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THE FUNCTION OF SALT CAVERN STORAGES IN THE FRAMEWORK OF NATIONAL AND EUROPEAN ENERGY SUPPLY – BY EXAMPLE OF THE ETZEL CAVERN STORAGE

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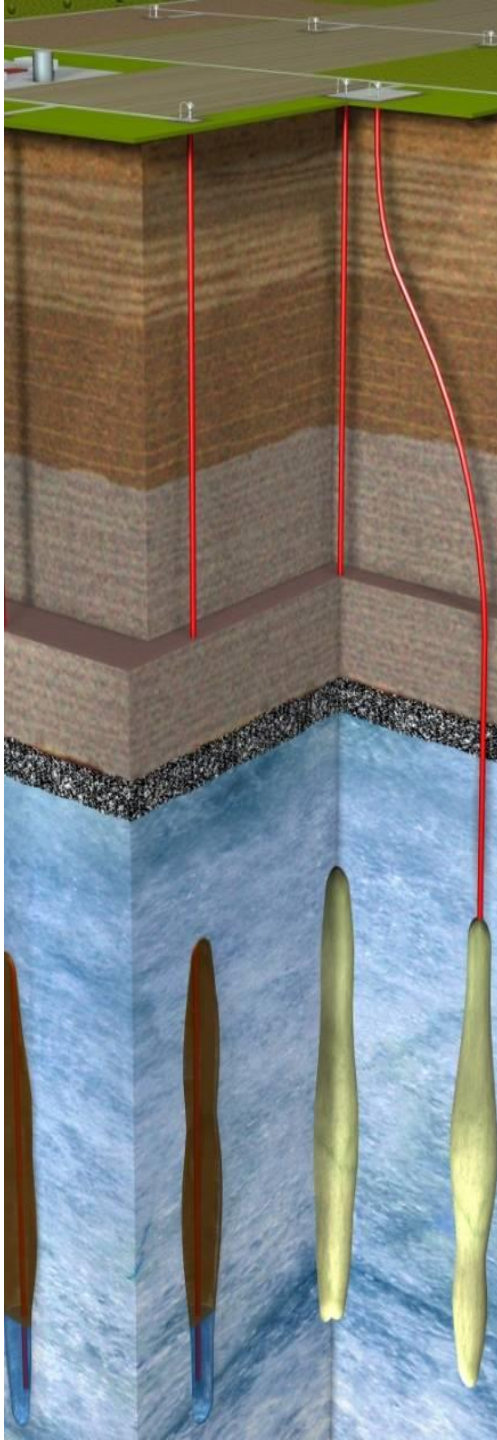
IVG
Passion for Real Assets

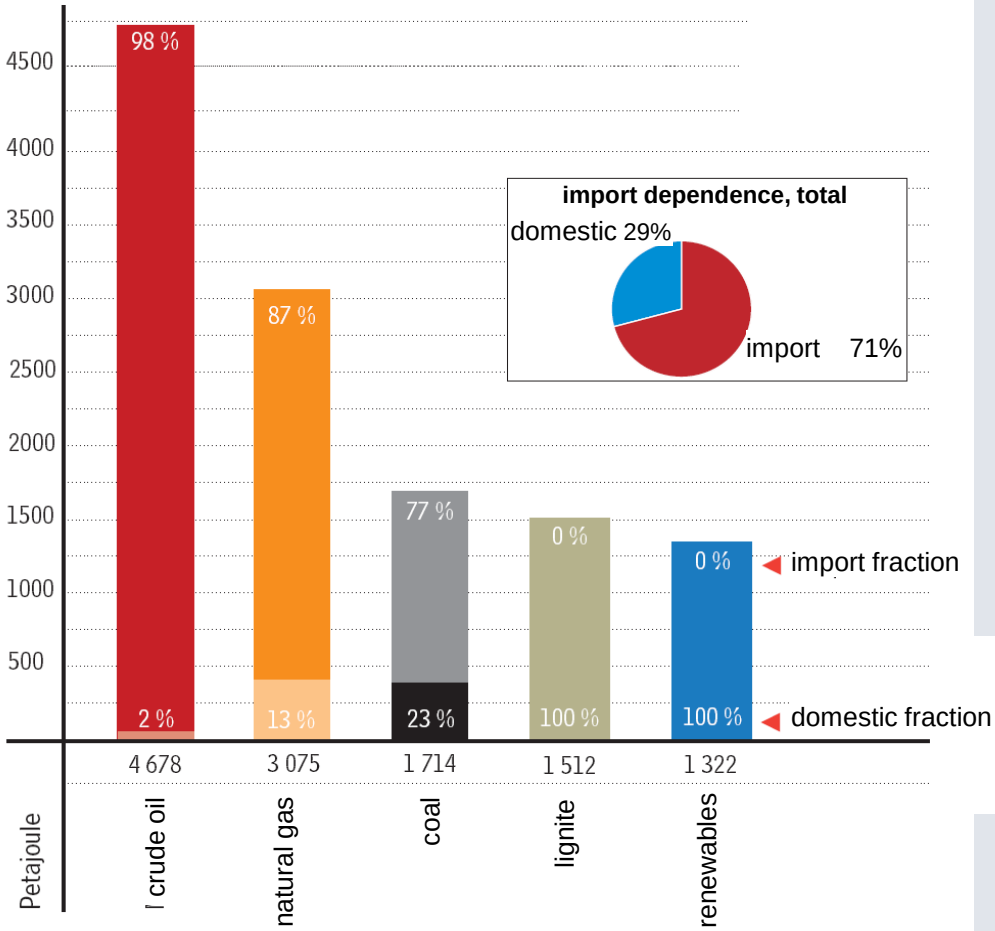


Outline

The Function of Salt Cavern Storages in the Framework of National and European Energy Supply

Primary Energy Supply of Germany

Self-Supply and Import (2010)



- **strong dependence on import of energy resources**
  - crude oil 98 %
  - natural gas 87 %
  - coal 77 %
- **high energy demand of German industry and economy**
- **high standard of living**
- **climate conditions**

→ **economic need to stockpile energy raw materials**

Source: Arbeitsgemeinschaft Energiebilanzen e.V., 2010 AGEB

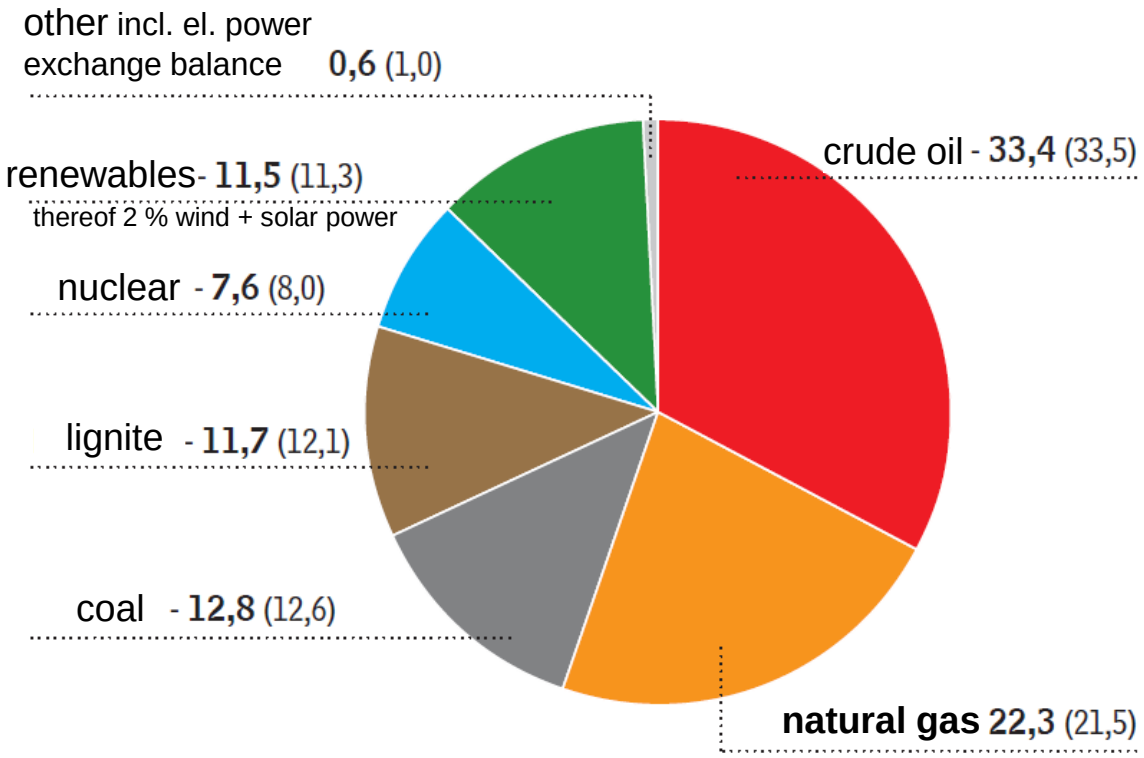
Energy Mix

2013

Natural gas and renewables increase their share

Structure of primary energy consumption in Germany

ratio in [%] (previous year in brackets)
total 13,908 PJ or 474.5 m t CE



Source: Arbeitsgemeinschaft Energiebilanzen (AGEB)

main gas suppliers:

• Russia	34 %
• Norway	31 %
• The Netherlands	19 %
domestic production	12 %

Motivation for Underground Storage

Stockpiling of Energy Resources
security of supply in case of

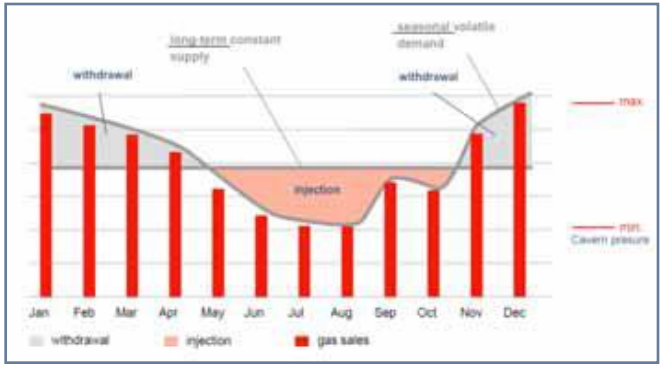
- fluctuating consumption (seasonal swing)
- technical disturbances in supply

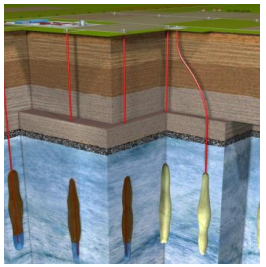
Safety: protection against

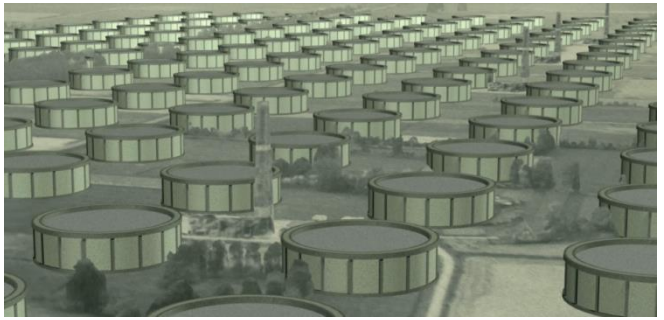
- war damage
- sabotage
- disaster (weather, accident)

Environmental Protection

- transport in a confined system
- little surface area



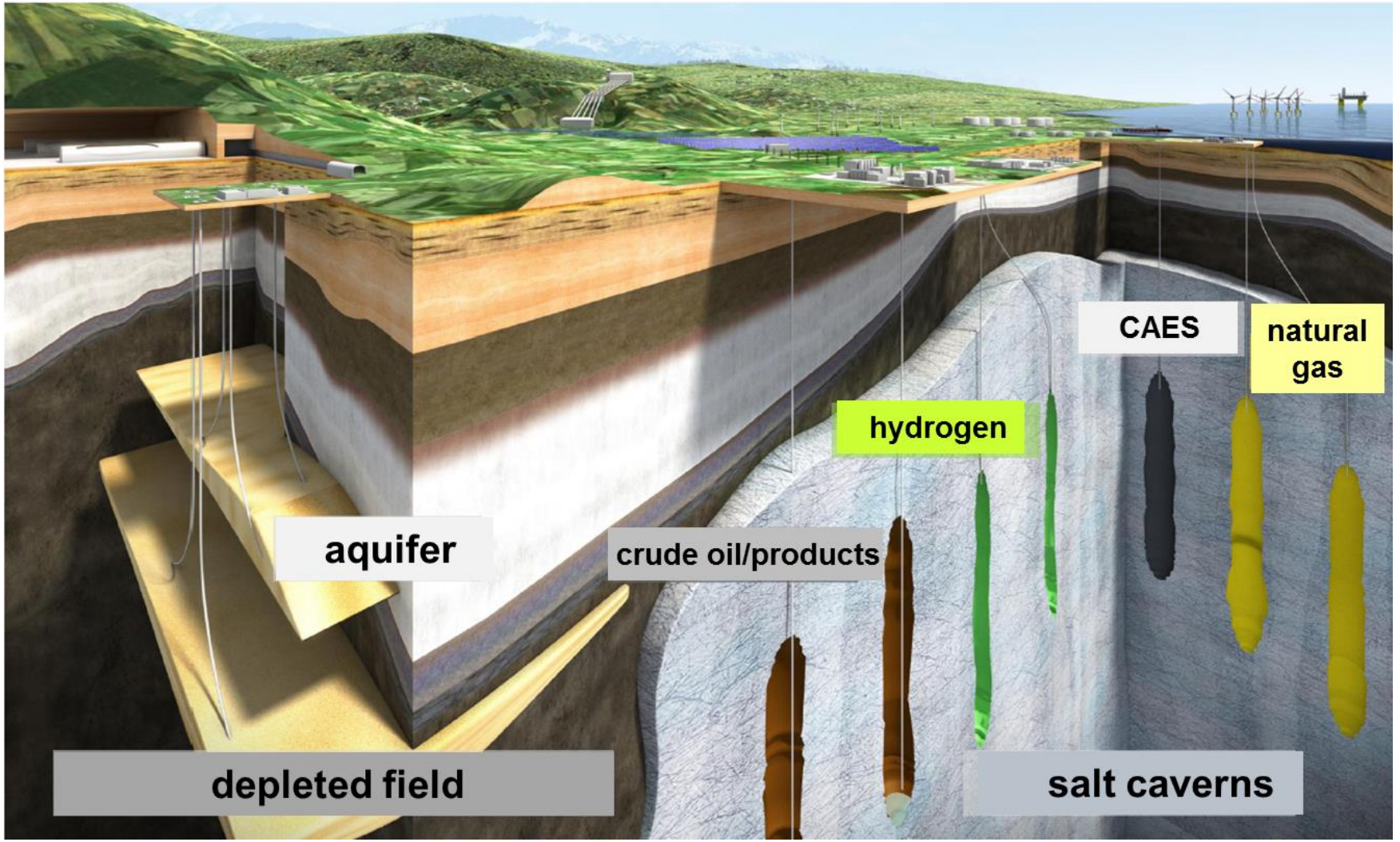




Pictures: EGS, IVG Kavernenspeicher Etzel: DEEP./KBB

Types of Underground Storages

Caverns for energy long-term storage



Source: KBB

Function of Crude Oil Cavern Storages

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Stockpiling for Crisis

- national petroleum reserve (crude, products) in case of supply interruptions
- regulated on statutory basis
- organized by stockpiling agency (public corporation)

Short-term Storage / Arbitrage

- subordinate importance
- only under specific economic conditions
- on initiative of oil trading companies
- risky (in respect to success)

Function and Development of Gas Cavern Storages

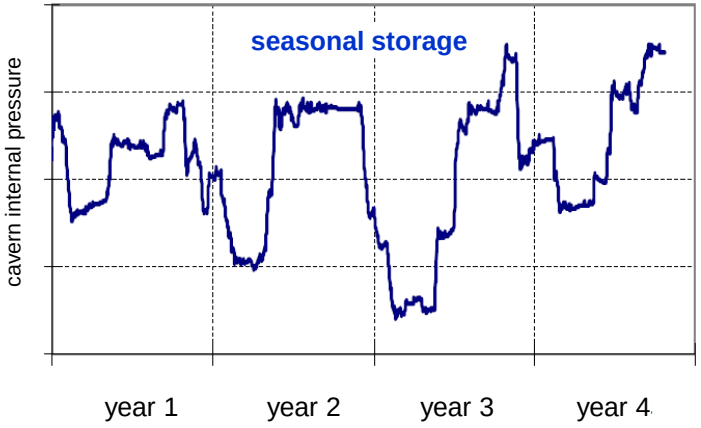
in the past

Phase 1: Safeguarding of Supply Contracts

- establishment of buffer storages
- to care for uncertainty of production or transport

Phase 2: Seasonal Storage

- to balance seasonal consumption
- to cover peak demand

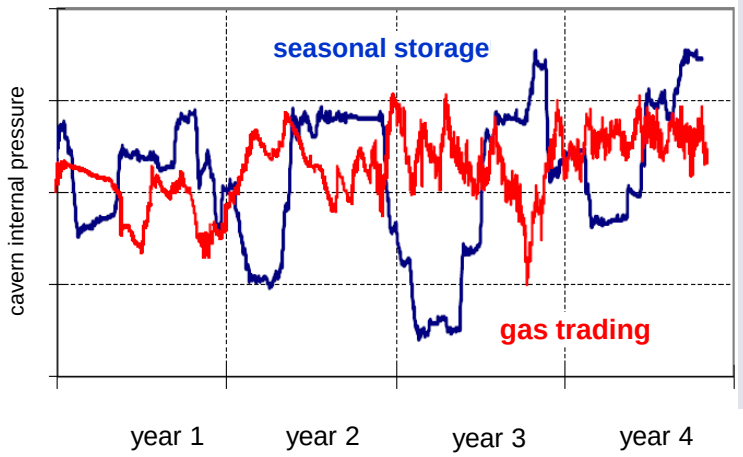


Function and Development of Gas Cavern Storages

today & tomorrow

Phase 3: Increase of Gas Trading

- resulting from liberalization of the European gas market
- diversification of supply
- enhancement of gas infrastructure
- installation of „hubs“



Phase 4: Entry to Storage of Renewable Energies

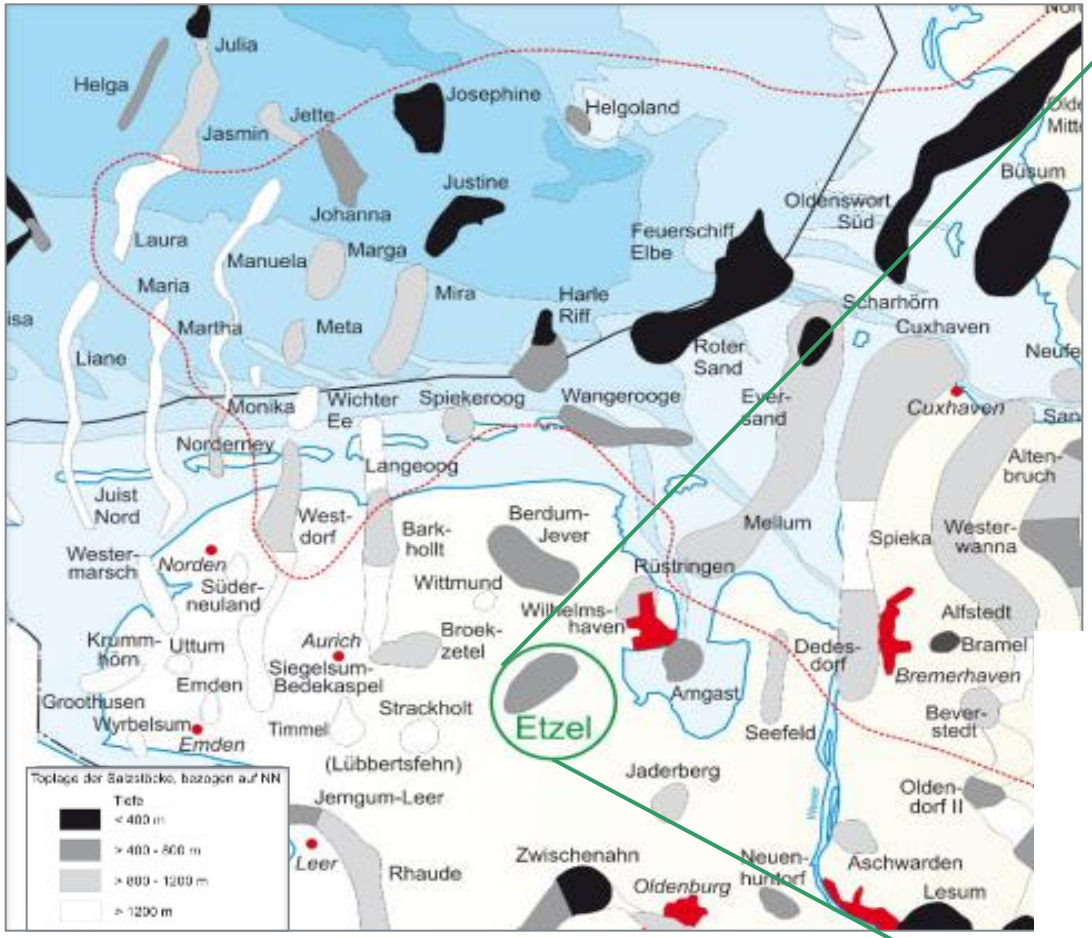
- transformation of electricity into mechanical energy (CAES)
- transformation of electricity into chemical energy carriers (PtG: H_2 or SNG)

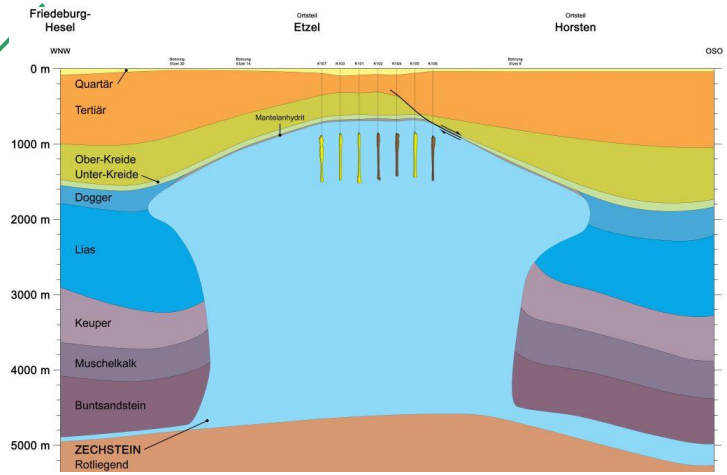
➡ re-conversation to electrical power to support grid stability and balance peak demand

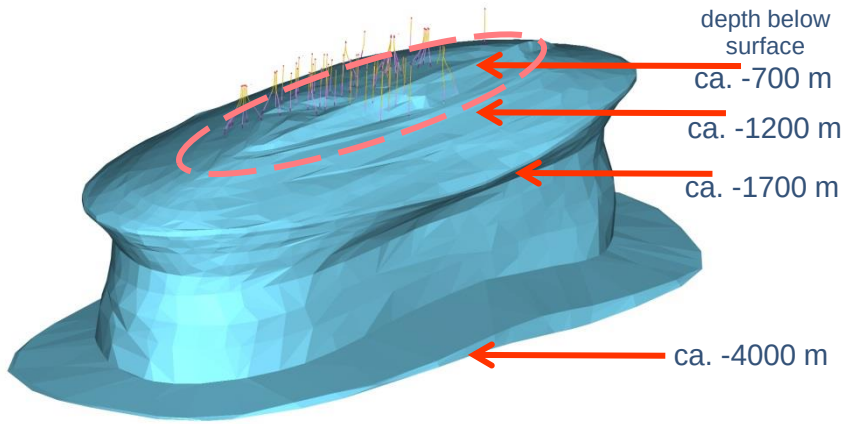
- storage of heat energy

Etzel Cavern Storage – Geographical & Geological Situation

Favorable conditions for cavern development







Favorable Conditions for the Etzel Site

Sea water withdrawal, brine disposal & crude oil infrastructure

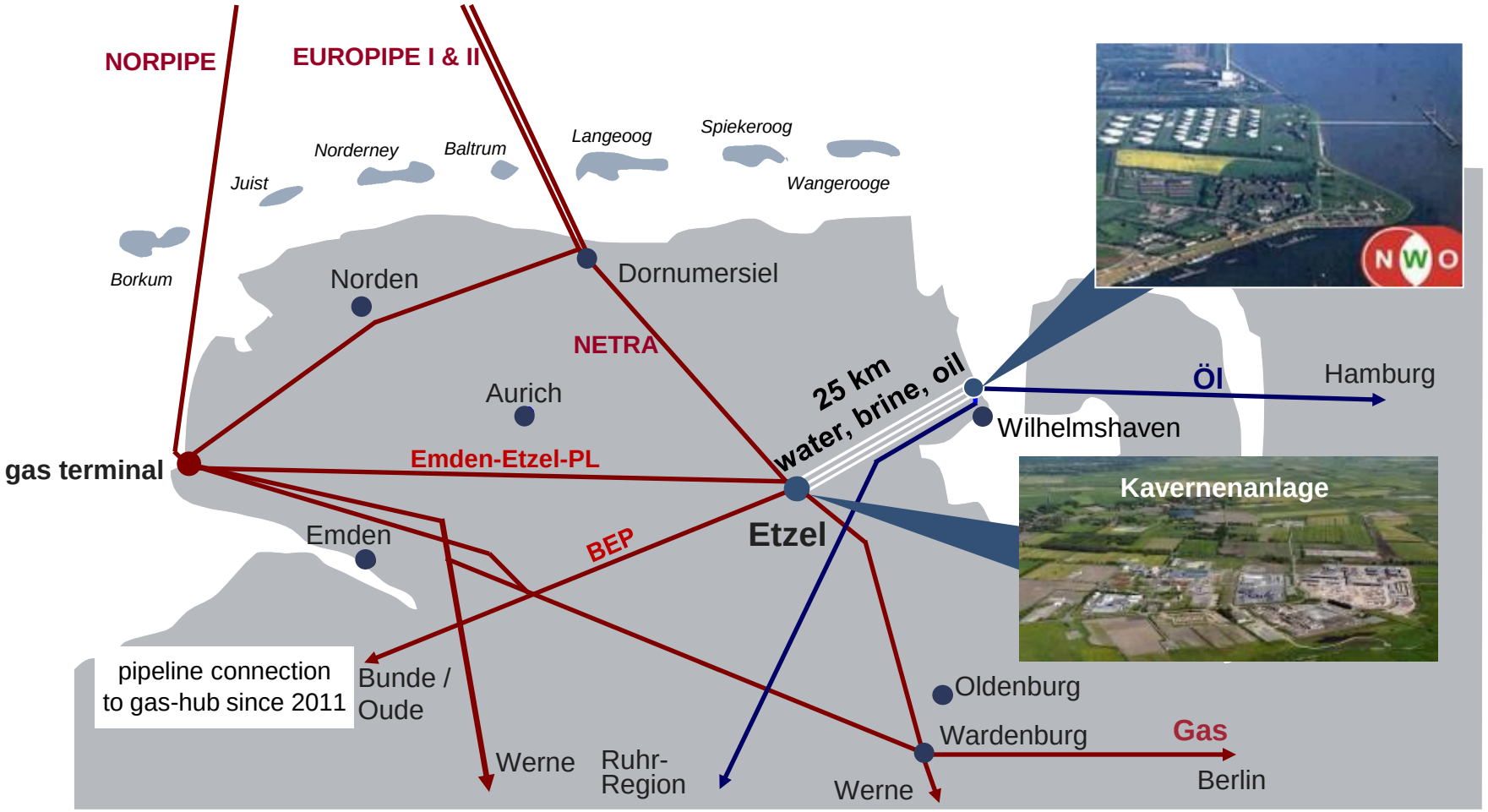
sea water withdrawal

NWO crude oil jetty and tank farm

brine disposal

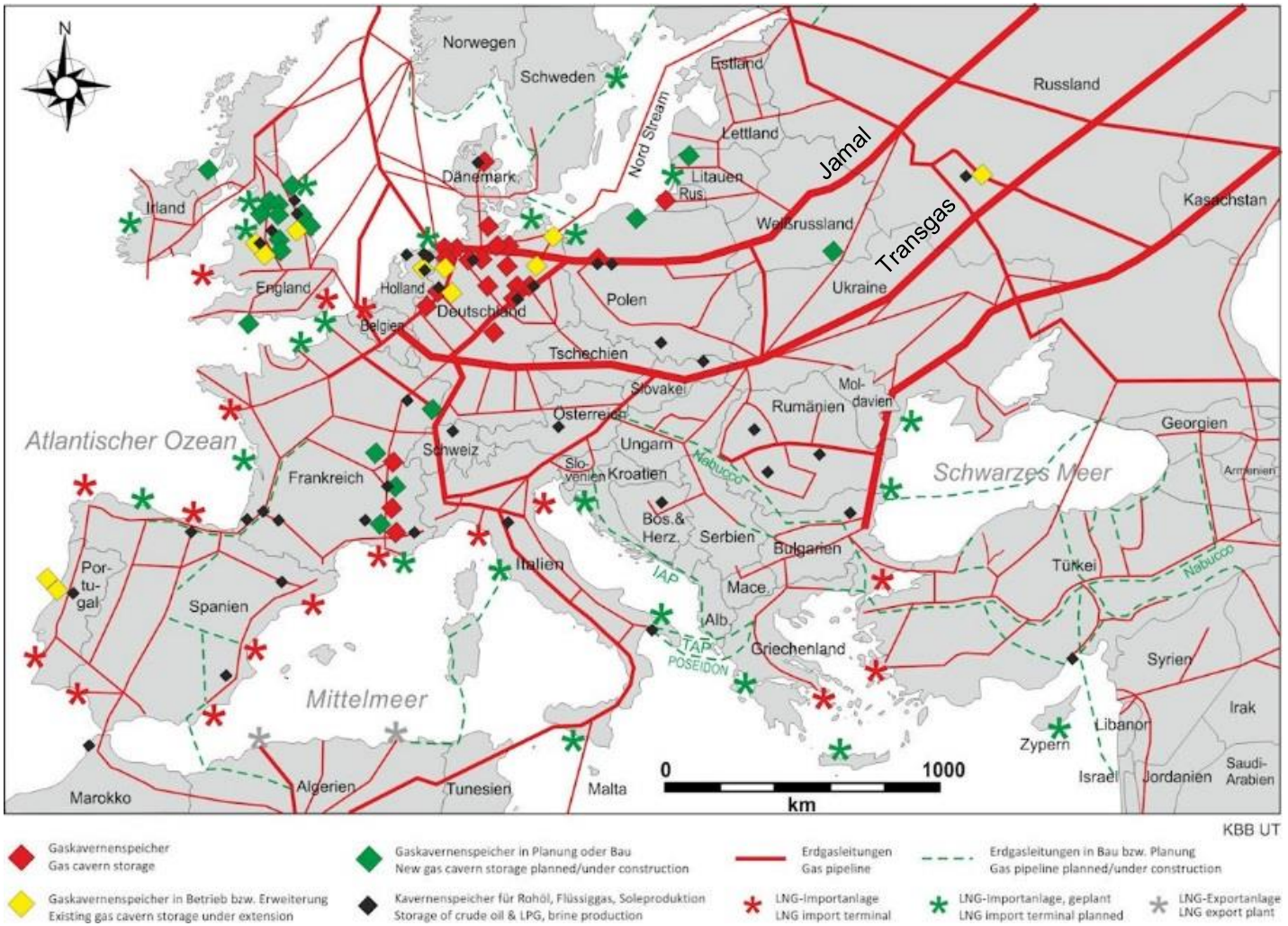
Connection to Supply Systems for Crude Oil and Natural Gas

Etzel Cavern Storage – Pipeline-Connections



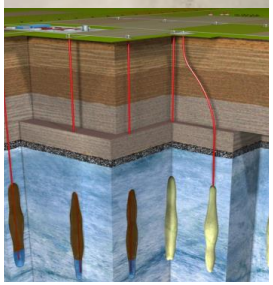
Supply Systems for Natural Gas

Gas on the way to central Europe



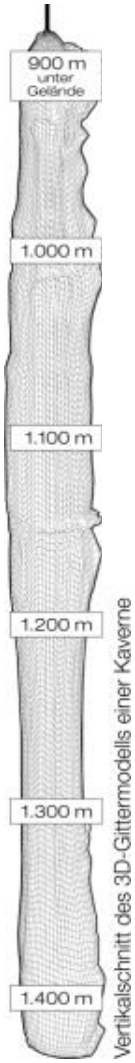
Source: KBB-UT

IVG Cavern Business – at a Glance



Facts

- IVG has been operating the cavern business since1971:
  > 40 years **experience** with construction, operation and lease of caverns
- Storage of a major part of the **strategic petroleum reserve** for Germany and other European countries
- **Interim storage** of import gas volumes
  - for seasonal balancing of consumption
  - coverage of peak demand
- Cavern **lease by long-term contracts**
  to customers from the energy branch
- Today, the cavern site comprises **73 caverns**
  - **crude oil** (24 caverns) ~ **10 m m³**
  - **natural gas** (49 caverns) ~ **4.2 bn Sm³** WGV
- Additional caverns are under construction
- If required, the storage is ready for further expansion

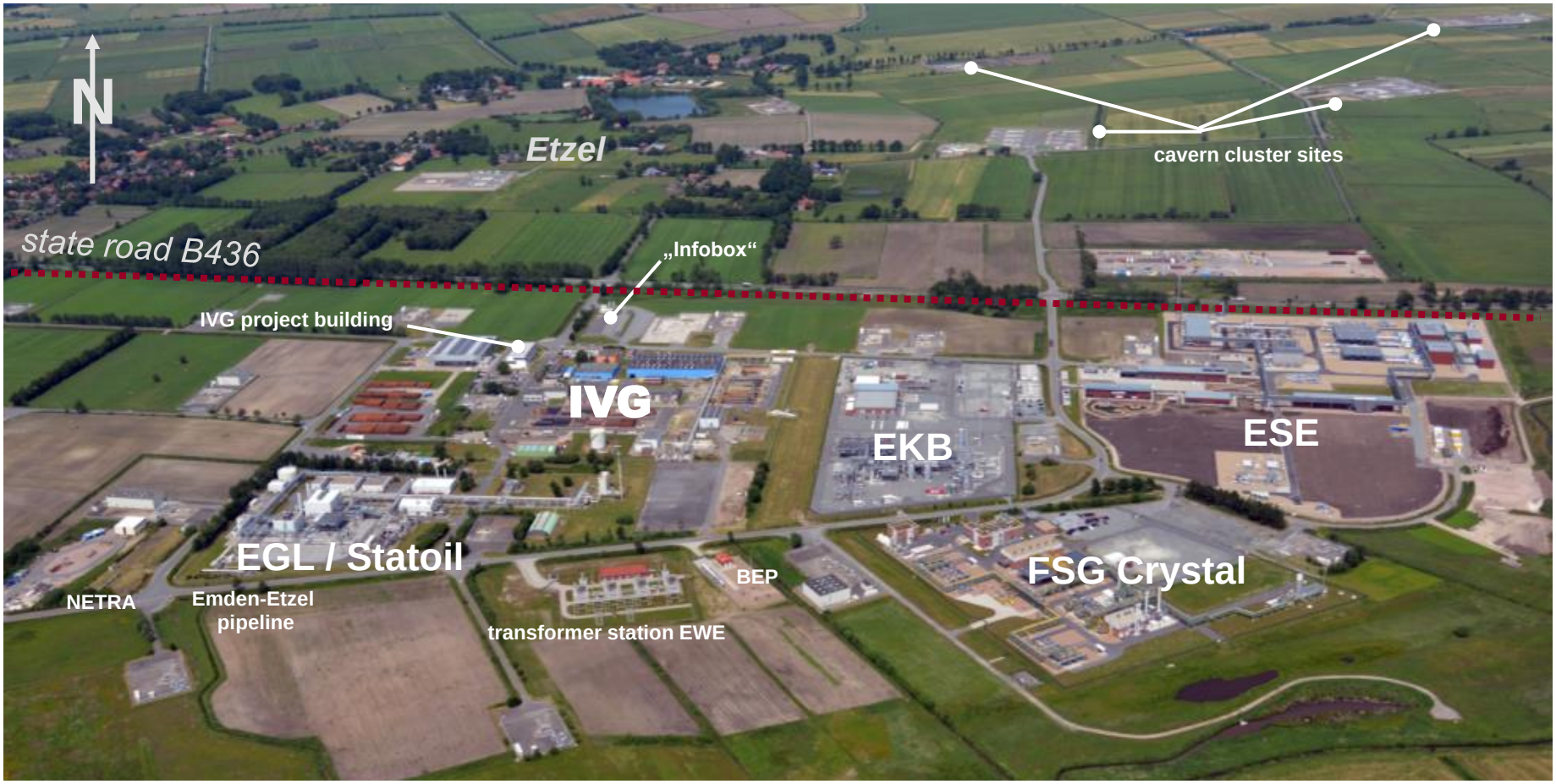


Vertikalschnitt des 3D-Gittermodells einer Kaverne

Status: July 2014

Etzel Cavern Storage

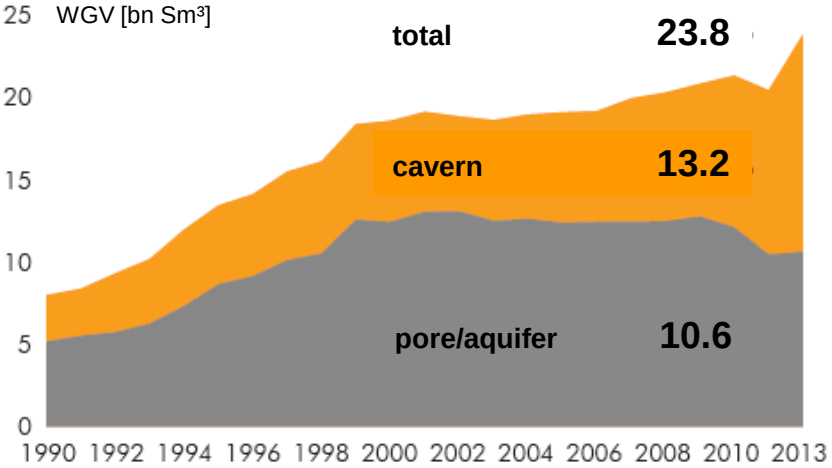
Above ground facilities, cavern sites and tenants



Development of Storage Capacity in Germany

in comparison to storage capacity of other European countries (2013)

Development of Storage Capacity in Germany



24% of the German natural gas consumption can be covered by underground storages

Underground Storage Capacity in the EU

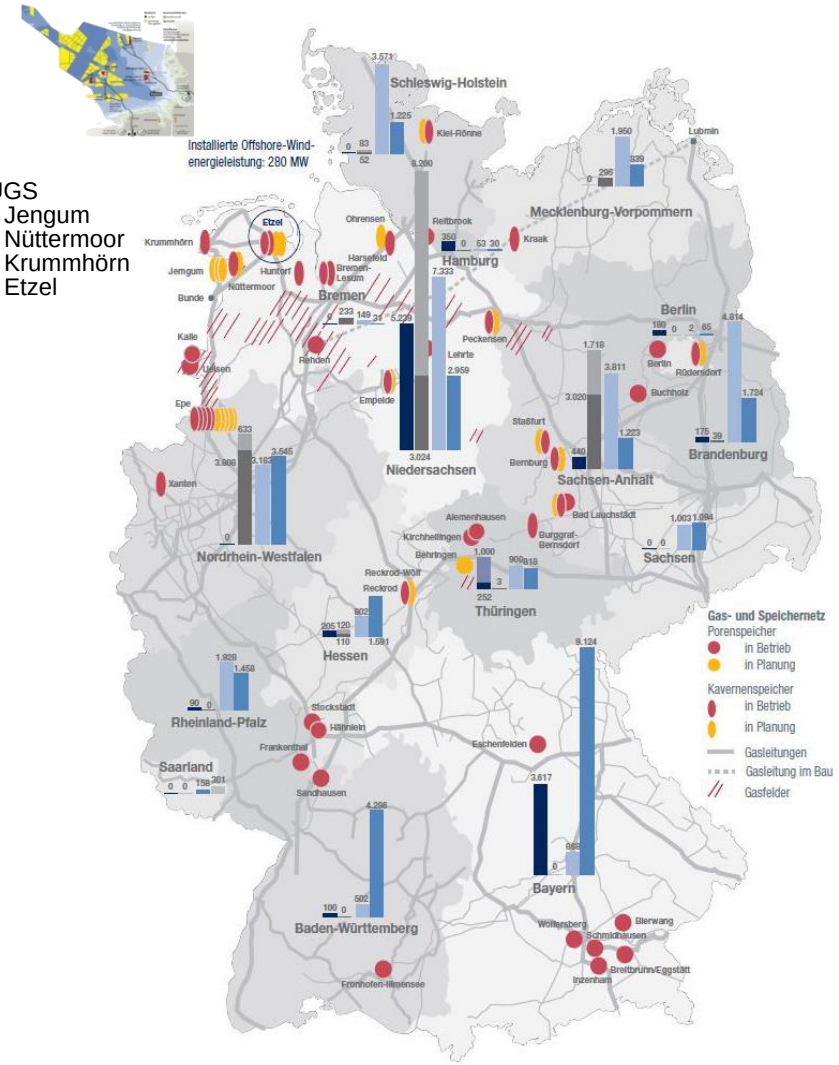
Working Gas Volume [bn Sm³]

- Germany is comparatively well secured by existing transport systems and underground storages
- Establishment of a Strategic Gas Reserve in political discussion
- Potential for European gas balancing system

Source: WEG, IGU

Underground Storages vs. Wind & Solar Power Generation in Germany

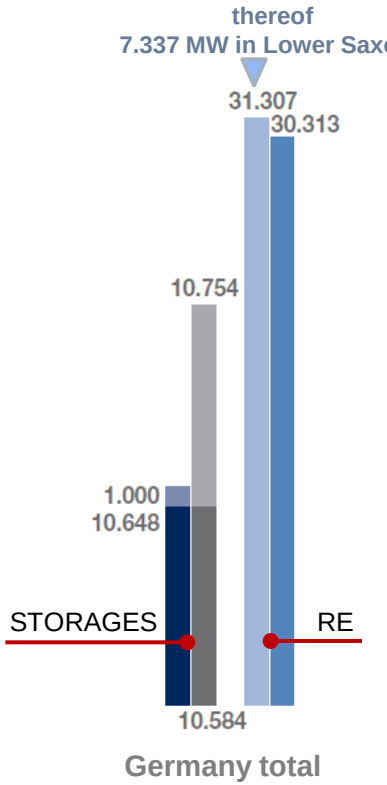
Regional distribution

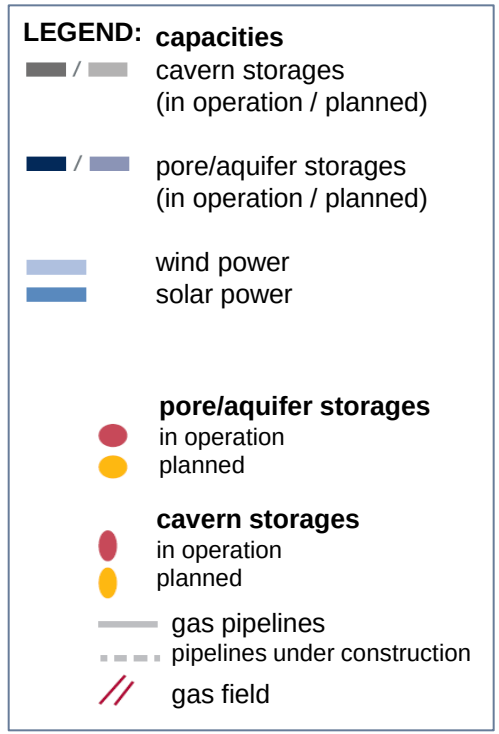


UGS
- Jengum
- Nüttermoor
- Krummhörn
- Etzel

Lower Saxony is in front in regard to

- **gas production**
- **wind power generation** (on-/off-shore)
- **underground storage**



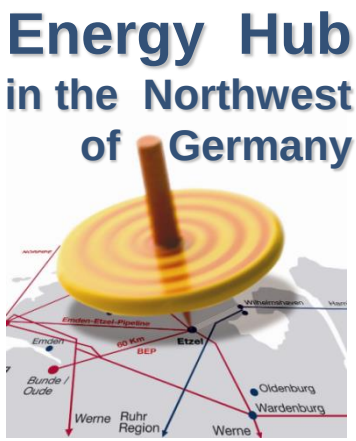


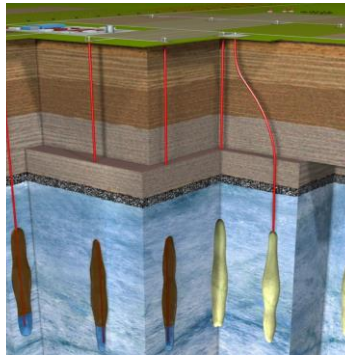
Capacity of German states (2012)
Source: IVG Research acc. to data from BMU / LBEG, KBB

Salt Caverns – Energy Storage Today and Tomorrow

Bulk storages also for renewable energies

- Cavern storages are of strategic importance for **security of supply** in Germany
- The Northwest of Germany is becoming an important energy region due to the further development of wind parks and the existence of underground storages
- Caverns can play a key role in future energy supply because they are suited to store excess electrical power in form of **compressed air** (CAES), **hydrogen** (H_2) or **synthetic natural gas** (SNG)





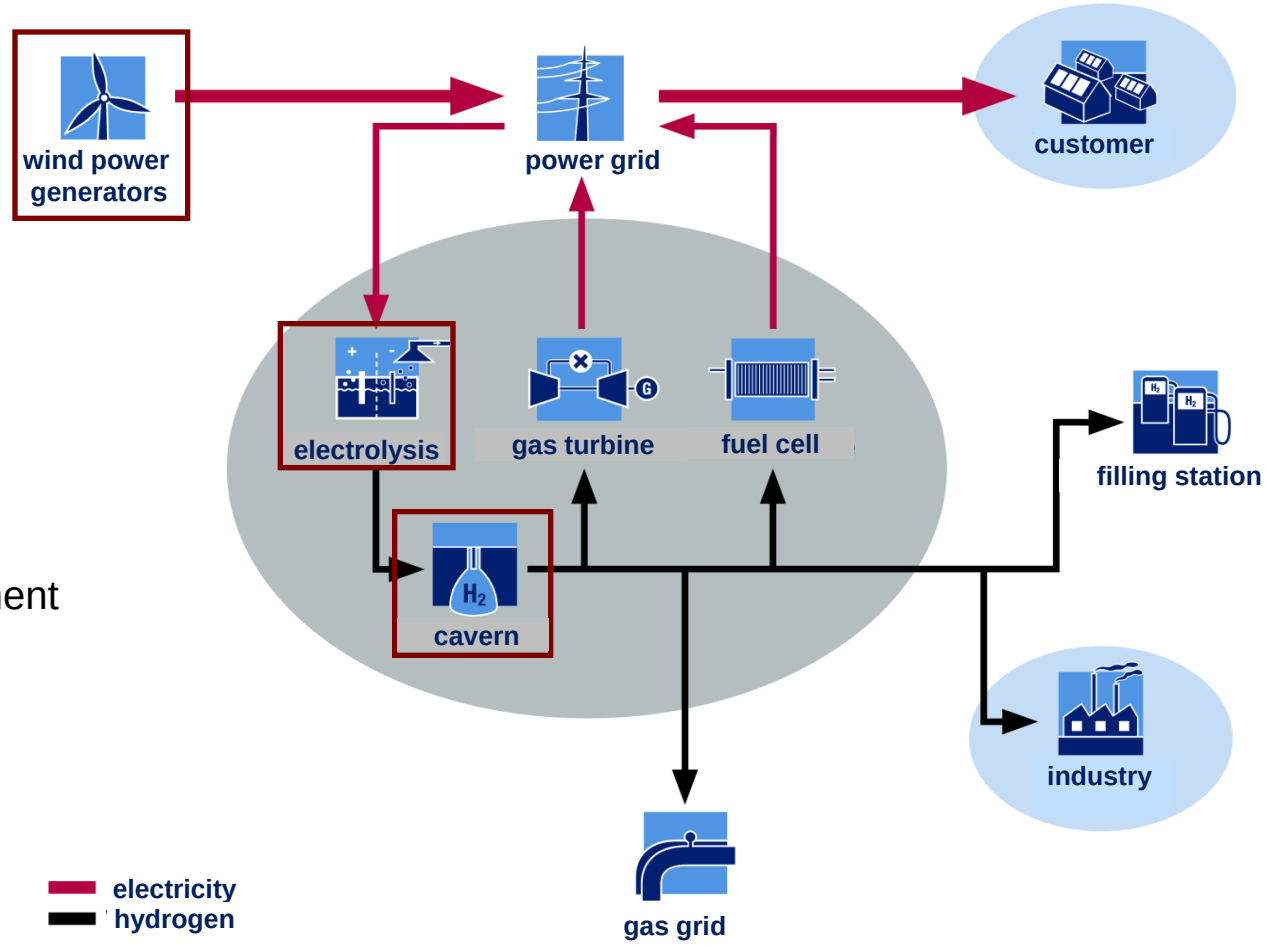
Challenges

- research & development (system efficiency, facilities at industrial scale)
- public acceptance
- competitive ability on the energy market

Pilot Plant „Wind Hydrogen Storage“ at Etzel

Long term storage of renewable energies (wind, solar)

- connection to WPG / windparks
- hydrogen generation by electrolysis
- caverns, energy storage and supply chain management



▶ Pilot plants are essential to demonstrate the feasibility of new technologies and to promote the development of new systems towards industrial level and economic use.

Conclusions

Function of underground storages

➡ **Security of Supply** for crude oil and natural gas

- strategic reserve against crisis
- safeguarding of short term supply disruptions
- balance for seasonal fluctuations of consumption
- coverage for peak demand

requirements:
- safe & reliable
- environmental friendly
- flexible, available at call
- economic and affordable

➡ **Challenge** due to energy turnaround:
Storage of renewable energies

- hydrogen storage (system „Power-to-Gas“) → long term storage
- compressed air energy storage (CAES) → peak demand
- heat energy storage

Challenge for the Energy and Gas Industry

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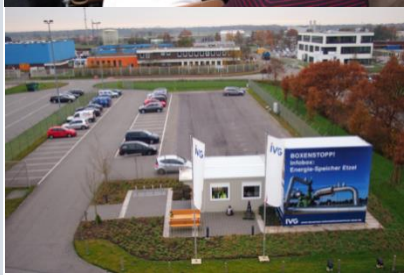
Technical and economic tasks

- safety and environmental protection with production and transport
- enhancement of network
- utilization of versatile supply
- structuring of energy sector to manage the complexity of the system
- research & development
- storage tailored to the market need
- cost control for energy supply

Communication and public relations

- consideration of the **social environment**
- cooperation with politics, federations and authorities in order to establish **planning reliability**
- generation of social **confidence and acceptance** by objective information and transparency



Thank you for your attention!

Questions?

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Passion for Real Assets