HI EAST 5 (Less-advanced)

H2 Interconnection Hungary - Slovakia (newly built)

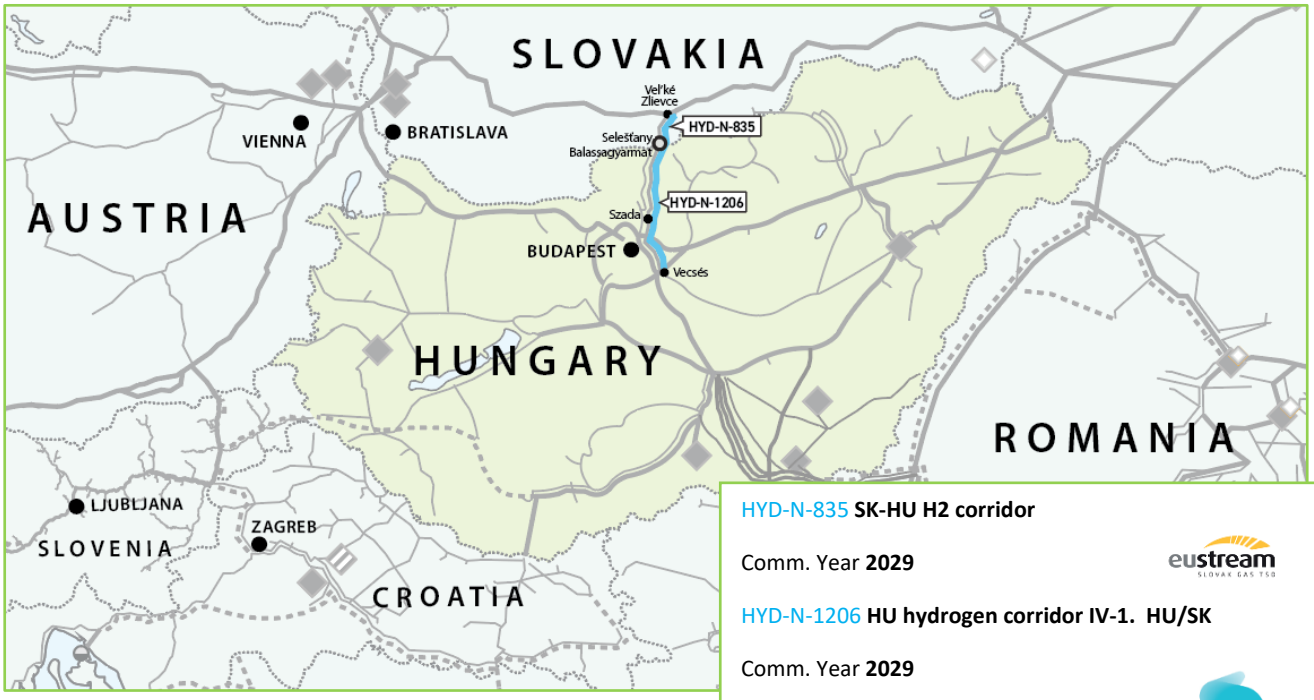
Reasons for grouping [ENTSOG]

The project group aims at interconnecting future hydrogen infrastructure between Hungary and Slovakia.

The group includes investments in Slovakia (HYD-N-835) and in Hungary (HYD-N-1206).

Objective of the group [Promoter]

Project will establish new supply route for hydrogen and will connect two neighboring countries: Slovakia and Hungary. Project will also contribute to development of hydrogen economy in the involved countries. Increased interest in domestic hydrogen production and consumption in both countries is expected since this project will enable access to hydrogen transmission system and allow export and import of hydrogen. With this project Slovakia and Hungary will gain access to North Africa region via Italy and South-East hydrogen corridor GR/BG/RO/HU/SK. North Africa and South-East Europe region have vast RES potential and significant hydrogen quantities are expected to be imported from this region. Project will contribute to diversification of energy sources and supply routes, which would result in increase of energy (hydrogen) supply from third countries and EU member states as well. Project will establish a new hydrogen IP between Slovakia and Hungary. Hydrogen capacity in both SK-HU and HU-SK directions will be up to 100 GWh/d. Group is a part of broader pan-European corridor connecting production areas with demand ones.



HYD-N-835 **SK-HU H2 corridor**

Comm. Year **2029**

HYD-N-1206 **HU hydrogen corridor IV-1. HU/SK**

Comm. Year **2029**

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]
HYD-N-835	Slovak section	New	800	20	0
HYD-N-1206	HU section HU/SK border-Vecsés	New	800	92	30
HYD-N-1206	HU section Vecsés-Városföld	New	800	78	
HYD-N-1206	HU section Vecsés-Ercsi	New	800	40	

Capacity increment [ENTSOG]

TYNDP Project code	Point name	Operator	From system	To system	Capacity increment [GWh/d]	Comm. year
HYD-N-835	H2_IP_SK-HU	eustream, a.s.	Transmission Hungary (HU Hydrogen)	Transmission Slovakia (SK Hydrogen)	100	2029
HYD-N-835	H2_IP_SK-HU	eustream, a.s.	Transmission Slovakia (SK Hydrogen)	Transmission Hungary (HU Hydrogen)	100	2029
HYD-N-1206	H2_IP_SK-HU	FGSZ Ltd.	Transmission Hungary (HU Hydrogen)	Transmission Slovakia (SK Hydrogen)	100	2029
HYD-N-1206	H2_IP_SK-HU	FGSZ Ltd.	Transmission Hungary (HU Hydrogen)	Transmission Slovakia (SK Hydrogen)	100	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-835	30	30 %	0.6	30 %
HYD-N-1206	454	30 %	40	30 %

Description of the cost and range [Promoter]

For project HYD-N-835

CAPEX includes the cost for installing the new 20 km long pipeline suitable for hydrogen and one ball valve station. No compressors installed.
OPEX includes cleaning and diagnostic pigging, maintenance of control valves and ball valves, inspection of insulation, maintenance of cathodic protection.

For project HYD-N-1206

• Description of CAPEX: the cost and range based on pre-feasibility study. During the preparation of TYNDP project submission ACER unit cost was not available for hydrogen project. FGSZ applied ACER based HU NRA guideline unit cost for natural gas 2022 multiplied by 1.3.

• Description of OPEX: the most significant impact on operating cost is the energy consumption of compressor stations. OPEX is estimated for max. capacity and electricity price 2022Q4, because we planned electric driven compressor units.

C. Project Benefits [ENTSOG]

C.1 Summary of benefits

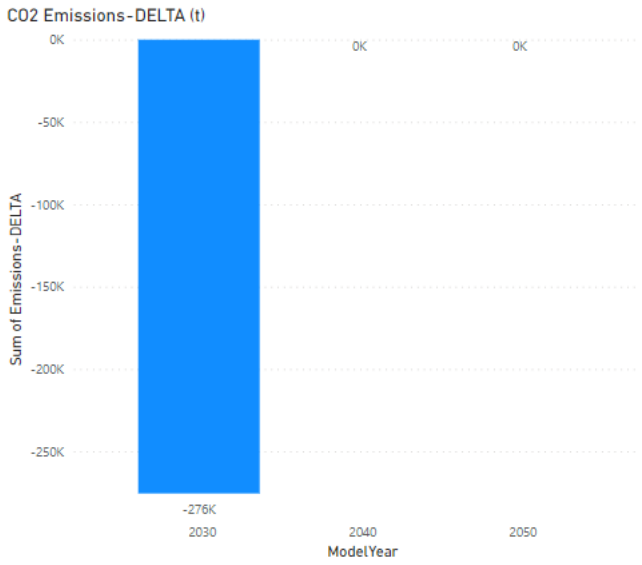
This section provides a summarised analysis by ENTSOG of the main benefits stemming from the realisation of the overall group. More details on the indicators are available in Annex D of TYNDP 2022[1].

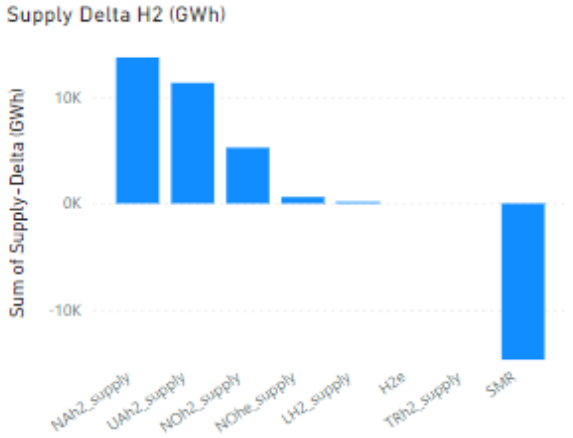
Distributed Energy

Project group has many benefits in 2030. However, it is important to mention that the benefits of this project group could be limited due to a competing project group (HI EAST 4, in 2040), located in the same geographical area connecting Slovakia and Hungary via the same route.

Sustainability:

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 276 kt in 2030. This is explained as the project group will enable replacement of SMR supply and, therefore, will reduce natural gas imports, due to access to green hydrogen supplies such as North African and Ukrainian.

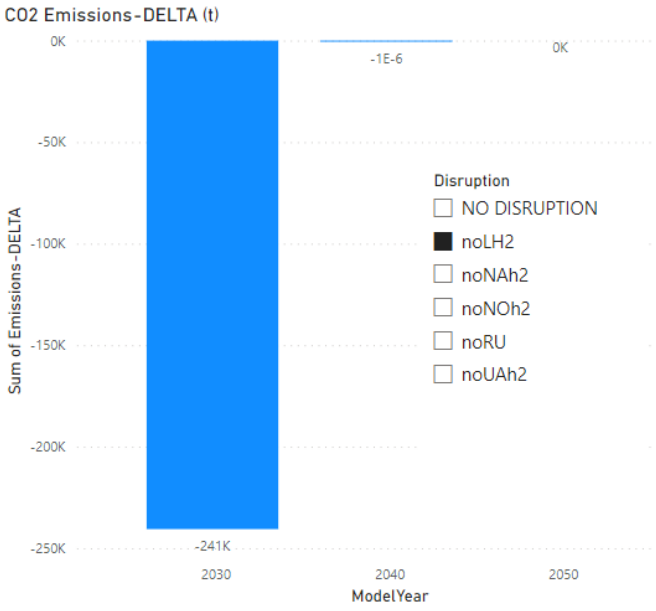


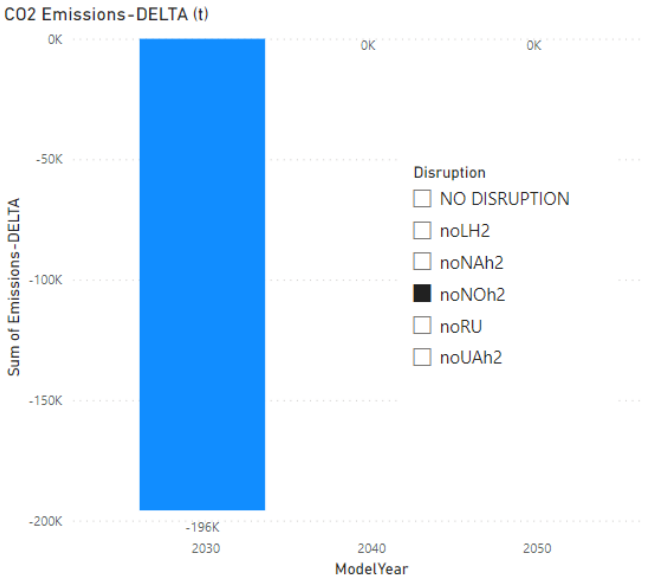


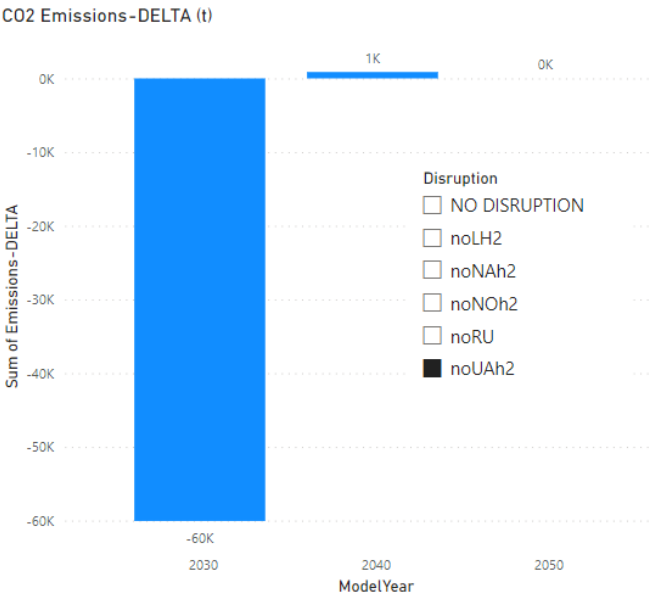
Similar benefits are expected under any disruption cases in 2030 up to 241kt CO2 reductions in case of LH2 disruption.

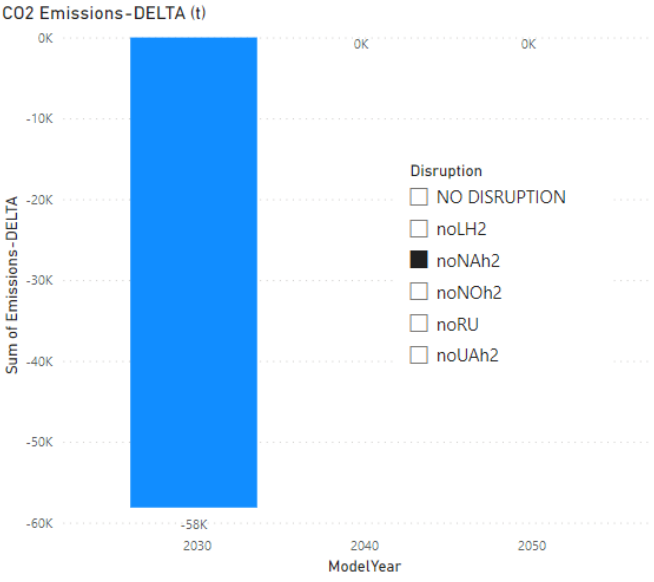
1 noLH2 : LH2 disruption / 2 noNOh2 : Norway disruption / 3 noUAh2 : Ukraine disruption/ 4 noNAh2 : North Africa disruption

[1] https://www.entsog.eu/sites/default/files/202304/ENTSOG_TYNDP_2022_Annex_D_Methodology_230411.pdf









Security of Supply:[2]

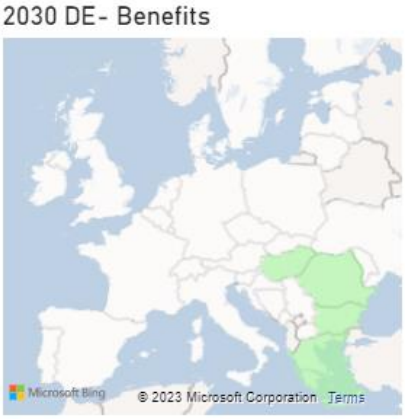
> Reference case:

[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.*

In the reference case, the project mitigates the risk of hydrogen demand curtailment in Hungary, Romania, Bulgaria and Greece by at least 22% in 2030. The project group improves flows to go to these countries from North to South.

> Climatic stress cases:

Under 2 -week and 2-week dunkelflaute climatic stress case, as well as under peak day climatic case the project group increases mitigation of risk of hydrogen demand curtailment in Greece and Bulgaria by 36% and in Romania and Hungary by 70% in 2030.

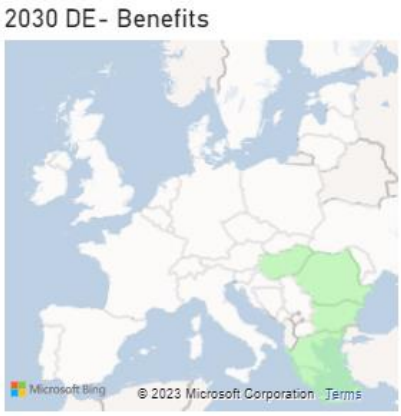


> Disruption cases (S-1):

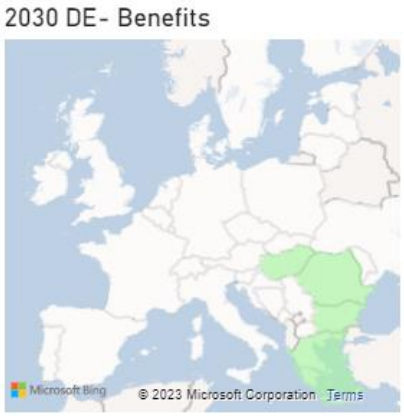
Similarly, under supply disruption cases, the project group mitigates in the same countries the risk of curtailment by 22-24% in 2030. Under Ukrainian disruption little benefits are expected by 2-3% in Croatia, Slovenia, Hungary, Romania, Bulgaria and Greece in 2040.

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

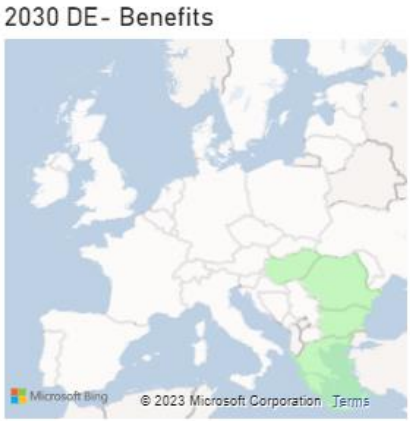
1 noLH2 : LH2 disruption

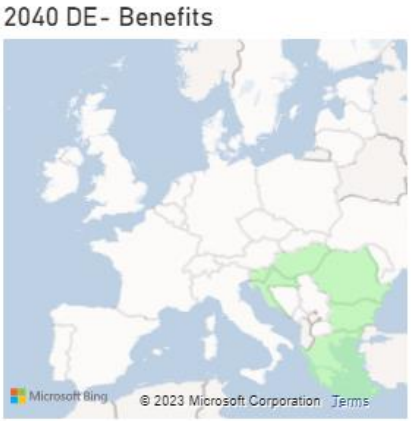


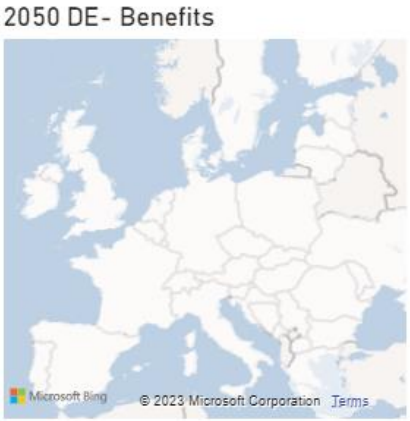
2 noNOh2 : Norway disruption



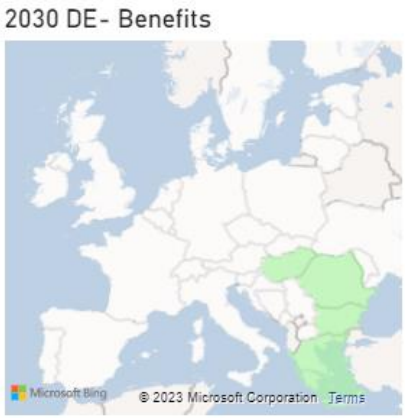
3 noUAh2 : Ukraine disruption





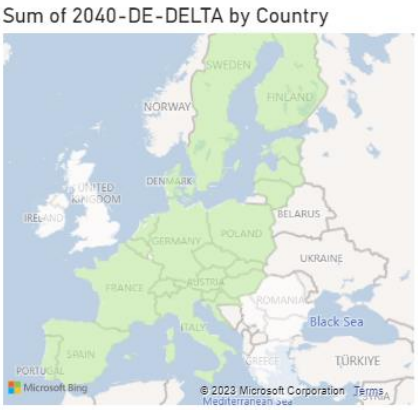


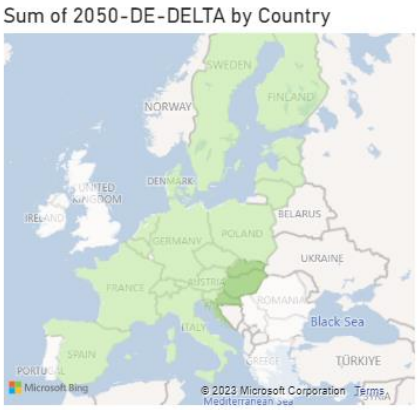
4 noNAh2 : North Africa disruption



> Single largest capacity disruption (SLCD):

In 2030, the projects group mitigates risk of demand curtailment by 37% in Hungary, 29% in Romania and Bulgaria, 15% in Greece in 2030. From 2040, the projects group mitigates risk of demand curtailment in almost all European countries by 1-2%.



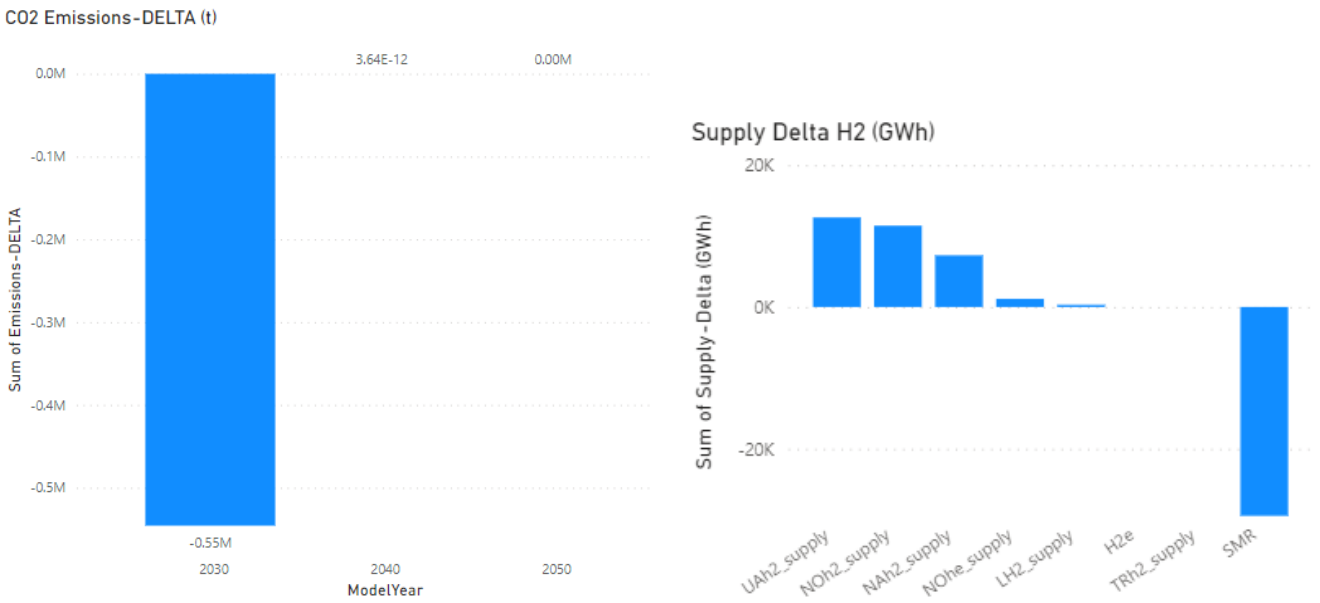


Global Ambition

Project group has many benefits in 2030. However, it is important to mention that the benefits of this project group could be limited due to a competing project group (HI EAST 4, in 2040), located in the same geographical area connecting Slovakia and Hungary via the same route.

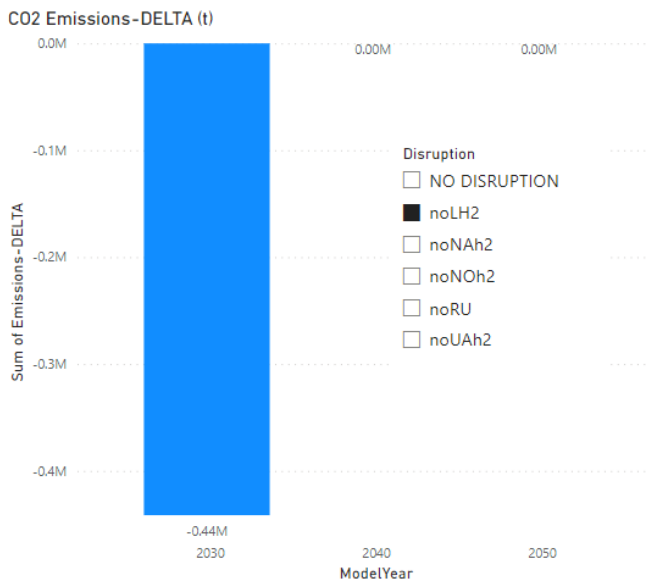
Sustainability

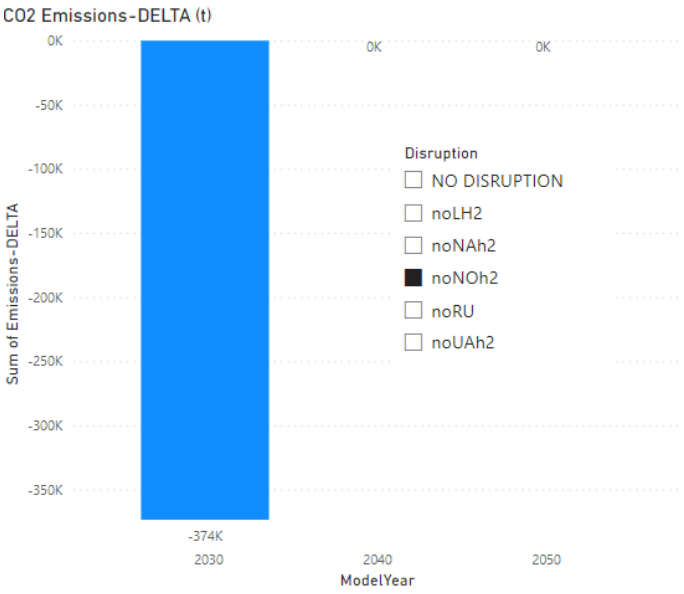
In the reference case which analyses yearly demand in two periods (average winter and average summer), the project group will contribute to sustainability by reducing overall CO2 emissions by 0,55 Mt in 2030. This is explained as the project group will enable replacement of SMR supply and, therefore, will reduce natural gas imports, due to access to green hydrogen supplies such as North African and Ukrainian.

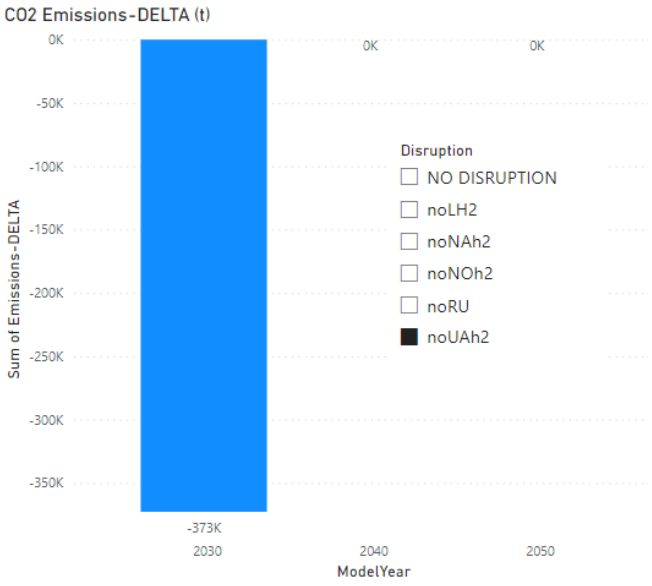


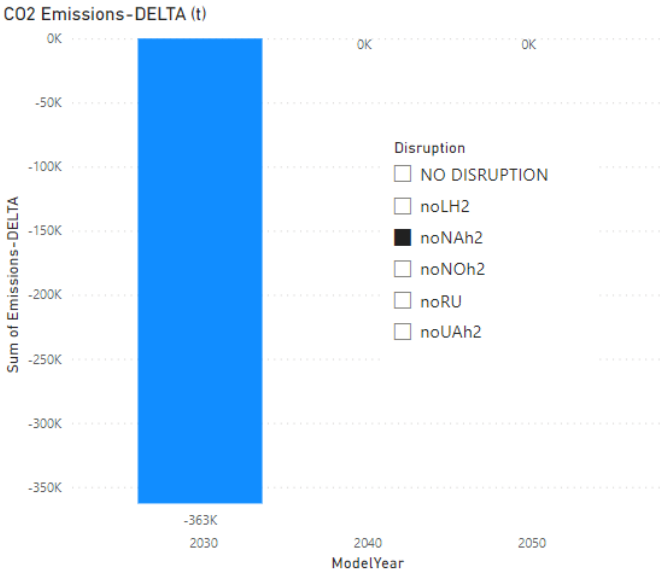
Similar benefits are expected under any disruption cases in 2030 up to 0,44 Mt CO2 reductions in case of LH2 disruption.

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









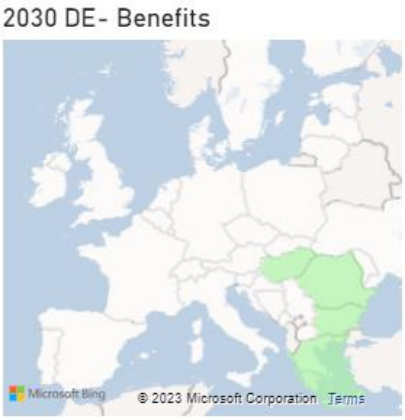
Security of supply :

> Reference case

In the reference case, the project mitigates the risk of hydrogen demand curtailment in Hungary, Romania, Bulgaria and Greece by 5-7% in 2030. The project group improves flows to go to these countries from North to South.

> Climatic stress cases

Under 2 -week and 2-week dunkelflaute climatic stress case, as well as under peak day climatic case the project group increases mitigation of risk of hydrogen demand curtailment in Greece and Bulgaria by 26% and in Romania and Hungary by 80% in 2030.

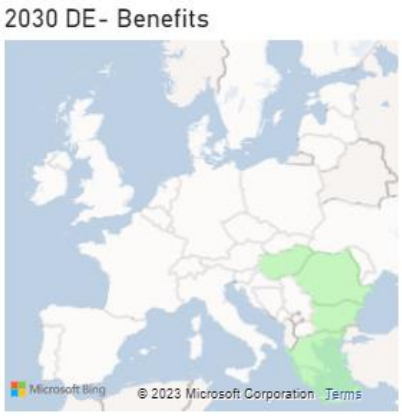


> Disruption cases (S-1)

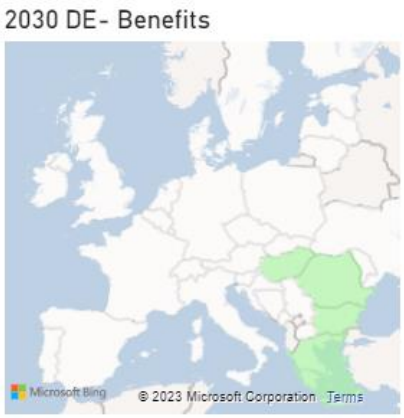
Similarly, under supply disruption cases, the project group mitigates in the same countries the risk of curtailment by 4-8% in 2030. Under Ukrainian disruption little benefits are expected by 3-4% in Croatia, Slovenia, Hungary, Romania, Bulgaria and Greece from 2040.

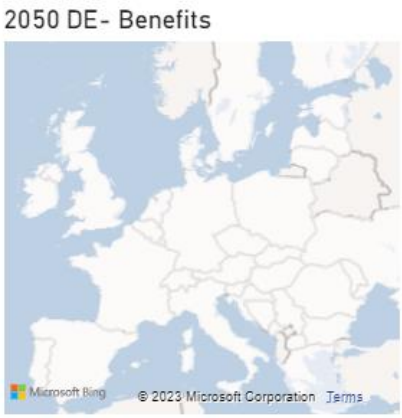
Maps for specifics disruptions: 1 noLH2 : LH2 disruption / 2 noNOh2 : Norway disruption / 3 noUAh2 : Ukraine disruption/ 4 noNAh2 : North Africa disruption

1 noLH2 : LH2 disruption

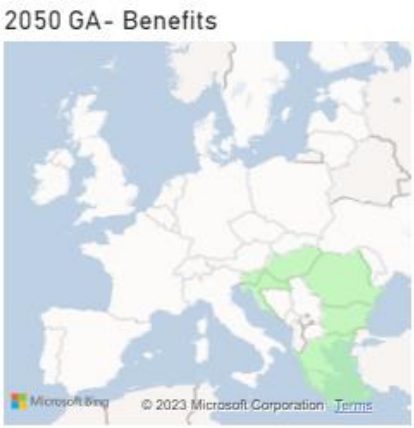


2 noNOh2 : Norway disruption



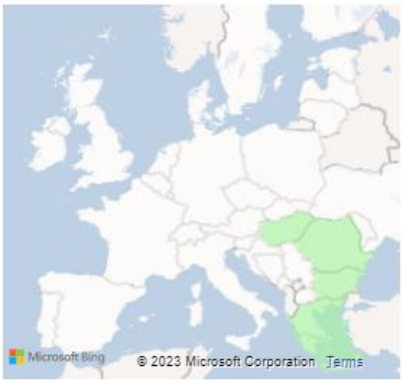


3 noUAh2 : Ukraine disruption



4 noNAh2 : North Africa disruption

2030 DE- Benefits



2040 DE- Benefits

2050 DE- Benefits

> Single largest capacity disruption (SLCD)

In 2030, the projects group mitigates risk of demand curtailment by 39% in Hungary, 36% in Romania and Bulgaria, 14% in Greece in 2030. In 2040, the projects group mitigates risk of demand curtailment in almost all European countries by 1-2%

Sum of 2030-GA-DELTA by Country

Sum of 2040-GA-DELTA by Country

Sum of 2050-GA-DELTA by Country

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	Emission Delta	Emission Plus	Emission Minus
2030	NO DISRUPTION	DE	tonne	-275.511	538.677.299	538.952.810
2030	NO DISRUPTION	GA	tonne	-545.744	592.910.448	593.456.193
2030	noLH2	DE	tonne	-240.584	540.175.890	540.416.474
2030	noLH2	GA	tonne	-441.353	594.817.481	595.258.834
2030	noNAh2	DE	tonne	-58.132	539.785.356	539.843.489
2030	noNAh2	GA	tonne	-362.874	594.141.433	594.504.307
2030	noNOh2	DE	tonne	-195.760	538.877.198	539.072.958
2030	noNOh2	GA	tonne	-373.690	593.310.994	593.684.684
2030	noUAh2	DE	tonne	-60.052	539.378.772	539.438.824
2030	noUAh2	GA	tonne	-372.743	593.627.618	594.000.361
2040	NO DISRUPTION	DE	tonne	0	392.077.044	392.077.044
2040	NO DISRUPTION	GA	tonne	0	396.523.252	396.523.252
2040	noLH2	DE	tonne	0	392.213.883	392.213.883
2040	noLH2	GA	tonne	0	397.455.197	397.455.197
2040	noNAh2	DE	tonne	0	392.188.098	392.188.098
2040	noNAh2	GA	tonne	0	397.301.977	397.301.977
2040	noNOh2	DE	tonne	0	392.144.023	392.144.023
2040	noNOh2	GA	tonne	0	397.450.977	397.450.977
2040	noUAh2	DE	tonne	869	392.399.183	392.398.314
2040	noUAh2	GA	tonne	0	397.478.498	397.478.498
2050	NO DISRUPTION	DE	tonne	0	232.557.735	232.557.735
2050	NO DISRUPTION	GA	tonne	0	228.306.707	228.306.707
2050	noLH2	DE	tonne	0	232.557.735	232.557.735
2050	noLH2	GA	tonne	0	228.306.707	228.306.707
2050	noNAh2	DE	tonne	0	232.557.735	232.557.735
2050	noNAh2	GA	tonne	0	228.306.707	228.306.707
2050	noNOh2	DE	tonne	0	232.557.735	232.557.735
2050	noNOh2	GA	tonne	0	228.306.707	228.306.707
2050	noRU	DE	tonne	0	232.557.735	232.557.735
2050	noRU	GA	tonne	0	228.306.707	228.306.707
2050	noUAh2	DE	tonne	0	232.557.735	232.557.735

2050	noUAh2	GA	tonne	0	228.306.707	228.306.707

Curtailment Rate (SLCD):

Country	2030-DE-DELTA	2030-GA-DELTA	2040-DE-DELTA	2040-GA-DELTA	2050-DE-DELTA	2050-GA-DELTA
Belgium	0%	0%	-2%	-1%	-1%	0%
Czechia	0%	0%	-2%	-2%	-2%	0%
Estonia	0%	0%	-2%	-1%	-2%	0%
Finland	0%	0%	-2%	-1%	-2%	0%
Germany	0%	0%	-2%	-1%	-1%	0%
Latvia	0%	0%	-2%	-1%	-1%	0%
Lithuania	0%	0%	-2%	-1%	-1%	-1%
Poland	0%	0%	-2%	-1%	-1%	0%
Portugal	0%	0%	-2%	-1%	0%	0%
Slovenia	0%	0%	-2%	-1%	-1%	0%
Sweden	0%	0%	-2%	-1%	-2%	0%
Switzerland	0%	0%	-2%	-1%	-1%	-1%
France	0%	0%	-2%	-1%	-1%	0%
The Netherlands	0%	0%	-1%	-1%	-2%	0%
Austria	0%	0%	-1%	-1%	-2%	0%
Croatia	0%	0%	-1%	0%	-8%	0%
Denmark	0%	0%	-1%	-1%	-1%	0%
Hungary	-37%	-39%	-1%	0%	-8%	0%
Italy	0%	0%	-1%	-1%	-2%	0%
Slovakia	0%	0%	-1%	0%	-8%	0%
Spain	0%	0%	-1%	-1%	-1%	0%
Bulgaria	-29%	-36%	0%	0%	0%	0%
Greece	-15%	-14%	0%	0%	0%	0%
Romania	-29%	-36%	0%	0%	0%	0%

Curtailment Rate (Climatic Stress):

SimulationPeriod	Country	2030-DE-DELTA	2030-GA-DELTA	2040-DE-DELTA	2040-GA-DELTA	2050-DE-DELTA	2050-GA-DELTA
Average2W	Austria	0%	0%	0%	0%	0%	0%
Average2W	Belgium	0%	0%	0%	0%	0%	0%
Average2W	Bulgaria	-20%	-15%	0%	0%	0%	0%
Average2W	Croatia	0%	0%	0%	0%	0%	0%
Average2W	Cyprus	0%	0%	0%	0%	0%	0%
Average2W	Czechia	0%	0%	0%	0%	0%	0%
Average2W	Denmark	0%	0%	0%	0%	0%	0%
Average2W	Estonia	0%	0%	0%	0%	0%	0%
Average2W	Finland	0%	0%	0%	0%	0%	0%
Average2W	France	0%	0%	0%	0%	0%	0%
Average2W	Germany	0%	0%	0%	0%	0%	0%

Average2W	Greece	-20%	-15%	0%	0%	0%	0%
Average2W	Hungary	-35%	-42%	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	-34%	-40%	0%	0%	0%	0%
Average2W	Serbia	0%	0%	0%	0%	0%	0%
Average2W	Slovakia	0%	0%	0%	0%	0%	0%
Average2W	Slovenia	0%	0%	0%	0%	0%	0%
Average2W	Spain	0%	0%	0%	0%	0%	0%
Average2W	Sweden	0%	0%	0%	0%	0%	0%
Average2W	Switzerland	0%	0%	0%	0%	0%	0%
Average2W	The Netherlands	0%	0%	0%	0%	0%	0%
Average2W	United Kingdom	0%	0%	0%	0%	0%	0%
Average2WDF	Austria	0%	0%	0%	0%	0%	0%
Average2WDF	Belgium	0%	0%	0%	0%	0%	0%
Average2WDF	Bulgaria	-20%	-15%	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%	0%	0%	0%	0%	0%
Average2WDF	Estonia	0%	0%	0%	0%	0%	0%
Average2WDF	Finland	0%	0%	0%	-1%	0%	0%
Average2WDF	France	0%	0%	0%	0%	0%	0%
Average2WDF	Germany	0%	0%	0%	0%	0%	0%
Average2WDF	Greece	-20%	-15%	0%	0%	0%	0%
Average2WDF	Hungary	-35%	-42%	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	-34%	-40%	0%	0%	0%	0%
Average2WDF	Serbia	0%	0%	0%	0%	0%	0%
Average2WDF	Slovakia	0%	0%	0%	0%	0%	0%
Average2WDF	Slovenia	0%	0%	0%	0%	0%	0%
Average2WDF	Spain	0%	0%	0%	0%	0%	0%
Average2WDF	Sweden	0%	0%	0%	0%	0%	0%
Average2WDF	Switzerland	0%	0%	0%	0%	0%	0%

Average2WDF	The Netherlands	0%	0%	0%	0%	0%	0%
Average2WDF	United Kingdom	0%	0%	0%	0%	0%	0%
DC	Austria	0%	0%	0%	0%	0%	0%
DC	Belgium	0%	0%	0%	0%	0%	0%
DC	Bulgaria	-16%	-14%	0%	0%	0%	0%
DC	Croatia	0%	0%	0%	0%	0%	0%
DC	Cyprus	0%	0%	0%	0%	0%	0%
DC	Czechia	0%	0%	0%	0%	0%	0%
DC	Denmark	0%	0%	0%	0%	0%	0%
DC	Estonia	0%	0%	0%	0%	0%	0%
DC	Finland	0%	0%	0%	0%	0%	0%
DC	France	0%	0%	0%	0%	0%	0%
DC	Germany	0%	0%	0%	0%	0%	0%
DC	Greece	-15%	-13%	0%	0%	0%	0%
DC	Hungary	-29%	-37%	0%	0%	0%	0%
DC	Ireland	0%	0%	0%	0%	0%	0%
DC	Italy	0%	0%	0%	0%	0%	0%
DC	Latvia	0%	0%	0%	0%	0%	0%
DC	Lithuania	0%	0%	0%	0%	0%	0%
DC	Luxembourg	0%	0%	0%	0%	0%	0%
DC	Malta	0%	0%	0%	0%	0%	0%
DC	Poland	0%	0%	0%	0%	0%	0%
DC	Portugal	0%	0%	0%	0%	0%	0%
DC	Romania	-28%	-36%	0%	0%	0%	0%
DC	Serbia	0%	0%	0%	0%	0%	0%
DC	Slovakia	0%	0%	0%	0%	0%	0%
DC	Slovenia	0%	0%	0%	0%	0%	0%
DC	Spain	0%	0%	0%	0%	0%	0%
DC	Sweden	0%	0%	0%	0%	0%	0%
DC	Switzerland	0%	0%	0%	0%	0%	0%
DC	The Netherlands	0%	0%	0%	0%	0%	0%
DC	United Kingdom	0%	0%	0%	0%	0%	0%

D. Environmental Impact [Promoter]

Any gas infrastructure has an impact on its surroundings. This impact is of particular relevance when crossing some environmentally sensitive areas. Mitigation measures are taken by the promoters to reduce this impact and comply with the EU and National regulations.

TYNDP Code	Type of infrastructure	Surface of impact	Environmentally sensitive area
HYD-N-835	N/A	N/A	N/A
HYD-N-1206	N/A	N/A	N/A

Potential impact	Mitigation measures	Related costs included in project CAPEX and OPEX	Additional expected costs
HYD-N-835	N/A	N/A	N/A
HYD-N-1206	N/A	N/A	N/A

Environmental Impact explained [Promoter]

This project uses the same corridor that are currently used to transport natural gas. Laying a parallel new line in the corridor will optimise existing land takes and operational and safety zones. No compressor station, no noise emissions on SK side are foreseen. Considering the relief of the country, no investments in anti-flooding measures are expected nor landslide remediation measures
*E*nvironmental impact is expected only during the construction phase. The new pipelines go parallel with existing pipeline. Compressor on HU side will be electricity driven compressor.

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]

SK part

- Project will give positive signals to the future hydrogen market development and could decrease uncertainty of other parts of hydrogen value chain to further invest into the hydrogen industrial technology or final customers' appliances.
- Connecting the project to another production area reduces Europe´s dependence on a limited number of hydrogen producers with a positive impact on sustainability, hydrogen availability and affordability.

HU Part

- Along the pipeline route hydrogen producers will have the possibility to establish electrolyzer and hydrogen entry points in both countries.
- The project group will help development of hydrogen economy in Central part of Hungary.
- Together with HI EAST 2B creates the RO>HU>SK hydrogen corridor and the South-Eastern EU region excess H2 supply from GR, BG and RO can be delivered towards the import dependent regions and countries.

F. Useful links [Promoter]

Useful links:

HU/SK hydrogen corridor: FGSZ Földgázszállító Alcím dia 1

Central European Hydrogen Corridor (cehc.eu)

European Hydrogen Backbone Maps | EHB European Hydrogen Backbone