HI WEST 32 D (Less-Advanced)

ACE Terminal Rotterdam

Reasons for grouping [ENTSOG]

The project group is a stand-alone ammonia terminal including a cracker in Rotterdam, Netherlands (HYD-N-754).

This project will enable hydrogen imports to Netherlands.

Objective of the group [Promoter]:

Hydrogen will play a key role to reach the European climate targets and accelerate the energy and feedstock transitions. With the import of ammonia as a carrier for green and low-carbon hydrogen, the industry can fulfill its demand for sustainable energy and feedstock. Three strategic partners: Gasunie, HES International and Vopak joined forces and knowledge to develop a large-scale open access import terminal for green ammonia as a carrier for green and low-carbon hydrogen and as a sustainable energy carrier and feedstock.

HYD-N-754 **ACE Terminal**

Comm. Year 2027

A. Project group technical information [Promoter/ ENTSOG]

Project technical information [Promoter]

Hydrogen Terminal

TYNDP Project code	Hydrogen carrier	H_2 Import capacity [GWh/d]	Injection capacity [GWh/d]	Storage capacity [m^3]
HYD-N-754	Ammonia	111,4 GWH/day cracking capacity	111,4 GWH/day into hydrogen grid	Phased development up to 1.000.000 m^3 (ammonia)

Capacity increment [ENTSOG]

TYNDP Project code	Point name	Operator	From system	To system	Capacity increment [GWh/d]	Comm. year
HYD-N-754	LH2_Tk_NL	N.V. NEDERLANDSE GASUNIE	Terminal Netherlands (LH2_Tk_NL)	Transmission Netherlands (NL Hydrogen)	47.7	2027

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-754	1858	50	487	50

Description of the cost and range [Promoter]

l The table below presents a high-level breakdown of the CAPEX and OPEX costs.

Opex (€ mln p.a. run-rate - FY 2022 Euro terms)	Amount	Comment
Energy - Variable	(13)	Assumes energy costs for 460 kcbm NH3 storage based on Joint Venture partner's operating experience.
Repair &Maintenance (both Opex / Maintenance Capex) - Fixed	(11)	Assumes a percentage of new build capex based on Joint Venture partner's operating experience.
Safety - Fixed	(0)	Assumes stand by firefighting team expenses based Joint Venture
Operational personnel - Fixed	(4)	Assumes 35 FTE based on Joint Venture partner's operating experience.
Insurance - Fixed	(2)	Assumes a percentage of new build capex based on Joint Venture partner's operating experience.
Property tax - Fixed	(4)	Assumes a percentage of new build capex based on Joint Venture partner's operating experience.
Operations - Tanks	**(34)**	
Energy - Variable	(410)	Mainly regards energy costs. Assumes long-term energy price of EUR 73 MwH. Energy use based on Entoc report (https://op.europa.eu/en/publication-detail/-/publication/7ab70e32-a5a0-11ec-83e1-01aa75ed71a1/language-en), which comes to 1.5 MwH / t NH3 cracked to Hydrogen. Forecast assumes 3.75 mt Ammonia cracked to c. 0.5 mt Hydrogen based on initial customer volume interest indications.
Repair &Maintenance (both Opex / Maintenance Capex) - Fixed	(19)	Assumes a percentage of new build capex based on Joint Venture partner's operating experience.
Safety - Fixed	(1)	Assumes stand by firefighting team expenses based Joint Venture partner's operating experience.
Operating personnel - Fixed	(4)	Assumes 40 FTE based on Joint Venture partner's operating experience.
Insurance - Fixed	(3)	Assumes a percentage of new build capex based on Joint Venture partner's operating experience.
Property tax - Fixed	(6)	Assumes a percentage of new build capex based on Joint Venture partner's operating experience.
Operations - Cracker	**(443)**	
Employment Costs - Fixed	(2)	Assumes 15 FTE based on Joint Venture partner's operating experience.
Other - Fixed	(2)	Assumes overhead costs other than employment (i.e. Housing, IT etc.) based on Joint Venture partner's operating experience.
Land & Quay Leases - Fixed	(5)	Assumes lease and quay costs for 40ha land and 700m quay on Joint Venture partner's operating experience.
Overhead	**(10)**	
Total	**(487)**	

The accuracy of CAPEX/OPEX estimates for ammonia tanks is high, thanks to their advanced maturity level. However, the situation is different for the cracker, as it is still in the early development phase, resulting in lower accuracy in estimation.

The main driver for OPEX costs is energy expenses, which are dependent on volatile energy prices and the instability caused by the Russian invasion in Ukraine.

C. Project Benefits [ENTSOG]

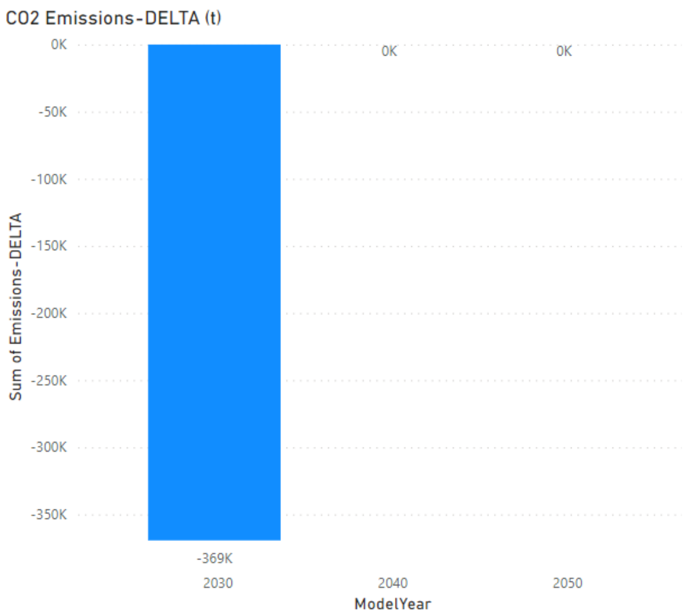
C.1 Summary of benefits

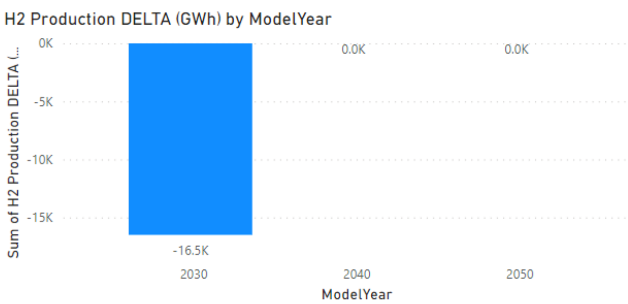
This section provides a summarised analysis by ENTSOG of the main benefits stemming from the realisation of the overall group. More details on the indicators are available in Annex D of TYNDP 2022[1].

Distributed Energy

Sustainability benefits

Thanks to the project group, from 2027, the newly built terminal improves and diversifies hydrogen supply in the Netherlands and other western countries. 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 369 kt in 2030. This can be explained as in 2030 the project group will enable the replacement of blue hydrogen locally produced (i.e SMR) with green hydrogen imports in form of ammonia and will therefore reduce natural gas imports.

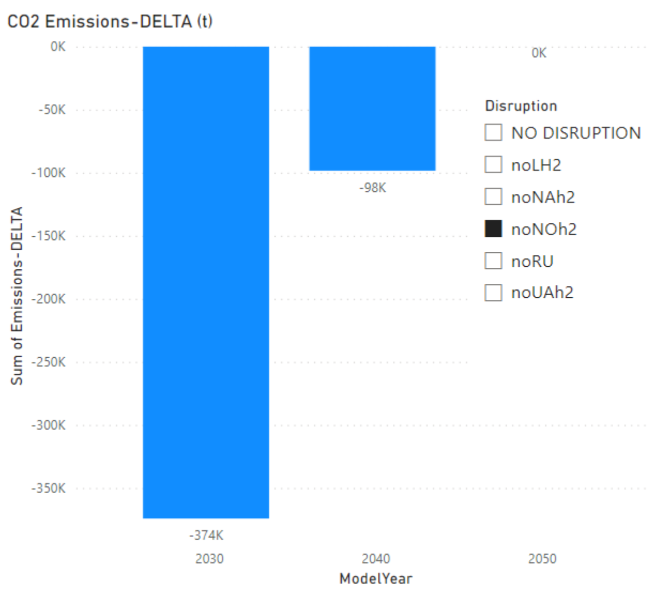


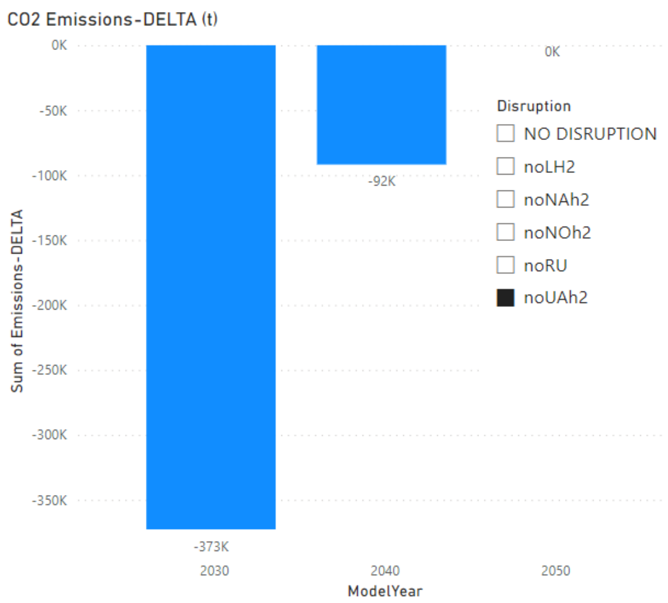


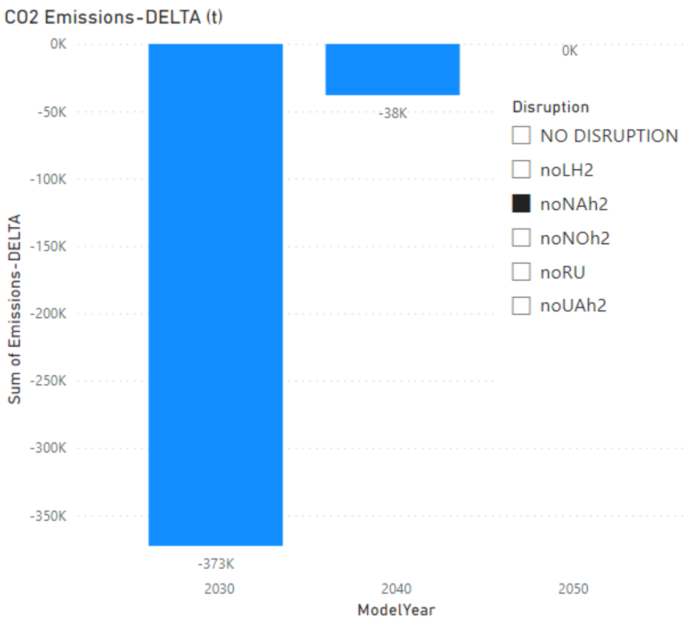
Sustainability benefits are increased under supply disruption cases, such as Norway, Ukraine, or North Africa Disruption for 2030 and 2040. For example, in case of Norway disruption the project group will reduce CO_2 emissions by 374 kt in 2030 and by 98 kt in 2040.

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]

[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 mitigating the risk of hydrogen demand curtailment for Belgium and the Netherlands by 1% in 2050. However, it is important to mention that the SoS benefits of this project group could be limited due to a competing(s) project group(s) (such as WEST 32 C, WEST 40) located in the same geographical area enabling, as well, liquid import supplies to flow to the Netherlands.

> 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 contributing to the mitigation of hydrogen demand curtailment risk in the Netherlands by 12% in 2030.

> Disruption cases (S-1):

Under supply disruption cases such as Norway and North Africa Supply disruption, the project is mitigating the risk of demand curtailment for some countries in 2050. In case of Norway disruption Germany can mitigate the risk of demand curtailment by 1%. In case of North Africa disruption, the project helps France, Sweden, Estonia and Slovenia to mitigate the risk of demand curtailment by 1%.

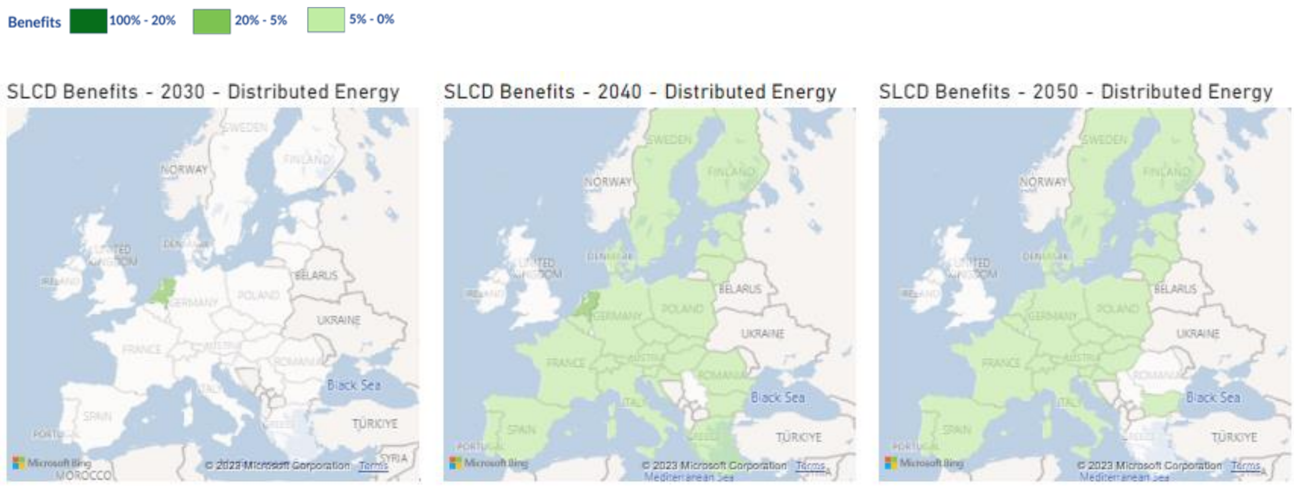
Maps for specifics disruptions: 1 noNOh2 : Norway disruption / 2 noNAh2 : North Africa disruption

1 noNOh2: Norway disruption

2 noNAh2 : North Africa disruption

> Single largest capacity disruption (SLCD):

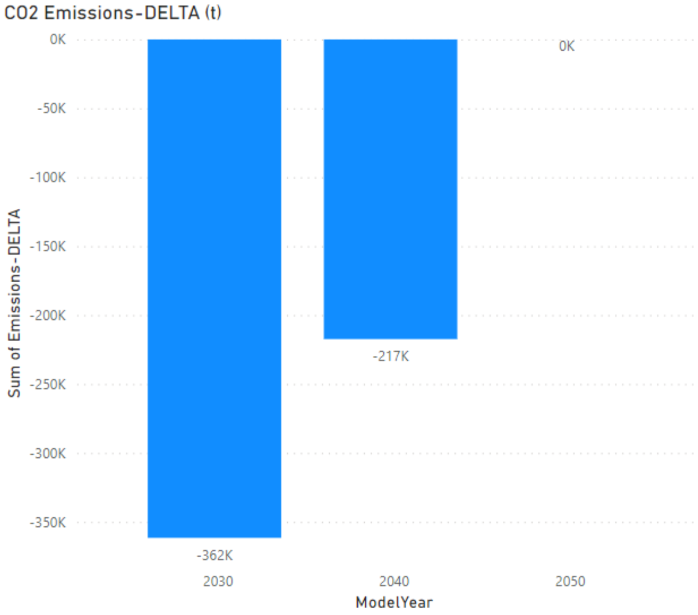
In case of SLCD many European countries benefitting from this project group by mitigating the risk of demand curtailment. The Netherlands are benefitting in all three timestamps including the mitigating of demand curtailment risk by 9% in 2030, by 8% in 2040 and by 5% in 2050. Other countries benefiting from this project can mitigate the risk of demand curtailment by 1-3% in 2040 and 2050.

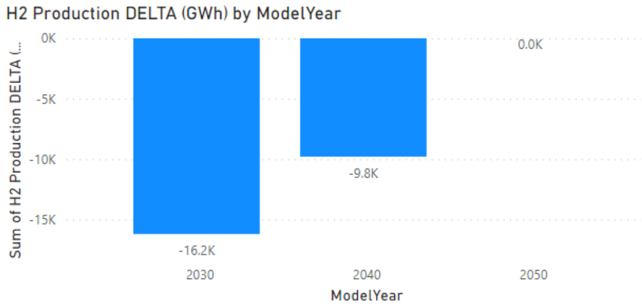


Global Ambition

Sustainability benefits

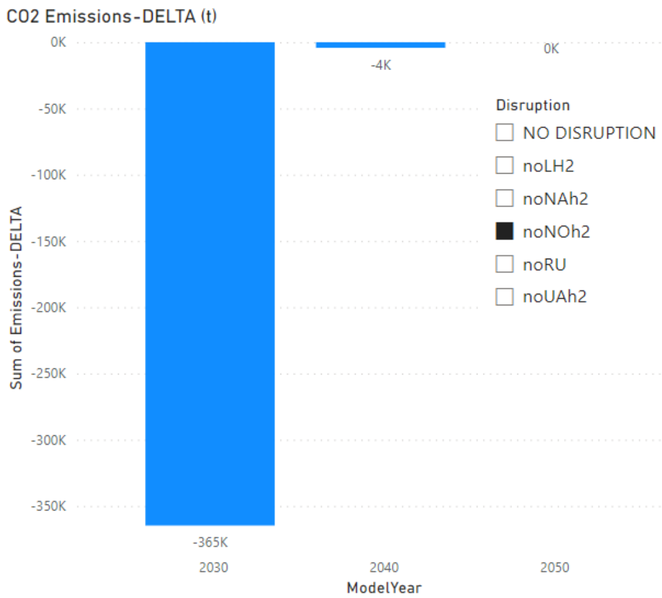
In the reference case, which analyses yearly demand in two periods (average winter and average summer), the project group will contribute to sustainability by reducing overall CO2 emissions by 362 kt in 2030 and by 217 kt in 2040. This can be explained as in 2030 and 2040 the project group enables mainly the replacement of blue hydrogen locally produced n (I.e SMR) with green hydrogen imports in form of ammonia. Therefore, less natural gas will be imported.

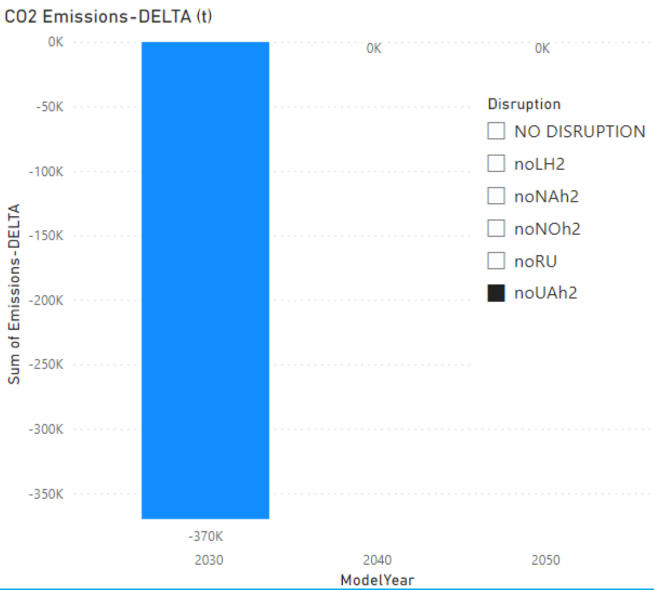


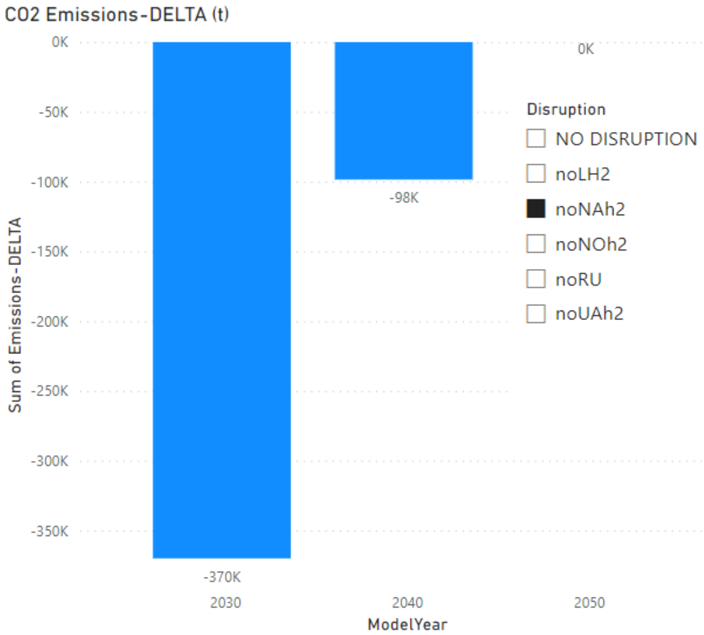


Sustainability benefits are slightly increased under supply disruption cases, such as Norway, Ukraine, or North Africa Disruption for 2030. For example, in case of Ukraine disruption the project group will reduce CO2 emissions by 370 kt in 2030.

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 helps to mitigate hydrogen demand curtailment risk in average summer and average winter for Netherlands and Belgium by 1%. In 2040 the project mitigates the risk in Belgium and in 2050 in Belgium and the Netherlands by 1%. However, it is important to mention that the SoS benefits of this project group could be limited due to a competing(s) project group(s) (such as WEST 32 C, WEST 40) located in the same geographical area enabling, as well, liquid import supplies to flow to the Netherlands.

> Climatic stress cases

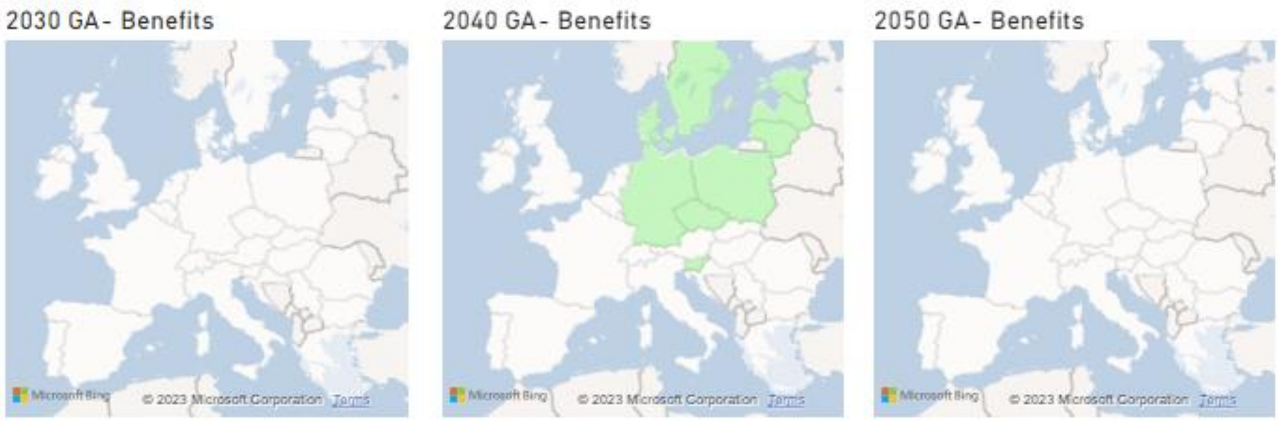
Under 2 -week and 2-week dunkelflaute climatic stress case, as well as under peak day climatic case the project group is contributing to the mitigation of hydrogen demand curtailment risk in the Netherlands by 10% in 2030.

> Disruption cases (S-1)

Under supply disruption cases such as Norway, Ukraine or North Africa supply disruption the project improves mitigation of hydrogen demand curtailment risk in 2040 for several countries by 1%. For example in case of Ukraine disruption France, Belgium, Netherlands, Sweden, Finland, Latvia, Poland and Czech Republic, thanks to the project, mitigate the risk by 1%.

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

2030 GA- Benefits

2040 GA- Benefits

2050 GA- Benefits

3 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. The Netherlands are benefitting the most and in all three timestamps including the mitigating of demand curtailment risk by 8% in 2030. In 2040 and 2050 countries benefitting from this project can reduce risk 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	-369340,36	538677299	539046639,4
2030	noLH2	DE	tonne	-117,45	540175890,2	540176007,7
2030	noNAh2	DE	tonne	-372704,51	539785356,1	540158060,6
2030	noNOh2	DE	tonne	-374156,75	538877197,8	539251354,6
2030	noUAh2	DE	tonne	-372704,51	539378771,9	539751476,4
2030	NO DISRUPTION	GA	tonne	-361585,93	592910448,4	593272034,4
2030	noLH2	GA	tonne	-161,21	594817481,2	594817642,4
2030	noNAh2	GA	tonne	-369963,88	594141433,2	594511397
2030	noNOh2	GA	tonne	-364710,71	593310994,3	593675705
2030	noUAh2	GA	tonne	-369963,88	593627617,9	593997581,8
2040	NO DISRUPTION	DE	tonne	0,00	392077044	392077044
2040	noLH2	DE	tonne	0,00	392213883,4	392213883,4
2040	noNAh2	DE	tonne	-38008,72	392188097,7	392226106,4
2040	noNOh2	DE	tonne	-98377,72	392144022,6	392242400,3
2040	noUAh2	DE	tonne	-91826,21	392399182,9	392491009,1
2040	NO DISRUPTION	GA	tonne	-217384,88	396523251,6	396740636,5
2040	noLH2	GA	tonne	0,00	397455196,7	397455196,7
2040	noNAh2	GA	tonne	-98496,46	397301976,6	397400473,1
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
The Netherlands	-9%	-8%	-8%	-4%	-5%	-2%
Czechia	0%	0%	-3%	-2%	-3%	-1%
Estonia	0%	0%	-3%	-1%	-2%	-1%
Latvia	0%	0%	-3%	-1%	-2%	-1%
Lithuania	0%	0%	-3%	-1%	-2%	-1%
Poland	0%	0%	-3%	-1%	-2%	-1%
Portugal	0%	-1%	-3%	-1%	-1%	-1%
Slovenia	0%	0%	-3%	-1%	-2%	-1%
France	0%	0%	-3%	-1%	-2%	-1%
Germany	0%	0%	-2%	-2%	-1%	-1%
Austria	0%	0%	-2%	-2%	-2%	-1%
Belgium	0%	0%	-2%	-2%	-2%	-1%
Denmark	0%	0%	-2%	-2%	-2%	-1%
Finland	0%	0%	-2%	-1%	-2%	-1%
Italy	0%	0%	-2%	-1%	-2%	-1%
Spain	0%	0%	-2%	-2%	-2%	-1%
Sweden	0%	0%	-2%	-1%	-2%	-1%
Switzerland	0%	0%	-2%	-1%	-1%	-1%
Bulgaria	0%	0%	-1%	-1%	-1%	-1%
Croatia	0%	0%	-1%	-1%	-1%	-1%
Greece	0%	0%	-1%	-1%	0%	-1%
Hungary	0%	0%	-1%	-1%	-1%	-1%
Romania	0%	0%	-1%	-1%	0%	-1%
Slovakia	0%	0%	-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	0%	0%	-1%	-1%	-1%	-1%
Average2W	Belgium	0%	0%	-1%	-1%	-1%	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	0%	0%	-1%	-1%	-1%	-1%
Average2W	Denmark	0%	0%	-1%	-1%	-1%	-1%
Average2W	Estonia	0%	0%	0%	-1%	-1%	-1%
Average2W	Finland	0%	0%	-1%	0%	-1%	-1%
Average2W	France	0%	0%	-1%	-1%	-1%	-1%
Average2W	Germany	0%	0%	0%	0%	0%	0%
Average2W	Greece	0%	0%	-1%	0%	0%	0%
Average2W	Hungary	0%	0%	-1%	-1%	0%	-1%
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%	0%	-1%
Average2W	Luxembourg	0%	0%	0%	0%	0%	0%
Average2W	Malta	0%	0%	0%	0%	0%	0%
Average2W	Poland	0%	0%	-1%	-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	0%	0%	-1%	-1%	0%	0%
Average2W	Slovenia	0%	0%	-1%	-1%	-1%	-1%
Average2W	Spain	0%	0%	-1%	0%	-1%	0%
Average2W	Sweden	0%	0%	-1%	0%	-1%	-1%
Average2W	Switzerland	0%	0%	-1%	-1%	0%	0%
Average2W	The Netherlands	-12%	-10%	-1%	-1%	-1%	0%
Average2W	United Kingdom	0%	0%	0%	0%	0%	0%
Average2WDF	Austria	0%	0%	-1%	-1%	-1%	-1%
Average2WDF	Belgium	0%	0%	0%	-1%	-1%	0%
Average2WDF	Bulgaria	0%	0%	-1%	-1%	0%	0%
Average2WDF	Croatia	0%	0%	-1%	-1%	0%	-1%
Average2WDF	Cyprus	0%	0%	0%	0%	0%	0%
Average2WDF	Czechia	0%	0%	-1%	-1%	-1%	-1%
Average2WDF	Denmark	0%	0%	-1%	-1%	-1%	-1%
Average2WDF	Estonia	0%	0%	-1%	0%	-1%	-1%
Average2WDF	Finland	0%	0%	-1%	-1%	-1%	0%
Average2WDF	France	0%	0%	-1%	-1%	-1%	-1%
Average2WDF	Germany	0%	0%	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	0%	0%	-1%	-1%	0%	-1%
Average2WDF	Slovenia	0%	0%	-1%	-1%	-1%	-1%
Average2WDF	Spain	0%	0%	-1%	-1%	-1%	0%
Average2WDF	Sweden	0%	0%	-1%	-1%	-1%	0%
Average2WDF	Switzerland	0%	0%	-1%	0%	0%	0%
Average2WDF	The Netherlands	-12%	-10%	-1%	-1%	-1%	0%
Average2WDF	United Kingdom	0%	0%	0%	0%	0%	0%
DC	Austria	0%	0%	0%	0%	-1%	-1%

DC	Belgium	0%	0%	0%	0%	0%	0%
DC	Bulgaria	0%	0%	-1%	0%	0%	0%
DC	Croatia	0%	0%	-1%	0%	0%	0%
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%	0%
DC	Finland	0%	0%	0%	0%	-1%	0%
DC	France	0%	0%	-1%	0%	-1%	0%
DC	Germany	0%	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%	0%	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%
DC	Malta	0%	0%	0%	0%	0%	0%
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%	0%	-1%	0%	0%	0%
DC	Slovenia	0%	0%	-1%	0%	0%	-1%
DC	Spain	0%	0%	0%	-1%	-1%	-1%
DC	Sweden	0%	0%	0%	0%	-1%	0%
DC	Switzerland	0%	0%	0%	0%	-1%	0%
DC	The Netherlands	-9%	-8%	0%	-1%	-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-754	Ammonia import terminal	-	-

Potential impact	Mitigation measures	Related costs included in project CAPEX and OPEX	Additional expected costs
NOx emission during construction, shipping and conversion of NH3 into hydrogen which cannot be captured for 100%	Launch study detailing the operational, environmental, reliability and safety specifications of available cracking technologies. Launch study on the possibilities for netting including a detailed analysis of NOx emission reduction technology.	Estimated to be immaterial in total CAPEX/OPEX bill	Estimated to be immaterial in total CAPEX/OPEX bill

Environmental Impact explained [Promoter]

Every project in the EU is under pressure to minimize its impact on the environment, ACE Terminal is no exception. Minimizing NOx emissions is essential to ease the impact on Europe's environmentally sensitive areas and to ensure a permit is granted by the authorities. Specifically, the NOx emissions of some cracking technologies will be evaluated carefully. The ACE project thus works closely together with local regulatory and permitting authorities in order to mitigate and minimize its environmental impact. The project will follow the strict EIA regulatory framework as required by the Dutch Ministry for Economic Affairs and Climate and will consider all environmental impact aspect during the permitting procedures. No significant harm to the environment or any negative effect on climate change will be created by the project.

NOx emissions occur during construction, shipping, and conversion of NH3 into hydrogen which cannot be captured for 100%. The project consortium has already taken the first steps to mitigate the risk by conducting a study on the possibilities for netting based on the existing permits. Also, a cracking technology selection study is planned in order to make an informed decision of the cracking technology to be used for the project. The result of this study includes a detailed analysis of the NOx emissions, operational performance, safety, maintenance and reliability of the different technology providers. In addition, the consortium follows closely the case of Porthos in the Netherlands and will act pre-emptively on possible similar challenges.

Furthermore, an environmental benefit of the ACE Terminal project is a significant reduction of GHG emissions. A report, executed by an independent consultancy and in full compliance with the JRC methodology, estimates that 77Mton GHG emissions will be avoided throughout the lifetime of the project. The NPV of societal benefit associated with avoidance of GHG based on the social costs of carbon equals to 33 353 million EUR. The share of renewable hydrogen supplied by the projects amounts to 95.8% and is 100% sustainable The amount of clean energy supplied by the project for industrial use amounts up to 426 300 GWh.

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 development of the ACE Terminal project offers environmental, commercial, social, policy and digital benefits to the EU:

- Contribution to the development of the hydrogen backbone and consequently to the hydrogen economy as envisaged in RePower EU *(this is aligned with the ENTSOG security of supply and sustainability analysis presented in section C above)*
- Contribution to the EU Green Deal, RePower EU, National hydrogen strategies, and the goals of the private industrial stakeholders *(this is aligned with the ENTSOG security of supply and sustainability analysis presented in section C above)*
- Security of the hydrogen supplies in the EU *(this is aligned with the ENTSOG security of supply analysis presented in section C above)*
- Advancing large-scale application of the ammonia cracker technology *(this is aligned with the ENTSOG security of supply and sustainability analysis presented in section C above; a large-scale ammonia cracking project such as ACE contains benefits a shift towards green hydrogen production with import of green ammonia produced from low-cost renewable sources)*
- Contribution to the diversification of the energy supplies *(this is aligned with the ENTSOG security of supply analysis presented in section C above)*
- Giving a clear signal to the industry to invest in hydrogen-based processes by ensuring the supply *(this is aligned with the ENTSOG security of supply analysis presented in section C above; without sufficient import volume, which ACE Terminal drives, the European hydrogen economy growth is likely to become supply constraint)*
- Contribution to the social benefits of society, including GHG reduction *(this is aligned with the ENTSOG security of supply and sustainability analysis presented in section C above; A report, executed by an independent consultancy and in full compliance with the JRC methodology, estimates that 77Mton GHG emissions will be avoided throughout the lifetime of the project. The NPV of societal benefit associated with avoidance of GHG based on the social costs of carbon equals to 33 353 million EUR. The share of renewable hydrogen supplied by the projects amounts to 95.8% and is 100% sustainable. The amount of clean energy supplied by the project for industrial use amounts up to 426 300 GWh; furthermore, hydrogen is the best position energy source to replace the flexible gas and coal energy production sources required for a well functioning economy; Europe cannot produce sufficient (low cost) hydrogen to satisfy the envisaged hydrogen demand growth in Europe, the ACE Terminal therefore plays a key role in ensuring sufficient hydrogen supply for a stable future European energy system)*
- Contribution to the regulatory framework *(this is aligned with the ENTSOG security of supply analysis presented in section C above)*

- Linking different actors/aspects of the hydrogen supply and value chains *(this is aligned with the ENTSOG security of supply analysis presented in section C above; again without (sufficient) hydrogen import capacity the growth of the European Hydrogen economy is likely to become supply constraint; ACE presents an ideal location for hydrogen import into Western Europe at proximity to feed into the hydrogen cross-border backbone pipeline system / local industry and in a port with deep draft access required for large import vessels)*
- Positive effect on the hydrogen price setting *(this is aligned with the ENTSOG security of supply analysis presented in section C above; large scale ammonia import take advantage of low energy costs in countries with abundant wind / solar energy capacity and efficiencies of scale in the import / cracking process from ammonia to hydrogen which ultimately benefit hydrogen prices)*
- Through open access approach providing non-discriminatory access to both small and big actors, allowing smooth transition toward hydrogen application in their production processes *(this is aligned with the ENTSOG security of supply and sustainability analysis presented in section C above; various industries (e.g. energy production, steel production) will need to transform their processes to reduce greenhouse gas emissions. The ACE Terminal contributes to creating sufficient relatively low cost hydrogen supply in Europe.)*
- Integration of the digital solutions into the ACE Terminal infrastructure such as terminal management system and energy management system

F. Useful links [Promoter]

Useful links:

https://www.aceterminal.nl/en/energy-transition

https://www.portofrotterdam.com/en/news-and-press-releases/study-ammonia-cracker-realistic-and-safe-method-for-large-scale-hydrogen

https://www.aceterminal.nl/en/newsroom/ace-terminal-iberdrola-and-gasunie-join-forces-for-hydrogen-corridor-between-spain-and-the-netherlands