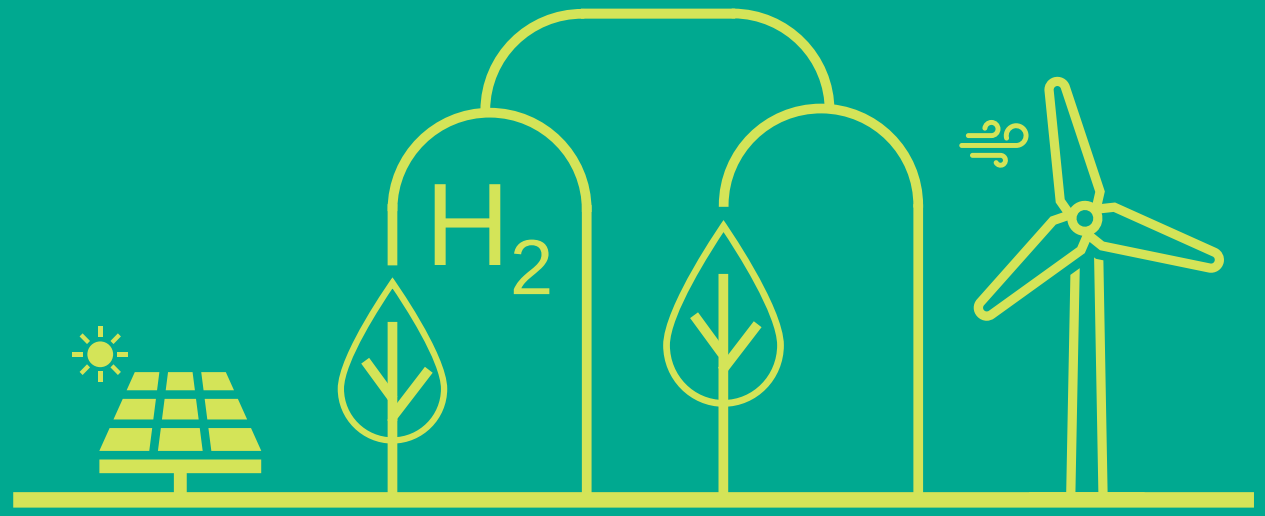
Rödl & Partner

GRMF HYDROGEN & GEOTHERMAL WEBINAR



Kai Imolauer

Nuremberg, 16. November 2023

AGENDA

1	General Information
2	European development
3	Current situation in Germany
4	Conclusion

RÖDL & PARTNER

>5.500 EMPLOYEES | >100 OFFICES | 50 COUNTRIES | ONE COMPANY

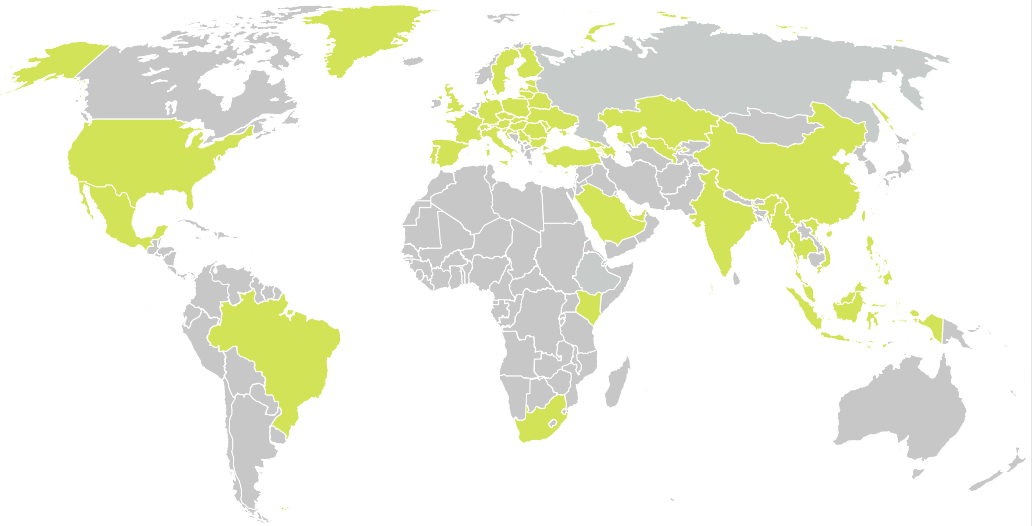
Legal Consulting

Tax Consulting

Auditing

Business Consulting

Rödl & Partner is one of the leading Audit and consulting companies worldwide



The foundation of our dynamic development:
1977 Opening of the law company in Nuremberg

Todays Locations:
Germany: **21**
International: **More than 100 Offices in 50 Countries**

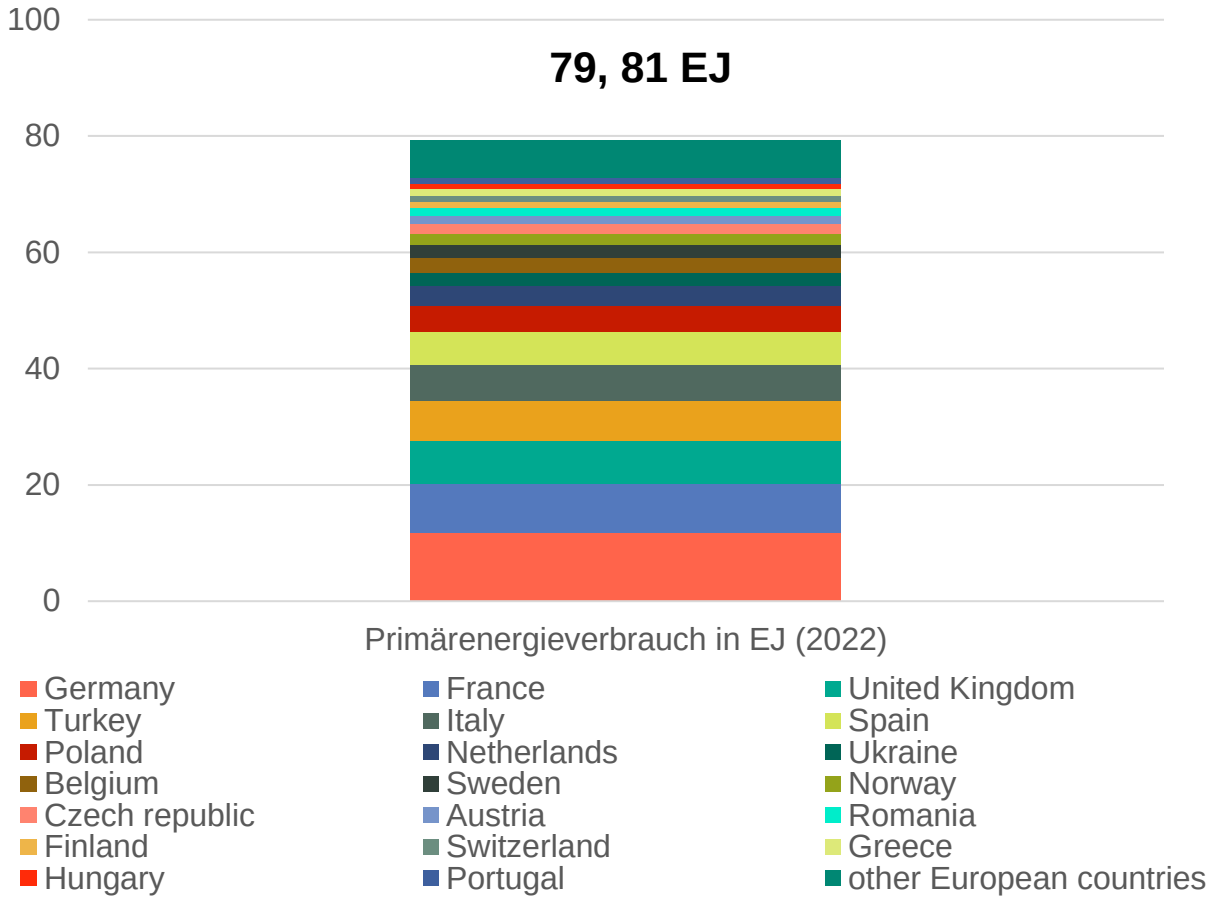
Development of the number of employees:

1990	174 employees
2000	2.000 employees
2023	More than 5.500 employees

PRIMARY ENERGY CONSUMPTION EUROPE / GERMANY

Primary energy consumption Europe 2022

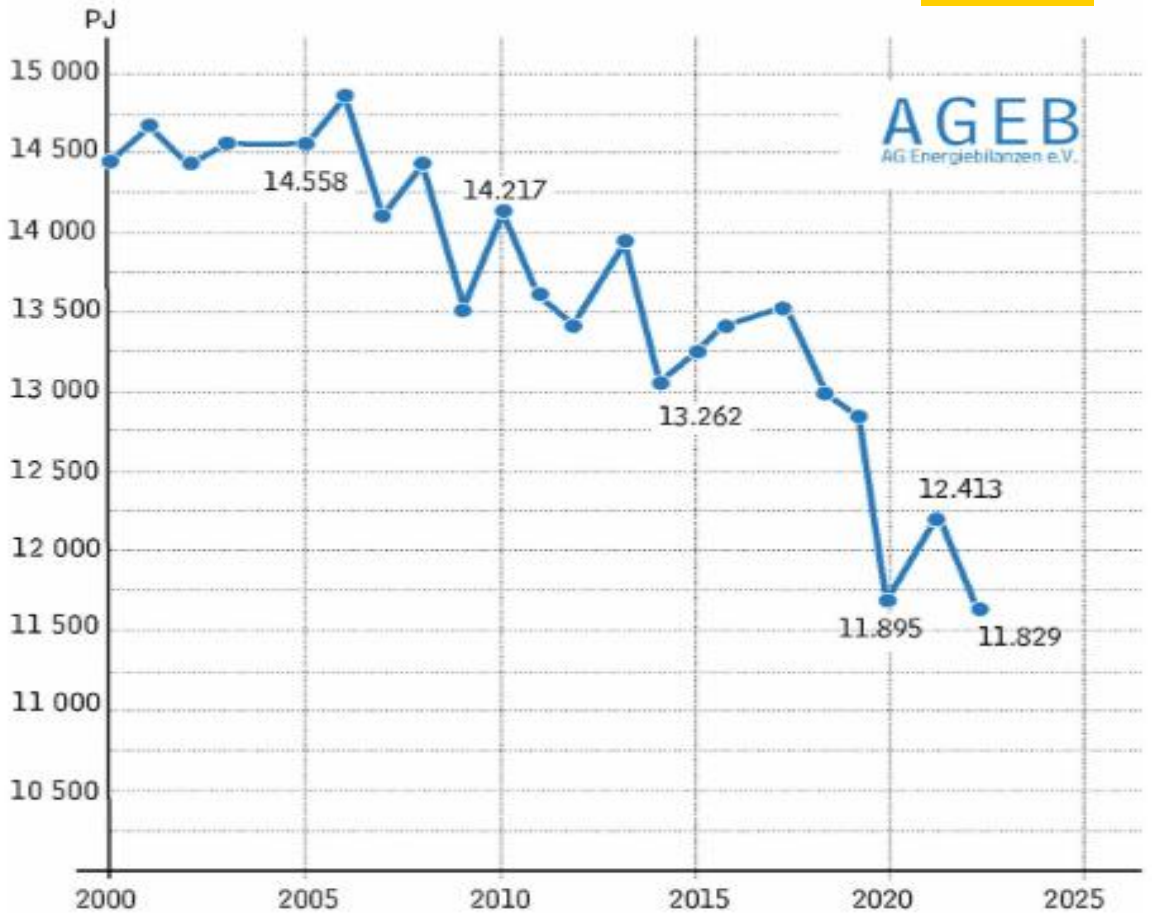
13,9% are from renewable energies



Quelle: BP, Energy Institute, destatis

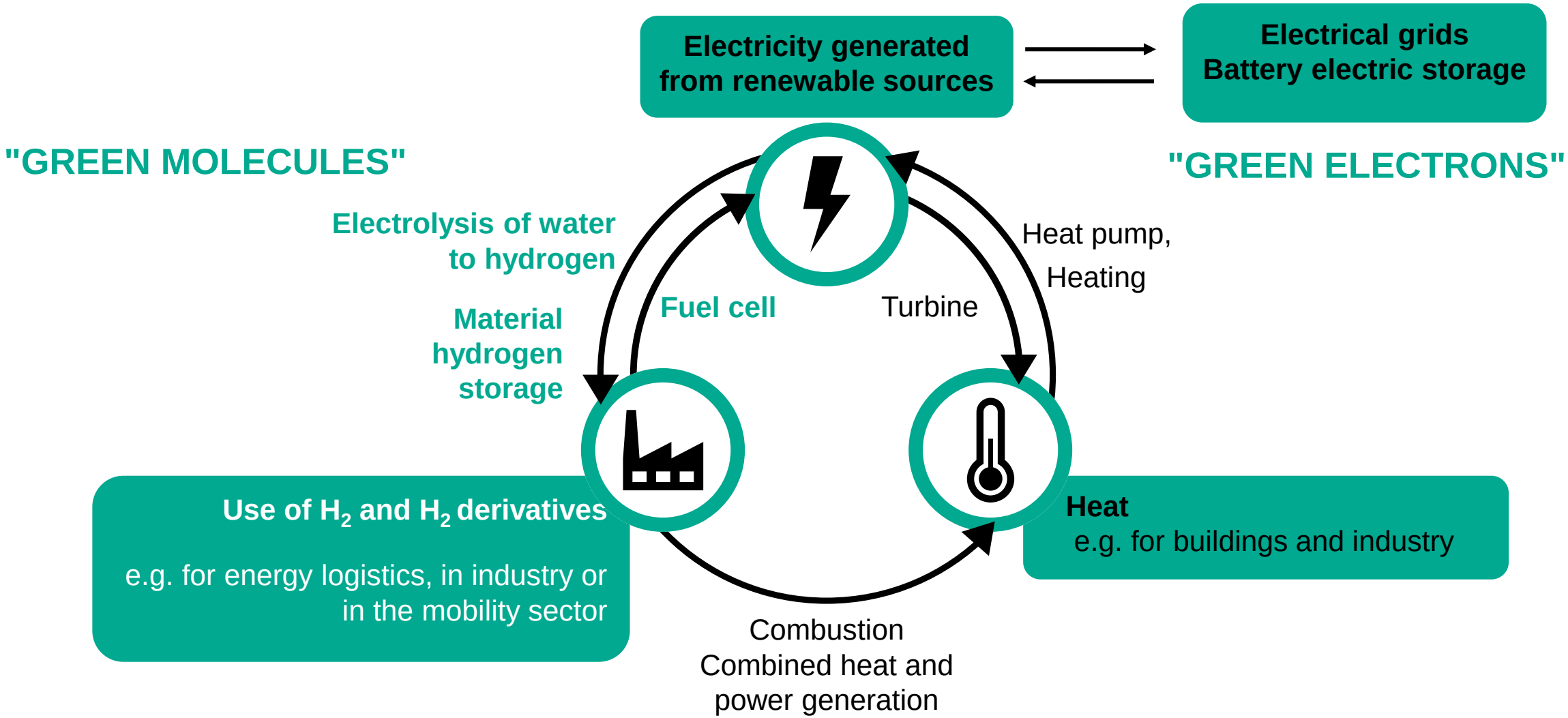
Primary energy consumption Germany 2022

17,1% are from renewable energies



Quelle: AG-Energiebilanzen

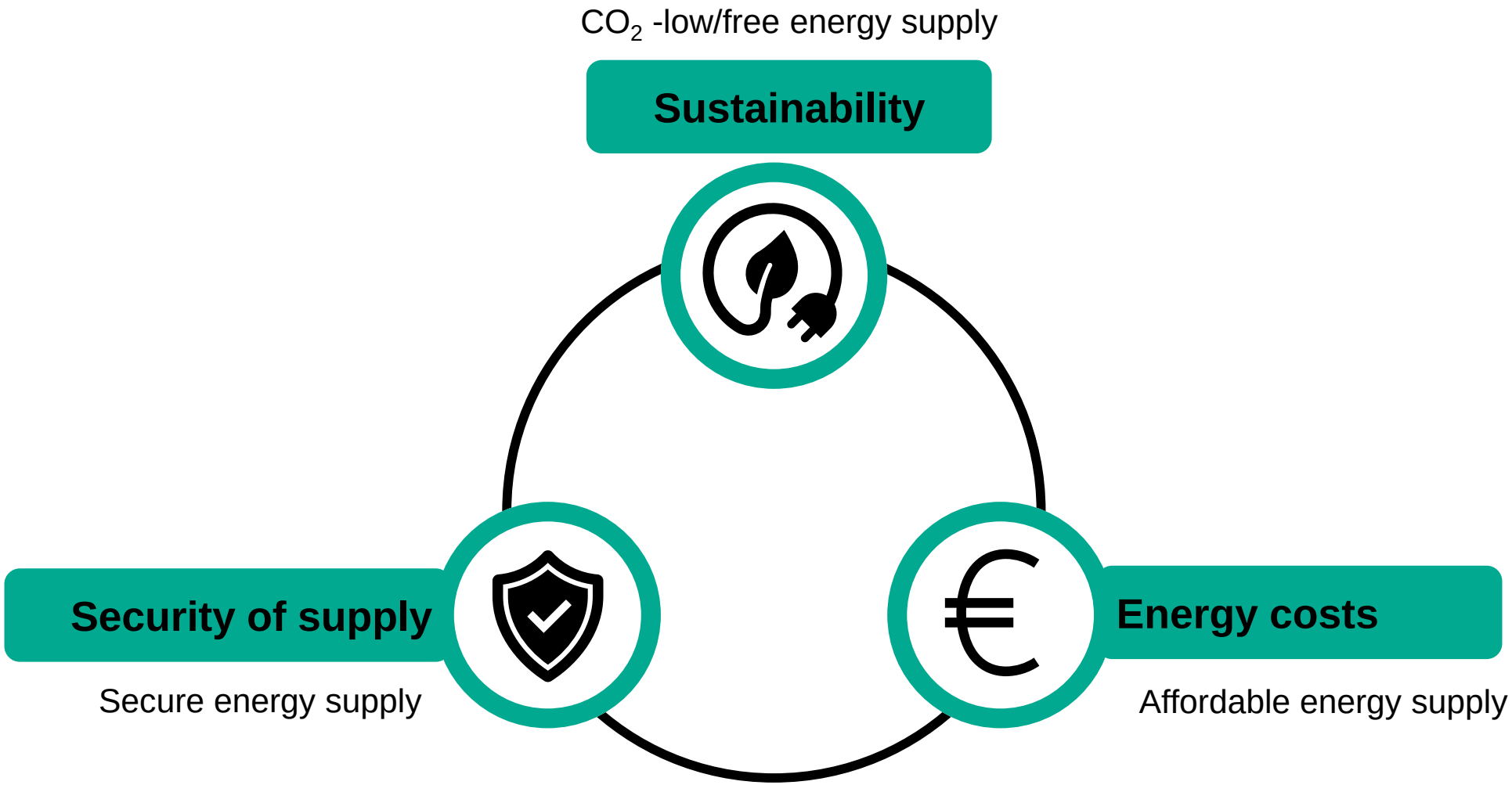
HOW WILL THE FULLY "DEFOSSILIZED" ENERGY SYSTEM OF THE FUTURE WORK?



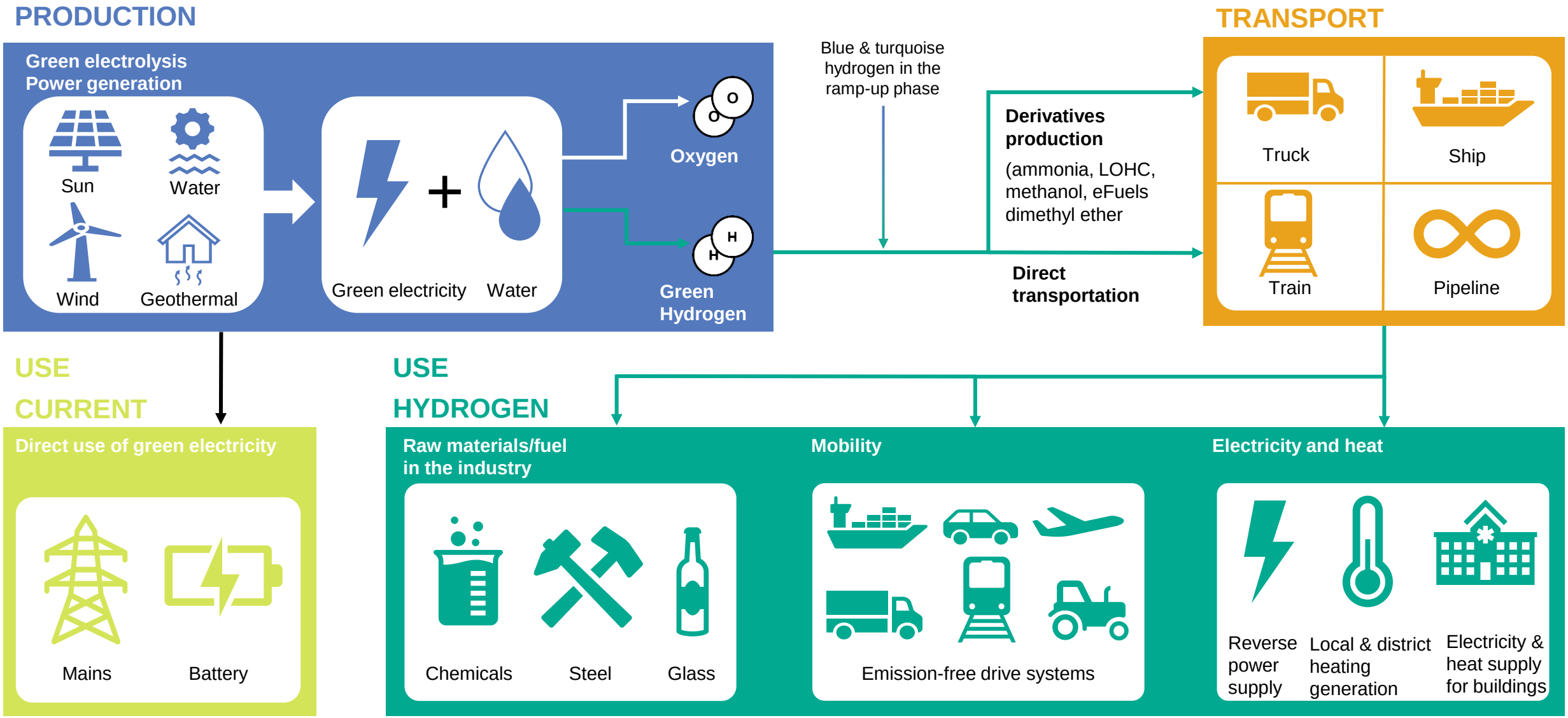
Source: Friedrich-Alexander-University Erlangen-Nuremberg, Prof. Dr. Wasserscheid

EFFICIENCY

"Efficiency" is not an end in itself in the energy system of the future - often not even a target-oriented criterion



THE ROLE OF HYDROGEN IN THE ENERGY SYSTEM OF THE FUTURE

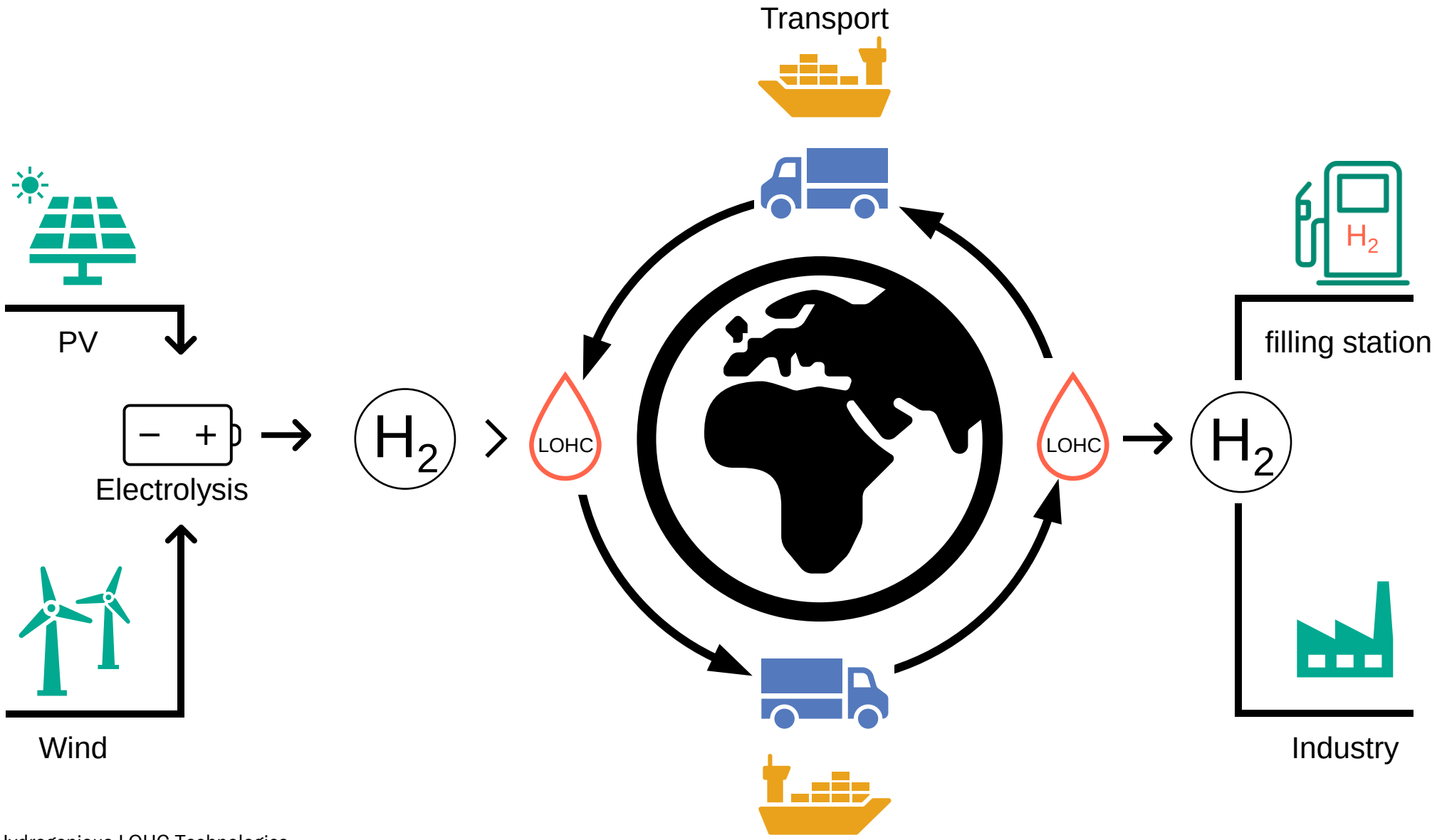


Source: Friedrich-Alexander-University Erlangen-Nuremberg, Prof. Dr. Wasserscheid

OVERVIEW OF THE INDIVIDUAL STORAGE METHODS

	Pro	Contra
Ammonia (NH_3)	• Lower requirements for storage tanks • Transportable at **10 bar**	• N_2 and H_2 react at 200 bar and 350 °C • Toxic (immense consequences of leaks)
Liquid Organic Hydrogen Carrier (LOHC)	• Similarly manageable as diesel • Transport with standard pressure	• Catalytic reaction for "H_2 -loading" (30 - 50 bar and T= 200 - 250°C) • "Discharge" at 250 - 320°C • Carrier medium must be returned to the shipping location to be loaded again
Gaseous	• Can be used directly	• Large high-pressure tanks required (350 or 700 bar)
Liquid	• Less space required • High storage density • Pure form of hydrogen	• Energy requirement for the conversion • Maintaining -253°C energy-intensive
Metal Hydrides	• Safe, standard pressure and easy to handle	• Very heavy and therefore unsuitable for transportation
Methanol	• Easy to handle and safe • Reaction from CO_2 and H_2	• CO_2 must be stored during H discharge$_2$

LOHC –LIQUIFIED ORGANIC HYDROGEN CARRIER



Source: Hydrogenious LOHC Technologies

2 EUROPEAN DEVELOPMENT

EUROPEAN HYDROGEN STRATEGY

The European hydrogen strategy was published in July 2020

1

Phase 1 (2020 - 2024):

- **Decarbonization** of hydrogen production
- Installation of at least **6 GW** of green H_2 **electrolysers**
- Production of **1 million tons** by 2024

2

Phase 2 (2024 - 2030):

- Installation of **40 GW** H_2 electrolysers and production of **10 million tons** by **2030**
- Production **close to users** and expansion into new sectors
- **An additional 40 GW of** green hydrogen capacity in the eastern and southern regions of Europe

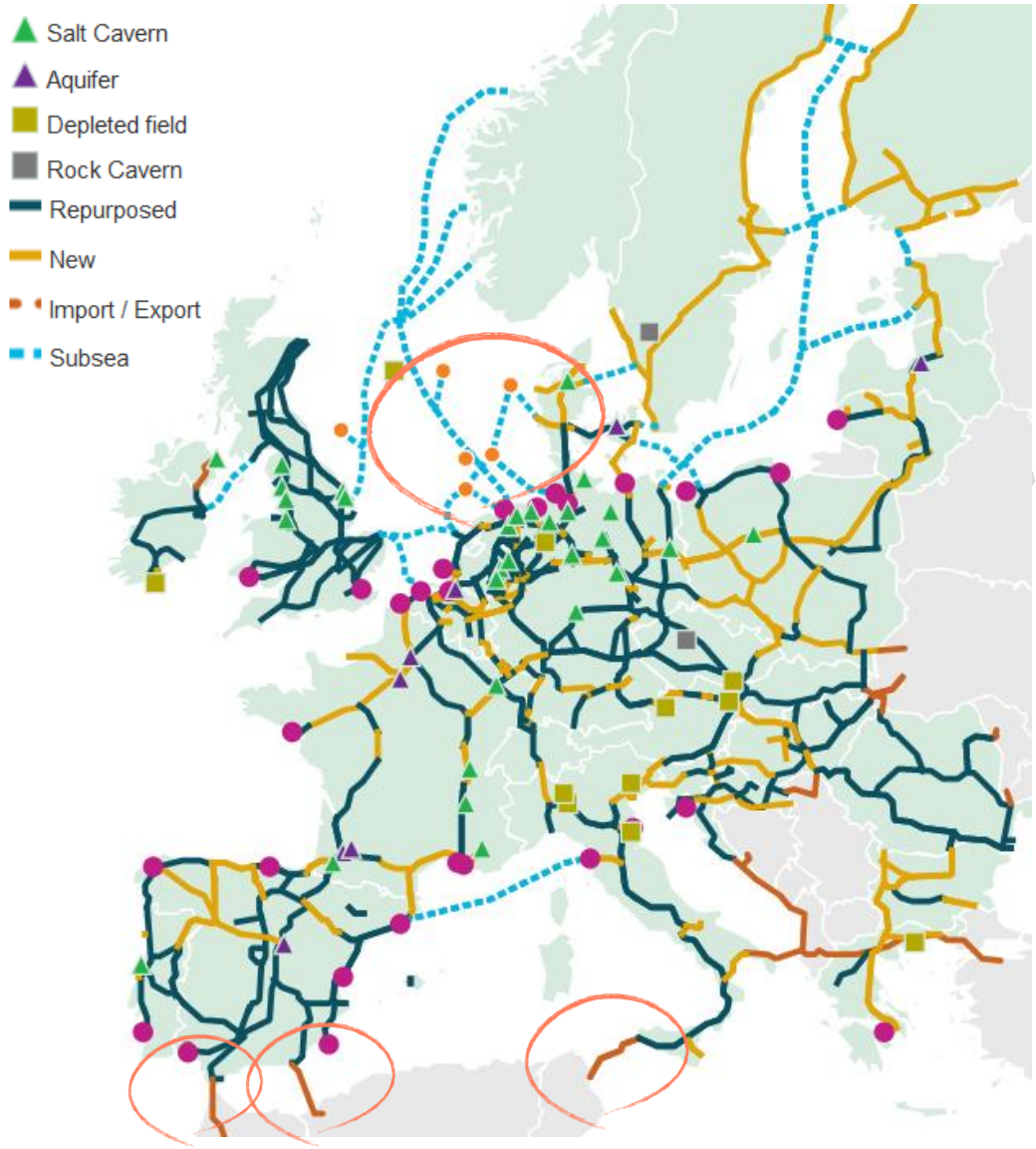
3

Phase 3 (2030 - 2050):

- **Large-scale use** of green H_2 in sectors that are difficult to decarbonize
- 300GW offshore wind energy and 40 GW marine energy

Source: European Hydrogen Strategy

EUROPA'S PIPELINE PLAN



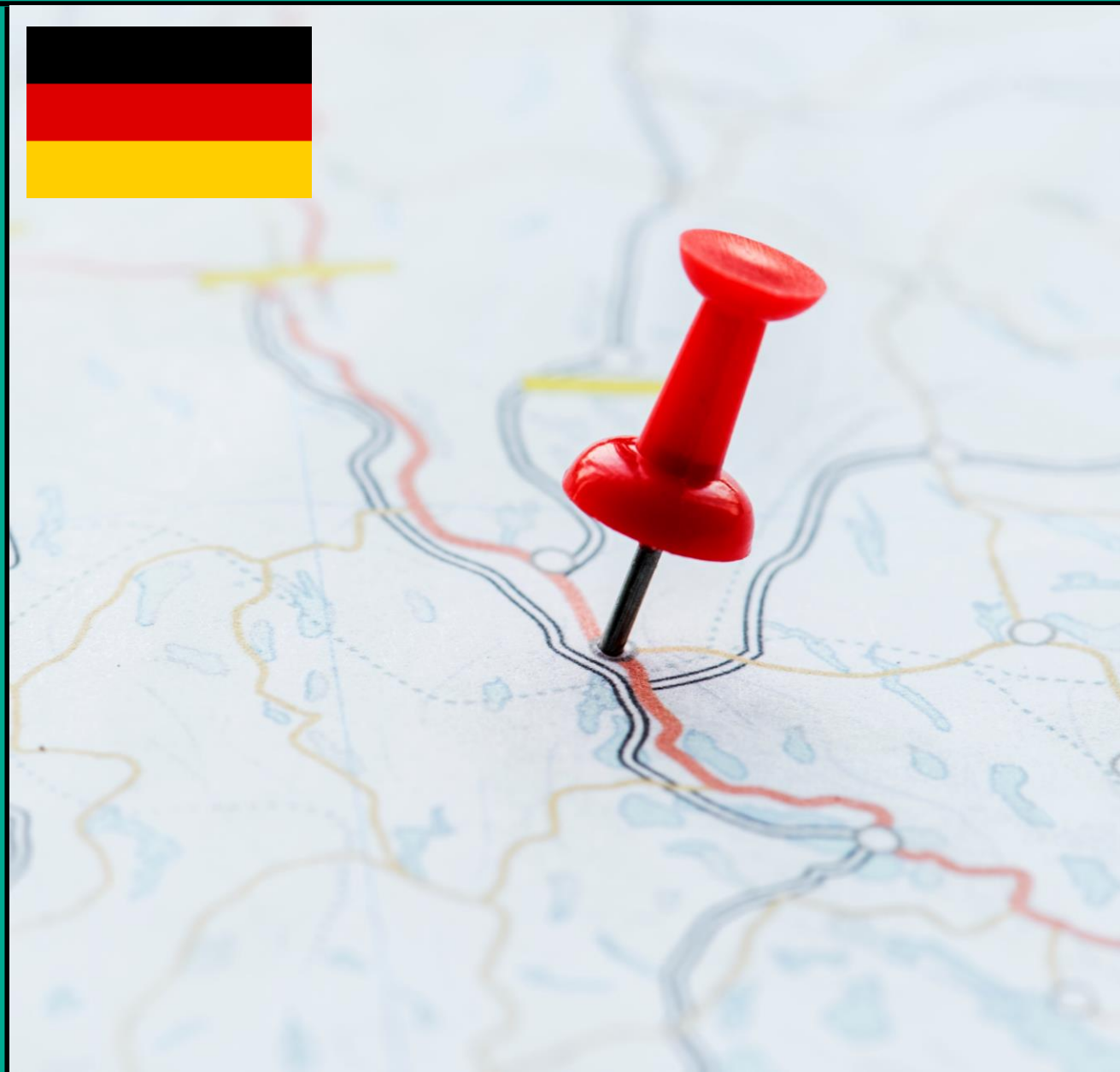
Source: ehb.eu

European Hydrogen Backbone is an initiative of **31 energy network operators** who have jointly defined an H_2 European network for **2040**

Key points are the **connections to Africa** and the **port area of Northern Europe**

Vision can be realized cost-effectively with **close cooperation between EU member states** and under **stable and regulatory framework conditions**

3 CURRENT SITUATION IN GERMANY



GERMANY'S HYDROGEN STRATEGY

The German government's hydrogen strategy was presented in June 2020

- **Production H_2 2030:** 1 million t/a (approx. 30-50% total energy demand D)
- **Demand by 2045:** increase to 265 TWh **(>70% import)**

- Future package of **€ 7 billion** for projects and **research & development**
- Additional **€ 4 billion for international partnerships**

- Development of a **domestic market** for hydrogen technologies
- Establishment as **market leader**

- According to the coalition agreement, electrolysis capacity by 2030: **10 GW** through expansion of offshore wind energy and international partnerships

Source: National Hydrogen Strategy, AGORA, hydrogeninsights

GERMANY'S HYDROGEN DIPLOMACY

German-Moroccan hydrogen agreement (2020):
Support for the production of green hydrogen, but the **project is currently on hold** due to the Western Sahara conflict

Research partner (2023):
+ France
+ Netherlands

Hydrogen alliance with New Zealand (2021): Research and further development of green hydrogen in New Zealand

German-Namibian hydrogen partnership (2021): Establishment of green hydrogen production

As a result of the changes planned for 2030 planned immense imports international relations are indispensable

Task force for hydrogen and synthetic fuels with the **United Arab Emirates (2021):** Deepening cooperation on green hydrogen

In 2021, the first **diplomatic offices** will be opened in **Nigeria** and **Angola**, followed by a third in **Saudi Arabia** in 2022

Hydrogen alliance with Canada (2022): Establishment of a supply chain for green hydrogen across the Atlantic by 2030 at the latest

And there are more to come!

Source: kooperation-international.de

VISION FOR A GERMANY-WIDE HYDROGEN NETWORK

Start of expansion with freed-up natural gas pipelines in the **Netherlands, Lower Saxony and NRW**

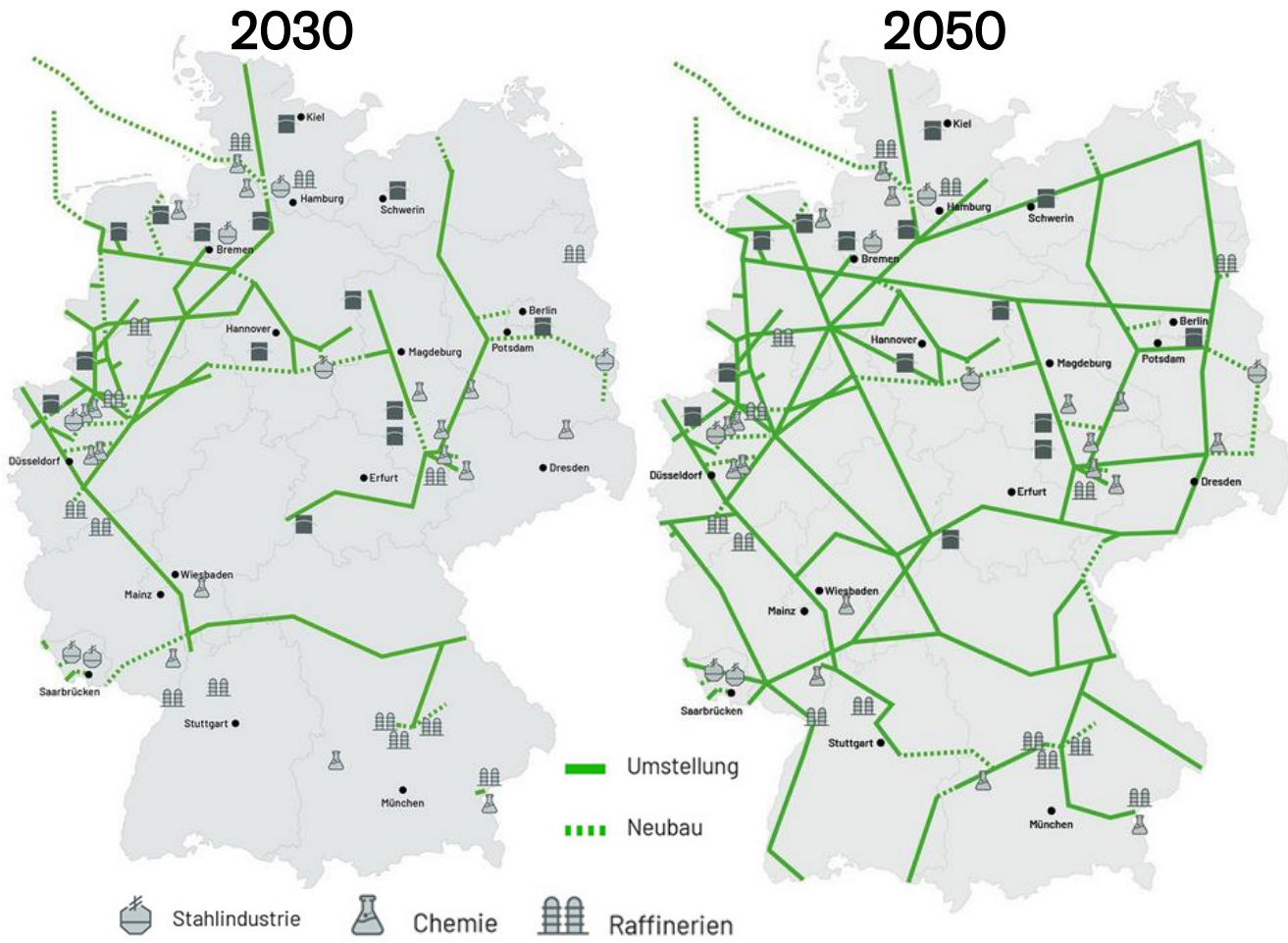
Vision comprises approx. **5,900 km of** pipelines and is based **>90% on the existing natural gas network**

H_2 -network 2030 approx. **5,100km** (of which **3,700km** converted gas pipelines)

-> Investments: **€ 6 billion**

Many projects **are already being planned** and some small projects are about to **start construction**

FNB scenarios for the H_2 grid



Source: Hydrogen Roadmap North Rhine-Westphalia. FNB Gas

HYDROGEN CORE GRID GERMANY FOR 2032

Start of construction: January 2024

Length: appr. 10.000km

Capacity: up to 270 TWh

Souce: Wasserstoff-Kernnetz_Karte fnb-gas.de, (Status now: 14.11.2023)

FOCUS: AFRICA

Algeria

VNG & Sonatrach

Establishment of a German-Algerian value chain for green hydrogen

Morocco

Alliance for the development of a Power-to-X sector

Egypt

Aflfanar (Saudi Arabia)

3.5 billion dollar project for the production of green ammonia

Indian ReNew Power Private Limited

8 billion € project for green hydrogen production (20,000 t/a)

BMWK

Strengthened partnership on green H_2 and LNG

Djibouti

CWP Global

Center for RE and green H_2 with **10 GW ELY capacity**

Mauritania

Project Nour Electrolysis Capacity: **10 GW**

AMAN electrolysis capacity: **30 GW**

Nigeria

Hydrogen office

Kenya

Fortescue

Production volume 2025: **1.7 Mt/a**
Ammonia capacity 2025: **300 MW**

EIB

Closer cooperation on the topic of green H_2

BMZ

Min. € 112 million for complete switch to renewables by 2030 (also green H_2)

Burkina Faso

PV2H

Study for green H_2 production using PV electricity

Angola

Green ammonia production

From 2024 280,000 t/a

Namibia

Hyphae

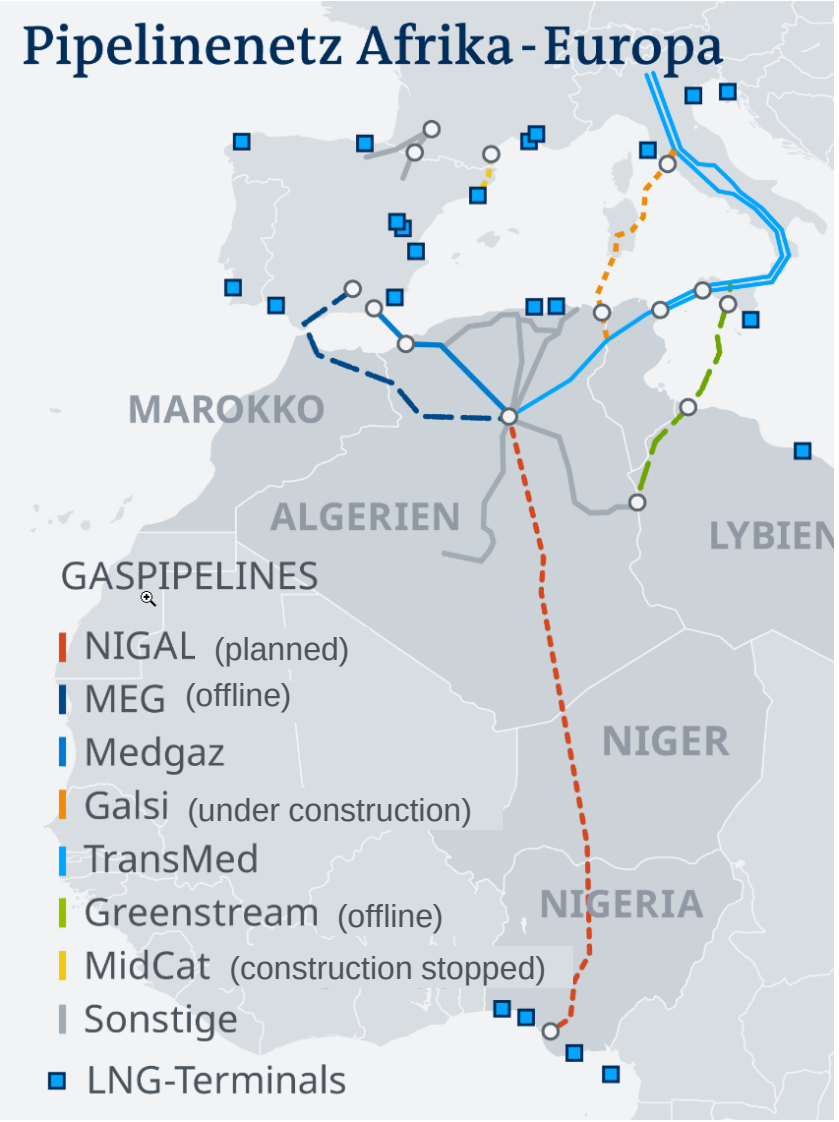
Electrolysis capacity: **3 GW**

South Africa

Electrolysis capacity 2030: **12 GW**

Source: Various internet sources

TRANSPORTATION TO EUROPE



North Africa has **natural gas pipelines** to Europe

Shipping from North Africa is efficient, but more expensive than pipelines

Rotterdam to become **hydrogen port** and plans H_2 pipelines to Germany

LNG terminals in Germany should also be able to import hydrogen in future

Source: Enlit, DW

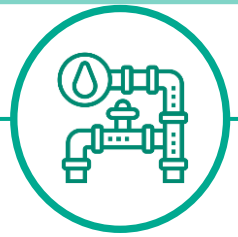
4 CONCLUSION

4 CONCLUSION

Hydrogen important for **decarbonization**, especially in **energy-intensive industry**

Market development already in full swing, **research** in full swing

Plans for infrastructure already in place



Many **international collaborations** on the topic of H_2

East Africa can play a **decisive role** in the hydrogen market with geothermal as source

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