Can energy storage serve as a new perspective for unused building complexes?

A study on the example of former military and industrial buildings

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production

demands
App. 3000 former bunkers dating back to WWII in Germany

overground bunkers
- small-scale serial bunkers of phase one
- mid-scale & partly standardised bunkers of phase I and II
- large-scale bunkers with extraordinary features

underground bunkers
- embedded underground bunkers
- exposed underground bunkers
- tunnel-like underground bunkers
- ample volume capacity
  \[ > 0.13 \text{ und } 0.75 \text{ kWh/m}^3 \]

- form activity

- heat source availability

- load bearing capacity
  \[ > 800 - 3200 \text{ kN/m}^2 \]

- closed shell

- sub-terrain volumes
small-scale serial bunkers of phase one

size \( \varnothing \, 10, \ h \ 22 \) [m]
capacity 1000 [m\(^3\)]
shell 2 [m]
large-scale bunkers with extraordinary features

- **size**: Ø 43, h 55 [m]
- **capacity**: 80,000 [m³]
- **shell**: up to 3,50 [m]
tunnel-like underground bunkers | former government bunker in the Ahrtal

- constructed between 1952 and 1972
- dismantling completed 2006
- overall tunnel length 19km
- oval profile 6 * 8 m
tunnel-like underground bunkers | former government bunker in the Ahrtal

compressed air storage

<table>
<thead>
<tr>
<th>parameter</th>
<th>value</th>
</tr>
</thead>
<tbody>
<tr>
<td>volume</td>
<td>250,000 [m³]</td>
</tr>
<tr>
<td>pressure</td>
<td>8 - 32 [bar]</td>
</tr>
<tr>
<td>density</td>
<td>0.35 - 0.75 [kWh/m³]</td>
</tr>
<tr>
<td>capacity</td>
<td>88 - 188 [MWh]</td>
</tr>
</tbody>
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concrete construction

circular cross section

closed shell

sub-terrain position

building volume
case study | vacant grain silo

pump water storage

case study | vacant grain silo

CONSTRUCTION INDUSTRY COUNCIL

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SBE SERIES

iSBE

UNITE

Global Alliance for Buildings and Construction

WORLD Sustainable Built Environment Conference 2017
building costs estimation

overall costs  3,300,000  [€]
costs/capacity  3200  [€/kWh]
Final conclusions

> significant potential in the typology of tunnel-like underground bunkers
> in depth analysis and case study necessary
> other large-scale facilities from the Cold War period exist
> suited building types are also found in the industrial building sector
> e.g. cooling towers or silos have a high potential
> case study of the grain silo demonstrates feasibility and efficiency
> conversion can help maintain building culture
> conversion saves material, energy and space
Thank you