HI EAST 16 (Less-advanced)

South Kavala H2 UGS

Reasons for grouping [ENTSOG]

The project group is composed of the underground storage in South Kavala (Greece) together with the connection to the hydrogen transmission system with a metering and regulation station. This project will enable storage of hydrogen in Greece by 2029 (HYD-N-385 and HYD-N-1092).

Objective of the group [Promoter]

The project group will increase flexibility of hydrogen supplies. The underground storage will allow hydrogen to be stored during low demand periods, for climatic stresses or international supply disruptions.

HYD-N-385 **South Kavala Underground Gas Storage facility**

Comm. Year **2029**

HYD-N-1092 **Metering and Regulating Station at UGS South Kavala**

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-385	35	35	NA	NA

Capacity increment [ENTSOG]

TYNDP Project code	Point name	Operator	From system	To system	Capacity increment [GWh/d]	Comm. year
HYD-N-385; HYD-N-1092	STcGRh2	Hellenic Republic Asset Management Fund	Transmission Greece (GR Hydrogen)	Storage Greece (GR Hydrogen)	35	2029
HYD-N-385; HYD-N-1092	STcGRh2	Hellenic Republic Asset Management Fund	Storage Greece (GR Hydrogen))	Transmission Greece (GR Hydrogen)	35	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-385	361	100%	7,1	100%
HYD-N-1092	7.5	25%	0,4	25%

Description of the cost and range [Promoter]

Costs are representative of the best estimations of the promoters at the time of the data collection for the TYNDP 2022.

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].

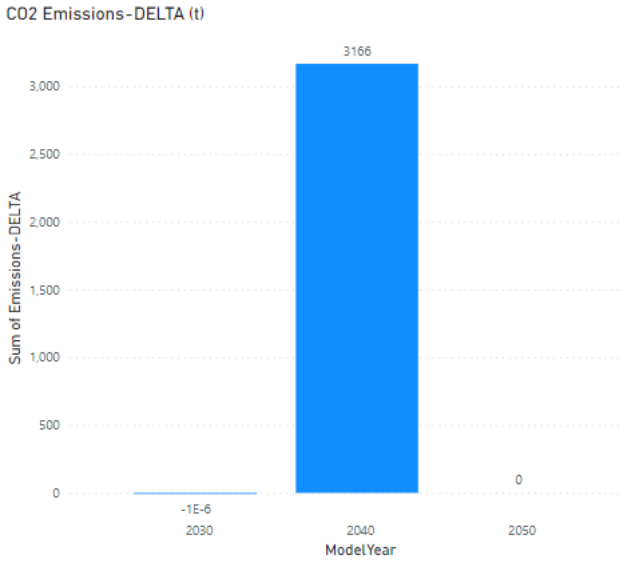
[1] https://www.entsog.eu/sites/default/files/2023-04/ENTSOG_TYNDP_2022_Annex_D_Methodology_230411.pdf

Distributed Energy

In 2029, the new storage in Greece allows hydrogen to be stored, during low demand period, for climatic stresses or international disruption.

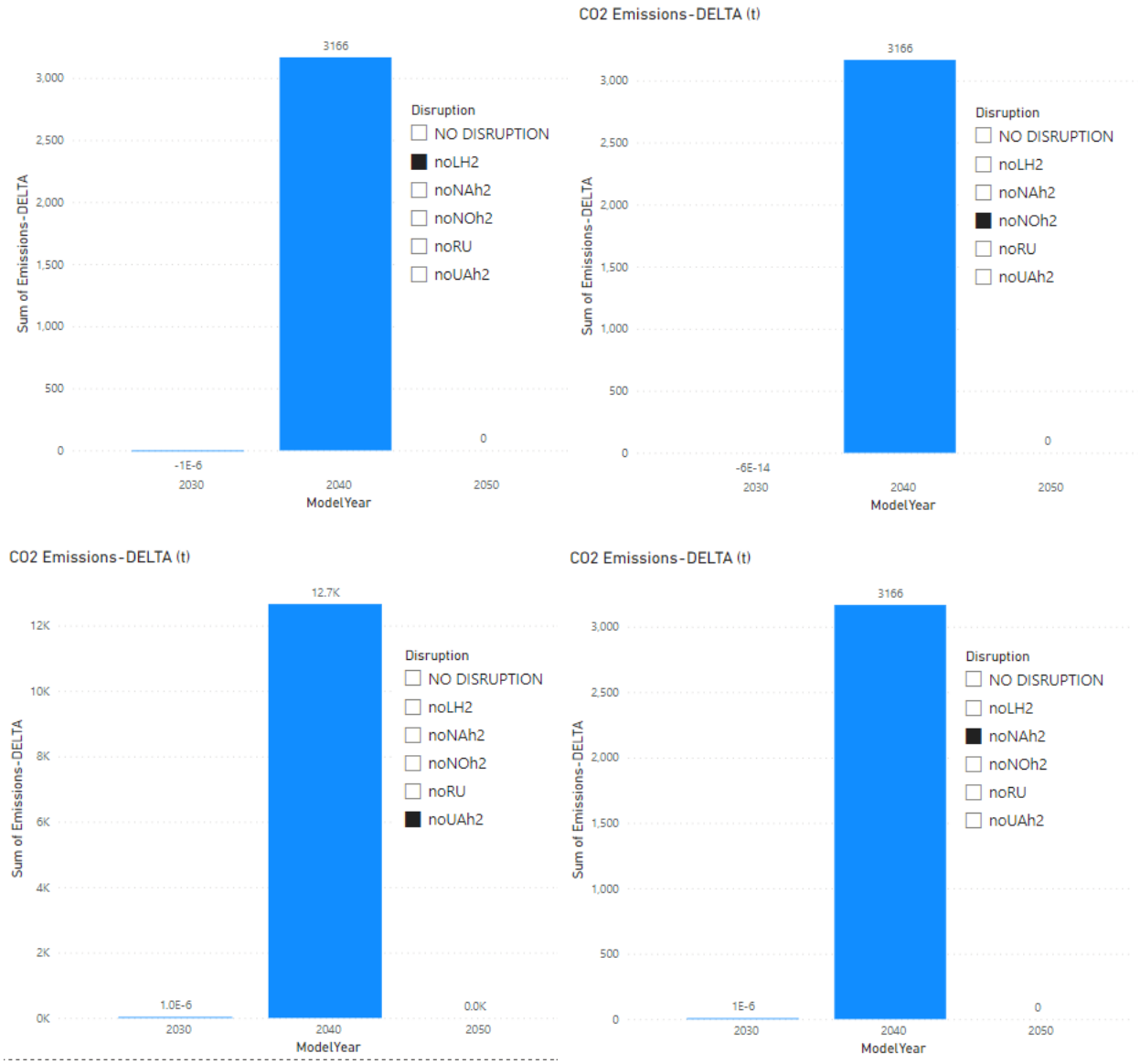
Sustainability benefits

The project group, will increase flexibility of hydrogen supplies, allowing for the replacement of blue hydrogen supplies, with green hydrogen supplies. Indeed, in 2040 the storage will allow green hydrogen to be stored replacing use of SMRs supplies.



Similar effects but on a higher scale are expected under any supply disruption cases, up to 12,9 kt in Ukrainian disruption case.

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



Security of Supply:[2]

> Reference case:

The project group mitigates the risk of hydrogen demand curtailment In Greece and Bulgaria by 5-6% in 2040. In 2050 benefits are also expected in Slovakia, Hungary Croatia and Romania

[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, more benefits are expected to mitigate demand curtailment in Hungary, Romania, Bulgaria and Greece from 2030 by 7-8%.

> Disruption cases (S-1):

Similarly, under supply disruption cases, the project group shows benefits for mitigating the risk of demand curtailment mainly in Greece but also, in Slovakia, Hungary, Croatia, Romania and Bulagaria

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

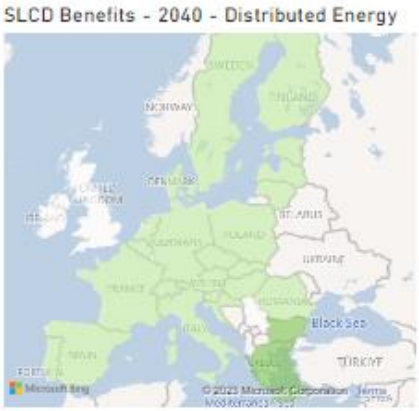
2 noNOh2: Norway disruption

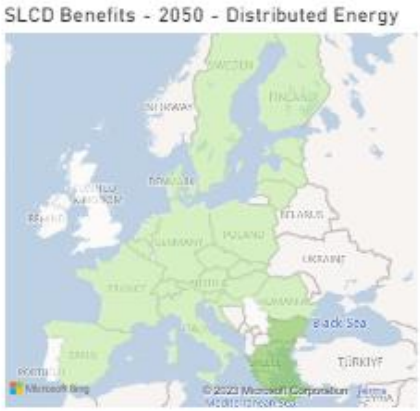
3 noUAh2: Ukraine disruption

4 noNAh2: North Africa disruption

> Single largest capacity disruption (SLCD):

In 2040 Romania, Bulgaria and Greece, the storages can mitigate the risk of demand curtailment by 8-14% and in other European countries by 1-2%. Similar benefits are expected also in 2050.

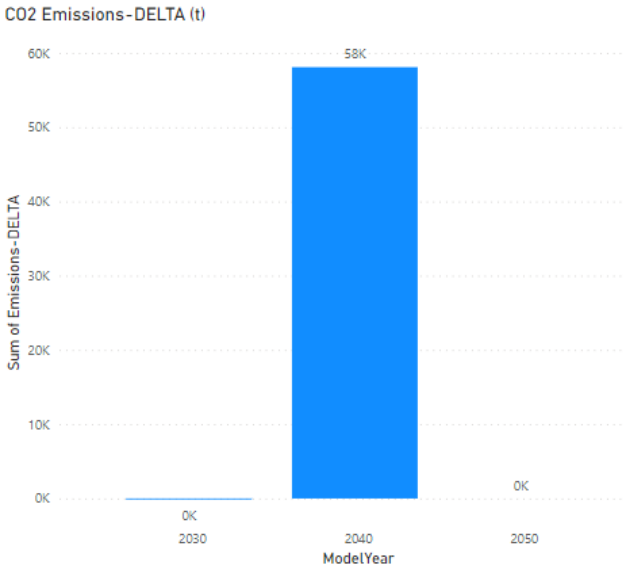


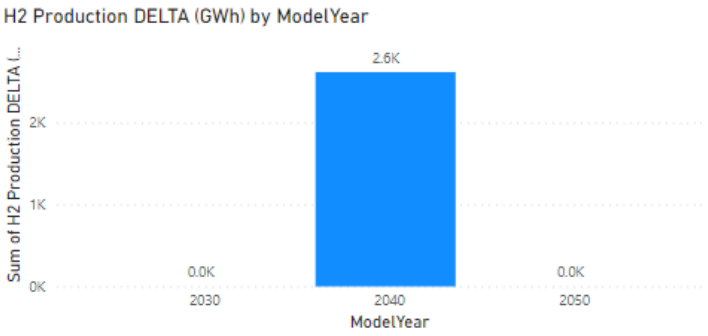


Global Ambition

Sustainability benefits

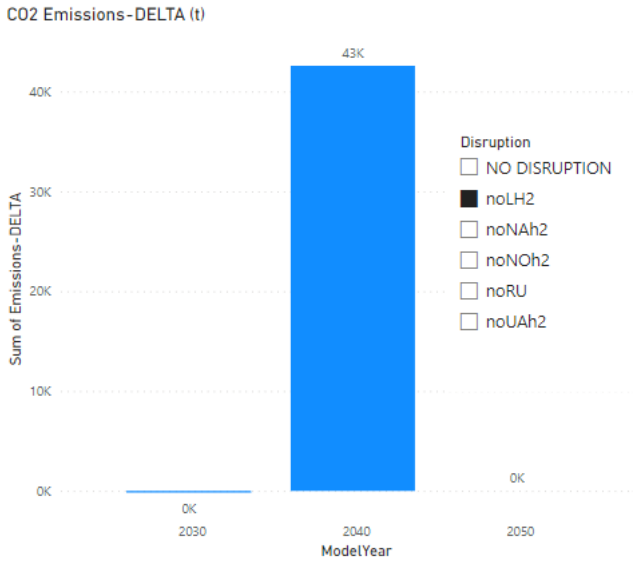
The project group will increase flexibility of hydrogen supplies, allowing for the replacement of blue hydrogen supplies, with green hydrogen supplies. Indeed, in 2040 the storage will allow green hydrogen to be stored replacing use of SMRs supplies and will reduce emissions by 58 kt.

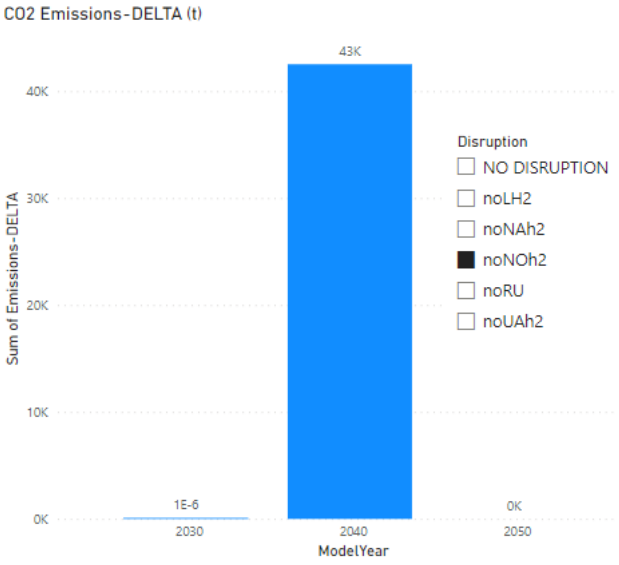


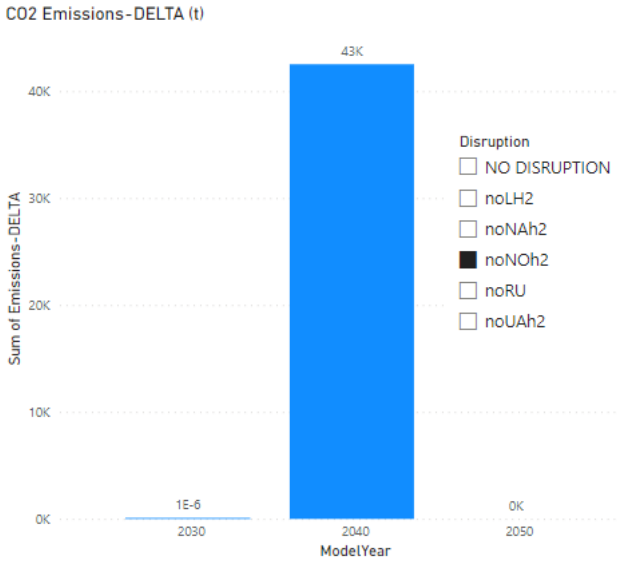


Similar effects but on a lower scale are expected under supply disruption cases such as LH2, Norway or North Africa disruption.

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



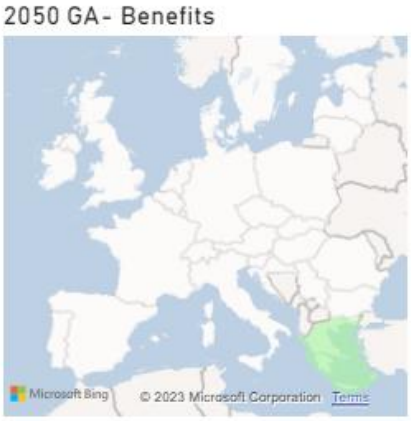




Security of supply:

> Reference case

The project group mitigates the risk of hydrogen demand curtailment by 4% in 2040 and by 3% in 2050.



> Climatic stress cases

Under 2 -week and 2-week dunkelflaute climatic stress case, as well as under peak day climatic case the project group, more benefits are expected to mitigate demand curtailment in Hungary, Romania, Bulgaria and Greece in 2030 by 5-6%.

> Disruption cases (S-1)

Under supply disruption cases, the project group shows benefits for mitigating the risk of demand curtailment in Greece up to 5%.

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

1 noLH2: LH2 disruption

2 noNOh2: Norway disruption

3 noNAh2: North Africa disruption

> Single largest capacity disruption (SLCD):

In 2040 Romania, Bulgaria and Greece, the storages can mitigate the risk of demand curtailment by 6-11% and in other 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	Emissions-DELTA	Emissions-PLUS	Emissions-MINUS
2030	NO DISRUPTION	DE	tonne	0,00	538677299	538677299
2030	noLH2	DE	tonne	0,00	540175890,2	540175890,2
2030	noNAh2	DE	tonne	0,00	539785356,1	539785356,1
2030	noNOh2	DE	tonne	0,00	538877197,8	538877197,8
2030	noUAh2	DE	tonne	0,00	539378771,9	539378771,9
2030	NO DISRUPTION	GA	tonne	-5,21	592910448,4	592910453,7
2030	noLH2	GA	tonne	-163,10	594817481,2	594817644,3
2030	noNAh2	GA	tonne	-2,40	594141433,2	594141435,6
2030	noNOh2	GA	tonne	0,00	593310994,3	593310994,3
2030	noUAh2	GA	tonne	0,00	593627617,9	593627617,9
2040	NO DISRUPTION	DE	tonne	3165,68	392077044	392073878,3
2040	noLH2	DE	tonne	3165,68	392213883,4	392210717,7
2040	noNAh2	DE	tonne	3165,68	392188097,7	392184932
2040	noNOh2	DE	tonne	3165,68	392144022,6	392140856,9
2040	noUAh2	DE	tonne	12655,93	392399182,9	392386527
2040	NO DISRUPTION	GA	tonne	58094,72	396523251,6	396465156,9
2040	noLH2	GA	tonne	42581,67	397455196,7	397412615,1
2040	noNAh2	GA	tonne	38294,42	397301976,6	397263682,2
2040	noNOh2	GA	tonne	42522,67	397450977,1	397408454,5
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
Greece	-28%	-29%	-14%	-11%	-8%	-6%
Bulgaria	-15%	-23%	-8%	-7%	-7%	-4%
Croatia	0%	0%	-3%	-2%	-2%	0%
Slovakia	0%	-1%	-3%	-2%	-2%	-1%
Hungary	-6%	-8%	-3%	-2%	-3%	0%
Belgium	0%	-1%	-2%	-1%	-1%	0%
Czechia	-1%	-1%	-2%	-2%	-2%	0%
Estonia	-1%	-1%	-2%	-1%	-2%	0%
Finland	-1%	-1%	-2%	-1%	-2%	0%
Germany	0%	-1%	-2%	-1%	-1%	0%
Latvia	-1%	-1%	-2%	-1%	-1%	0%
Lithuania	0%	-1%	-2%	-1%	-1%	-1%
Poland	0%	-1%	-2%	-1%	-1%	0%
Portugal	0%	-1%	-2%	-1%	0%	0%
Romania	-8%	-7%	-2%	-3%	-2%	-2%
Slovenia	0%	0%	-2%	-1%	-1%	0%
Sweden	-1%	-1%	-2%	-1%	-2%	0%
Switzerland	0%	0%	-2%	-1%	-1%	0%
France	0%	-1%	-2%	-1%	-1%	0%
The Netherlands	0%	0%	-1%	-1%	-2%	0%
Austria	-1%	-1%	-1%	-1%	-2%	0%
Denmark	0%	-1%	-1%	-1%	-1%	0%
Italy	0%	0%	-1%	-1%	-2%	0%
Spain	0%	-1%	-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%	-1%	0%	-1%	0%	0%
Average2W	Belgium	0%	0%	0%	-1%	0%	0%
Average2W	Bulgaria	-8%	-6%	-7%	-1%	-2%	0%
Average2W	Croatia	0%	0%	0%	-1%	-3%	0%
Average2W	Cyprus	0%	0%	0%	0%	0%	0%
Average2W	Czechia	0%	-1%	0%	-1%	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%	-1%	0%	0%
Average2W	Germany	0%	-1%	0%	0%	0%	0%
Average2W	Greece	-8%	-6%	-8%	0%	-2%	-6%
Average2W	Hungary	-7%	-6%	0%	0%	-3%	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%	-1%	0%	0%
Average2W	Romania	-8%	-5%	0%	-1%	-3%	0%
Average2W	Serbia	0%	0%	0%	0%	0%	0%
Average2W	Slovakia	0%	-1%	0%	-1%	-2%	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%	-1%	0%	0%
Average2W	United Kingdom	0%	0%	0%	0%	0%	0%
Average2WDF	Austria	0%	-1%	-1%	-1%	0%	0%
Average2WDF	Belgium	0%	0%	0%	-1%	0%	0%
Average2WDF	Bulgaria	-8%	-6%	-7%	-1%	-2%	0%
Average2WDF	Croatia	0%	0%	0%	0%	-2%	0%
Average2WDF	Cyprus	0%	0%	0%	0%	0%	0%
Average2WDF	Czechia	0%	-1%	0%	-1%	0%	0%
Average2WDF	Denmark	0%	-1%	0%	-1%	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%	-1%	0%	0%	0%	0%
Average2WDF	Greece	-8%	-6%	-8%	-1%	-3%	-6%
Average2WDF	Hungary	-7%	-6%	0%	0%	-2%	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	-8%	-5%	0%	0%	-3%	0%
Average2WDF	Serbia	0%	0%	0%	0%	0%	0%
Average2WDF	Slovakia	0%	-1%	0%	0%	-2%	0%
Average2WDF	Slovenia	0%	0%	0%	-1%	0%	0%
Average2WDF	Spain	0%	0%	0%	-1%	0%	0%
Average2WDF	Sweden	0%	-1%	0%	-1%	0%	0%
Average2WDF	Switzerland	0%	0%	0%	0%	0%	-1%
Average2WDF	The Netherlands	0%	0%	0%	-1%	0%	0%
Average2WDF	United Kingdom	0%	0%	0%	0%	0%	0%
DC	Austria	0%	-1%	0%	0%	0%	0%
DC	Belgium	0%	0%	0%	0%	0%	0%

DC	Bulgaria	-8%	-8%	-5%	0%	-2%	0%
DC	Croatia	0%	0%	-1%	0%	-2%	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%	-1%	0%	0%	0%
DC	Germany	0%	0%	0%	-1%	0%	0%
DC	Greece	-8%	-8%	-5%	-1%	-3%	-6%
DC	Hungary	-6%	-7%	-1%	0%	-2%	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%	-1%	0%	0%	0%
DC	Romania	-6%	-7%	-1%	0%	-2%	0%
DC	Serbia	0%	0%	0%	0%	0%	0%
DC	Slovakia	0%	0%	-1%	0%	-2%	0%
DC	Slovenia	0%	0%	-1%	0%	0%	0%
DC	Spain	0%	-1%	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
UGS-N-0385	Underground storage		
HYD-N-1092	Above Ground Installation	Approximately 10,000 m2	Protected areas are not affected

Potential impact	Mitigation measures	Related costs included in project CAPEX and OPEX	Additional expected costs
HYD-N-1092 ：No significant adverse impacts	To be determined during the Environmental Impact Assessment based on final project's specifications		

Environmental Impact explained [Promoter]
Metering and Regulating Stations do not induce adverse impacts to the environment (natural and anthropogenic). Smart design and mitigation measures that will be determined in the Environmental Impact Assessment ensure limited, if any, impacts of low intensity and within legislative and regulatory framework.

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]

F. Useful links [Promoter]

Useful links:

Network Development Plan: NNGS DEVELOPMENT PLAN 2021-2030 (desfa.gr)