HI WEST 36 (Less-Advanced)

HyONE Network NL

Reasons for grouping [ENTSOG]

The project group enables the transport of green hydrogen produced offshore in the Netherlands. Potential connections to other North Sea States in particular Germany are possible.

The project group consists of an offshore pipeline network in the Netherlands (HYD-N-1011)

Objective of the group [Promoter]

The Dutch Government has set the goals for harvesting wind energy on the Dutch EEZ of the North Sea at 70GW in 2050. The offshore energy system requires an integrated approach between electricity and hydrogen. Scenarios show 20-30 GW of installed offshore electrolysis in the Dutch EEZ, and on top of that hydrogen imports from Denmark (via the German EEZ). The P-Promotor will be the appointed exclusive HNO transporting and transiting hydrogen to off-takers onshore. The network will be open-access, non-discriminatory infrastructure operated under the implementation of the Decarbonisation package.

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-1011	West leg NL ring	New	1066	160	TBD	50
HYD-N-1011	East leg NL ring	New	1066	220	TBD	50
HYD-N-1011	Interconnector NL-DE	New	812	100	TBD	50

Capacity increment [ENTSOG]

TYNDP Project code	Point name	Operator	From system	To system	Capacity increment [GWh/d]	Comm. year
HYD-N-1011	NPcNLhe	N.V. NEDERLANDSE GASUNIE	National Production Netherlands (Electrolyser)	Transmission Netherlands (NL Hydrogen)	20.6	2032
HYD-N-1011	NPcNLhe	N.V. NEDERLANDSE GASUNIE	National Production Netherlands (Electrolyser)	Transmission Netherlands (NL Hydrogen)	30.9	2035
HYD-N-1011	NPcNLhe	N.V. NEDERLANDSE GASUNIE	National Production Netherlands (Electrolyser)	Transmission Netherlands (NL Hydrogen)	77.27	2040
HYD-N-1011	NPcNLhe	N.V. NEDERLANDSE GASUNIE	National Production Netherlands (Electrolyser)	Transmission Netherlands (NL Hydrogen)	180.29	2050

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-1011	3500	25	175	25

Description of the cost and range [Promoter]

A routing assessment and flow assessment was done based on a feasibility study (finalized in March 2021) with similar pipeline characteristics in the German EEZ, finetuned for a trajectory in the Dutch Northsea bed (delivered in December 2022). This resulted in OPEX and CAPEX estimates with a class 4 estimate, with an accuracy of +40%/-25% and a contingency of 25%.

The numbers presented in the table above are for the full closed loop of the hydrogen network with two landfalls, one in the North and one on the West, both providing connectivity to the onshore network. Numbers shown are without the 25% contingency, assume price levels of 2022. Two platforms are included as well as offshore compression to be done by the Promotor (70 bar).

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].

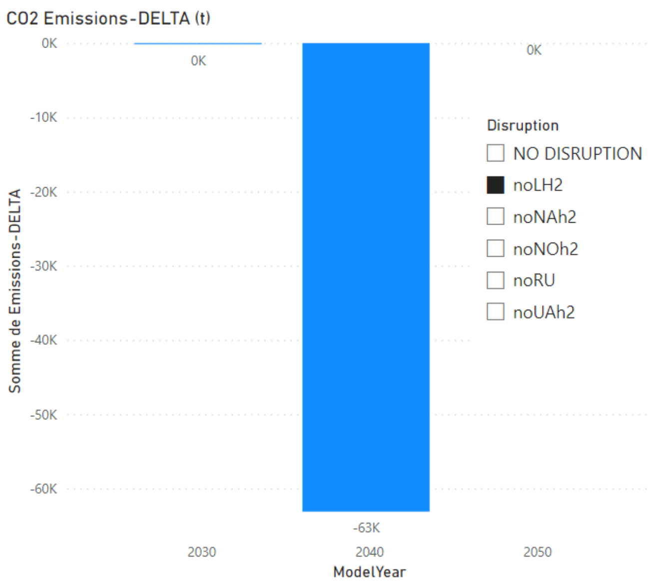
Distributed Energy

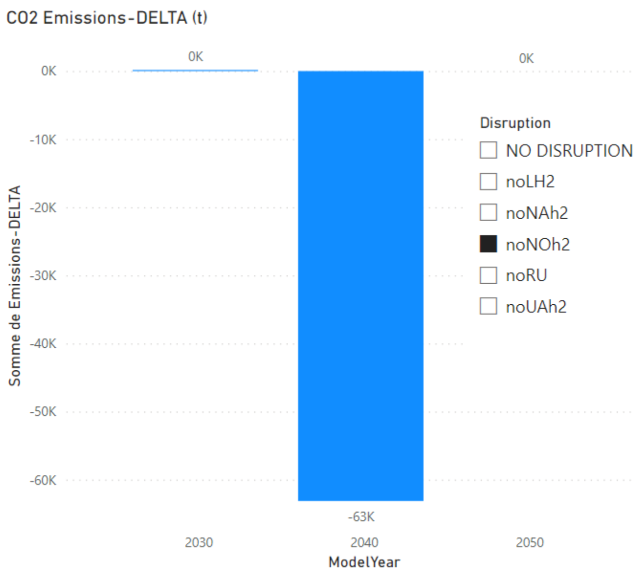
Sustainability benefits

Thanks to the projects group, from 2032, the newly built infrastructure will bring green offshore hydrogen to the hydrogen network in the Netherlands and helps to improve and diversifies hydrogen supply in Europe. In the refence case the project is not contributing to sustainability.

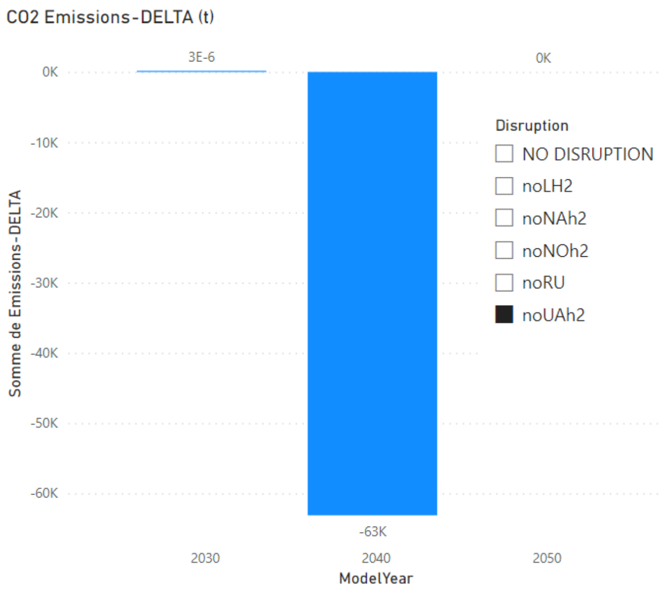
Under all supply disruption cases in 2040 the project is contributing to sustainability by reducing overall CO2 emissions by at least 21,3 kt up to 63 kt per year in case of Ukraine supply disruption. This can be explained that under supply disruption the project group is enabling the replacement of locally produced blue hydrogen (i.e. SMR) with green hydrogen produced offshore.

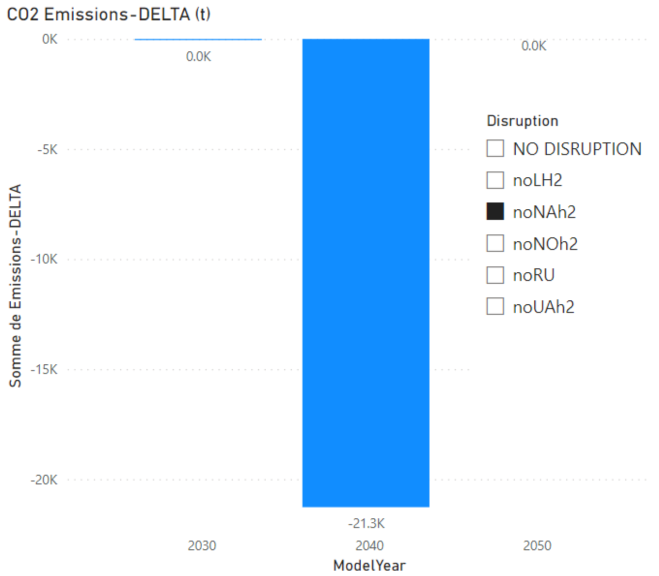
1 noLH2 : LH2 disruption / 2 noNOh2 : Norway disruption / 3 noUAh2 : Ukraine disruption/ 4 noNAh2 : North Africa disruption





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





Security of Supply:[2]

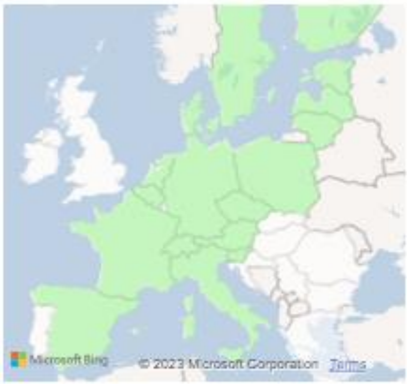
> Reference case:

In the reference case, the project group mitigates the risk of demand curtailment in many European countries in average winter and average summer for 2050. In 2050 countries such as the Netherlands and Belgium can mitigate the risk of hydrogen demand curtailment by 8-9%. Other benefitting countries can reduce the risk by 2% thanks to the project.

2030 DE- Benefits

2040 DE- Benefits

2050 DE- Benefits



> Climatic stress cases:

[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) 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.*

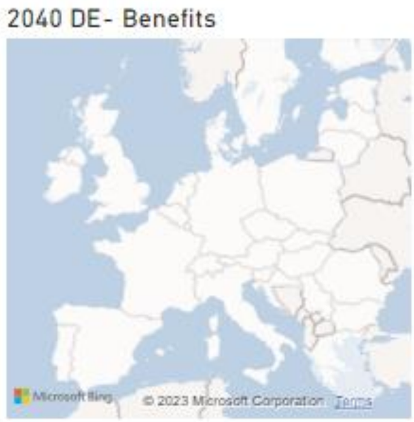
Under 2 -week and 2-week dunkelflaute climatic stress case, as well as under peak day climatic case the project group maintains mitigation of hydrogen demand curtailment risk for many European countries in 2050. The Netherlands is benefitting the most by reducing the risk of hydrogen demand curtailment by 5%.

> Disruption cases (S-1):

Similar under supply disruption cases and refence yearly demand, the project group mitigates the risk of demand curtailment for many European countries in 2050. For example, under Ukraine supply disruption the project group mitigates the risk of demand curtailment for almost all European countries by 2-3%.

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

1 noLH2 : LH2 disruption



2 noNOh2 : Norway disruption

3 noUAh2 : Ukraine disruption

4 noNAh2 : North Africa disruption

> Single largest capacity disruption (SLCD):

In case of SLCD almost all 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 1-2%, whereas in 2050 risk can be reduced by 1-3%.

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

SLCD Benefits - 2030 - Distributed Energy

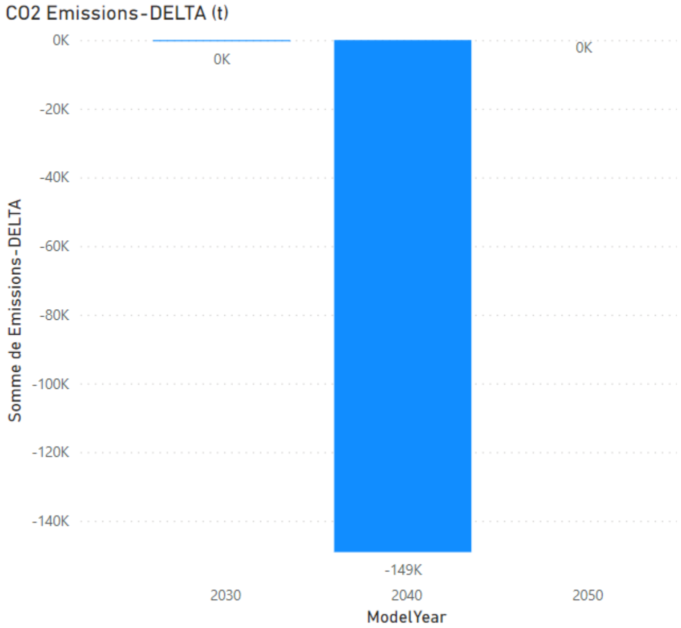
SLCD Benefits - 2040 - Distributed Energy

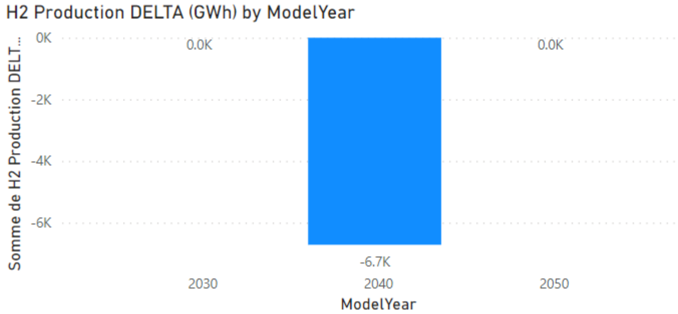
SLCD Benefits - 2050 - Distributed Energy

Global Ambition

Sustainability

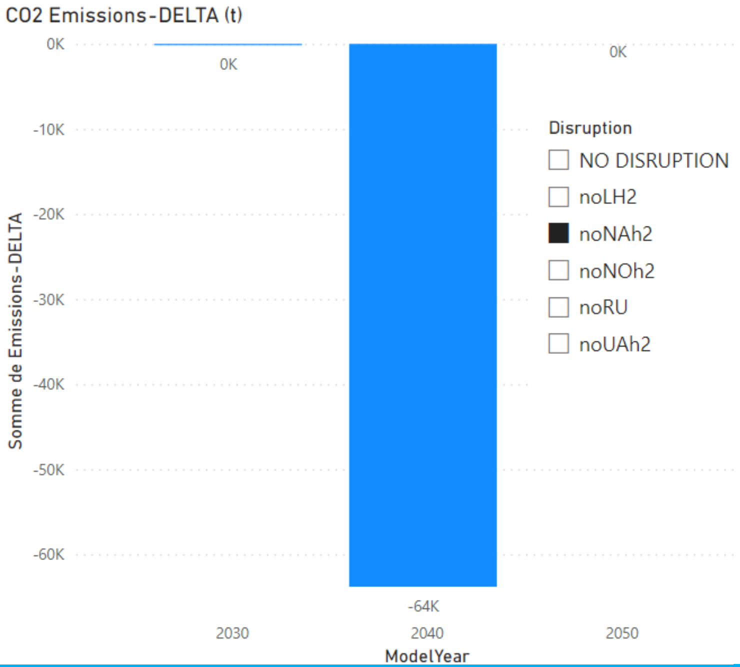
In the reference case, which analyses yearly demand in two periods (average winter and average summer), the project group will contribute to sustainability by reducing overall CO_2 emissions by 149 kt in 2040. In 2040 the project group is enabling the replacement of locally produced blue hydrogen (i.e. SMR) with green hydrogen produced offshore.





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

noNAh2 : North Africa disruption



Security of supply benefits

> 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 many European countries in 2050. In 2050 countries such as the Netherlands and Belgium can mitigate the risk of hydrogen demand curtailment by 4-5%. Other benefitting countries can reduce the risk by 1-2% thanks to the project.

> Climatic stress cases:

Similar under 2 -week and 2-week dunkelflaute climatic stress case, as well as under peak day climatic case the project group maintains the positive security of supply benefits for many European countries in 2050.

> 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 2050.

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

1 noLH2 : LH2 disruption

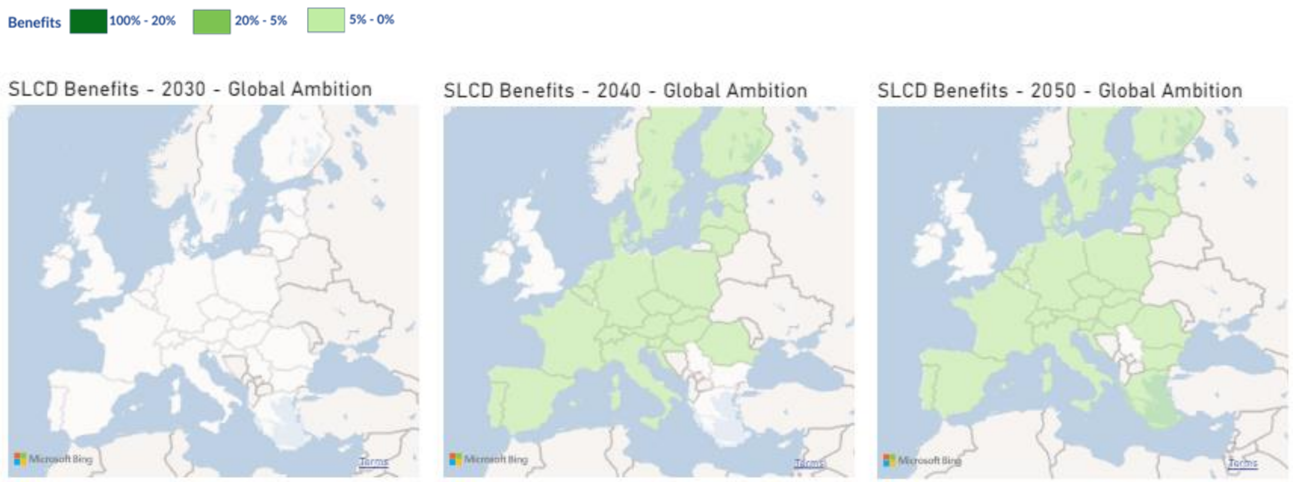
2 noNOh2 : Norway disruption

3 noUAh2 : Ukraine disruption

4 noNAh2 : North Africa disruption

> Single largest capacity disruption (SLCD):

In case of SLCD almost all European countries are benefiting from this project group by mitigating the risk of demand curtailment from 2040 onwards. All respective countries can reduce the risk of demand curtailment by 1-2% in under SLCD in 2040 and 2050.



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	-63119,80	392213883,4	392277003,2
2040	noNAh2	DE	tonne	-21268,63	392188097,7	392209366,3
2040	noNOh2	DE	tonne	-63119,80	392144022,6	392207142,4
2040	noUAh2	DE	tonne	-63119,80	392399182,9	392462302,7
2040	NO DISRUPTION	GA	tonne	-149122,78	396523251,6	396672374,4
2040	noLH2	GA	tonne	0,00	397455196,7	397455196,7
2040	noNAh2	GA	tonne	-63805,88	397301976,6	397365782,5
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
France	0%	0%	-3%	-1%	-3%	-2%
Austria	0%	0%	-2%	-1%	-3%	-1%
Belgium	0%	0%	-2%	-1%	-3%	-2%
Czechia	0%	0%	-2%	-2%	-4%	-2%
Denmark	0%	0%	-2%	-1%	-3%	-1%
Estonia	0%	0%	-2%	-1%	-3%	-1%
Finland	0%	0%	-2%	-1%	-3%	-2%
Germany	0%	0%	-2%	-2%	-3%	-1%
Italy	0%	0%	-2%	-1%	-3%	-1%
Latvia	0%	0%	-2%	-1%	-3%	-1%
Lithuania	0%	0%	-2%	-1%	-3%	-2%
Poland	0%	0%	-2%	-1%	-3%	-2%
Portugal	0%	0%	-2%	-1%	-2%	-1%
Slovenia	0%	0%	-2%	-1%	-3%	-1%
Sweden	0%	0%	-2%	-1%	-3%	-2%
Switzerland	0%	0%	-2%	-1%	-2%	-1%
The Netherlands	0%	0%	-2%	-2%	-4%	-3%
Spain	0%	0%	-2%	-1%	-3%	-1%
Bulgaria	0%	0%	-1%	0%	-1%	-2%
Croatia	0%	0%	-1%	-1%	-2%	-1%
Greece	0%	0%	-1%	0%	-1%	-1%
Hungary	0%	0%	-1%	-1%	-1%	-1%
Romania	0%	0%	-1%	-1%	-1%	-1%
Slovakia	0%	0%	-1%	-1%	-2%	-2%

Curtailment Rate (Climatic Stress):

SimulationPeriod	Country	2030-DE-DELTA	2030-GA-DELTA	2040-DE-DELTA	2040-GA-DELTA	2050-DE-DELTA	2050-GA-DELTA
Average2W	Austria	0%	0%	-1%	-1%	-2%	-1%
Average2W	Belgium	0%	0%	-1%	-1%	-4%	-1%
Average2W	Bulgaria	0%	0%	-1%	-1%	0%	-1%
Average2W	Croatia	0%	0%	-1%	-1%	0%	-1%
Average2W	Cyprus	0%	0%	0%	0%	0%	0%
Average2W	Czechia	0%	0%	-1%	-1%	-2%	-1%
Average2W	Denmark	0%	0%	-1%	-1%	-1%	-2%
Average2W	Estonia	0%	0%	0%	0%	-2%	-1%
Average2W	Finland	0%	0%	-1%	0%	-2%	-2%
Average2W	France	0%	0%	-1%	-1%	-2%	-2%
Average2W	Germany	0%	0%	0%	0%	-1%	-1%
Average2W	Greece	0%	0%	-1%	0%	0%	0%
Average2W	Hungary	0%	0%	0%	-1%	0%	-1%
Average2W	Ireland	0%	0%	0%	0%	0%	0%
Average2W	Italy	0%	0%	-1%	0%	-1%	-1%

Average2W	Latvia	0%	0%	0%	0%	-1%	-1%
Average2W	Lithuania	0%	0%	0%	0%	-1%	-1%
Average2W	Luxembourg	0%	0%	0%	0%	0%	0%
Average2W	Malta	0%	0%	0%	0%	0%	0%
Average2W	Poland	0%	0%	0%	0%	-1%	-2%
Average2W	Portugal	0%	0%	-1%	-1%	0%	-1%
Average2W	Romania	0%	0%	0%	-1%	0%	-1%
Average2W	Serbia	0%	0%	0%	0%	0%	0%
Average2W	Slovakia	0%	0%	-1%	-1%	0%	-1%
Average2W	Slovenia	0%	0%	-1%	-1%	-1%	-1%
Average2W	Spain	0%	0%	0%	0%	-2%	-1%
Average2W	Sweden	0%	0%	-1%	0%	-2%	-2%
Average2W	Switzerland	0%	0%	-1%	0%	-1%	-1%
Average2W	The Netherlands	0%	0%	-1%	-1%	-5%	-2%
Average2W	United Kingdom	0%	0%	0%	0%	0%	0%
Average2WDF	Austria	0%	0%	-1%	-1%	-2%	-2%
Average2WDF	Belgium	0%	0%	0%	-1%	-4%	-1%
Average2WDF	Bulgaria	0%	0%	0%	-1%	0%	-1%
Average2WDF	Croatia	0%	0%	0%	-1%	0%	-1%
Average2WDF	Cyprus	0%	0%	0%	0%	0%	0%
Average2WDF	Czechia	0%	0%	-1%	-1%	-2%	-1%
Average2WDF	Denmark	0%	0%	-1%	-1%	-1%	-2%
Average2WDF	Estonia	0%	0%	0%	0%	-2%	-1%
Average2WDF	Finland	0%	0%	-1%	-1%	-2%	-1%
Average2WDF	France	0%	0%	-1%	-1%	-2%	-2%
Average2WDF	Germany	0%	0%	0%	0%	-1%	-1%
Average2WDF	Greece	0%	0%	-1%	-1%	0%	0%
Average2WDF	Hungary	0%	0%	0%	0%	0%	-1%
Average2WDF	Ireland	0%	0%	0%	0%	0%	0%
Average2WDF	Italy	0%	0%	-1%	0%	-1%	-1%
Average2WDF	Latvia	0%	0%	0%	0%	-1%	-1%
Average2WDF	Lithuania	0%	0%	0%	0%	-1%	-2%
Average2WDF	Luxembourg	0%	0%	0%	0%	0%	0%
Average2WDF	Malta	0%	0%	0%	0%	0%	0%
Average2WDF	Poland	0%	0%	0%	0%	-1%	-2%
Average2WDF	Portugal	0%	0%	-1%	0%	0%	-1%
Average2WDF	Romania	0%	0%	0%	-1%	0%	-2%
Average2WDF	Serbia	0%	0%	0%	0%	0%	0%
Average2WDF	Slovakia	0%	0%	0%	-1%	0%	-1%
Average2WDF	Slovenia	0%	0%	-1%	-1%	-1%	-2%
Average2WDF	Spain	0%	0%	-1%	-1%	-2%	-1%
Average2WDF	Sweden	0%	0%	-1%	-1%	-2%	-1%
Average2WDF	Switzerland	0%	0%	-1%	0%	-1%	-1%
Average2WDF	The Netherlands	0%	0%	-1%	-1%	-5%	-2%
Average2WDF	United Kingdom	0%	0%	0%	0%	0%	0%

DC	Austria	0%	0%	0%	0%	-2%	-1%
DC	Belgium	0%	0%	0%	0%	-2%	-1%
DC	Bulgaria	0%	0%	-1%	0%	0%	0%
DC	Croatia	0%	0%	-1%	0%	0%	-1%
DC	Cyprus	0%	0%	0%	0%	0%	0%
DC	Czechia	0%	0%	0%	0%	-2%	-1%
DC	Denmark	0%	0%	0%	0%	-2%	-1%
DC	Estonia	0%	0%	-1%	0%	-2%	-1%
DC	Finland	0%	0%	0%	0%	-2%	-1%
DC	France	0%	0%	-1%	0%	-2%	-1%
DC	Germany	0%	0%	0%	-1%	-1%	-1%
DC	Greece	0%	0%	-1%	0%	0%	0%
DC	Hungary	0%	0%	-1%	0%	0%	-1%
DC	Ireland	0%	0%	0%	0%	0%	0%
DC	Italy	0%	0%	0%	0%	-2%	0%
DC	Latvia	0%	0%	-1%	0%	-1%	-1%
DC	Lithuania	0%	0%	-1%	0%	-1%	0%
DC	Luxembourg	0%	0%	0%	0%	0%	0%
DC	Malta	0%	0%	0%	0%	0%	0%
DC	Poland	0%	0%	-1%	0%	-1%	-1%
DC	Portugal	0%	0%	-1%	0%	0%	-1%
DC	Romania	0%	0%	-1%	0%	0%	-1%
DC	Serbia	0%	0%	0%	0%	0%	0%
DC	Slovakia	0%	0%	-1%	0%	0%	-1%
DC	Slovenia	0%	0%	-1%	0%	-2%	-1%
DC	Spain	0%	0%	0%	0%	-2%	-1%
DC	Sweden	0%	0%	0%	0%	-2%	-1%
DC	Switzerland	0%	0%	0%	0%	-2%	0%
DC	The Netherlands	0%	0%	0%	0%	-3%	-2%
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-1011	Hydrogen pipeline and platforms		North Sea, Wadden Sea

Potential impact	Mitigation measures	Related costs included in project CAPEX and OPEX	Additional expected costs
Shore crossing	Construction of tunnel and/or other mitigations	TBD	TBD

Environmental Impact explained [Promoter]

The Wadden Sea is a sensitive area which will have to be crossed for the Northern landfall of the project in The Netherlands. The Western landfall (most likely the Den Helder area) is regarded less sensitive in this respect. The Dutch Ministry of Economic Affairs has initiated the project PAWAOZ, which aims at looking at combined Wadden Sea crossings of a hydrogen pipeline and electrical cables for the windfarms. In the project VAWOZ, the Western landfalls for both types of infrastructure is investigated. The Promotor is actively involved and contributing and will follow recommendations of these studies.

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 offshore hydrogen network HyONE-NL has the primary role of evacuating hydrogen produced offshore to the coast, and further to offtakers. The various scenarios issued by the Dutch Government all show a need for hydrogen in the Netherlands for which imports of derivates will not be sufficient. Next to the clear demand, the wind energy produced offshore will not reach the shores in the form of electrons. The Dutch Government is considering ''Energy Hubs'' where wind energy is connected, collected and (partially) converted into Hydrogen. The promotor will be appointed the exclusive role of HNO for offshore hydrogen transport and plays and important role in defining the lay-out of these Energy Hubs, together with the e-TSO of The Netherlands and the Ministry of Climate. In the EIPN project (see link below) the governance and market structures will be established as well as an update of the Development Framework (see link below) which will also govern the roll-out of offshore electrolysis.

Next to offshore electrolysis for domestic consumption, The Netherlands will also be playing a role as transit country with imports and exports to other North Sea countries. Potential imports from the UK and Denmark may be routed towards Germany and Belgium. In the next updates of the TYNDP these initiatives will become clearer and more visible.

F. Useful links [Promoter]

Useful links:

- Bringing offshore wind energy to shore | RVO.nl
- Plans 2030-2050 | RVO.nl
- Letter-to-Parliament-Offshore-Wind-Energy-2030-2050.pdf (rvo.nl)