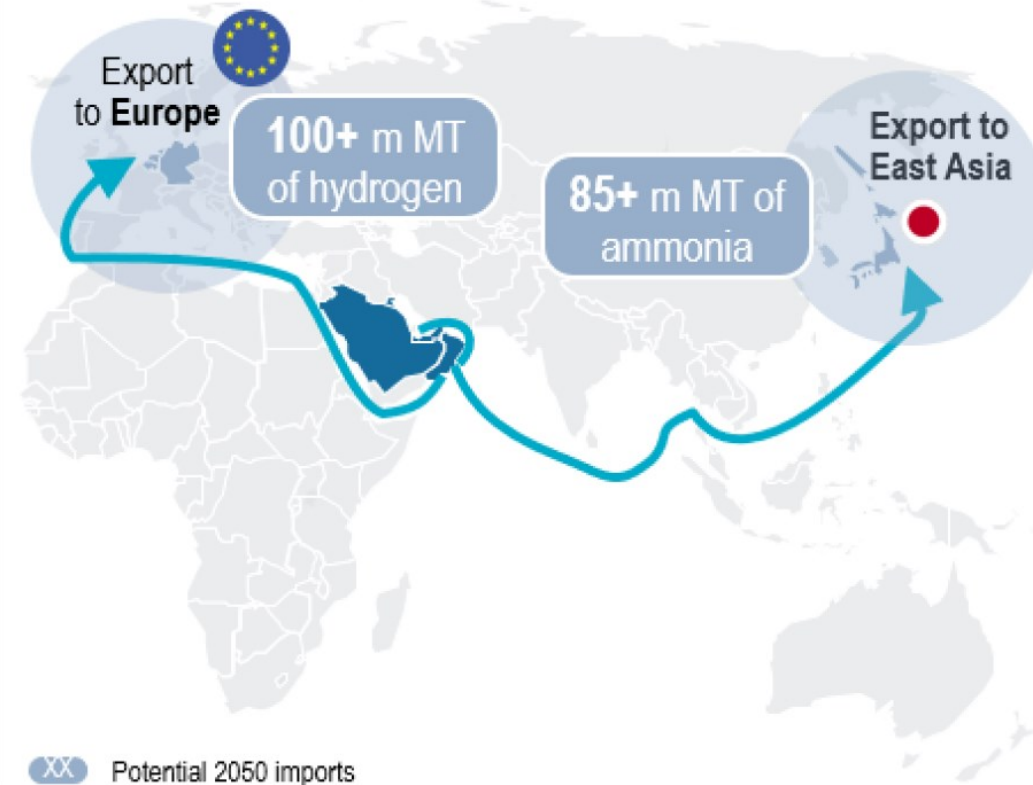
Port of Rotterdam: Target imports of **20 m MT**



Germany: Estimated imports of **~25 m MT** – **EUR 2 bn** to build **international partnerships** for H₂ imports



Japan: Potential ammonia imports of **85 m MT**



Potential 2050 hydrogen imports of selected regions and countries [2050]



Renewable Hydrogen Plans and Projects in Arab Region

Green Hydrogen Initiative 2 x 40 GW- Road map for green hydrogen production in the European Union with a capacity of 40 gigawatts until 2030
[17] Initiative by Hydrogen Europe and several other organizations to have 2 x 40 GW electrolyser installed by 2030, 40 GW in Europe and 40 GW in Ukraine and North Africa

Electrolyser Capacity	2023	2024	2025	2026	2027	2028	2029	2030	Total 2030
Domestic Market MW									7500
Ammonia for North Africa	75	125	250	500	750	1000	1250	1500	5450
Ammonia for Ukraine		50	100	200	250	300	400	500	1800
For Steel and Glass Industry				10	20	30	40	50	150
Hydrogen refueling stations					10	20	30	40	100
Export Market									32500
Hydrogen plants in North Africa		500	1000	2000	3000	4000	6000	8000	24500
Hydrogen Plants in Ukraine			500	700	1000	1400	1900	2500	8000
Total in MW	75	675	1850	3410	5030	6750	9620	12590	40000



Renewable Hydrogen Plans and Projects in Arab Region

Country	Location	Company Name	Installed Electrolyzer Capacity	Hydrogen Production Capacity	Targeted Year	Products
Morocco	N/A	MASEN	100 MW	-	2024	Green hydrogen
	N/A	Saipem / Alboran Hydrogen / xlinks / IRESEN / ONEE	Between 300 and 500 MW	-	2025	Green hydrogen and green ammonia
Saudi Arabia	Tabuk	ARAMCO	4,000 MW	650 tons per day	2025	Green hydrogen shipped as green ammonia
Oman	Duqm	Belgian firm DEME	500 MW			green hydrogen
Algeria						

Egypt hydrogen potential

In January, the Egyptian government and Siemens announced a plan to develop a pilot project for the production of green hydrogen in Egypt.