HI WEST 5 (Less-Advanced)

H2 storage Spain North-2

Reasons for grouping [ENTSOG]

The project group is a stand-alone underground storage in Spain. This project will enable storage of hydrogen in Spain from 2029 (HYD-N-1152).

Objective of the group [Promoter]

This storage is enabler of the Spanish hydrogen backbone which subsequently is an enabler of H2Med-CelZa and H2Med-BarMar interconnectors with Portugal and France.

The salt cavern storage enables the Spanish hydrogen backbone providing flexibility and balancing of supply and demand.

Key data:

- Working Gas Volume by 2029: 240 GWh.
- Full WGV to reach 812 GWh in a later stage of development.

HYD-N-1152 **H2 storage North-2**

Comm. Year **2029**

A. Project group technical information [Promoter/ ENTSOG]

Project technical information [Promoter]

Storage

TYNDP Project code	Maximum Injection rate [GWh/d]	Maximum Withdrawal rate [GWh/d]	Working gas volume [GWh]	Geometrical Volume [m3]
HYD-N-1152	30	60	240	

Capacity increment [ENTSOG]

TYNDP Project code	Point name	Operator	From system	To system	Capacity increment [GWh/d]	Comm. year
HYD-N-1152	H2_ST_ES	Enagas Transporte S.A.U.	Transmission Spain (ES Hydrogen)	Storage Spain (ES Hydrogen)	30	2029
HYD-N-1152	H2_ST_ES	Enagas Transporte S.A.U.	Storage Spain (ES Hydrogen)	Transmission Spain (ES Hydrogen)	60	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-1152	590	30%	6	30%

Description of the cost and range [Promoter]

Enagas is expecting a 30% CAPEX range based on some degree of uncertainty at this stage coupled with Enagas' cost estimates on how equipment and materials might evolve over time due to potential impact of inflation on prices.

30% range in OPEX estimate is driven by the volatility on energy prices witnessed after Russian invasion of Ukraine.

C. Project Benefits [ENTSOG]

C.1 Summary of benefits

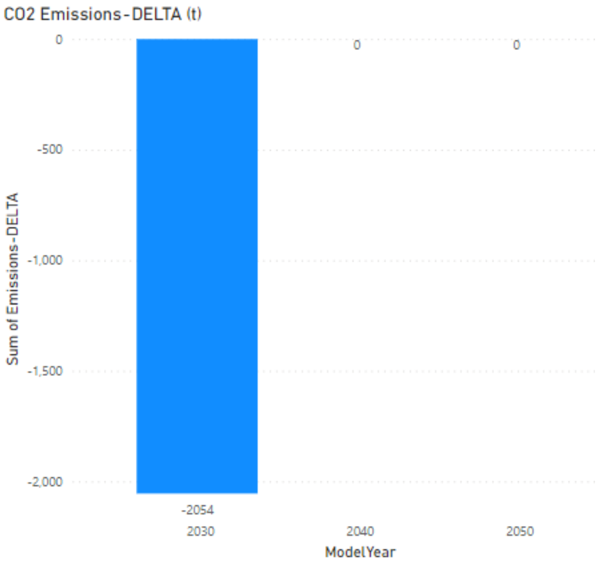
This section provides a summarised analysis by ENTSOG of the main benefits stemming from the realisation of the overall group. More details on the indicators are available in Annex D of TYNDP 2022[1].

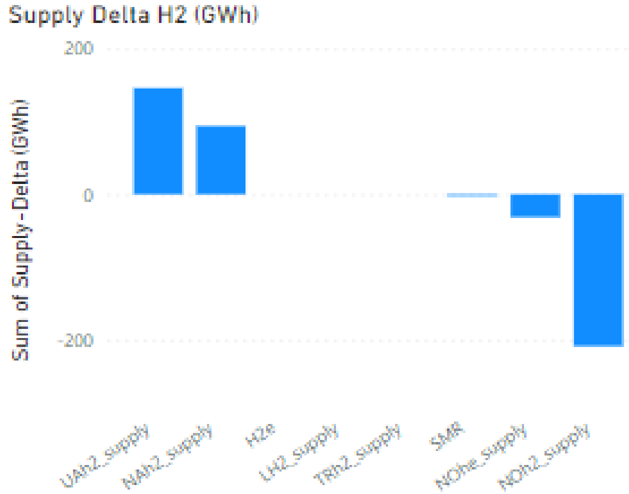
[1] https://www.entsog.eu/sites/default/files/2023-04/ENTSOG_TYNDP_2022_Annex_D_Methodology_230411.pdf

Distributed Energy

Sustainability benefits

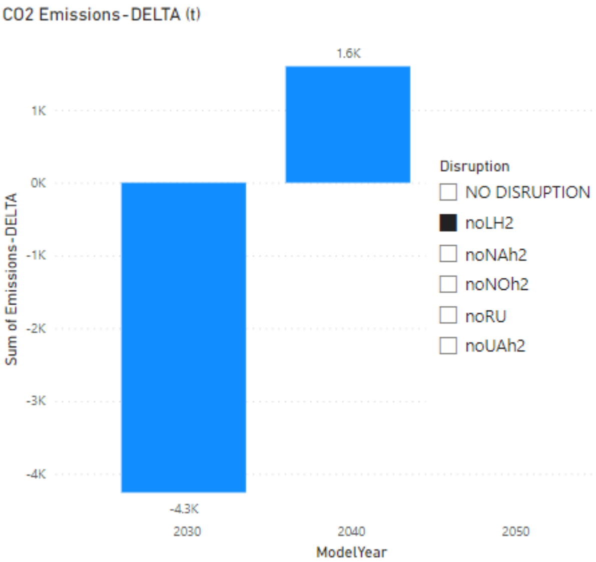
In the reference case, which analyses yearly demand in two periods (average winter and average summer), the project group will contribute to sustainability by reducing overall CO_2 emissions by 2 kt in 2030. The project group enables the transport of green hydrogen and so then replacing use of Norwegian supply which is considered as blue hydrogen in 2030.

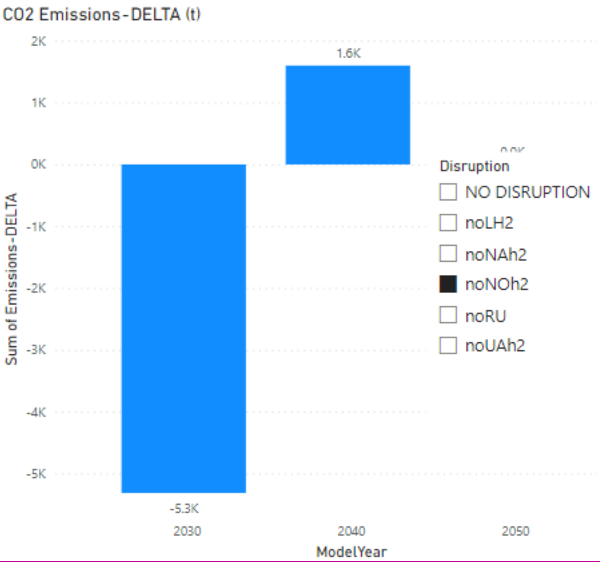


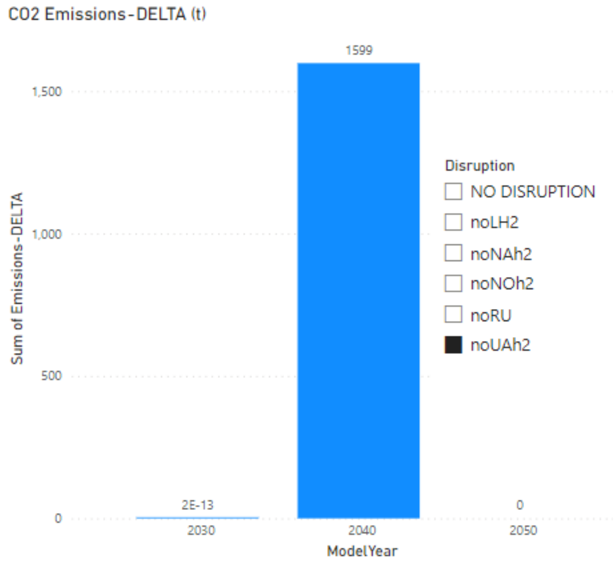


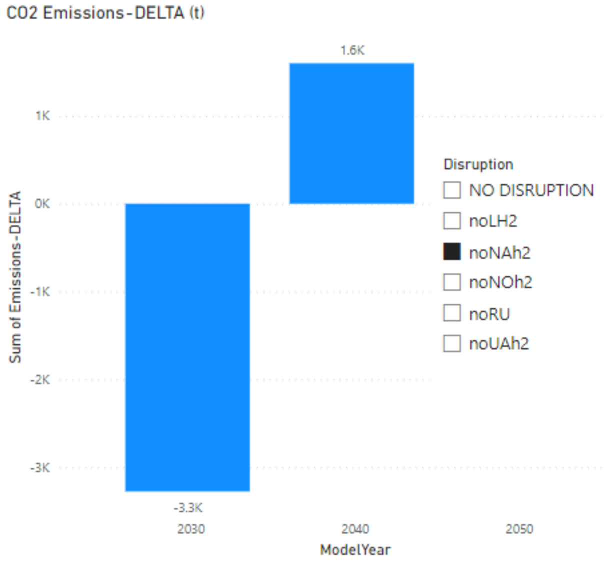
Similar trend is expected under any supply disruption in 2030. However, in 2040, triggered by the higher hydrogen demand project group will increase overall CO_2 emissions by using more SMRs and hence reduce demand curtailment.

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









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 a little in 2040, that cannot be displayed on the map.

> Climatic stress cases

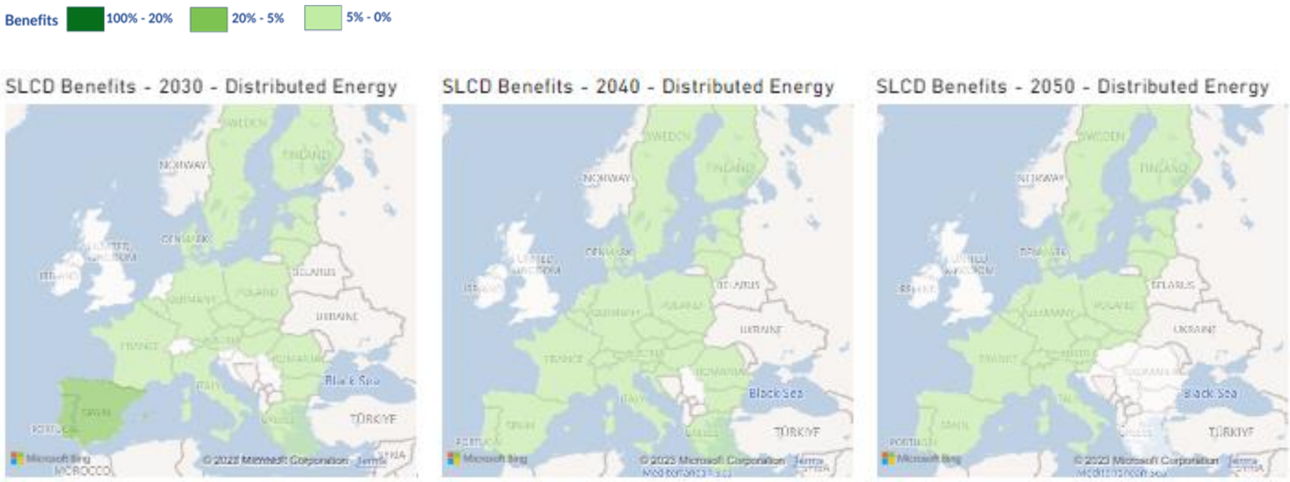
Under 2 -week and 2-week dunkelflaute climatic stress case, as well as under peak day climatic case the project group is also not showing security of supply benefits.

> Disruption cases (S-1):

[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.*

Similarly, under supply disruption cases, the project group is not further contributing to the mitigation of hydrogen demand curtailment risk.

> Single largest capacity disruption (SLCD):

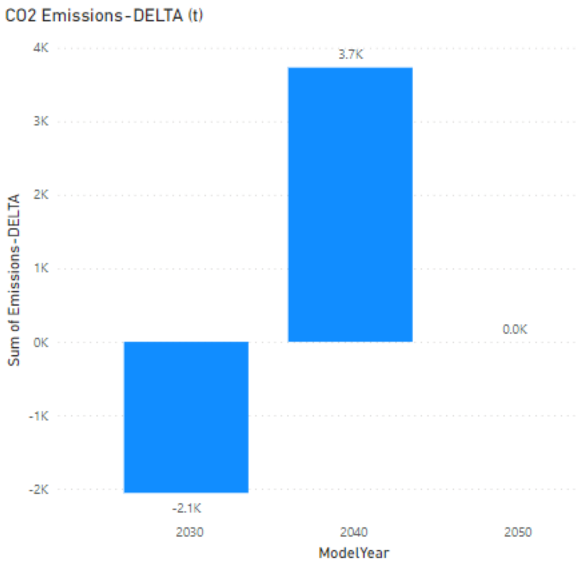


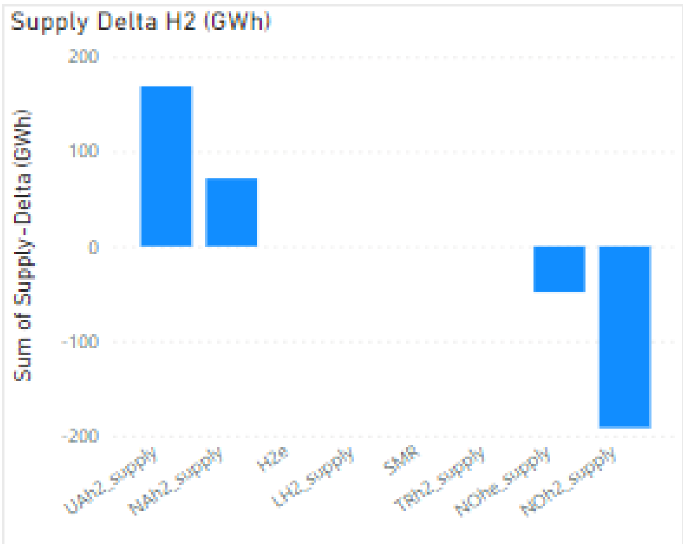
In case of single largest capacity disruption (SLCD), the project group significantly reduces the risk of demand curtailment in the Iberian Peninsula by 14% in 2030. In addition, also from 2030, the project group helps to mitigate the risk of demand curtailment due to the increase of storage capacity in Europe.

Global Ambition

Sustainability benefits

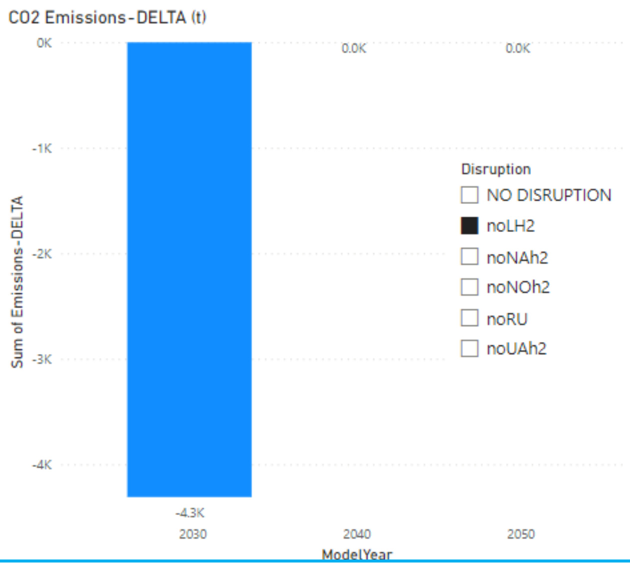
In the reference case, which analyses yearly demand in two periods (average winter and average summer), the project group will contribute to sustainability by reducing overall CO2 emissions by 2,1 kt in 2030. The project group enables the transport of green hydrogen and so then replacing use of Norwegian supply which is considered as blue hydrogen in 2030. However, in 2040, triggered by the higher hydrogen demand project group will increase overall CO2 emissions by using more SMRs to reduce demand curtailment.

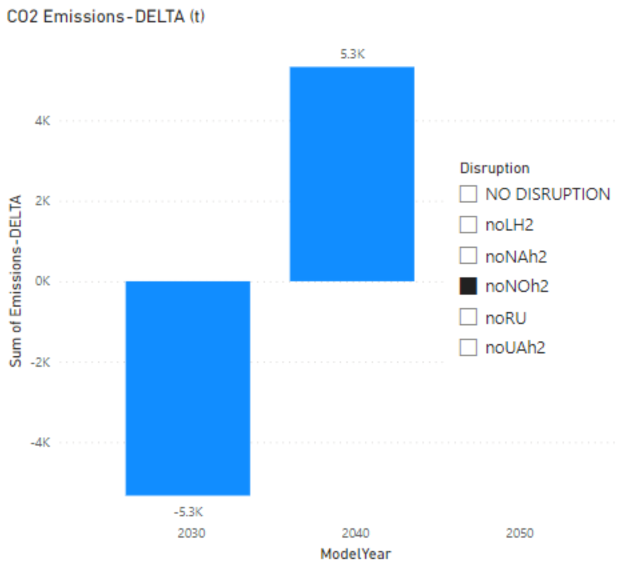


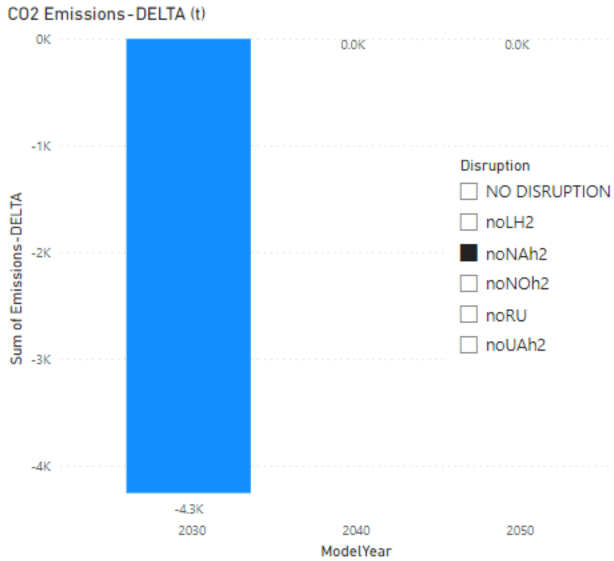


Similar trend is expected under supply disruptions.

1 noLH2 : LH2 disruption / 2 noNOh2 : Norway 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 a little in 2040, that cannot be displayed on the map.

> 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 also not showing security of supply benefits.

> Disruption cases (S-1):

Similarly, under supply disruption cases, the project group is not further contributing to the mitigation of hydrogen demand curtailment risk.

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

In case of single largest capacity disruption (SLCD), the project group significantly reduces the risk of demand curtailment in the Iberian Peninsula by 12% in 2030. In addition, also from 2030, the project group helps to mitigate the risk of demand curtailment due to the increase of storage capacity in 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	-2054,24	538677299	538679353,3
2030	noLH2	DE	tonne	-4256,95	540175890,2	540180147,2
2030	noNAh2	DE	tonne	-3274,58	539785356,1	539788630,7
2030	noNOh2	DE	tonne	-5312,80	538877197,8	538882510,6
2030	noUAh2	DE	tonne	0,00	539378771,9	539378771,9
2030	NO DISRUPTION	GA	tonne	-2055,48	592910448,4	592912503,9
2030	noLH2	GA	tonne	-4308,85	594817481,2	594821790
2030	noNAh2	GA	tonne	-4256,95	594141433,2	594145690,1
2030	noNOh2	GA	tonne	-5328,81	593310994,3	593316323,1
2030	noUAh2	GA	tonne	0,00	593627617,9	593627617,9
2040	NO DISRUPTION	DE	tonne	0,00	392077044	392077044
2040	noLH2	DE	tonne	1598,64	392213883,4	392212284,7
2040	noNAh2	DE	tonne	1598,64	392188097,7	392186499
2040	noNOh2	DE	tonne	1598,64	392144022,6	392142424
2040	noUAh2	DE	tonne	1598,64	392399182,9	392397584,2
2040	NO DISRUPTION	GA	tonne	3730,17	396523251,6	396519521,4
2040	noLH2	GA	tonne	0,00	397455196,7	397455196,7
2040	noNAh2	GA	tonne	0,00	397301976,6	397301976,6
2040	noNOh2	GA	tonne	5328,81	397450977,1	397445648,3
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
Portugal	-14%	-13%	-4%	-2%	-1%	-2%
Spain	-14%	-12%	-4%	-2%	-3%	-2%
France	-2%	-2%	-3%	-1%	-2%	-1%
Austria	-1%	-1%	-2%	-1%	-2%	-1%
Belgium	-1%	-2%	-2%	-1%	-1%	-1%
Czechia	-2%	-1%	-2%	-2%	-3%	-1%
Denmark	-2%	-2%	-2%	-1%	-2%	0%
Estonia	-2%	-2%	-2%	-1%	-2%	-1%
Finland	-2%	-2%	-2%	-1%	-2%	-1%
Germany	-1%	-1%	-2%	-2%	-1%	-1%
Italy	-1%	-1%	-2%	-1%	-2%	-1%
Latvia	-2%	-2%	-2%	-1%	-2%	-1%
Lithuania	-2%	-2%	-2%	-1%	-2%	-1%
Poland	-1%	-1%	-2%	-1%	-2%	-1%
Slovenia	0%	0%	-2%	-1%	-2%	-1%
Sweden	-2%	-2%	-2%	-1%	-2%	-1%
Switzerland	0%	0%	-2%	-1%	-1%	-1%
The Netherlands	0%	0%	-2%	-1%	-2%	-1%
Bulgaria	-1%	-1%	-1%	0%	0%	-1%
Croatia	0%	0%	-1%	0%	0%	-1%
Greece	-1%	-1%	-1%	-1%	0%	-1%
Hungary	-1%	-1%	-1%	0%	0%	-1%
Romania	-1%	-1%	-1%	0%	0%	-1%
Slovakia	-1%	-1%	-1%	-1%	-1%	-1%

Curtailment Rate (Climatic Stress):

Average2W	Austria	-1%	0%	0%	0%	0%	0%
Average2W	Belgium	0%	0%	0%	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	-1%	0%	0%	0%	0%	0%
Average2W	Denmark	0%	-1%	0%	-1%	0%	0%
Average2W	Estonia	0%	0%	0%	0%	0%	0%
Average2W	Finland	0%	0%	0%	0%	0%	0%
Average2W	France	0%	-1%	0%	0%	0%	0%
Average2W	Germany	0%	0%	0%	0%	0%	0%
Average2W	Greece	0%	0%	0%	0%	0%	0%
Average2W	Hungary	0%	-1%	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%	-1%	0%	0%
Average2W	Spain	0%	0%	0%	0%	0%	0%
Average2W	Sweden	0%	-1%	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%	-1%	0%	0%	0%
Average2WDF	Belgium	-1%	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%	0%	0%
Average2WDF	Denmark	0%	-1%	0%	0%	0%	0%
Average2WDF	Estonia	0%	0%	0%	0%	0%	0%
Average2WDF	Finland	0%	0%	0%	-1%	0%	0%
Average2WDF	France	0%	-1%	0%	0%	0%	0%
Average2WDF	Germany	0%	0%	0%	0%	0%	0%
Average2WDF	Greece	0%	0%	0%	0%	0%	0%
Average2WDF	Hungary	0%	-1%	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%	-1%	0%	0%	0%	0%
Average2WDF	Switzerland	0%	0%	0%	0%	0%	-1%
Average2WDF	The Netherlands	0%	0%	0%	0%	0%	0%
Average2WDF	United Kingdom	0%	0%	0%	0%	0%	0%
DC	Austria	-1%	-1%	0%	0%	0%	0%
DC	Belgium	-1%	-1%	0%	0%	0%	0%
DC	Bulgaria	0%	-1%	-1%	0%	0%	0%

DC	Croatia	0%	0%	-1%	0%	0%	0%
DC	Cyprus	0%	0%	0%	0%	0%	0%
DC	Czechia	-1%	0%	0%	0%	-1%	0%
DC	Denmark	-1%	-1%	0%	0%	0%	0%
DC	Estonia	0%	-1%	-1%	0%	-1%	0%
DC	Finland	0%	-1%	0%	0%	0%	0%
DC	France	-1%	-1%	-1%	0%	0%	0%
DC	Germany	-1%	-1%	0%	-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	-1%	-1%	0%	0%	-1%	0%
DC	Latvia	-1%	-1%	-1%	0%	0%	-1%
DC	Lithuania	-1%	-1%	-1%	0%	0%	0%
DC	Luxembourg	0%	0%	0%	0%	0%	0%
DC	Malta	0%	0%	0%	0%	0%	0%
DC	Poland	-1%	-1%	-1%	0%	0%	0%
DC	Portugal	-1%	-1%	-1%	0%	0%	0%
DC	Romania	0%	-1%	-1%	0%	0%	0%
DC	Serbia	0%	0%	0%	0%	0%	0%
DC	Slovakia	-1%	-1%	-1%	0%	0%	0%
DC	Slovenia	0%	0%	-1%	0%	0%	-1%
DC	Spain	-1%	-1%	0%	0%	0%	-1%
DC	Sweden	0%	-1%	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-1152	H2 Gas Storage	6-12 hectares (Surface facilities)	Minimal environmental impacts expected due to the surface facilities construction

Potential impact	Mitigation measures	Related costs included in project CAPEX and OPEX	Additional expected costs
Environmental Impacts (ecological, humans, society, industrial and economical)	Come to an agreement with a third party on using the brine in an industrial process Minimize fresh water consumption needed in the lixiviation process Monitoring programs for leaks and induced seismicity. Operational & Maintenance KPI´s to reduce incidence frequency	CAPEX: • around 10% of the Project Cost OPEX: • Around 30% of Project Studies (pre-permitting) • Less than 1% of the Project Cost (for monitoring)	

Environmental Impact explained [Promoter]

All the impacts will be measured and solutions will be looked for, in order to avoid or compensate those impacts on the habitat.

Expected environmental impacts are related to the construction and operation of the surface facilities and cavities. Surface facilities comprise lineal infrastructures such as hydrogen connections to the main pipeline, high voltage power line and brineline connections. In addition, treatment facilities to dry and remove impurities and compression equipment will installed for the storage operation.

Several drilling campaigns will be needed for the cavities construction. Safety and environmental aspects will be studied and planned to avoid any leak to aquifer formations during the drilling operations.

Lixiviation process will be accomplished to create the cavities. This process will require a considerable volume of fresh water. Hydrogeological studies will be done to optimize and chose the lixiviation flow rates to minimise the water consumption

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]

Sustainability. The project aims to:

- storage only renewable, contributing significantly to achieve the EU sustainability targets.
- achieve the REPowerEU targets of EU consumption by 2030.

This project is expected to support the development of hydrogen clusters and valleys in Spain and will contribute to achieve decarbonisation targets. As the volumes of hydrogen will be supplied from Iberia and transported via the Spanish hydrogen backbone the project will further accelerate the deployment of the hydrogen economy in Spain

Market integration. The storage facilitates market integration and efficient management of surplus production in relation to the import/exports balance.

Security of supply. The storage facility will help to storage the production of green H2 from the Iberian Peninsula contributing to the reduction of the EU's energy dependence on third countries with geopolitical instability.

Competition. It will provide access to competitive hydrogen, and will also increase the number of players on a transparent and non-discriminate manner.

Flexibility provided by underground storages is key for the adequacy of supply and demand along different timeframes, peak, seasonal etc. Developing hydrogen storage capacity will avoided investments in other technologies ssuch as SMR/ATR or you can avoid oversizing the electricity generation technologies to meet seasonal demand variations.

F. Useful links [Promoter]

Useful links:

https://www.enagas.es/content/dam/enagas/en/files/accionistas-e-inversores/comunicados-cnmv/otra-informacion-relevante/2023/20230119_PPT_D%C3%ADa_H2_INGL%C3%89S.pdf

https://www.lamoncloa.gob.es/serviciosdeprensa/notasprensa/transicion-ecologica/Paginas/2022/161222-h2med-espana-hub-hidrogeno-verde.aspx