HI WEST 2 A (Less-Advanced)

Spain-France-Germany H2Med-BarMar - HYFEN - H2ercules South

Reasons for grouping [ENTSOG]

The project group aims at interconnecting future hydrogen infrastructure between Spain and France through an offshore hydrogen pipeline and also France Germany until the Czechia border by partially repurposing existing natural gas infrastructure. The project group includes H2Med-BarMar project conformed by the investments from the three operators (HYD-N-1153 Enagas, HYD-N-819 Terega HYD-N-1151 Grtgaz), as well as, HY-FEN H2 corridor in France and Hercules South in Germany (HYD-N-569 and HYD-N-1052).

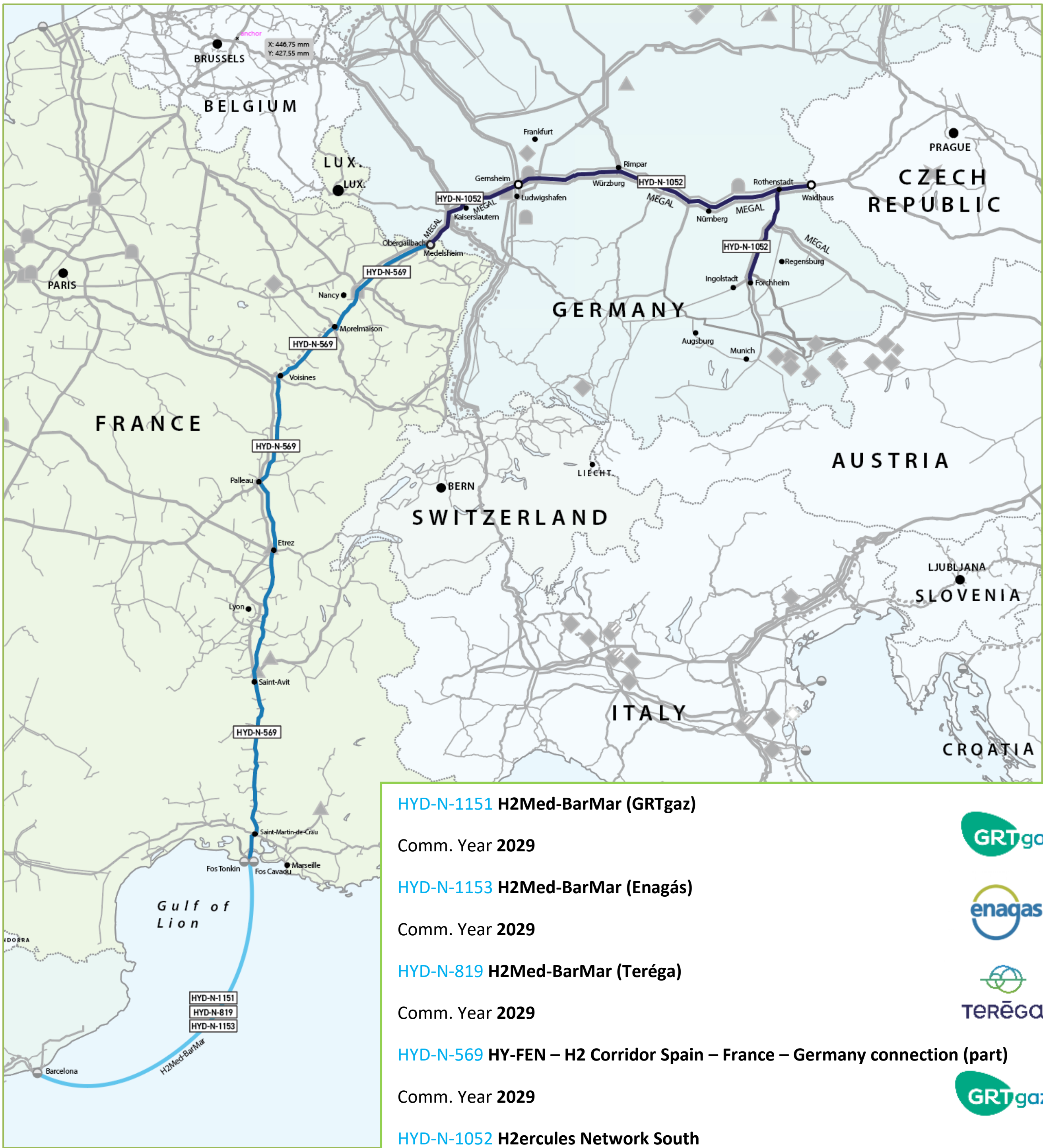
Objective of the group [Promoter]

The corridor connects the potentials of green and affordable hydrogen of the Iberian Peninsula via France to the demand clusters in Germany, especially in Southern Germany. It is planned to forward the first available hydrogen volumes along the route starting from 2030 onwards. The group is one of the major hydrogen import corridors via the Mediterranean identified in the REPowerEU plan.

The project H2Med-BarMar between Spain and France will be ready in 2030, enabling the transport of 2 Mt/y of hydrogen and contributing to the emergence of one of the major hydrogen import corridors via the Mediterranean Sea identified in the REPowerEU plan.   Two new interconnections are foreseen: A new hydrogen onshore pipeline between Celorico da Beira (Portugal) and Zamora and an offshore maritime pipeline connecting Barcelona and Marseille. This corridor is designed as the most direct and efficient option to connect the Iberian Peninsula to Central Europe, as part of a Green Energy Corridor connecting Portugal, Spain and France with the EU's energy network. In Alicante on 9th of December 2022, they confirmed the launching of this corridor, newly called H2Med and whose contours were specified in the presence of the European Commission President, Ursula von der Leyen. A support statement has been issued by Ursula von der Leyen the European Commission President, on the 9th of December 2022 (https://ec.europa.eu/commission/presscorner/detail/en/statement_22_7616)

The HY-FEN project aims to develop a French hydrogen transmission network via pipeline, connected to Iberic peninsula (via H2MED) and Germany (H2ercules) and national storage sites by 2030.HY-FEN will further enhance the HYnframed, MosaHYc, HySoW and RHYn projects by providing access to competitive H2 from various sources, particularly imports. Through HY-FEN, more potential consumers also gain access to production projects (such as HyGreen). Further, security of supply and flexibility will be enhanced through access to UHS projects (such as GeoH2, HySoW and future salt cavern projects in Etrez and Tersanne/Hauterives in the Rhône Valley). Overall, stakeholders of the above projects will gain access to H2 volumes produced/stored outside their immediate periphery, thereby broadening the market for large H2 volumes.

The H2ercules network aims to create a super-sized H2 infrastructure for Germany by 2030. To make this happen, The H2ercules network by OGE consists of about 1,600 km of pipelines in place – of which the majority is repurposed pipelines. With the H2ercules network OGE can establish a connection to five European countries (NOR, NL, BE, FR and CZ) via pipeline and one terminal (LH2) which connects different import routes for the German H2 supply and diversifies sources. This application relates to the south H2ercules section from France to the Czech Republic – operated by OGE and GRTgaz Deutschland – and is one of four H2ercules network PCI-applications (HYD-N-1037, HYD-N-1075, HYD-N-1038).



[1]

HYD-N-1151 **H2Med-BarMar (GRTgaz)**

Comm. Year **2029**

HYD-N-1153 **H2Med-BarMar (Enagás)**

Comm. Year **2029**

HYD-N-819 **H2Med-BarMar (Teréga)**

Comm. Year **2029**

HYD-N-569 **HY-FEN – H2 Corridor Spain – France – Germany connection (part)**

Comm. Year **2029**

HYD-N-1052 **H2ercules Network South**

Comm. Year **2029**

[1] Hyfen branch linking to HySoW was withdrawn because it was considered by the Commission to be ineligible for PCI application

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-1151 HYD-N-1153 HYD-N-819	Compressor Station in Barcelona	New			144	n/a
HYD-N-1151 HYD-N-1153 HYD-N-819	Interconnector Barcelona-Marseille	New	700	455		2560
HYD-N-569	HY-FEN	Mix		1200		n/a
HYD-N-1052	Repurposing I – MEGAL (H2ercules Network South)	Repurposing	1100	458	No compression planned	n/a
HYD-N-1052	Repurposing II - Connection Ingolstadt (H2ercules Network South)	Repurposing	1000	103	No compression planned	n/a

Capacity increment [ENTSOG]

TYNDP Project code	Point name	Operator	From system	To system	Capacity increment [GWh/d]	Comm. year
HYD-N-1151	H2_IP_FR-ES	GRTgaz	Transmission Spain (ES Hydrogen)	Transmission France (FR Hydrogen)	216	2029
HYD-N-1151	H2_IP_FR-ES	GRTgaz	Transmission France (FR Hydrogen)	Transmission Spain (ES Hydrogen)	216	2029
HYD-N-1153	H2_IP_FR-ES	Enagas Transporte S.A.U.	Transmission France (FR Hydrogen)	Transmission Spain (ES Hydrogen)	216	2029
HYD-N-1153	H2_IP_FR-ES	Enagas Transporte S.A.U.	Transmission Spain (ES Hydrogen)	Transmission France (FR Hydrogen)	216	2029
HYD-N-819	H2_IP_FR-ES	TERÉGA	Transmission Spain (ES Hydrogen)	Transmission France (FR Hydrogen)	216	2029
HYD-N-819	H2_IP_FR-ES	TERÉGA	Transmission France (FR Hydrogen)	Transmission Spain (ES Hydrogen)	216	2029
HYD-N-569	H2_IP_DE-FR	GRTgaz	Transmission Germany (DE Hydrogen)	Transmission France (FR Hydrogen)	192	2029
HYD-N-569	H2_IP_DE-FR	GRTgaz	Transmission France (FR Hydrogen)	Transmission Germany (DE Hydrogen)	192	2029
HYD-N-1052	H2_IP_DE-FR	Open Grid Europe GmbH and GRTgaz Deutschland GmbH	Transmission France (FR Hydrogen)	Transmission Germany (DE Hydrogen)	192	2029
HYD-N-1052	H2_IP_DE-FR	Open Grid Europe GmbH and GRTgaz Deutschland GmbH	Transmission Germany (DE Hydrogen)	Transmission France (FR Hydrogen)	192	2029

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-1151 HYD-N-1153 HYD-N-819	2135	40%	22	40%
HYD-N-569	4500	50%	80	40%
HYD-N-1052	170	30%	21	30%

Description of the cost and range [Promoter]

[H2MED/BarMar]

CAPEX and OPEX estimates are based on pre-feasibility study results.

Given the state of the studies to date and the information gathered at this stage CAPEX and OPEX cost estimate are class 5 cost estimates, in the 40% cost range for CAPEX and 40 % for OPEX.

[HY-FEN]

CAPEX and OPEX estimates are based on pre-feasibility study results.

Given the state of the studies to date and the information gathered at this stage CAPEX and OPEX cost estimate are class 5 cost estimates, in the 50% cost range for CAPEX and 40 % for OPEX.

[H2ercules]

CAPEX and OPEX are based on best estimates at the time of project submission in December 2022 and might be subject to changes, e.g. due to supplier price adjustments or concretization of project scope. Cost deviations are already considered in both CAPEX and OPEX cost ranges.

C. Project Benefits [ENTSOG]

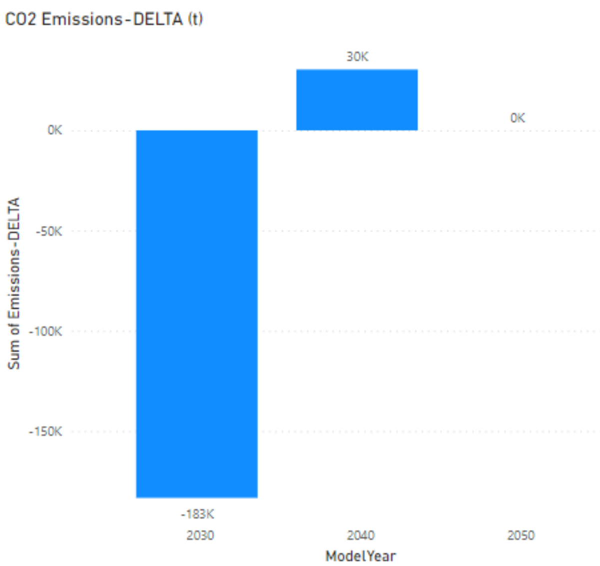
C.1 Summary of benefits

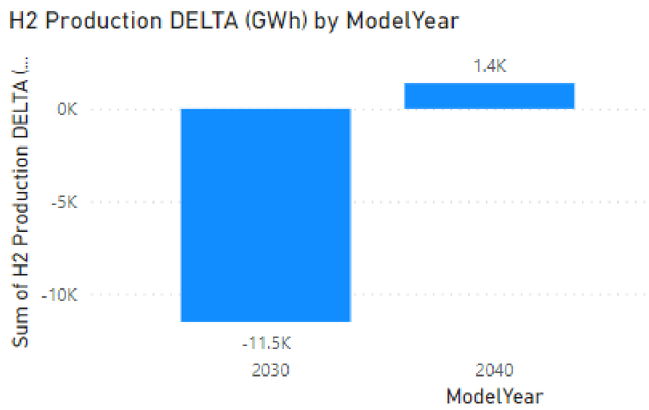
This section provides a summarised analysis by ENTSOG of the main benefits stemming from the realisation of the overall group. More details on the indicators are available in Annex D of TYNDP 2022[2].

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 183 kt in 2030. The project group enables the transport of green hydrogen and so then replacing use of SMRs supplies. In 2040, project shows an increase of CO2. Indeed, as all green hydrogen supply sources are already used at their maximum capacity, an increase in blue hydrogen (i.e. SMR) is needed to satisfy the hydrogen demand in 2040 and reduce demand curtailment.

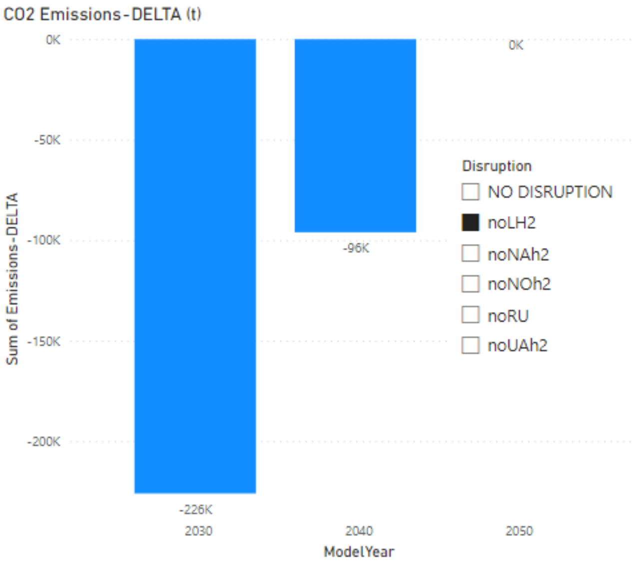


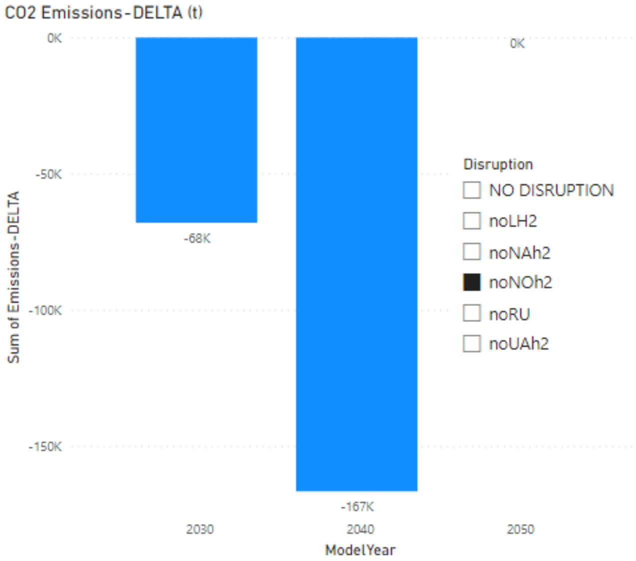


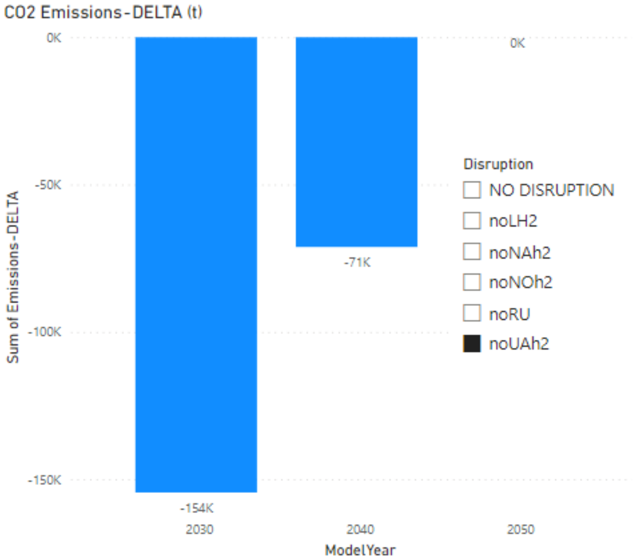
Increased benefits are expected under disruption cases in 2030 and 2040.

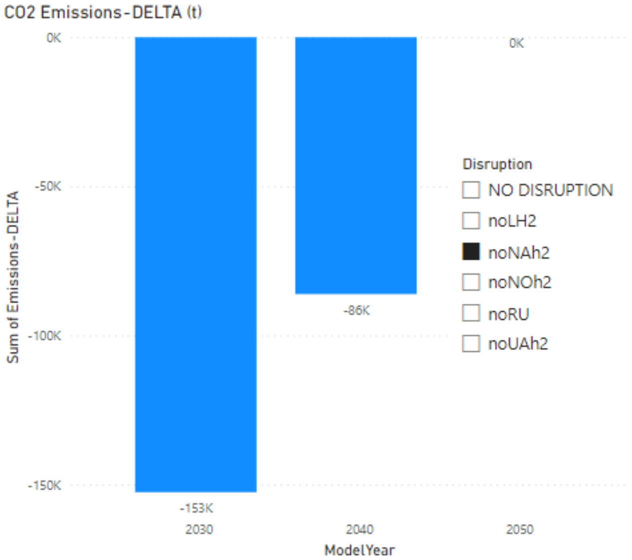
1 noLH2 : LH2 disruption / 2 noNOh2 : Norway disruption / 3 noUAh2 : Ukraine disruption/ 4 noNAh2 : North Africa disruption

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







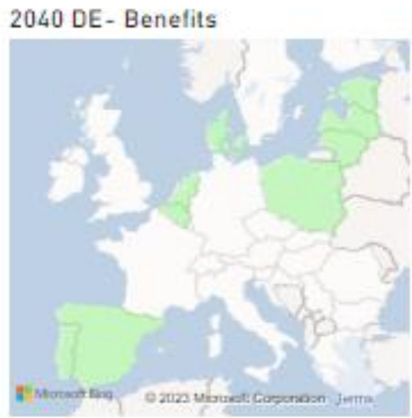


Security of Supply:[3]

> Reference case:

[3] *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.*

In the reference case, the projects group mitigates the risk of hydrogen demand curtailment in Iberian Peninsula and in northern and eastern countries. Indeed, the project enable flow and then reduce demand curtailment by 2-4% in Iberian Peninsula and 1-2% in other green countries.



> Climatic stress cases:

Under 2 -week and 2-week dunkelflaute climatic stress case, as well as under peak day climatic case the projects group increases mitigation of risk of hydrogen demand curtailment in Portugal and Spain by 13% in 2030 and by 1-2% in other countries from 2040.

> Disruption cases (S-1):

Under supply disruptions, the project group mitigates from 2040, risk of demand curtailment up to 14-16% in Italy, Switzerland, Spain and Portugal under north African disruption. Moreover, northern countries are benefiting mitigation of demand curtailment under Norwegian or LH2 disruptions by 3-4% from 2040.

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

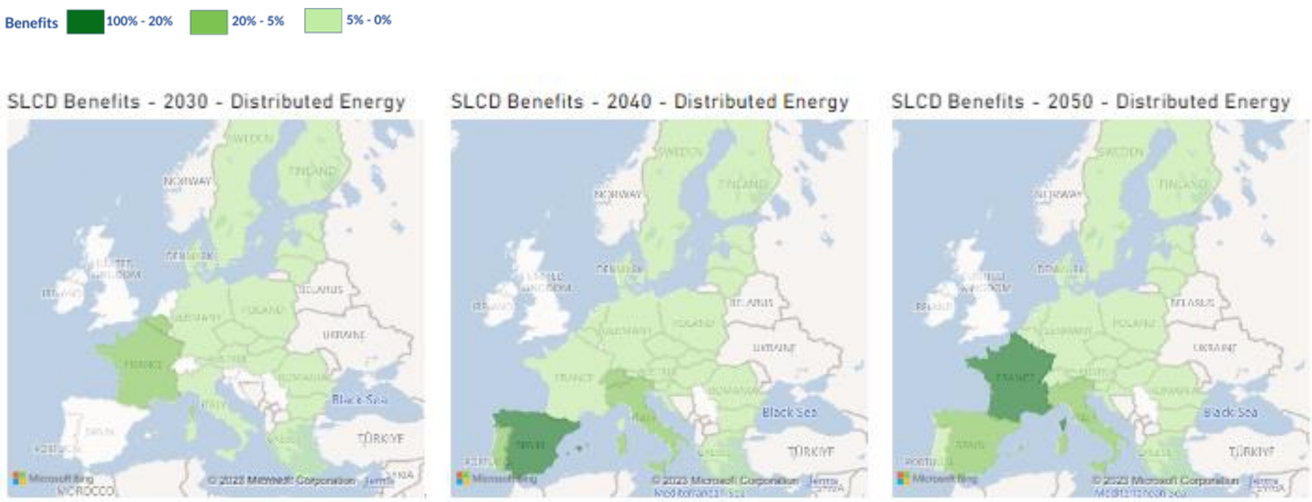
2 noNOh2 : Norway disruption

3 noUAh2 : Ukraine disruption

4 noNAh2 : North Africa disruption

> Single largest capacity disruption (SLCD):

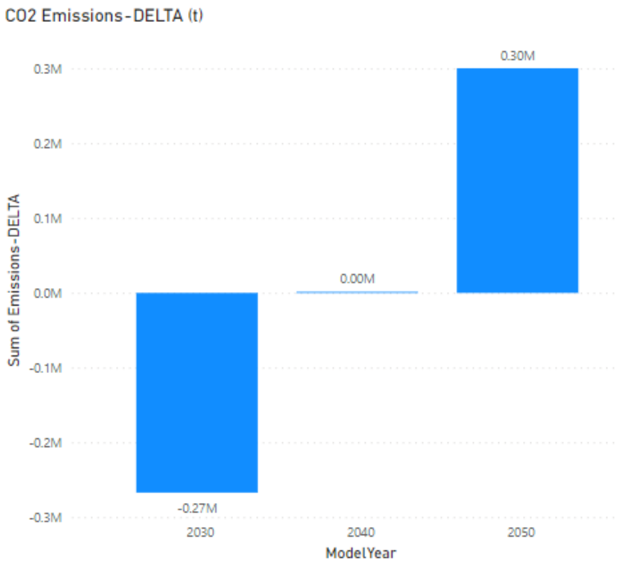
In case of SLCD, benefits are expected in most of European countries by 4-7% in 2030. Moreover, Spain and Portugal are concerned in 2040 by 29% and 10% on demand curtailment mitigation.

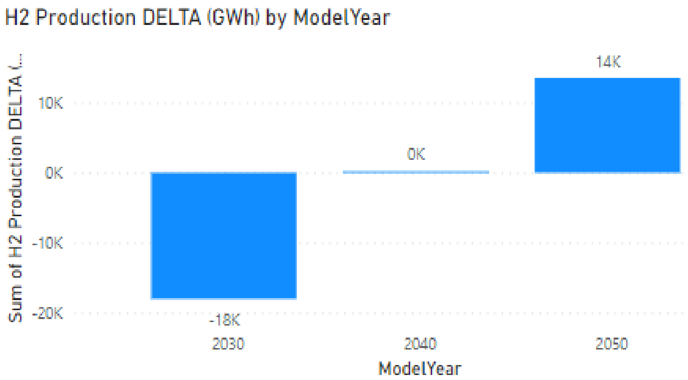


Global Ambition

Sustainability benefits

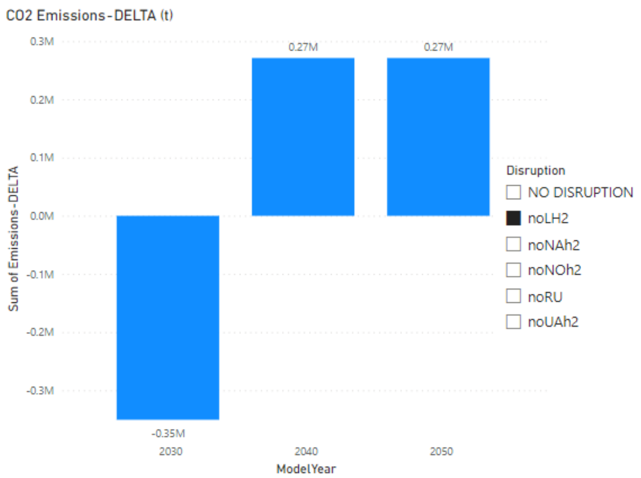
In the reference case, which analyses yearly demand in two periods (average winter and average summer), the project group will contribute to sustainability by reducing overall CO_2 emissions by 267 kt in 2030. The project group enables the transport of green hydrogen and so then replacing use of SMRs supplies. In 2050, the projects group shows an increase of CO_2. Indeed, as all green hydrogen supply sources are already used at their maximum capacity, an increase in blue hydrogen (i.e. SMR) is needed to satisfy the hydrogen demand in 2050 and reduce demand curtailment.

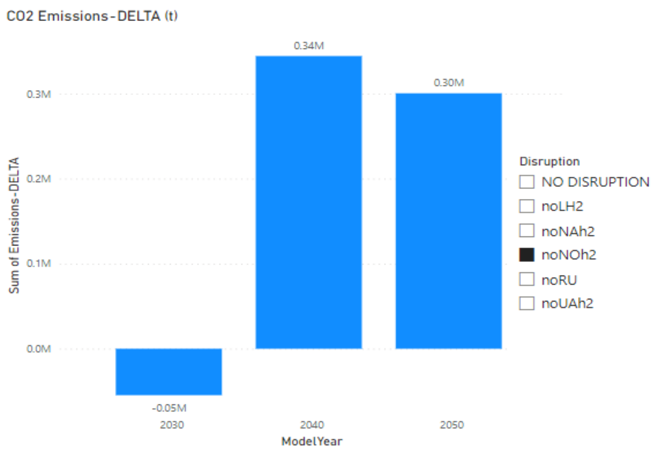


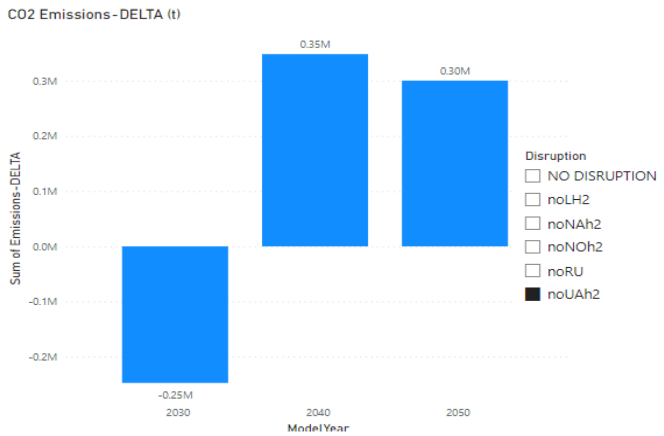


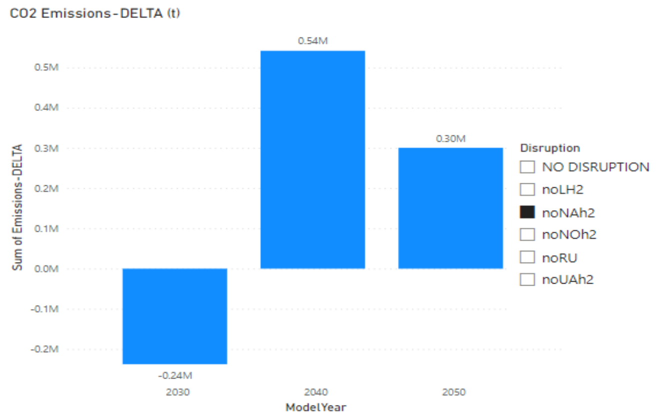
Increased benefits are expected under disruption cases in 2030. However as for the reference case, to avoid demand curtailment an increase in blue hydrogen is needed.

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









Security of supply:

> Reference case

In the reference case, the project group mitigates the risk of hydrogen demand curtailment in Spain and Portugal by 12% and in other countries by 2-3% in 2040. In 2050 project is mitigating risk of demand curtailment in Spain and Portugal by 7-9% and in other countries by 2-3%.

> Climatic stress cases

Under 2 -week and 2-week dunkelflaute climatic stress case, as well as under peak day climatic case the projects group increases mitigation of risk of hydrogen demand curtailment in Portugal and Spain by 18% in 2030, France and Belgium by 3% and inn 2040, in Spain and Portugal by 13% in 2040. In 2050, projects group is mitigating risk of demand curtailment in Spain and Portugal by 7% and in other countries by 2-3%.

> Disruption cases (S-1)

Under supply disruptions, the projects group mitigates from 2040, risk of demand curtailment up to 15-16% in Italy, Switzerland, Spain and Portugal under north African disruption. Moreover, northern countries are benefiting mitigation of risk of demand curtailment under Norwegian or LH2 disruptions by 3-4% from 2040.

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

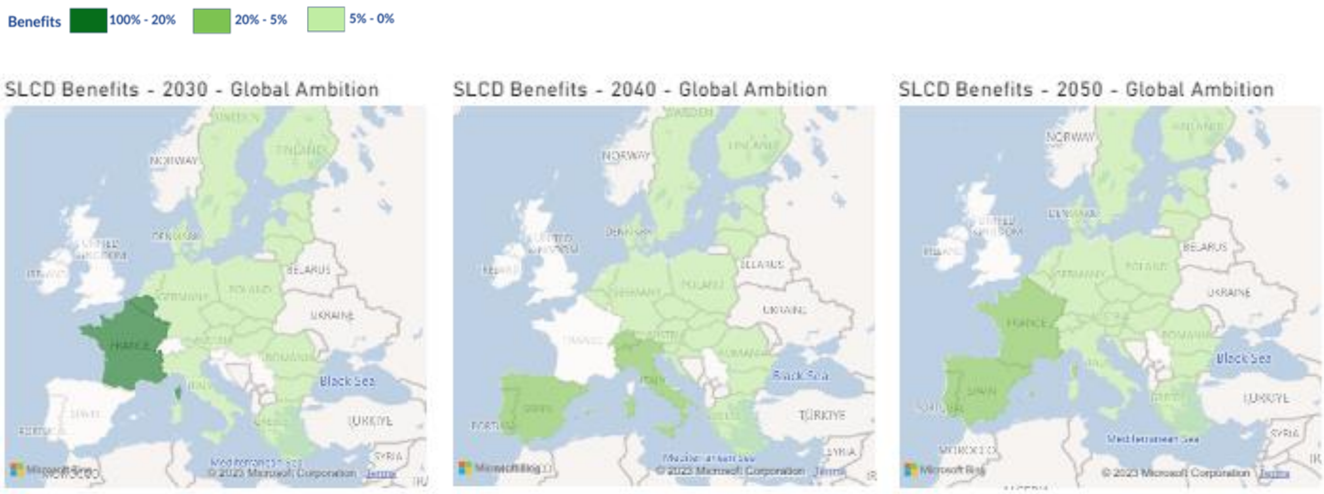
2 noNOh2: Norway disruption

3 noUAh2: Ukraine disruption

4 noNAh2: North Africa disruption

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

In case of SLCD, France and Belgium are the first countries to benefit from the projects group by 29% of mitigation of demand curtailment in 2030. In 2040, highest benefits are expected in Portugal, Spain, Switzerland and Italy up to 19%. In 2050, highest benefits are expected in France, Portugal and Spain with 12% to 14%.



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	-183255,70	538677299	538860554,7
2030	noLH2	DE	tonne	-225953,23	540175890,2	540401843,5
2030	noNAh2	DE	tonne	-152507,43	539785356,1	539937863,5
2030	noNOh2	DE	tonne	-67944,37	538877197,8	538945142,2
2030	noUAh2	DE	tonne	-154426,88	539378771,9	539533198,8
2030	NO DISRUPTION	GA	tonne	-267085,98	592910448,4	593177534,4
2030	noLH2	GA	tonne	-350487,88	594817481,2	595167969,1
2030	noNAh2	GA	tonne	-237599,66	594141433,2	594379032,8
2030	noNOh2	GA	tonne	-54655,53	593310994,3	593365649,8
2030	noUAh2	GA	tonne	-247467,12	593627617,9	593875085
2040	NO DISRUPTION	DE	tonne	30343,57	392077044	392046700,4
2040	noLH2	DE	tonne	-96036,32	392213883,4	392309919,7
2040	noNAh2	DE	tonne	-86091,88	392188097,7	392274189,6
2040	noNOh2	DE	tonne	-166508,88	392144022,6	392310531,5
2040	noUAh2	DE	tonne	-71140,63	392399182,9	392470323,5
2040	NO DISRUPTION	GA	tonne	440,34	396523251,6	396522811,3
2040	noLH2	GA	tonne	271195,69	397455196,7	397184001
2040	noNAh2	GA	tonne	541610,89	397301976,6	396760365,7
2040	noNOh2	GA	tonne	344251,31	397450977,1	397106725,8
2040	noUAh2	GA	tonne	348462,25	397478498,3	397130036,1
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	300432,10	228306706,5	228006274,4
2050	noLH2	GA	tonne	271195,69	228306706,5	228035510,9
2050	noNAh2	GA	tonne	300432,10	228306706,5	228006274,4
2050	noNOh2	GA	tonne	300432,10	228306706,5	228006274,4
2050	noRU	GA	tonne	300427,34	228306706,5	228006279,2
2050	noUAh2	GA	tonne	300432,10	228306706,5	228006274,4

Curtailment Rate (SLCD):

Country	2030-DE-DELTA	2030-GA-DELTA	2040-DE-DELTA	2040-GA-DELTA	2050-DE-DELTA	2050-GA-DELTA
Spain	0%	0%	-29%	-19%	-19%	-12%
Portugal	0%	0%	-10%	-18%	-5%	-8%
Switzerland	0%	0%	-9%	-6%	-5%	-4%
Italy	-4%	-2%	-9%	-7%	-6%	-4%
France	-7%	-29%	-4%	0%	-20%	-14%
Slovenia	0%	0%	-4%	-3%	-3%	-4%
Poland	-4%	-2%	-4%	-3%	-3%	-2%
Austria	-5%	-3%	-3%	-3%	-3%	-3%
Belgium	-7%	-28%	-3%	-3%	-3%	-3%
Czechia	-5%	-3%	-3%	-4%	-4%	-3%
Denmark	-4%	-3%	-3%	-3%	-3%	-2%
Estonia	-4%	-3%	-3%	-3%	-4%	-2%
Finland	-4%	-3%	-3%	-2%	-3%	-2%
Germany	-4%	-3%	-3%	-3%	-3%	-2%
Latvia	-4%	-3%	-3%	-3%	-3%	-3%
Lithuania	-4%	-3%	-3%	-3%	-3%	-3%
Sweden	-4%	-3%	-3%	-2%	-3%	-3%
The Netherlands	0%	-5%	-3%	-3%	-4%	-2%
Bulgaria	-3%	-2%	-2%	-2%	-2%	-3%
Croatia	0%	0%	-2%	-3%	-2%	-2%
Hungary	-3%	-2%	-2%	-3%	-1%	-2%
Romania	-2%	-2%	-2%	-2%	-1%	-3%
Slovakia	-4%	-3%	-2%	-2%	-2%	-3%
Greece	-3%	-2%	-2%	-2%	-1%	-3%

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%	-2%	-1%	-2%	-2%
Average2W	Belgium	0%	-3%	-2%	-1%	-2%	-1%
Average2W	Bulgaria	0%	0%	-1%	-1%	0%	-1%
Average2W	Croatia	0%	0%	-1%	-1%	0%	-2%
Average2W	Cyprus	0%	0%	0%	0%	0%	0%
Average2W	Czechia	0%	0%	-2%	-1%	-2%	-2%
Average2W	Denmark	0%	0%	-1%	-1%	-2%	-2%
Average2W	Estonia	0%	0%	-1%	-1%	-2%	-1%
Average2W	Finland	0%	0%	-1%	-1%	-2%	-2%
Average2W	France	0%	-3%	0%	0%	0%	0%
Average2W	Germany	0%	0%	-1%	0%	-2%	-1%
Average2W	Greece	0%	0%	-1%	-1%	0%	0%
Average2W	Hungary	0%	0%	-1%	-1%	0%	-2%
Average2W	Ireland	0%	0%	0%	0%	0%	0%
Average2W	Italy	0%	0%	-2%	-1%	-2%	-3%
Average2W	Latvia	0%	0%	-1%	-1%	-2%	-2%

Average2W	Lithuania	0%	0%	-1%	-1%	-2%	-2%
Average2W	Luxembourg	0%	0%	0%	0%	0%	0%
Average2W	Malta	0%	0%	0%	0%	0%	0%
Average2W	Poland	0%	0%	-1%	-1%	-2%	-2%
Average2W	Portugal	-13%	-18%	-1%	-13%	0%	-7%
Average2W	Romania	0%	0%	-1%	-1%	0%	-2%
Average2W	Serbia	0%	0%	0%	0%	0%	0%
Average2W	Slovakia	0%	0%	-1%	-1%	0%	-1%
Average2W	Slovenia	0%	0%	-1%	-1%	-2%	-2%
Average2W	Spain	-13%	-18%	-2%	-13%	-2%	-7%
Average2W	Sweden	0%	0%	-2%	-1%	-2%	-2%
Average2W	Switzerland	0%	0%	-2%	-1%	-2%	-4%
Average2W	The Netherlands	0%	0%	-2%	-1%	-2%	-1%
Average2W	United Kingdom	0%	0%	0%	0%	0%	0%
Average2WDF	Austria	0%	0%	-2%	-1%	-2%	-2%
Average2WDF	Belgium	0%	-3%	-1%	-1%	-2%	-1%
Average2WDF	Bulgaria	0%	0%	-1%	-1%	0%	-1%
Average2WDF	Croatia	0%	0%	-1%	-1%	0%	-2%
Average2WDF	Cyprus	0%	0%	0%	0%	0%	0%
Average2WDF	Czechia	0%	0%	-2%	-1%	-2%	-2%
Average2WDF	Denmark	0%	0%	-1%	-1%	-2%	-2%
Average2WDF	Estonia	0%	0%	-1%	-1%	-2%	-1%
Average2WDF	Finland	0%	0%	-2%	-1%	-2%	-1%
Average2WDF	France	0%	-3%	0%	0%	0%	0%
Average2WDF	Germany	0%	0%	-1%	-1%	-2%	-1%
Average2WDF	Greece	0%	0%	-1%	-1%	0%	0%
Average2WDF	Hungary	0%	0%	-1%	-1%	0%	-2%
Average2WDF	Ireland	0%	0%	0%	0%	0%	0%
Average2WDF	Italy	0%	0%	-2%	-1%	-2%	-4%
Average2WDF	Latvia	0%	0%	-1%	-1%	-2%	-2%
Average2WDF	Lithuania	0%	0%	-1%	-1%	-2%	-2%
Average2WDF	Luxembourg	0%	0%	0%	0%	0%	0%
Average2WDF	Malta	0%	0%	0%	0%	0%	0%
Average2WDF	Poland	0%	0%	-1%	-1%	-2%	-2%
Average2WDF	Portugal	-13%	-18%	-1%	-12%	0%	-6%
Average2WDF	Romania	0%	0%	-1%	-1%	0%	-2%
Average2WDF	Serbia	0%	0%	0%	0%	0%	0%
Average2WDF	Slovakia	0%	0%	-1%	-1%	0%	-1%
Average2WDF	Slovenia	0%	0%	-1%	-1%	-2%	-2%
Average2WDF	Spain	-13%	-18%	-2%	-12%	-2%	-7%
Average2WDF	Sweden	0%	0%	-2%	-1%	-2%	-1%
Average2WDF	Switzerland	0%	0%	-2%	-1%	-2%	-4%
Average2WDF	The Netherlands	0%	0%	-2%	-1%	-2%	-1%
Average2WDF	United Kingdom	0%	0%	0%	0%	0%	0%
DC	Austria	-1%	-2%	-1%	-2%	-2%	-2%

DC	Belgium	-2%	-1%	-1%	-1%	-1%	-1%
DC	Bulgaria	0%	-1%	-1%	-1%	0%	-1%
DC	Croatia	0%	0%	-1%	-1%	0%	-2%
DC	Cyprus	0%	0%	0%	0%	0%	0%
DC	Czechia	-1%	-1%	-1%	-2%	-2%	-2%
DC	Denmark	-2%	-1%	-1%	-2%	-2%	-1%
DC	Estonia	-1%	-1%	-2%	-1%	-2%	-2%
DC	Finland	-1%	-1%	-1%	-1%	-2%	-1%
DC	France	-2%	-1%	0%	0%	0%	0%
DC	Germany	-2%	-1%	-1%	-2%	-1%	-2%
DC	Greece	0%	-1%	-2%	-1%	0%	0%
DC	Hungary	0%	-1%	-1%	-1%	0%	-2%
DC	Ireland	0%	0%	0%	0%	0%	0%
DC	Italy	-1%	-1%	-1%	-1%	-2%	-3%
DC	Latvia	-1%	-1%	-2%	-1%	-2%	-2%
DC	Lithuania	-1%	-1%	-2%	-1%	-2%	-1%
DC	Luxembourg	0%	0%	0%	0%	0%	0%
DC	Malta	0%	0%	0%	0%	0%	0%
DC	Poland	-1%	-1%	-2%	-1%	-2%	-1%
DC	Portugal	0%	0%	-2%	-2%	0%	-3%
DC	Romania	0%	-1%	-1%	-1%	0%	-2%
DC	Serbia	0%	0%	0%	0%	0%	0%
DC	Slovakia	-1%	-2%	-1%	-1%	0%	-2%
DC	Slovenia	0%	0%	-2%	-2%	-2%	-2%
DC	Spain	0%	0%	-1%	-2%	-2%	-3%
DC	Sweden	-1%	-1%	-1%	-1%	-2%	-1%
DC	Switzerland	0%	0%	-1%	-1%	-2%	-3%
DC	The Netherlands	0%	0%	-1%	-2%	-2%	-1%
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-569	H2 network	800 km	New pipeline sections : The network will pass by protected natural areas and urban/industrial zones. Repurposed pipeline sections : Minimal environmental impacts expected due to repurposing of pipeline or locally limited interferences.
HYD-N-1052	Repurposing of pipelines for hydrogen transport	Reconstruction of existing above-ground objects or locally limited interferences	Minimal environmental impacts expected due to repurposing of pipeline or locally limited interferences.
HYD-N-819, HYD-N-1151 HYD-N-1153	H2 network	455 km	The pipeline may pass by protected natural areas and land in urban/industrial zones

Potential impact	Mitigation measures	Related costs included in project CAPEX and OPEX	Additional expected costs
HYD-N-569	**Industrial Safety Measures** Specific design studies regarding safety and mitigation options (Maintenance equipment, mechanical protections, monitoring systems) **Environmental Impacts (ecological, human, societal, industrial and economical)** Specific study by independent consultant to analyze and propose the best corridor (minimum impact). Measuring all the impact and looking for solutions to avoid, reduce or compensate. (fauna flaura, water, protected aeras…)	The costs related to industrial safety measures and environmental impact studies are included in the project CAPEX and OPEX.	
HYD-N-1052	Minimal environmental impacts expected due to repurposing of pipeline or locally limited interferences.	Detailed calculation is not available yet	Not expected
HYD-N-819 HYD-N-1151 HYD-N-1153	**Industrial Safety Measures** Specific design studies regarding safety and mitigation options (Maintenance equipment, mechanical protections, monitoring systems) **Environmental Impacts (ecological, human, societal, industrial and economical)** Specific study by independent consultant to analyze and propose the best corridor (minimum impact). Measuring all the impact and looking for solutions to avoid, reduce or compensate. (fauna flaura, water, protected aeras…)	The costs related to industrial safety measures and environmental impact studies are included in the project CAPEX and OPEX. They represent about - 30% of OPEX during the pre-commissioning / study period - 1% of OPEX during operation	

Environmental Impact explained [Promoter]

The environmental impact concerns the new pipelines, both onshore and offshore. GRTgaz, *Enagas* and Teréga have a strong track record concerning limitation of the impact on environment due to new pipelines. Mitigations measures are included in the costing and respect the Avoid / Reduce / Compensate principle. The specific study led by an independent consultant at the very beginning of the FEED allow to adapt the project's layout (to Avoid sensitive areas) and identify needed measures to reduce or compensate.

In France, the specific environmental requirements defined by this study will be followed by French authorities all along the pipeline's life. Teams within GRTgaz and Teréga are dedicated to the follow-up of this topic.

Moreover, explicit support from the region and main stakeholders will further allow to reduce the risk from public and local opposition.

[H2ercules Network South]: No serious environmental threats have been identified as the repurposing will take place mostly in the existing above-ground objects or locally limited interferences. The impact of works will be reduced with the maximum effort by selecting the most suitable technology during the implementation of the project. In order to avoid air and water pollution, respective measures will be taken during the construction phase. The construction sites will be equipped with technical means for the possible remediation of leakage of fuel or other harmful substances that may endanger the quality of surface or underground water. All produced waste will be collected, disposed of, or recycled in accordance with applicable regulation. Waste collection containers will be placed in designated places and marked accordingly. Further detailed measures will be described in the building permit design and agreed with the concerned environmental authority.

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]

H2Med-BarMar (CelZa, Spanish Backbone, BarMar) and HY-FEN

Due to time constraints and the dynamics of the energy situation in Europe, the scenarios used for the TYNDP2022 system assessment and PS-CBA simulations to assess the benefits of the PCI candidate projects are not based on the most recent available data and do not include, for example, agreements between countries at the European level.

This is the case, especially for Spain and Portugal in terms of hydrogen supply and demand, a situation that led Member States (MS) to provide in their system needs' assessment updated values. TSOs have provided updated supply and demand hydrogen data for the TYNDP2024 process on-going, but NECPs have not even been updated yet. The timing issue might remain in the long term, but in the case of H2Med, the input data used for the assessment of the project under TYNDP22 is particularly inappropriate.

Also, a difficulty inherent in the process is the infrastructure level against which to assess the project, as there is no current hydrogen network. The option chosen by ENTSOG is to assess against the projects submitted for PCI status, but different options would have been equally valid and valuable to enlarge the scope of the analysis. For instance, the project could be assessed against the cost-optimal infrastructure to connect the assumed demand and supply figures, or conversely in the absence of a developed infrastructure as is the case today. To our knowledge, the value of the project has not been tested against this major uncertainty.

To deliver first insights based on these suggestions, the project promoters performed an integrated model-based analysis of the project, according to the methodology proposed by the JRC. An integrated capacity expansion and dispatch optimization tool simulating methane, hydrogen and electricity has been used to assess the benefits of hydrogen model for the full EU system and not only between a few member states.

The corridor projects have been assessed by taking it out of the infrastructure level and quantifying their impact on the KPIs suggested by the JRC (the benefits highlighted in the table show the differences between the configuration "with case" and "without case", as per the Harmonised system-wide CBA for candidate hydrogen projects). Two sets of input data for demand and supply have been tested, and for one of these scenarios, the robustness towards the infrastructure level has also been assessed. In a nutshell, the competitive Iberian hydrogen production leads the model to deliver massive hydrogen flows through France to reach the northern EU markets, even in the presence of alternative routes and hydrogen origins in all scenarios considered.

Our first insights show that the societal benefits related to **GHG emission savings would be up to 40 B€** (considering only the direct CO2 emissions reduction). In addition, the corridor allows an optimal market integration, by connecting three Member States through this corridor to the centre of Europe.

The project saves up to 26B€ on operational costs between 2030 and 2055, which is much more than the project costs. The TSOs scenario analysis demonstrates **positive impacts on all the assessed KPIs across all sensitivities, and already in 2030.**

H2ercules Network South

Sustainability benefits:

A faster ramp-up of the hydrogen economy in Germany is more important than ever in order to drive forward the decarbonization program, put the German energy system on a more robust footing, and thus contribute towards a decarbonized security of supply. This is where the H2ercules can make a significant contribution, as it overcomes many challenges on a large scale. The ramp-up of the hydrogen market can thus reduce the use of conventional energy sources. This helps to reduce GHG emissions and to use more and more decarbonized energy. This project enables the transmission of hydrogen across the borders of the Member States Germany, France and the Czech Republic. Since no hydrogen is transported on this route via pipeline today, this will be a significant increase compared to the situation prior to the commissioning of the project. The majority of the network can be repurposed which makes it cost efficient and sustainable.

Competition, market integration, security of supply and flexibility benefits:

The project's main impact is to create new hydrogen capacities at cross-border points. H2ercules Network South establishes a cross-border transport of hydrogen from the French/German and Czech/German border to demand centres in southern Germany. By exchanging with the adjacent TSOs and projects, interoperability is ensured. This linkage has a positive impact on system flexibility and security of supply as well. A non-discriminatory network is established which impacts competition between market participants.

The overall H2ercules establishes direct cross-border connections to five European countries (Norway, the Netherlands, Belgium, France and the Czech Republic). In addition, the import corridors also indirectly impact the countries not directly bordering with Germany but being part of the same supply corridors. H2ercules Network South enables the hydrogen import to Germany from regions with the biggest potential for renewable hydrogen production as Ukraine, Southern Europe and Northern Africa as well as the Baltic region.

The H2ercules Network contributes to the connection of different value chains (production, storage, demand centres). The H2ercules pipeline network will enable the connection of domestic green hydrogen production and thus connects new sources to the existing pipeline network. The H2ercules network reaches demand centres in Germany with a total demand of about 90 TWh in 2030 - that is nearly 2/3 of Germany's hydrogen demand. Furthermore, several storage facilities in the north of Germany can be connected. The H2ercules network thus makes a significant contribution to European supply security and facilitates development of a European Hydrogen Backbone.

The H2ercules project received several Letters of Support from partners / consortia from the hydrogen value chain:

- The Ministry for the Environment, Energy and Climate Protection of the State of Lower Saxony
- Ministry of Economic Affairs, Industry, Climate Action and Energy of the State of North Rhine-Westphalia
- Ministry of the Environment, Climate Protection and the Energy Sector, Baden-Württemberg
- Bavarian Ministry of Economic Affairs, Regional Development and Energy
- Federal Ministry for Economic Affairs and Climate Action
- NET4GAS s.r.o., Eustream a.s., Gas Transmission Operator of Ukraine LLC,
- NET4GAS s.r.o., Eustream a.s., Trans Austria Gasleitung GmbH, SNAM S.p.A.
- NET4GAS s.r.o, GASCADE Gastransport GmbH
- BASF SE, Shell Chemicals and Products
- GRTgaz SA, Terega SA, REN – Gasodutos, S.A.,Enagas Transporte S.A.U.,
- Bayernets GmbH
- HNS Hydrogen Network
- Fluxys Belgium
- Uniper Hydrogen GmbH

F. Useful links [Promoter]

Useful links:

H2Med agreement: https://www.lamoncloa.gob.es/presidente/actividades/Documents/2022/091222-H2MED.pdf

https://www.grtgaz.com/en/our-actions/renewable-gas-circular-economy/hyfen

https://www.grtgaz.com/en/our-actions/renewable-gas-circular-economy/barmar

https://www.enagas.es/en/energy-transition/gas-network/energy-infrastructure/hydrogen-transmission/

https://www.terega.fr/en/our-activities/hydrogen-energy-carrier-for-the-future

H2ercules (h2ercules.com)