Hydrogen infrastructures
The Italian present situation and perspectives

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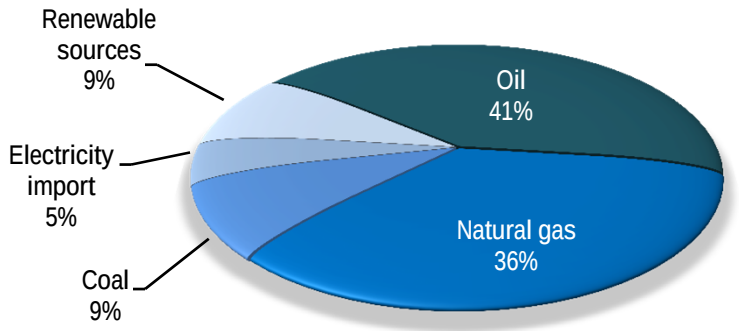
Outline

- *The Italian Energy System*
- *Present Situation of Hydrogen Infrastructures*
- *Future Hydrogen Infrastructure Prospects*
- *Considerations and Conclusions*

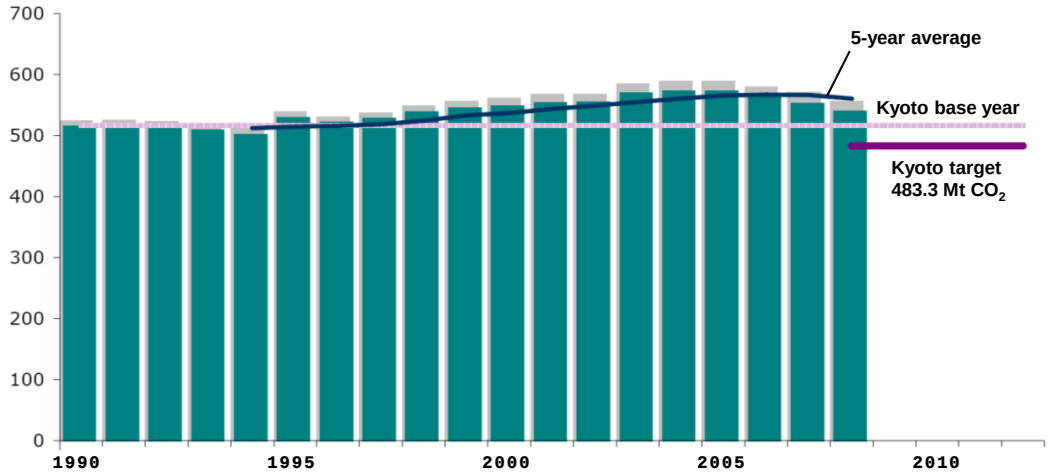
Italian energy system and GHG emissions

Primary energy demand: 192 Mtoe in 2008

- High dependence on fossil fuels (>85% imported)
- 9% of renewables, mainly hydroelectric
- About 5% of electricity import



- Large use of fossil fuels makes difficult reduce GHG emissions
- Average emissions over the period 2004-2008 were 8.5 % higher than the base-year level, still significantly above the target of - 6.5 % for the period 2008-2012



Emissions 1990 (base year) 516.3 $MtCO_2$ eq **Total GHG emissions 2008 540.7 $MtCO_2$ eq**

Why hydrogen in Italy?

Hydrogen and fuel cells utilized for mobile and stationary applications can allow:

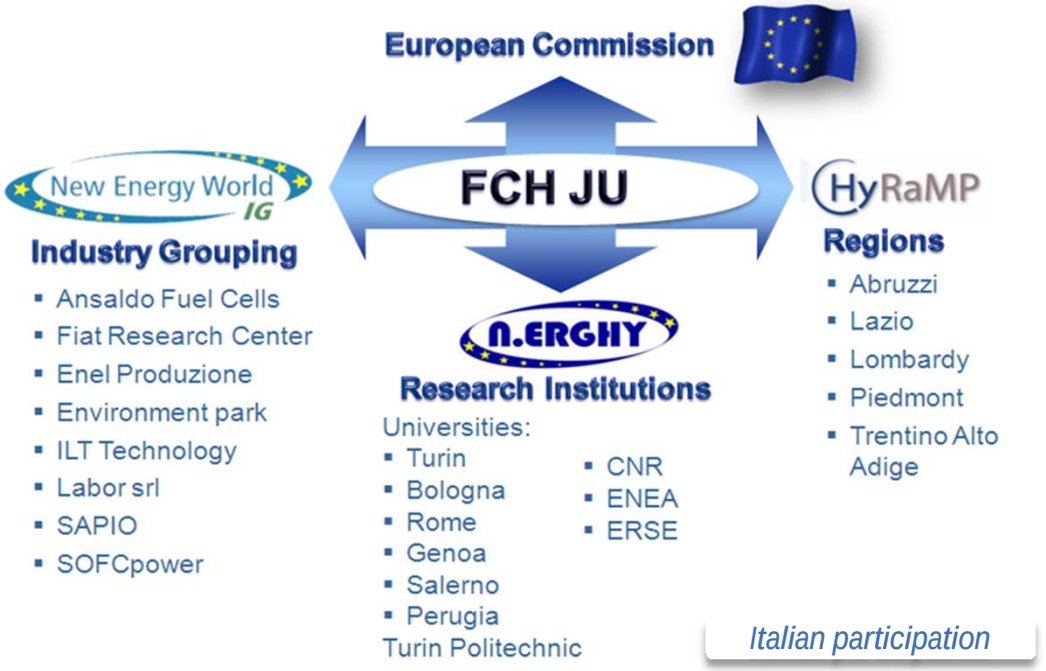
- Reduction of greenhouse gas emissions and local pollution
- Diversification of primary energy sources, increase of energy security, more sustainable use of fossil fuels and storage of renewable intermittent sources
- Promotion of industrial development in high technology innovative sectors

Italian activities on hydrogen and fuel cells

- In the last years the Italian interest on hydrogen has grown according with similar trends characterising the major industrialised countries
- RD&D projects are being carried out, in the frame of European and national programmes, with involvement of industries, research organisations and users
- Government (Ministries of Scientific Research, Environment and Economic Development) and Local Authorities (Regions and Municipalities) are both promoting RD&D activities
- But, because a lot of stakeholders are fostering hydrogen initiatives, it is hard to establish an effective coordination among them, to avoid duplication and allow full advantage of the previous results on the next demonstrations

INTERNATIONAL COLLABORATIONS

- **International Partnership for Hydrogen Economy**
- **Implementing Agreements IEA**
- **Fuel Cells & Hydrogen Joint Undertaking**



Examples of Hydrogen and Fuel Cells Italian Research Programmes

FISR PROGRAMME "HYDROGEN AND FUEL CELLS"

supported by the **Ministry of Education, University** and **Research and Ministry of Environment** through the **Special Integrative Fund for Research** (FISR)

- **14 projects (8 on hydrogen technologies, 6 on fuel cells)**

FISR funding : 90 M€ *Total cost of the projects: 120 M€* *Duration: 2005-2010*

INDUSTRIA 2015

Ministry of Economic Development has launched in the 2007 the "Industria 2015" Programme aimed at assisting **Industrial innovation projects** in different thematic areas

ENERGY EFFICIENCY

- MICROGEN 30 / ICI Caldaie -30 kWe CHP system with PEFC for residential applications
- EFESO / Merloni Termosanitari - 1-2.5 kW micro-CHP prototypes with SOFC
- HYDROSTORE / Venezia Tecnologie - Study and development of storage systems

SUBSTAINABLE MOBILITY

- VISION /Fincantieri – Hydrogen ferry for Venice lagoon with fuel cell hybrid system
- PBI (Innovative Bus Platform /Breda Menarinibus- Systems for the safe and integrated mobility (vehicles and infrastructures for passenger and/or freight transport)

MSE funding: 30,1 M€ *Total cost of the projects: around 70 M€* *Duration: 3 years*

Hydrogen and Fuel Cells Projects in Italy

AGENZIA NAZIONALE PER LE NUOVE TECNOLOGIE, L'ENERGIA E LO SVILUPPO ECONOMICO SOSTENIBILE

- FIAT Research Center - Realization and demonstration of fuel cell vehicles (PANDA, HyTRAN and HySys Projects)
- Piedmont Hydrogen System (SPH2) - R&D on hydrogen technologies

- Zero Regio Project -Testing FC vehicles (Panda Hydrogen minifleet) and hydrogen infrastructures in Mantova
- Methane/hydrogen blends Project - Testing of a fleet of 20 ICE cars fuelled with HCNG blends; 2 ENI refueling stations in Milan

- H2U Hydrogen University - "Sailing boat to Hydrogen" (APU unit fuelled with H_2 from renewable sources)

- Hydrogen along Motorway Bolzano-Modena Multinergy refuelling station in south Bolzano (H_2 and HCNG blends)

- Arezzo Project - H_2 distribution network for goldsmith district and use in small cogeneration systems (PEFC); FC hybrid vehicle (H2kart Project)
- MultiEnergy Project - Hydrogen refuelling dispenser in a multifuel station
- Filiera Idrogeno Project (Pontedera /Pisa) Bipower FIAT Multipla (gasoline/H2 mixture); H_2 production/ distribution

- Hydrogen Park (Porto Marghera) - Development and application of hydrogen technologies in transportation and electricity generation
- ENEL Fusina - Hydrogen power generation plant (gas turbine fueled with H_2 supplied by chemical plants)
- Vision Project (Fincantieri) - Hydrogen boat in Venice

- HyCHAIN Project - Demonstration of urban fuel cell vehicles (10 out of 158)
- Methane/hydrogen blends Project (Forlì/Ravenna) - Testing of bus for public transport

- Sotacarbo Project – Hydrogen production from coal

- UNIQUE Project - Hydrogen from biomasses

- Polo Idrogeno Lazio - RD&D hydrogen technologies
- H2-Tpl Project - Hydrogen minibus in Rome public transport (CIRPS/ATAC, hydrogen from electrolysis)

- Puglia Region Project - Distribution network of hydrogen from renewable sources

- Benevento - FC vehicles development (motocycle and van)

- Mata&Grifone project - Development of FC mini-bus and mini-van for Messina ATM
- Messina (Giano project) - Development of FC mini-car for small islands

Long term Italian vision on Hydrogen

A proposal of Italian vision related to the hydrogen deployment in Italy (Italian Hydrogen Platform) has been developed by an experts' team on the basis of the following 2050 targets :

- ✓ Creation of a vehicle fleet of at least 15 millions of hydrogen cars (i.e. about one half of the present car fleet)
- ✓ Hydrogen production based both on fossils and renewables, with the last ones providing a share of one third of the total
- ✓ Use of at least 40% of the hydrogen, for transport and the remaining for power production (mainly through fossils and CCS)

Such hydrogen vision implies for Italy hydrogen production at 2050 equal to about 5 Mt/year, corrisponding to 13 Mtep

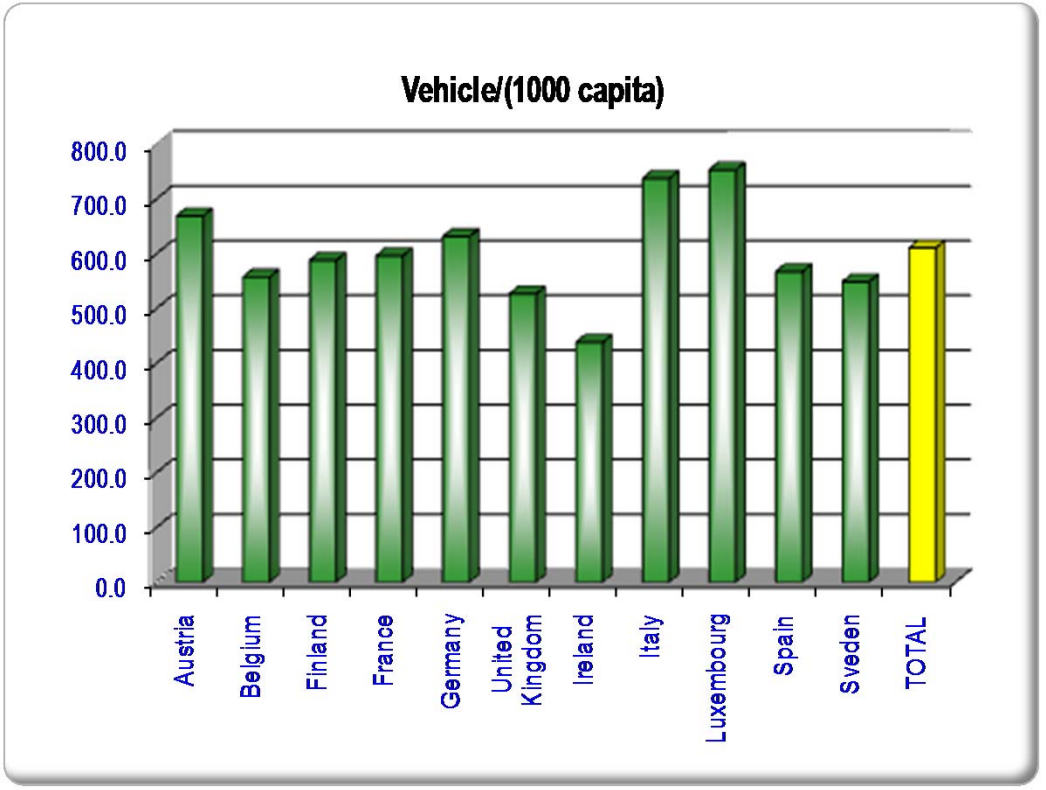
The Italian setup of the road transport

Italy is presently one of the European country with the highest vehicle/capita. In 2008 the Italian vehicle fleet is composed of:

- ✓ **36 millions of cars**
- ✓ **4.5 millions of trucks**
- ✓ **5 millions of motorcycles**
- ✓ **100 thousands of buses**

2008 fuel consumption in road transport was:

- ✓ **11 Mt of gasoline (11.2 Mtoe)**
- ✓ **26 Mt of diesel (26.5 Mtoe)**
- ✓ **1 Mt of LPG (1.1 Mtoe)**
- ✓ **0.52 Mt of NG (0.6 Mtoe)**



In **2008** the **transport** sector has contributed to the CO_2 emissions for 126,5 Mt, on a total of 540,7 Mt (23,4%)

Hydrogen impact in the transport sector

Hydrogen can help to reduce GHG emissions in transport sector especially considering that:

- Alternative fuels (NG, LPG, etc.) have presently limited diffusion and don't completely eliminate CO_2 emissions
- Biofuels can only partially substitute conventional fuels and can conflict with large agricultural territories presently used for food
- Electric vehicles have limitations in range and GHG emissions can be cut only in presence of high shares of renewables and CCS

Many demonstration projects have been therefore carried out with the aim to promote the use of hydrogen vehicles, based both on Fuel Cells technologies and internal combustion.

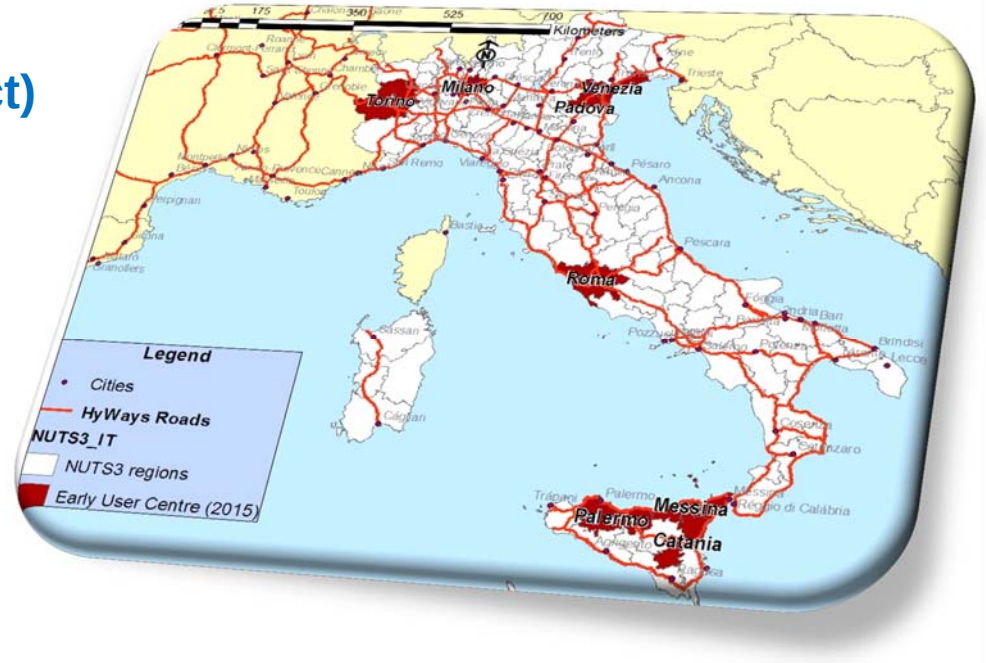
Hydrogen penetration scenarios

Short term

Criteria for the choice of sites for early applications (HyWays Project)

- Availability of hydrogen, possibly at low cost, for instance as by-product.
- Presence of regional development plans
- Significant industrial presence

Areas for early applications



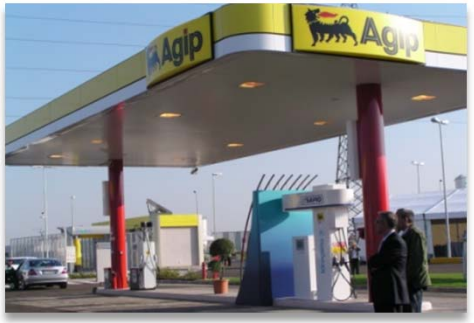
Source: HyWays Project

Turin, Milan, Venice, Rome and Messina

Hydrogen refueling stations

MultiEnergy stations - Eni Refining & Marketing Div.

- Collesalvetti (Livorno) - in cooperation with Tuscany Region
- Frankfurt (Germany) and Mantua (Lombardy) Zero Regio Project, EU 6FQ
- Agip Magliana Nord (Rome) HCNG service station



Experimental stations for prototypes fueled with pure H_2 and HCNG blends

- Ponsacco (Tuscany) – **ILT Technologie**
- Brasimone Research Center **ENEA** (Emilia Romagna)

Hydrogen stations are also planned :

- ✓ **4 along the motorway Bolzano-Modena (AlpenGas, Institut for Innovative Technologies Bolzano)**
- ✓ **2 in Milan area (Lombardy Region, Fiat research Center, Sapio, Agip)**

Hydrogen vehicles

FUEL CELLS VEHICLES

- Three **Panda Hydrogen** in Mantua (Lombardy) - Zero Regio Project, FIAT Research Center

- Three **Hydrogen mini-buses** in Rome - Polo Idrogeno Lazio/ATAC

- **Hydrogen light truck** in Modena - HyCHAIN Project (Air Liquide Italy, Democenter, Fast, VEM)

- Three **Citaro FC buses** (CHIC Project) in Milan starting from 2011 (ATM and Lombardy Region)

ICE VEHICLES

- In the city of Milan**,** 20 **natural gas Panda modified for HCNG use** (up up to 30% of hydrogen) - FIAT Research Centre

- **MHyBus Project -** Two **buses** fuelled with **HCNG** (5-25% H_2) - ATM, Emilia Romagna Region, ASTER, ENEA

- **Bifuel vehicles (**hydrogen/gasoline, FIAT Multipla and Doblò) - ILT Tecnologie, Piel

Hydrogen vehicle considerations

In Italy, due to the quite consistent number of **NG vehicles**, the possibility to use **mixtures** of **NG** and **hydrogen** during the first period of hydrogen transition has been fostered, as:

- ✓ for low H_2 concentration (<15-20%) **no modification** is required on NG vehicles and then minimum additional costs are required
- ✓ H_2 beneficial effects are important even at **low concentration**, while additional costs of H_2 production are limited, and more drivers can be involved with the same H_2 quantity
- ✓ H_2 can be easily produced **on-site** through SMR or electrolysis processes at the filling stations
- ✓ **drivers** can become **familiar** with hydrogen and remove most of the reluctances to its use

Conclusions

- The use of hydrogen and fuel cells can provide future significant benefits in Italy, in terms of **emission reduction**, both at local and global level, **primary energy sources diversification** and **new opportunities** for national industry
- Several **RD&D projects** are carried out, as result of European, national and regional programs, with the participation of industries, research organisations and users
- But the introduction of hydrogen and fuel cells into the market requires the overcoming of considerable **barriers** in the areas of **technology**, **infrastructure** and **economics**.
- The **safety aspects** play a particularly critical role, as the **international standards** are **far to be applied** in Italy at the moment and **quite a lot of stakeholders** are involved in decisions, **delaying** the H_2 initiative approval times
- **Regions** and **Local Authorities** are taking the **leading role**, financing demonstrations and infrastructure deployment.
- But a **better coordination** is required between the **national** and **local Authorities** to provide more **rapid** and **effective decisions** and **integration** of **available resources**, to keep the pace of the **most involved countries** and to seize also the opportunities arising from the **international collaborations**.

Thank you for your attention