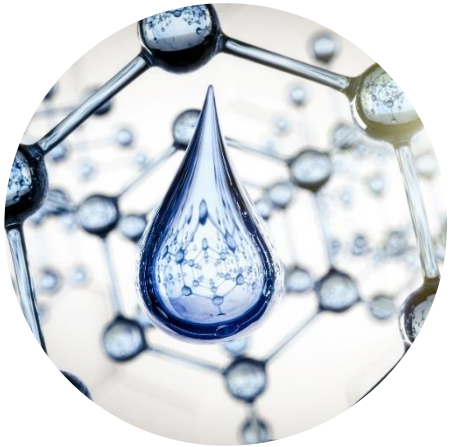
HORVÁTH

National Hydrogen Strategy for Romania

2030 Hydrogen Strategy Outlook

Zsuzsa Bereschi

The Romanian Hydrogen Strategy focuses on decarbonization of hard-to-abate sectors, research and innovation and Power-to-X solutions



Using hydrogen with priority in sectors with the biggest impact on CO_2 footprint reduction

- Stimulate production and consumption of clean hydrogen in industry and transport
- Create a favourable environment for investments and diverse technologies for clean hydrogen
- Develop infrastructure for clean hydrogen and for use of clean hydrogen in transportation

Economic growth by developing hard-to-abate sectors and increasing their competitiveness

- Develop hydrogen valleys to connect production potential to industrial and transport hubs
- Encourage international cooperation to create new innovative value chains for green steel, green plastics etc.

Technological development and innovation to mobilize hydrogen deployment on the long-term and attract Romanian capital

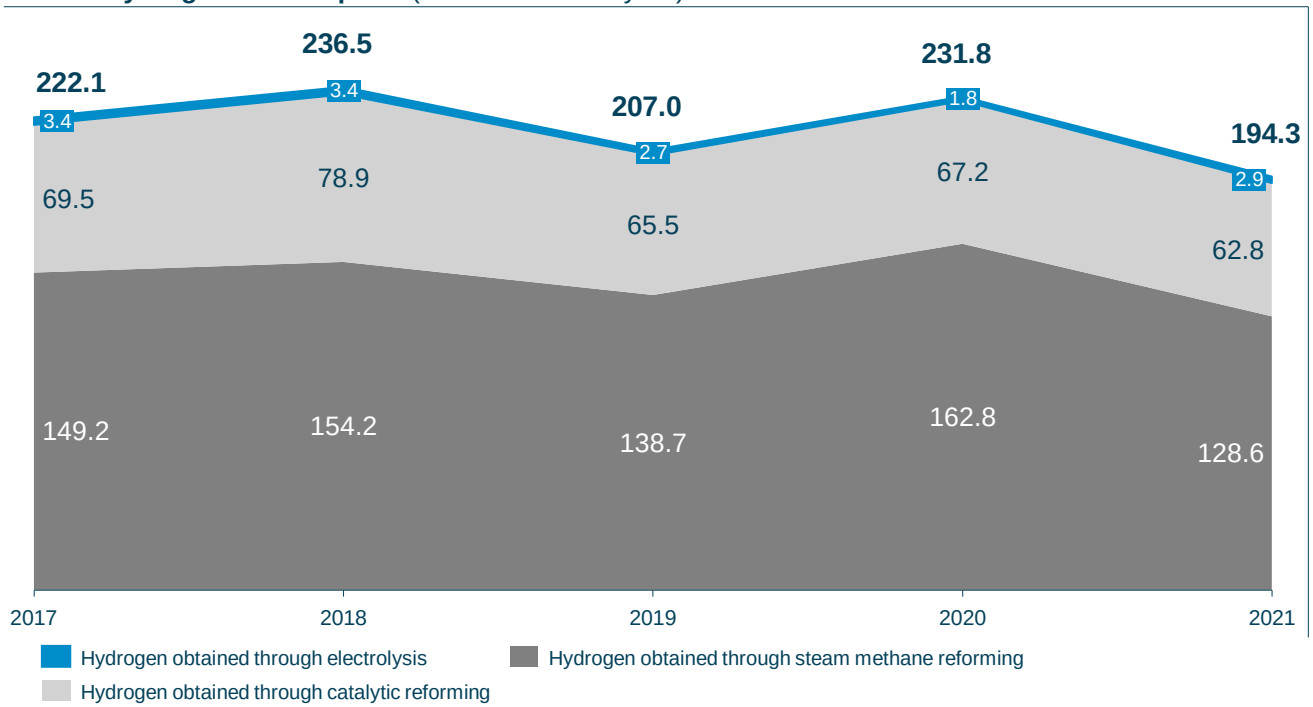
- Support research and innovation from laboratory to industrial pilots
- Development of existing research and innovations centers on hydrogen to further support technological transfer and promote strategic sectors

Use hydrogen and Power-to-X solutions to successfully integrate renewables and achieve sector coupling

- Support long-term storage of hydrogen to integrate significant renewables capacities and balance the Romanian energy systems (on seasonal level)
- Introduce Power-to-X solutions

More than 98% of the hydrogen consumed by private companies is produced using steam methane reforming and catalytic reforming

Annual hydrogen consumption (thousand tonnes/year)[1]



Romania needs ~10.3 TWh of renewable energy (~17.6% of Romania's total demand in 2021) to produce the annual hydrogen demand

- **The demand of hydrogen** obtained through steam methane reforming and through catalytic reforming reflected similar decreasing trends of **13.8% and of 9.7% respectively** in 2021 compared to 2017
- **The demand of hydrogen obtained through electrolysis[2]** shows similar trends, decreasing by **13.8%** in the period 2017-2021, and represents **less than 1%** of the total annual hydrogen demand
- The preliminary analysis indicates the **potential to replace** grey hydrogen with **green or low-CO_2 (clean)** hydrogen

[1]The total consumption represents the sum of the hydrogen consumption of the 11 respondents from the primary environment (February 2022 questionnaire)
[2]Hydrogen is obtained through Hystat electrolysis (62 tonnes), water electrolysis (148 tonnes) and ion exchange electrolysis membrane (2728 tons)

Romania's National H_2 Strategy considers green H_2 as a key towards decarbonization in several sectors

Industrial consumption, where grey hydrogen - currently used in industrial processes - is replaced by renewable hydrogen

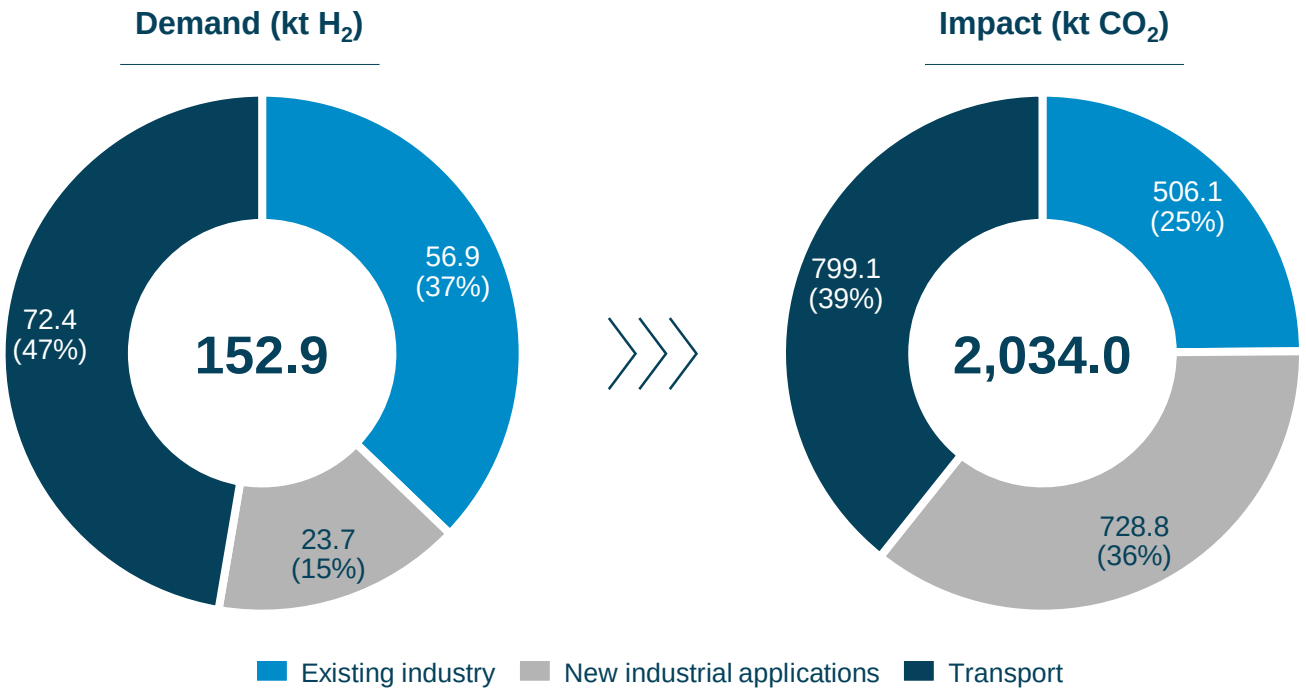
Consumption from the **steel industry**, where novel industrial applications of renewable hydrogen are employed to produce steel

Consumption in the **transportation sector**: road transportation of heavy and medium tonnage goods, passenger cars, rail transportation, public passenger transportation, and transportation in the maritime sector, as well as transportation in the field of aviation, both as an addition to the level of airport activity

Implementation of hydrogen projects will have a significant contribution towards meeting Romania's decarbonization target in 2030

	Total	Existing industry	New industrial applications (steel)	Transport
Hydrogen demand (tonnes/year)	152.9	56.9	23.7	72.4
CO_2 emissions reduction	2,034	506.1	728.8	799.1
Electrolysis capacity required (MW)	2,130	792	330	1,008
RES capacity required (MW)	4,261	1,585	660	2,016

Green H_2 demand in Romania is estimated at 153 thousand tonnes by 2030, reducing the carbon emissions by 2 million tonnes of CO_2

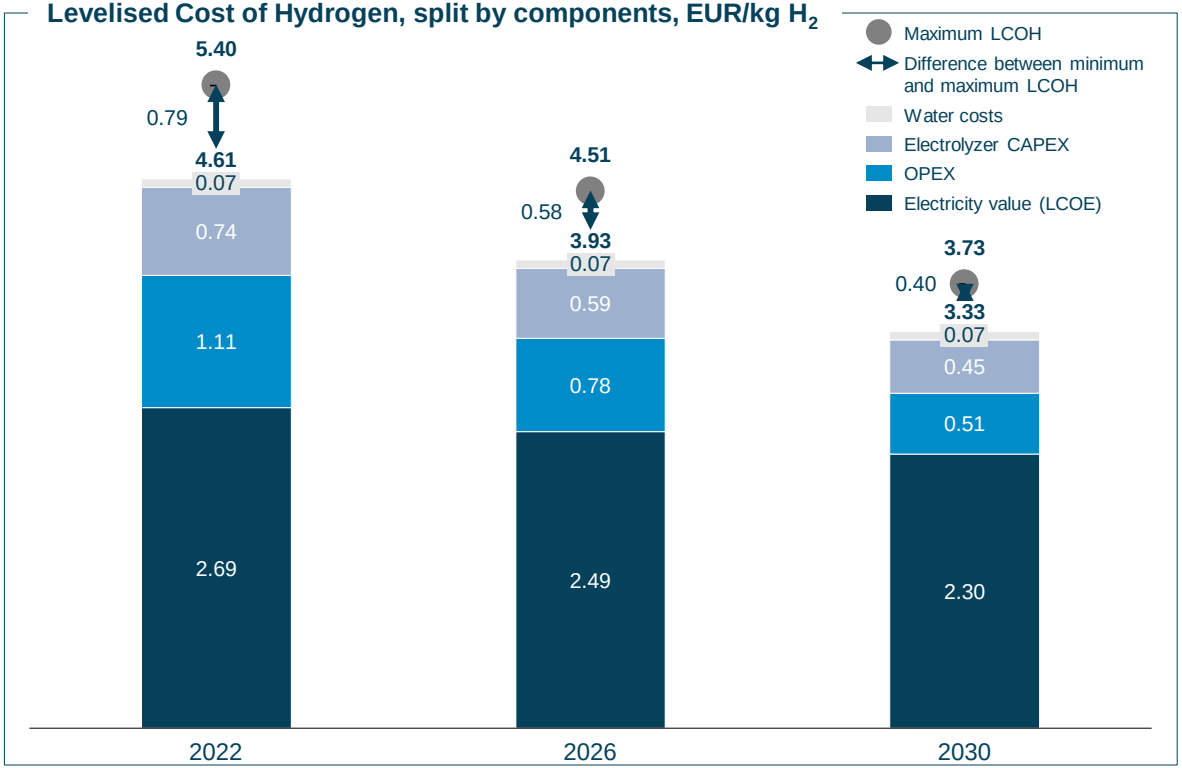


Romania's hydrogen demand has been estimated using current and future potential use cases across various sectors

Use cases	Demand	Transport	Storage
Existing industry	▪ **42% green H_2** target* out of the **total demand** of H_2 in **current industry** (chemical, steel and fertilisers industries)	▪ **Electrolysis capacities** to be installed **on-site** where technically feasible ▪ Alternatively, transport will be required, taking into consideration **Hydrogen Backbone proximity**	▪ **Storage required** during electrolysers off-work hours to **sustain baseload hydrogen availability** for **industrial processes**
New industrial applications (steel)	▪ **0.5 million tonnes of green steel** produced anually by 2030 using green H_2 in **DRI-EAF** technology**		
Transport	▪ **Bottom-up target of green H_2 accounting for 1.4%** of total energy consumption in the transport sector to achieve the target set between 1% and 5.5% of RED III* under the condition of sufficient local biofuel production to reach the 5.5% target (approximately 250 kt/year in 2030 ▪ **Bottom-up estimation** takes into consideration the use of H_2 as fuel for light and heavy-duty vehicles, passenger cars, public transport (bus fleet and trains), as well as in the maritime and aviation sector ▪ Additionally, the **refinery industry** will use **green H_2** equal to **1% of total energy consumption** in the transport sector	▪ **Transport** to **refueling stations** using **railway infrastructure** (combined with first/last mile), where available, and **HDVs** ▪ Refueling stations will be positioned along **TEN-T corridors**	▪ **Storage** for **refueling stations** using on-site mobile tanks, also enabling convenient transport

*According to Council and Parliament provisional deal and targets on RED (Renewable Energy Directive)
**DRI – Direct Reduced Iron, EAF – Electric Arc Furnace

Most of the main components in the levelized cost of hydrogen show decreasing costs in the next decade



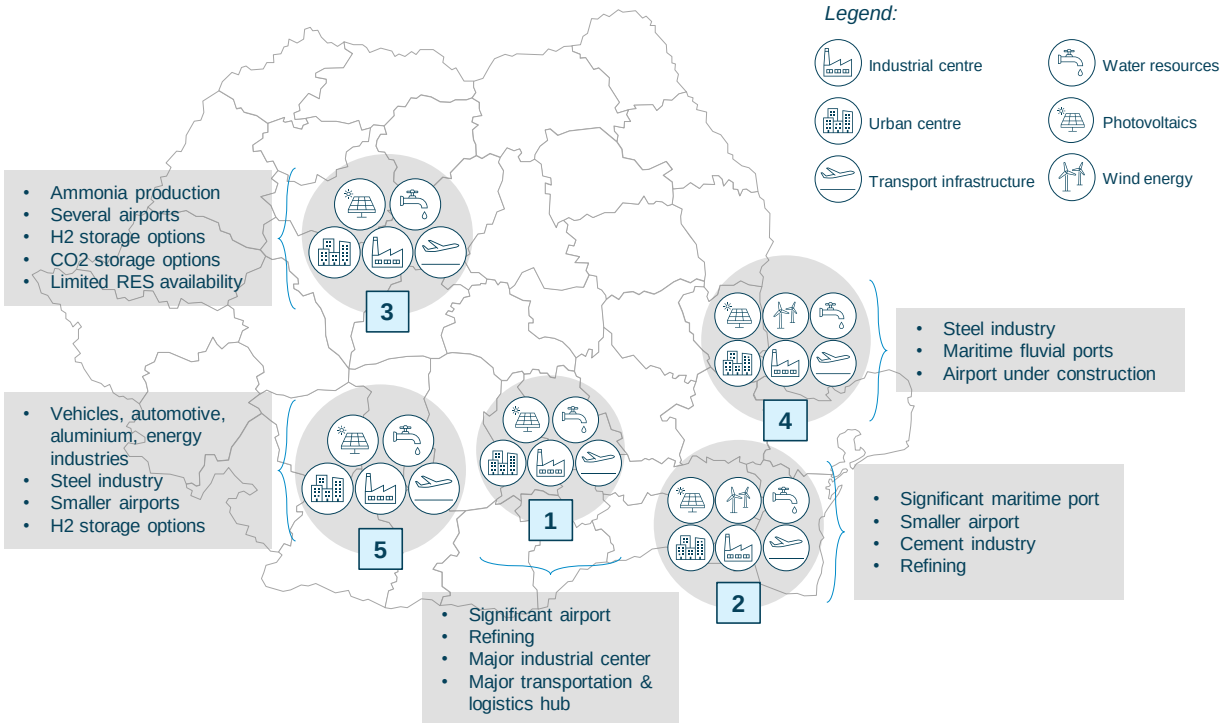
Assumptions

- **Levelised Cost of Green Hydrogen (LCOH) is** expected to range between 3.3-3.8 EUR/kg in 2030, a 30% decrease from 2022
- The analysis considers **3.527 hours** electrolyser operating capacity using electricity produced by own wind/solar capacities and additional hidro electricity supplied through PPAs at LCOE (without cost of capital) plus transmission cost
- **Electrolyser CAPEX** is expected to decrease by 33-36% in the 2022-2030 due to both technological advancement of most of its components, as well as economies of scale
- **OPEX** (calculated as a percentage out of CAPEX) will decrease from 4% in 2022 to 3% in 2030 due to economies of scale, improved operational efficiency, maturing learning curves and training levels of human resources
- **Levelised Cost of Electricity (LCOE)** is expected to decrease until 2030 due to significant improvement in the CAPEX related to RES installed capacities (especially offshore wind and solar)
- **Water cost** will remain a relatively small component in the LCOH model

Following the preliminary analysis and based on the applied criteria, five areas with potential to become hydrogen valleys have emerged

Preliminary draft version

Defined and analysed criteria to identify regions with potential to become H_2 Valleys



Methodology description

The following five areas have been identified and show the basic conditions to support the ecosystems required by hydrogen valleys:

1. **București – Ploiești – Târgoviște – Pitești**
2. **Constanța – Medgidia – Călărași – Slobozia**
3. **Cluj – Târgu Mureș – Sighișoara – Sibiu – Sebeș**
4. **Galați – Brăila – Tulcea**
5. **Craiova – Slatina – Târgu Jiu**

The geological storage capacity of hydrogen in these ecosystems will be treated as an advantage, but not as a criterion for elimination, as we are assuming that by 2030 we will not have such a significant production as to require large volumes of storage.

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