



SMARTENERGY

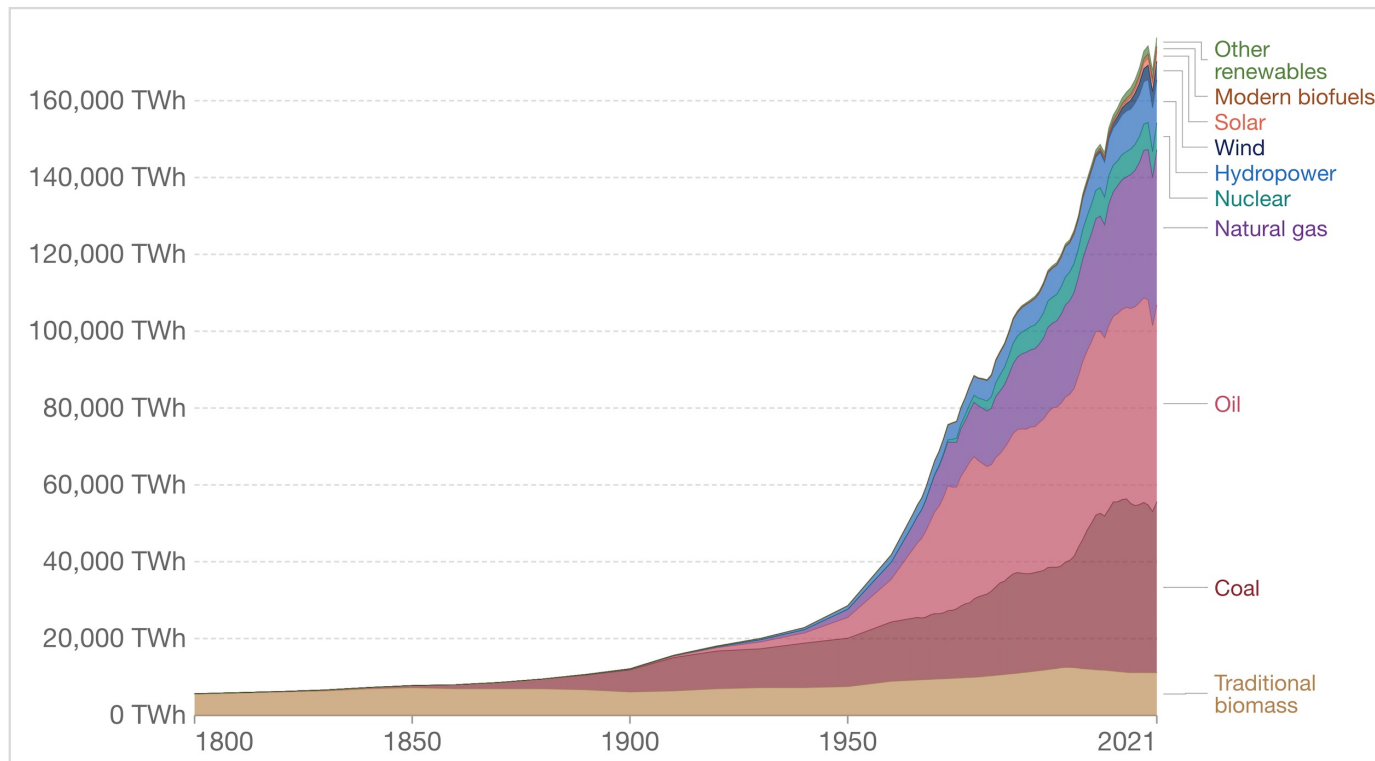
The relevance of green hydrogen and synthetic fuels for the energy transition

Manuel Costeira da Rocha

2023 Ano OE Energia e Clima | Equilíbrio Carbónico e Energias Limpas
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The speed and scale of the energy transition we need today in switching from fossil fuels to low-carbon energy is a new challenge, very different from the past, when energy transitions have always occurred at slow rate.

Global primary energy consumption by source



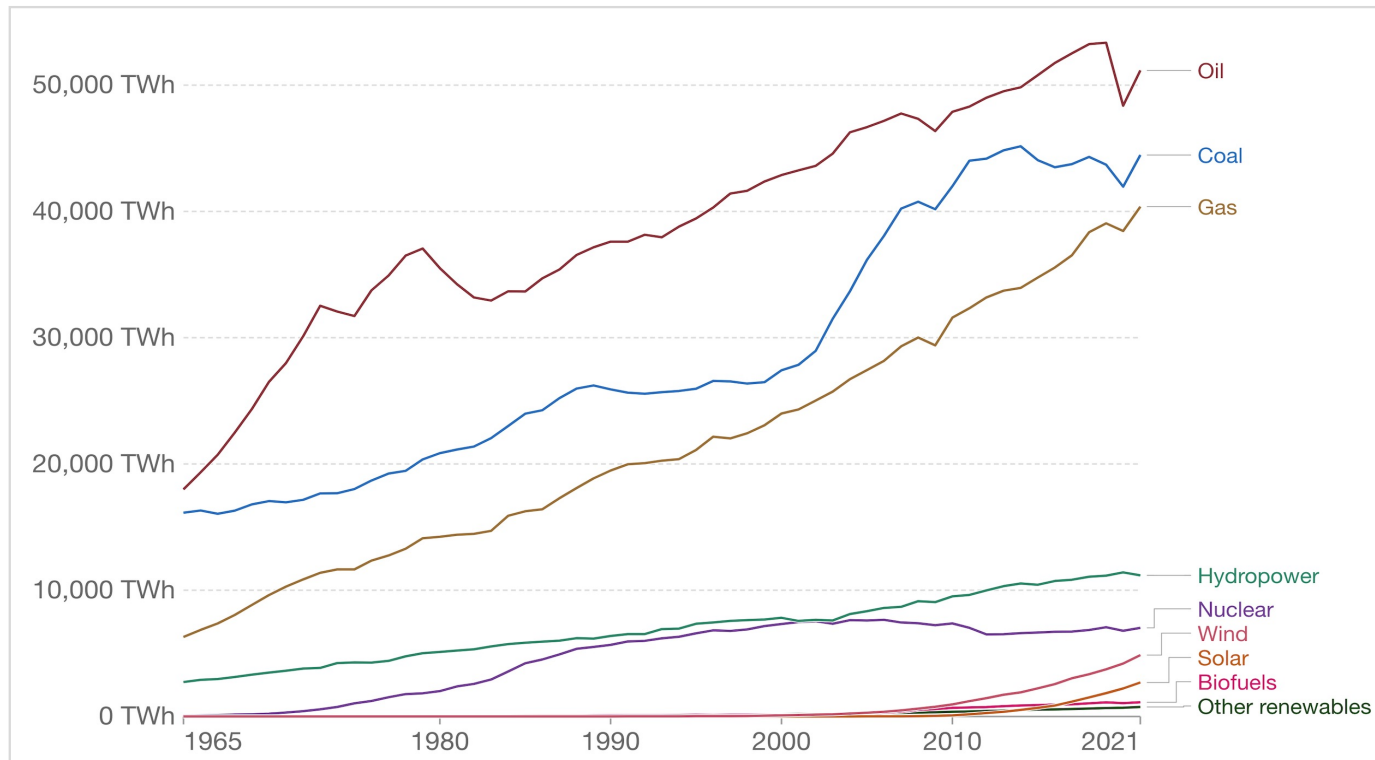
- Until the mid-19th century:
 - biomass
- Industrial Revolution:
 - rise of coal;
 - followed by oil, gas;
- 1950:
 - Hydropower;
- 1960:
 - Nuclear;
- 1980/1990:
 - Solar
 - wind.

Source: Our World in Data based on Vaclav Smil (2017) and BP Statistical Review of World Energy 2021



The speed and scale of the energy transition we need today in switching from fossil fuels to low-carbon energy is a new challenge, very different from the past, when energy transitions have always occurred at slow rate.

Primary energy consumption by source, World



Source: Our World in Data based on Vaclav Smil (2017) and BP Statistical Review of World Energy 2021

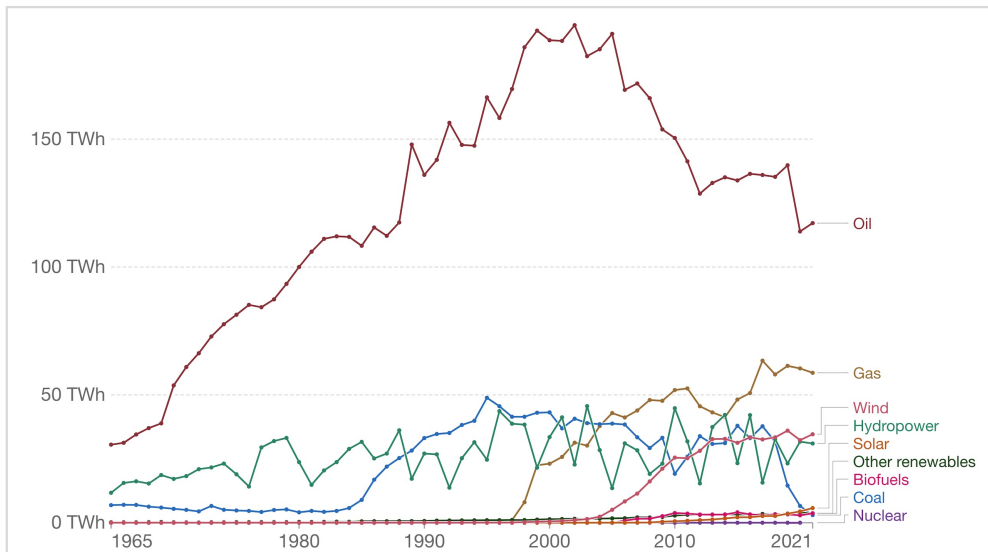
Global energy consumption, 2021:

- 84.3% comes from fossil fuels;
- 15.7% comes from low carbon sources:
 - 4.3% from nuclear
 - 11.4% from renewables



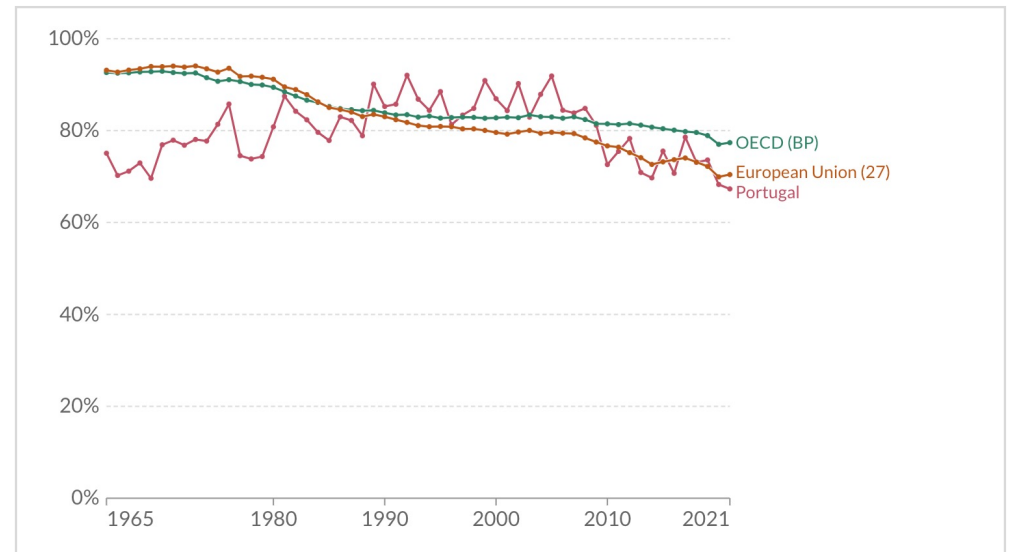
The primary energy consumption in Portugal is based on oil and gas, with fossil fuels representing 67% of the global energy consumption in 2021.

Primary energy consumption by source, Portugal



Source: Our World in Data

Share of primary energy from fossil fuels, Portugal

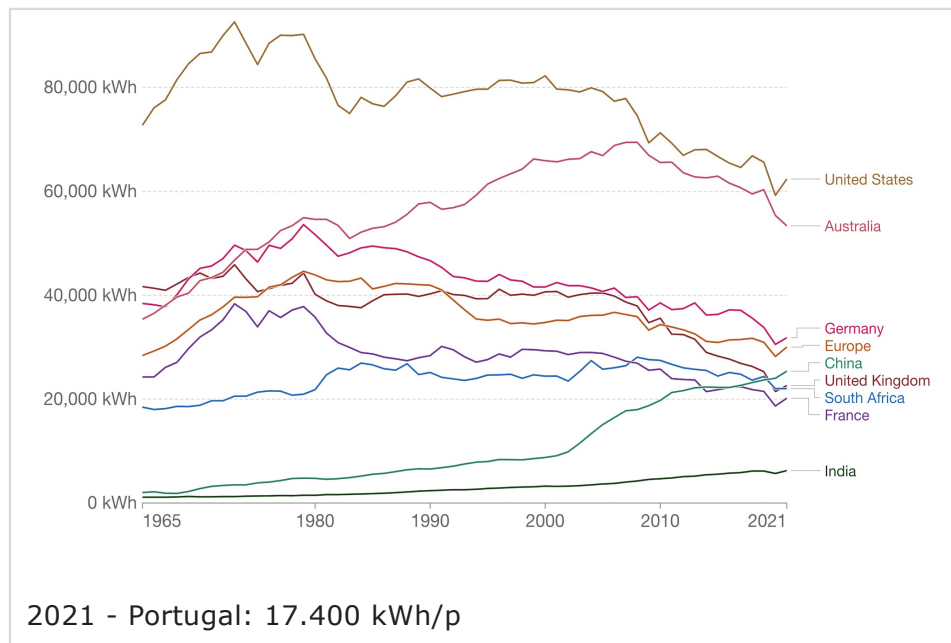


Source: Our World in Data



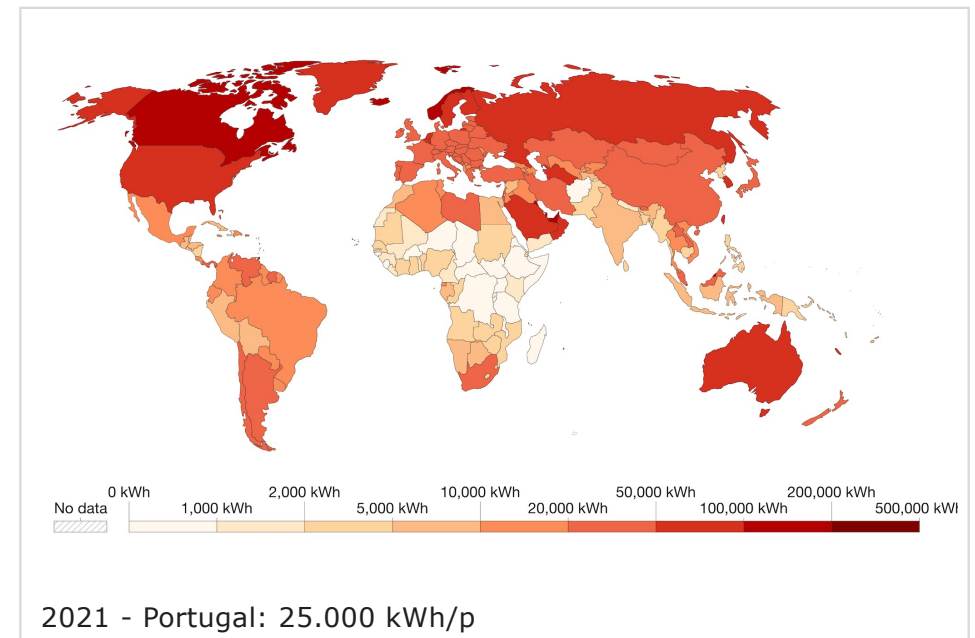
The fossil fuel consumption per person is increasing in China and in India, while in US, Australia and Europe is decreasing.

Fossil fuel consumption per person



Source: Our World in Data

Energy use per person, 2021



Source: Our World in Data



Pathways to reduce CO₂ emissions caused by burning fossil fuels

Moving away from fossil fuels – straight forward reduction

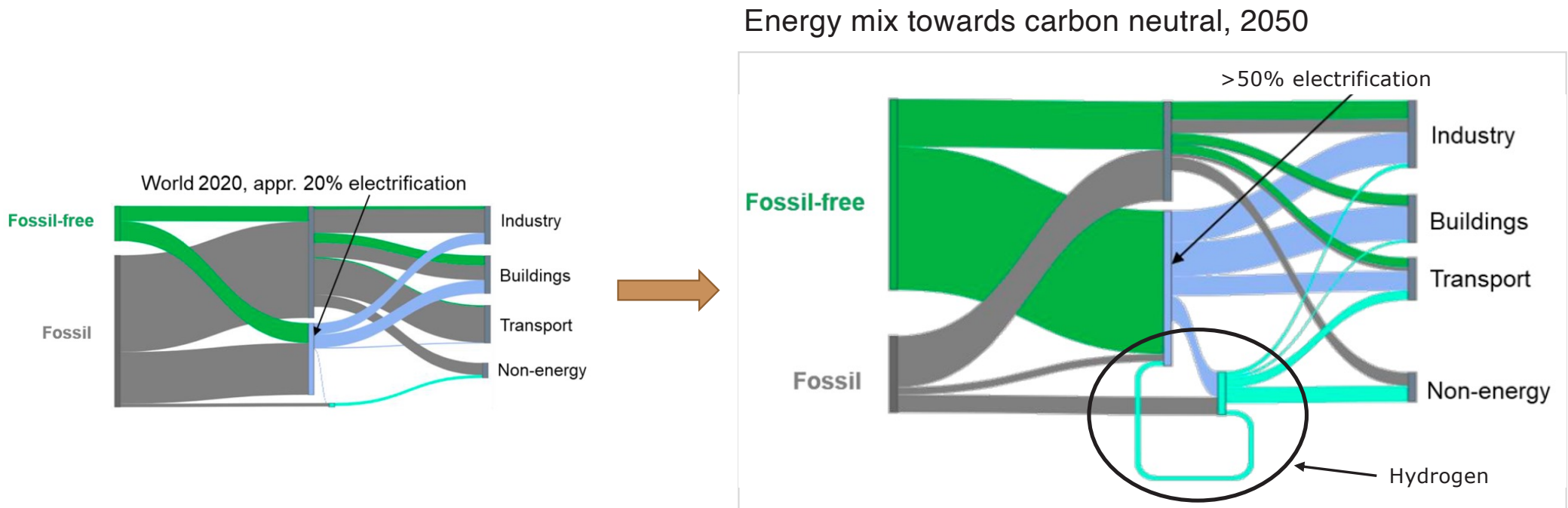
Moving to lower-carbon fuels (diesel to natural gas, ...)

Using carbon fuels made from sustainable sources (waste oils, vegetable matter)

Removing CO₂ from the atmosphere through CCUS

Using carbon-free fuels (hydrogen, renewable electricity, ...)

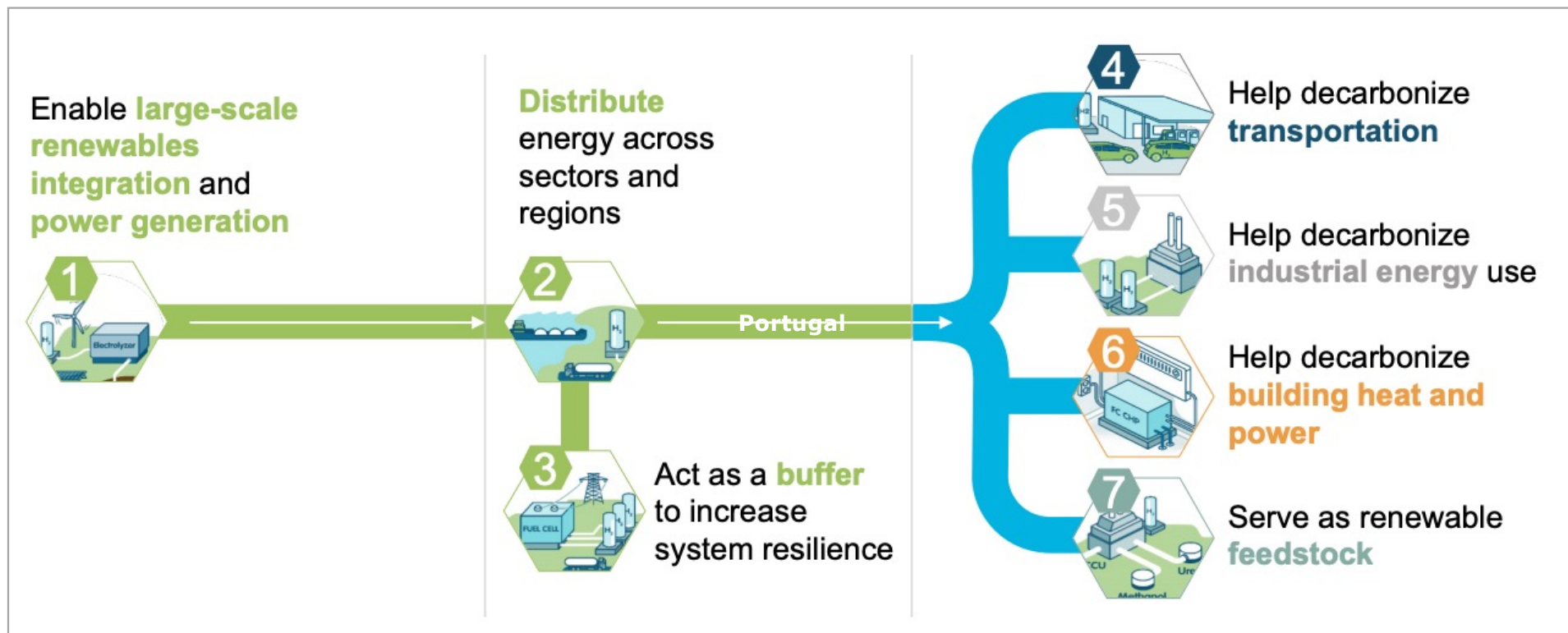
Hydrogen-based fuels will have an important role in sectors where emissions are hard to abate, such as heavy industry and long-distance transport. They can also facilitate integration of renewables and grid balancing



In the global power system of 2050, we need four times of today's generation capacity and we will need to transfer three times as much electrical energy.

Hydrogen can play several roles in the energy transition

Enable the renewable energy system → Decarbonize end uses

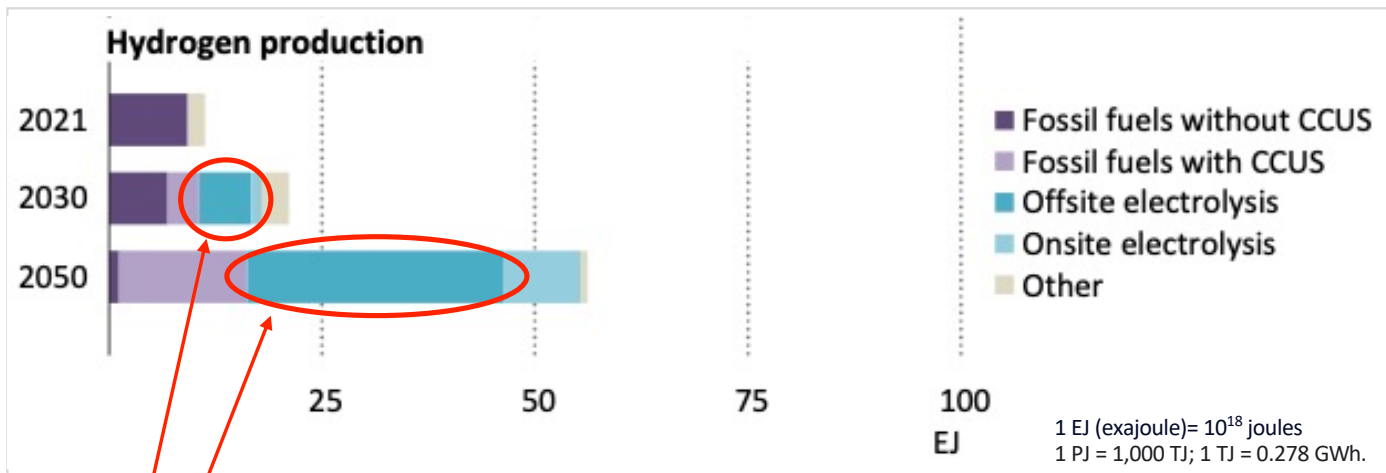


Source: Hydrogen Council



The supply of low-emissions hydrogen is expected to increase from 0.3 Mt today to 90 Mt in 2030 and 450 Mt in 2050

hydrogen production by source in the NZE Scenario, 2021-2050



Source: World energy outlook 2022, IEA

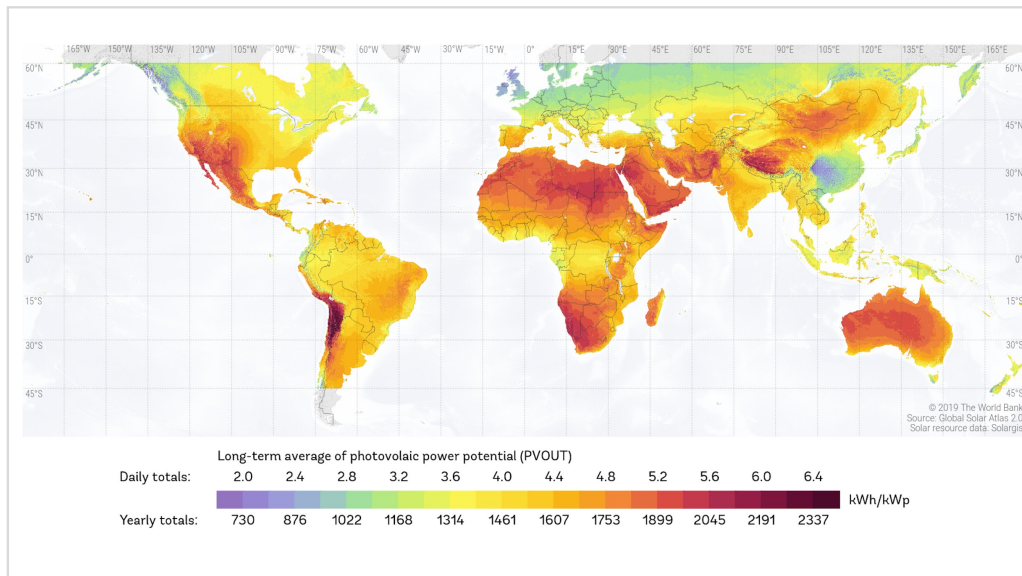
Offsite H2 production

2022:	0.3 Mt
2030:	90.0 Mt
2050:	450.0 Mt

Europe: 20 Mt:
(10 Mt produced locally, 10 Mt imported)

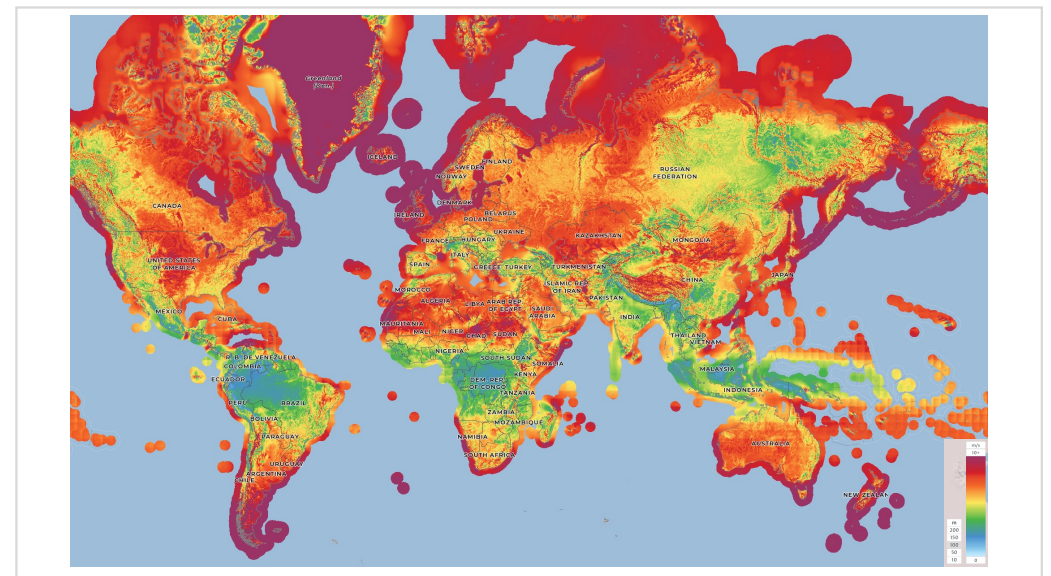
RES-H2 will require very cheap, abundant and clean electrical energy. Water and land will also be key drivers!

Photovoltaic Power Potential



Source: Solargis

Wind Potential

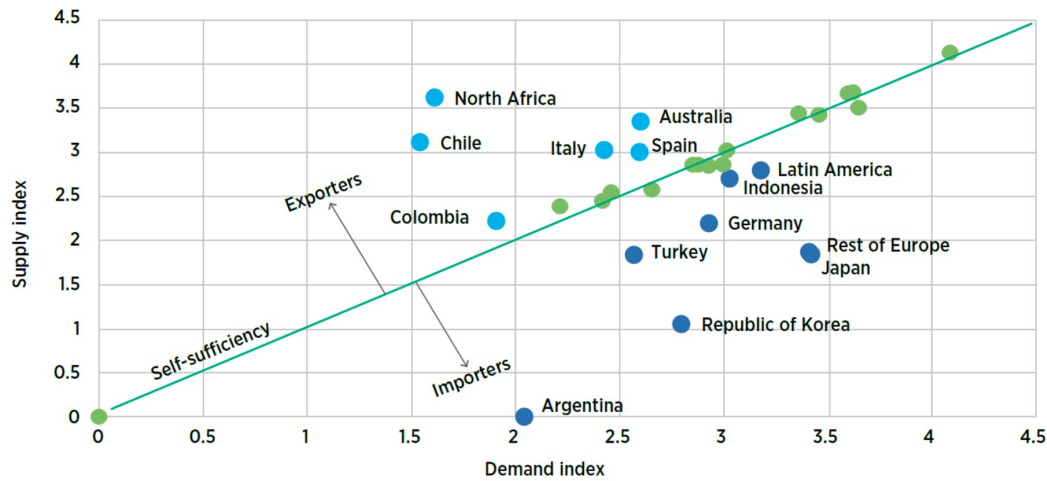


Source: Global Wind Atlas

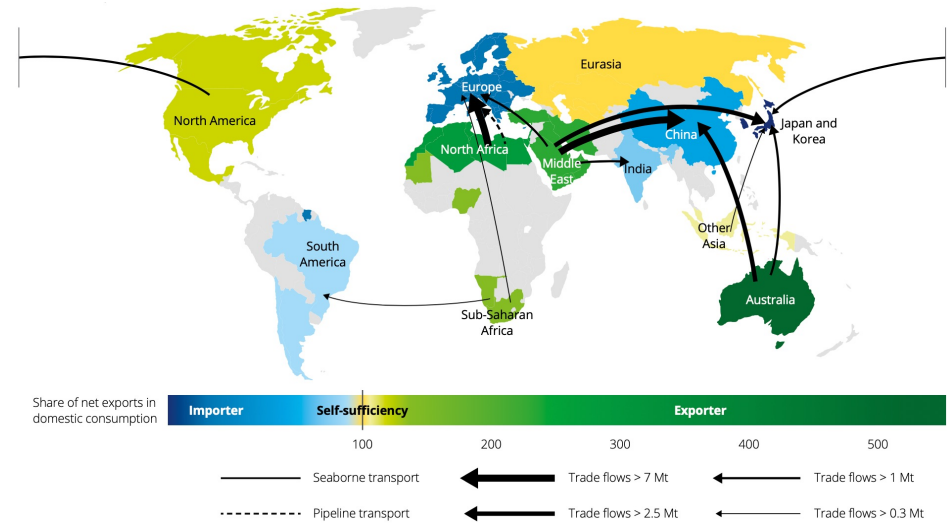
Global hydrogen trade among key regions, 2030

Industrialised nations in Europe and Asia will be importers. Nations with ideal wind and / or solar, land availability or natural gas resources with local CCS potential will be Exporters. Proximity will link import / export nations.

Importing regions seek to diversify their mix of suppliers to enhance energy security, leveraging on retrofitted and new gas pipelines (pure hydrogen) complemented by coastal terminals (ammonia, methanol, and SAF).



Source: IRENA

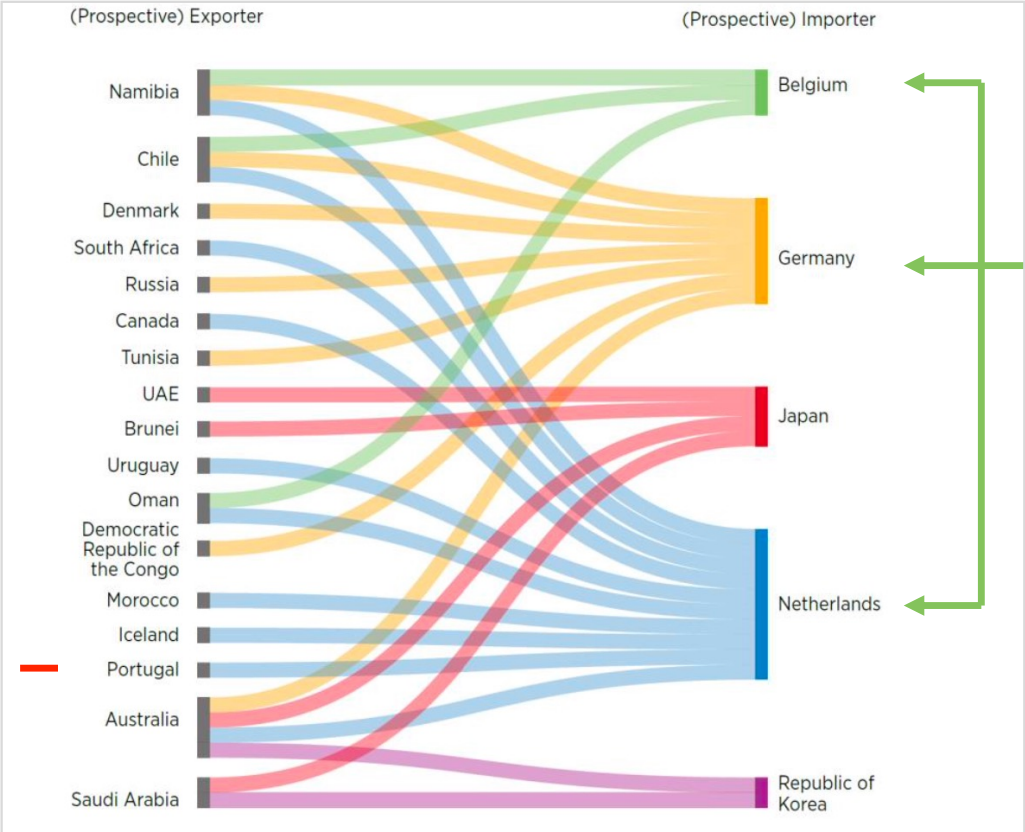


Source: Deloitte; Green hydrogen: Energizing the path to net zero

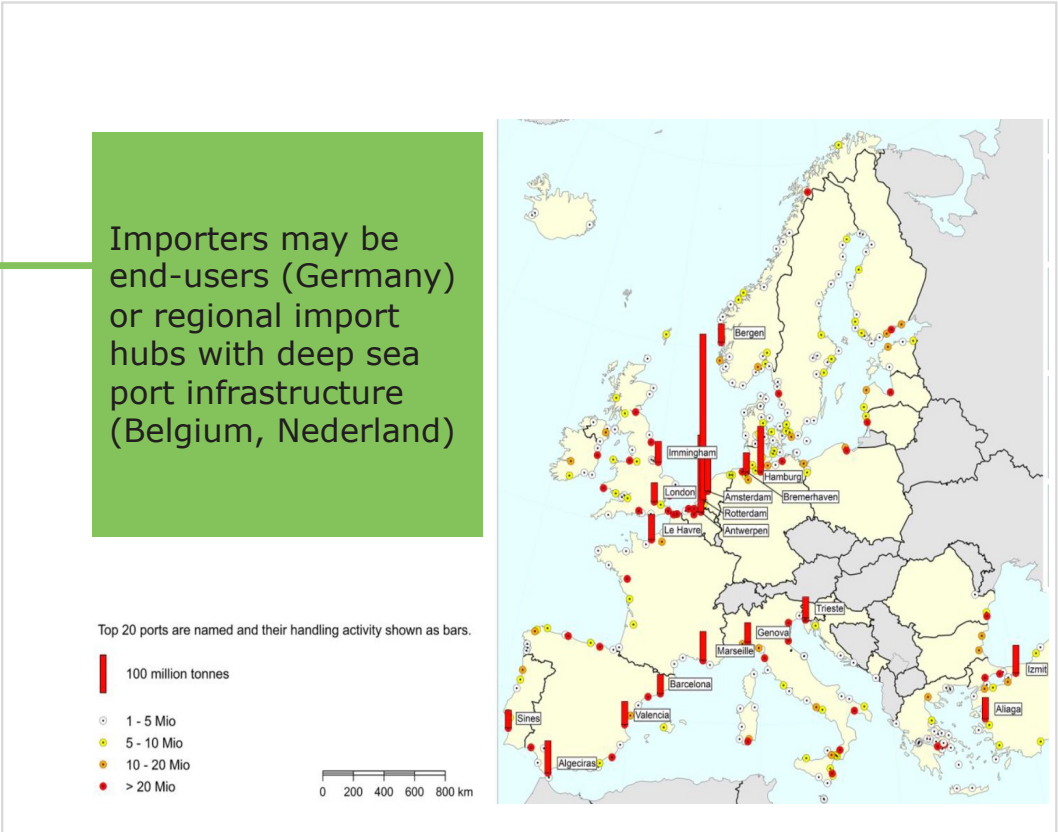


Global hydrogen trade among key regions, 2030

Import and export countries



Source: IRENA

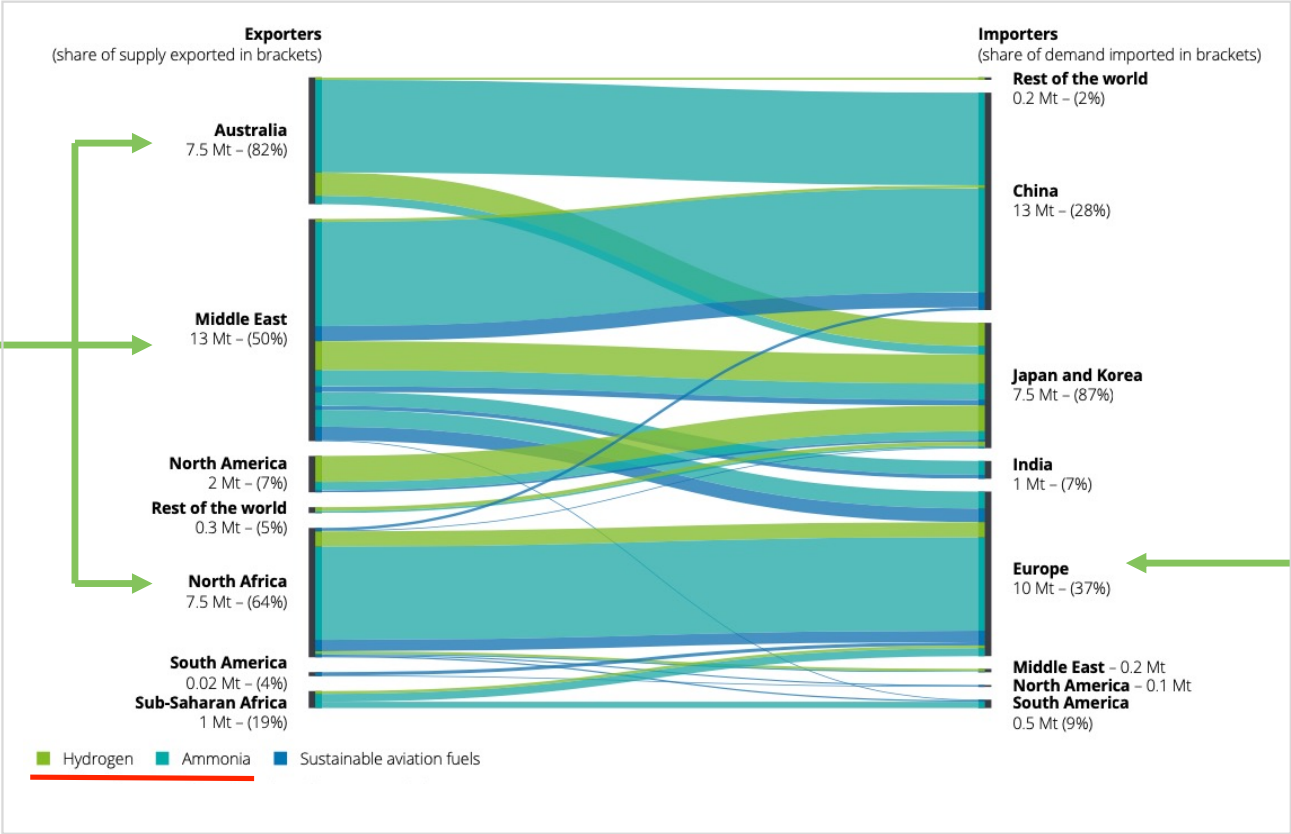


Source: Eurostat



Breakdown of trade by commodities by 2030: the most important will probably be ammonia

Global hydrogen trade among key regions, 2030



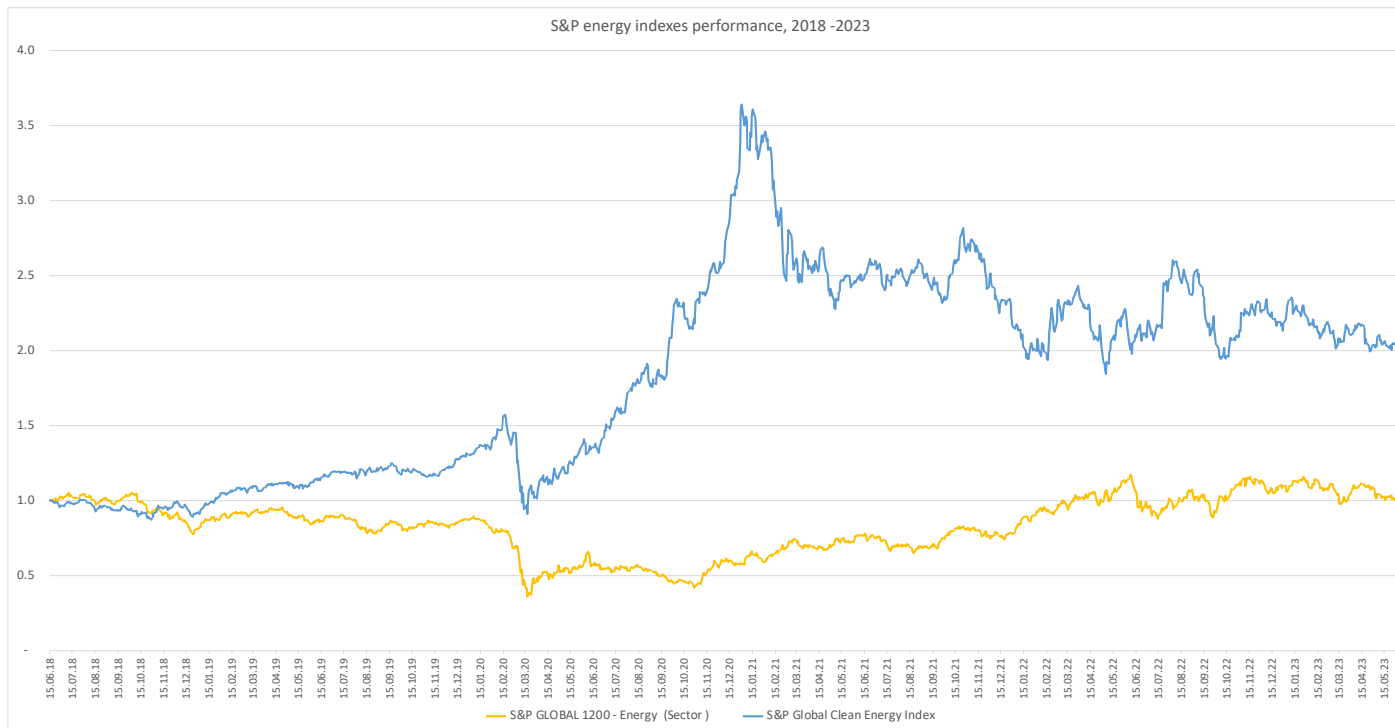
90% of global hydrogen trade

10 MtH2eq
(37% of demand)
Ammonia
North Africa
(ca 70% of EU imports)

Source: Deloitte; Green hydrogen: Energizing the path to net zero



Power sector policies and investments will increasingly bring energy security and the energy transition together. Stakeholders will focus on energy affordability, only possible with clean technologies and digitalization.



Source: Smartenergy, based in S&P data and reports

S&P Global Clean Energy Select Index measures the performance of 30 largest companies in global clean energy related businesses from both developed and emerging markets.

Trends in 2023 for Global Power and Renewables Markets

1. **Economic uncertainty and high energy costs** will lead power market stakeholders to focus heavily on electricity's affordability.
2. Power sector policies and investments will increasingly bring **energy security and the energy transition together**.
3. **High interest rates and cost inflation** will challenge power project financing, but renewable projects will endure.
4. Many power companies will **retrench geographically** to avoid pitfalls and embrace new business plans to capture opportunities.
5. **Difficulties in balancing variable renewables** will stimulate the development of firm clean energy solutions.

Source: S&P Global Commodity Insights



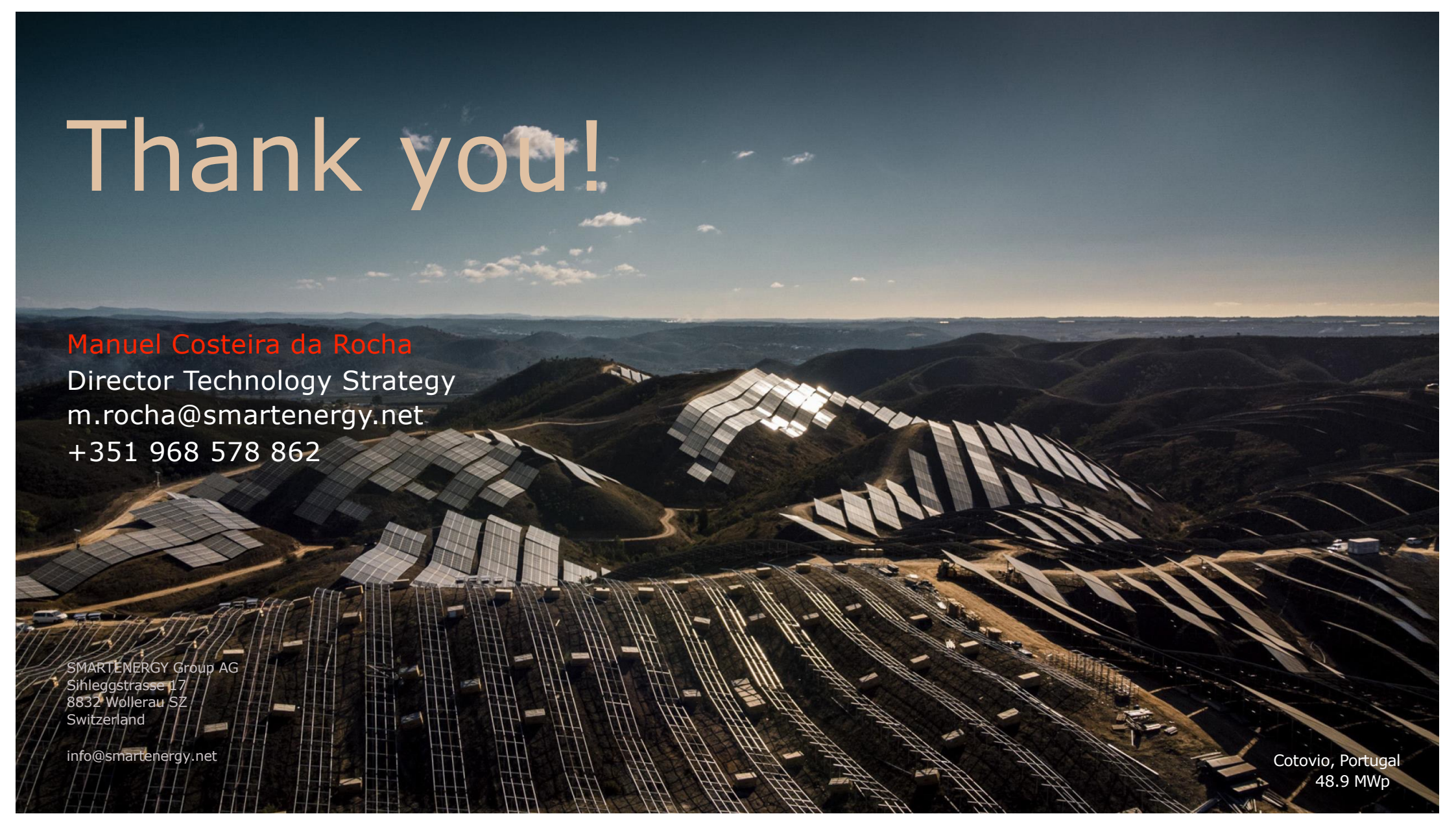
Thank you!

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