# HI EAST 11 (Less-advanced)

# H2 Interconnection Austria-Slovenia

## Reasons for grouping [ENTSOG]

The project group aims at interconnecting future hydrogen infrastructure between Austria and Slovenia and stretches in Slovenia until the border to Croatia.

The group includes investments in Austria (HYD-N-1354) and Slovenia (HYD-N-1237).

## Objective of the group [Promoter]

The objective of the concerned projects is to support the evolution to a hydrogen network and contribute to achieving the objectives of the REPowerEU plan, as well as the European Green Deal. The projects enable bidirectional hydrogen transport at the IP Murfeld in both directions (AT->SI, SI->AT). With the projects, potential hydrogen sources from the south (e.g. converted LNG Terminal in Krk or Italy) could be connected to demand centers in central Europe as well as to storage sites.
Projects will enable to transport hydrogen also on national levels and will connect national hydrogen sources with national demand centers and thus encourage domestic production of hydrogen in all involved countries and herewith increase the level of security of supply substantially. With the projects, all involved countries will gain access to European hydrogen markets, which will be beneficial from hydrogen price perspective.

# 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-1354 | SOL HYD New | New | 500 | 26.1 | |
| HYD-N-1237 | Upgrade of Murfeld/Ceršak interconnection | New | 800 | 0.2 | |
| HYD-N-1237 | M1 retrofitting | Repurposing | 500 | 58 | |
| HYD-N-1237 | CS Kidričevo, 2nd phase of upgrade | New | | | 8 |
| HYD-N-1237 | Upgrade of Rogatec interconnection | Repurposing | 800 | 3.8 | |

## Capacity increment [ENTSOG]

| TYNDP Project code | Point name | Operator | From system | To system | Capacity increment [GWh/d] | Comm. year |
|---|---|---|---|---|---|---|
| HYD-N-1354 | H2_IP_SI-AT | GAS CONNECT AUSTRIA GmbH | Transmission Slovenia (SI Hydrogen) | Transmission Austria (AT Hydrogen) | 33 | 2035 |
| HYD-N-1354 | H2_IP_SI-AT | GAS CONNECT AUSTRIA GmbH | Transmission Austria (AT Hydrogen) | Transmission Slovenia (SI Hydrogen) | 33 | 2035 |
| HYD-N-1237 | H2_IP_SI-AT | Plinovodi d.o.o. | Transmission Slovenia (SI Hydrogen) | Transmission Austria (AT Hydrogen) | 16 | 2035 |
| HYD-N-1237 | H2_IP_SI-AT | Plinovodi d.o.o. | Transmission Austria (AT Hydrogen) | Transmission Slovenia (SI Hydrogen) | 33 | 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-1354 | 73 | 25% | 3 | 50% |
| HYD-N-1237 | 144.5 | 30% | 11.2 | 30% |

### Description of the cost and range [Promoter]

During the period of preparing the project data collection for TYNDP 2022, the costs associated with HYD-N-1354 and HYD-N-1237 were in the process of being determined at the national levels as part of the national development plans. Consequently, the aforementioned costs for HYD-N-1354 and HYD-N-1237 were estimated based on the unit prices provided in the EHB study.

# C. Project Benefits [ENTSOG]

## C.1 Summary of benefits

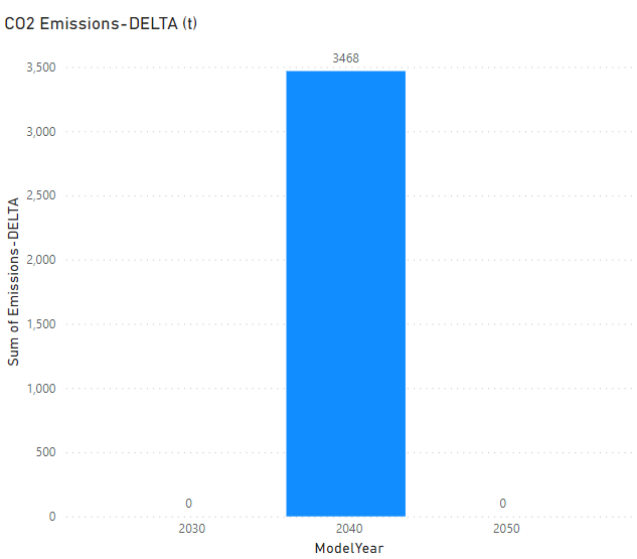
This section provides a summarised analysis by ENTSOG of the main benefits stemming from the realisation of the overall group. More details on the indicators are available in Annex D of TYNDP 2022[1].

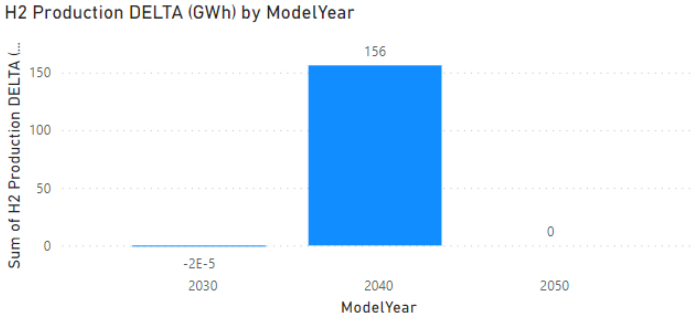
### Distributed Energy

#### Sustainability benefits

Thanks to the projects group, from 2035, the interconnection route from Austria to Slovenia allows hydrogen to flow in both directions.

In the reference case, which analyses yearly demand in two periods (average winter and average summer), the project group increases cooperation between countries and as all green hydrogen supply sources (both locally produced and imported) 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 reduces demand curtailment.



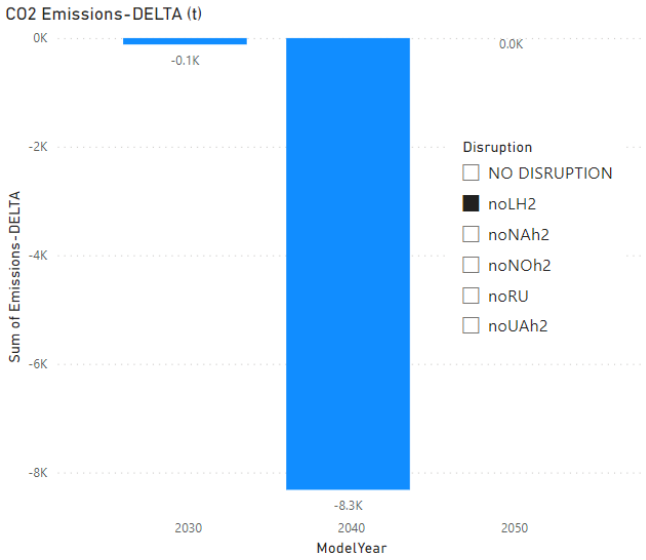



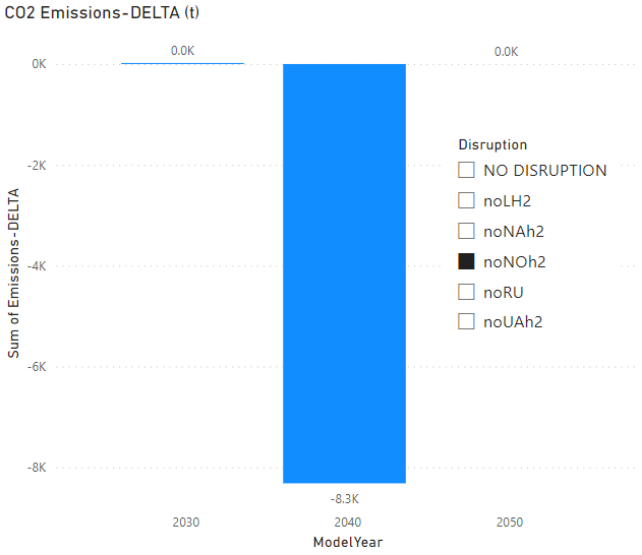

Sustainability benefits are increased under supply disruption cases, besides disruption from Ukraine, in 2040, as lower availability of hydrogen supplies will allow the project group to contribute to the reduction of CO2 emissions by using less SMR supplies.

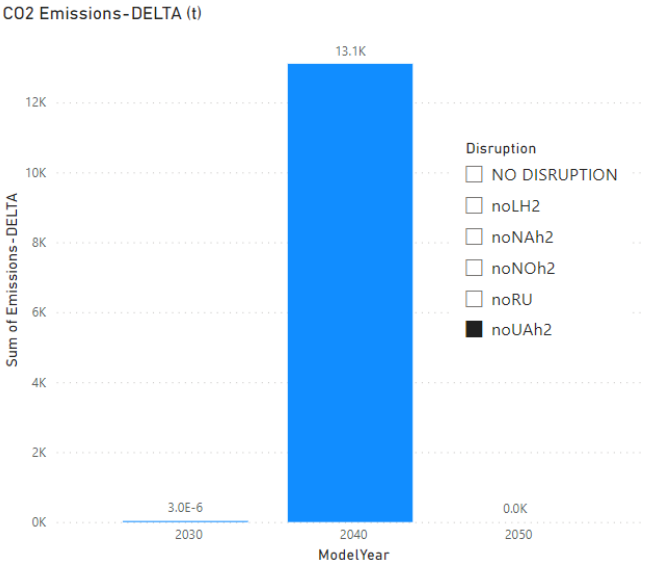
For example, it will reduced CO2 emissions by 8.3 kt in case of LH2 disruption and for Norway disruption in 2040.

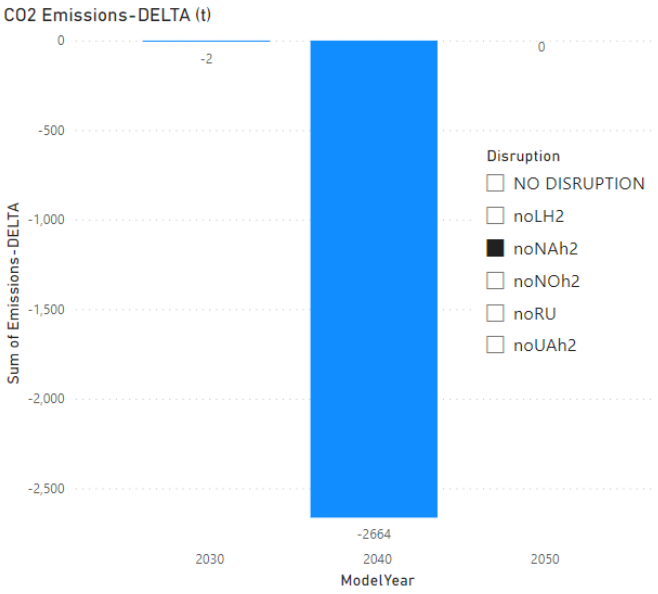
*1 noLH2 : LH2 disruption / 2 noNOh2 : Norway disruption / 3 noUAh2 : Ukraine disruption/ 4 noNAh2 : North Africa disruption*

[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 not contributing to further mitigation of hydrogen demand curtailment risk in average summer and average winter. Similar to the sustainability indicator, the benefits could be limited based on the composition of the hydrogen reference infrastructure level.

[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.*

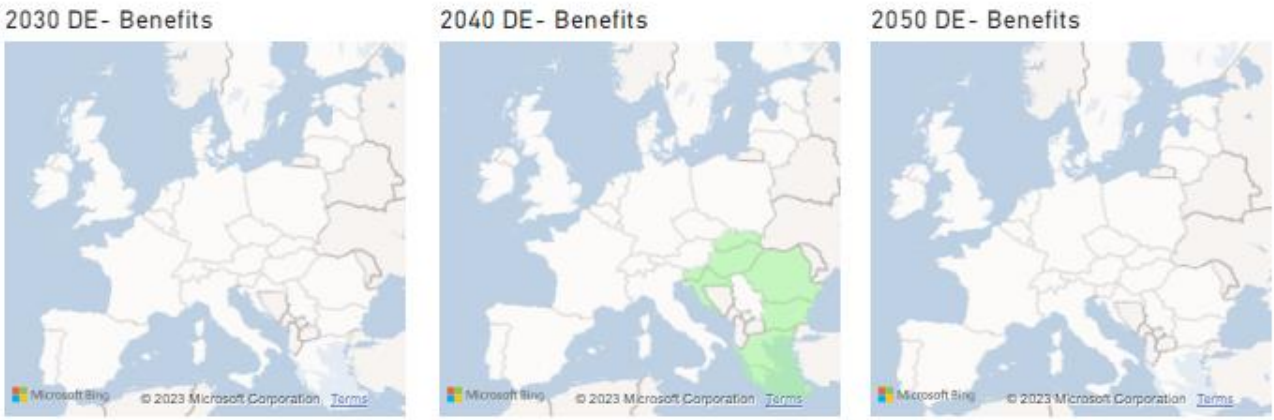

> Climatic stress cases:

Under 2 -week and 2-week dunkelflaute climatic stress case, as well as under peak day climatic case the project group the project group is not further mitigating the risk of demand curtailment. However, the same remark as in the reference case is valid.

> Disruption cases (S-1):

In case of Ukraine Hydrogen supply disruption, in average winter the project group mitigates the risk of demand curtailment in Eastern EU countries in 2040 by 2-3% for Slovenia, Croatia, Hungary, Slovakia, Romania, Bulgaria and Greece.

*noUAh2: Ukraine disruption*




> Single largest capacity disruption (SLCD):

In case of SLCD many European countries benefitting on a small extent from this project group by mitigating the risk of demand curtailment from 2040 onwards. Under SLCD the projects group mitigates

demand curtailment by 1-2% in 2040 and 2050 in the Baltic Region and other States in Central and Western Europe.

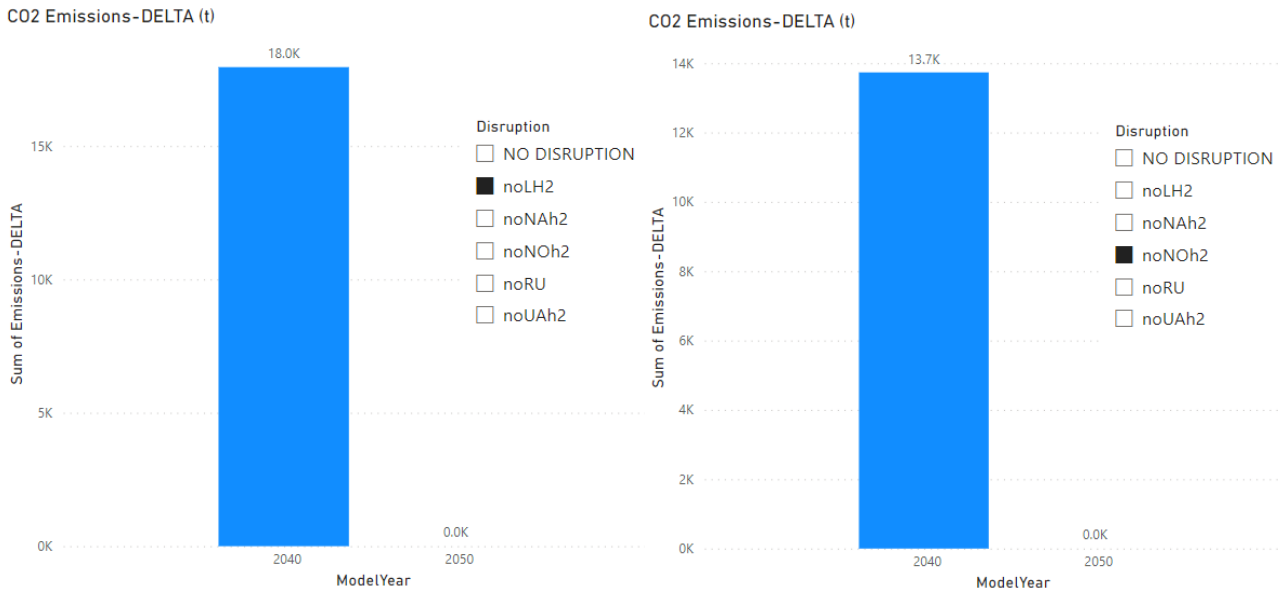
## Global Ambition

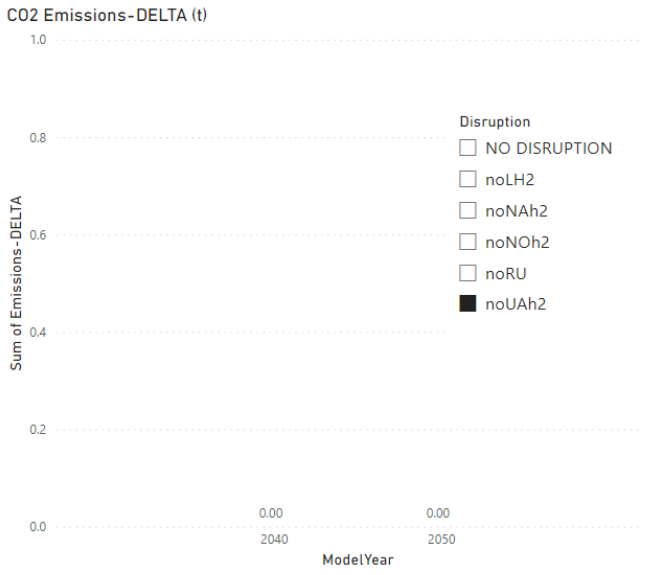
### Sustainability benefits

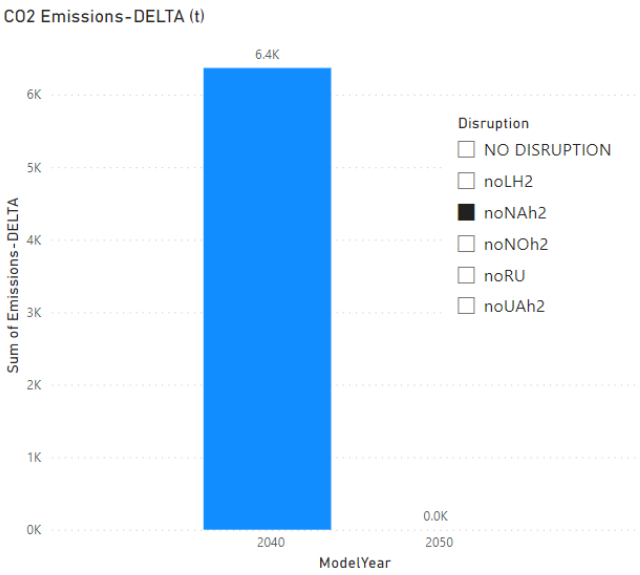
In the reference case, which analyses yearly demand in two periods (average winter and average summer), the project group increases cooperation between countries and therefore contributing to security of Supply but not further contributing to sustainability.

In case of all disruption cases and as green 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 under the respective disruption case in 2040. In case of Ukraine disruption with or without the project SMR is already used at the maximum in this region and therefore there is no Delta in CO Emissions.

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






**Security of supply:**

### > Reference case

The conversion of the existing natural gas infrastructure doesn't impact the methane demand and in the reference case, the project is not contributing to further mitigation of hydrogen demand curtailment risk in average summer and average winter. The benefits could be limited based on the composition of the hydrogen reference infrastructure level.



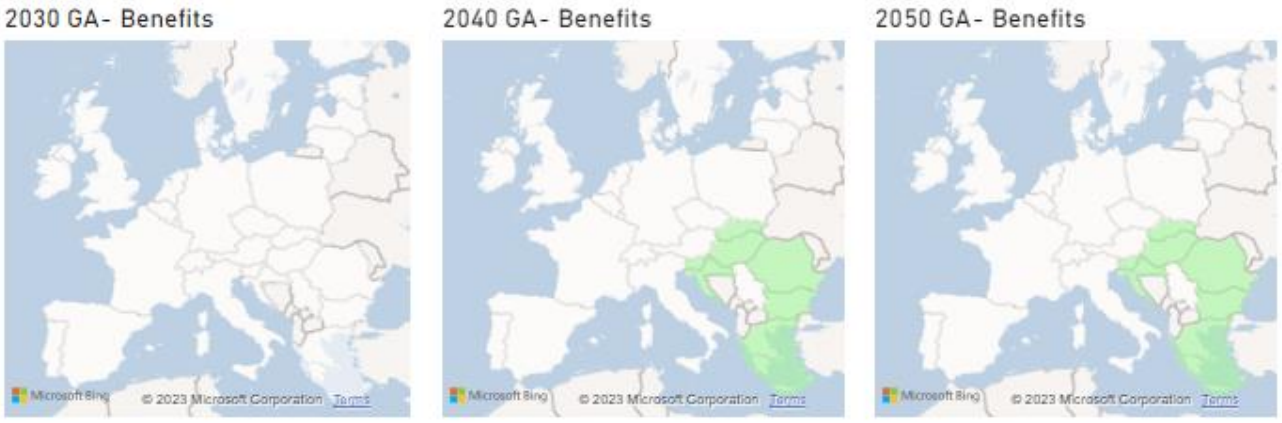

### > Climatic stress cases

Under 2-week and 2-week dunkelflaute climatic stress case, as well as under peak day climatic case the project group the project group is not further mitigating the risk of demand curtailment. Similar to the reference case the benefits could be limited based on the composition of the hydrogen reference infrastructure level.

### > Disruption cases (S-1)

In case of Ukraine Hydrogen supply disruption, in average winter the project group mitigates the risk of demand curtailment in Eastern EU countries from 2040 onwards by 4-5% for Slovenia, Croatia, Hungary, Slovakia, Romania, Bulgaria and Greece.

*noUAh2: Ukraine disruption*




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

In case of SLCD many European countries benefitting on a small extent from this project group by mitigating the risk of demand curtailment by 1-2% in 2040. In 2050 under SLCD the projects group mitigates demand curtailment by 1-2% in Lithuania, Slovenia, Croatia and Bulgaria.

## 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 |
|---|---|---|---|---|---|---|
| 2040 | NO DISRUPTION | DE | tonne | 3.468 | 392.077.044 | 392.073.576 |
| 2040 | NO DISRUPTION | GA | tonne | 0 | 396.523.252 | 396.523.252 |
| 2040 | noLH2 | DE | tonne | -8.319 | 392.213.883 | 392.222.202 |
| 2040 | noLH2 | GA | tonne | 17.953 | 397.455.197 | 397.437.244 |
| 2040 | noNAh2 | DE | tonne | -2.664 | 392.188.098 | 392.190.762 |
| 2040 | noNAh2 | GA | tonne | 6.368 | 397.301.977 | 397.295.609 |
| 2040 | noNOh2 | DE | tonne | -8.319 | 392.144.023 | 392.152.341 |
| 2040 | noNOh2 | GA | tonne | 13.733 | 397.450.977 | 397.437.244 |
| 2040 | noUAh2 | DE | tonne | 13.104 | 392.399.183 | 392.386.079 |
| 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 | 2040-DE-DELTA | 2040-GA-DELTA | 2050-DE-DELTA | 2050-GA-DELTA |
|---|---|---|---|---|
| Belgium | -2% | -1% | -1% | 0% |
| Czechia | -2% | -2% | -2% | 0% |
| Estonia | -2% | -1% | -2% | 0% |
| Finland | -2% | -1% | -2% | 0% |
| Germany | -2% | -1% | -1% | 0% |
| Latvia | -2% | -1% | -1% | 0% |
| Lithuania | -2% | -1% | -1% | -1% |

| | | | | |
|---|---|---|---|---|
| Poland | -2% | -1% | -1% | 0% |
| Portugal | -2% | -1% | 0% | 0% |
| Sweden | -2% | -1% | -2% | 0% |
| France | -2% | -1% | -1% | 0% |
| Slovenia | -2% | -1% | -1% | -2% |
| The Netherlands | -1% | -1% | -2% | 0% |
| Austria | -1% | -1% | -2% | 0% |
| Denmark | -1% | -1% | -1% | 0% |
| Italy | -1% | -1% | -2% | 0% |
| Spain | -1% | -1% | -1% | 0% |
| Switzerland | -1% | -1% | -1% | 0% |
| Greece | -1% | 0% | 0% | 0% |
| Bulgaria | 0% | 0% | 0% | -1% |
| Croatia | 0% | 0% | 0% | -1% |
| Slovakia | 0% | 0% | 0% | -1% |

**Curtailment rate (Climatic Stress):**

| SimulationPeriod | Country | 2040-DE-DELTA | 2040-GA-DELTA | 2050-DE-DELTA | 2050-GA-DELTA |
|---|---|---|---|---|---|
| Average2W | Austria | 0% | 0% | 0% | 0% |
| Average2W | Belgium | 0% | 0% | 0% | 0% |
| Average2W | Bulgaria | 0% | -1% | 0% | 0% |
| Average2W | Croatia | 0% | 0% | 0% | 0% |
| Average2W | Cyprus | 0% | 0% | 0% | 0% |
| Average2W | Czechia | 0% | 0% | 0% | 0% |
| Average2W | Denmark | 0% | -1% | 0% | 0% |
| Average2W | Estonia | 0% | 0% | 0% | 0% |
| Average2W | Finland | 0% | 0% | 0% | 0% |
| Average2W | France | 0% | 0% | 0% | 0% |
| Average2W | Germany | 0% | 0% | 0% | 0% |
| Average2W | Greece | 0% | 0% | 0% | 0% |
| Average2W | Hungary | 0% | 0% | 0% | 0% |
| Average2W | Ireland | 0% | 0% | 0% | 0% |
| Average2W | Italy | 0% | 0% | 0% | 0% |
| Average2W | Latvia | 0% | 0% | 0% | 0% |
| Average2W | Lithuania | 0% | 0% | 0% | 0% |
| Average2W | Luxembourg | 0% | 0% | 0% | 0% |
| Average2W | Malta | 0% | 0% | 0% | 0% |
| Average2W | Poland | 0% | 0% | 0% | 0% |
| Average2W | Portugal | 0% | 0% | 0% | 0% |
| Average2W | Romania | 0% | 0% | 0% | 0% |
| Average2W | Serbia | 0% | 0% | 0% | 0% |
| Average2W | Slovakia | 0% | 0% | 0% | 0% |
| Average2W | Slovenia | 0% | -1% | 0% | 0% |

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

| | | | | | |
|---|---|---|---|---|---|
| DC | Germany | 0% | 0% | 0% | 0% |
| DC | Greece | 0% | 0% | 0% | 0% |
| DC | Hungary | 0% | 0% | 0% | 0% |
| DC | Ireland | 0% | 0% | 0% | 0% |
| DC | Italy | 0% | 0% | 0% | 0% |
| DC | Latvia | 0% | 0% | 0% | 0% |
| DC | Lithuania | 0% | 0% | 0% | 0% |
| DC | Luxembourg | 0% | 0% | 0% | 0% |
| DC | Malta | 0% | 0% | 0% | 0% |
| DC | Poland | 0% | 0% | 0% | 0% |
| DC | Portugal | 0% | 0% | 0% | 0% |
| DC | Romania | 0% | 0% | 0% | 0% |
| DC | Serbia | 0% | 0% | 0% | 0% |
| DC | Slovakia | 0% | 0% | 0% | 0% |
| DC | Slovenia | 0% | 0% | 0% | 0% |
| DC | Spain | 0% | 0% | 0% | 0% |
| DC | Sweden | 0% | 0% | 0% | 0% |
| DC | Switzerland | 0% | 0% | 0% | 0% |
| DC | The Netherlands | 0% | 0% | 0% | 0% |
| DC | United Kingdom | 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-1354 | N/A | N/A | N/A |
| HYD-N-1237 | N/A | N/A | N/A |

| Potential impact | Mitigation measures | Related costs included in project CAPEX and OPEX | Additional expected costs |
|---|---|---|---|
| HYD-N-1354 | N/A | N/A | N/A |
| HYD-N-1237 | N/A | N/A | N/A |

**Environmental Impact explained** [Promoter]

Environmental impact assessments for the 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.

## 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 will be completed by 2029 and will allow to transport hydrogen on the local national level. 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.

## F. Useful links [Promoter]

### Useful links:

https://h2backbone-murfeld.at/

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