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
European Hydrogen demand

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
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

<table>
<thead>
<tr>
<th>Electrolyser Capacity</th>
<th>2023</th>
<th>2024</th>
<th>2025</th>
<th>2026</th>
<th>2027</th>
<th>2028</th>
<th>2029</th>
<th>2030</th>
<th>Total 2030</th>
</tr>
</thead>
<tbody>
<tr>
<td>Domestic Market [MW]</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>7,500</td>
</tr>
<tr>
<td>Ammonia North Africa</td>
<td>75</td>
<td>125</td>
<td>250</td>
<td>500</td>
<td>750</td>
<td>1,000</td>
<td>1,250</td>
<td>1,500</td>
<td>5,450</td>
</tr>
<tr>
<td>Ammonia Ukraine</td>
<td>50</td>
<td>100</td>
<td>200</td>
<td>250</td>
<td>300</td>
<td>400</td>
<td>500</td>
<td>1,800</td>
<td></td>
</tr>
<tr>
<td>Other (glass, steel, rectories)</td>
<td>10</td>
<td>20</td>
<td>30</td>
<td>40</td>
<td>50</td>
<td>150</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hydrogen refuelling stations</td>
<td>10</td>
<td>20</td>
<td>30</td>
<td>40</td>
<td>100</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Export Market [MW]</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>32,500</td>
</tr>
<tr>
<td>Hydrogen North Africa (Hydrogen plants)</td>
<td>500</td>
<td>1,000</td>
<td>2,000</td>
<td>3,000</td>
<td>4,000</td>
<td>6,000</td>
<td>8,000</td>
<td>24,500</td>
<td></td>
</tr>
<tr>
<td>Hydrogen Ukraine (Hydrogen plants)</td>
<td>500</td>
<td>700</td>
<td>1,000</td>
<td>1,400</td>
<td>1,900</td>
<td>2,500</td>
<td>8,000</td>
<td></td>
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</tr>
</tbody>
</table>

- 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 tons 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

<table>
<thead>
<tr>
<th></th>
<th>Capex (€/kW)</th>
<th>OPEX %/yr Capex</th>
<th>System Efficiency (HHV**)</th>
<th>Electricity (4,000-5,000hr) (€/MWh)</th>
<th>Hydrogen (€/kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>2020-2025</strong></td>
<td>300-600</td>
<td>1.5%</td>
<td>75-80%</td>
<td>25-50</td>
<td>1.5-3.0</td>
</tr>
<tr>
<td><strong>2025-2030</strong></td>
<td>250-500</td>
<td>1%</td>
<td>80-82%</td>
<td>15-30</td>
<td><strong>1.0-2.0</strong></td>
</tr>
<tr>
<td><strong>Up to 2050</strong></td>
<td>&lt;200</td>
<td>&lt;1%</td>
<td>&gt;82%</td>
<td>10-30</td>
<td>0.7-1.5</td>
</tr>
</tbody>
</table>

*Hydrogen production cost for hydrogen delivered at 30 bar pressure and 99.99% purity

**HHV = Higher Heating Value

GW scale electrolysers 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 electrolysers and green hydrogen production.