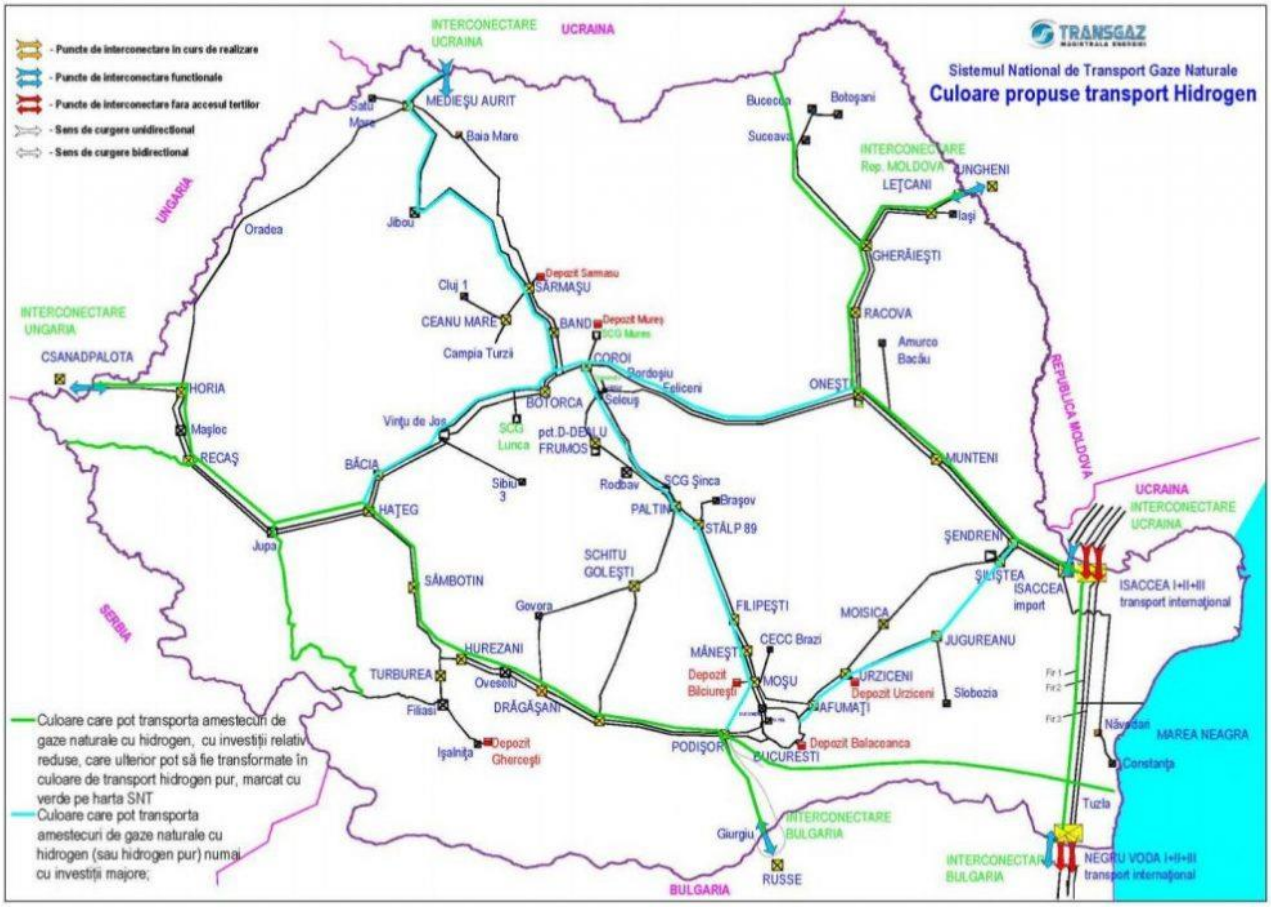
TRANSGAZ WANTS TO INTEGRATE RENEWABLE AND LOW-CARBON HYDROGEN INTO THE TRANSMISSION SYSTEM



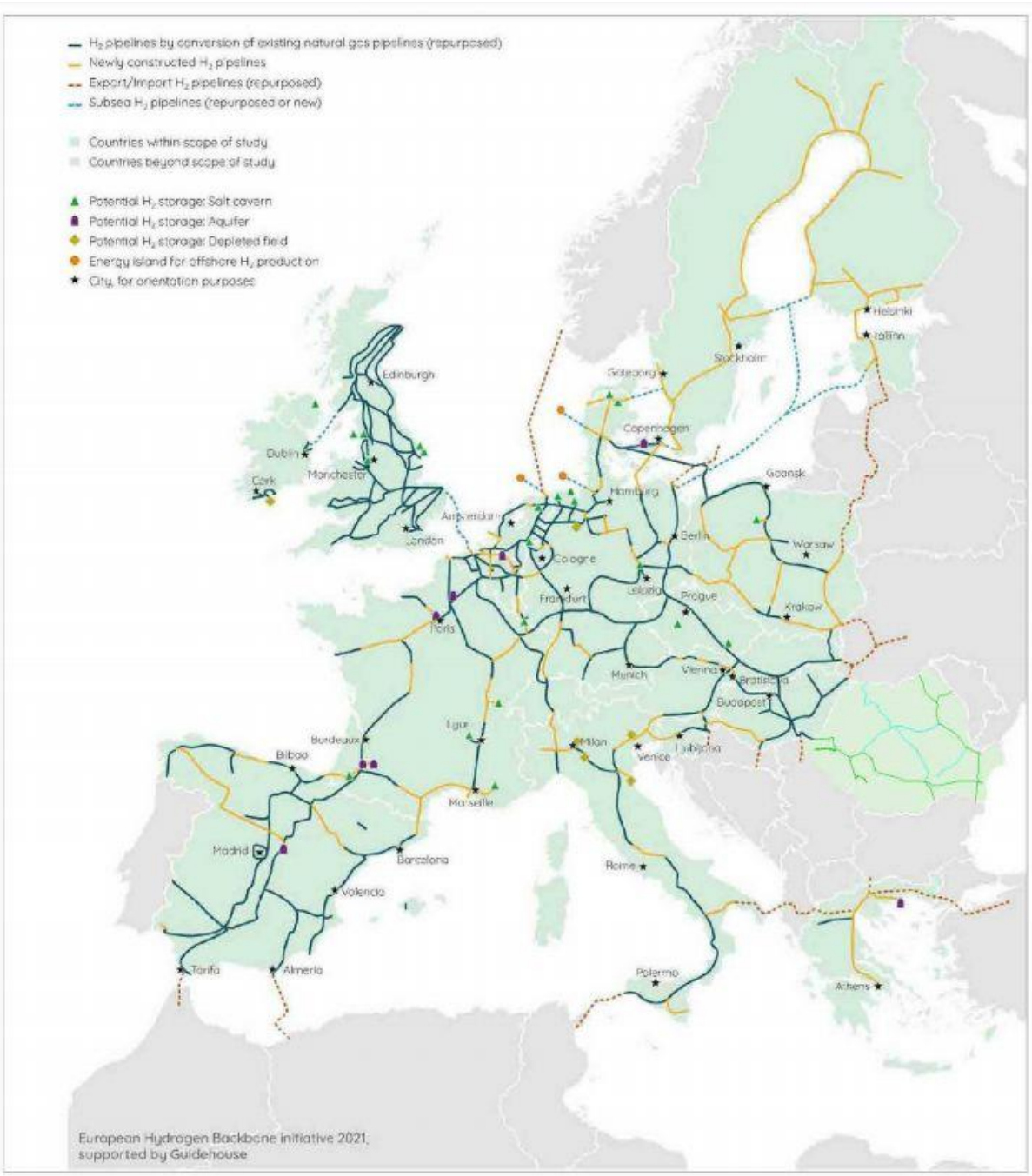
Harta propunere "coloana vertebrală" SNT pentru transportul hidrogenului

Map – proposal NTS backbone for hydrogen transport

- **Transgaz has identified specific locations where it is to carry out a pilot project for the transmission and use of natural gas - hydrogen mixture.**

- **The National Recovery and Resilience Plan (PNRR): infrastructure for the distribution of natural gas in combination with hydrogen – investments of euro 400 million.**

Large-scale hydrogen consumption will require a well-developed hydrogen transmission infrastructure based on a "European Hydrogen Backbone" that connects hydrogen demand with supply from north to south and from west to east.



EU Hydrogen Backbone, including the proposed NTS corridors

Transgaz, as the operator of the natural gas transmission system, provided for the integration of hydrogen from renewable and low-carbon sources into the natural gas transmission system in its development strategy, with a view to aligning it with the Existing European Directives, Strategies and Agreements.

The company also identified specific locations where it will, in the immediately following period, carry out a pilot project for the transmission and use of the natural gas - hydrogen mixture.

- **11 corridors for the NTS 'backbone', as regards the transmission of hydrogen**

Following a preliminary analysis meant to establish the NTS "backbone", 11 corridors have been identified which may be included in the 'backbone' of the future European hydrogen transmission system. These are:

1. *Transit pipelines corridor (using a pipeline)*
2. *Black Sea – Podisor corridor*
3. *Giurgiu – Podisor – Jupa – Nădlac (BRUA) Corridor*
4. *Onești – Gherăești – Letscani – Ungheni (Republic of Moldova) Corridor*
5. *Petrovaselo – Comloșu Mare (Serbia) Corridor*
6. *Jupa – Prunișor Corridor*
7. *Isaccea – Onești Corridor*
8. *Silistea – Bucharest Corridor*
9. *Onești – Coroi – Hațeg Corridor*
10. *Coroi – Mediesu Aurit Corridor*
11. *Podișor – Coroi Corridor*

The proposed corridors for the transmission of hydrogen ensure the interconnection with all the neighbouring states of Romania, namely Hungary, Serbia, Bulgaria, Ukraine and the Republic of Moldova and also provide access to the existing natural gas storage facilities.

Subject to the status of the existing pipelines, there may be corridors that can transport mixtures of natural gas and hydrogen, with relatively low investments, which can then be converted into pure hydrogen transmission corridors, or there may be corridors that can carry mixtures of natural gas and hydrogen (or pure hydrogen) only based on major investments.

The lengths of these proposed corridors are approximately:
– 1683 km for the corridors where relatively new pipelines are built which can transport mixtures of natural gas and hydrogen, with relatively low investments, which can then be converted into pure hydrogen transmission corridors;
– 1132 Km for the corridors where the mixtures of natural gas and hydrogen (or pure hydrogen) can be transported only based on major investments.

The volumes of natural gas which can be transported through these corridors are:
– 4.4 billion cm/year to/from Hungary
– 1.5 billion cm /year to/from Bulgaria (Ruse)
– 6.0 billion cm /year to/from Bulgaria (Negru Voda)
– 1.6 billion cm /year to/from Serbia
– 2.2 billion cm /year to/from the Republic of Moldova
– 12 billion cm /year to/from Ukraine
If mixtures of 10 % (volume) of hydrogen are transported through such transmission corridors, the total quantity of hydrogen that can be transported is:
– 39,600 tonnes H2/year to/from Hungary
– 13,500 tonnes H2/year to/from Bulgaria (Ruse)
– 54,000 tonnes H2/year to/from Bulgaria (Negru Voda)
– 14,400 tons H2/year to/from Serbia
– 19,800 tons H2/year to/from the Republic of Moldova
– 108,000 tons H2/year to/from Ukraine

As regards the transmission of hydrogen through the existing NTS pipelines, both the impact on the various means of metering the quantities of natural gas and the impact on the different materials and equipment related to the natural gas transmission pipelines has to be taken into account.

According to energy specialists, the presence of hydrogen in natural gas, up to 10% volume percentages, does not significantly affect turbine and ultrasonic meters (with a flow rate of over 400 m3/h). The turbine and ultrasonic meters measuring gas with flow rates below 400 m3/h must be tested with a mixture of hydrogen and natural gas to confirm the results obtained with the large meters. For H2 in a proportion of over 10%, the gas characteristics change progressively and, consequently, based on its underlying principle the metering will be affected, pursuant to the specialists we consulted, who also say that as far as the ultrasonic meters are concerned there is a significant influence of the percentage of H2 on the density, sound velocity and specific gas heat.

As regards the impact on the various materials and equipment related to the natural gas transmission pipelines, certain equipment manufacturers guarantee, in respect of the standard products, the possibility to use a hydrogen concentration of up to 20 % (volume) in the natural gas.
As regards the compression of the hydrogen - natural gas mixture, the specialists informed us that, for instance, a manufacturer of compressor units claimed that, for the delivered equipment, at a hydrogen concentration of up to 4% (volume), no necessary changes in the installation of the compression units (for both the turbine and the compressor) are estimated. Therefore, the experts believe that no additional costs are expected.

For a hydrogen concentration higher than 4% (but less than 25%) changes are required in the set-up of the compressor units which generate additional costs, based on the existing compressor units. For hydrogen concentrations higher than 25%, pursuant to the specialists we consulted, the manufacturer of compressor units explained that they did not have a clear-cut solution for the moment.

*** Tuzla-Podisor project; Feasibility study for the construction and operation of a small-scale H2 production facility in Dobrogea region**

For about 6 months, Transgaz has been discussing with the company's financers for two-way non-refundable financing.

Thus, with regard to the Decarbonisation Strategy, Transgaz is considering the Tuzla-Podisor Project — the analysis of C02/CH4 emissions and the required investments in technology to reduce them.

Moreover, the company is considering a Feasibility Study for the construction and operation of a small-scale H2 production facility in Dobrogea region, with hydrogen to be experimentally introduced into Tuzla-Podisor pipeline to analyse the behaviour from a technical point of view and to test a market model for hydrogen demand, as well as the regulations related to such transactions.

- **Business models studied in Europe**

Today, hydrogen is a modest fraction of the global and European energy mix and is still largely produced by fossil fuels, especially natural gas or coal. Clean hydrogen, obtained with renewable energy sources, can contribute to the decarbonisation of heavy industry or road freight transport, which would otherwise consume a large part of fossil fuels.

Multilateral European banks (EIB, EBRD) are beginning to render funding subject to the existence of a decarbonisation strategy and to the implementation of concrete actions to decarbonise the transmission network (by transporting a mix of methane gas with H2, synthetic gas or biogas).

There are several hydrogen business models in Europe, according to the specialists who stated: "There is the model in which the H2 is mixed with gas and then it is burned as if it were gas, with the aim of reducing the emissions of C02 and CH4 for that H2component.

There is also the Business Model in which H2, once introduced into the pipeline, is extracted at its destination by a certain technology and consumed by various industrial or economic consumers. There is also the Model of networks dedicated exclusively to the transport of H2".

- **The National Recovery and Resilience Plan - PNRR: The infrastructure for the distribution of natural gas in combination with hydrogen – 400 million euro**

Hydrogen is a clean fuel with a very high efficiency/calorific value, capable of addressing the energy needs of the population as well as of the business environment. In Romania, more than half of the population is not served by natural gas, using polluting, high-emission, costly and health-damaging energy sources, according to the National Recovery and Resilience Plan. Thus, the authorities state that PNRR offers Romania the chance to take a step into the future, building from the very beginning natural gas transmission and distribution networks fully capable of integrating the gas of the future, i.e. the hydrogen.

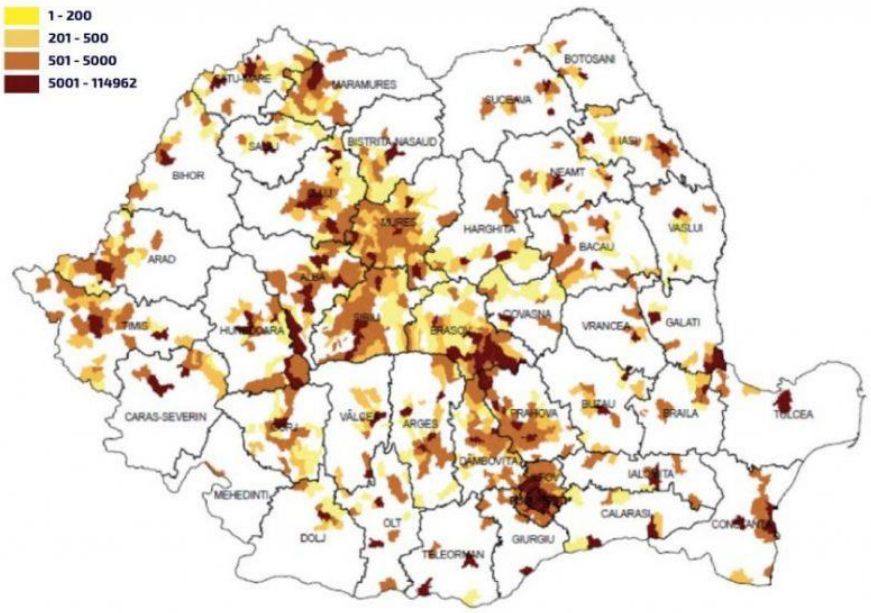
According to the document, the density of the natural gas network is uneven in Romania, as such regions with poor access should be prioritised with this investment, especially since it would be an investment outside the current transmission and distribution network.

The PNRR envisages the development of a regional natural gas infrastructure (transport, distribution, compressor stations) in a region poorly connected to natural gas, capable of taking hydrogen and other decarbonated gas (e.g. bio-methane, etc.) up to 10% of capacity. The total amount of the investment is estimated at EUR 400 million.

The PNRR also provides for: "From our preliminary estimates, bearing in mind that Oltenia region is the weakest region in terms of its connection to the natural gas distribution infrastructure, with counties such as Mehedinti and Dolj where the connection is almost non-existent, we propose that the pilot region for the implementation of this low-carbon smart grid of the future should be Oltenia.

Map 1 – Territorial Administrative Units connected to the gas grid and the annual consumption

Gas consumption for household use, 2016 (thousand cm)



According to our estimates, the allocated budget could cover approximately 4,000 km of smart pipelines with 160,000 smart metering system connections, based on the following data:

- The average cost related to the construction of smart distribution pipelines is approx. 110 euro/ml.
- The average cost related to the building of a connection, with smart metering system, is about. 1,000 euro/piece.
- The average cost related to the building of one km of smart distribution pipeline, with 40 related connections, is approx. euro 150,000.

Taking into consideration the average annual consumption per connection of 20 MWh (1,800 N.c.), it results that we will have an estimated total annual consumption of about 3,200 GWh.

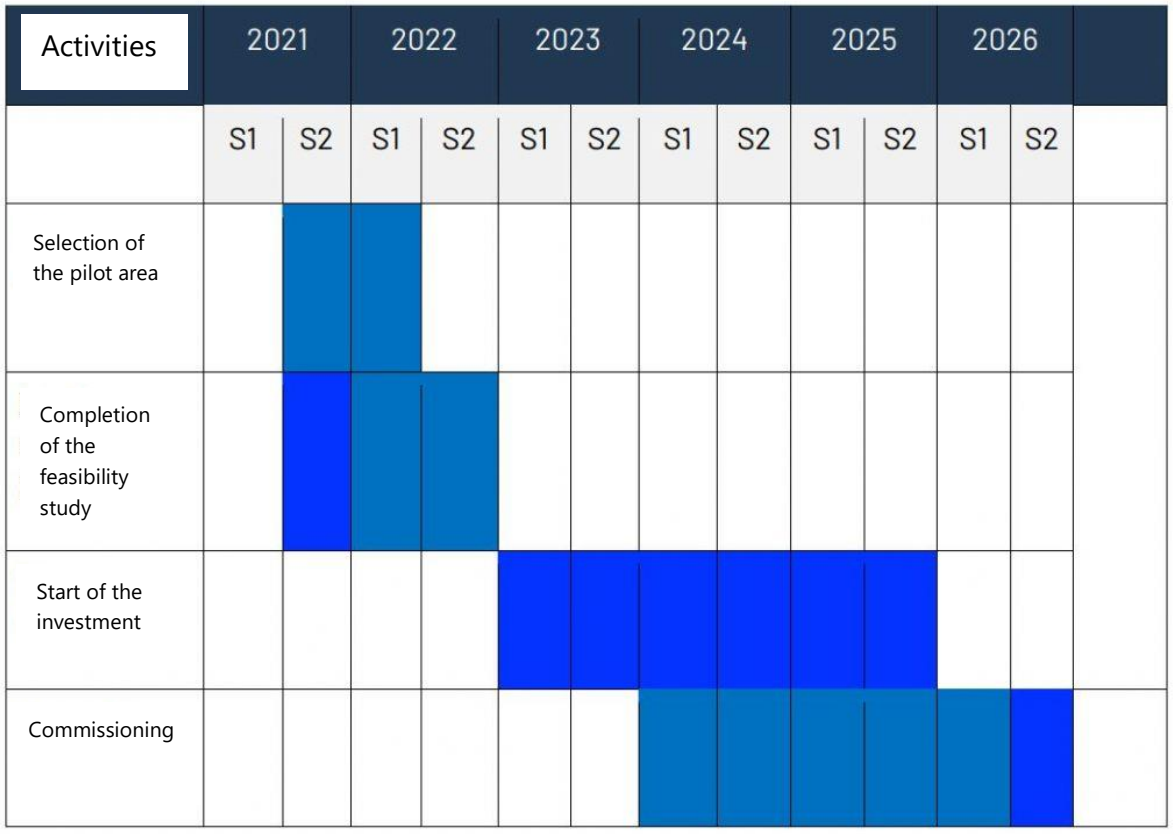
In order to cover the injection requirement of up to 10% H2 into the smart gas network, a quantity of approx. 9,500 to green H2 will be necessary, by means of electrolysers to be powered by approx. 580 GWh of power produced from renewable sources (photovoltaic, hydro and wind). For example, this amount of renewable energy (580 GWh) can be produced during a calendar year by photovoltaic farms with an installed power of approx. 450 MW or microhydro plants with installed power of approx. 150 MW.

The injection of hydrogen into the smart grid will be carried out after the metering and regulating station (MRS) of the national gas transmission system (NTS), thus avoiding the absorption of hydrogen into the national transmission network and the blending will be carried out under conditions of maximum security.

The digitalisation and effectiveness of the DSO and TSO operations in order to increase the ability to take over hydrogen flows from the network is one of the characteristics of the new smart grids to be achieved. Through this investment Romania will actively participate in the implementation of the European Union hydrogen strategy and it will install on its own territory by 2024 30 GW in electrolysers for the production of 1,500 H2 tons.

Target investment group – natural gas transmission operator, natural gas distribution operator, and the responsible entity – Ministry of Energy, public authorities.

Responsible entity: The Ministry of Energy, public authorities



For the investments in the 'hydrogen ready' natural gas transmission and distribution network, the beneficiaries of which will be the gas transmission operator and/or the gas distribution operators, State aid rules shall not apply as the natural gas transmission networks are a monopoly.

- **The Recovery and Resilience National Plan: Romania plans to develop a dedicated national hydrogen strategy**

Romania intends to develop a national hydrogen strategy based on the definition of a set of policies meant to guide, coordinate and mobilise public and private investment in the fields of production, storage, transmission and consumption/use of hydrogen (renewable gas), according to PNRR. Pursuant to the document, the legislative framework needed to stimulate this area will be subsequently revised.

According to the PNRR, the direct beneficiary is the Ministry of Energy, and the indirect beneficiaries are large energy companies involved in relevant research projects, natural gas transmission and natural gas distribution operators, hydrogen processing operators, carriers and consumers.

According to the PNRR, Romania does not currently have a regulatory framework for the production of hydrogen electricity, and a clear vision of the use of hydrogen in the domestic or export market will be defined. Romania is considering the development of hydrogen technologies mainly in the transport, natural gas and electricity sectors.

Romania has a favourable environment to address the implementation of hydrogen from renewable sources, having regard to its national organisations active in this field (e.g. Romanian Hydrogen Energy Association), its gas transmission system operator (TSO) (SNTGN Transgaz SA) committed to using the existing natural gas transmission infrastructure for hydrogen as well, its national research activities and involvement in the Green Hydrogen @ Blue Danube2, Zero-emission Urban Delivery @ Rainbow UnHycorn3 and H2GO4, potential IONCEI projects'.