UNDERGROUND PUMPED HYDROELECTRIC STORAGE
USING EXISTING COAL MINING INFRASTRUCTURE
OF PROSPER HANIEL MINE, GERMANY

23rd May 2018
Underground Pumped Hydroelectric Storage (UPHS) using existing coal mining infrastructure of Prosper-Haniel Mine

Location in Germany: North Rhine-Westphalia
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Energy in the post-mining situation
Underground pumped-storage (UPHS)

Source: University of Duisburg-Essen
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. €
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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
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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

Franz Haniel Schacht 1+2
-530 m
New Storage Ring Structure

- Length: 15.5 km
  Shafts I and II are used as penstock,
- Volume: 575,000 m³
  communication lines, and energy connections
- Net discharge: 40 m³/s
- Water head: 530 m
- Power: 200 MW
- Energy per cycle: 750 MWh
### Underground Pumped Hydroelectric Storage (UPHS)

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

#### Location of Prosper-Haniel and exemplary plant specifications

<table>
<thead>
<tr>
<th>Specification</th>
<th>New Storage Ring</th>
</tr>
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<tbody>
<tr>
<td>Length ring structure [km]</td>
<td>15.5</td>
</tr>
<tr>
<td>Volume [m³]</td>
<td>575,000</td>
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<tr>
<td>Water head [m]</td>
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<tr>
<td>Net discharge [m³/s]</td>
<td>40</td>
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<tr>
<td>Power [MW]</td>
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<tr>
<td>Energy per cycle [MWh]</td>
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</tr>
<tr>
<td>Cavern [mBSL]</td>
<td>-501</td>
</tr>
</tbody>
</table>
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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

„Battery with a symbol“
Currently: international interested parties

THE WALL STREET JOURNAL
Pumped Up: Renewables Growth Revives Old Energy–Storage Method

- 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 an unique showcase/demonstrator for the Ruhr area (e.g.: sustainable post-mining situation)
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Operations and Research on UPHS worldwide

- USA
- Europe
- China
- South Africa
- South Korea
- Australia
Operations and Research on UPHS in Europe

- Germany
- Poland
- Ukraine
- Czech Rep.
- Slovenia
- Italy
- Spain
- France
- Belgium
Thank you!