HI WEST 16 A (Less-Advanced)

Amplifhy Antwerp Ammonia Terminal

Reasons for grouping [ENTSOG]

The project group is a stand-alone terminal in Belgium. This project will enable imports of hydrogen to Belgium partially in 2026 and fully in 2030 (HYD-N-1100).

Objective of the group [Promoter]

To enable large scale hydrogen imports into the European backbone system in the form of cracked green ammonia, helping to decarbonize hard to abate industries in Europe as well as providing balancing services to the European hydrogen system in times of low renewables availability.

Amplifhy Antwerp will be connected to other European countries (incl. Germany and Belgium) via the Belgian Hydrogen Backbone HYD-N-1311

A. Project group technical information [Promoter/ ENTSOG]

Project technical information [Promoter]

Liquified Hydrogen Terminal

TYNDP Project code	Hydrogen carrier	H_2 Import capacity [GWh/d]	Injection capacity [GWh/d]	Storage capacity [m^3]
HYD-N-1100	Ammonia	495	45	90.000

Description of hydrogen terminal [Promoter]

The ammonia import terminal will grow over time to facilitate the increasing flows of ammonia into Europe. The initial terminal will have excess capacity as a pre-investment for future growth.

The terminal figures above are for the 2030 size of the terminal. It is planned to increase in size after 2030.

Import capacity is based on the number of jetties at the terminal and the discharge flow rates from vessels into the terminal.

Capacity increment [ENTSOG]

TYNDP Project code	Point name	Operator	From system	To system	Capacity increment [GWh/d]	Comm. year
HYD-N-1100	LH2_Tk_BE	VTTI terminal support services	Terminal Belgium (LH2_Tk_FR)	Transmission Belgium (BE Hydrogen)	5	2026
HYD-N-1100	LH2_Tk_BE	VTTI terminal support services	Terminal Belgium (LH2_Tk_FR)	Transmission Belgium (BE Hydrogen)	2	2028
HYD-N-1100	LH2_Tk_BE	VTTI terminal support services	Terminal Belgium (LH2_Tk_FR)	Transmission Belgium (BE Hydrogen)	38	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-1100	642	30%	28	30%

Description of the cost and range [Promoter]

Capex is for the cracker and terminal size in 2028-2030, in line with PCI submission.

Scope and level of engineering detail is progressing as well as key material markets are changing vs the initial PCI submission date. Capex and opex figures are different per technology supplier, so final partner selection will also influence the final cost figures.

Therefore, cost estimate might change over time.

C. Project Benefits [ENTSOG]

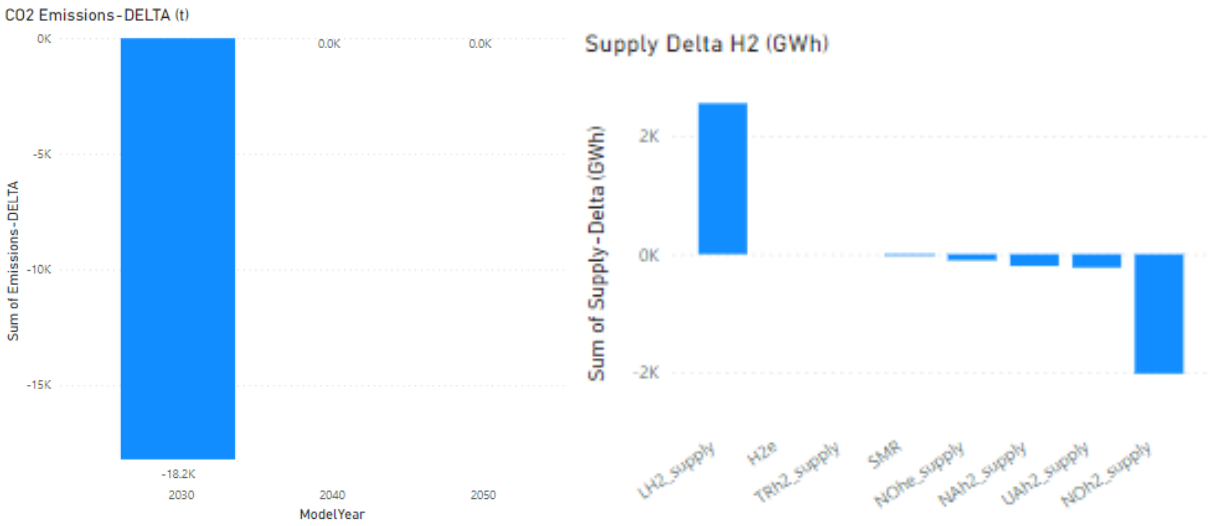
C.1 Summary of benefits

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

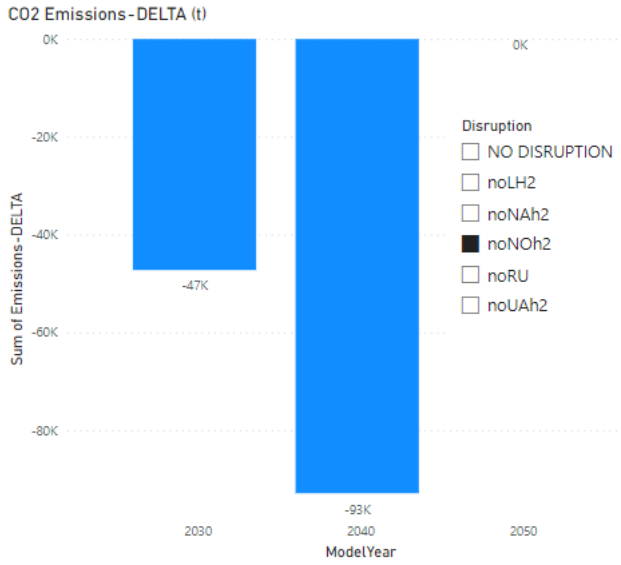
In the reference case, which analyses yearly demand in two periods (average winter and average summer), the project group will contribute to sustainability by reducing overall CO2 emissions by 18,2 kt in 2030. The project group enables imports of green hydrogen and so then replacing use of Norwegian supply which is considered as blue hydrogen in 2030.

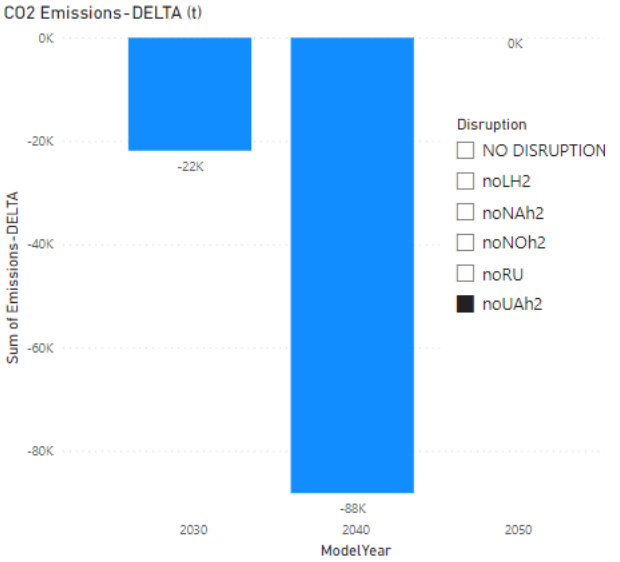


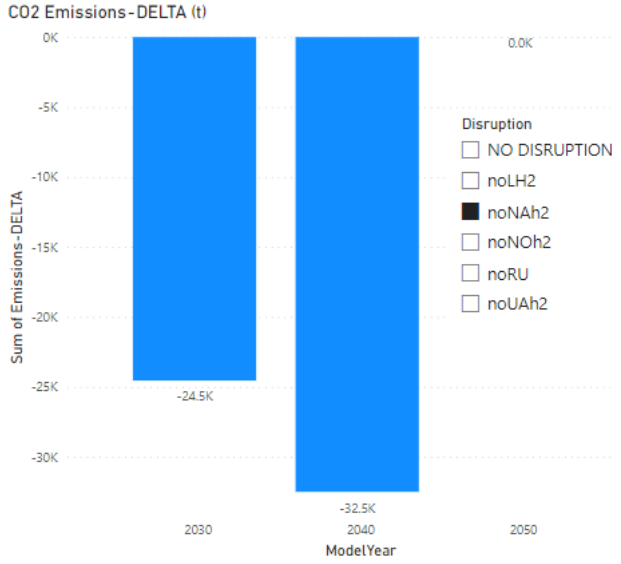
Similar trend is expected under any supply disruption in 2030 with even more benefits, up to 47 kt. In 2040, The project has more sustainability benefits by reducing the use of SMRs.

1 noNOh2 : Norway disruption / 2 noUAh2 : Ukraine disruption/ 3 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 is contributing to further mitigation of hydrogen demand curtailment risk in average summer and average winter in 2050 by 1%, in Belgium and in the Netherlands.

[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.*

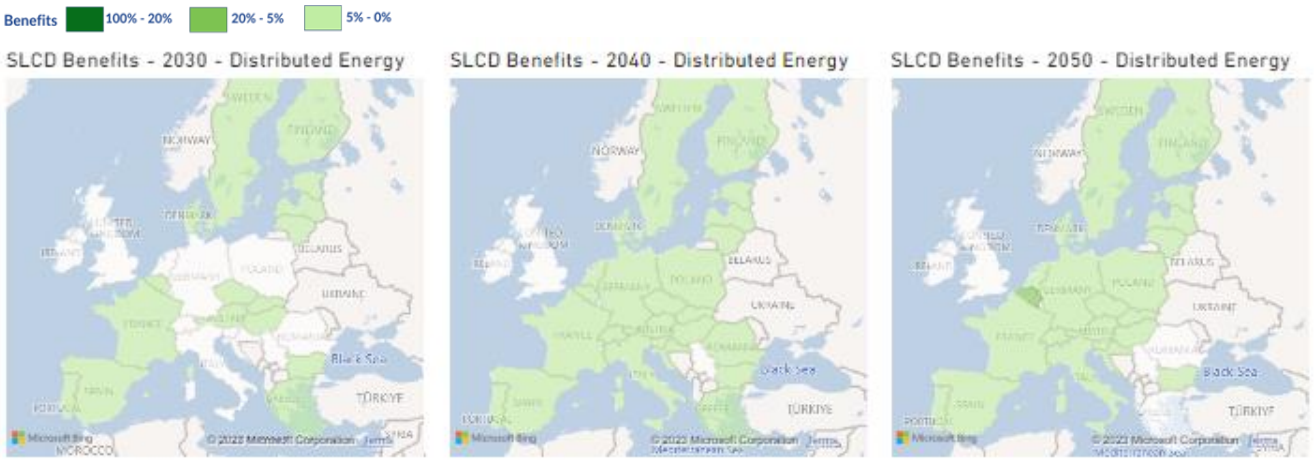
> Climatic stress cases

Under 2 -week and 2-week dunkelflaute climatic stress case, as well as under peak day climatic case the project group is not mitigating demand curtailment.

> Disruption cases (S-1):

Similarly, under supply disruption cases, the project group is not mitigating demand curtailment .

> Single largest capacity disruption (SLCD):

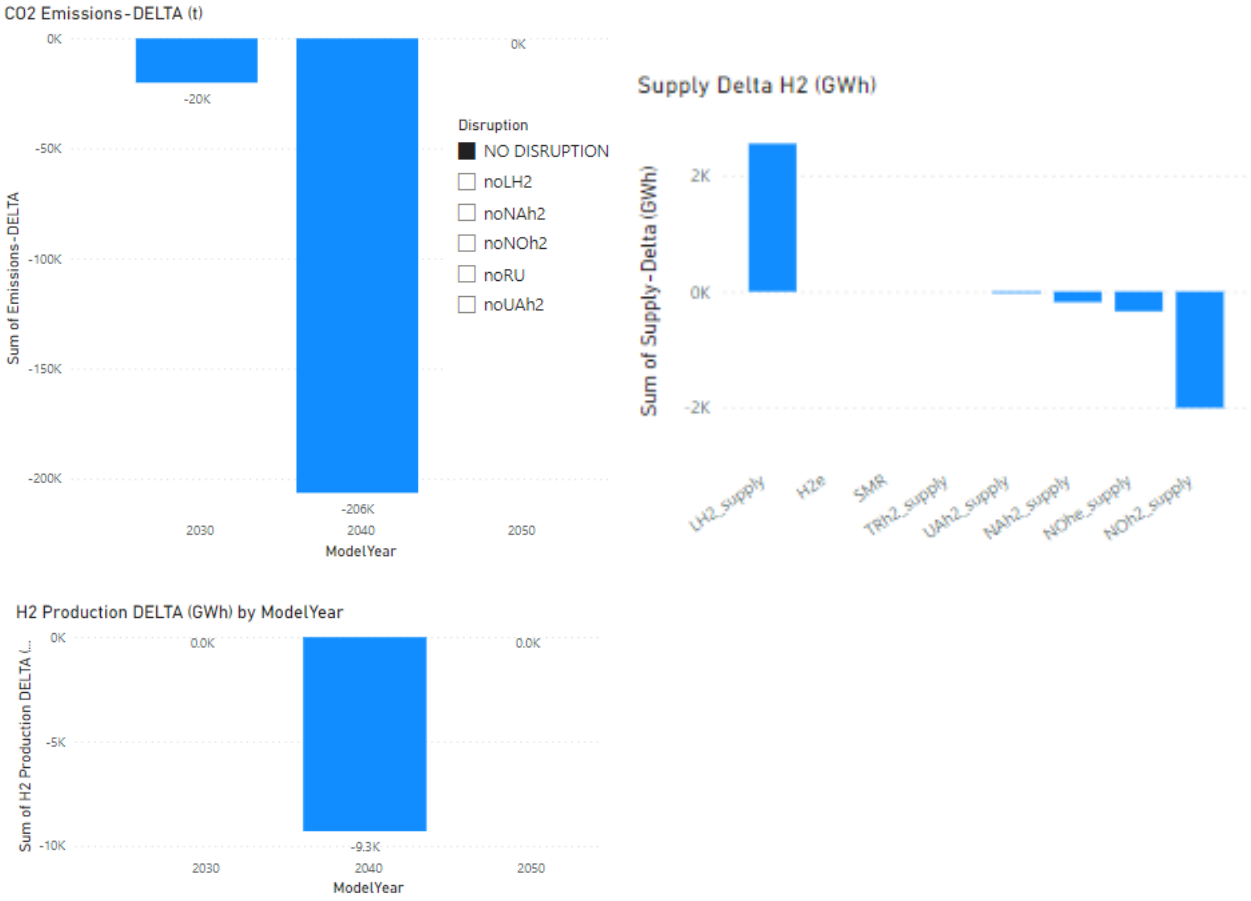


In case of single largest capacity disruption (SLCD), the project group reduces the risk of demand curtailment in some parts of Europe in 2030, by 1 %. From 2040, the project has more effect on demand curtailment and reduces risk by 2-3% in all Europe. Moreover in 2050, it is in Belgium where demand curtailment is the most reduce by 8%.

Global Ambition

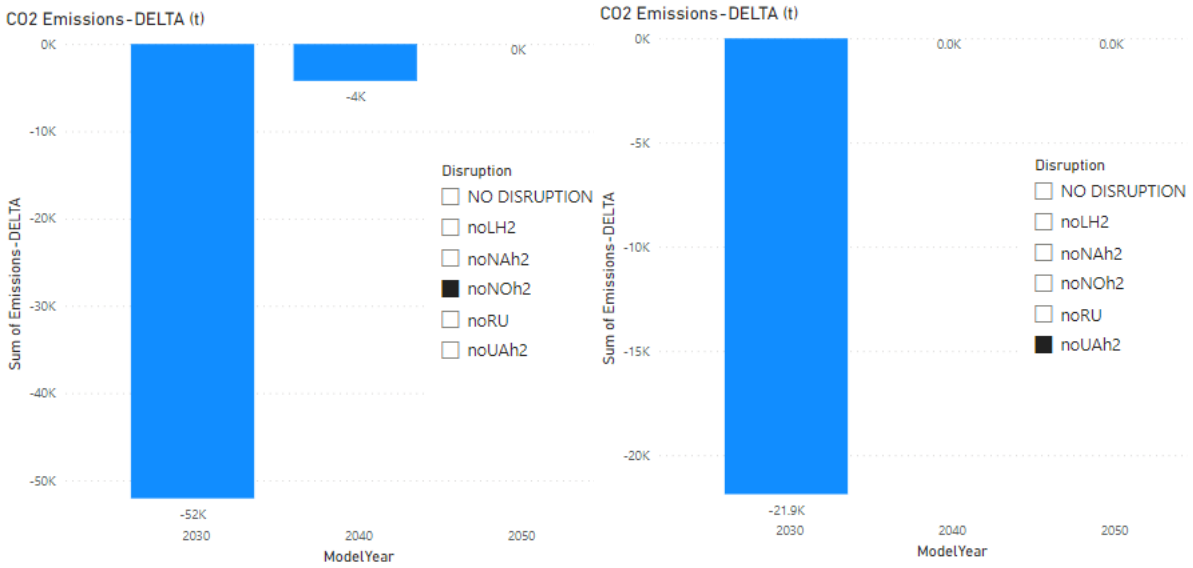
Sustainability benefits

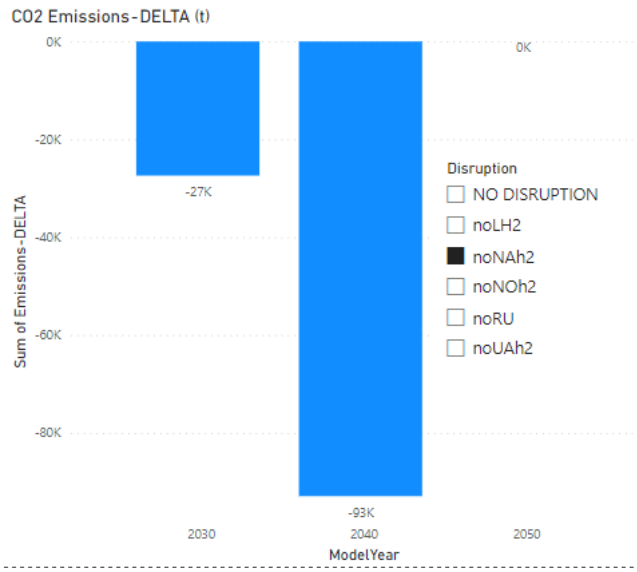
In the reference case, which analyses yearly demand in two periods (average winter and average summer), the project group will contribute to sustainability by reducing overall CO2 emissions by 20 kt in 2030. The project group enables the transport of green hydrogen and so then replacing use of Norwegian supply which is considered as blue hydrogen in 2030. Moreover, in 2040, as the hydrogen demand is higher, the terminal will decrease overall CO2 emissions by using less SMRs.



Similar trend is expected under supply disruptions.

1 noNOh2 : Norway disruption / 2 noUAh2 : Ukraine 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 from 2040 by 1-2% in Belgium.

2030 GA- Benefits

2040 GA- Benefits

2050 GA- 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 not mitigating demand curtailment.

2030 DE- Benefits

2040 DE- Benefits

2050 DE- Benefits

> Disruption cases (S-1):

Similarly, under supply disruption cases, the project group mitigates demand curtailment in some European countries, depending of cases, from 2040 by 1-2%.

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

1 noNOh2 : Norway disruption

2 noUAh2 : Ukraine disruption

3 noNAh2 : North Africa disruption

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

In case of single largest capacity disruption (SLCD), the project group reduces the risk of demand curtailment in some parts of Europe in 2030, by 1 %. From 2040, the project has more effect on demand curtailment and reduces risk by 1-2% in almost all 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
2030	NO DISRUPTION	DE	tonne	-18214,24	538677299	538695513,3
2030	noLH2	DE	tonne	-117,45	540175890,2	540176007,7
2030	noNAh2	DE	tonne	-24543,31	539785356,1	539809899,4
2030	noNOh2	DE	tonne	-47232,80	538877197,8	538924430,6
2030	noUAh2	DE	tonne	-21869,07	539378771,9	539400641
2030	NO DISRUPTION	GA	tonne	-20089,56	592910448,4	592930538
2030	noLH2	GA	tonne	-51,90	594817481,2	594817533,1
2030	noNAh2	GA	tonne	-27410,96	594141433,2	594168844,1
2030	noNOh2	GA	tonne	-52066,95	593310994,3	593363061,2
2030	noUAh2	GA	tonne	-21869,07	593627617,9	593649487
2040	NO DISRUPTION	DE	tonne	0,00	392077044	392077044
2040	noLH2	DE	tonne	-1564,91	392213883,4	392215448,3
2040	noNAh2	DE	tonne	-32493,40	392188097,7	392220591,1
2040	noNOh2	DE	tonne	-92862,40	392144022,6	392236885
2040	noUAh2	DE	tonne	-88169,31	392399182,9	392487352,2
2040	NO DISRUPTION	GA	tonne	-206414,19	396523251,6	396729665,8
2040	noLH2	GA	tonne	0,00	397455196,7	397455196,7
2040	noNAh2	GA	tonne	-92921,19	397301976,6	397394897,8
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
Czechia	-1%	-1%	-3%	-2%	-3%	-1%
Estonia	-1%	-1%	-3%	-1%	-2%	-1%
Latvia	-1%	-1%	-3%	-1%	-2%	-1%
Lithuania	-1%	-1%	-3%	-1%	-2%	-1%
Poland	-1%	-1%	-3%	-1%	-2%	-1%
Portugal	-1%	-1%	-3%	-1%	-1%	-1%
Slovenia	0%	0%	-3%	-1%	-2%	-1%
France	-1%	-1%	-3%	-1%	-2%	-1%
Germany	-1%	-1%	-2%	-2%	-1%	-1%
Austria	-1%	-1%	-2%	-1%	-2%	-1%
Belgium	-1%	-3%	-2%	-2%	-8%	-3%
Denmark	-1%	-1%	-2%	-2%	-2%	-1%
Finland	-1%	-1%	-2%	-1%	-2%	-1%
Italy	-1%	-1%	-2%	-1%	-2%	-1%
Spain	-1%	-1%	-2%	-2%	-2%	-1%
Sweden	-1%	-1%	-2%	-1%	-2%	-1%
Switzerland	0%	0%	-2%	-1%	-1%	-1%
The Netherlands	0%	0%	-2%	-2%	-2%	-1%
Bulgaria	-1%	0%	-1%	-1%	-1%	-1%
Croatia	0%	0%	-1%	-1%	-1%	-1%
Greece	-1%	0%	-1%	-1%	0%	-1%
Hungary	-1%	-1%	-1%	-1%	-1%	-1%
Romania	0%	-1%	-1%	-1%	0%	-1%
Slovakia	-1%	-1%	-1%	-1%	-1%	-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	-1%	0%	-1%	-1%	-1%	-1%
Average2W	Belgium	0%	0%	-1%	-1%	0%	0%
Average2W	Bulgaria	0%	0%	-1%	-1%	0%	0%
Average2W	Croatia	0%	0%	-1%	-1%	0%	-1%
Average2W	Cyprus	0%	0%	0%	0%	0%	0%
Average2W	Czechia	-1%	0%	-1%	-1%	-1%	-1%
Average2W	Denmark	0%	-1%	-1%	-1%	-1%	-1%
Average2W	Estonia	0%	0%	0%	-1%	-1%	0%
Average2W	Finland	0%	0%	-1%	0%	-1%	-1%
Average2W	France	0%	-1%	-1%	-1%	-1%	-1%
Average2W	Germany	0%	-1%	0%	0%	0%	0%
Average2W	Greece	0%	0%	-1%	0%	0%	0%
Average2W	Hungary	0%	0%	-1%	-1%	0%	0%

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

Average2WDF	United Kingdom	0%	0%	0%	0%	0%	0%
DC	Austria	0%	-1%	0%	0%	-1%	-1%
DC	Belgium	0%	0%	-1%	-1%	0%	0%
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%	-1%	-1%
DC	Denmark	0%	0%	0%	0%	0%	0%
DC	Estonia	0%	0%	-1%	0%	-1%	-1%
DC	Finland	0%	0%	0%	0%	-1%	0%
DC	France	0%	0%	-1%	0%	0%	0%
DC	Germany	-1%	0%	-1%	-1%	0%	0%
DC	Greece	0%	0%	-1%	0%	0%	0%
DC	Hungary	0%	0%	-1%	0%	0%	0%
DC	Ireland	0%	0%	0%	0%	0%	0%
DC	Italy	0%	-1%	0%	0%	-1%	0%
DC	Latvia	0%	0%	-1%	0%	0%	-1%
DC	Lithuania	0%	0%	-1%	0%	0%	0%
DC	Luxembourg	0%	0%	0%	0%	0%	0%
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DC	Poland	0%	0%	-1%	0%	0%	0%
DC	Portugal	0%	0%	-1%	0%	0%	0%
DC	Romania	0%	0%	-1%	0%	0%	-1%
DC	Serbia	0%	0%	0%	0%	0%	0%
DC	Slovakia	0%	-1%	-1%	0%	0%	0%
DC	Slovenia	0%	0%	-1%	0%	0%	-1%
DC	Spain	0%	-1%	0%	-1%	-1%	-1%
DC	Sweden	0%	0%	0%	0%	-1%	0%
DC	Switzerland	0%	0%	0%	0%	-1%	0%
DC	The Netherlands	0%	0%	0%	0%	-1%	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-1100	n.a	n.a	n.a

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

Environmental Impact explained [Promoter]

NOx emissions during construction and operation will remain within the legislative boundaries set in the host country. Furthermore, project Amplifhy has the ambition to minimize emissions of any kind within the boundaries of economic feasibility by selecting specific low or zero emission technologies.

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]

F. Useful links [Promoter]

Useful links:

https://amplifhy-antwerp.vtti.com/