HI EAST 2 B (Less-advanced)

Interconnection Romania - Hungary with link to H2 Production in Romania

Reasons for grouping [ENTSOG]

The project group aims at interconnecting future hydrogen infrastructure between Hungary and Romania to connect hydrogen production facilities located at Black Sea.

The group includes investments in Hungary (HYD-N-1259) and in Romania (HYD-N-999 and HYD-N-608)

Objective of the group [Promoter]

The project group helps ensure the hydrogen demand and transmission in Romania and Hungary. The project will establish new supply route for hydrogen and will connect two neighboring countries: RO and HU. With this project Romania and Hungary will gain access to TR/GR/BG/RO/HU/SK, UA/RO hydrogen corridor. The South-East Europe region have huge 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 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. Project will establish a new hydrogen IP between Romania and Hungary. Hydrogen capacity in both RO-HU and HU-RO directions will be up to 76.8 GWh/d.

HYD-N-999 **Giurgiu - Nădlac corridor modernization for hydrogen transmission**

Comm. Year **2029**

HYD-N-1259 **HU hydrogen corridor V-1. HU/RO**

Comm. Year **2029**

HYD-N-608 **Black Sea – Podișor Pipeline modernization for hydrogen transmission**

Comm. Year **2030**

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-999	Giurgiu - Podișor - Nădlac	Repurposing/New	800	650	42
HYD-N-1259	Csanádpalota-Kiskundorozsma	New	800	60	30
HYD-N-1259	Kiskundorozsma-Városföld	New	1000	67	
HYD-N-608	Amzacea - Podisor	Repurposing	1000	276	
HYD-N-608	Black Sea - Amzacea	Repurposing	1200	32.5	

Capacity increment [ENTSOG]

TYNDP Project code	Point name	Operator	From system	To system	Capacity increment [GWh/d]	Comm. year
HYD-N-999	H2 IP RO-HU	SNTGN Transgaz S.A.	Transmission Hungary (HU Hydrogen)	Transmission Romania (RO Hydrogen)	76.8	2029
HYD-N-1259	H2 IP RO-HU	FGSZ Ltd.	Transmission Hungary (HU Hydrogen)	Transmission Romania (RO Hydrogen)	76.8	2029
HYD-N-999	H2 IP RO-HU	SNTGN Transgaz S.A.	Transmission Romania (RO Hydrogen)	Transmission Hungary (HU Hydrogen)	76.8	2029
HYD-N-1259	H2 IP RO-HU	FGSZ Ltd.	Transmission Romania (RO Hydrogen)	Transmission Hungary (HU Hydrogen)	76.8	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-999	464.4	30 %	7	30 %
HYD-N-1259	322	30 %	15	0 %
HYD-N-608	199.6	30 %	3	30 %

Description of the cost and range [Promoter]

For project HYD-N-1259

• 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 FGSZ planned electric driven compressor units.

For project HYD-N-999

• Description of CAPEX: During the preparation of TYNDP project submission ACER unit cost was not available for hydrogen project, thus, the estimated costs in the concept phase of the project were determined on the basis of specific costs published by the European Hydrogen Backbone (EHB) initiative.

Description of OPEX: the most significant impact on operating cost is the fuel consumption required to operate the compressor stations. OPEX is estimated for maximum capacity taking into account some specific cost elements published by the European Hydrogen Backbone (EHB) initiative.

For project HYD-N-608

• Description of CAPEX: During the preparation of TYNDP project submission ACER unit cost was not available for hydrogen project, thus, the estimated costs in the concept phase of the project were determined on the basis of specific costs published by the European Hydrogen Backbone (EHB) initiative.

•Description of OPEX: OPEX is estimated for maximum capacity taking into account some specific cost elements published by the European Hydrogen Backbone initiative (EHB).

C. Project Benefits [ENTSOG]

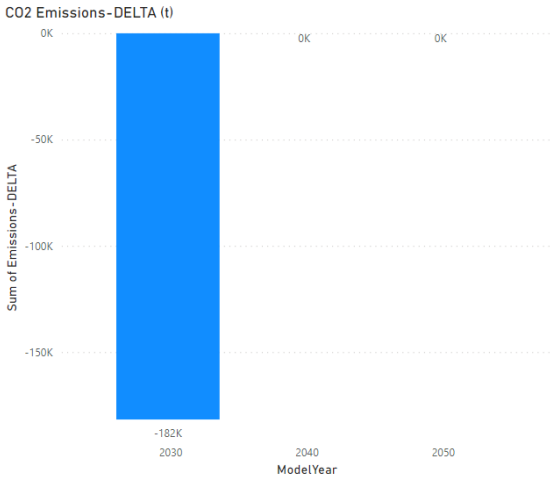
C.1 Summary of benefits

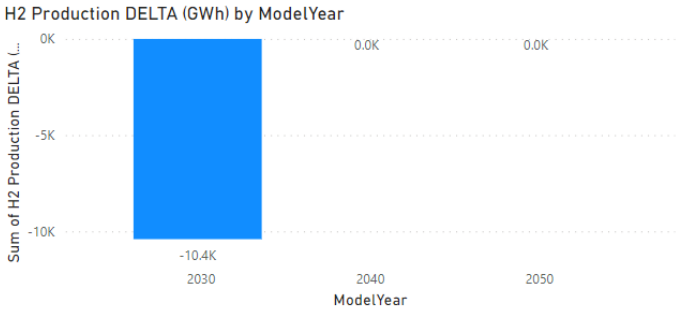
This section provides a summarised analysis by ENTSOG of the main benefits stemming from the realisation of the overall group. More details on the indicators are available in Annex D of TYNDP 2022[1].

Distributed Energy

Sustainability:

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 182 kt in 2030. This is explained as the project group will enable replacement of SMRs supplies, mainly by green hydrogen from Ukraine and North Africa to be used in interconnected countries and will therefore reduce natural gas imports.

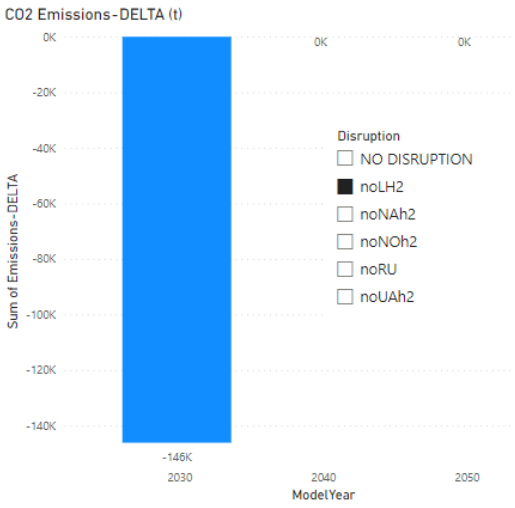


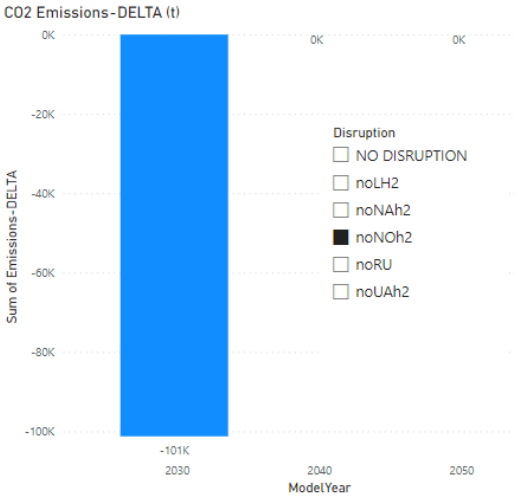


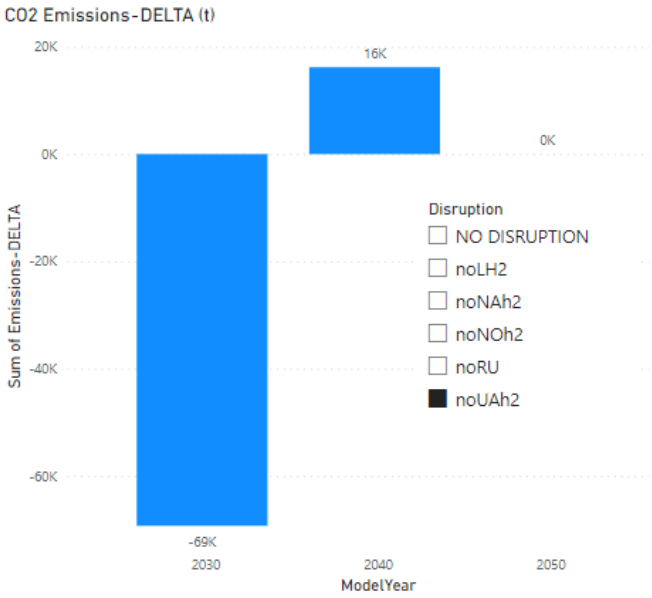
Slightly reduced sustainability benefits are expected under supply disruption cases for 2030.

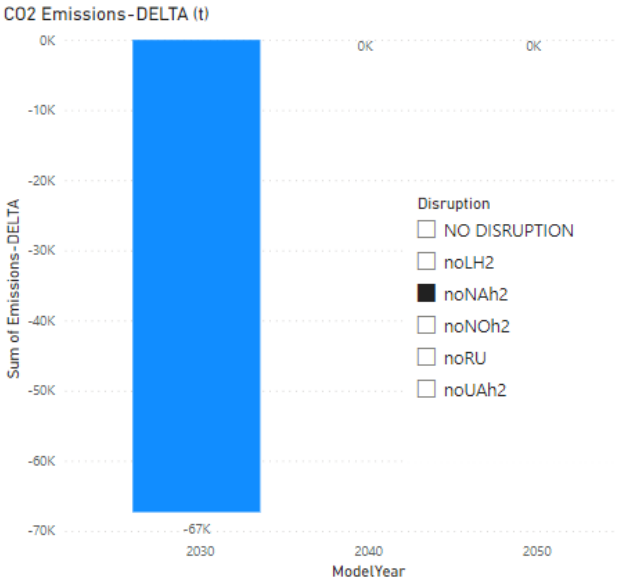
1 noLH2 : LH2 disruption / 2 noNOh2 : Norway disruption / 3 noUAh2 : Ukraine disruption/ 4 noNAh2 : North Africa disruption

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





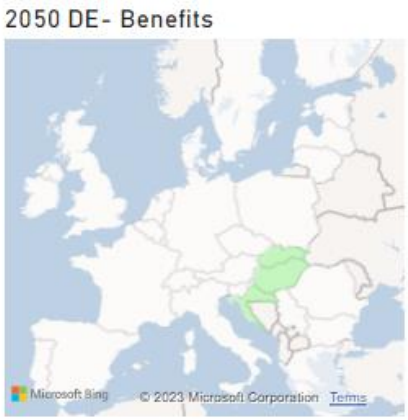




Security of Supply:[2]

> Reference case

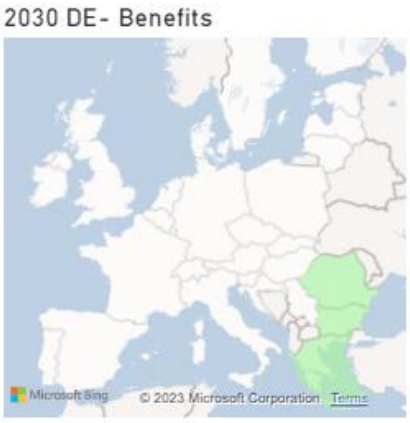
[2] *As for the hydrogen system there is no existing infrastructure level available yet, ENTSOG has identified a possible hydrogen network according to the information provided by promoters in their project submission for the TYNDP/PCI process (i.e., H2 Infrastructure level). Therefore, the System Assessment 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.*

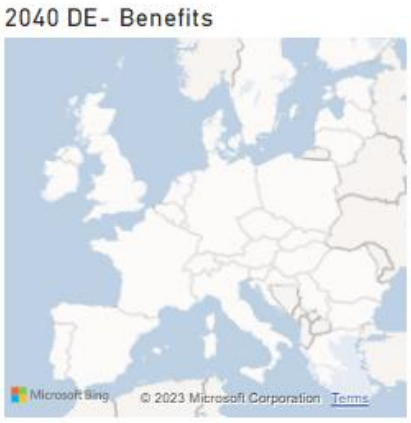


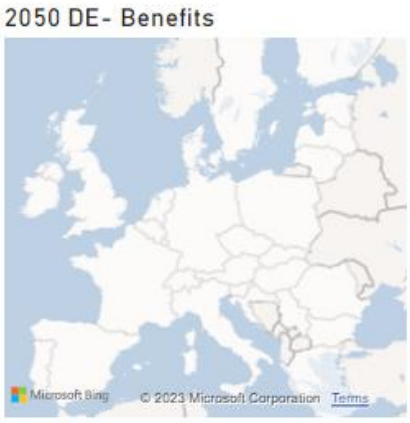
In the reference case, the project group mitigates the risk of hydrogen demand curtailment in Romania, Bulgaria, and Greece in 2030. Moreover in 2050, the project group mitigates demand curtailment in Slovakia, Hungary, and Croatia. In general, the interconnection improve cooperation between South Eastern Countries.

> Climatic stress cases:

Similar security of supply benefits re expected for 2030 under 2-week and 2-week dunkelflaute climatic stress cases and under peak day climatic case.

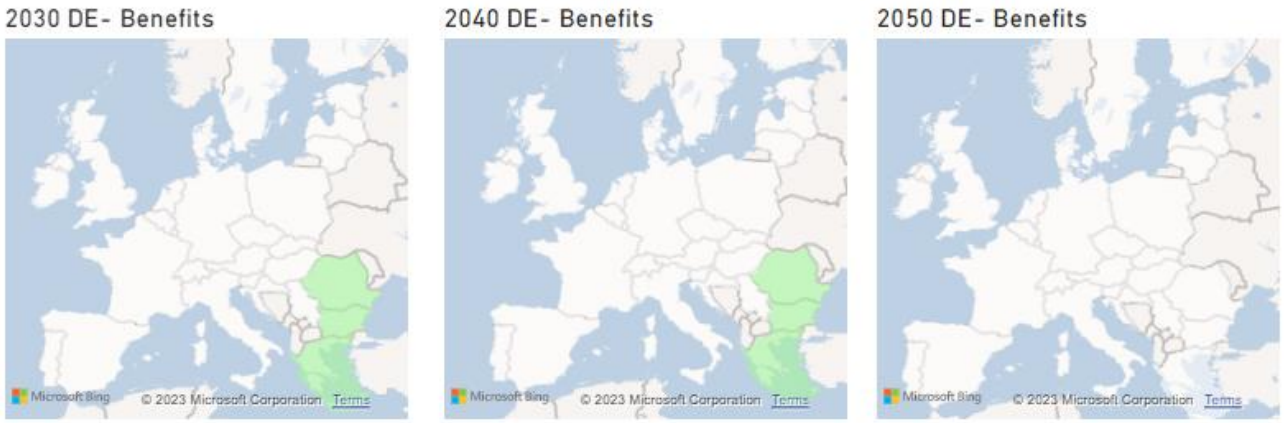






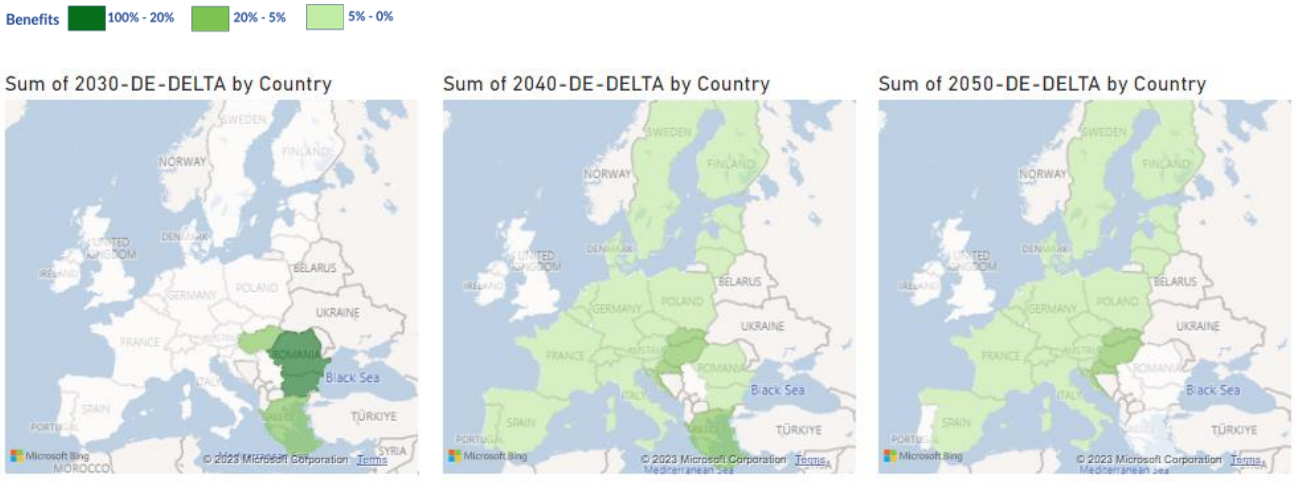
> Disruption cases (S-1):

Under supply disruption cases, the project group will enable cooperation between Hungary and Romania, allowing security of supplies benefits in Romania, Bulgaria and Greece in case of Ukrainian H2 supply disruption in 2030 and 2040.



> Single largest capacity disruption (SLCD):

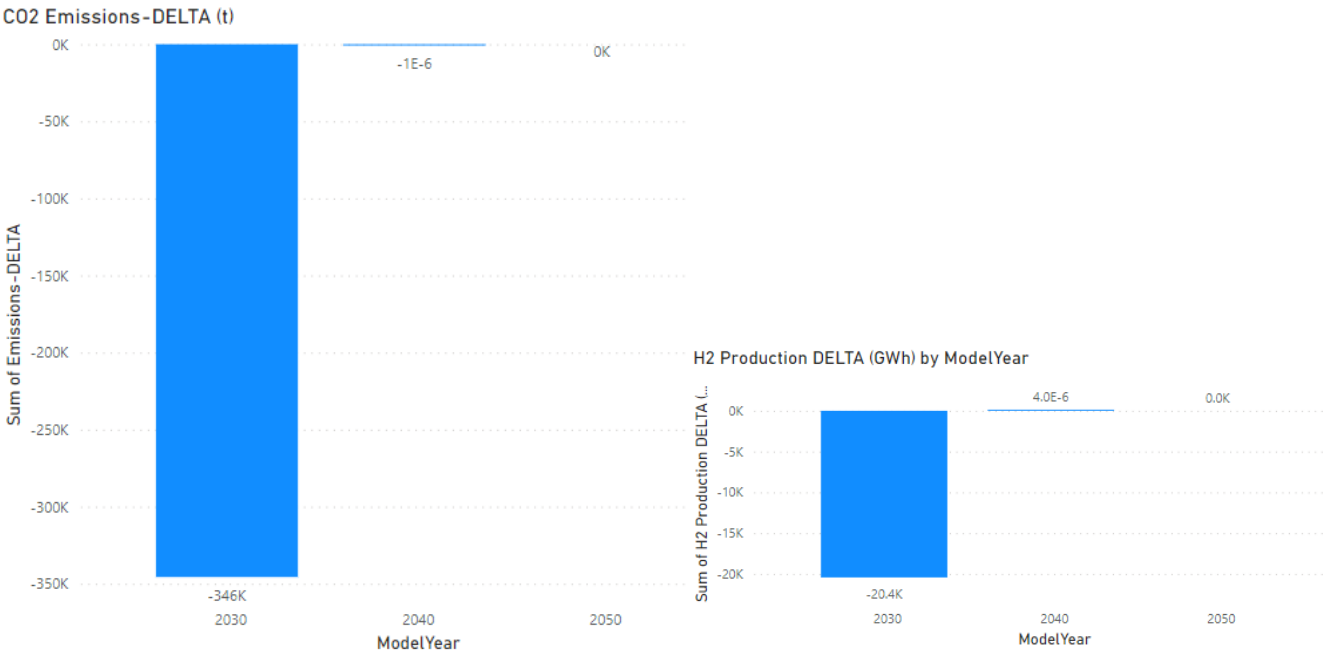
In 2030, the projects group mitigates risk of demand curtailment in Romania and Bulgaria by 26%, and also by 9% in Hungary and by 15% in Greece. From 2040, the project groups mitigates risk of demand curtailment in all European countries.



Global Ambition

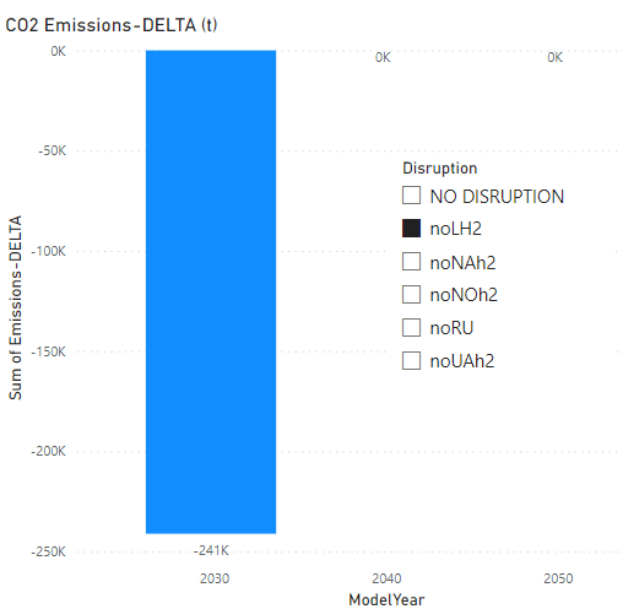
Sustainability

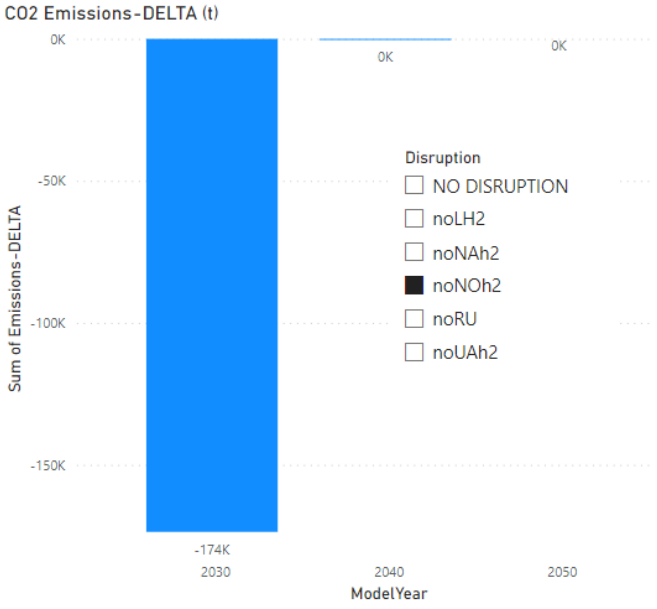
In the reference case, which analyses yearly demand in two periods (average winter and average summer), the project group will contribute to sustainability by reducing overall CO2 emissions by 346 kt in 2030. This is explained as the project group will enable replacement of SMRs supplies, mainly by green hydrogen from Ukraine and North Africa to be used in interconnected countries and will therefore reduce natural gas imports.

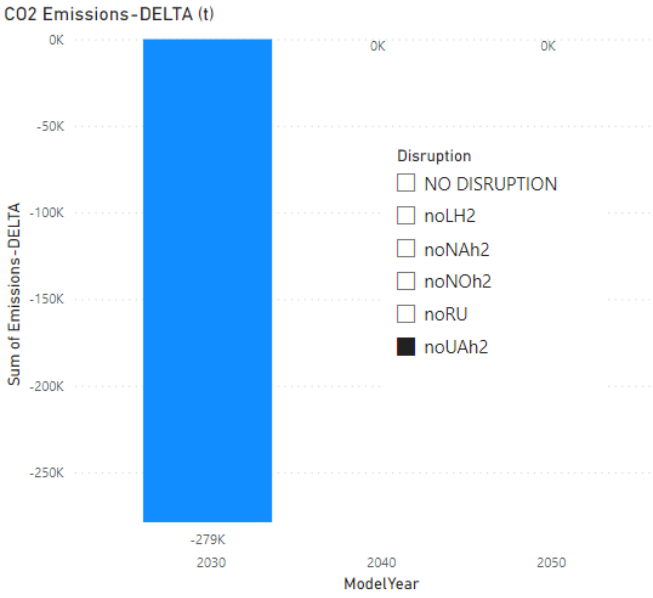


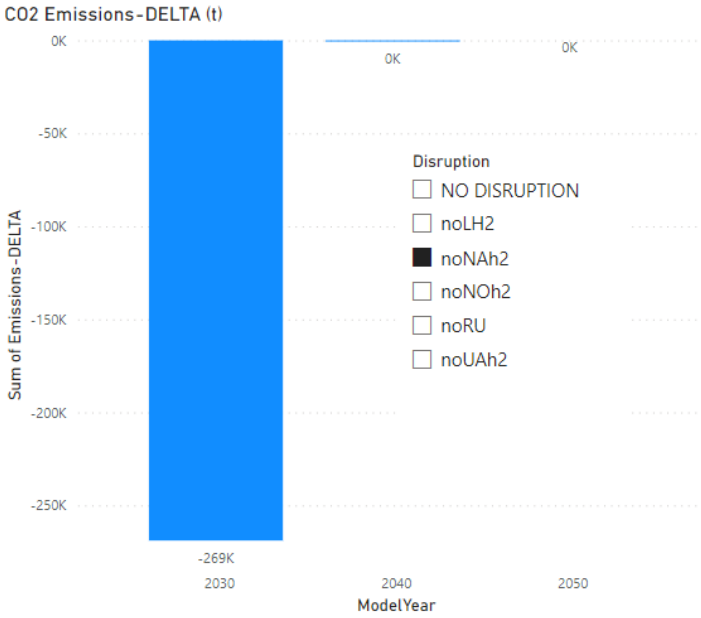
Slightly reduced sustainability benefits are expected under supply disruption cases for 2030.

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 is not mitigating risk of demand curtailment.

> Climatic stress cases

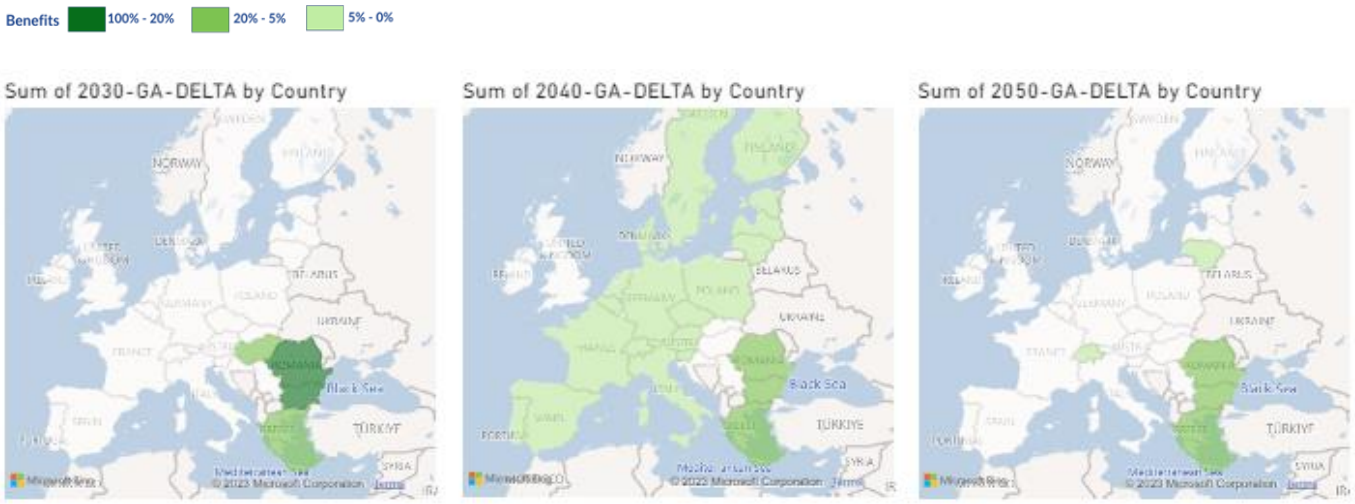
Under 2-week and 2-week dunkelflaute climatic stress cases, the project group will enable cooperation between Hungary and Romania, allowing security of supplies benefits in Romania, Bulgaria and Greece. Therefore the project mitigates risk of curtailment by 15% in Greece and Bulgaria and up to 27% in Romania.

> Disruption cases (S-1)

Similarly to the reference case, project group is not mitigating risk of demand curtailment in case of LH2, Norwegian or North African disruption. However, in case of Ukrainian disruption, project mitigates risk by 11% in 2040 and 9% in 2050, in Romania, Bulgaria and Greece.

> Single largest capacity disruption (SLCD)

In 2030, the projects group mitigates a lot risk of demand curtailment in Romania and Bulgaria by 31%, and also by 11% in Hungary and by 14% in Greece. In 2040, the project groups mitigates risk of demand curtailment in almost European countries. However in 2050, benefits are limited except in Romania, Bulgaria and Greece, where risk is reduced by 7%.



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	-181.718	538.677.299	538.859.017
2030	NO DISRUPTION	GA	tonne	-345.631	592.910.448	593.256.079
2030	noLH2	DE	tonne	-146.142	540.175.890	540.322.033
2030	noLH2	GA	tonne	-241.112	594.817.481	595.058.593
2030	noNAh2	DE	tonne	-67.331	539.785.356	539.852.687
2030	noNAh2	GA	tonne	-268.864	594.141.433	594.410.297
2030	noNOh2	DE	tonne	-101.255	538.877.198	538.978.453
2030	noNOh2	GA	tonne	-173.576	593.310.994	593.484.570
2030	noUAh2	DE	tonne	-69.250	539.378.772	539.448.022
2030	noUAh2	GA	tonne	-278.734	593.627.618	593.906.352
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	-3	397.301.977	397.301.980
2040	noNOh2	DE	tonne	0	392.144.023	392.144.023
2040	noNOh2	GA	tonne	-145	397.450.977	397.451.122
2040	noUAh2	DE	tonne	16.179	392.399.183	392.383.004
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
Croatia	0%	0%	-9%	0%	-11%	0%
Slovakia	0%	0%	-9%	0%	-11%	-1%
Hungary	-9%	-11%	-8%	0%	-10%	0%
Greece	-15%	-14%	-6%	-10%	0%	-7%
Bulgaria	-25%	-30%	-5%	-10%	0%	-7%
Romania	-26%	-31%	-5%	-9%	0%	-7%
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%
Denmark	0%	0%	-1%	-1%	-1%	0%
Italy	0%	0%	-1%	-1%	-2%	0%
Spain	0%	0%	-1%	-1%	-1%	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%	-1%	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	0%	0%	0%	0%	-1%	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	-23%	-27%	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%	0%	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	0%	0%	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	-23%	-27%	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%	-1%

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	0%	0%	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	-20%	-26%	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%	-1%	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-1259	N/A	N/A	N/A
HYD-N-999	N/A	N/A	N/A

Potential impact	Mitigation measures	Related costs included in project CAPEX and OPEX	Additional expected costs
HYD-N-1259	N/A	N/A	N/A
HYD-N-999	N/A	N/A	N/A

Environmental Impact explained [Promoter]

For project HYD-N-1259

All new pipelines will be built parallel with existing ones. Environmental impact on the Hungarian side is expected only during the construction phase, but not envisage major difficulties. Compressor will be electricity driven compressor.

For project HYD-N-999

All new pipelines will be built parallel with existing ones. Environmental impact on the Romanian side is expected during the construction and operation phase, but no major difficulties are envisaged. The compressor will be a compressor driven electrically or by hydrogen transmitted by pipeline.

For project HYD-N-608

All new pipelines will be built parallel with existing ones. Environmental impact on the Romanian side is expected during the construction and operation phase, but no major difficulties are envisaged. The compressor will be a compressor driven electrically or by hydrogen transmitted by pipeline.

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]

For project HYD-N-1259

Along the pipeline route hydrogen producers will have the possibility to establish electrolyzers and hydrogen entry points in both countries.

The project group will help development of hydrogen economy in South-Eastern Hungary.

With this project Romania and Hungary will gain access to TR/GR/BG/RO/HU/SK corridor and the whole European Hydrogen Backbone system will be available for both countries.

For project HYD-N-999

Along the pipeline route hydrogen producers will have the possibility to establish electrolyzers and hydrogen entry points in both countries.

The project group will help development of hydrogen economy in South-Westerm Romania.

With this project, Romania and Hungary will have access to the TR/GR/BG/RO/HU/SK corridor, and the whole European Hydrogen Backbone system will be available for both countries.

For project HYD-N-608

Along the pipeline route hydrogen producers will have the possibility to establish electrolyzers and hydrogen entry points in both countries.

The project group will help development of hydrogen economy in South-Westerm Romania.

With this project, Romania and Hungary will have access to the TR/GR/BG/RO/HU/SK corridor, and the whole European Hydrogen Backbone system will be available for both countries.

F. Useful links [Promoter]

Useful links:

HU/SI hydrogen corridor: FGSZ Földgázszállító Alcím dia 1