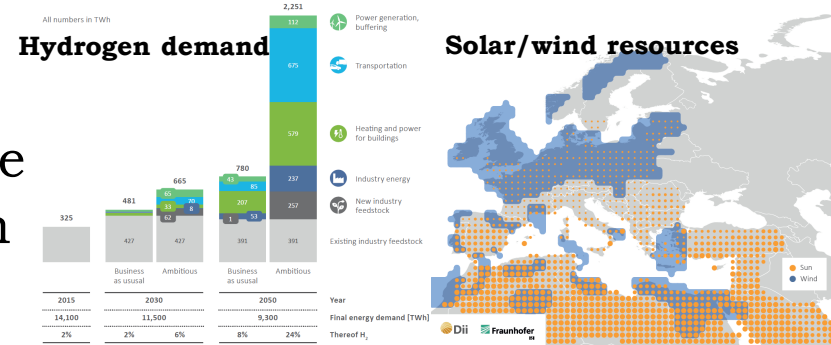


Green Hydrogen for a European Green Deal A 2x40 GW Initiative

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Europe Unique opportunity to develop green hydrogen

- Increasing demand for hydrogen
- Good renewable resources in Europe
- Outstanding renewable resources in North-Africa and Middle East



- Re-use gas infrastructure
- Storage potential in salt caverns
- World class electrolyser industry

Hydrogen backbone



African Pipelines

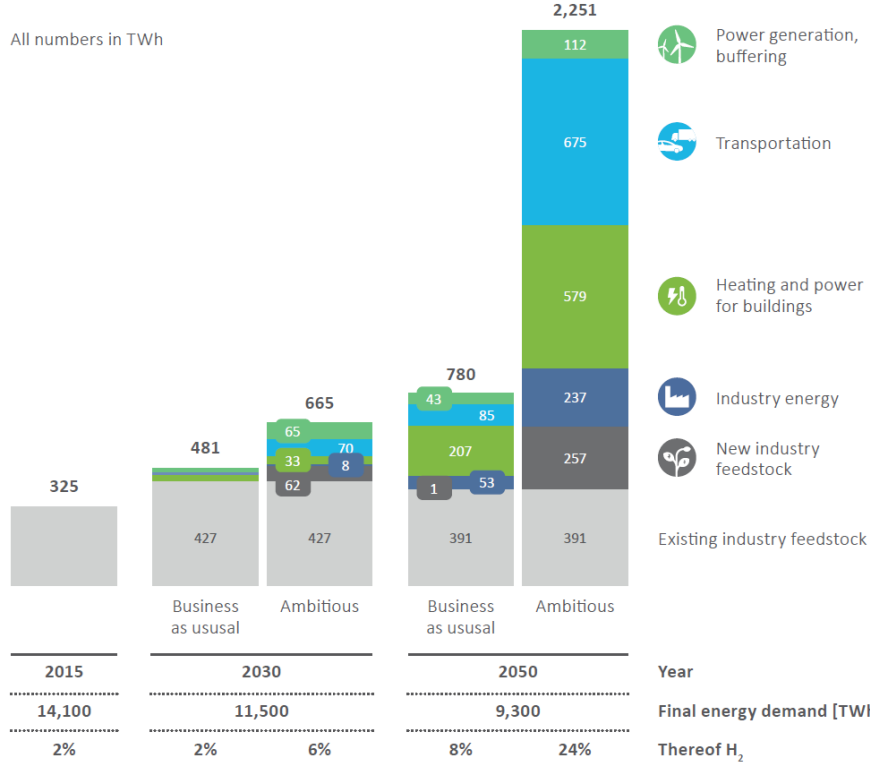


Salt Caverns



European Hydrogen demand

All numbers in TWh

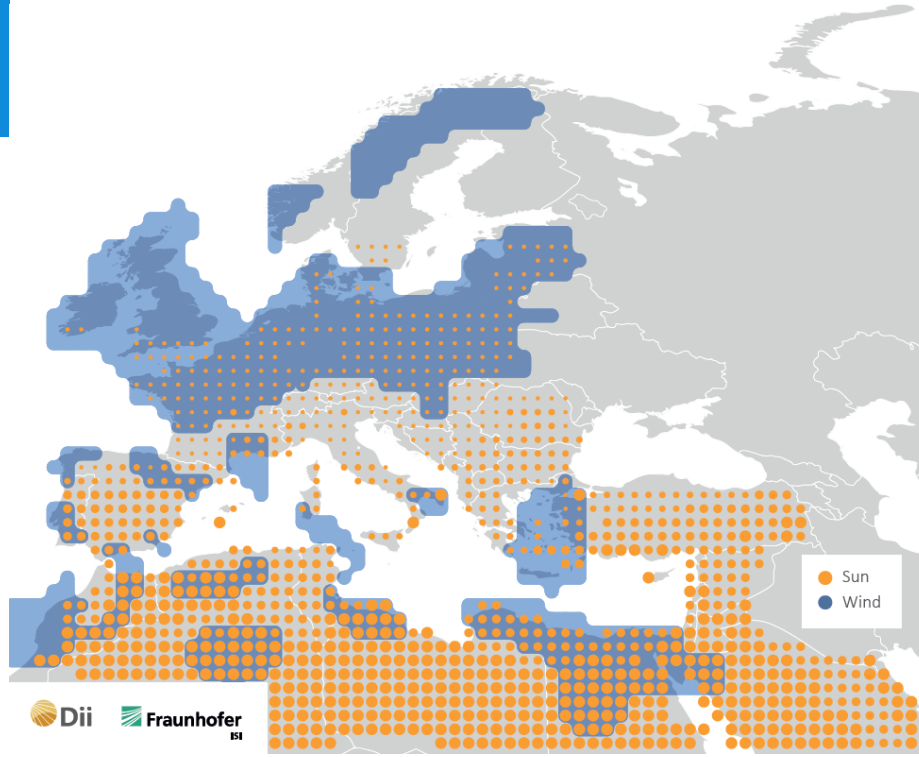


Hydrogen demand ambitious scenario 2030 = 665 TWh or 17 million ton

623 TWh or 15.8 million ton (>90% of total) is pure hydrogen demand

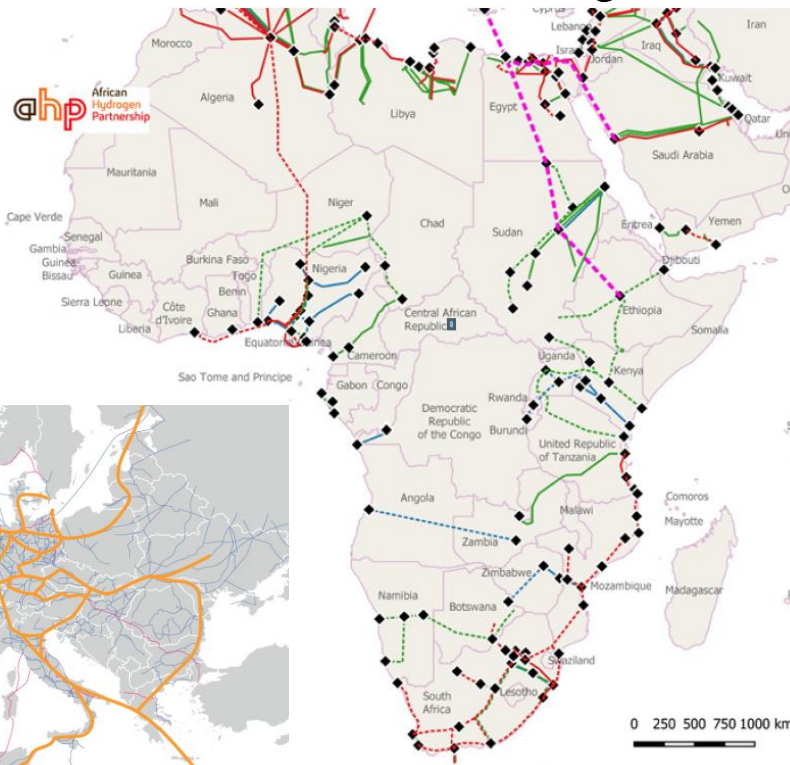
Renewable Energy Resources

Abu Dhabi Al Dhafra



- Tender for 1.5 GW Solar PV
- 28 April 2020
- Lowest bid USD 1.35 cents/kWh
- By EDF and JinkoPower

African Pipeline Infrastructure for Future Hydrogen Transport



H₂ Transport Pipeline
 Length 2.500 km,
 Capacity 2x33 GW

Transport cost
0.005 €/kWh =
0.2 €/kg



Roadmap 40 GW electrolyser capacity in the EU 2030

Electrolyser Capacity	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	Total 2030
Captive Market [MW]												6,000
Chemical	5	20	45	130	200	200	250	300	350	400	450	2,350
Refineries	10	40	50	100	100	100	200	200	300	300	400	1,800
Steel			20	30	50	100	100	100	100	150	150	800
Other (glass, ceramics)		10	20	30	40	50	50	50	50	50	50	400
Hydrogen refuelling stations	10	20	30	40	50	60	70	80	90	100	100	650
Hydrogen Market [MW]												34,000
Centralised GW scale (Hydrogen plants)			200	500	1,000	2,000	3,000	4,000	5,500	7,000	8,500	31,700
Decentralised 10-100 MW scale	10	20	40	70	110	160	220	290	370	460	550	2,300
Total (MW)	35	110	405	900	1,550	2,670	3,890	5,020	6,760	8,460	10,200	40,000

A roadmap to 40 GW electrolyser capacity in the EU in 2030 shows both a 6 GW captive and a 34 GW hydrogen market. This 40 GW electrolyser capacity will produce 4.4 million ton or 173 TWh hydrogen in 2030, representing 25% of the total EU hydrogen market in 2030.

Roadmap 40 GW electrolyser capacity in North Africa and Ukraine 2030

Electrolyser Capacity	2023	2024	2025	2026	2027	2028	2029	2030	Total 2030
Domestic Market [MW]									7,500
Ammonia North Africa	75	125	250	500	750	1,000	1,250	1,500	5,450
Ammonia Ukraine		50	100	200	250	300	400	500	1,800
Other (glass, steel, refineries)				10	20	30	40	50	150
Hydrogen refuelling stations					10	20	30	40	100
Export Market [MW]									32,500
Hydrogen North Africa (Hydrogen plants)		500	1,000	2,000	3,000	4,000	6,000	8,000	24,500
Hydrogen Ukraine (Hydrogen plants)			500	700	1,000	1,400	1,900	2,500	8,000
Total (MW)	75	675	1,850	3,410	5,030	6,750	9,620	12,590	40,000

A roadmap to 40 GW electrolyser capacity in North Africa and the Ukraine in 2030 includes a 7.5 GW domestic market and a 32.5 GW export market. The domestic market is mainly for ammonia production, while the export market is mainly export by pipeline to the EU, about 3 million ton or 118 TWh hydrogen in 2030, representing 17% of the total EU hydrogen market in 2030.

Impact 2x40 GW Green Hydrogen Initiative 2030

Total avoided CO₂ emissions by 2x40 GW green hydrogen production is 90 MTon per year.

The European Union reduces CO₂ emissions with 82 MTon per year by green hydrogen production in the European Union and import from North-Africa/Ukraine

Total investment in 2x40 GW electrolyser capacity is between €25 and €30 billion

Number of jobs for manufacturing and maintenance of 2x40 GW electrolyser capacity is between 140,000 and 170,000 up to 2030

Green Hydrogen cost competitive 2030

Hydrogen production by electrolyzers*	Capex (€/kW)	OPEX %/yr Capex	System Efficiency (HHV**)	Electricity (4.000-5.000hr) (€/MWh)	Hydrogen (€/kg)
2020-2025	300-600	1.5%	75-80%	25-50	1.5-3.0
2025-2030	250-500	1%	80-82%	15-30	1.0-2.0
Up to 2050	<200	<1%	>82%	10-30	0.7-1.5

*Hydrogen production cost for hydrogen delivered at 30 bar pressure and 99,99% purity

**HHV = Higher Heating Value

GW scale electrolyzers at good wind and solar integrated electricity-hydrogen production sites can produce renewable hydrogen at costs competitive with low-carbon hydrogen (1.5-2.0€/kg) in 2025 and with grey hydrogen, (1.0-1.5€/kg) in 2030.

There is a unique opportunity for the EU to develop a green hydrogen economy, which will contribute to economic growth, jobs and to a sustainable, affordable and fair energy system. Building on this position, the EU can secure its position as the world market leader for electrolyzers and green hydrogen production.