



Low Carbon Hydrogen Economy in Tunisia



*This project
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THE COLOURS OF HYDROGEN

Grey Hydrogen

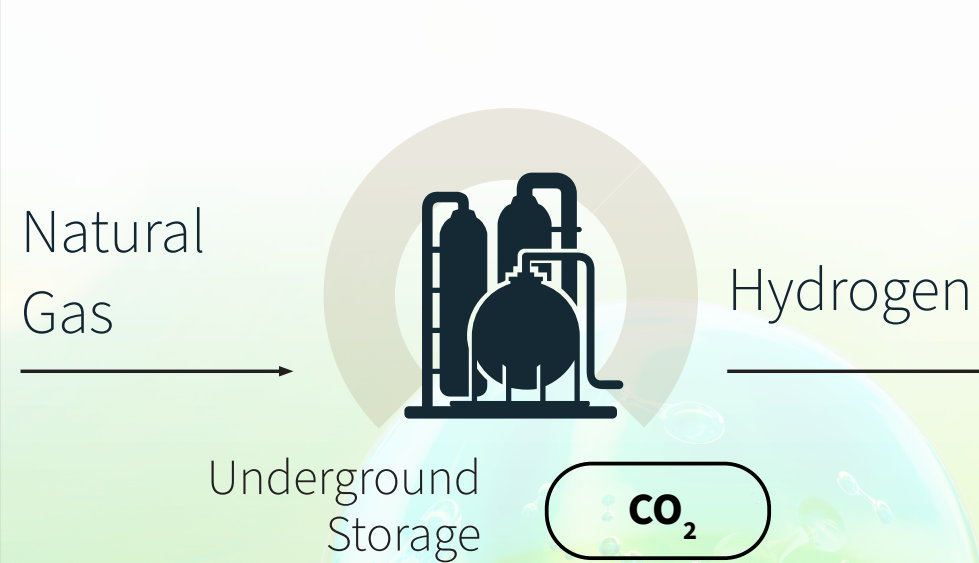
Steam methane reforming (SMR) of natural gas



- Fossil fuels are used as a feedstock and chemically converted to yield hydrogen
- High emissions and uses non-renewable resource

Blue Hydrogen

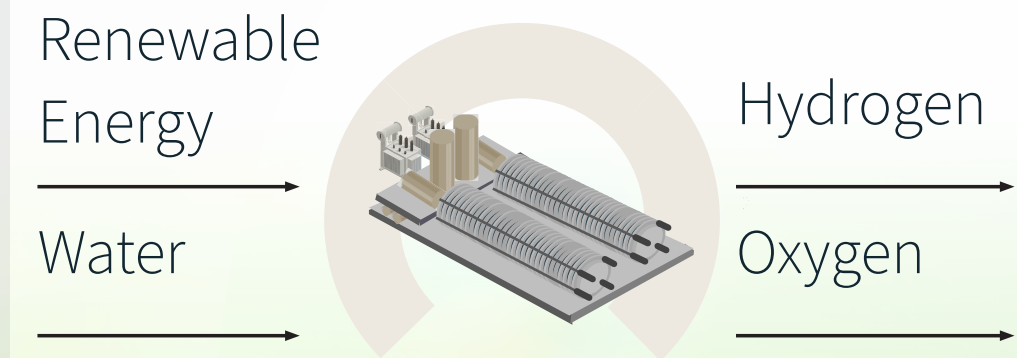
SMR with carbon capture and storage (CCS)



- Similar to grey hydrogen but with capture and storage of CO₂ emissions
- Low Scope 1 and 2 emissions but still uses non-renewable resource

Green Hydrogen

Water Electrolysis



- Uses electrolysis (separation of water into H₂ and O₂) to form hydrogen
- Minimal Scope 1 and 2 emissions

Tunisia's strengths in developing a low carbon hydrogen economy

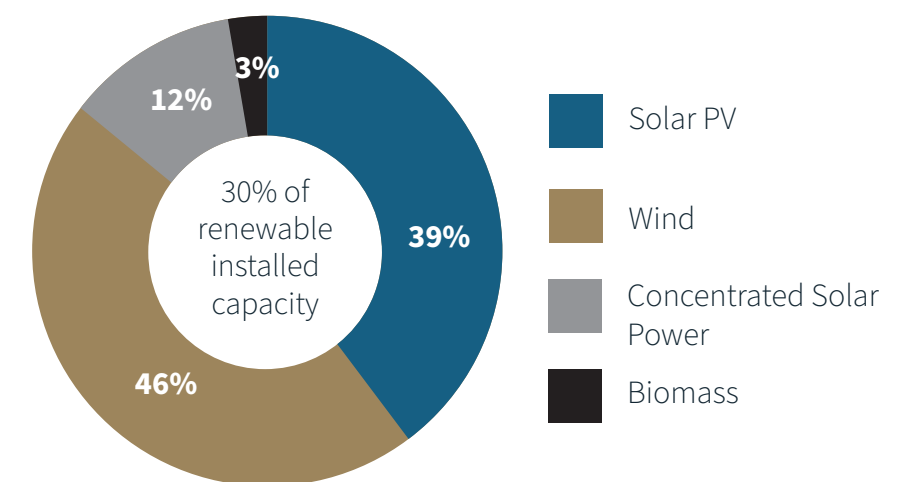
Tunisia's excellent geographical location meets demands of low-carbon hydrogen economy

Tunisia has a long coastline, providing necessary area for desalination to meet water demand for low carbon hydrogen production. Tunisia is situated on the Mediterranean Sea, a prominent shipping route to Europe, making Tunisia a potential hub for shipping and bunkering of ammonia and e-fuels. Tunisia's proximity to the TransMed Pipeline, also shows potential for hydrogen export to Europe through Italy after any domestic demand for hydrogen derivatives is met.

Ammonia handling experience through fertiliser industry

Tunisia's fertiliser industry, based on its extensive phosphate resources, provides a likely focal point for domestic production of green ammonia as feedstock. With experience in importing ammonia through Gabes port, Tunisia has appropriate work force and knowledge for future potential green ammonia plants, bringing security of supply to the fertiliser industry in Tunisia. Ambition to slash energy and ammonia imports will also foster domestic production of green ammonia in Tunisia.

Great quality renewable resources and high expansion and development potential



Tunisia's renewable energy target 2030

Tunisia has high quality wind and solar resources, especially in the southern region, with 401 MW of renewable capacity installed as of 2020. Growth targets include 12% renewables capacity by 2022 and 30% by 2030 with a mix of renewable energy employed.

The low cost and high potential availability of renewable electricity will boost the establishment of a low carbon hydrogen economy in Tunisia.

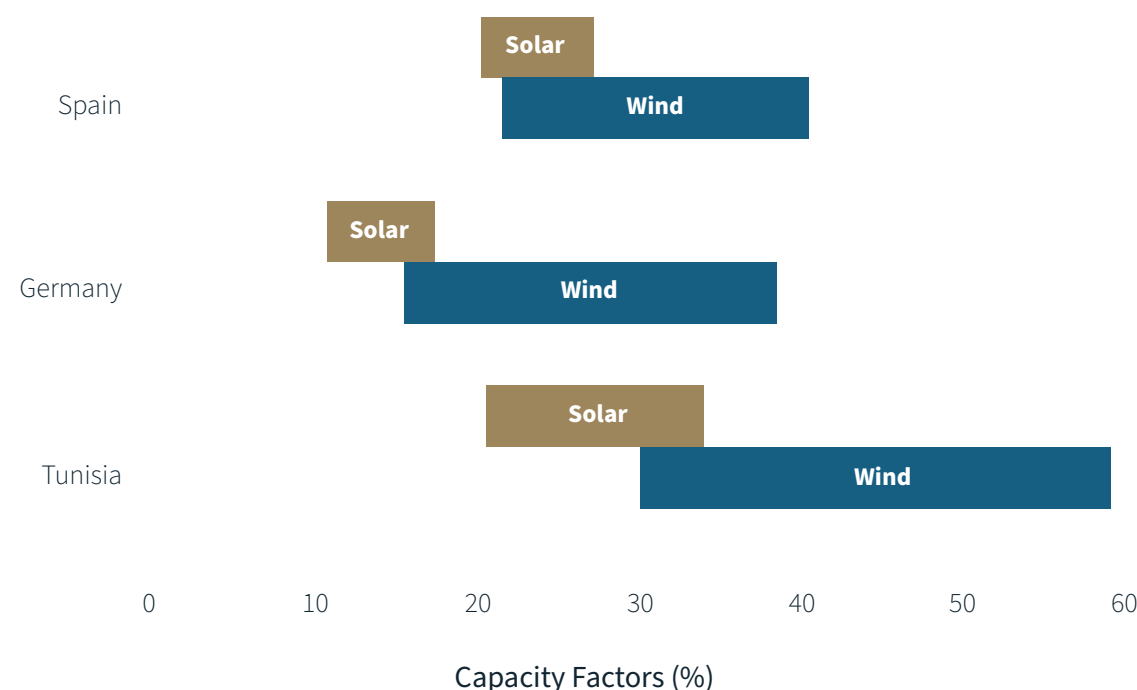
Port La Goulette, Tunisia



TUNISIA'S LOW CARBON HYDROGEN PRODUCTION COMPETITIVENESS

Green hydrogen production costs

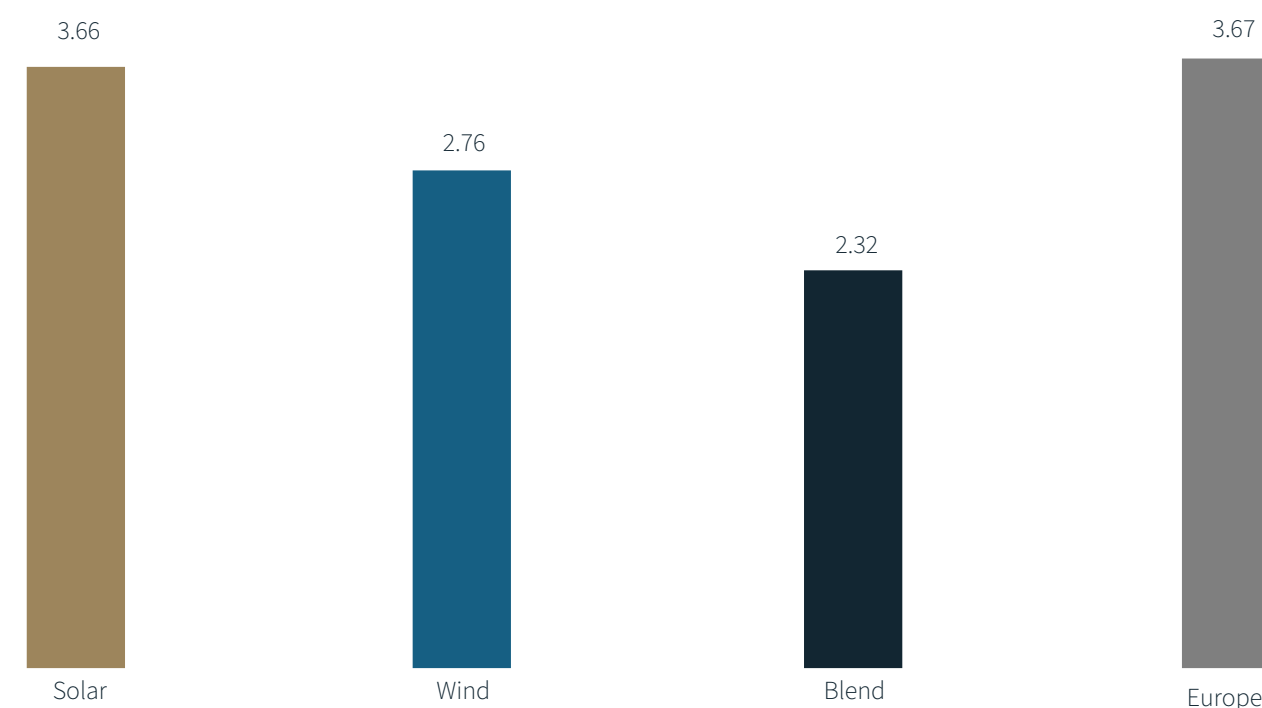
The levelised cost of hydrogen (LCOH) is highly sensitive to capacity factor. When the capacity factor decreases the LCOH increases, especially apparent with solar where the low capacity factors lead to low utilisation of high capital electrolyser modules and thus higher LCOH. Still, green hydrogen in Tunisia is likely to be cheaper than green hydrogen produced elsewhere in Europe if cost efficient transportation measures are employed such as the TransMed Pipeline. Due to intermittency of renewables, the lowest cost green hydrogen option for Tunisia would consist of a blend of wind and solar resources, maximising the electrolyser utilisation load factor and achieving a LCOH of around 2.32 €/kg.



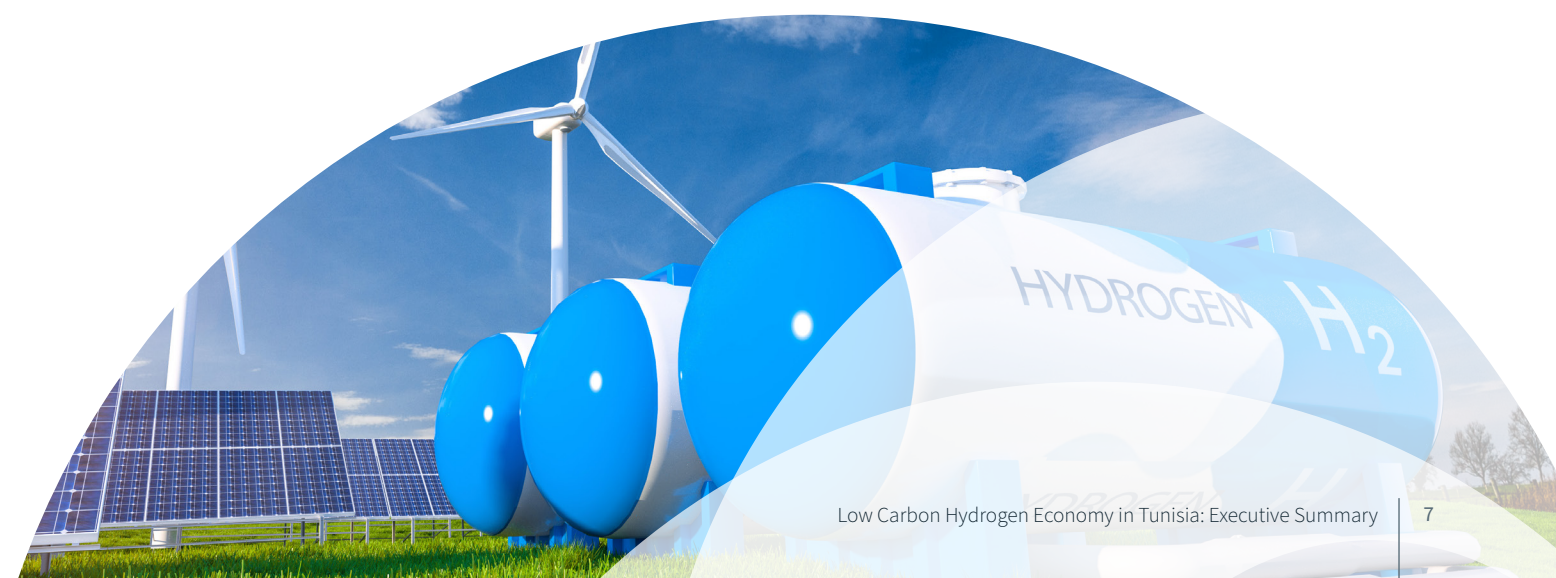
Renewable resource capacity factors compared

Regional analysis and considerations

Tunisia is well-positioned for development of the low carbon hydrogen economy as suitable renewable resources and existing demand in the southern region near port of Gabes indicate that hydrogen could be produced and used locally, negating significant infrastructure for hydrogen transport. This is a huge advantage which allows Tunisia to achieve a LCOH of 2.32 €/kg and be competitive with other players in the region. Demand for hydrogen derivatives will be highest in Gabes region due to fertiliser industries while Northern regions will be suitable for hydrogen export due to proximity to the TransMed pipeline.



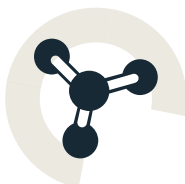
Green Hydrogen LCOH in EUR/kg (2030)



How low carbon hydrogen can be used in Tunisia and potential for exporting

Tunisia has an established phosphate fertiliser market, facilitated by imported ammonia

Enabling security of supply of ammonia in Tunisia



Tunisia import all their ammonia, equivalent to a green hydrogen demand of 62 thousand tonnes per annum, for use in the phosphate fertiliser industry. Thus there is a high potential for switching to domestic green ammonia production to meet demand. An initial focus on green ammonia production would bring security of supply to Tunisian markets. Its existing ammonia demand and handling experience are key elements to supporting the H₂ economy in Tunisia.

Low carbon fuels

Transport, shipping, and industry decarbonisation



In the medium and long-term, low carbon hydrogen can be used in the domestic market for fuel in marine transport and other mobility applications. Energy intensive industries could also utilise hydrogen as an industrial fuel. Finally, the use of green hydrogen in the power sector as carrier for energy storage would aid grid balancing and reduce or replace natural gas consumption, providing green energy to industry and other end-users.

Export of green energy and synthetic liquid fuels

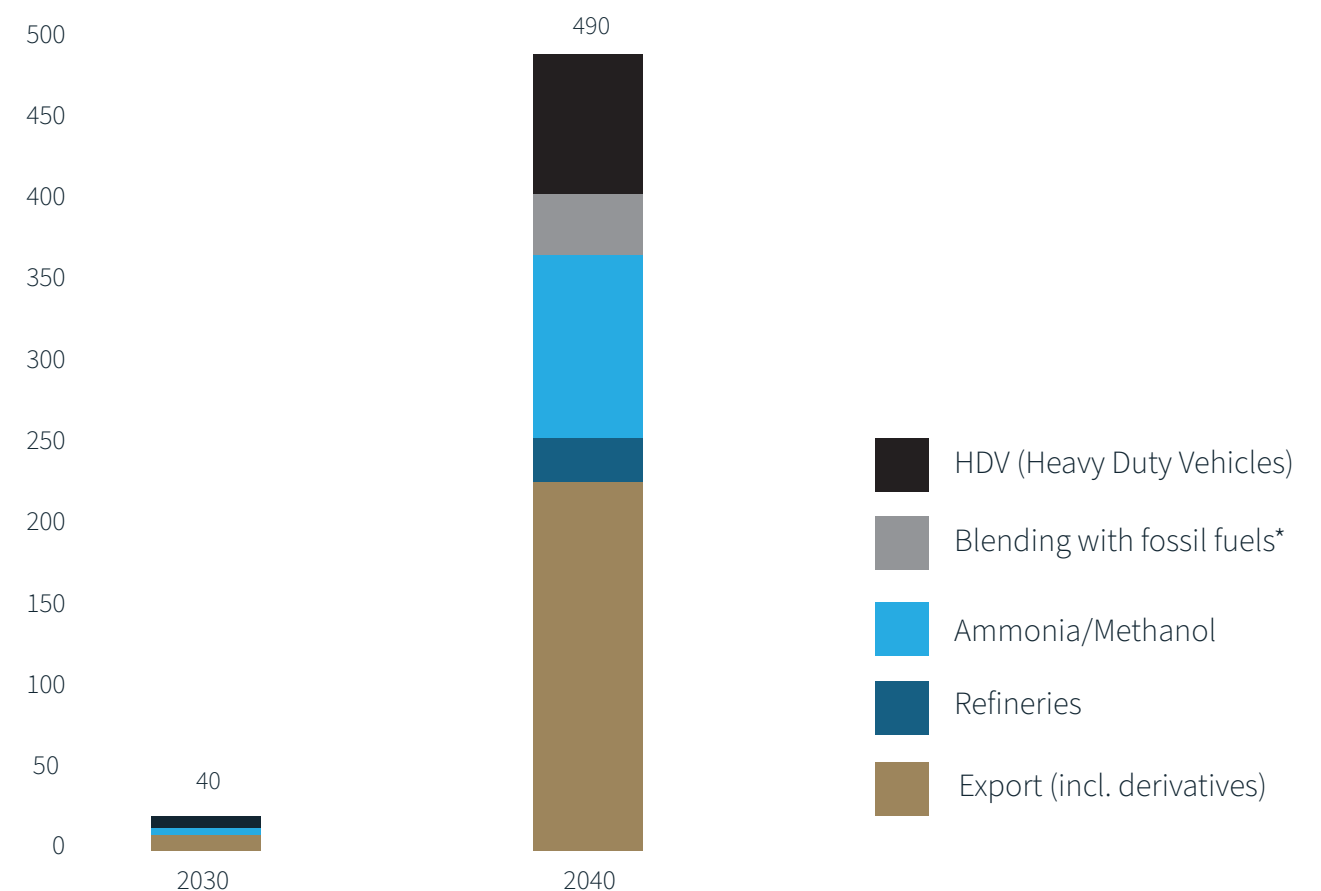
Due to the proximity of Tunisia to the TransMed pipeline, another use for hydrogen includes satisfying demand of hydrogen in Italy and the rest of Europe through transport in re-purposed natural gas pipelines. Targets have been set in 2021 to enable the export of hydrogen from North Africa to Europe through the TransMed pipeline by 2030 with one pipeline out of the 5 converted to 100% hydrogen.

Tunisia's shipping industry, though concentrated around mostly imports, shows potential to export hydrogen via ammonia to Europe, after domestic demand for green ammonia in fertiliser industry has been met, especially as Gabes port currently has ammonia handling facilities. Exports and domestic demand could increase similarly to those in the neighbouring countries in the SEMED region, initially this would require the Tunisian Government to send the right market signals to support the development of a hydrogen economy.

TransMed Pipeline conversion to hydrogen



Ammonia exports to Europe via Gabes



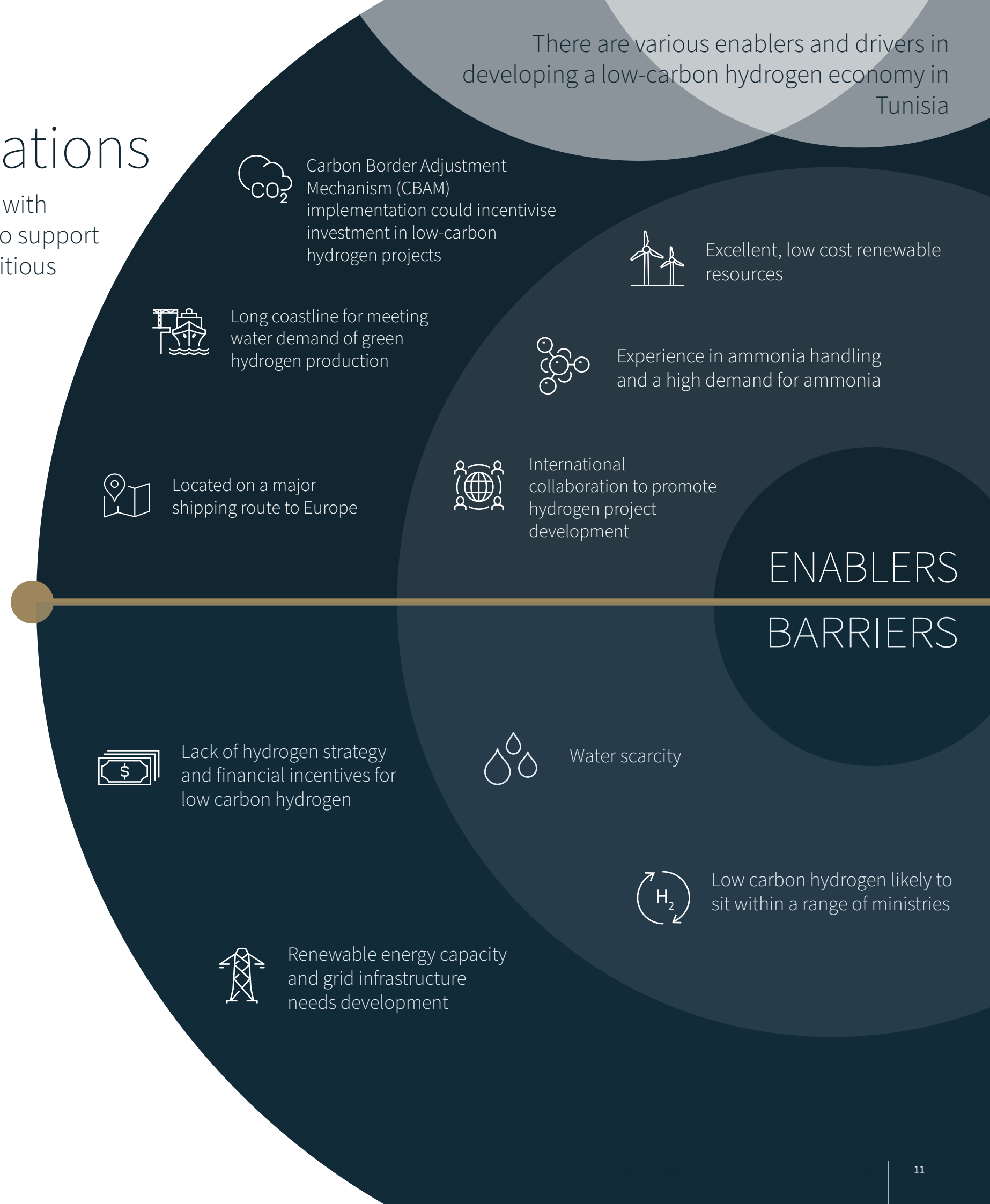
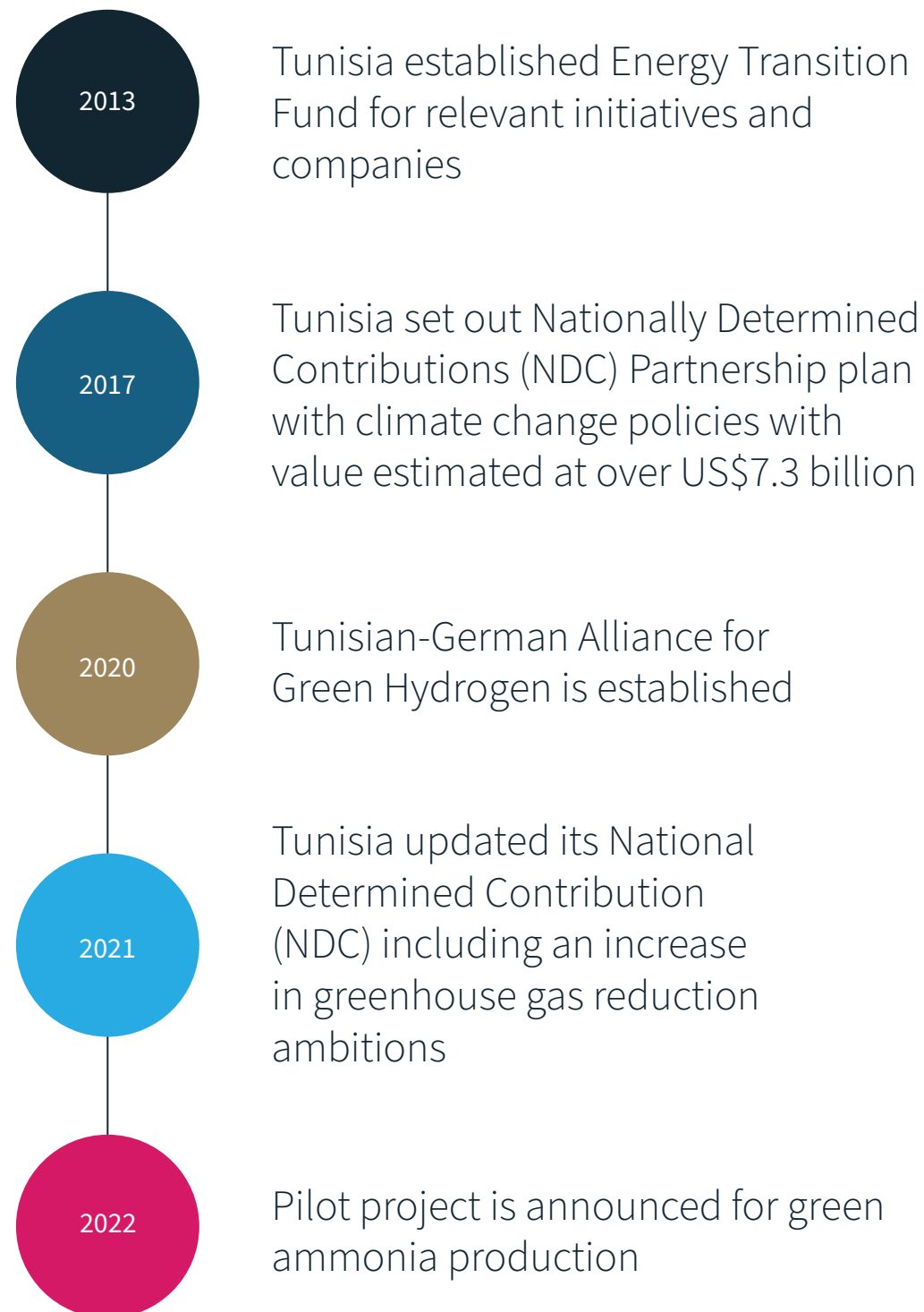
Growth of low carbon hydrogen in Tunisia (kilotonnes per annum) **

*Hydrogen later de-blended at industrial site

**Mixture of additional low carbon hydrogen demand and displacing existing grey hydrogen demand which is currently 40 kTPA

Relevant Policy & Regulations

Tunisia is prioritising developing a hydrogen economy with relevant policies and regulations in place or planned, to support the development of the wider economy and their ambitious plans for the energy transition.



What Tunisia needs to build a low carbon hydrogen economy

Tunisian Government Actions

A national hydrogen strategy is needed to develop a roadmap to scale up hydrogen across Tunisia with emphasis on green ammonia in the short-term. This should be coupled with a strategic investment in relevant infrastructure such as major power transmission connections and assessing new hydrogen pipelines or repurposing existing natural gas infrastructure to support the low carbon hydrogen economy.

Tangible financial support and legislation to promote the hydrogen economy is needed. Plans to increase tax revenues, cut the fiscal deficit, and introduce a carbon tax system should be coupled with an implementation strategy for such policies. This is to ensure short term competitiveness and support as the hydrogen economy is established, whilst planning long term revenue generation for Tunisia.

An expansion of the electricity grid in line with future demand should be devised to ensure low-cost access to the electricity grid to support the supply of electricity for green hydrogen and ammonia production.

Key Industry Players and Green Hydrogen Demand

The key to developing the hydrogen economy in Tunisia is green ammonia, a reliable supply of green hydrogen would enable fertiliser products to decarbonise but would also provide increasing opportunities for domestic investment, enable



Development of hydrogen roadmap and policies

Financial Incentives and legislation

Expansion of electricity grid

greater security of supply, provide an export opportunity, and hedge against a volatile ammonia market. Especially with the price of natural gas, green ammonia could be competitive in 2030s, inviting not only a domestic but also an export market.

Additionally, low carbon shipping fuels such as e-methanol or green ammonia show potential with major ports in Tunisia having ammonia handling facilities on the major sea-freight route to the Mediterranean. Green hydrogen could also provide a viable alternative transport fuel for remote areas more difficult to electrify.

Technical assessment of the suitability of the TransMed pipeline to transport both blended and 100% hydrogen from Tunisia to Italy and beyond is needed to further the hydrogen economy in Tunisia, especially once a domestic market for green hydrogen and ammonia has been met.

Maximizing Low Carbon Economy Benefits

To maximise benefits to Tunisia it is necessary to have a coordinated ramp up of the local supply chain and upskill the workforce. This will enable the costs and risks associated with gigawatt scale projects to be reduced and to better realise the true global demand for hydrogen and its derivatives. At first these will need substantial financial support from governments, in form of grants and subsidies.



Green ammonia implementation

e-Fuels and ammonia potential in port locations



Ramp up supply chain
Upskill workforce



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