

**HI WEST 31 (Less-Advanced)**



**H2 Storage in Gronau-Epe**

**Reasons for grouping [ENTSOG]**

The project group is a stand-alone underground storage in Germany. This project will enable storage of hydrogen in Germany from 2029 (HYD-N-767).

**Objective of the group [Promoter]**

The project deals with the enlargement of the planned H2 storage Gronau-Epe – part of ICPEI H2 (H2Infra wave, project ID DE24; funding and FID is pending)– including planning, permission, construction, commissioning and operation of additional H2 storage capacities. The H2 storage will be located in Gronau-Epe nearby the Dutch border. Commercial start of these additional capacities is supposed to be in 2029 and will support the development and upscale of the infrastructure of one of the first H2 clusters in Germany. As such, the enlargement of the H2 storage will enable market parties to balance and structure the increasing H2 flows matching the needs of the end users and thus the project will contribute to the development of the European Hydrogen Backbone (EHB).



**HYD-N-767 RWE H2 Storage expansion Gronau-Epe**

Comm. Year 2029



## A. Project group technical information [Promoter/ ENTSOG]

### Project technical information [Promoter]

#### Storage

TYNDP Project code	Maximum Injection rate [GWh/d]	Maximum Withdrawal rate [GWh/d]	Working gas volume [GWh]	Geometrical Volume [m3]
HYD-N-767	5,4	5,4	131	510,000

### Capacity increment [ENTSOG]

TYNDP Project code	Point name	Operator	From system	To system	Capacity increment [GWh/d]	Comm. year
HYD-N-767	H2_ST_DE	RWE Gas Storage West	Transmission Germany (DE Hydrogen)	Storage Germany (DE Hydrogen)	5,4	2029
HYD-N-767	H2_ST_DE	RWE Gas Storage West	Storage Germany (DE Hydrogen)	Transmission Germany (DE Hydrogen)	5,4	2029

## B. Project Cost Information

During the TYNDP 2022 Project Data Collection, promoters were asked to indicate whether their costs were confidential or not. The following tables display the non-confidential costs provided by the promoters (as of December 2022, end of PCI project collection). The amounts provided can differ from the figures used by the project promoters in other contexts, where costs can be updated and/or evaluated using different methodologies or assumptions.

#### [ENTSOG]

TYNDP Project code	CAPEX [M€]	CAPEX range [%]	OPEX [M€]	OPEX range [%]
HYD-N-767	293	15%	9.3	30%

## Description of the cost and range [Promoter]

### CAPEX

RWE Gas Storage West GmbH is developing a first H<sub>2</sub> storage in Gronau-Epe and has applied for IPCEI funding (Project consortium GET H<sub>2</sub> IPCEI – IPCEI funding and FID is pending) with an expected start of the commercial operation as of 01.01.2027. The learnings from this project - including information on costs - will be used for the planned extension of this H<sub>2</sub> storage (HI WEST 31 / HYd-N-767) with additional two caverns and corresponding above surface installation.

The planned extension through the present project will consist of a sub-surface installation – mainly two salt cavern currently used for storing natural gas that will be rededicated to the usage for H<sub>2</sub> - and a newly developed above surface installation consisting of injection and withdrawal facilities and general installation as building, metering stations etc.. It is planned to connect this project to the planned GET H<sub>2</sub> IPCEI transmission grid. The following table shows the essential trades of the investments to be made.

<b>Asset group</b>	<b>Details – main installations</b>
<i>General installations</i> <i>(part of the above surface facility)</i>	<ol style="list-style-type: none"> <li>(1) energy supply</li> <li>(2) control &amp; instrumentation (MSR)</li> <li>(3) civil and noise protection</li> <li>(4) safety installations</li> <li>(5) metering and gas quality assurance for the grid connection to the H<sub>2</sub>-grid</li> </ol>
<i>Injection facilities</i> <i>(part of the above surface facility)</i>	<ol style="list-style-type: none"> <li>(1) compressors</li> <li>(2) cooling</li> <li>(3) filters</li> </ol>
<i>Withdrawal facilities</i> <i>(part of the above surface facility)</i>	<ol style="list-style-type: none"> <li>(1) H<sub>2</sub> purification</li> <li>(2) H<sub>2</sub> dehydration</li> <li>(3) H<sub>2</sub> cooling, pressure and volume control systems</li> </ol>
<i>Caverns</i>	<ol style="list-style-type: none"> <li>(1) caverns</li> <li>(2) well completion and well head</li> <li>(3) control instrumentation</li> <li>(4) cushion hydrogen gas</li> <li>(5) temporary equipment for debrining</li> <li>(6) well-services</li> </ol>
<i>Pipeline</i>	<ol style="list-style-type: none"> <li>(1) pipeline construction</li> <li>(2) power and control cables</li> </ol>

The estimates of the investment costs in this project are based on the findings from the IPCEI project, which is scheduled to go commercially operational in 2027. Thereby, some approaches still come from a feasibility study which was carried out in 2019 in combination with an engineering report in 2021. Significant parts, however, come from current, concrete offers from manufacturers and service companies that were received in tenders for the IPCEI project.

Current developments on the procurement markets, supplemented by experience in the construction and operation of large-volume gas storage facilities, lead to the understanding that new construction projects cause unexpected measures that lead to additional investment costs. A range for these unplanned investments is usually 30-40%. Against the background of the findings from the IPCEI project, some risks can already be avoided, so that according to current estimates the range can be halved and therefore the CAPEX range is 15%.

#### **OPEX**

No significant findings from the current IPCEI project can be used with regard to operating costs (OPEX), as the IPCEI project will not go into operation until 2027. Therefore, the estimate of OPEX is generally derived from figures relevant to the operation of a natural gas storage facility which is the core business of RWE Gas Storage West over decades. They represent a sufficient approximation to the OPEX for a H2 storage facility, as it is assumed that the salt caverns for H2 have comparable requirements. This is especially relevant for the cost items materials and services and H2 consumption as well as personnel / administrative costs. In contrast, energy costs of operating a H2 storage facility do show significant variance to a natural gas storage facility. This is due to differing cycle patterns for the injection and withdrawal expected for H2, which mainly determines the costs mentioned. It is expected that H2 storage facilities show, unlike natural gas storages, which have to meet seasonal variation in natural gas demand, regular injection and withdraw operations as they are meant to balance and structure fluctuating supply and demand conditions of H2.

With regard to OPEX, no significant findings from IPCEI can be transferred, so the full range für unplanned measures must be taken into account for OPEX especially against the background of the large share of electricity costs in the OPEX and their developments in the recent past.

## **C. Project Benefits [ENTSOG]**

### **C.1 Summary of benefits**

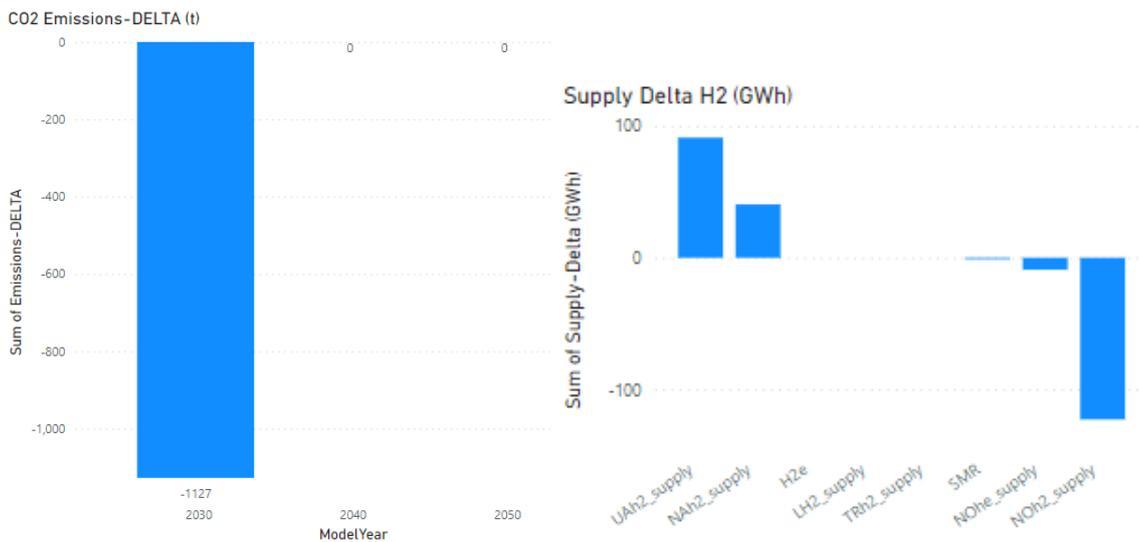
This section provides a summarised analysis by ENTSOG of the main benefits stemming from the realisation of the overall group. More details on the indicators are available in Annex D of TYNDP 2022<sup>1</sup>.

<sup>1</sup> [https://www.entsog.eu/sites/default/files/2023-04/ENTSOG\\_TYNDP\\_2022\\_Annex\\_D\\_Methodology\\_230411.pdf](https://www.entsog.eu/sites/default/files/2023-04/ENTSOG_TYNDP_2022_Annex_D_Methodology_230411.pdf)

## Distributed Energy

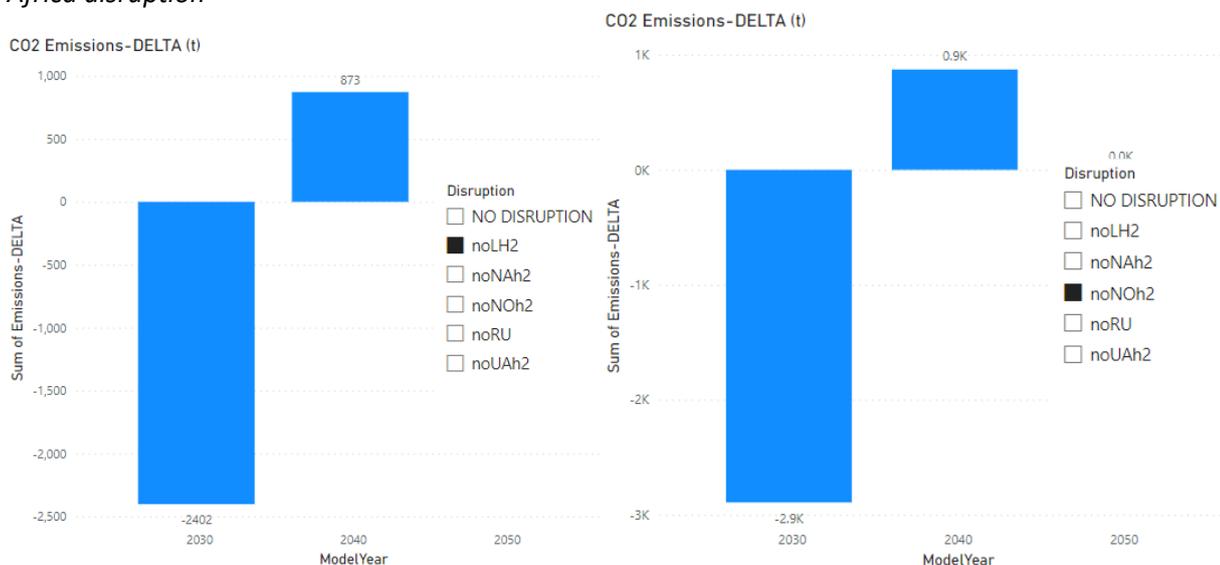
### Sustainability benefits

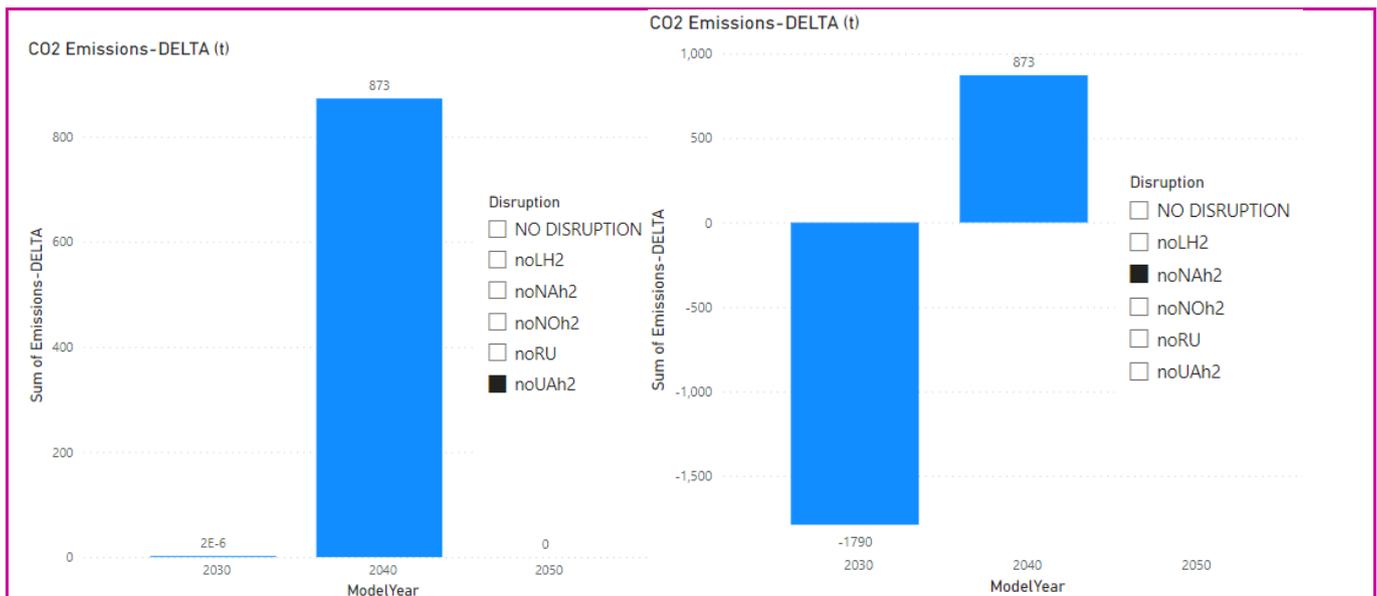
In the reference case, which analyses yearly demand in two periods (average winter and average summer), the project group will contribute to sustainability by reducing overall CO2 emissions by 1,2 kt in 2030. The project group enables the transport of green hydrogen and so then replacing use of Norwegian supply which is considered as blue hydrogen in 2030.



Similar trend is expected under any supply disruption in 2030. However, in 2040, triggered by the higher hydrogen demand project group will increase overall CO2 emissions by using more SMRs and hence reduce demand curtailment.

1 noLH2 : LH2 disruption / 2 noNOh2 : Norway disruption / 3 noUAh2 : Ukraine disruption / 4 noNAh2 : North Africa disruption





### Security of Supply:<sup>2</sup>

#### > Reference case

In the reference case, the project is contributing to further mitigation of hydrogen demand curtailment risk in average summer and average winter a little in 2040, that cannot be displayed on the map.

2030 DE- Benefits



2040 DE- Benefits



2050 DE- Benefits



#### > Climatic stress cases

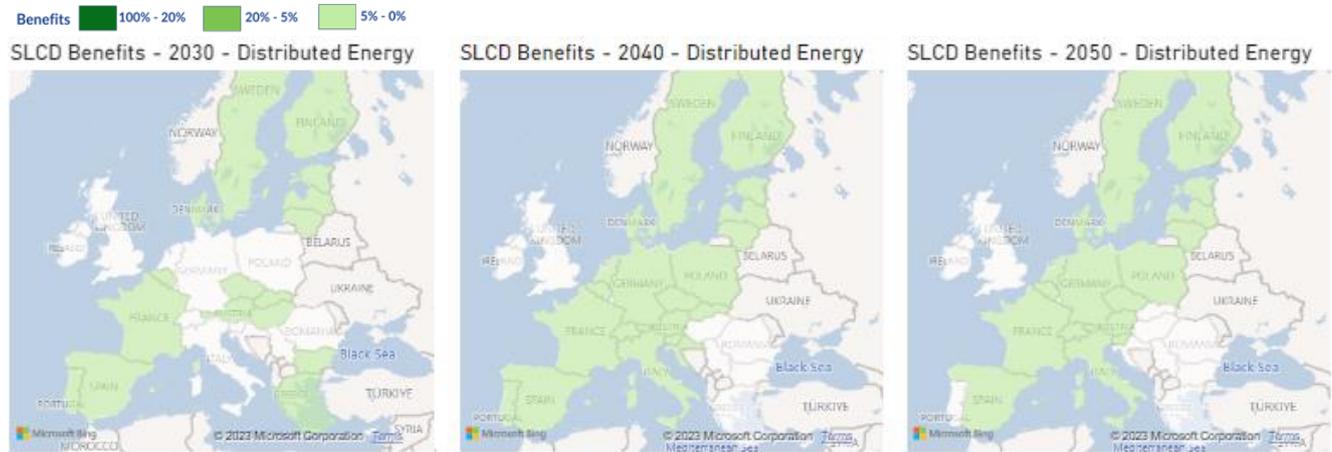
Under 2-week and 2-week dunkelflaute climatic stress case, as well as under peak day climatic case the project group is also not showing security of supply benefits.

#### > Disruption cases (S-1):

<sup>2</sup> As for the hydrogen system there is no existing infrastructure level available yet, ENTSOG has identified a possible hydrogen network according to the information provided by promoters in their project submission for the TYNDP/PCI process (i.e., H2 Infrastructure level). Therefore, the System Assessment shows the results that could be reached (for different timestamps) under the hypothesis of a full commissioning of the H2 infrastructure projects that were submitted by project promoters but that are not yet in place. Therefore, even in configurations where no demand curtailment is identified (e.g., average winter in 2030) these results should not be read as an absence of H2 infrastructure needs for the given scenario. On the contrary, the full availability of the planned infrastructures composing the H2 infrastructure level is assumed to avoid the potential demand curtailment.

Similarly, under supply disruption cases, the project group is not further contributing to the mitigation of hydrogen demand curtailment risk.

> Single largest capacity disruption (SLCD):

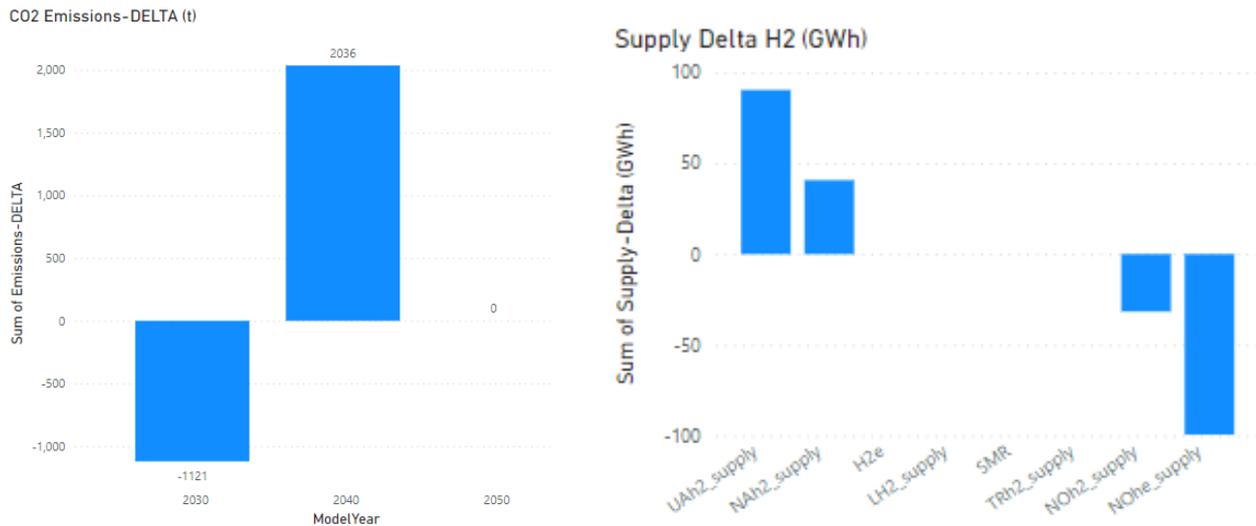


In case of single largest capacity disruption (SLCD), the project group reduces the risk of demand curtailment in some European countries in 2030, by 1% in 2030. However, from 2040 project is mitigating demand curtailment risk by 1-2% in all Europe due to the increase of storage capacity in Europe.

## Global Ambition

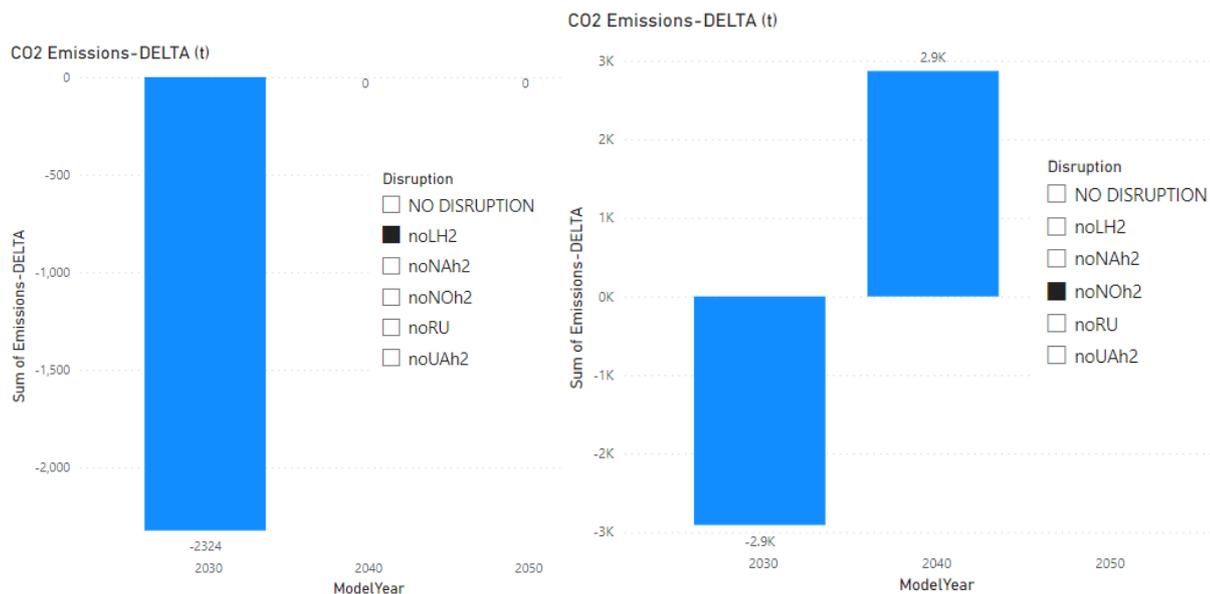
### Sustainability benefits

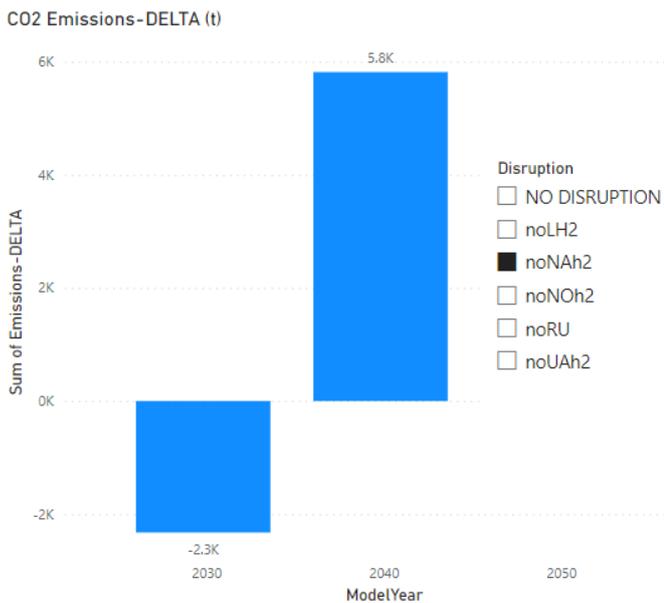
In the reference case, which analyses yearly demand in two periods (average winter and average summer), the project group will contribute to sustainability by reducing overall CO2 emissions by 1,1 kt in 2030. The project group enables the transport of green hydrogen and so then replacing use of Norwegian supply which is considered as blue hydrogen in 2030. However, in 2040, triggered by the higher hydrogen demand project group will increase overall CO2 emissions by using more SMRs to reduce demand curtailment.



Similar trend is expected under supply disruptions.

1 noLH2 : LH2 disruption / 2 noNOh2 : Norway disruption / 3 noNAh2 : North Africa disruption





### Security of supply benefits

#### > Reference case

In the reference case, the project is contributing to further mitigation of hydrogen demand curtailment risk in average summer and average winter a little in 2040, that cannot be displayed on the map.

2030 DE- Benefits



2040 DE- Benefits



2050 DE- Benefits



#### > Climatic stress cases

Under 2-week and 2-week dunkelflaute climatic stress case, as well as under peak day climatic case the project group is also not showing security of supply benefits.

#### > Disruption cases (S-1):

Similarly, under supply disruption cases, the project group is not further contributing to the mitigation of hydrogen demand curtailment risk.

#### > Single largest capacity disruption (SLCD):

Benefits  100% - 20%
  20% - 5%
  5% - 0%

SLCD Benefits - 2030 - Global Ambition



SLCD Benefits - 2040 - Global Ambition



SLCD Benefits - 2050 - Global Ambition



In case of single largest capacity disruption (SLCD), the project group reduces the risk of demand curtailment in some European countries in 2030, by 1% in 2030. However, in 2040 project is mitigating demand curtailment risk by 1-2% in all Europe due to the increase of storage capacity in Europe.

## C.2 Quantitative benefits [ENTSOG]

The following tables display all the benefits quantified by ENTSOG through specific indicators and stemming from the realisation of the considered project group.

### CO2 Emissions:

ModelYear	Disruption	Scenario	Unit	Emissions-DELTA	Emissions-PLUS	Emissions-MINUS
NO						
2030	DISRUPTION	DE	tonne	-1127,44	538677299	538678426,5
2030	noLH2	DE	tonne	-2402,03	540175890,2	540178292,3
2030	noNAh2	DE	tonne	-1789,78	539785356,1	539787145,9
2030	noNOh2	DE	tonne	-2892,63	538877197,8	538880090,4
2030	noUAh2	DE	tonne	0,00	539378771,9	539378771,9
NO						
2030	DISRUPTION	GA	tonne	-1121,27	592910448,4	592911569,7
2030	noLH2	GA	tonne	-2323,58	594817481,2	594819804,8
2030	noNAh2	GA	tonne	-2323,58	594141433,2	594143756,7
2030	noNOh2	GA	tonne	-2908,64	593310994,3	593313902,9
2030	noUAh2	GA	tonne	0,00	593627617,9	593627617,9
NO						
2040	DISRUPTION	DE	tonne	0,00	392077044	392077044
2040	noLH2	DE	tonne	872,59	392213883,4	392213010,8
2040	noNAh2	DE	tonne	872,59	392188097,7	392187225,1
2040	noNOh2	DE	tonne	872,59	392144022,6	392143150
2040	noUAh2	DE	tonne	872,59	392399182,9	392398310,3
NO						
2040	DISRUPTION	GA	tonne	2036,05	396523251,6	396521215,6
2040	noLH2	GA	tonne	0,00	397455196,7	397455196,7
2040	noNAh2	GA	tonne	5817,29	397301976,6	397296159,4
2040	noNOh2	GA	tonne	2869,71	397450977,1	397448107,4
2040	noUAh2	GA	tonne	0,00	397478498,3	397478498,3
NO						
2050	DISRUPTION	DE	tonne	0,00	232557734,8	232557734,8
2050	noLH2	DE	tonne	0,00	232557734,8	232557734,8
2050	noNAh2	DE	tonne	0,00	232557734,8	232557734,8
2050	noNOh2	DE	tonne	0,00	232557734,8	232557734,8
2050	noRU	DE	tonne	0,00	232557734,8	232557734,8
2050	noUAh2	DE	tonne	0,00	232557734,8	232557734,8
NO						
2050	DISRUPTION	GA	tonne	0,00	228306706,5	228306706,5
2050	noLH2	GA	tonne	0,00	228306706,5	228306706,5
2050	noNAh2	GA	tonne	0,00	228306706,5	228306706,5
2050	noNOh2	GA	tonne	0,00	228306706,5	228306706,5
2050	noRU	GA	tonne	0,00	228306706,5	228306706,5
2050	noUAh2	GA	tonne	0,00	228306706,5	228306706,5

### Curtailement Rate (SLCD):

Country	2030-DE-DELTA	2030-GA-DELTA	2040-DE-DELTA	2040-GA-DELTA	2050-DE-DELTA	2050-GA-DELTA
Belgium	-1%	-1%	-2%	-1%	-1%	0%
Czechia	-1%	-1%	-2%	-2%	-2%	-1%
Estonia	-1%	-1%	-2%	-1%	-2%	0%
Finland	-1%	-1%	-2%	-1%	-2%	0%
Germany	0%	0%	-2%	-1%	-1%	0%
Latvia	-1%	-1%	-2%	-1%	-1%	0%
Lithuania	-1%	-1%	-2%	-1%	-1%	-1%
Poland	-1%	-1%	-2%	-1%	-1%	0%
Portugal	-1%	-1%	-2%	-1%	0%	-1%
Slovenia	0%	0%	-2%	-1%	-1%	0%
Sweden	-1%	-1%	-2%	-1%	-2%	-1%
Switzerland	0%	0%	-2%	-1%	-1%	-1%
France	-1%	-1%	-2%	-1%	-1%	0%
The Netherlands	0%	0%	-2%	-1%	-2%	0%
Austria	-1%	-1%	-1%	-1%	-2%	0%
Croatia	0%	0%	-1%	-1%	0%	-1%
Denmark	-1%	-1%	-1%	-1%	-1%	0%
Italy	0%	-1%	-1%	-1%	-2%	0%
Slovakia	-1%	-1%	-1%	0%	0%	-1%
Spain	-1%	-1%	-1%	-1%	-1%	0%
Hungary	-1%	0%	-1%	-1%	0%	0%
Greece	-1%	0%	-1%	0%	0%	0%
Bulgaria	-1%	0%	0%	0%	0%	0%
Cyprus	0%	0%	0%	0%	0%	0%
Ireland	0%	0%	0%	0%	0%	0%
Luxembourg	0%	0%	0%	0%	0%	0%
Malta	0%	0%	0%	0%	0%	0%
Romania	0%	-1%	0%	0%	0%	0%

### Curtailement Rate (Climatic Stress):

Simulation Period	Country	2030-DE-DELTA	2030-GA-DELTA	2040-DE-DELTA	2040-GA-DELTA	2050-DE-DELTA	2050-GA-DELTA
Average2W	Austria	0%	0%	0%	0%	0%	0%
Average2W	Belgium	0%	0%	0%	0%	0%	0%
Average2W	Bulgaria	0%	0%	0%	-1%	0%	0%
Average2W	Croatia	0%	0%	0%	0%	0%	0%
Average2W	Cyprus	0%	0%	0%	0%	0%	0%
Average2W	Czechia	0%	-1%	0%	0%	0%	0%
Average2W	Denmark	0%	0%	0%	-1%	0%	0%
Average2W	Estonia	0%	0%	0%	0%	0%	0%
Average2W	Finland	0%	0%	0%	0%	0%	-1%
Average2W	France	0%	0%	0%	0%	0%	0%
Average2W	Germany	0%	0%	0%	0%	0%	0%
Average2W	Greece	0%	0%	0%	0%	0%	0%

Average2W	Hungary	0%	-1%	0%	0%	0%	0%
Average2W	Ireland	0%	0%	0%	0%	0%	0%
Average2W	Italy	0%	0%	0%	0%	0%	0%
Average2W	Latvia	0%	0%	0%	0%	0%	0%
Average2W	Lithuania	0%	0%	0%	0%	0%	0%
Average2W	Luxembourg	0%	0%	0%	0%	0%	0%
Average2W	Malta	0%	0%	0%	0%	0%	0%
Average2W	Poland	0%	0%	0%	0%	0%	0%
Average2W	Portugal	0%	0%	0%	0%	0%	0%
Average2W	Romania	0%	0%	0%	0%	0%	0%
Average2W	Serbia	0%	0%	0%	0%	0%	0%
Average2W	Slovakia	0%	0%	0%	0%	0%	0%
Average2W	Slovenia	0%	0%	0%	-1%	0%	0%
Average2W	Spain	0%	0%	0%	0%	0%	0%
Average2W	Sweden	0%	-1%	0%	0%	0%	0%
Average2W	Switzerland	0%	0%	0%	0%	0%	0%
Average2W	The Netherlands	0%	0%	0%	0%	0%	0%
Average2W	United Kingdom	0%	0%	0%	0%	0%	0%
Average2WDF	Austria	0%	0%	0%	0%	0%	0%
Average2WDF	Belgium	-1%	0%	0%	0%	0%	0%
Average2WDF	Bulgaria	0%	0%	0%	0%	0%	0%
Average2WDF	Croatia	0%	0%	0%	0%	0%	0%
Average2WDF	Cyprus	0%	0%	0%	0%	0%	0%
Average2WDF	Czechia	0%	-1%	0%	0%	0%	0%
Average2WDF	Denmark	0%	0%	0%	0%	0%	-1%
Average2WDF	Estonia	0%	0%	0%	0%	0%	0%
Average2WDF	Finland	0%	0%	0%	0%	0%	0%
Average2WDF	France	0%	0%	0%	0%	0%	0%
Average2WDF	Germany	0%	0%	0%	0%	0%	0%
Average2WDF	Greece	0%	0%	0%	0%	0%	0%
Average2WDF	Hungary	0%	-1%	0%	0%	0%	0%
Average2WDF	Ireland	0%	0%	0%	0%	0%	0%
Average2WDF	Italy	0%	0%	0%	0%	0%	0%
Average2WDF	Latvia	0%	0%	0%	0%	0%	0%
Average2WDF	Lithuania	0%	0%	0%	0%	0%	0%
Average2WDF	Luxembourg	0%	0%	0%	0%	0%	0%
Average2WDF	Malta	0%	0%	0%	0%	0%	0%
Average2WDF	Poland	0%	0%	0%	0%	0%	0%
Average2WDF	Portugal	0%	0%	0%	0%	0%	0%
Average2WDF	Romania	0%	0%	0%	0%	0%	0%
Average2WDF	Serbia	0%	0%	0%	0%	0%	0%
Average2WDF	Slovakia	-1%	0%	0%	0%	0%	0%
Average2WDF	Slovenia	0%	0%	0%	0%	0%	0%
Average2WDF	Spain	0%	0%	0%	0%	0%	0%
Average2WDF	Sweden	0%	-1%	0%	0%	0%	0%
Average2WDF	Switzerland	0%	0%	0%	0%	0%	0%

Average2WDF	The Netherlands	0%	0%	0%	0%	0%	0%
Average2WDF	United Kingdom	0%	0%	0%	0%	0%	0%
DC	Austria	0%	-1%	0%	0%	0%	0%
DC	Belgium	0%	0%	0%	0%	0%	0%
DC	Bulgaria	0%	0%	0%	0%	0%	0%
DC	Croatia	0%	0%	0%	0%	0%	0%
DC	Cyprus	0%	0%	0%	0%	0%	0%
DC	Czechia	0%	0%	0%	0%	0%	0%
DC	Denmark	0%	0%	0%	0%	0%	0%
DC	Estonia	0%	0%	0%	0%	0%	0%
DC	Finland	0%	0%	0%	0%	0%	0%
DC	France	0%	0%	-1%	0%	0%	0%
DC	Germany	0%	0%	0%	0%	0%	0%
DC	Greece	0%	0%	0%	0%	0%	0%
DC	Hungary	0%	0%	0%	0%	0%	0%
DC	Ireland	0%	0%	0%	0%	0%	0%
DC	Italy	0%	0%	0%	0%	0%	0%
DC	Latvia	0%	0%	0%	0%	0%	0%
DC	Lithuania	0%	0%	0%	0%	0%	0%
DC	Luxembourg	0%	0%	0%	0%	0%	0%
DC	Malta	0%	0%	0%	0%	0%	0%
DC	Poland	0%	0%	0%	0%	0%	0%
DC	Portugal	0%	0%	0%	0%	0%	0%
DC	Romania	0%	0%	0%	0%	0%	0%
DC	Serbia	0%	0%	0%	0%	0%	0%
DC	Slovakia	0%	-1%	0%	0%	0%	0%
DC	Slovenia	0%	0%	0%	0%	0%	0%
DC	Spain	0%	-1%	0%	0%	0%	0%
DC	Sweden	0%	0%	0%	0%	0%	0%
DC	Switzerland	0%	0%	0%	0%	-1%	0%
DC	The Netherlands	0%	0%	0%	0%	0%	0%
DC	United Kingdom	0%	0%	0%	0%	0%	0%

## D. Environmental Impact [Promoter]

Any gas infrastructure has an impact on its surroundings. This impact is of particular relevance when crossing some environmentally sensitive areas. Mitigation measures are taken by the promoters to reduce this impact and comply with the EU and National regulations.

TYNDP Code	Type of infrastructure	Surface of impact	Environmentally sensitive area
HYD-N-767	H2 Storage	H2 storage site - no new impact - H2 storage will be installed on an existing natural gas storage site	Surrounding of the H2 storage plant, further explanations please see below
HYD-N-767	H2 Storage	pipeline routes between H2 storage site and caverns – at the moment it is not expected that sensitive areas are affected	

Potential impact	Mitigation measures	Related costs included in project CAPEX and OPEX	Additional expected costs
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### **Environmental Impact explained [Promoter]**

The project comply with the principle of 'do no significant harm' (DNSH) within the meaning of Article 17 of Regulation (EU) 2020/852, please find below further explanations:

GHG emissions - Emissions from the planned H2 storage facility are limited to the secondary emissions from the use of electrical energy. The usage of electrical energy is necessary for the systems for injection (compressors with electric drive) and withdrawal (gas-cleaning with electrically-driven heaters and refrigeration-systems).

The plant is specially designed for the minimization of emissions and to the possible use of renewable energies, e.g.:

- Compressors with electric drive and optimized efficiency will be used instead of compressors with combustion drive and standard efficiency
- Heating of the process gas during gas-cleaning is done by the immediate effect of electric heaters instead of combustional heaters
- Appearance of tail-gas is avoided due to the use of appropriate techniques; related to that, utilization or dissipation of the tail-gas is not necessary.

Climate change adaptation - An adverse impact on the climate is not to be seen. Contrary to that, the project leads secondary to significant positive impacts on the climate due to structuring of the production and usage of renewable H2.

Negative effects to nature, people and assets are taken into account with the environmental impact study as a part of the permit procedure.

The permission for the operation will only be given, if only minor negative effects are evaluated by external experts.

The sustainable use and protection of water and marine resources – planned project does not involve the use of water

The transition to a circular economy, including waste prevention and recycling - The planned facility only leads to a narrowed amount of hazardous waste which will be incinerated (if not recyclable) or exploited (if recyclable) by accredited disposal contractors and in accordance to the guidelines of circular economy laid down in the national waste regulations.

Pollution prevention and control - direct emissions to the environment are reduced to a minimum level by design of the plant.

Emission of pollutants is prevented, on the one hand, by the renouncement of combustional compressor-drives or heating processes and, on the other hand, by the absence of tail-gas.

Emissions of pollutants are strictly limited to the mandatory requirements for the emergency-handling (e.g. emergency-flare).

The activity complies with Directive 2012/18/EU of the European Parliament and of the Council. The Directive has been implemented in national law which is applicable for the approval process before building and getting the facility into operation and the operational process itself.

protection and restoration of biodiversity and ecosystems - Based on the evolvement of cavern storage since the 1970s at the cavern field Gronau-Epe, the environmental obligations regarding the implementation and operation of new caverns are high.

The H2 storage will be built on an existing storage site and is subject to an environmental impact assessment under national legislation during the permitting process.

By building the new H2 storage the following aspects have to be handled:

- Minimization of direct emissions due to the plant-operation (see explanations above)
- Prevention of direct H<sub>2</sub>-emissions related to the normal operation (tail-gas)
- Selection of components, which are as quiet as possible
- Having a sound concept for the whole storage site, not only the H<sub>2</sub> storage, but also including the natural gas storage by creating an added value also for the natural gas storage
- Compensative measures for the necessary interventions into the landscape
- Construction of biotopes in the region of the storage site to ensure species development
- Keeping light emissions as small as possible by having a lighting concept – lighting only when necessary and usage of light sources, which are light scattering
- The used cooling medium will only be used in closed loops and is state of the art
- By building the H<sub>2</sub> storage on the site of the existing natural gas storage the interventions into the landscape will be kept as small as possible
- If possible, already existing pipeline routes will be used and will also keep the intervention into the landscape as small as possible. Pipeline routes are the only parts of the project, which are directly located within restricted areas (area of outstanding natural beauty)
- Having a concept for the construction works to ensure species protection and keep the measures environmentally compatible

## E. Other benefits [Promoter]

Missing benefits are all benefits of a project which may be not captured by ENTSOG analysis.

As a necessary condition a missing benefit cannot have discrepancies with the benefits already covered by the assessment run by ENTSOG and this condition needs to be proved and justified.

### Description of Other benefits [Promoter]

The H2 storage is expected to have the same connection to the H2 pipeline system as in expansion stage 1 by grid operator OGE + Nowega (already requested within NDP 2022-2032 H2 grid). A capacity increase to serve the expansion stage 2 of the H2 storage will be requested in next NDP. The pipeline system is part of evolving H2 cluster of GET H2 which is connected to the H2ercules Network North (HYD-N-1037) of OGE.

The H2 storage also could be connected to the planned H2 pipelines of Thyssengas GmbH, more concrete their projects HYD-N-917 and HYD-N-906. With an additional connection the H2 storage will get an access to a pipeline system with further boarder point connections and will support the integration of pipeline systems.

## F. Useful links [Promoter]

### Useful links:

<https://www.rwe-gasstorage-west.com/en/hydrogen/>

<https://get-h2-netz.de/leitung-hep-2/>

<https://www.h2ercules.com/en>

<https://h2.thyssengas.com/unser-h2-startnetz/>

