ROMANIA

# Opportunities for **Hydrogen Energy Technologies** Considering the National Energy & Climate Plans

H2

FCH
FUEL CELLS AND HYDROGEN JOINT UNDERTAKING

Contract details
Fuel Cells and Hydrogen 2 Joint Undertaking (FCH 2 JU)
Study on Opportunities arising from the inclusion of Hydrogen
Energy Technologies in the National Energy & Climate Plans
(Ref. FCH / OP / Contract 234)
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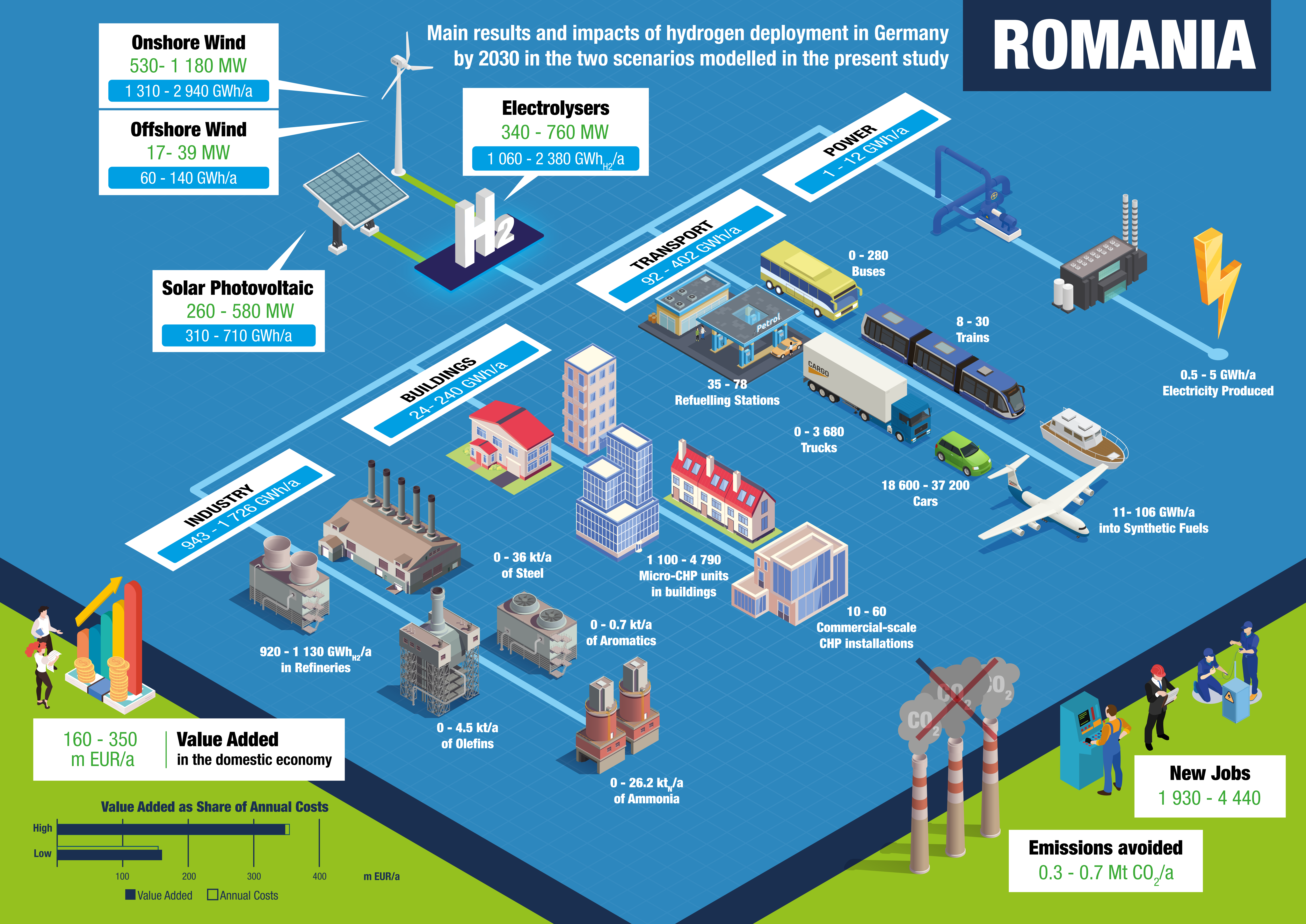
# Introduction

The **Fuel Cells and Hydrogen Joint Undertaking** (FCH JU), in close cooperation with the **European Commission - DG Energy**, has commissioned a study on the "Role of Hydrogen in the National Energy and Climate Plans". This study is being conducted by the consultancies **Trinomics and LBST**.

This fiche represents one of the outputs of the study; it comprises two major parts:
- Analysis of **national opportunities for hydrogen deployment**, based on the national hydrogen production and demand potential, the gas infrastructure and the enabling environment. In this context, the role of hydrogen in the current National Energy and Climate Plan is in particular analysed.
- Assessment of **national economic, environmental and technical impacts of hydrogen deployment** under a high and a low scenario.

This information is expected to provide useful information to EU Member States that are considering to include renewable or low-carbon hydrogen deployment in their decarbonisation policies or roadmaps.



ROMANIA
Main results and impacts of hydrogen deployment in Germany by 2030 in the two scenarios modelled in the present study
Onshore Wind
530- 1 180 MW
1 310 - 2 940 GWh/a
Offshore Wind
17- 39 MW
60 - 140 GWh/a
Electrolysers
340 - 760 MW
1 060 - 2 380 $GWh_{H2}$/a
Solar Photovoltaic
260 - 580 MW
310 - 710 GWh/a
$H_2$
POWER
1 - 12 GWh/a
TRANSPORT
92 - 402 GWh/a
BUILDINGS
24- 240 GWh/a
INDUSTRY
943 - 1 726 GWh/a
0 - 280
Buses
8 - 30
Trains
35 - 78
Refuelling Stations
Petrol
CARGO
0 - 3 680
Trucks
18 600 - 37 200
Cars
11- 106 GWh/a
into Synthetic Fuels
0.5 - 5 GWh/a
Electricity Produced
0 - 36 kt/a
of Steel
1 100 - 4 790
Micro-CHP units
in buildings
10 - 60
Commercial-scale
CHP installations
920 - 1 130 $GWh_{H2}$/a
in Refineries
0 - 0.7 kt/a
of Aromatics
0 - 4.5 kt/a
of Olefins
0 - 26.2 $kt_N$/a
of Ammonia
$CO_2$
$CO_2$
$CO_2$
160 - 350
m EUR/a
Value Added
in the domestic economy
Value Added as Share of Annual Costs
High
Low
100
200
300
400
m EUR/a
Value Added
Annual Costs
New Jobs
1 930 - 4 440
Emissions avoided
0.3 - 0.7 Mt $CO_2$/a

# EXECUTIVE SUMMARY

## Romania's commitment for hydrogen deployment according to its NECP

According to its NECP, Romania considers hydrogen deployment mainly in the transport, gas and power sectors. Romania has an enabling environment to address the deployment of renewable hydrogen, given its national organizations active in this domain (e.g. Romanian Association for Hydrogen Energy[1]), its gas TSO (SNTDGN Transgaz s.a.) committed to use the existing natural gas transport infrastructure also for hydrogen, its national research activities and involvement in the Green Hydrogen @ Blue Danube[2], Zero-emission Urban Delivery @ Rainbow UnHycorn[3] and H2GO[4] potential IPCEI projects[4]. Romania was also involved in the HyLaw[5] project, that identified and assessed major regulatory barriers, in view of prioritizing measures to address them.

Romania seems to consider hydrogen applications as a long-term perspective. Its NECP does not include specific objectives or targets for the production or use of hydrogen, nor hydrogen specific policies and measures.

In May 2019, Romania hosted the International Conference on Hydrogen Production[6], "providing a forum to exchange on the latest technological advances, to disseminate new research developments in the areas of hydrogen production and use, and to debate on the future directions and priorities for the deployment of a hydrogen economy for a sustainable future".

## The scenario assessment shows substantial potential benefits of hydrogen deployment in Romania by 2030

### Hydrogen demand

Two (high and low) scenarios of hydrogen demand in 2020-2030 were developed, based on different levels of ambition linked to the national context. The resulting values are summarised in the scheme in the previous page. For Romania, a limited development of hydrogen demand is assumed in the considered scenarios in **transport**, especially for passenger cars and trains, and also in aviation (through hydrogen-based liquid fuels or PtL) and navigation[7]. A limited development of hydrogen demand is also assumed in the scenarios in **industry**, especially in the ammonia, refinery, olefin and aromatics industries. These industries use fossil-based hydrogen as feedstock or reducing agent, which could be replaced by renewable hydrogen. Switching high temperature heat processes fuels to renewable hydrogen could represent another important potential use in the considered scenarios.

In the **building** sector, hydrogen can replace part of the current use of natural gas and can be distributed via existing gas grids through admixture to natural gas. The building sector is expected to have in the Low scenario a limited demand of hydrogen by 2030 but would have a stronger demand in the High scenario.

The scenarios assume only a marginal use of hydrogen for electricity generation by 2030, mainly in combined heat and power installations.

### Hydrogen production

To cover the estimated hydrogen demand from new uses and from substitution of fossil-based hydrogen, 0.8 to 1.8 GW of dedicated renewable electricity sources would have to be installed to produce green hydrogen via electrolysis. While "surplus" electricity might be available in times of high renewable electricity production, the main share will have to be covered by dedicated sources. In the two scenarios, part of the 2030 hydrogen demand would still be covered by fossil-based hydrogen produced via steam-methane reforming using fossil fuels.

In its draft NECP, Romania estimates the production of 16 TWh of variable renewable electricity in 2030. The technical potential for renewable electricity production in Romania seems however significantly higher[8]. Building additional renewable electricity capacity dedicated for hydrogen production thus could be a feasible scenario.

### Estimated socio-economic and environmental impacts

The annual costs to produce green hydrogen (including the cost of dedicated renewable electricity sources), to develop the transport infrastructure (or adapt the existing one) and end-user applications would in the considered scenarios reach respectively 155 and 355 million EUR. These activities will generate value added in the domestic economy, amongst others by creating jobs in manufacturing, construction and operation of hydrogen technologies and will contribute to greenhouse gas emission reductions. This is in particular important in hard-to-decarbonize industries. According to the European EUCO3232.5 scenario[9], the Romanian GHG emissions should be reduced by 28 Mt $CO_2$ in 2030, compared to 2015. In the scenarios considered, the deployment of hydrogen could contribute 0.3 – 0.7 Mt $CO_2$ to this goal, which is equivalent to 1.1% - 2.5% of the required emission reduction.

1 *www.h2romania.ro or https://www.icsi.ro/h2romania/*
2 *https://static1.squarespace.com/static/5d3f0387728026000121b2a2/t/5d9b5e81e73c03421d1dd837/1570463369453/Green+HH2+Blue+Danube+poster_print.pdf*
3 *https://static1.squarespace.com/static/5d3f0387728026000121b2a2/t/5d9b5ee7f5229f74dc24aa73/1570463472420/Rainbow+Unicorn+poster_print.pdf*
4 *https://www.hydrogen4climateaction.eu/projects*
5 *https://www.hylaw.eu/sites/default/files/2018-10/National%20Policy%20Paper%20-%20Denmark%20%28EN%29.pdf*
6 *http://www.icsi.ro/ICH2P2019/*
7 *Detailed assumptions are available in the methodology annex of the report, that can be consulted via the following link : http://trinomics.eu/project/opportunities-for-hydrogen-in-necps.*
8 *The technical potential for renewable electricity production is based on the study commissioned by DG ENER Impact of the use of the biomethane and hydrogen potential on trans-European infrastructure (Trinomics, LBST, E3M; 2019).*
9 *EC, 2019. Technical Note on Results of the EUCO3232.5 scenario on Member States. Available at https://ec.europa.eu/energy/sites/ener/files/technical_note_on_the_euco3232_final_14062019.pdf*

# HYDROGEN IN THE NECP OF ROMANIA

According to its NECP, Romania will assess in 2021-2022 the ability of using its existing natural gas infrastructure to transport and distribute hydrogen and synthetic methane. The 'excessive' electricity supply from variable renewable energy sources could be converted into renewable hydrogen and transported to end-users or stored. The injection of hydrogen into the existing grid can optimise the gas infrastructure use on the long-term by extending its operation (closer to the technical lifetime), as natural gas consumption may decrease in the future.

Romania has implemented policy measures to support the demand for environmentally friendly vehicles and the use of ecological fuels, such as the application of a tax reduction for low carbon vehicles (including vehicles fuelled with hydrogen).

According to Romania's draft NECP, the National Hydrogen and Fuel Cell Center (CNHPC[10]) coordinates the research activities in the field of generation, storage and use of hydrogen and fuel cell applications, focusing on:

- gas-to-power (conversion of hydrogen into electricity);
- solutions for the storage of energy including hybrid applications (e.g. lithium-ion program);
- power-to-gas plants;
- development of "clean" engines for mobility (e.g. "H-mobility" program).

The Center collaborates with the Fuel Cell and Hydrogen Joint Undertaking (FCH JU) and with Hydrogen Europe Research (former N.ERGHY) and is involved in other joint initiatives.


[10] *part of ICSI (National Research and Development Institute for Cryogenic and Isotopic Technologies) Energy Rm. Valcea*

# OPPORTUNITY ASSESSMENT

## Hydrogen production potential & its role in energy system flexibility

The technical variable renewable electricity production potential in Romania is almost ten times higher than the expected electricity demand in 2030, which creates a significant opportunity to utilize part of this potential in renewable electricity generation to produce hydrogen via electrolysis. According to the draft NECP, Romania would by 2030 only use 3% of its technical potential in renewable electricity generation, so there is a great margin for building up additional dedicated renewable electricity sources for hydrogen production.

There is also an opportunity to use power-to-hydrogen conversion as a flexibility provider, as the Romanian energy system is expected to have in 2030 a higher installed capacity of variable renewable electricity generation than the average load. This opportunity is further reinforced by the fact that the electricity interconnection level of Romania is expected to remain rather limited, especially when compared to the installed variable renewable generation capacity.

| | Technical variable renewable electricity potential (TWh/yr) | Technical renewable electricity generation potential compared to forecasted gross electricity consumption in 2030 (Draft NECP) | Draft NECP estimate of variable renewable electricity production in 2030 (TWh/yr) | Draft NECP estimate of variable renewable electricity production in 2030 compared to its technical potential | Ratio between variable power generation capacity in 2030 and average load (based on EUCO) | Readiness for $CO_2$ storage |
|---|---|---|---|---|---|---|
| Romania | 507 | 583% | 16.00 | 3% | 171% | Low |

Romania has limited readiness for wide-scale deployment of CCS and there is only limited indication of progress towards capturing $CO_2$ and re-using captured $CO_2$ in industrial processes and/or utilizing the potential storage capacities.

## Energy infrastructure

Romania considers using its existing methane infrastructure for hydrogen transport and distribution, and plans to assess the economic and technical feasibility of injecting hydrogen and synthetic methane into the natural gas infrastructure.

Romania could in the frame of this feasibility study, also consider converting (part of) its network to dedicated hydrogen use.

As about half of the distribution network is made up of polyethylene, this part could be converted to hydrogen at a relatively low cost.

However, conversion of the methane networks to dedicated hydrogen pipelines would be a longer-term consideration. In the short and medium term, the production volumes of hydrogen will be relatively low and hydrogen could hence be blended with methane in the existing grid, without the need for physical adjustments to the transport and end-use infrastructure.

| | Technical and economic feasibility of converting gas distribution networks to hydrogen (share of polyethylene pipelines in distribution grid) | Natural gas demand in residential and services sectors / length of gas distribution network (GWh/km) | Existing salt cavern natural gas storage sites (TWh) | Suitable geological formations (potential for future hydrogen storage) |
|---|---|---|---|---|
| Romania | 52% | N.A | 0 | Yes |
| EU | MS range 16%-99% | | | |

Romania currently operates underground natural gas storage facilities, which could on the medium or long term be used for hydrogen storage.
There are also important underground salt layers in the Centre of the country, that could provide additional underground gas storage opportunities. The availability of suitable formations to develop storage sites for seasonal hydrogen storage represents an opportunity for Romania and offers it a competitive advantage compared to other Member States


# Current and potential gas & hydrogen demand

In Romania, there are significant opportunities for the deployment of hydrogen across sectors, with the largest potential in industry. In this sector, hydrogen can be used to decarbonise the natural gas supply, which currently accounts for a third of the energy use in industry. On the short to medium term, renewable and low-carbon hydrogen can also be deployed to replace the existing use of fossil-derived hydrogen in ammonia industry and refineries. On the medium to long term, there is a large potential for the deployment of hydrogen for the generation of high temperature heat, and a lower-scale potential to decarbonise the Romanian steel industry. Next to industry, the transport sector also holds considerable potential for the deployment of hydrogen, especially in road transport and the rail sector. In Romania's built environment, hydrogen can be deployed to replace the existing natural gas use, which accounts for over 40% of the heating demand and on a smaller scale it can contribute to the decarbonisation of the fuel mix used in district heating plants.

## Opportunities for hydrogen demand in industry

In Romania, the opportunities for the deployment of hydrogen in industry are substantial. First of all, natural gas accounts for 34% of the industrial energy mix and the deployment of renewable or low-carbon hydrogen is one of the ways to decarbonise this part of the energy use. Romania also hosts ammonia industry and refineries. These industries currently consume fossil-based hydrogen, which could be replaced by renewable or low-carbon hydrogen. Next to this, the need for high-temperature process heat is responsible for almost 60% of the industrial energy demand. Hydrogen is one of the low-emission energy carriers that is well-suited for the generation of high-temperature heat. Lastly, the Romanian steel sector, although relatively small, is still dependent on a conventional fossil-based steelmaking process. On the medium to long term, this sector could reduce its GHG emissions by switching to a process where Direct Reduction Iron is produced using hydrogen.

| | Presence of ammonia industry / share of ammonia production capacity in EU28 total | Presence of refineries / Share of Romanian refineries in total captive hydrogen production by refineries in the EU28 | Share of Romania in total primary steel production in the EU28 | Share of natural gas in industrial energy demand (2017) | Share of high-temperature (>200°C) process heat in industrial energy demand (2015) |
|---|---|---|---|---|---|
| Romania | 5% | 2.7% | 2% | 34% | 58% |
| EU | MS range 0%-16% | MS range 0%-26% | MS range 0%-30% | Average 32% MS range 0%-43% | Average 38% MS range 9%-60% |

## Opportunities for hydrogen demand for heating and cooling in the built environment

In the built environment of Romania, natural gas accounts for 34% of the final energy demand, and 42% of the demand for heating. Therefore, hydrogen could play a substantial role in the decarbonisation of space and water heating. The rest of the demand for heating in Romania's built environment is primarily satisfied through biomass combustion and district heating. Fossil fuels account for 84% of the fuel use in dedicated heat plants. Therefore, hydrogen could be one of the alternative low-carbon energy carriers that can replace this fossil fuel use in heat plants in the future.

| | Share of natural gas in the household and service sector energy demand (2017) | Share of heating in the household and service sector energy demand (2015) | Share of cooling in the household and service sector energy demand (2015) |
|---|---|---|---|
| Romania | 34% | 69% | 1% |
| EU | Average: 34% MS range: 0% - 60% | Average: 74% MS range: 41% - 82% | Average: 3% MS range: 0% - 46% |

## Opportunities for hydrogen demand in transport

Romania´s road transport sector is still strongly dependent on fossil fuels and hydrogen is one of the solutions that can be deployed to decarbonise energy use in this sector, especially in heavy-duty road transport, which represents approximately 34% of the energy use in road transport. Hydrogen can also play a role in the decarbonisation of passenger car transport, especially in the larger car segment and for consumers who need cars with large driving ranges. Furthermore, Romania's railway sector is still dependent on fossil fuels for 57% of its energy use. Together with further electrification, deployment of decarbonised hydrogen can be one of the solutions to reduce GHG emissions from the Romanian rail sector. On the medium to long term, hydrogen and derived fuels can also play a role in the decarbonisation of the aviation sector in Romania which up to now still represents a relatively minor share of the energy demand in transport. The same holds for the shipping sector, which represents an even smaller part of the energy use in Romanian transport.

| | Share of heavy transport (trucks, buses & vans) in total energy demand in road transport in 2020 | Share of fossil fuels in energy use of rail transport (and absolute consump-tion) in 2017 | Share of inland shipping in overall energy demand for transport in 2017 | Energy use by international shipping relative to total (domestic) final energy use in transport in 2017 | Share of domestic and international aviation in overall energy demand for transport (incl. energy use int. aviation) in 2017 | Share of fossil fuels in energy use of road transport in 2017 |
|---|---|---|---|---|---|---|
| Romania | 34% (20 166 GWh) | 57% (1 342 GWh) | 0.7% (470 GWh) | 0.5% (324 GWh) | 6% (4 377 GWh) | 95% (64 580 GWh) |
| EU | Average 32% MS range 18%-48% | Average 30% MS range 0%-95% | Average 2% MS range 0%-9.8% | Average 14% MS range 0%-1011% | Average 14% MS range 1%-25% | Average 95% MS range 79%-100% |


# Enabling environment: national hydrogen policies and plans, projects and industry

The assessment shows that while Romania does in its NECP consider hydrogen deployment in the transport, gas and power sectors, there is no comprehensive framework for the deployment and use of hydrogen yet. The draft NECP refers to hydrogen in the context of its use in the transport sector and its injection into the methane grid and has a broader approach within the R&I area.

Romania could provide further support for dedicated hydrogen related research and facilitate the implementation of pilot and demonstration projects, which can contribute to paving the way for the use of renewable or low-carbon hydrogen as a means to achieve deep decarbonisation.

**Existence of (or concrete plans for) national hydrogen roadmaps or strategies** — Positive environment: ✗

An overarching hydrogen roadmap has not yet been developed in Romania; such a comprehensive roadmap would support the country in mainstreaming hydrogen within the energy system.

Taking into account its large potential for hydrogen deployment, it would be appropriate for Romania to consider the deployment of hydrogen within its broader energy policy to address the decarbonisation challenges across all energy end-use sectors, preferably in coordination with the neighbouring countries and taking into account the initiatives and policies at EU level. The Romanian Association for Hydrogen Energy[11] could provide support in such strategic work. The association aims at supporting actions related to hydrogen production, end-use and infrastructure, through technology transfer, while promoting Romanian expertise, and in close cooperation with international and other national associations.

[11] https://www.icsi.ro/h2romania/

**GHG mitigation gap in non-ETS sectors (need for additional GHG reduction measures)** — Positive environment

Romania is expected to meet its greenhouse gas emission target in 2030 of -2 % compared to 2005 for sectors not covered by the EU Emissions Trading System (non-ETS), as set out in the Effort Sharing Regulation (ESR), if it effectively implements the policies and measures in line with the projections provided, notably in the transport and agriculture sectors. The final plan could benefit from considering hydrogen as an option to complement the agreed measures.

**Existence of (active) hydrogen national association** — Positive environment: ✓

## Current and planned hydrogen refuelling infrastructure for the transport sector

Alternative fuels infrastructure directive (2014/94/EU)

There are currently no hydrogen refuelling stations in Romania, and there is no publicly available information regarding plans in this domain.

| | Inclusion of hydrogen in national plans for the deployment of alternative fuels infrastructure (2014/94/EU) | Existence of hydrogen refuelling stations (2019) | which is equivalent to 1 refuelling station per … cars |
|---|---|---|---|
| Romania | **NPF not received** | **0** | **Not applicable** |
| EU | | Total **156** | Average **1 677 543** |

## Existence of (investment on) hydrogen-related projects

There are currently no hydrogen-related industrial projects in Romania.

| | Existing R&D and pilot projects directly related to hydrogen | RD&D annual expenditure on hydrogen & fuel cells (m EUR) (average 2013-2017) | Activities and projects in industry to use hydrogen as feedstock | Number of power-to-gas projects (existing and planned) |
|---|---|---|---|---|
| Romania | **NO** | **0.0** | **NO** | **0** |

| Existence of national tax incentives ($CO_2$ pricing mechanisms & car taxation) | Positive environment |
|---|---|
| Romania has no $CO_2$ pricing mechanism in place but has introduced carbon related taxation for vehicles, which could contribute to support the shift to low carbon vehicles (including on hydrogen). | ✓ |

## Fossil energy import bill

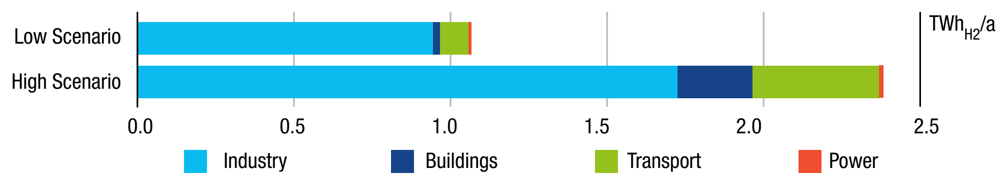
As Romania depends to a very limited extent on imports for its natural gas use, switching from natural gas to nationally produced hydrogen would not have a major impact on its energy import dependence.
However, as its domestic natural gas production potential is declining, it could become an issue on the medium term. Its oil dependency is more sensitive and the slow increase of the share of oil imports throughout the last decade shows that Romania could have interest to consider domestic production of hydrogen to reduce its oil import dependence and bill.

| | Import bill for natural gas as share of national Gross Value Added | Import bill for all fossil fuels |
|---|---|---|
| Romania | 0.1% | 1.5% |
| EU | Average: 0.6%<br>MS range: 0% - 1.5% | Average: 2%<br>MS range: 0% - 7% |

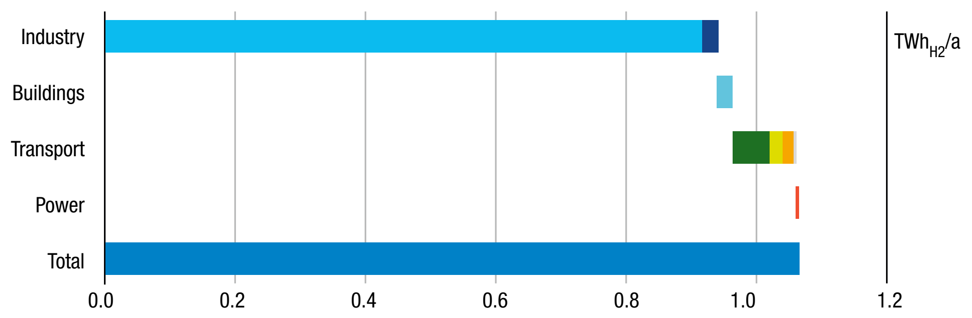
# SCENARIO ASSESSMENT

## Estimated renewable/low carbon hydrogen demand for Romania by 2030

Hydrogen demand in the year 2030 has been estimated in a low and a high scenario covering the range of uncertainty. Today, conventional hydrogen mainly used in industry is produced from fossil fuels (e.g. through steam methane reforming) or is a by-product from other chemical processes. Both scenarios assume that in 2030 renewable hydrogen will be provided to partially substitute current conventional production and to cover additional demand (e.g. from transport sector).

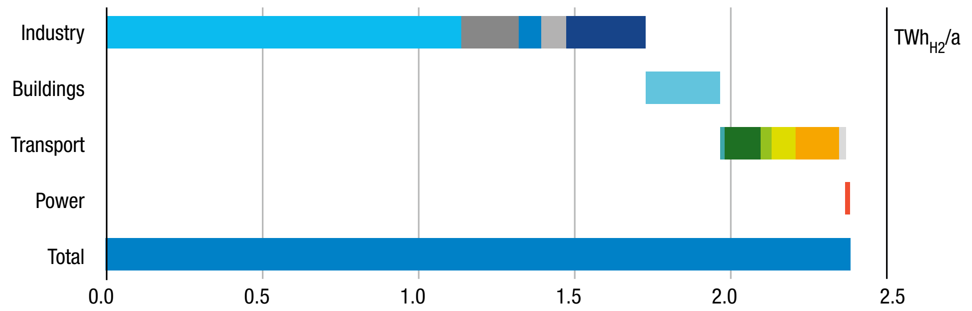



### Low scenario

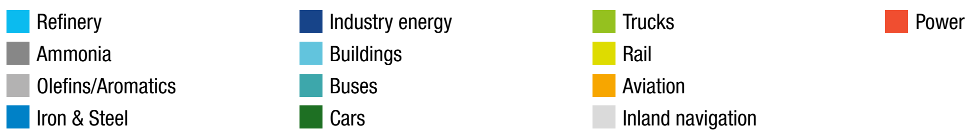



In the low scenario, renewable hydrogen accounts for 0.4% of final total energy demand (i.e. 1.1 out of 258 TWh/a) or 1.7% of final gas demand (63 TWh/a) according to EUCO3232.5.

### High scenario



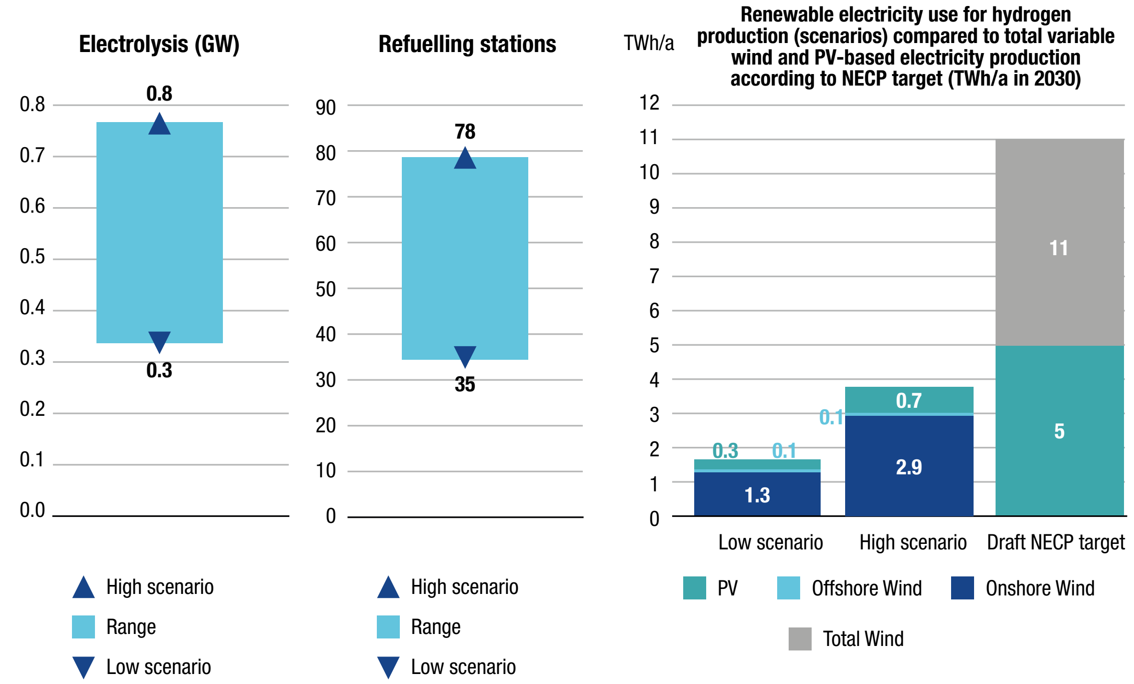

In the high scenario, renewable hydrogen accounts for 0.9% of final total energy demand (i.e. 2.4 out of 258 TWh/a) or 3.8% of final gas demand (63 TWh/a) according to EUCO3232.5.




# Hydrogen generation, infrastructure and end users in Romania by 2030

The analysis of renewable hydrogen generation, infrastructure and end use is based on the demand estimates presented above. Renewable hydrogen is generated from variable renewable power using electrolysis. The analysis covers only national hydrogen production to satisfy domestic demand and does not take into account any cross-border trade of hydrogen (i.e. hydrogen imports and exports are not included in this analysis).

### Renewable hydrogen generation and infrastructure




The required renewable power production accounts for 0.5% of the overall technical renewable power potential in the low scenario and for 1.0% in the high scenario.

### End users

| End user | Unit | Low scenario | High scenario |
|---|---|---|---|
| Passenger cars | Nº | 18 600 | 37 200 |
| Buses | Nº | 0 | 280 |
| Lorries | Nº | 0 | 3 200 |
| Heavy duty vehicles | Nº | 0 | 480 |
| Trains | Nº | 8 | 33 |
| Substituted fuel in aviation | GWh/a | 10 | 94 |
| Substituted fuel in navigation | GWh/a | 1.3 | 12.4 |
| Micro CHP | Nº | 1 100 | 4 790 |
| Large CHP | Nº | 10 | 60 |
| Iron&Steel | % of prod. | 0% | 1% |
| Methanol | % of prod. | 0% | 0% |
| Ammonia | % of prod. | 0% | 5% |

According to the estimations, the hydrogen refuelling station network will by 2030 encompass between 30-80 stations for 19 000-41 000 fuel cell vehicles on the road.

In addition, the analysis estimates substitution of up to 1% of the conventional steel production by renewable hydrogen-based steelmaking.

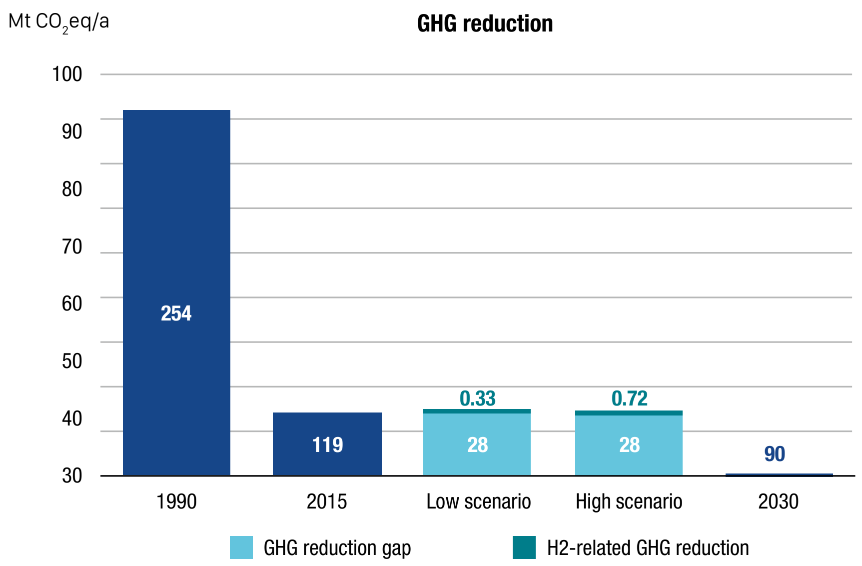
Further use of renewable hydrogen is foreseen in ammonia production (up to 5%).

Finally, the introduction of 1 110-4 850 stationary fuel cells for combined power and heat production is estimated.

# Environmental and financial impact in Romania by 2030

Greenhouse gas (GHG) emission reductions were calculated by estimating the fuels replaced by hydrogen, and their respective greenhouse gas footprint. Comparing these to the 2030 GHG reduction targets results in the contribution of hydrogen to achieving these targets.

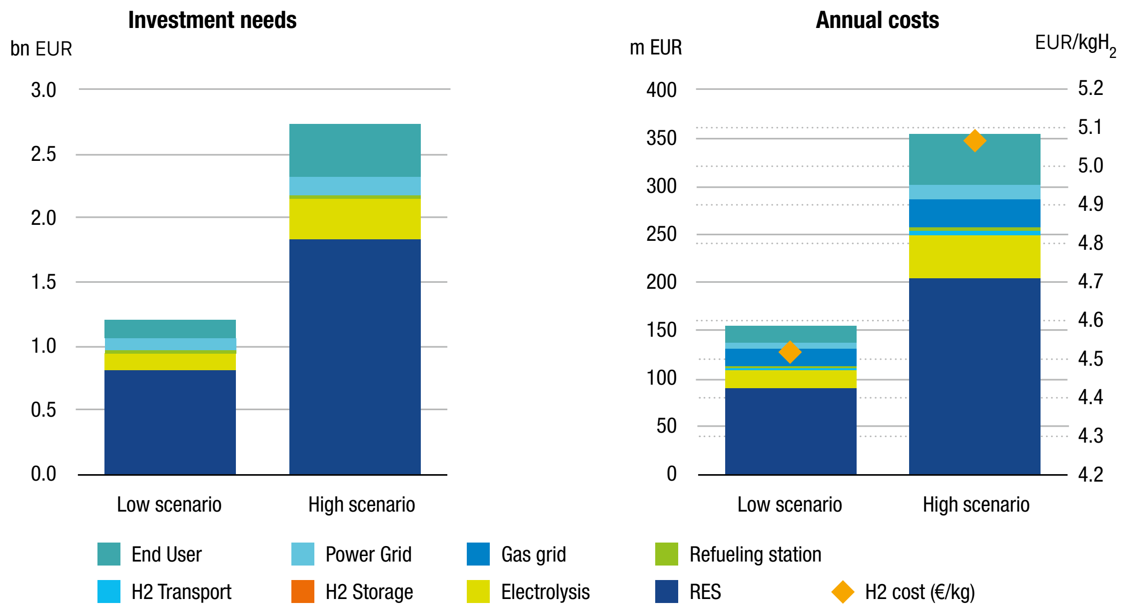
## Environmental impact




An additional GHG emission reduction of 0.3-0.7 Mt $CO_2$ is estimated in 2030 corresponding to 1.1%-2.5% of the overall GHG emission reduction gap towards 2030 target (based on EUCO3232.5).

## Financial impact

The financial scenario assessment includes investments (CAPEX) until 2030 and operating expenses (OPEX) per year in 2030. Cumulative investments in hydrogen technologies are estimated at 1.2-2.7 billion EUR until 2030, while annual expenditure would amount to 150-360 million EUR (including end user appliances as well as power and gas grids).



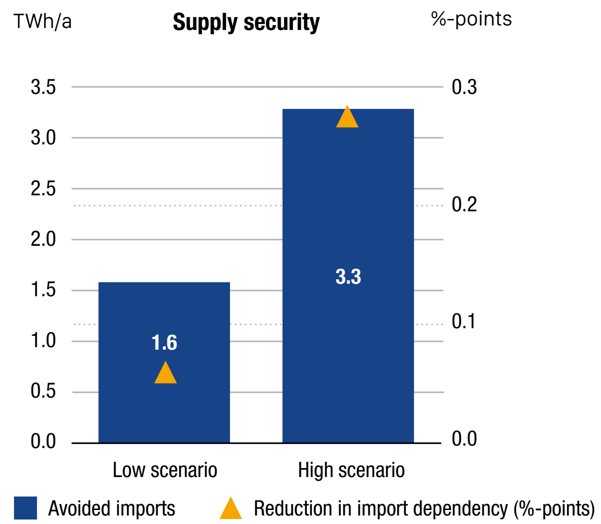



# Impact on security of supply, jobs and economy in Romania by 2030

Hydrogen contributes to the security of energy supply security objective by reducing fossil energy import dependence and enhances energy supply diversification by facilitating deployment of renewable energy sources. This is assessed by estimating imported fossil fuels that will be replaced by hydrogen based on domestic renewable sources.

## Security of energy supply

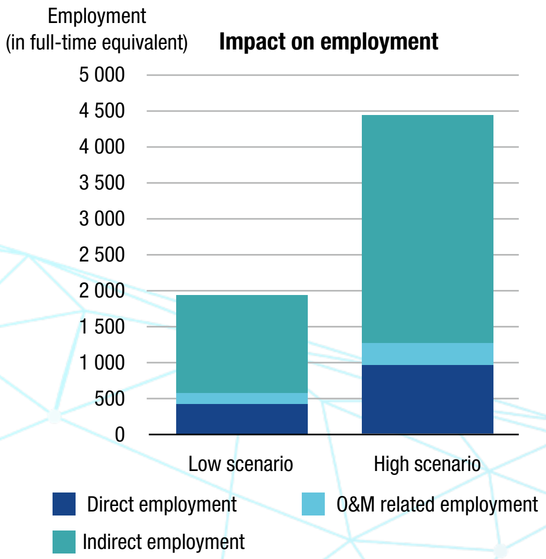
Deployment of renewable hydrogen would lead to 1.6-3.3 TWh/a of avoided imports, and thus reduce import dependency by 0.1-0.2% (in volume terms) in 2030, depending on the scenario.

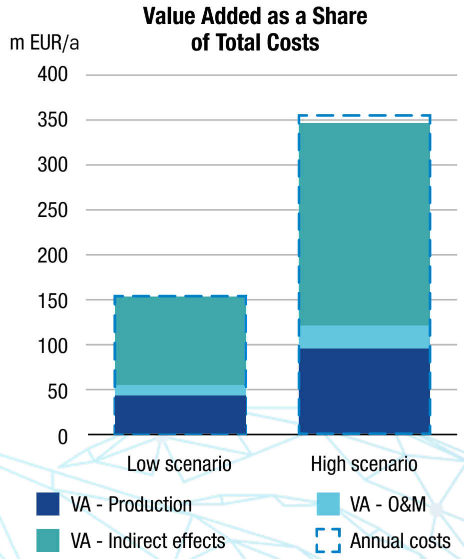


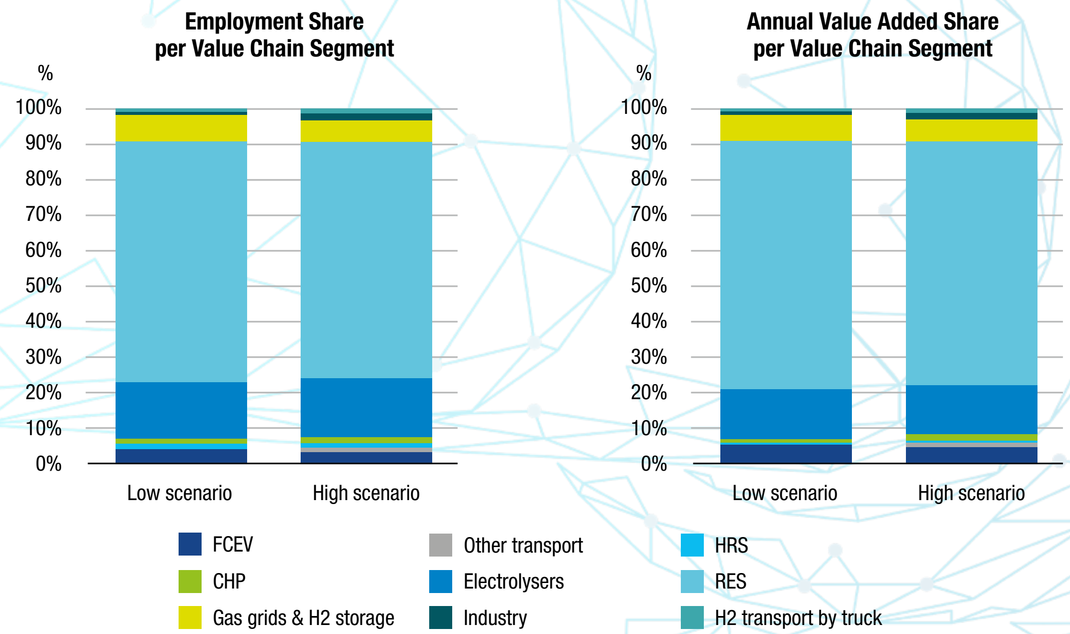

## Impact on employment and value added

This analysis shows that in the years 2020-2030 around 56 million EUR can be retained annually in the domestic economy as value added in the low scenario, and over 123 million EUR in the high scenario (value added is defined here as sum of wages for employees, margins for companies and taxes). If the indirect effects induced by the investment in and operation of hydrogen technologies are also taken into account, around 155 million EUR (low scenario) and almost 350 million EUR (high scenario) of value added can be created in the Romanian economy annually, which is almost equivalent to the amount of annual investment needed. Most of this value added is expected to be created by building and operating dedicated renewable electricity sources and electrolysers for hydrogen production, and by building and operating hydrogen transport networks and storage facilities.

The hydrogen-related expenditures in 2020-2030 are estimated to generate employment of 560 – 1 300 direct jobs (in production and operations & maintenance) and contribute to a further 1 360 – 3 200 indirectly related jobs, depending on the scenario. Most of these jobs are expected to be created in the by building and operating renewable electricity sources, electrolysers and hydrogen transport infrastructure.




# Romania

Opportunities arising from the inclusion of **Hydrogen Energy Technologies** in the National Energy & Climate Plans

FUEL CELLS AND HYDROGEN
JOINT UNDERTAKING