

# UNDERGROUND PUMPED HYDROELECTRIC STORAGE

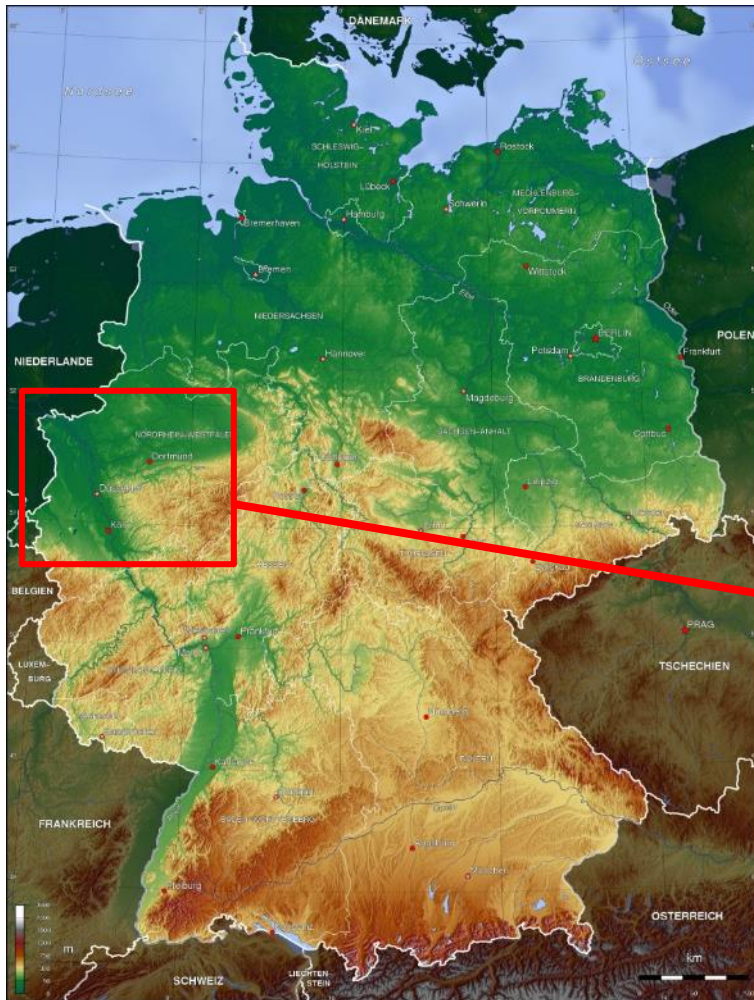
## USING EXISTING COAL MINING INFRASTRUCTURE

### OF PROSPER HANIEL MINE, GERMANY

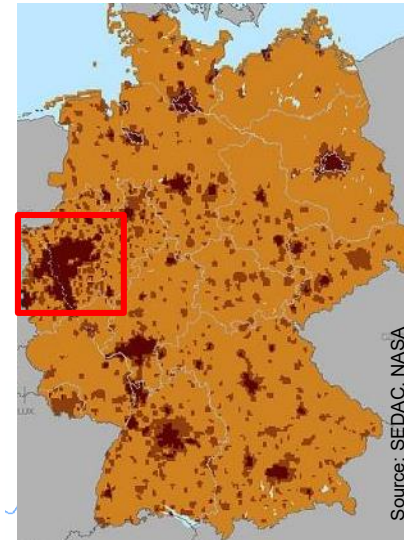


# Underground Pumped Hydroelectric Storage (UPHS) using existing coal mining infrastructure of Prosper-Haniel Mine

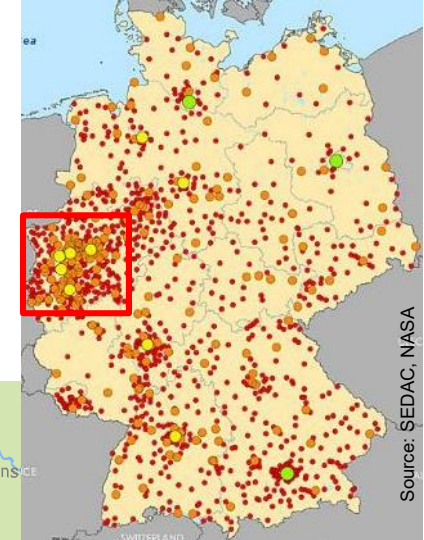
## Location in Germany: North Rhine-Westphalia



Population density



Settlements



**Prosper-Haniel mine**

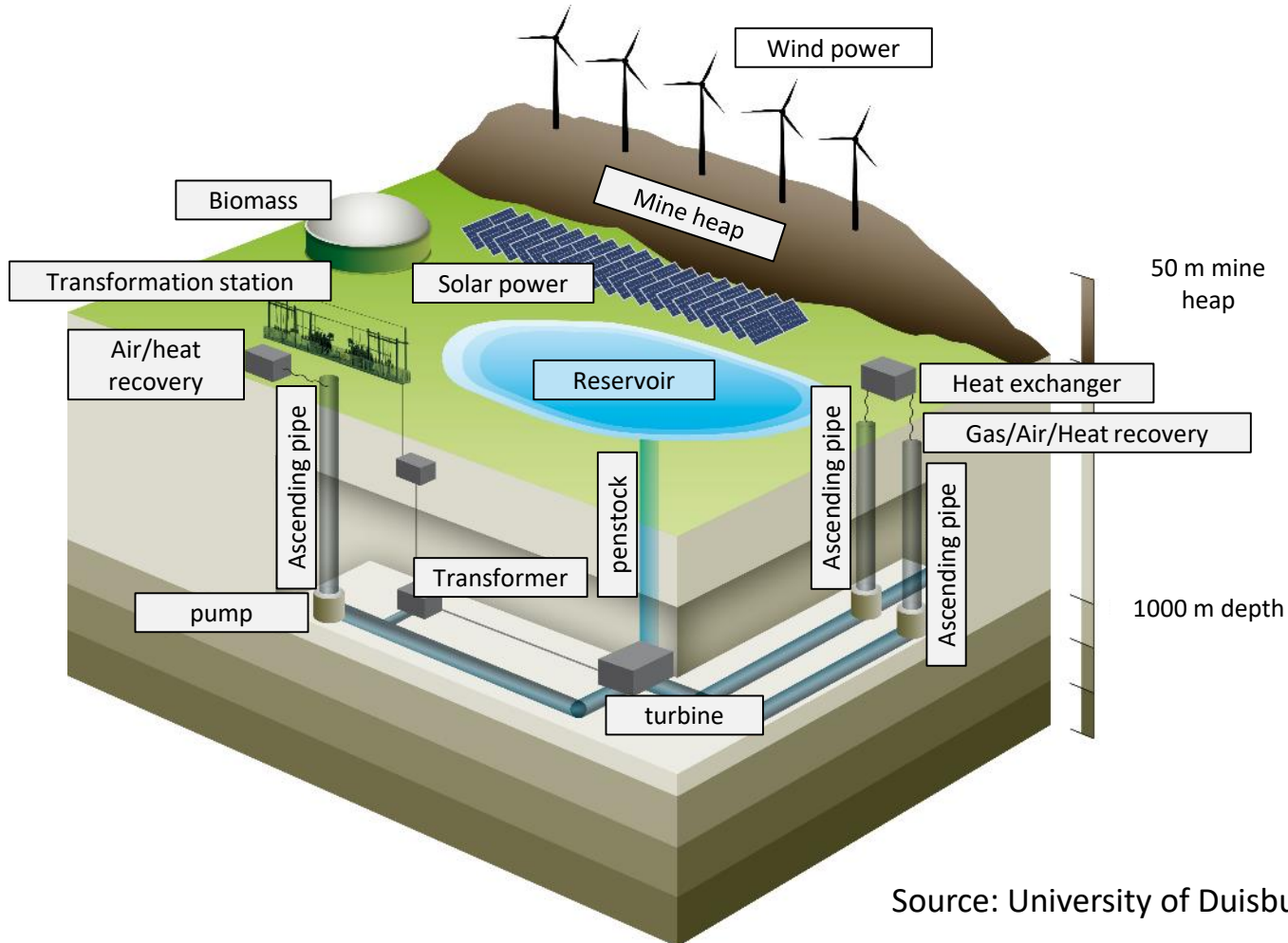


# Underground Pumped Hydroelectric Storage (UPHS)

using existing coal mining infrastructure of Prosper-Haniel Mine

## Energy in the post-mining situation

## Underground pumped-storage (UPHS)



Source: University of Duisburg-Essen



# Underground Pumped Hydroelectric Storage (UPHS) using existing coal mining infrastructure of Prosper-Haniel Mine

## First phase of a stepped feasibility study

„Developing an **implementation concept** for reusing former coal mines as underground pumped-storage facilities“ (11/2012-04/2014)

Result: **general feasibility**

## Just Finished: Research within the second phase (until 12/2018)

The funding Agreement was handed over by Minister Remmel (Ministry of Environment) at the 25th of August 2016

result: **technical feasibility** at the location „Bergwerk Prosper-Haniel“



funded by: total funding since 2012: 3,1 Mio. €



Bundesministerium  
für Wirtschaft  
und Energie

Ministerium für Klimaschutz, Umwelt,  
Landwirtschaft, Natur- und Verbraucherschutz  
des Landes Nordrhein-Westfalen



## Relevant results and arguments of research

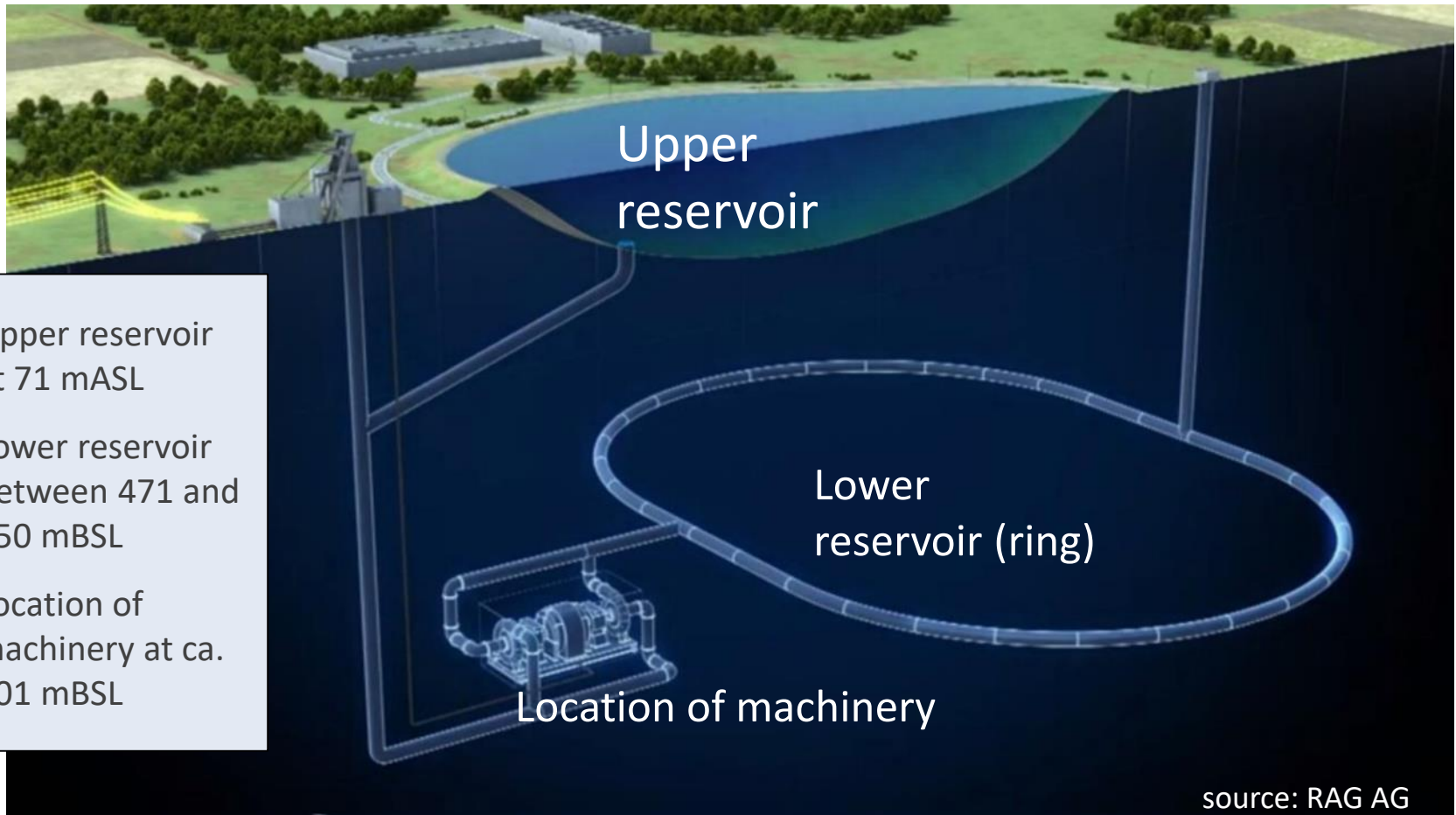
### Energy economical /-technical view

- The realization of this kind of energy storage solution contributes to Germany's Energiewende
- Using the actual/well developed grid infrastructure in NRW
- Energy storage in an area with high energy demand (Ruhr Area: 5.2 Mio. inhabitants)
- Setting up the Energy Grid after Blackout: Possible
- Technical highlight placed at an innovative location (unique selling point, worldwide)

### Social-/non-monetary aspects

- Sharpening this region as a region for energy efficiency and energy production and storage
- Significant contribution towards a sustainable post-mining landscape
- Technology leadership /mining knowledge provides an international perspective
- Generating economical effects within the Ruhr Area
- The UPHS system has only minor ecological effects compared to conventional PHES

## Concept Sketch UPHS



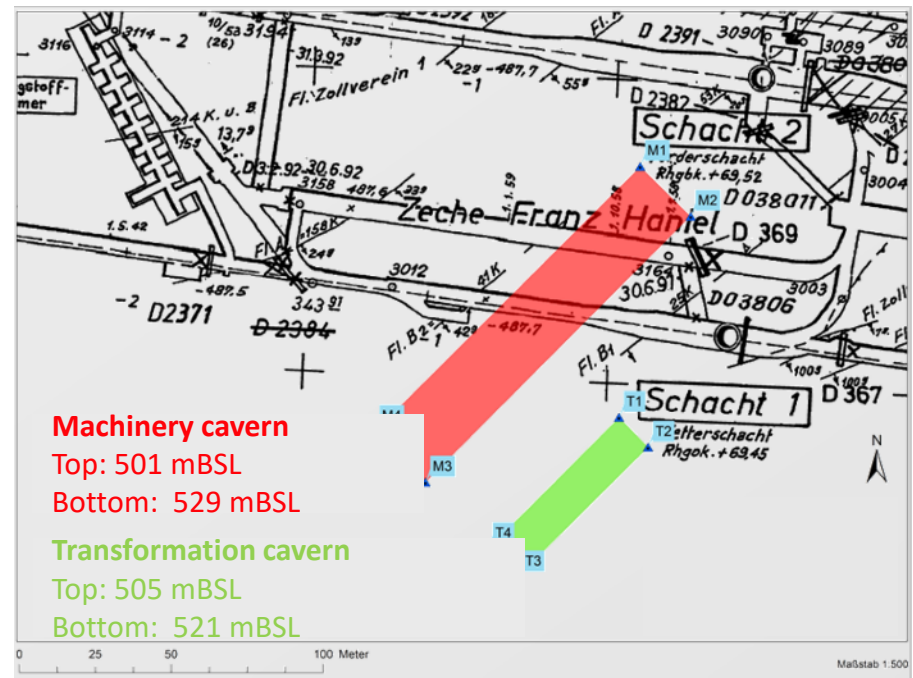
- Upper reservoir at 71 mASL
- Lower reservoir between 471 and 450 mBSL
- Location of machinery at ca. 501 mBSL

source: RAG AG

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## Location concept caverns

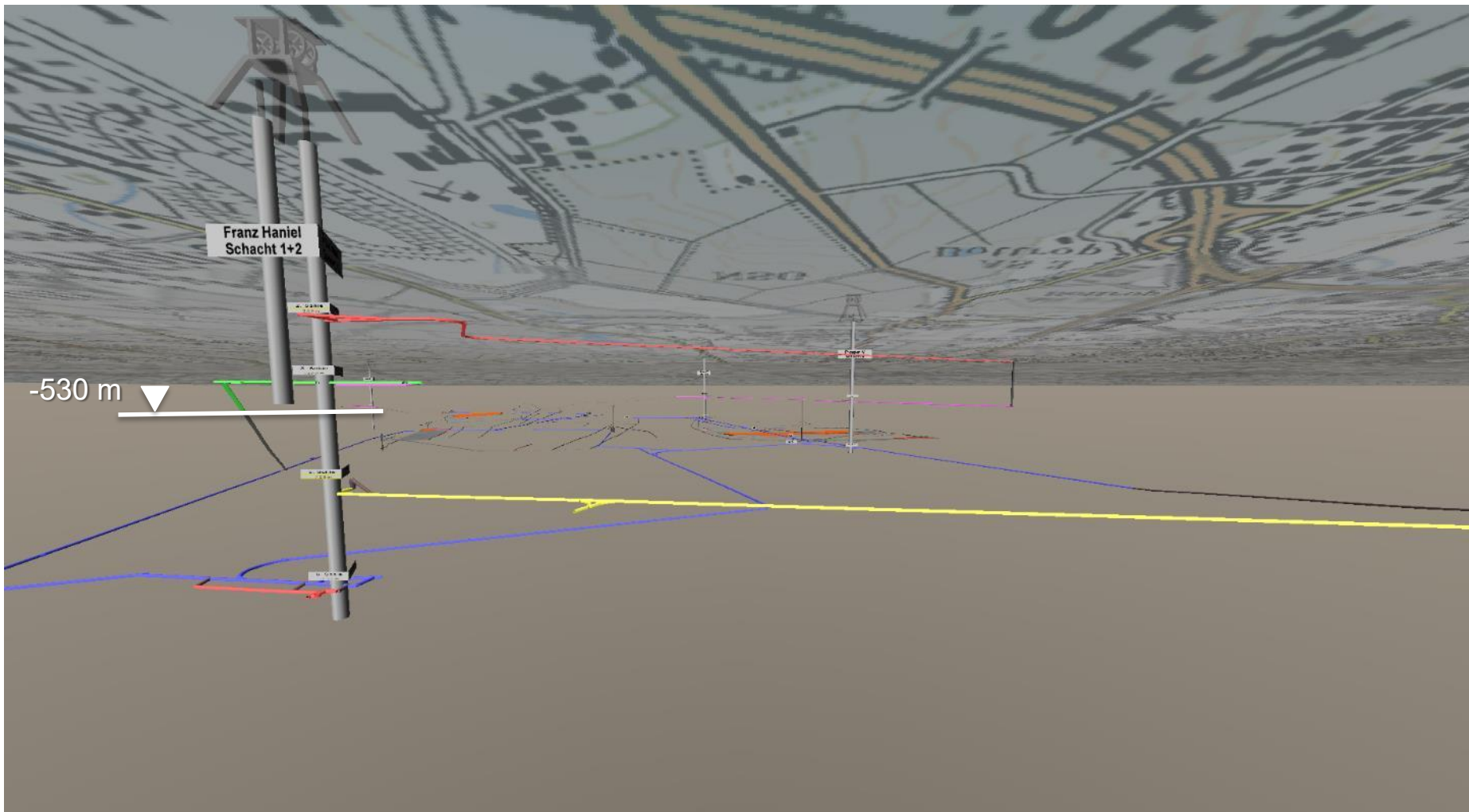
- Use of the very detailed site exploration of the mining operator RAG AG (80a)
- Splitted caverns- One for turbomachinery / one for electrical generators and transformation
- Cavern orientation is based on geological conditions (restrictions have to be considered)
- Ridges of the caverns are located in the sandstone layer





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## Existing infrastructure Prosper-Haniel

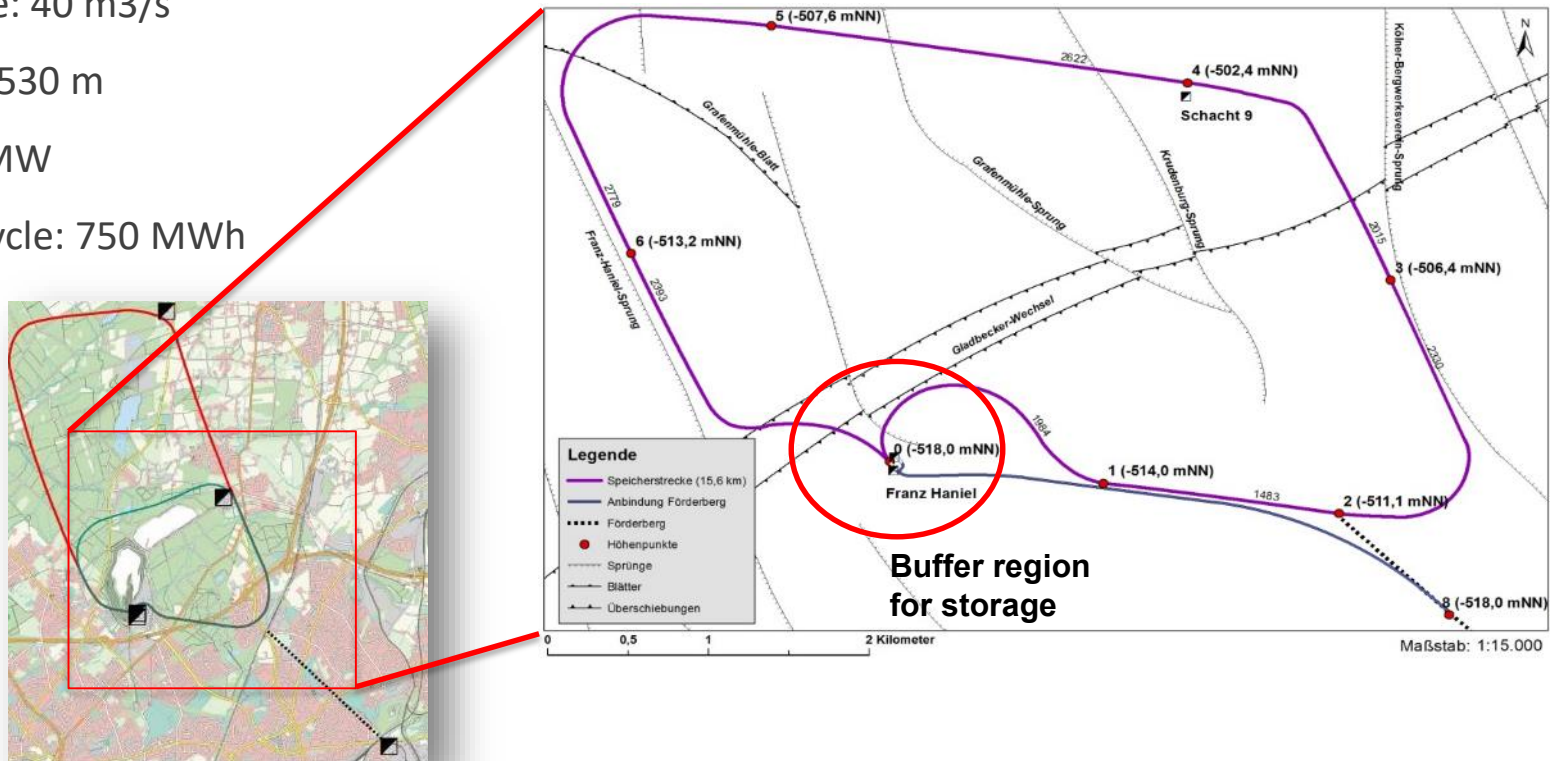




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## New Storage Ring Structure

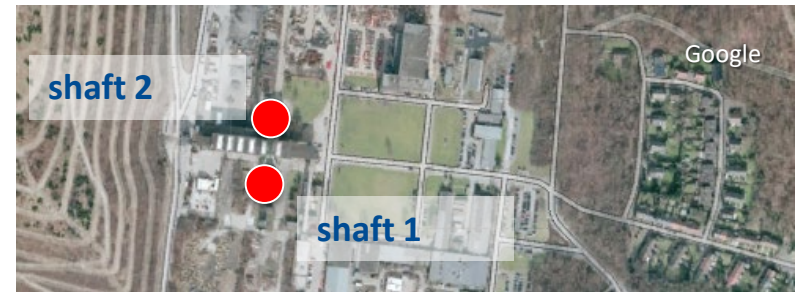
- Length: 15.5 km
  - Volume: 575.000 m<sup>3</sup>
  - Net discharge: 40 m<sup>3</sup>/s
  - Water head: 530 m
  - Power: 200 MW
  - Energy per cycle: 750 MWh
- Shafts I and II are used as penstock, communication lines, and energy connections



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## Location of Prosper-Haniel and exemplary plant specifications

Specification	New Storage Ring
Length ring structure [km]	15,5
Volume [m <sup>3</sup> ]	575.000
Water head [m]	530
Net discharge [m <sup>3</sup> /s]	40
Power [MW]	200
Energy per cycle [MWh]	750
Cavern [mBSL]	-501





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## Upper reservoir - a technical construction



- Upper reservoir can be located on the existing mining site



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## Press Releases (Extract)

[www.upsw.de](http://www.upsw.de)

„Battery with a symbol“



**PRI** - In Germany, miners and others prepare for a soft exit from hard coal (11.12.2017)



**Frankfurter Allgemeine** - Neue Energie von der Halde (05.12.2017)



**Sonne, Wind & Wärme** - Bergwerk als Pumpspeicherkraftwerk (05.12.2017)



**scinexx** - Strom speichern unter der Erde (13.10.2017)



**GRIST** - Life After Coal (29.11.2017)



**CNBC** - Here's why coal mines could be crucial cogs in the transition to renewables (17.11.2017)



**Energy Transition** - Life Beyond Coal (03.10.2017)



**Ruhr Universität Bochum** - Strom speichern unter der Erde (13.09.2017)



**Scientific American** - Germany's Transition from Coal to Renewables Offers Lessons for the World (05.09.2017)



**The Wall Street Journal** - Coal Mines Are Reimagined as a New Power Source (25.05.2017)



**Cleanenergy-Project** - Die Wasserkraft aus der Kohlemine (11.05.2017)



**Connaissance des energies-allemande** - Une mine de charbon en site de stockage? (29.03.2017)



# Underground Pumped Hydroelectric Storage (UPHS) using existing coal mining infrastructure of Prosper-Haniel Mine

## Currently: international interested parties

### THE WALL STREET JOURNAL



Bloomberg

Pumped Up: Renewables Growth Revives Old Energy-Storage Method

How to Make Electricity in a Disused Coal Mine

- Since 2016: Publications from all leading media e.g. *Bloomberg* and *The Wall Street Journal*, *Arte*, *CNBC*, and many others (>200)
- Technical Requests from: Australia, China, Chile, South Korea, Spain, Slovenia, South Africa, Belgium, France, Ukraine, Poland, Czechia, USA, Italy with workshops, visits ...



→ This plant could become a unique showcase/demonstrator for the Ruhr area (e.g.: sustainable post-mining situation)



National Geographic - Clean Energy In A Coal Mine (07.2018)



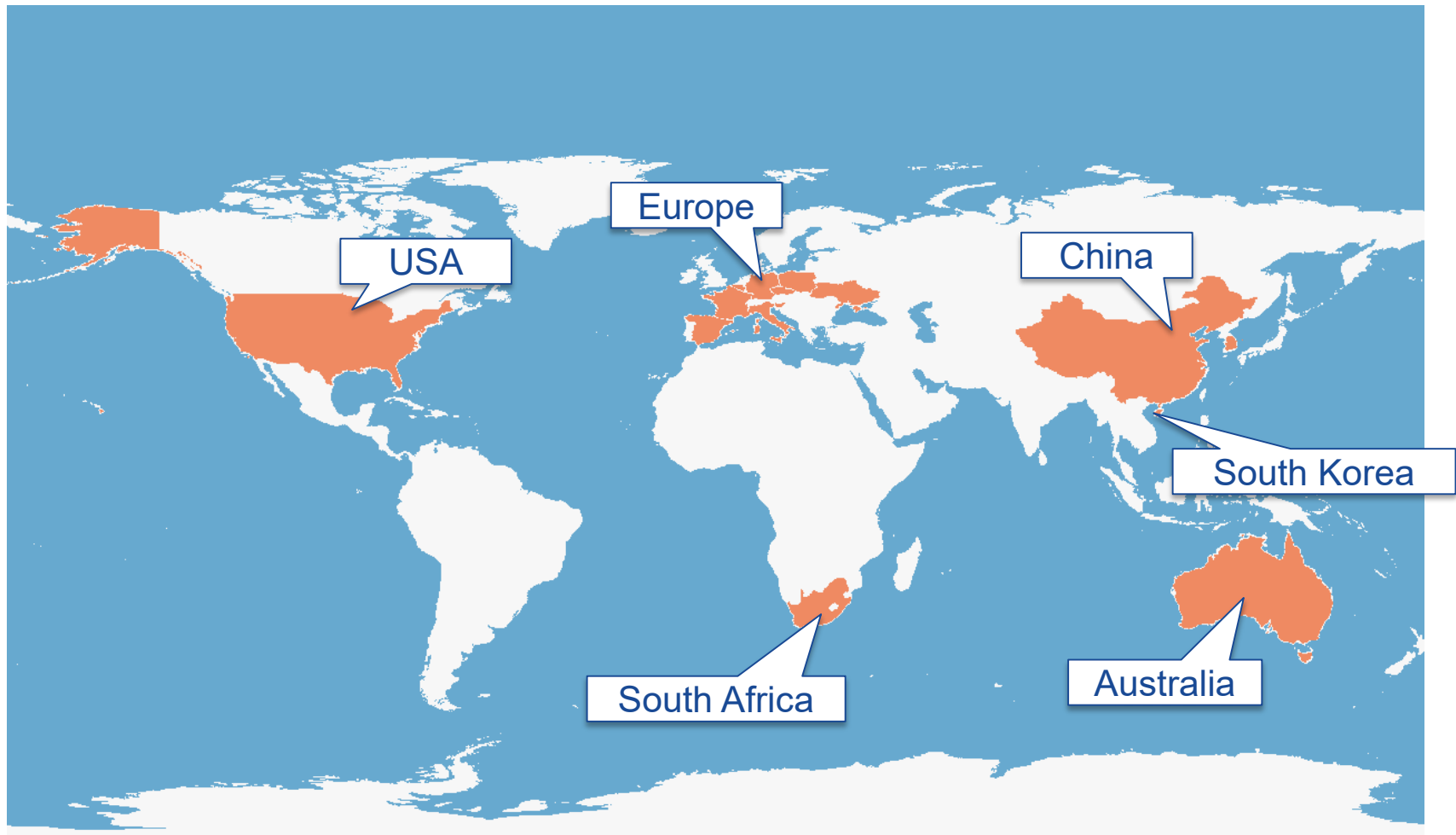
Mining Report - Ein untertägiges Pumpspeicherwerk am Bergwerk Prosper-Haniel in Bottrop - Sachstand und Perspektiven (06.2018)



Bild der Wissenschaft - Neue Power fürs Revier (02.2018)

# *Underground Pumped Hydroelectric Storage (UPHS)* *using existing coal mining infrastructure of Prosper-Haniel Mine*

## Operations and Research on UPHS worldwide

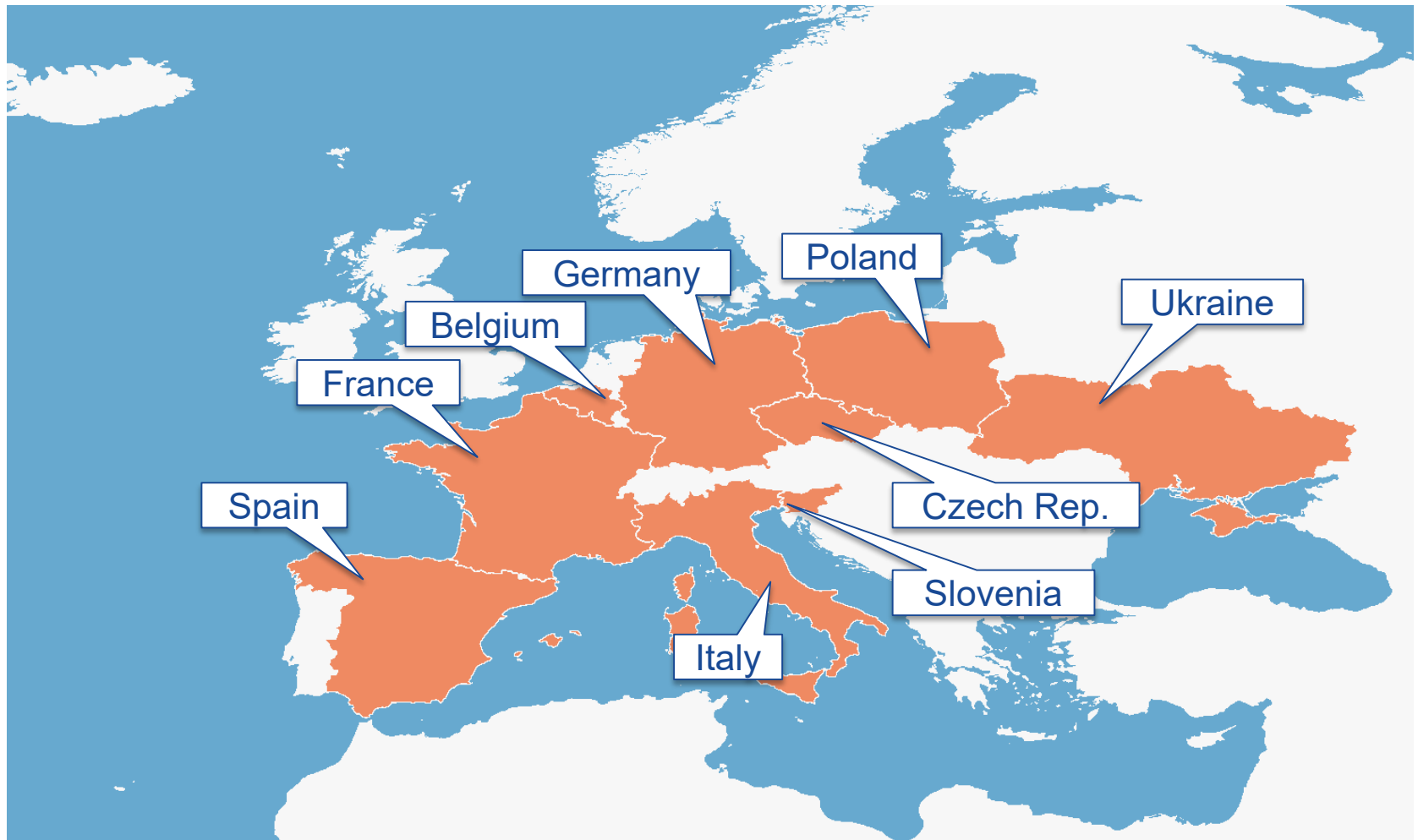




# *Underground Pumped Hydroelectric Storage (UPHS)*

*using existing coal mining infrastructure of Prosper-Haniel Mine*

## Operations and Research on UPHS in Europe



# Thank you!



Prof. Dr.-Ing. Andre Niemann (Project Lead)  
University of Duisburg-Essen  
Institute of Hydraulic Engineering and Water Resources Management  
Universitätsstraße 15  
45141 Essen –Germany

**WaWi**  
UDE

email: [andre.niemann@uni-due.de](mailto:andre.niemann@uni-due.de)