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WORKSHOP
Introduction to Underground Hydrogen Storage Developments: *Identifying and Overcoming Technical Challenges*

LECTURES

- **The promise of hydrogen and the role of underground storage**
  - Dr. Karin de Borst, SHELL
- **Hydrogen: The flexibility powerbroker?**
  - Nassar Pragt M.Sc., KRACHTWERK
- **Global sweet-spotting of low carbon hydrogen**
  - Max Brouwers M.Sc., MBA, GETECH
- **The need for and potential of underground hydrogen storage in depleted gas fields in the Netherlands**
  - Bastiaan Jaarsma, M.Sc., EBN
- **Hydrogen storage in porous reservoirs – state-of-the-art and technical challenges**
  - Dr. Remco Groenenberg, TNO

BREAKOUT SESSIONS

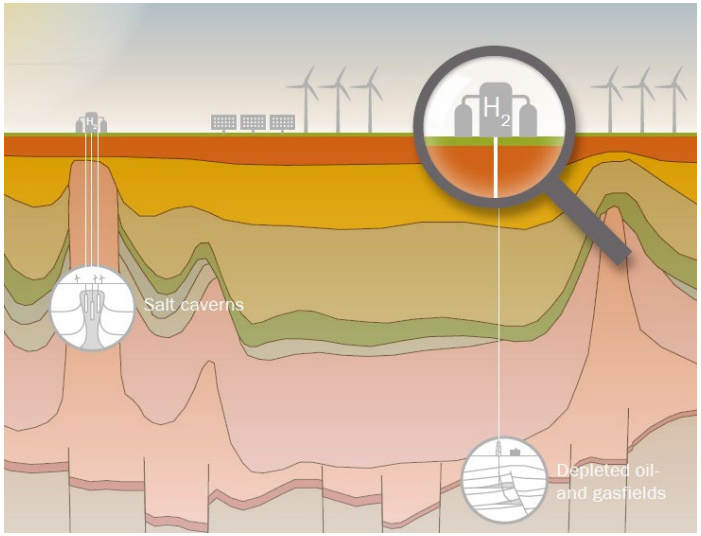
- Working sessions on Reservoir engineering, Geomechanics, Geochemical and Biogenic processes, Facilities and Wells

LOCATION, DATE & TIMINGS

- Energy Cave, Rijswijk, The Netherlands; 10:00 – 18:00; 15th February 2024

Sponsors

KRACHTWERK TNO ebn



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Karin de Borst

Hydrogen Storage Lead, Shell

Karin de Borst is a subsurface specialist at Shell with experience in CO2 storage and H2 storage. She currently holds the position of Hydrogen Storage Lead, in which she is developing subsurface storage technologies with an interdisciplinary team in support of Shell's evolving H2 business.

Karin has a PhD in Computational Mechanics and was pursuing an academic career in the field of material science before joining Shell in 2015, having been Reader in the School of Engineering at University of Glasgow in her last role.

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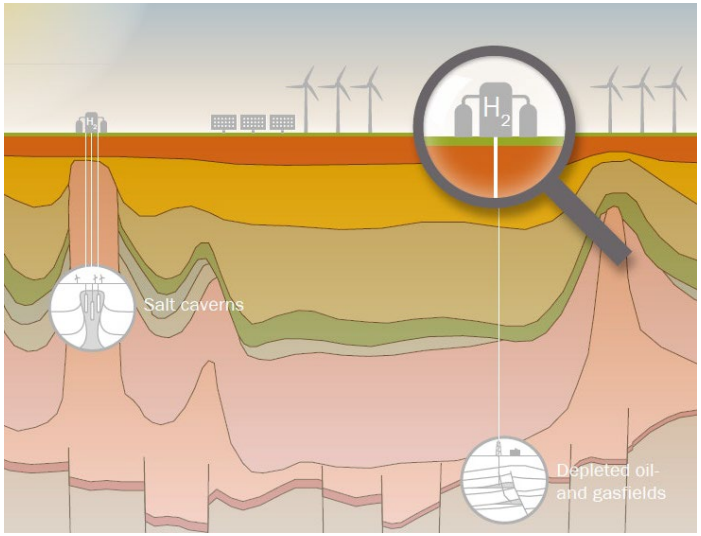
Lecture 1: The promise of hydrogen and the role of underground storage

Hydrogen is expected to be crucial for reaching a net-zero emission energy system. It can be transported over large distances and stored over long periods of time, as opposed to electricity. Hydrogen serves as an energy carrier that can balance the intermittency of renewable energy sources in space and time and, hence, a higher share of renewable energy is provided to the energy system. Moreover, its relatively high energy density in combination with a low carbon footprint allows for both centralized as well as de-centralized use in e.g., hard-to-abate industry sectors and heavy-duty transport. Offering a balancing mechanism to the energy system will require large-scale storage facilities, which are most cost-effectively realized in the subsurface, using mined salt caverns, depleted reservoirs, or aquifers.

This presentation will outline decarbonization pathways with hydrogen and its multiple sources and production processes before zooming in on storage. By introducing underground storage concepts and their role in scaling up the hydrogen economy, it will lead into the ensuing technical talks addressing purposes and challenges of underground storage in more detail.



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KRACHTWERK

Nassar Pragt

Technology Consultant, KRACHTWERK

Nassar has worked as a technology consultant in the energy sector for more than a half a decade. He brings deep technical knowledge from his background as Petroleum Engineer together with his consulting experience to translate challenges into solutions.

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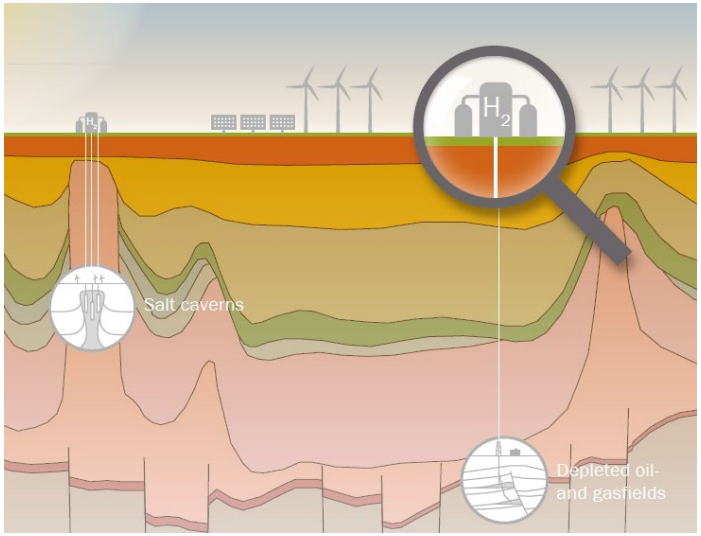
Lecture 2: Hydrogen: The flexibility power broker?

Hydrogen is playing an important role in the EU's energy transition strategy. The first applications will be as a feedstock for heavy industry and energy storage. However, hydrogen will be part of the larger energy market. This potentially unlocks new revenue streams that currently are often overlooked.

As the share of renewable energy increases, so does the volatility on the grid. One of the main solutions is more flexibility on both the supply and demand sides. Hydrogen assets offer that flexibility. A service that can be sold creating additional revenues.

Krachtwerk analysed the different roles hydrogen can play as part of the flex and energy market. How it changes the value chain and creates new sources of revenue. And how it impacts business cases, creating either totally new ones, opening previously unprofitable ones or increasing margins. During this lecture you will learn how the energy market operates and the outcome of the analysis.



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getech

Max Brouwers

Chief Business Development Officer, GETECH

Max Brouwers is a senior executive driving the energy transition. He works as Chief Business Development Officer for Getech, where he leads the growth for all of the company's priority sectors: geothermal, low-carbon hydrogen, critical minerals, plus CO2 & energy storage.

Max started his career at Shell in 1996 and his last role there was Vice President Exploration for Europe, Russia and Caspian. He is also the chair of the AAPG Energy Transition Forum, member of the UK Subsurface Taskforce and has an MBA plus an MSc in Geology.

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Lecture 3: Global sweet-spotting of Low Carbon Hydrogen

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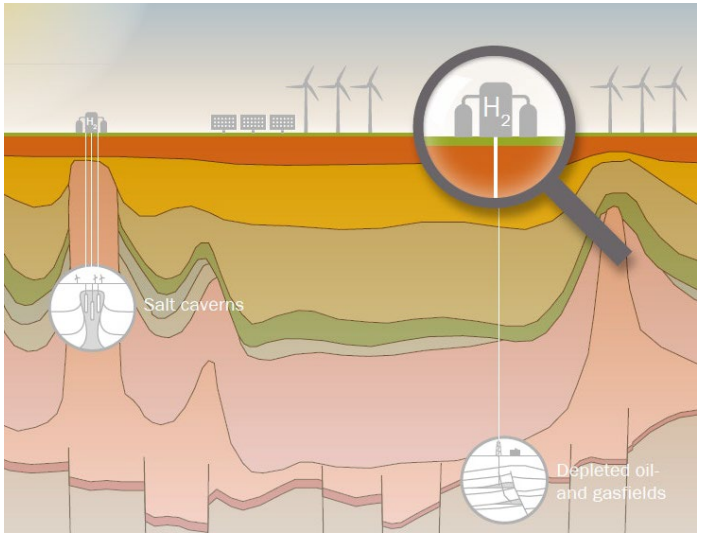

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Bastiaan Jaarsma

Project Manager Energy Storage Studies, EBN

Bastiaan Jaarsma has been working at EBN since 2011; first on oil & gas exploration and (induced) seismicity, followed by coordinating a technical program on ultradeep geothermal energy. For two years, Bastiaan is leading EBN's program on underground hydrogen storage, with activities covering many aspects of this evolving technology.

Before joining EBN, Bastiaan worked in the oil and gas industry. Bastiaan holds a Masters in Geophysics from the University of Utrecht and is married with 4 children. In his free time, Bastiaan is active in a local field hockey club.

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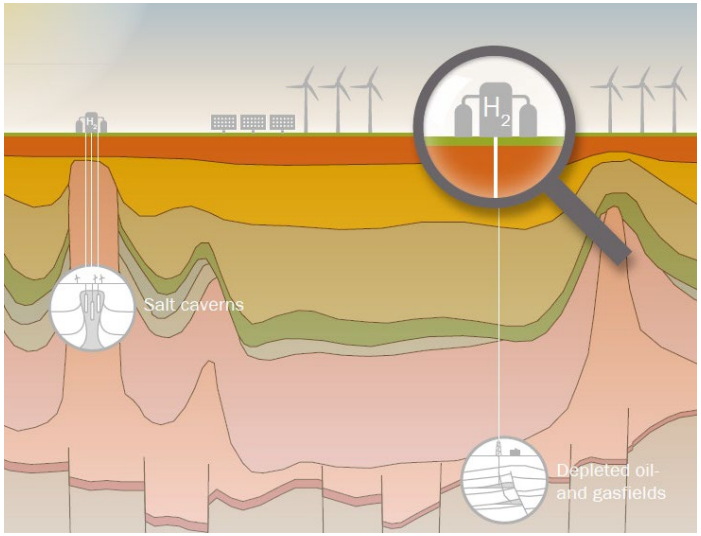
Lecture 4: The need for, and potential of underground hydrogen storage in depleted gas fields in the Netherlands

Timely availability of sufficient underground hydrogen storage is essential for the development of a sustainable hydrogen chain and therefore for achieving the Paris climate goals. This storage is necessary to balance fluctuations in supply and demand of renewable hydrogen and thus serves the security of supply during seasonal peak energy demand and the growing use of hydrogen in industry.

Underground storage in onshore salt caverns is currently the most developed technology. The first caverns for cyclic hydrogen storage in the Netherlands will be in operation around 2030. The storage requirement will continue to grow rapidly in the thirties. Therefore, all options and alternatives for underground hydrogen storage must become clear as soon as possible, both onshore and offshore.

A lot of research is underway into the possibilities of storing hydrogen in empty gas fields. A pilot project will have to show what the feasibility is specifically for Dutch gas fields. The possibilities for reuse of existing gas infrastructure and installations are considered, in addition to screening of salt structures and gas fields in the Dutch subsurface for suitability and availability for a second life as underground hydrogen storage.



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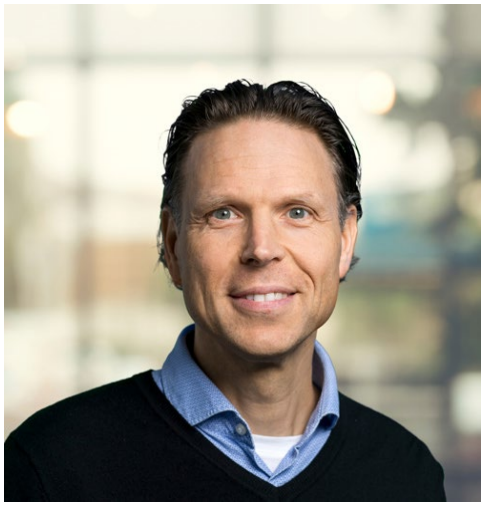
Remco Groenenberg

Scientific Lead for Subsurface Energy Storage of the unit Energy and Materials Transition, TNO



Dr. Remco Groenenberg is the Scientific Lead for Subsurface Energy Storage of the unit Energy and Materials Transition of TNO, the Netherlands Organization for Applied Scientific Research. He holds a PhD in Applied Earth Sciences from Delft University of Technology, and an MSc in Geology from Utrecht University.

His current activities include acquisition of contract R&D work, scientific oversight, and geoscience consultancy in the field of subsurface energy storage, energy system integration, and re-use of energy industry assets and infrastructure to accelerate the energy transition.

During his career Remco held several positions in industry and academia in the fields of subsurface energy storage, geothermal energy production, CO2 storage, and oil and gas exploration and production.

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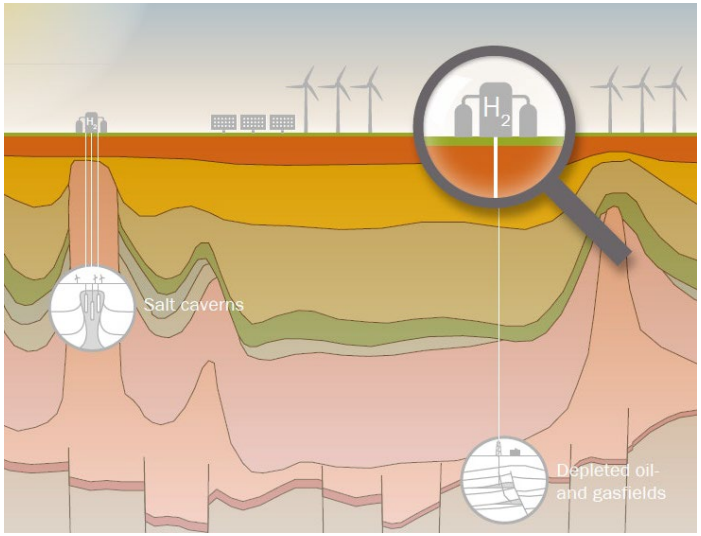
Lecture 5: Hydrogen Storage in Porous Reservoirs – State-Of-The-Art and Technical Challenges

Hydrogen is foreseen to play an important role in our future energy system. It is a versatile energy carrier that can be produced from renewable electricity, and then used as a fuel to (re-)generate electricity and/or heat (in the build environment and industry), for mobility, or as feedstock for the chemical industry. A key advantage of hydrogen is that it can be stored underground in salt caverns, and potentially also in porous reservoirs (depleted gas fields, aquifers) in large quantities, thereby offering essential services to society in the form of balancing solutions for unavoidable intra- to inter-seasonal variations in energy supply and demand, and strategic energy reserves. Currently, salt cavern storage is one of the few technologies considered mature enough to be applied for storing hydrogen in such large quantities. However, a large number of salt caverns will be required to create the estimated storage capacities, which will meet with technical, market, societal and spatial constraints. Therefore, storage of hydrogen in porous reservoirs (depleted hydrocarbon fields, aquifers) may be also required. Although it is in many ways similar to storage of natural gas in porous reservoirs, the feasibility of this technology is not yet proven. In this presentation, we will review the state-of-the art in hydrogen storage in porous reservoirs, and discuss the technical challenges that must be addressed for safe, reliable, and affordable implementation.



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