HI EAST 3 (Less-advanced)

H2 Interconnection Hungary - Slovenia

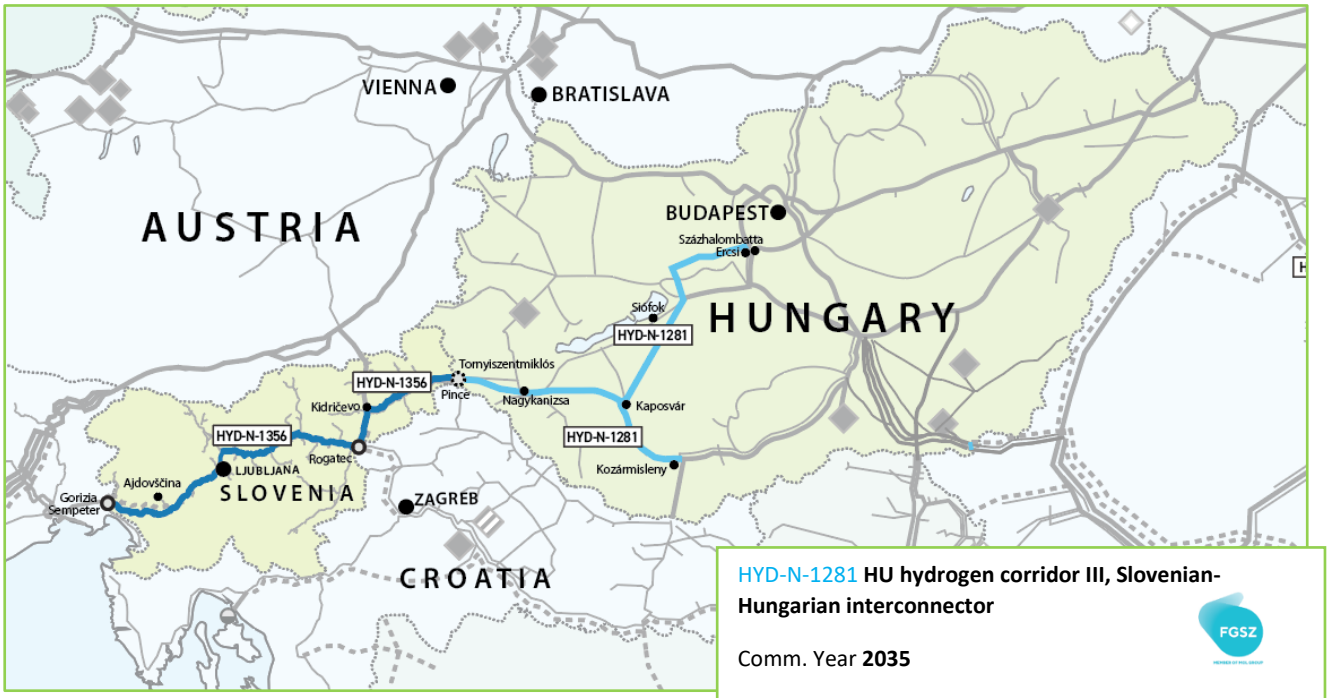
Reasons for grouping [ENTSOG]

The project group aims at interconnecting future hydrogen infrastructure between Italian-Slovenian border and Hungary through Slovenia.

The group includes investments Slovenia (HYD-N-1356) and in Hungary (HYD-N-1281).

Objective of the group [Promoter]

Project will establish new bidirectional supply route for hydrogen and will connect two neighboring countries: Slovenia and Hungary. With this project, Slovenia and Hungary will gain access to North Africa region via Italy. North Africa has 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. 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 Slovenia and Hungary.



HYD-N-1281 **HU hydrogen corridor III, Slovenian-Hungarian interconnector**

Comm. Year **2035**

HYD-N-1356 **Italy-Slovenia-Hungary H2 corridor**

Comm. Year **2035**

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-1281	HU/SI border -Nagykanizsa	New	600	41	20
HYD-N-1281	Nagykanizsa - Kozármisleny	New	600	158	
HYD-N-1356	R15/1 Pince - Lendava - Kidričevo	New	500	75	
HYD-N-1356	M1 retrofitting	Repurposing	500	20	
HYD-N-1356	M2 retrofitting	Repurposing	400	109	
HYD-N-1356	M3/1 Vodice - Šempeter	New	800	101	
HYD-N-1356	CS Kidričevo, 3rd phase of upgrade	New			1
HYD-N-1356	CS Ajdovščina, 2nd phase of upgrade	New			8

Capacity increment [ENTSOG]

TYNDP Project code	Point name	Operator	From system	To system	Capacity increment [GWh/d]	Comm. year
HYD-N-1281	H2 IP SI-HU	FGSZ Ltd.	Transmission Slovenia (SI Hydrogen)	Transmission Hungary (HU Hydrogen)	19.6	2035
HYD-N-1281	H2 IP SI-HU	FGSZ Ltd.	Transmission Hungary (HU Hydrogen)	Transmission Slovenia (SI Hydrogen)	19.6	2035
HYD-N-1356	H2 IP SI-HU	Plinovodi d.o.o.	Transmission Slovenia (SI Hydrogen)	Transmission Hungary (HU Hydrogen)	19.6	2035
HYD-N-1356	H2 IP SI-HU	Plinovodi d.o.o.	Transmission Hungary (HU Hydrogen)	Transmission Slovenia (SI Hydrogen)	19.6	2035

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-1281	361	30 %	15	30 %
HYD-N-1356	484	30%	11.7	30%

Description of the cost and range [Promoter]

Slovenia: During the period of preparing the project data collection for TYNDP 2022, the costs associated with HYD-N-1356 were in the process of being determined at the national level as part of the national development plan. Consequently, the aforementioned costs for HYD-N-1356 were estimated based on the unit prices provided in the EHB study.

Hungary - for project HYD-N-1281:

• 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.

**Regarding project HYD-N-1281, Kaposvár-Ercsi pipeline is an alternative route, CAPEX figure doesn't contain the related CAPEX demand.*

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].

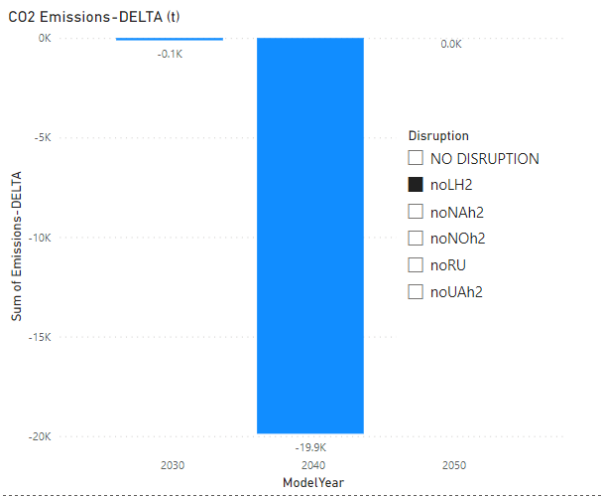
Distributed Energy

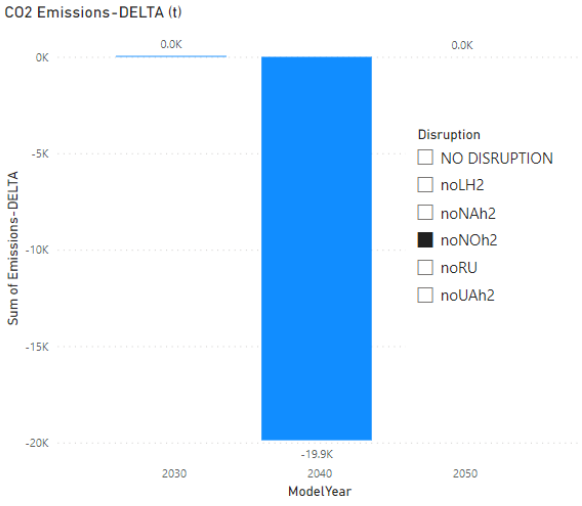
Sustainability

In the reference case, which analyses yearly demand in two periods (average winter and average summer), the project group contributes to sustainability by reducing hydrogen demand curtailment. With the implementation of the project group, countries in the region can further cooperate avoiding demand curtailment. However, as project groups is commissioning in 2035, benefits are lower due to many other supplies routes to Slovenia and Hungary.

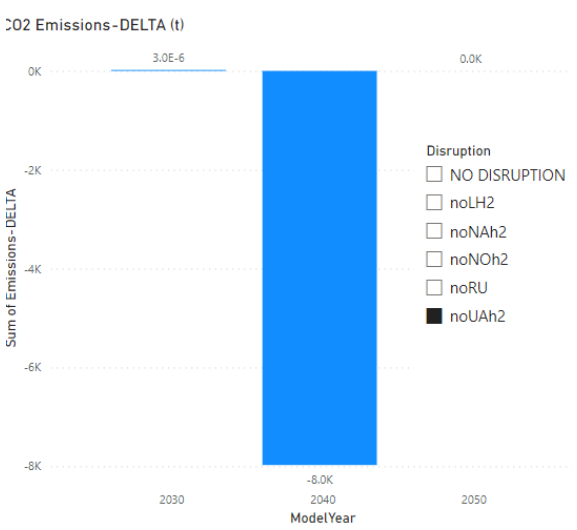
In case of disruptions, the project group will contribute to sustainability by reducing overall CO2 emissions up to 19,9kt kt in 2040 for Norwegian or LH2 disruptions.

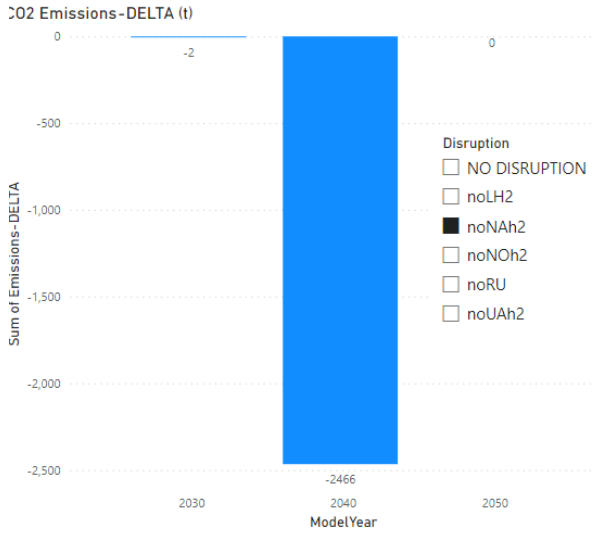
1 noLH2 : LH2 disruption / 2 noNOh2 : Norway disruption / 3 noUAh2 : Ukraine disruption/ 4 noNAh2 : North Africa disruption





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





Security of Supply:[2]

> Reference case:

In the reference case, the project is contributing a little to further mitigation of hydrogen demand curtailment risk in average summer and average winter, lower than 1% which is not visible 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 increases mitigation of risk of hydrogen demand curtailment in Germany, Poland and Lithuania by 1% in 2040 and in Germany, Italy and Slovenia by 1% in 2050.

[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.*

> Disruption cases (S-1):

Similarly, under supply disruption cases, the project group mitigates in the same way as climatic stress demand curtailment risk in different countries by 1% depending on disruptions cases.

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):

From 2040, the projects group mitigates risk of demand curtailment in almost all European countries by 1-2%.

Sum of 2030-DE-DELTA by Country

Sum of 2040-DE-DELTA by Country

Sum of 2050-DE-DELTA by Country

Global Ambition

Sustainability

The project group contributes to sustainability by reducing hydrogen demand curtailment. With the implementation of the project group countries in the region can further cooperate avoiding demand curtailment. However, as project groups is commissioning in 2035, benefits are lower due to many other supplies routes to Slovenia and Hungary.

In disruptions cases, 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.

Security of supply

> Reference case

In the reference case, the project is not contributing to further mitigation of hydrogen demand curtailment risk in average summer and average winter. It is important to mention that the security of supply benefits of this project group could be limited due the inclusion of competing/complementary projects in the infrastructure level that will increase flows from alternative routes to Slovenia and Hungary.

> Climatic stress cases

Similarly, to reference case the project group is not further contributing to the mitigation of hydrogen demand curtailment risk.

> Disruption cases (S-1)

Under supply disruption cases, the project is contributing to further mitigation of hydrogen demand curtailment risk in different countries by 1% depending on disruptions cases.

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 2040, the projects group mitigates risk of demand curtailment in almost all European countries by 1-2%.

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	0	538.677.299	538.677.299
2030	NO DISRUPTION	GA	tonne	-5	592.910.448	592.910.454
2030	noLH2	DE	tonne	-117	540.175.890	540.176.008
2030	noLH2	GA	tonne	-52	594.817.481	594.817.533
2030	noNAh2	DE	tonne	-2	539.785.356	539.785.359
2030	noNAh2	GA	tonne	-78	594.141.433	594.141.512
2030	noNOh2	DE	tonne	16	538.877.198	538.877.182
2030	noNOh2	GA	tonne	0	593.310.994	593.310.994
2030	noUAh2	DE	tonne	0	539.378.772	539.378.772
2030	noUAh2	GA	tonne	0	593.627.618	593.627.618
2040	NO DISRUPTION	DE	tonne	11.025	392.077.044	392.066.019
2040	NO DISRUPTION	GA	tonne	0	396.523.252	396.523.252
2040	noLH2	DE	tonne	-19.881	392.213.883	392.233.764
2040	noLH2	GA	tonne	66.584	397.455.197	397.388.613
2040	noNAh2	DE	tonne	-2.466	392.188.098	392.190.564
2040	noNAh2	GA	tonne	26.108	397.301.977	397.275.869
2040	noNOh2	DE	tonne	-19.881	392.144.023	392.163.904
2040	noNOh2	GA	tonne	62.364	397.450.977	397.388.613
2040	noUAh2	DE	tonne	-7.974	392.399.183	392.407.157
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
Austria	0%	0%	-2%	-1%	-2%	-1%
Belgium	0%	0%	-2%	-1%	-1%	0%
Czechia	0%	0%	-2%	-2%	-2%	-1%
Estonia	0%	0%	-2%	-1%	-2%	-1%
Finland	0%	0%	-2%	-1%	-2%	0%
Germany	0%	0%	-2%	-2%	-1%	0%
Latvia	0%	0%	-2%	-1%	-1%	-1%
Lithuania	0%	0%	-2%	-1%	-1%	-1%
Poland	0%	0%	-2%	-1%	-1%	0%
Portugal	0%	0%	-2%	-1%	-1%	-1%
Slovenia	0%	0%	-2%	-1%	-2%	-1%
Sweden	0%	0%	-2%	-1%	-2%	0%
Switzerland	0%	0%	-2%	-1%	-1%	-1%
The Netherlands	0%	0%	-2%	-1%	-2%	0%
France	0%	0%	-2%	-1%	-2%	0%
Italy	0%	0%	-2%	-1%	-2%	0%
Denmark	0%	0%	-1%	-1%	-2%	0%
Spain	0%	0%	-1%	-1%	-2%	0%
Croatia	0%	0%	0%	0%	0%	-1%
Slovakia	0%	0%	0%	0%	-1%	-1%

Curtailment Rate (Climatic Stress):

SimulationPeriod	Country	2030-DE-DELTA	2030-GA-DELTA	2040-DE-DELTA	2040-GA-DELTA	2050-DE-DELTA	2050-GA-DELTA
Average2W	Austria	0%	0%	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	0%	0%	-1%	0%	0%	0%
Average2W	Denmark	0%	0%	0%	-1%	0%	0%
Average2W	Estonia	0%	0%	0%	0%	-1%	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	0%	0%	0%	0%	0%	0%
Average2W	Hungary	0%	0%	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%	-1%	-1%	-1%	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%	-1%	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	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%	0%	0%	0%	0%	0%
Average2WDF	Estonia	0%	0%	0%	0%	-1%	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	0%	0%	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	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%	-1%	-1%	-1%	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%	-1%	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	0%	0%	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%	-1%	0%
DC	Finland	0%	0%	0%	0%	0%	0%
DC	France	0%	0%	-1%	0%	0%	0%
DC	Germany	0%	0%	0%	0%	0%	0%
DC	Greece	0%	0%	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%	-1%	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%	-1%	0%	0%	0%
DC	Portugal	0%	0%	-1%	0%	0%	0%
DC	Romania	0%	0%	0%	0%	0%	0%
DC	Serbia	0%	0%	0%	0%	0%	0%
DC	Slovakia	0%	0%	0%	0%	0%	0%
DC	Slovenia	0%	0%	-1%	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%	-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-1356	N/A	N/A	N/A
HYD-N-1281	N/A	N/A	N/A

Potential impact	Mitigation measures	Related costs included in project CAPEX and OPEX	Additional expected costs
HYD-N-1356	N/A	N/A	N/A
HYD-N-1281	N/A	N/A	N/A

Environmental Impact explained [Promoter]

Environmental impact assessments for the Slovenian projects have not indicated any substantial and irreversible impacts on the environment. In order to ensure that environmental assessments are correct, environmental monitoring is carried out before, during and after the repurposing and construction of the infrastructure.

Environmental impact on the Hungarian side is expected only during the construction phase. Compressor 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]

Repurposing of the Slovenian part of the existing infrastructure, completed by 2029 and newly built hydrogen pipelines by 2035, will allow to transport hydrogen on the local national level from HU-SI border to SI-IT border. Repurposed part of the infrastructure will connect potential hydrogen producers with various natural gas consumers, which will be able to choose between natural gas and hydrogen. It will encourage hydrogen producers to invest in hydrogen production Infrastructure, and existing natural gas consumers to switch to domestically produced hydrogen. In Slovenia, project will be beneficial for development of hydrogen value chain even before the whole corridor will be operational in 2035.

The intention, concerning the cooperation between Slovenian and Italian TSOs with regard to the PCI hydrogen projects and the development of the North Africa & Southern Europe corridor, was agreed.

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-Western Hungary.

F. Useful links [Promoter]

Useful links:

HU/SI hydrogen corridor: FGSZ Földgázszállító Alcím dia 1

https://www.plinovodi.si/sl/prenosni-sistem/razvoj-projektov-za-prenos-vodika/