Hydrogen – for smart cities

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SMART CITIES OF ROMANIA CONFERENCE 2020
Bucharest, Romania

INCD TCI ICSI Rm. Valcea / Romanian Association for Hydrogen Energy

RM. VALCEA (city)

HyRO
National Center for Hydrogen & Fuel Cell

www.icsi.ro

NATIONAL R&D INSTITUTE OF CRYOGENICS AND ISOTOPIC TECHNOLOGIES -ICSI RM.VALCEA-

National Center for Hydrogen and Fuel Cell

- **2009** – National Center for Hydrogen and Fuel Cell has been developed due to results, knowledge and expertise acquired in the research projects done in the renewable energy field.
  - Member of Joint Undertaking on Hydrogen and Fuel Cell, a unique public-private partnership supporting research, technological development and demonstration in the field of fuel cells and hydrogen-based energy technologies in Europe.
- **2012** - Hydrogen Research Group within ICSI Energy leads to the foundation of the Romanian Association for Hydrogen Energy.
- August 2014 - National Center for Hydrogen and Fuel Cells becomes a National Interest Facility, being a support installation with experimental and testing equipment to address a wide range of research into the use of hydrogen for energy purposes.
- The entire R&D has been completed both instrumentally and from human resources capabilities by developing two other facilities research: Low Temperature Laboratory - CRYO-HY (2012) and Energy Storage Laboratory - ROM-EST (2015).

Why to Rm. Valcea?

Perioada	Competitie	Nr. Proiecte	Sume estimate (mii Euro)
2000-2004	MENER (sp. C), MATNAN TECM (sp. 5), CERES, Programe Nucleu Planul Sectorial	4 3 2 1 1 Total: 11	(160+90+90+*) 340 (27+47+33) 107 (70+43) 113 43 325 Total: 928 (< 1 mil. Euro)
2005-2006	CEEX 2005 (M1) CEEX 2006 (M1+M3)	3 (11+2) 13 Total: 16	• Sume initiale propuse 0,5 mil. Euro/proiect
2007-2008	PNCDI II 2007 (AT 2 +7) PNCDI II 2008 (AT 2 +3+7)	12 9 Total: 21	• Sume initiale propuse 0,5 mil. Euro/proiect

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Nr.	Project	-	Call
1	Develop and implement new solutions to improve performance of fuel cell proton exchange membrane	INCDTCI-ICSI Rm. Valcea,	CEEX 2005 Module 1
2	Develop a system for hydrogen production at low cost by the method of proton exchange membrane electrolysis	INCDTCI-ICSI Rm. Valcea,	CEEX 2006 Module 1
3	Heat and water management systems for PEM fuel cells	INCDTCI-ICSI Rm. Valcea	CEEX 2006 Module 1
4	Development of an integrate production of hydrogen and fertilizer for the soil by use of biomass and residues	INCDTCI-ICSI Rm. Valcea,	PNCDI II 2-Energy 2007
5	Regenerative electrolyzer-fuel cell energy converter, architecture design and implementation	INCDTCI-ICSI Rm. Valcea,	PNCDI II 2-Energy 2007
6	Innovative system for power using high temperature PEM fuel cells and hydrogen produced by reforming of acetic acid	INCDTCI-ICSI Rm. Valcea,	PNCDI II 2-Energy 2008
7	Environmental impact analysis in the context of the widespread use of hydrogen-based technologies	INCDTCI-ICSI Rm. Valcea,	PNCDI II 3-Environ. 2008

~20%

ICSI Rm. Valcea

How new is the hydrogen and fuel cells?!

In **1766–81**, Henry Cavendish was the first to recognize that hydrogen gas was a substance.

In **1838**, *The London and Edinburgh Philosophical Magazine and Journal of Science* William Grove (physicist and barrister) wrote about the development of his first fuel cells.

In **1938** - Rhine-Ruhr, the first 240 km (150 mi) hydrogen pipes.

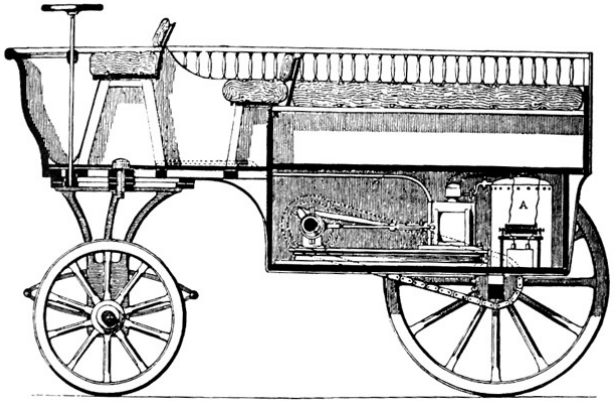
In **1939**, Francis Thomas Bacon (British engineer) successfully developed a 5 kW stationary fuel cell.

How new is the hydrogen cars?!

First hydrogen car!

Francois Isaac de Rivaz
1807, France, Patent

Second hydrogen car!



Lenoir's "Hippomobile"
1860, France, Patent
Hydrogen, generated from water via electrolysis!

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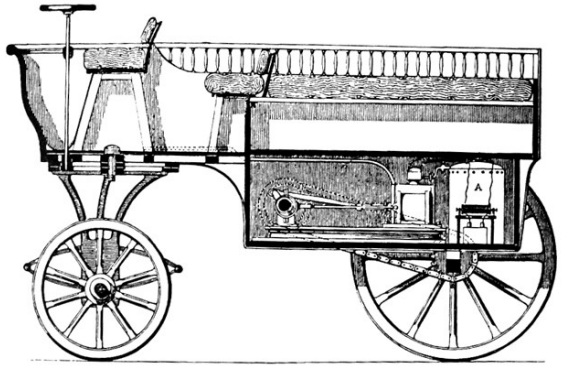
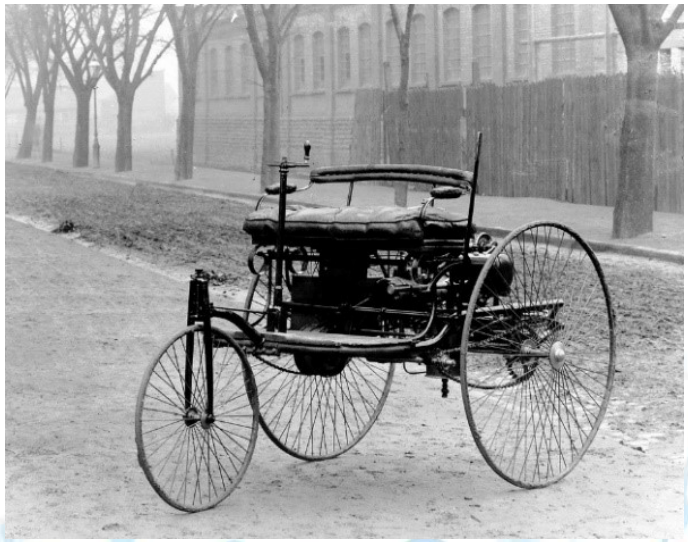


First gasoline automobile, **1885/86** powered by an internal combustion engine. (Karl Friedrich Benz)



Sources: www.H2mobility.org

Hydrogen production in Romania

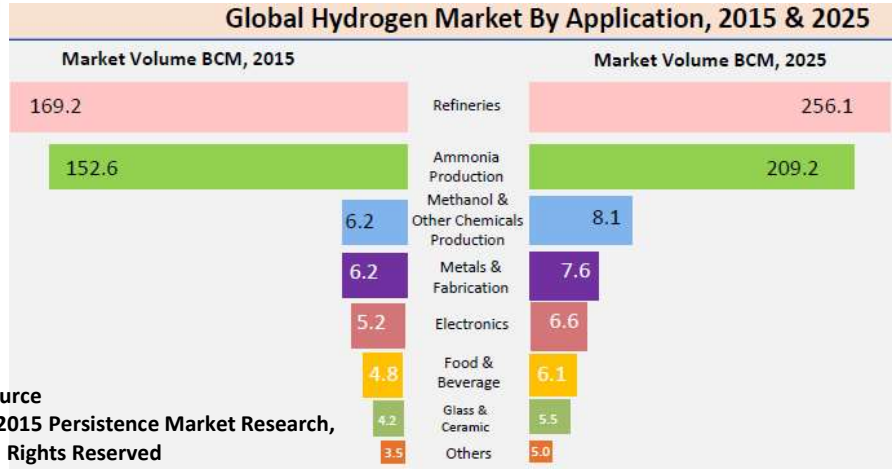
No.	Company	utilization	Obs.
1	Amonil (Slobozia)	ammonia	Captive
2	Astra (Ploieşti)	refinery	Captive
3	Arpechim (Piteşti)	refinery	Captive
4	Azochim (Piatra Neamţ)	ammonia	Captive
5	Azomureş (Tg. Mureş)	ammonia	Captive
6	Chimcomplex (Borzeşti)	Chlor-alkali	By-product
7	G. I. P.(Brăila)	?	?
8	DoljChim (Craiova)	ammonia	Captive
9	Donau Chem (Tg. Măgurele)	ammonia	Captive
10	Nitramonia (Făgăraş)/Viromet (Victoria)	ammonia	Captive
11	Oltchim/Chimcomplex (Rm. Vâlcea)	Chlor-alkali	By-product
12	Petrotel (Ploieşti)	refinery	Captive
13	Sofet (Bacău)	ammonia	Captive

Romania is included in the small group of countries (under thirty) that **traditionally produce hydrogen**.

This hydrogen is produced by:

- the catalytic reforming of hydrocarbons (especially natural gas) or
- the electrolysis of brine (NaCl).

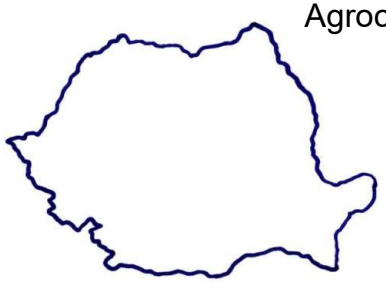
Hydrogen for cities mobility!



1 kg H_2/100 km

100 kg H_2/y

Hydrogen, production capacity in Romania



Agrochemistry (ammonia): 230 000 t H_2/y

Refineries: 70 000 t H_2/y

Total: **300 000 t H_2/y**

Chimcomplex, Rm. Valcea: 2500 **t H_2/an**

Hydrogen for cities mobility!

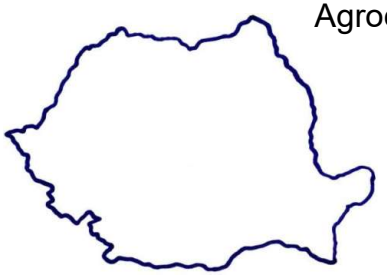
1 t H_2 ≈ 10 cars per year

Year	Romanian fleet	No. of cars	New cars
2019	8,749,390	6,901,236	289,520
2015	6,600,325	5,153,182	209,676

1 kg H_2/100 km

100 kg H_2/an

Hydrogen, production capacity in Romania



Agrochemistry (ammonia): 230 000 t H_2/y

Refineries: 70 000 t H_2/y

Total: **300 000 t H_2/y**

3 000 000 cars (FCEVs)/y

2 500 cars (FCEVs)/y

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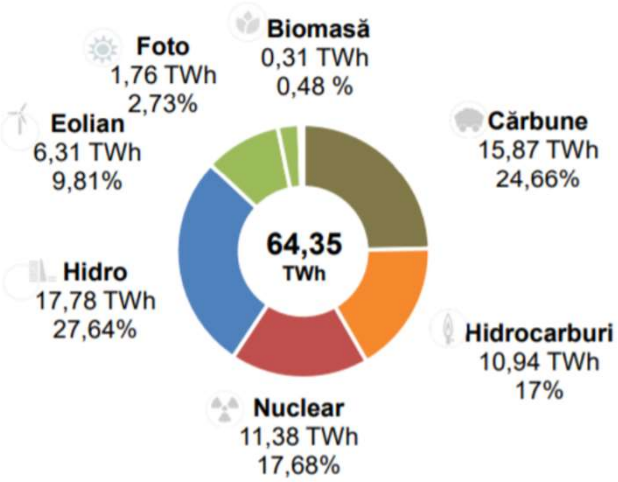
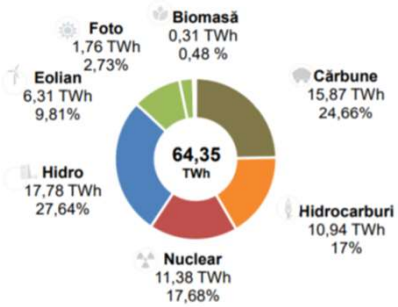
Hydrogen for cities energy need!



	Grup.	P net. (MW)
Carbune/coal	26	4 103.30
Hidrocarburi/hydrocarbons	147	2 650.14
Ape/hydro	881	6 312.48
Nucleara/nuclear	2	1 300.00
Eolian/wind	116	2 979.96
Biomass/Biogaz	57	125.39
Solara/solar	625	1 309.60
Geotermala/geothermal	1	0.00
Total	1855	18 780.87

Amount of energy (lower heating value)	**1 t H_2**	**33,3 MWh**
Energy consumption to produce hydrogen	1 t H_2	± 55 MWh
	1 MW	± 18 kg/h H_2

Hydrogen for cities energy need!



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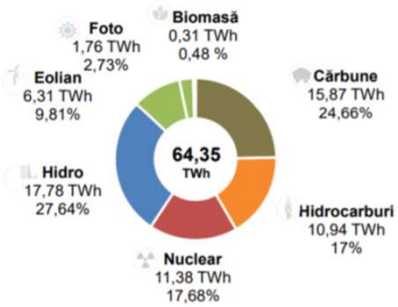
Energy consumption to produce hydrogen	1 t H_2	± 55 MWh
	1 MW	± 18 kg/h H_2

	CO_2 emissions	CO_2 emissions
	Electricity	Hydrogen
Zero carbon/renewable	0 t CO_2/MWh	0 t CO_2/t H_2
Y 2019	0,91 t CO_2/MWh	50 t CO_2/t H_2
Y 2025	0,62 t CO2/MWh	34 t CO_2/t H_2
Current reforming technology	0,22 t CO2/MWh	12 CO_2/t H_2

Hydrogen for cities energy need!



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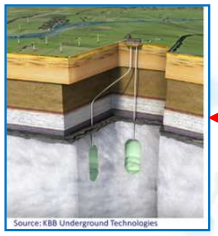
Large scale zero carbon hydrogen production and seasonal underground storage



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Thank you!

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