HI WEST 33 (Advanced)
Delta Rhine Corridor H2

Reasons for grouping [ENTSOG]

The project group aims at interconnecting threw a future hydrogen infrastructure, producers and consumers between the Netherlands Belgium and Germany.

The group includes investments in the Netherland, Belgium and in Germany (HYD-N-793).

Objective of the group [Promoter]

- The Delta Rhine Corridor aims to develop a bundling of multiple pipelines connecting Rotterdam with major inland industry clusters in the Netherlands (Moerdijk & Chemelot), Germany (North Rhine- Westphalia and Rhineland-Palatinate) and potentially Belgium (Antwerp) with branches along the entire corridor.
- Establishment of a major cross border H2 infrastructure in the 'HI West H2 gas corridor'.
- Transport of renewable and low-carbon H2 from non EU countries as well as domestically produced clean H2.
- Contribution to climate objective of the Netherlands, Germany (and Belgium) by offering deeper inland industrial clusters an accelerated decarbonisation opportunity.
- Create additional synergy due to the industrial proposition for CO_2 transport.

HYD-N-793 **Delta Rhine Corridor H2**

Comm. Year **2028-2030**

A. Project group technical information [Promoter/ ENTSOG]

Project technical information [Promoter]

Hydrogen Terminal

TYNDP Project code	Hydrogen carrier
H2.Sines.Rotterdam	Liquid Hydrogen
Holland Hydrogen 1	Hydrogen
Project Helios	NH3
ACE terminal	NH3
Amplifhy Rotterdam	NH3

Hydrogen Transmission

TYNDP Project code	Section name	New / Repurposing	Nominal Diameter [mm]	Section Length [km]	Compressor power [MW]
HYD-N-793	German section	New	900	413	tbd
HYD-N-793	Dutch section	New	1050	150	tbd
HYD-N-793	Dutch section	Repurposing	1050	100	tbd

The envisioned new hydrogen pipeline has a diameter of 42 inch with an overall 2.18 MTPA transport capacity by 2040. The operating pressure is aimed to be 66,2 barg. Booster capacity is further investigated and detailed in the ongoing feasibility study to potentially further increase the pipeline throughput. The route in the Netherlands has a length of 249 km, of which 35km along the pipeline route of Port of Rotterdam, 33 km along the LSNED and 182 km along the SVB strips. The section Venlo - Gelsenkirchen/Scholven has an estimated length of 82 km. Within this trajectory there is near Wesel a tie-in envisioned to make a connection to Duisburg. This leg Wesel-Duisburg has an estimated length of 18 km. The section Venlo - Cologne/Wesseling has an estimated length of 103 km. The section Cologne/Wesseling - Ludwigshafen has an estimated length of 210 km.

The section Moerdijk - Antwerp has an estimated length of 67 km. The trajectory will follow mostly one of the existing pipeline corridors. Within the overarching DRC project regarding this section, the construction of a CO_2 pipeline is more mature (also in synergy with CO2TransPorts PCI). Simultaneous construction of both pipelines (H_2 and CO_2) would offer (cost) efficiency benefits. The Port of Antwerp is developing its own H_2 import portfolio that can fulfil potentially the local demand and thus diminishes the need for an interconnection with DRC. However, interconnection could boost the resilience and security of supply of the cross-border network and European Hydrogen backbone in general. The opportunity to extend the DRC corridor to Antwerp is currently under consideration.

Please note that the above information reflects the project status when the PCI application was filed in December 2022. The project partners are currently working on a potential optimization of the routing, which would make use of re-purposed natural gas pipelines.

Capacity increment [ENTSOG]

TYNDP Project code	Point name	Operator	From system	To system	Capacity increment [GWh/d]	Comm. year
HYD-N-793	H2_IP_DE-NL		Transmission Netherlands (NL Hydrogen)	Transmission Germany (DE Hydrogen)	131,5	2028-2030

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-793	2545	15%	25,45	15%

Description of the cost and range [Promoter]

The number that is being used for CAPEX and OPEX that are presented in the application are based on the P85 estimates. The annual OPEX is calculated as a percentage of the CAPEX in line with IEA estimations

C. Project Benefits [ENTSOG]

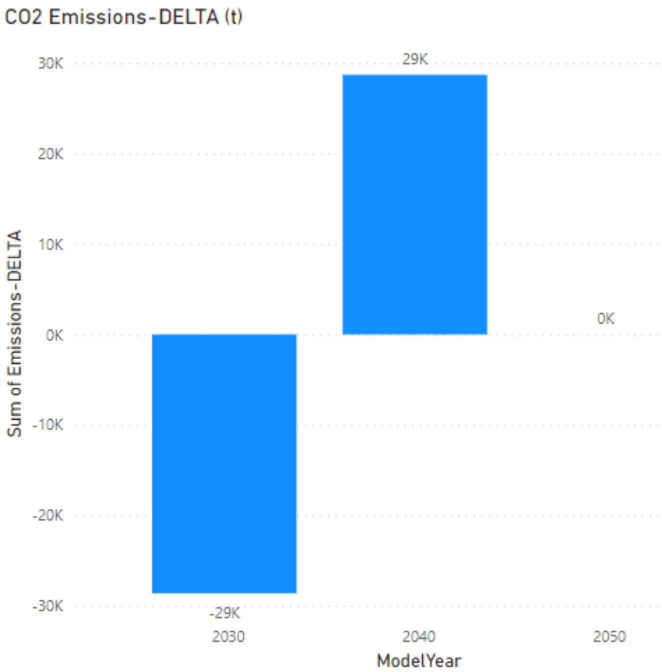
C.1 Summary of benefits

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

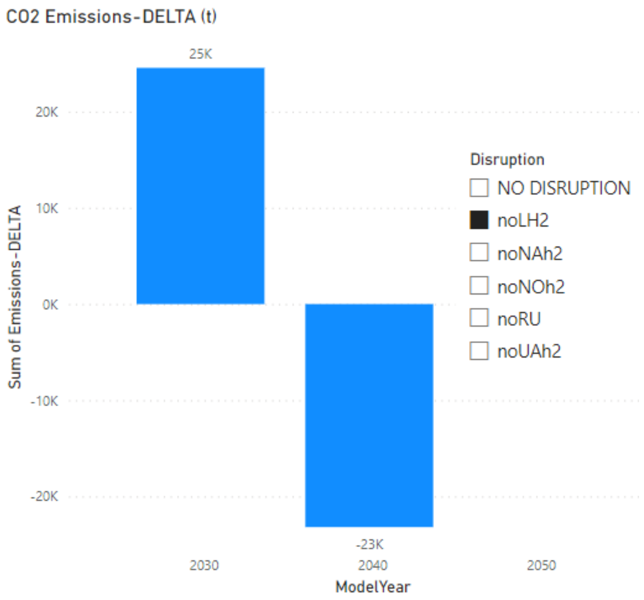
In the reference case, which analyses yearly demand in two periods (average winter and average summer), the project group will contribute to sustainability by reducing overall CO_2 emissions by 29 kt in 2030. The project group enables the transport of green hydrogen and so then replacing use of SMR's.

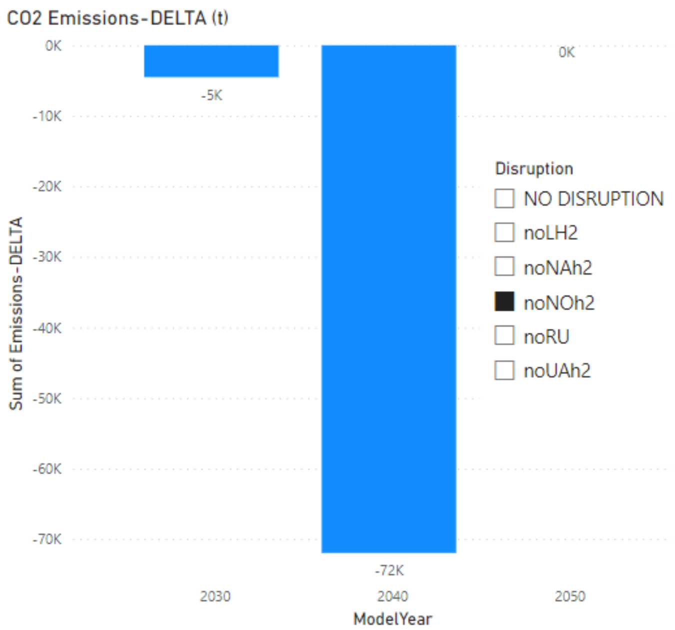


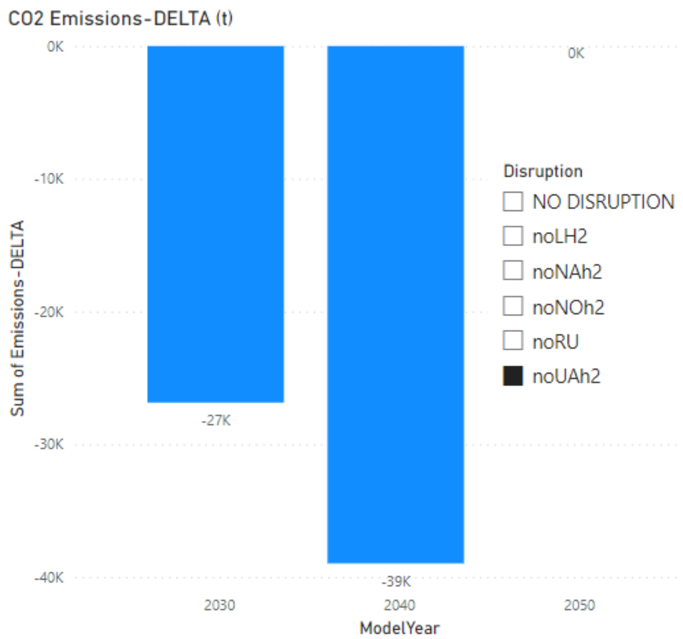
Similar trend is expected under any supply disruption.

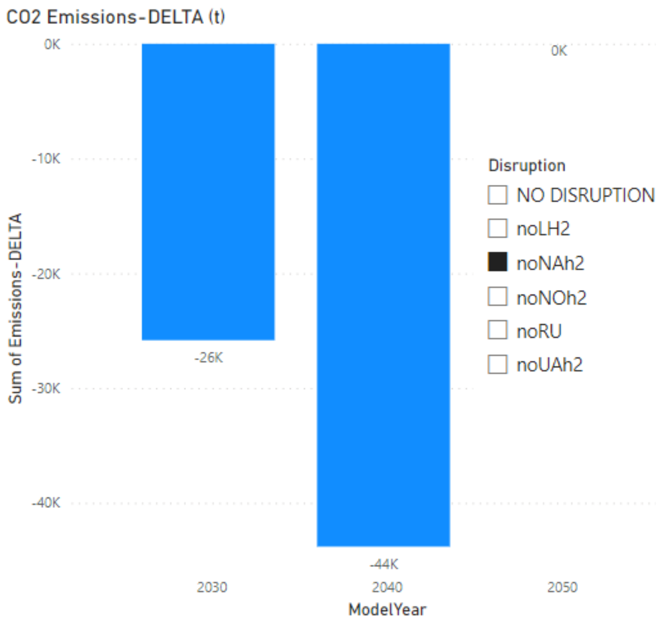
1 noLH2 : LH2 disruption / 2 noNOh2 : Norway disruption / 3 noUAh2 : Ukraine disruption/ 4 noNAh2 : North Africa disruption

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









Security of Supply:[2]

Because of competing projects groups, between the Netherlands and Germany, benefits could be limited.

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[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.*

> Reference case:

In the reference case, the project is not further mitigating hydrogen demand curtailment risk in average summer and average winter for European countries.

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 projects group is contributing to mitigate demand curtailment in the Netherlands in 2030. Moreover, in 2040, group mitigates demand curtailment in almost all the European countries.

2030 DE- Benefits

2040 DE- Benefits

2050 DE- Benefits

> Disruption cases (S-1):

Similarly, under disruptions cases, projects group is mitigating demand curtailment. First in case of noLH2, group is mitigating demand curtailment in the Netherlands in 2030, then under other supplies disruptions in different countries in 2040, depending on the case.

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

1 noLH2 : LH2 disruption

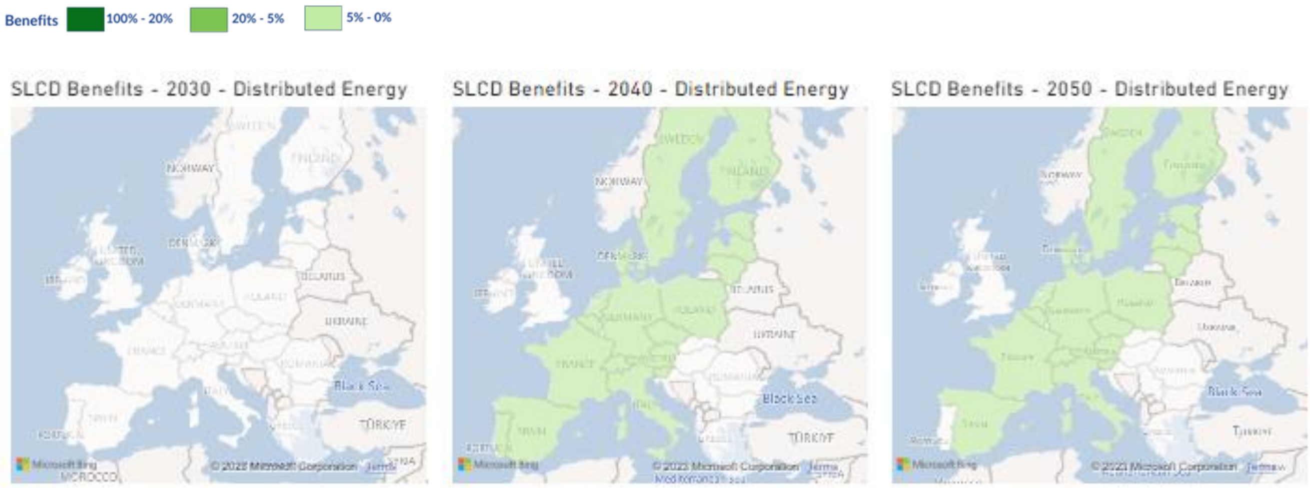
2 noNOh2 : Norway

3 noUAh2 : Ukraine disruption

4 noNAh2 : North Africa disruption

> Single largest capacity disruption (SLCD):

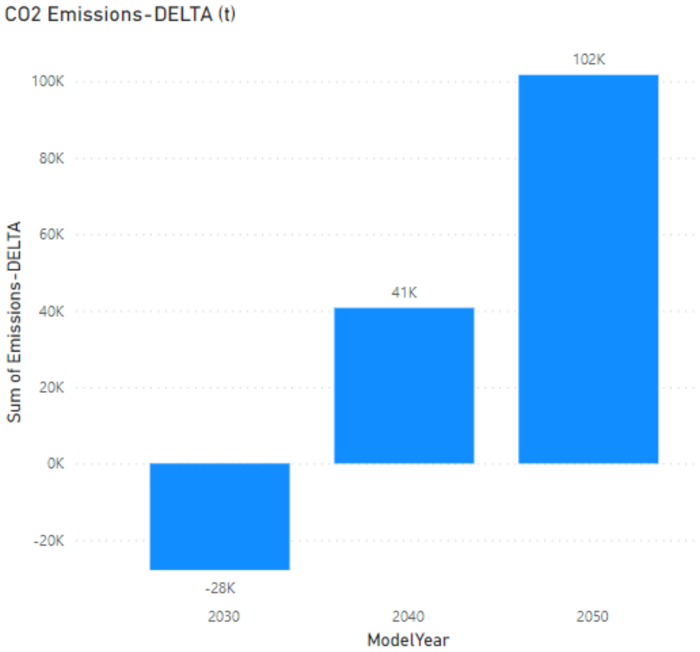
In case of SLCD many European countries benefitting on small scale from this project group by mitigating the risk of demand curtailment from 2040 by 1-2%.



Global Ambition

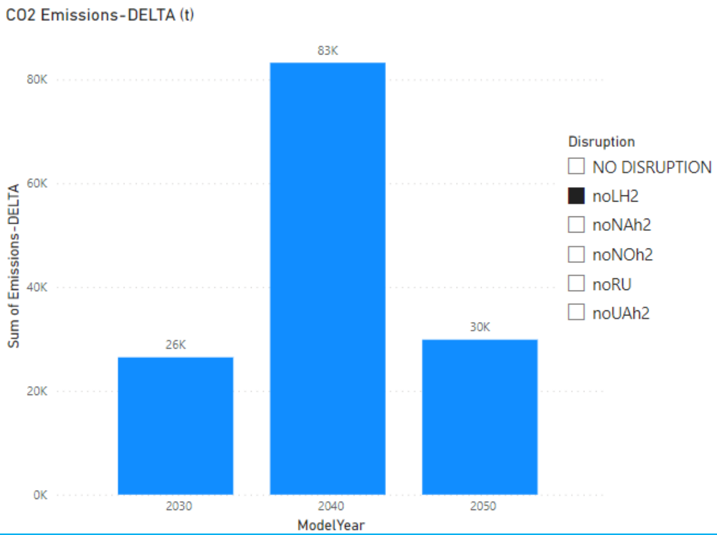
Sustainability benefits

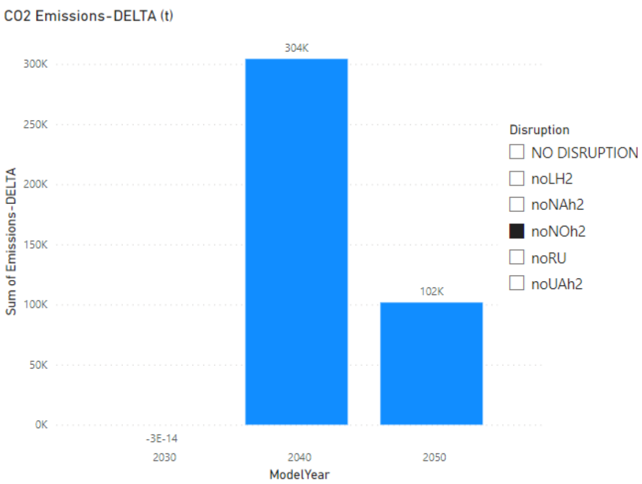
In the reference case, which analyses yearly demand in two periods (average winter and average summer), the project group will contribute to sustainability by reducing overall CO_2 emissions by 28 kt in 2030. The project group enables the transport of green hydrogen and so then replacing use of SMR's.

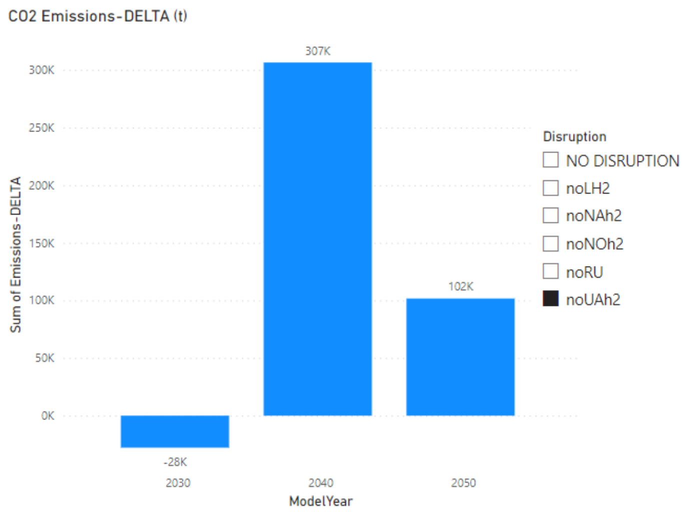


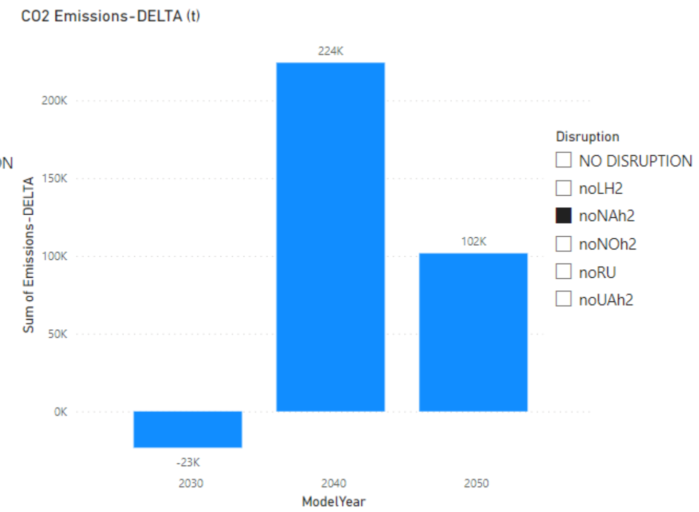
Sustainability benefits are increased under supply disruption cases, such as Norway, Ukraine, or North Africa Disruption for 2030. For example, in case of North Africa disruption the project group will reduce CO_2 emissions by 100 kt in 2030.

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









Security of supply benefits

> Reference case

In the reference case, the projects group is contributing to mitigate demand curtailment in almost all European countries in 2040.

> Climatic stress cases

Under 2 -week and 2-week dunkelflaute climatic stress case, as well as under peak day climatic case the projects group is contributing to mitigate demand curtailment in the Netherlands in 2030. Moreover, in 2040, group mitigates demand curtailment in Denmark, Czechia and Slovenia.

> Disruption cases (S-1)

Similarly under disruptions cases, projects group is mitigating demand curtailment. First in case of noLH2, group is mitigating demand curtailment in the Netherlands in 2030, then under other supplies disruptions in different countries in 2040, depending on the case.

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

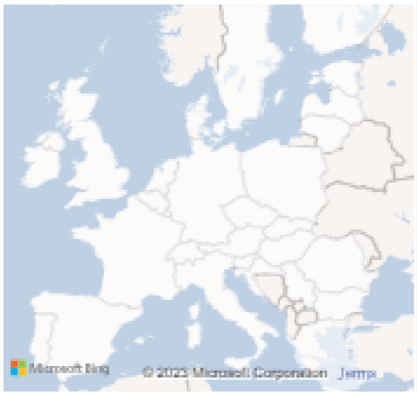
1 noLH2 : LH2 disruption

2 noNOh2 : Norway

2030 GA- Benefits

2040 GA- Benefits

2050 DE- Benefits

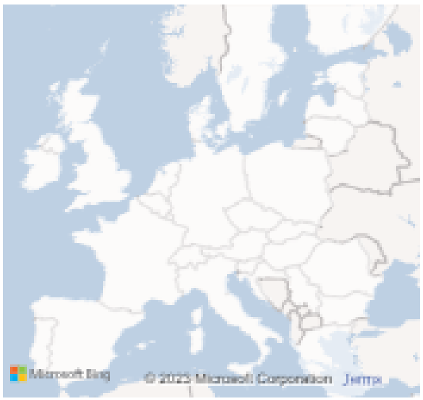


3 noUAh2 : Ukraine disruption

2030 GA- Benefits

2040 GA- Benefits

2050 DE- 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 on small scale from this project group by mitigating the risk of demand curtailment in 2040 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	-28613,65	538677299	538648685,4
2030	noLH2	DE	tonne	24550,14	540175890,2	540200440,4
2030	noNAh2	DE	tonne	-25822,73	539785356,1	539759533,4
2030	noNOh2	DE	tonne	-4523,22	538877197,8	538872674,6
2030	noUAh2	DE	tonne	-26853,26	539378771,9	539351918,7
2030	NO DISRUPTION	GA	tonne	-27743,93	592910448,4	592882704,5
2030	noLH2	GA	tonne	26448,37	594817481,2	594843929,6
2030	noNAh2	GA	tonne	-23336,76	594141433,2	594118096,4
2030	noNOh2	GA	tonne	0,00	593310994,3	593310994,3
2030	noUAh2	GA	tonne	-27743,45	593627617,9	593599874,5
2040	NO DISRUPTION	DE	tonne	28692,92	392077044	392105736,9
2040	noLH2	DE	tonne	-23181,11	392213883,4	392190702,3
2040	noNAh2	DE	tonne	-43803,43	392188097,7	392144294,3
2040	noNOh2	DE	tonne	-71965,59	392144022,6	392072057
2040	noUAh2	DE	tonne	-38965,14	392399182,9	392360217,7
2040	NO DISRUPTION	GA	tonne	40708,67	396523251,6	396563960,3
2040	noLH2	GA	tonne	83226,35	397455196,7	397538423,1
2040	noNAh2	GA	tonne	224245,63	397301976,6	397526222,3
2040	noNOh2	GA	tonne	304241,79	397450977,1	397755218,9
2040	noUAh2	GA	tonne	306507,23	397478498,3	397785005,6
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	101661,63	228306706,5	228408368,2
2050	noLH2	GA	tonne	29856,26	228306706,5	228336562,8
2050	noNAh2	GA	tonne	101661,63	228306706,5	228408368,2
2050	noNOh2	GA	tonne	101661,63	228306706,5	228408368,2
2050	noRU	GA	tonne	101661,63	228306706,5	228408368,2
2050	noUAh2	GA	tonne	101661,63	228306706,5	228408368,2

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%	-2%	-1%	-1%	0%
Czechia	0%	0%	-2%	-2%	-2%	0%
Estonia	0%	0%	-2%	-1%	-2%	0%
Finland	0%	0%	-2%	-1%	-2%	0%
Germany	0%	0%	-2%	-1%	-1%	0%
Latvia	0%	0%	-2%	-1%	-1%	0%
Lithuania	0%	0%	-2%	-1%	-1%	-1%
Poland	0%	0%	-2%	-1%	-1%	0%
Portugal	0%	-1%	-2%	-1%	0%	0%
Slovenia	0%	0%	-2%	-1%	-1%	0%
Sweden	0%	0%	-2%	-1%	-2%	0%
Switzerland	0%	0%	-2%	-1%	-1%	0%
France	0%	0%	-2%	-1%	-1%	0%
The Netherlands	0%	0%	-1%	-1%	-2%	0%
Austria	0%	0%	-1%	-1%	-2%	0%
Denmark	0%	0%	-1%	-1%	-1%	0%
Italy	0%	0%	-1%	-1%	-2%	0%
Spain	0%	0%	-1%	-1%	-1%	0%
Slovakia	0%	0%	0%	0%	0%	-1%

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%	0%	0%	0%	0%
Average2W	Belgium	0%	0%	-1%	0%	0%	0%
Average2W	Bulgaria	0%	0%	0%	0%	0%	0%
Average2W	Croatia	0%	0%	0%	0%	0%	0%
Average2W	Cyprus	0%	0%	0%	0%	0%	0%
Average2W	Czechia	0%	0%	0%	0%	0%	0%
Average2W	Denmark	0%	0%	0%	0%	0%	0%
Average2W	Estonia	0%	0%	0%	0%	0%	0%
Average2W	Finland	0%	0%	0%	0%	0%	0%
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%	0%	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%	0%	0%	0%
Average2W	Spain	0%	0%	0%	0%	0%	0%
Average2W	Sweden	0%	0%	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%	-1%	0%
Average2WDF	Belgium	0%	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%	0%	0%	0%	-1%	0%
Average2WDF	Denmark	0%	0%	0%	0%	0%	0%
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%	0%	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	0%	0%	0%	0%	0%	0%
Average2WDF	Slovenia	0%	0%	0%	0%	0%	0%
Average2WDF	Spain	0%	0%	0%	0%	0%	0%
Average2WDF	Sweden	0%	0%	0%	0%	-1%	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%	0%	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%	0%	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%	0%	0%	0%	0%	0%
DC	Slovenia	0%	0%	0%	0%	0%	0%
DC	Spain	0%	0%	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-793	n.a	n.a	n.a

Potential impact	Mitigation measures	Related costs included in project CAPEX and OPEX	Additional expected costs

The Delta Rhine Corridor will make use of an existing pipeline corridor in the Netherlands, designated for hazardous pipelines, with already several pipelines operating in the corridor. Currently the environmental impact is being assessed and will be published by the end of the year 2023 and updated in 2024 in line with permitting requirements.

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]

Market integration
The overarching Delta Rhine Corridor project comprises a bundle of pipelines between the Rotterdam port, Chemelot, and the German Rhineland region and potentially Antwerp. This project will provide access to clean hydrogen and carbon capture and storage (CCS) capacity being realized. The integration of hydrogen and carbon capture and storages technologies within common value chains can contribute to the effective decarbonization of the energy system and hard-to-abate sectors where electrification may not be technically possible or cost effective. Hence, the combined H2-CCS chain is a strategic value chain in the process towards a low carbon and increasingly integrated energy system. The simultaneous implementation offers various benefits (spatial planning, permitting, construction).

Local benefits
The project has been positively received by the various local communities as they could benefit from the pipelines. These benefits include the built-up areas along the Brabant Route (opportunities for urban densification around station locations), residents (reduced transport of hazardous substances by rail), the business, and employees (the improved competitive position and opportunities for making the transition would keep industry competitive on the international stage). The knowledge sharing, communication and dissemination strategy, also in order to further improve public perception and stakeholder management, will be further detailed in the feasibility study.

F. Useful links [Promoter]

Useful links:

https://www.delta-rhine-corridor.com/en