HI WEST 21 A (Less-advanced)

HyONE-DE

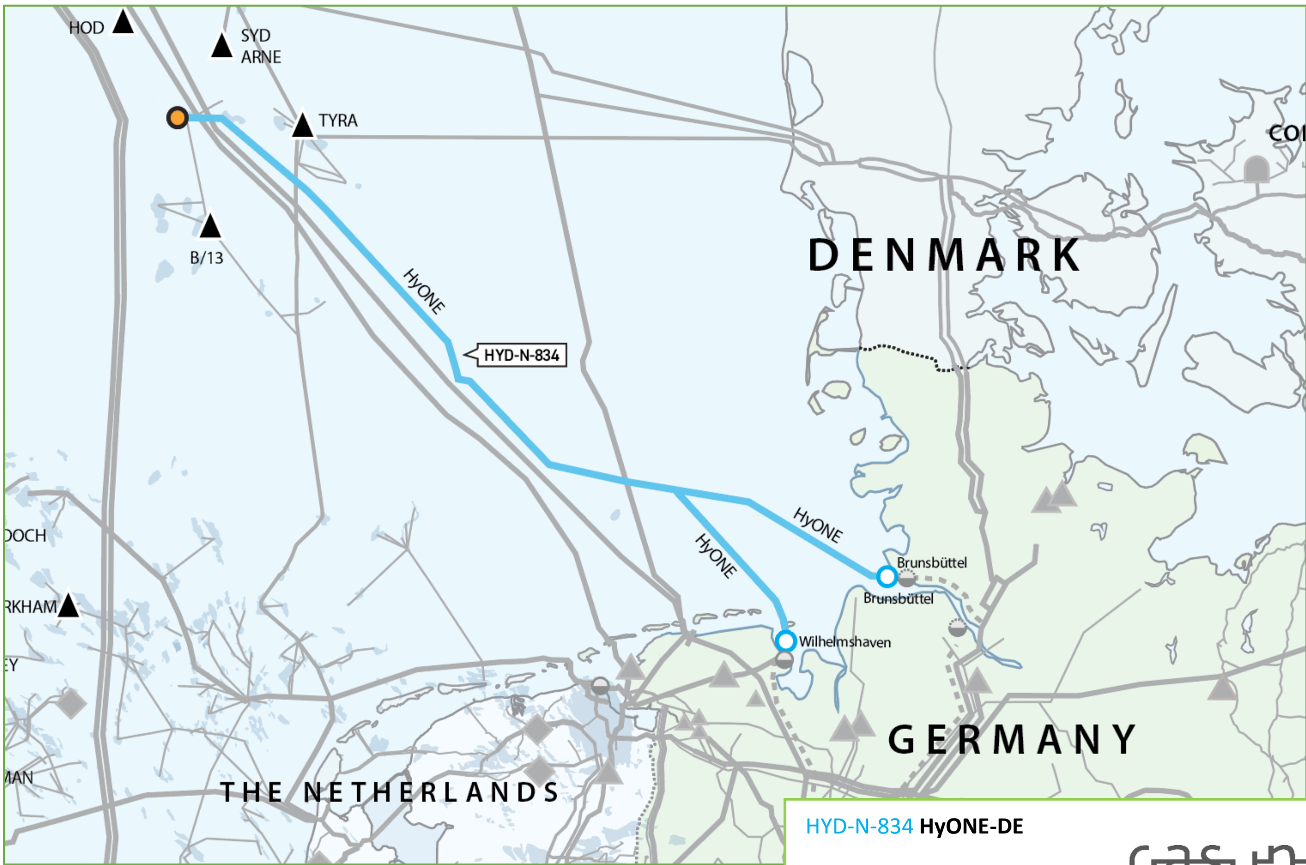
Reasons for grouping [ENTSOG]

The project group enables the transport of green hydrogen produced offshore in the German North Sea. Potential connections to other North Sea states are possible.

The project group consists of an offshore pipeline in Germany with landing in Wilhelmshaven and further onshore connection until Barßel (HYD-N-834).

Objective of the group [Promoter]

The HyONE-DE project in the German EEZ is primarily meant to collect hydrogen produced by wind energy in the EEZ (max target of 10GW). The hydrogen shall be transported to the onshore hydrogen network for further distribution to the off-takers. The infrastructure shall be operated open-access, non-discriminatory and shall in the future also be catering for imports from Norway/Denmark (of which volumes were undecided in 2022 and be made known in the next update of the TYNDP). The interconnector between future energy hubs in the Danish and Dutch EEZ will be connected to the HyONE-NL project. Both will enable the transport of renewable and low-carbon hydrogen along the HI West hydrogen corridor.



HYD-N-834 **HyONE-DE**

Comm. Year **2030**

A. Project group technical information [Promoter/ ENTSOG]

Project technical information [Promoter]

Hydrogen Transmission

TYNDP Project code	Section name	New / Repurposing	Nominal Diameter [mm]	Section Length [km]	Compressor power [MW]	Maximum depth [m]
HYD-N-834	N/A	New	1066	424	TBD	55

Capacity increment [ENTSOG]

TYNDP Project code	Point name	Operator	From system	To system	Capacity increment [GWh/d]	Comm. year
HYD-N-834	NPcDEhe	Gasunie Energy Development GmbH	National Production Germany (Electrolyser)	Transmission Germany (DE Hydrogen)	10,3	2030
HYD-N-834	NPcDEhe	Gasunie Energy Development GmbH	National Production Germany (Electrolyser)	Transmission Germany (DE Hydrogen)	10,3	2033
HYD-N-834	NPcDEhe	Gasunie Energy Development GmbH	National Production Germany (Electrolyser)	Transmission Germany (DE Hydrogen)	20,6	2035
HYD-N-834	NPcDEhe	Gasunie Energy Development GmbH	National Production Germany (Electrolyser)	Transmission Germany (DE Hydrogen)	41,21	2037
HYD-N-834	NPcDEhe	Gasunie Energy Development GmbH	National Production Germany (Electrolyser)	Transmission Germany (DE Hydrogen)	20,6	2040

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-834	2189	40	13	40

Gasunie and Gascade, supported by future hydrogen producers, have conducted a thorough feasibility study which was presented in March 2021. Routing, pipeline dimensions, pressure regimes were evaluated and OPEX and CAPEX estimates were performed. A class 4 estimate was provided with an accuracy of +40%/-25% and a contingency of 25%.

The scenario chosen was a pipeline infrastructure with 5 connection platforms operating at 70bars. Compression to be done by parties feeding in, two landfall options assessed to which total CAPEX cost are not sensitive.

The numbers presented in the table above are presented without the 25% contingency, as price levels of 2021 are assumed. Battery limits are an entry point at the German coast (not included in the estimates) and the EEZ itself. No interconnectors are taken into account yet.

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[1].

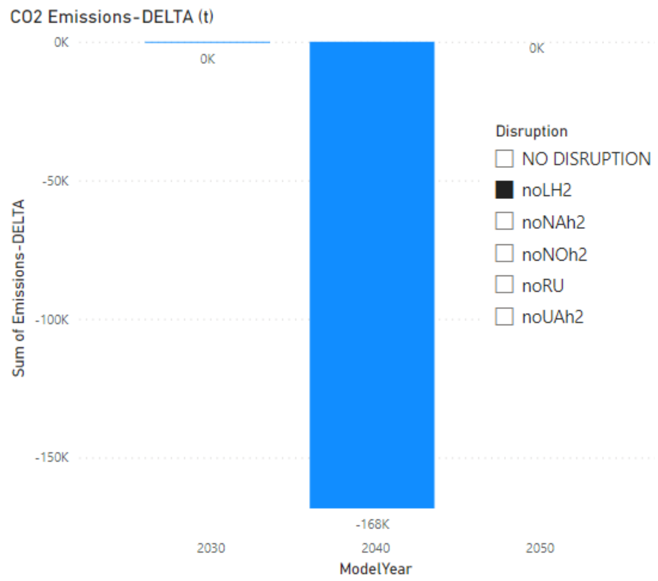
[1] https://www.entsog.eu/sites/default/files/2023-04/ENTSOG_TYNDP_2022_Annex_D_Methodology_230411.pdf

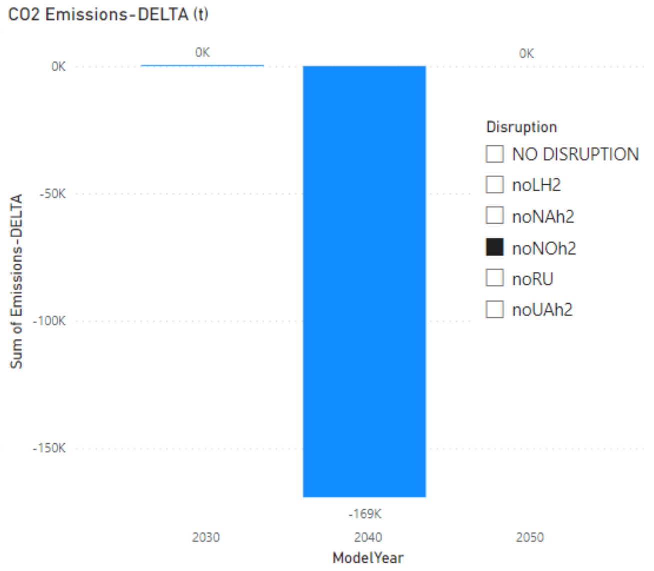
Distributed Energy

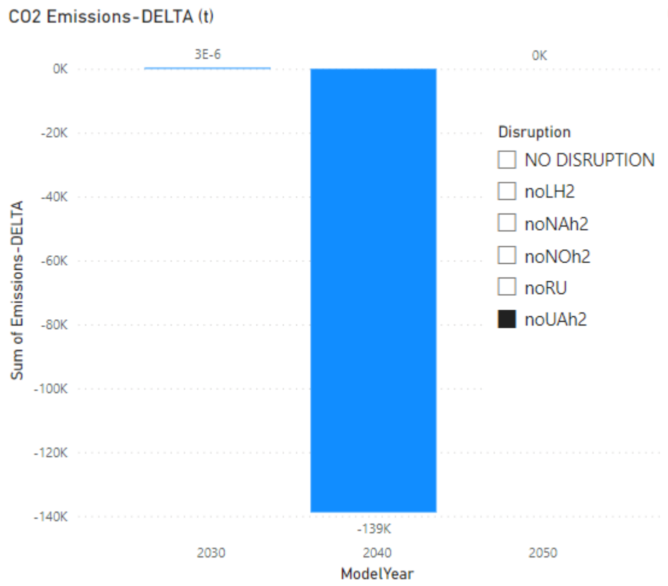
Sustainability benefits

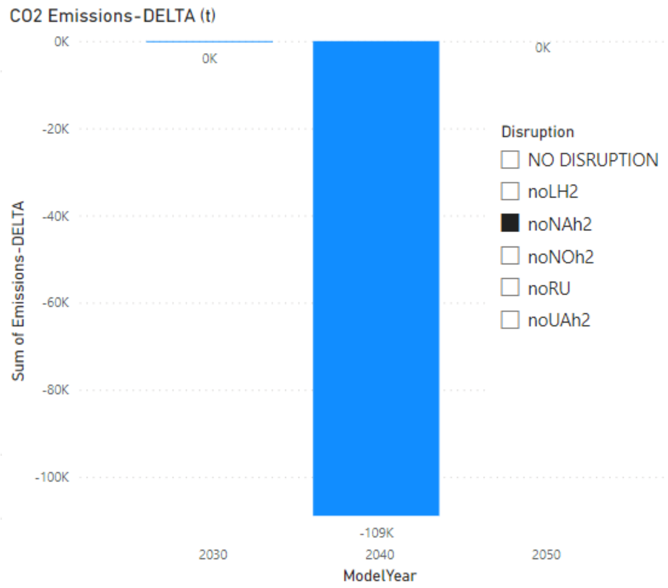
Thanks to the projects group, from 2030, the newly built infrastructure will bring green offshore hydrogen to the German hydrogen network and helps to improve and diversifies hydrogen supply in Europe. Under all supply disruption cases in 2040 the projects group will contribute to sustainability by reducing overall CO2 emissions by at least 109kt up to 169kt in case of Norway disruption. Indeed, the projects group is enabling the replacement of locally produced blue hydrogen (i.e. SMR) with green hydrogen produced offshore.

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









Security of Supply:[2]

> Reference case:

In the reference case, the project is mitigating hydrogen demand curtailment risk in average summer and average winter for many European countries in 2040 and 2050. Respective countries can reduce the risk of demand curtailment by 1% in 2040 and 1-2% in 2050.

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 mitigates further the risk of demand curtailment for all European countries in 2040 by 1%.

2030 DE- Benefits

2040 DE- Benefits

2050 DE- Benefits

> Disruption cases (S-1):

[2] *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)*

Similar under all supply disruption cases and refence yearly demand, the project group mitigates the risk of demand curtailment for many European countries in 2040 and 2050.

1 noLH2: LH2 disruption

2 noNOh2: Norway disruption

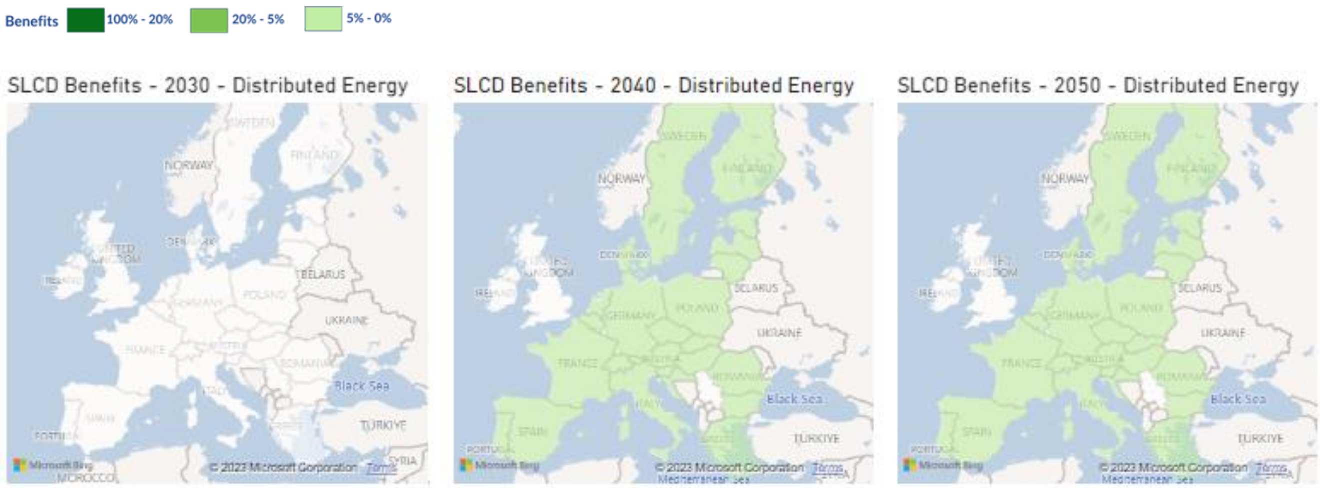
3 noUAh2: Ukraine disruption

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.

4 noNAh2: North Africa disruption

> Single largest capacity disruption (SLCD):

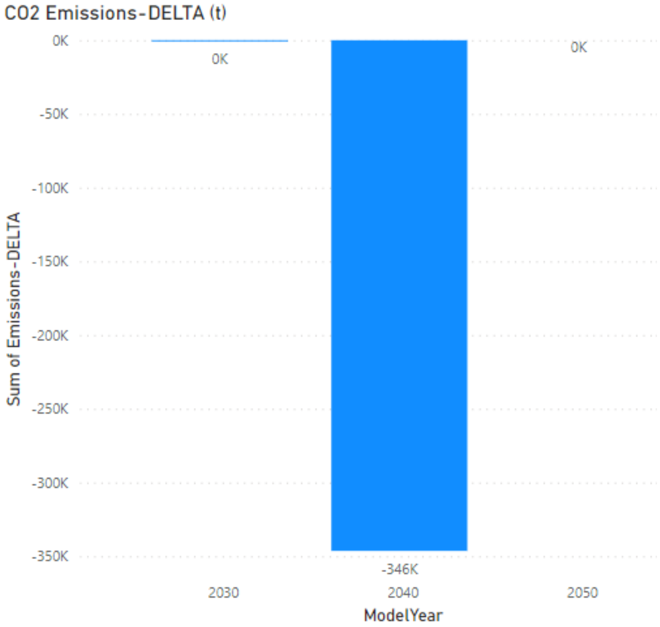
In case of SLCD many European countries benefitting from this project group by mitigating the risk of demand curtailment from 2040 onwards. In 2040 respective countries can mitigate the demand curtailment by 2-3%, whereas in 2050 risk can be reduced by 1-2%.

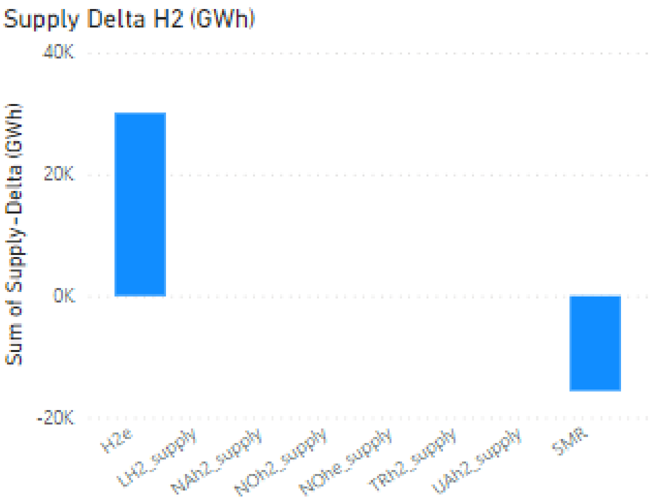


Global Ambition

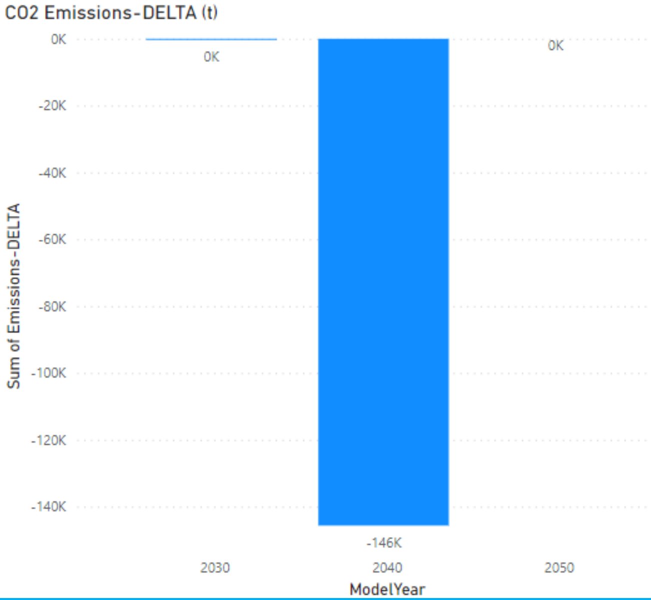
Sustainability benefits

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 346 kt in 2040. In 2040 the project group is enabling the replacement of locally produced blue hydrogen (i.e. SMR) with green hydrogen produced offshore.





Sustainability benefits are also expected under north African disruption case for 2040.



Security of supply:

> Reference case

Thanks to the project green hydrogen will be transported and in the reference case, the projects group mitigates risk of demand curtailment in almost all European countries in 2040. In 2040 projects group can mitigate the risk of demand curtailment by 1-2% and in 2050 in respective countries by 1-2% also.

2030 GA- Benefits

2040 GA- Benefits

2050 GA- Benefits

> Disruption cases (S-1)

Under all hydrogen supply disruption cases and refence yearly demand, the project group mitigates the risk of demand curtailment for many European countries by 1-3% in 2040 and 2050.

1 noLH2: LH2 disruption

2030 GA- Benefits

2040 GA- Benefits

2050 GA- Benefits

2 noNOh2: Norway disruption

2030 GA- Benefits

2040 GA- Benefits

2050 GA- Benefits

3 noUAh2: Ukraine disruption

2030 GA- Benefits

2040 GA- Benefits

2050 GA- Benefits

4 noNAh2: North Africa disruption

2030 GA- Benefits

2040 GA- Benefits

2050 GA- Benefits

> Single largest capacity disruption (SLCD):

In case of SLCD many European countries benefitting from this project group by mitigating the risk of demand curtailment from 2040 onwards. In 2040 and 2050 respective countries can mitigate the demand curtailment by 1-2%.

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

SLCD Benefits - 2030 - Global Ambition

SLCD Benefits - 2040 - Global Ambition

SLCD Benefits - 2050 - Global Ambition

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
2030	NO DISRUPTION	DE	tonne	0,00	538677299	538677299
2030	noLH2	DE	tonne	-117,45	540175890,2	540176007,7
2030	noNAh2	DE	tonne	-2,40	539785356,1	539785358,5
2030	noNOh2	DE	tonne	16,01	538877197,8	538877181,8
2030	noUAh2	DE	tonne	0,00	539378771,9	539378771,9
2030	NO DISRUPTION	GA	tonne	-5,21	592910448,4	592910453,7
2030	noLH2	GA	tonne	-51,90	594817481,2	594817533,1
2030	noNAh2	GA	tonne	-78,45	594141433,2	594141511,6
2030	noNOh2	GA	tonne	0,00	593310994,3	593310994,3
2030	noUAh2	GA	tonne	0,00	593627617,9	593627617,9
2040	NO DISRUPTION	DE	tonne	0,00	392077044	392077044
2040	noLH2	DE	tonne	-168339,88	392213883,4	392382223,2
2040	noNAh2	DE	tonne	-108911,25	392188097,7	392297008,9
2040	noNOh2	DE	tonne	-169280,25	392144022,6	392313302,9
2040	noUAh2	DE	tonne	-138837,67	392399182,9	392538020,6
2040	NO DISRUPTION	GA	tonne	-346317,50	396523251,6	396869569,1
2040	noLH2	GA	tonne	0,00	397455196,7	397455196,7
2040	noNAh2	GA	tonne	-145635,68	397301976,6	397447612,3
2040	noNOh2	GA	tonne	-4219,61	397450977,1	397455196,7
2040	noUAh2	GA	tonne	0,00	397478498,3	397478498,3
2050	NO 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
2050	NO 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

Curtailment Rate (SLCD):

Country	2030-DE-DELTA	2030-GA-DELTA	2040-DE-DELTA	2040-GA-DELTA	2050-DE-DELTA	2050-GA-DELTA
Belgium	0%	0%	-3%	-2%	-2%	-1%
Czechia	0%	0%	-3%	-3%	-3%	-1%
Estonia	0%	0%	-3%	-2%	-3%	-1%
Finland	0%	0%	-3%	-2%	-2%	-1%
Germany	0%	0%	-3%	-2%	-2%	-1%
Latvia	0%	0%	-3%	-2%	-2%	-1%
Lithuania	0%	0%	-3%	-2%	-2%	-1%
Poland	0%	0%	-3%	-2%	-2%	-1%
Portugal	0%	0%	-3%	-2%	-1%	-1%
Slovenia	0%	0%	-3%	-2%	-2%	-1%
Sweden	0%	0%	-3%	-2%	-3%	-1%
France	0%	0%	-3%	-2%	-2%	-1%
The Netherlands	0%	0%	-2%	-2%	-3%	-1%
Austria	0%	0%	-2%	-2%	-2%	-1%
Denmark	0%	0%	-2%	-2%	-2%	-1%
Italy	0%	0%	-2%	-1%	-2%	-1%
Spain	0%	0%	-2%	-2%	-2%	-1%
Switzerland	0%	0%	-2%	-1%	-2%	-1%
Bulgaria	0%	0%	-1%	-1%	-1%	-1%
Croatia	0%	0%	-1%	-1%	-1%	-1%
Greece	0%	0%	-1%	-1%	-1%	-1%
Hungary	0%	0%	-1%	-1%	-1%	-1%
Romania	0%	0%	-1%	-1%	-1%	-1%
Slovakia	0%	0%	-1%	-1%	-1%	-1%

Curtailment Rate (Climatic Stress):

Country	2030-DE-DELTA	2030-GA-DELTA	2040-DE-DELTA	2040-GA-DELTA	2050-DE-DELTA	2050-GA-DELTA
Austria	0%	0%	-1%	-1%	-1%	-1%
Belgium	0%	0%	-1%	-1%	-1%	-1%
Bulgaria	0%	0%	-1%	-1%	0%	0%
Croatia	0%	0%	-1%	-1%	0%	-1%
Cyprus	0%	0%	0%	0%	0%	0%
Czechia	0%	0%	-2%	-1%	-2%	-1%
Denmark	0%	0%	-1%	-1%	-1%	-1%
Estonia	0%	0%	-1%	-1%	-1%	-1%
Finland	0%	0%	-1%	-1%	-1%	-1%
France	0%	0%	-1%	-1%	-1%	-1%
Germany	0%	0%	-1%	-1%	-1%	-1%
Greece	0%	0%	-1%	-1%	0%	0%
Hungary	0%	0%	-1%	-1%	0%	-1%
Ireland	0%	0%	0%	0%	0%	0%
Italy	0%	0%	-1%	-1%	-1%	0%

Latvia	0%	0%	-1%	-1%	-1%	-1%
Lithuania	0%	0%	-1%	-1%	-1%	-1%
Luxembourg	0%	0%	0%	0%	0%	0%
Malta	0%	0%	0%	0%	0%	0%
Poland	0%	0%	-1%	-1%	-1%	-1%
Portugal	0%	0%	-1%	-1%	0%	-1%
Romania	0%	0%	-1%	-1%	0%	-1%
Serbia	0%	0%	0%	0%	0%	0%
Slovakia	0%	0%	-1%	-1%	0%	-1%
Slovenia	0%	0%	-1%	-1%	-1%	-1%
Spain	0%	0%	-1%	-1%	-1%	-1%
Sweden	0%	0%	-1%	-1%	-1%	-1%
Switzerland	0%	0%	-1%	-1%	-1%	0%
The Netherlands	0%	0%	-1%	-1%	-1%	0%
United Kingdom	0%	0%	0%	0%	0%	0%
Austria	0%	0%	-2%	-1%	-2%	-1%
Belgium	0%	0%	-1%	-1%	-1%	-1%
Bulgaria	0%	0%	-1%	-1%	0%	0%
Croatia	0%	0%	-1%	-1%	0%	-1%
Cyprus	0%	0%	0%	0%	0%	0%
Czechia	0%	0%	-1%	-1%	-2%	-1%
Denmark	0%	0%	-1%	-1%	-1%	-1%
Estonia	0%	0%	-1%	-1%	-1%	-1%
Finland	0%	0%	-1%	-1%	-1%	-1%
France	0%	0%	-1%	-1%	-1%	-1%
Germany	0%	0%	-1%	-1%	-1%	-1%
Greece	0%	0%	-1%	-1%	0%	0%
Hungary	0%	0%	-1%	-1%	0%	-1%
Ireland	0%	0%	0%	0%	0%	0%
Italy	0%	0%	-1%	-1%	-1%	0%
Latvia	0%	0%	-1%	-1%	-1%	-1%
Lithuania	0%	0%	-1%	-1%	-1%	-1%
Luxembourg	0%	0%	0%	0%	0%	0%
Malta	0%	0%	0%	0%	0%	0%
Poland	0%	0%	-1%	-1%	-1%	-1%
Portugal	0%	0%	-1%	-1%	0%	0%
Romania	0%	0%	-1%	-1%	0%	-1%
Serbia	0%	0%	0%	0%	0%	0%
Slovakia	0%	0%	-1%	-1%	0%	-1%
Slovenia	0%	0%	-1%	-1%	-1%	-1%
Spain	0%	0%	-1%	-1%	-1%	0%
Sweden	0%	0%	-1%	-1%	-2%	-1%
Switzerland	0%	0%	-1%	-1%	-1%	0%
The Netherlands	0%	0%	-1%	-1%	-1%	-1%
United Kingdom	0%	0%	0%	0%	0%	0%

Austria	0%	0%	-1%	-1%	-1%	-1%
Belgium	0%	0%	-1%	-1%	-1%	0%
Bulgaria	0%	0%	-1%	-1%	0%	0%
Croatia	0%	0%	-1%	-1%	0%	-1%
Cyprus	0%	0%	0%	0%	0%	0%
Czechia	0%	0%	-1%	-1%	-1%	-1%
Denmark	0%	0%	0%	-1%	-1%	0%
Estonia	0%	0%	-1%	0%	-1%	-1%
Finland	0%	0%	-1%	0%	-1%	0%
France	0%	0%	-1%	-1%	-1%	0%
Germany	0%	0%	-1%	-1%	-1%	-1%
Greece	0%	0%	-1%	-1%	0%	0%
Hungary	0%	0%	-1%	-1%	0%	-1%
Ireland	0%	0%	0%	0%	0%	0%
Italy	0%	0%	-1%	0%	-1%	0%
Latvia	0%	0%	-1%	0%	-1%	-1%
Lithuania	0%	0%	-1%	0%	-1%	0%
Luxembourg	0%	0%	0%	0%	0%	0%
Malta	0%	0%	0%	0%	0%	0%
Poland	0%	0%	-1%	0%	-1%	0%
Portugal	0%	0%	-1%	-1%	0%	0%
Romania	0%	0%	-1%	-1%	0%	-1%
Serbia	0%	0%	0%	0%	0%	0%
Slovakia	0%	0%	-1%	-1%	0%	0%
Slovenia	0%	0%	-1%	-1%	-1%	-1%
Spain	0%	0%	0%	-1%	-1%	-1%
Sweden	0%	0%	-1%	0%	-1%	0%
Switzerland	0%	0%	-1%	0%	-1%	0%
The Netherlands	0%	0%	-1%	-1%	-1%	0%
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-834	Hydrogen pipeline and platforms		Waddensea / Northsea

Potential impact	Mitigation measures	Related costs included in project CAPEX and OPEX	Additional expected costs
Waddensea crossing	Environmental friendly construction	TBD	TBD

Environmental Impact explained [Promoter]

The HyONE-DE pipeline will have to cross the natural reserve area in the German Bight, the Waddensea. During the feasibility, study the consultant ARSU completed a desktop study for the various landfall options in the Brunsbuttel, Busum and Wilhelmshaven area. Options were rated against length passing the sanctuary area and known protected species in certain areas. Further investigation needs to be done, as well as alignment with the onshore hydrogen network planning as currently going on in Germany (‘Kernnetz discussion’ and approval rounds).

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]

In 2021, when the feasibility study was conducted, the importance of interconnected the hydrogen pipeline systems of the various countries at the North Sea was not a topic of concern. The Ukraine crisis made Germany more aware of energy imports and interconnectivity of windfarms, as well as energy interconnectors, amongst which the first hydrogen interconnector (Germany-Norway) became important in policymaking.

The German gas TSOs are in competition with hydrogen pipeline projects, in qualifying them for the ''Kernnetz''. The HyONE-DE project is one of the candidate projects in the North Sea to collect domestic offshore produced hydrogen and imports from Norway.

In the current design of HyONE-DE, an interconnector with the Dutch offshore hydrogen network (HyONE-NL, HYD-N-1011) is incorporated. Interconnectors to Norway and Denmark were still in its preliminary stages in Q3-2022 and, hence, could not fully incorporated in the HyONE-DE initiative. The Promotor is however actively working with Ministries and other TSOs to get more interconnectivity into the next update of the TYNDP.

Note: the HYD-N-1011 comprises the interconnector between the network in the Dutch EEZ and a nodal point in the German EEZ. This nodal point will be further defined in upcoming TYNDP.

F. Useful links [Promoter]

Useful links:

- One-Stop-Shop - Wasserstoff - Die Nationale Wasserstoffstrategie (bmwk.de)
- BMWK - Norway and Germany intensify cooperation on energy on the path towards climate neutrality
- BMWK - Bundeskabinett beschließt Gesetzentwurf zur Schaffung eines Wasserstoff-Kernnetzes