

FCVs status in Italy production and applications

Annex XXVI Experts' Meeting
Fuel Cells for transportation

Grenoble, France, 3 December 2014

- 1. Many FCVs produced up to prototype level in Italy**
- 2. Mostly used for product innovation or demonstration projects**
- 3. Currently there are only few FCVs under testing in European Union Projects**
- 4. The presentation will give a survey of most recent prototypes and demo applications**

Fuel Cell Hybrid Bus IVECO-IRISBUS

Tests performed in Turin



IVECO FUEL CELL HYBRID BUS

Two vehicles have been demonstrated : one in **Turin** and one in **Madrid**. Two powertrain configurations are possible: **Hybrid** with high-power battery Pack and **Full Power** with 2x FCS in parallel.

Electric motor

Tipo	Asincrono Trifase
Potenza massima	160 kW @ 1500 rpm
Velocità base	1500 rpm
Coppia massima	1500 Nm

H2 Tank

Pressurized tanks	n. 9 x 140 liter
Material	Stainless steel

Batteries

Type	Lead AGMbito
Voltage	576 V
Capacity	50 Ah

Fuel Cell PEM (U.T.C.)

Fuel Power	Compressed H2(250 bar) 60 kW
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Examples of the most FCV produced in Italy

FIAT Panda Hydrogen



3 Panda Hydrogen produced and delivered between 2007 and 2009 (an average of 6 months for type-approval and permission for road use) for the EU Project **ZERO Regio** and used in Mantua

Fiat Panda *HYDROGEN*

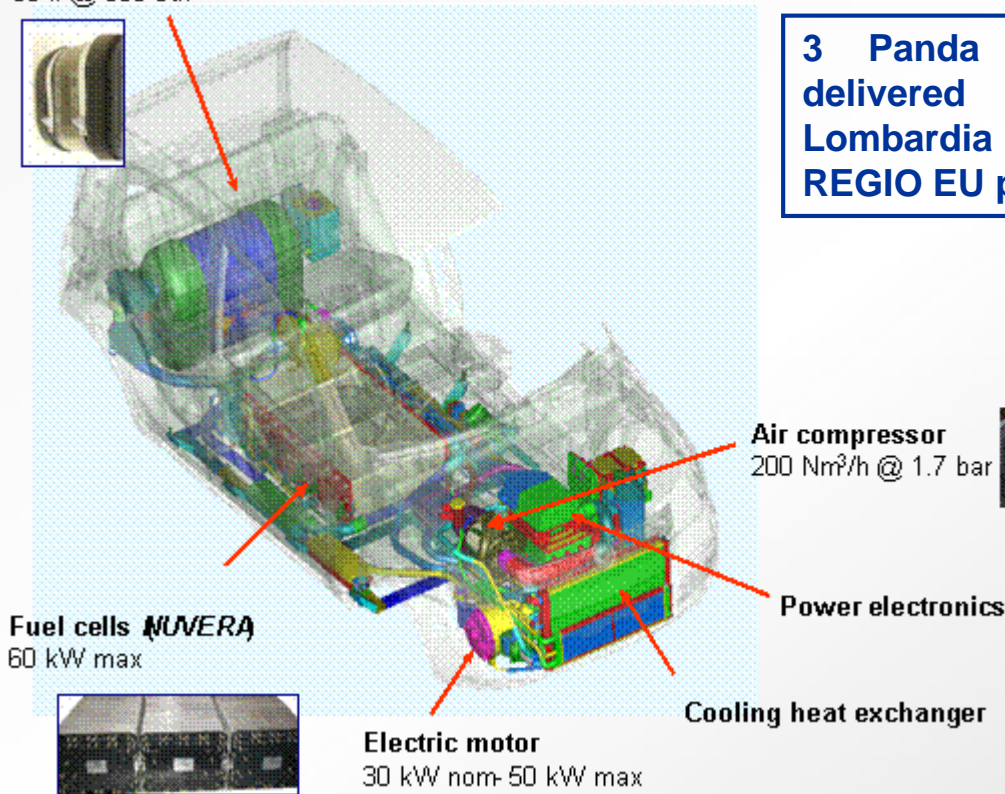
GENERAL CHARACTERISTICS

- Full power PEM fuel cell vehicle
- New generation air compressor
- Carbon fiber hydrogen tank
- AC induction electric motor

Hydrogen tank ()
60 l. @ 350 bar



3 Panda FC Hydrogen
delivered to Regione
Lombardia within ZERO-
REGIO EU program



TECHNICAL DATA

Seats	4 passengers
Vehicle curb weight	1400 kg
Acceleration 0-50 km/h	5 s
Max speed	130 km/h
Max slope (full load)	23%
Refueling time	<5 min
Range (UDC)	>200 km`

Examples of FCV produced ZEV1



Prestazioni del veicolo ZEV1

Tecnologia	PEM Fuel Cell , Configurazione Full Power
Velocità massima	70 km/h
Pendenza massima	15 %
Autonomia	Da 50 a 80 km
Peso totale a terra	2600 kg
Portata	Fino a 1400 kg
Accumulo idrogeno	1,1 kg
Marcia ridotta disponibile	Si
Potenza massima	20 kW

**ARCOTRONICS FUEL CELLS – no
longer existing**

Examples of FCV produced ZEV2



**ARCOTRONICS FUEL CELLS – no
longer existing**

Prestazioni del veicolo ZEV2

Tecnologia	PEM Fuel Cell , Configurazione Full Power
Velocità massima	45 km/h
Pendenza massima	17 %
Autonomia	Da 50 a 80 km
Peso totale a terra	222 kg
Portata	Fino a 108 kg
Accumulo idrogeno	140 g
Variatore elettronico di velocità	Si
Potenza massima Stack	4 kW

JU FCH Program H2 Moves (2 MITO FCVs)

Hydrogen European Lighthouse Project

The 4rd generation: Alfa Romeo MHyt FC

General Characteristics:

- Seats 4
- Max Speed 150 km/h
- Acc. 0 – 100 km/h 9 s
- Range (Urban Cycle) 350 km
- Max Slope 23%
- Refuelling time 5 min
- Cold start -30°C
- Fuel economy 120 km/kg

Powertrain:

- Fuel cell system PEM - Nuvera
- Electric Motor Asynchronous
- Hydrogen Tank gaseous H₂ @ 700 bar

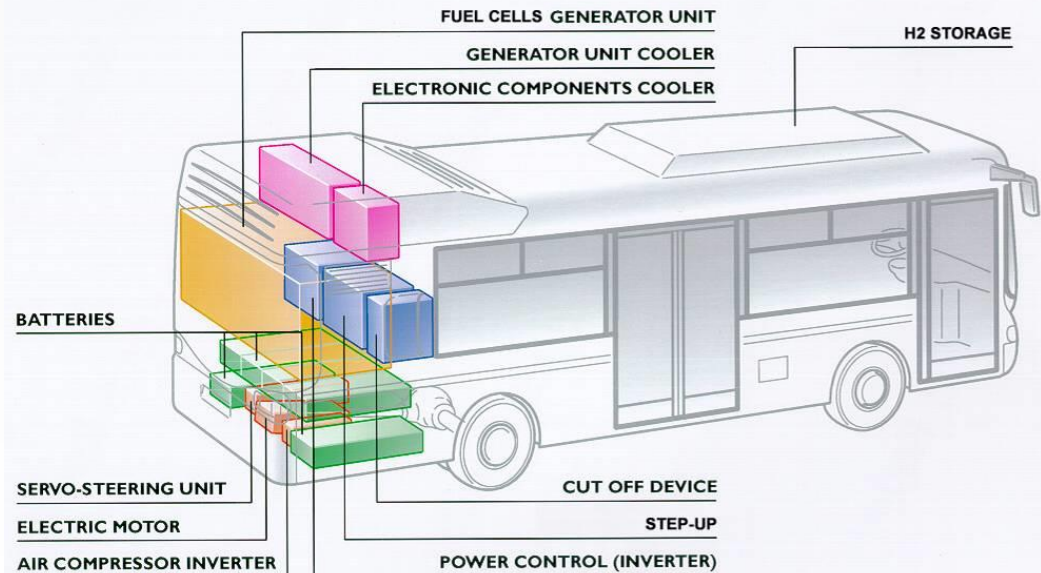


The Alfa Romeo MiTo Fuel Cell car uses a Nuvera Fuel Cell stack combined with a compact Li-ion traction battery pack to supply power to the electric motor; top speed of 150 km/h (93 mph) and acceleration from 0 to 100 km in 10 sec, with hydrogen consumption of 3.2 L diesel equivalent/100 km (74 mpg US) and a range of 450 kilometers (280 miles) in NEDC, thanks to 700 bar H₂ tanks.

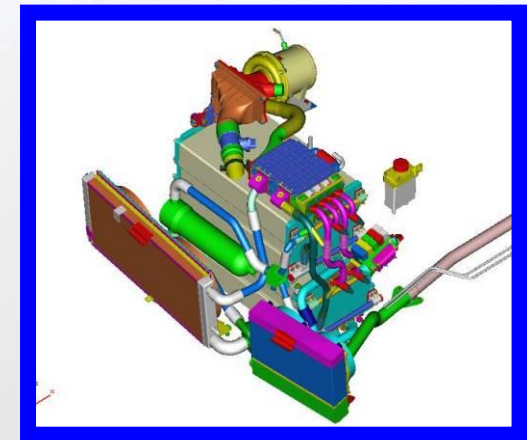
IVECO EUROPOLIS FUEL CELL Next Generation



New FC Bus planned



- System: series hybrid
- Length: 7.4 m.
- Chassis: super-low (350 mm.)
- Payload: > 30 passengers
- Batteries: Ni-Cd / Ni-MeH
- Range: > 200 km (hybrid mode)



60kW Fuel Cell System

Rampini FC Bus



M.T.T.	11,800 kg
Lunghezza	7,720 mm
Larghezza	2,200 mm
Altezza	3,180 mm
Passo	3,675 mm
Sbalzo	2,345 mm
Velocità massima	> 62 km/h
Posti (seduti, in piedi, disabili, autista)	no. 9 + 33 + 1 + 1 = 44
Autonomia	circa 170/190 km (in ciclo urbano)
Bombole idrogeno	Dynatech, no. 2, 350 bar, 4,8 kg cad.
Cella a combustibile	Hydrogenics, HyPM16, 16 kW
Batterie	libro ferrite, circa 90 kWh
Motore	Siemens, AC trifase sincrono, 85/150kW
Inverter	Siemens, DC-DC/IGBT MONO Inverter
Tempo di ricarica	minimo 2 ore
Tempo di rifornimento	circa 10/20 min.



Tecnobus (Hydrogenics) FC Midi Bus



Technical Data

Length	5,30 m
Width	2,10 m
Type	Low floor
Seats	8 + 2
Standing	14
Max speed	33 km/h
Autonomy	200 km
Drive	PEM Fuel Cell
Fuel	Hydrogen(99.99 %)
Gas storage	Compressed gas (200 bar)
Energ storage	NiCd Batteries

- **Bolzano –FC Busses**
- **Mantova – Panda FC**
- **Milano –Panda FC, FC Busses**
- **Savona – FC Buses**
- **Trento – Daily using biogas and HydroBiomethane, and FC Busses**
- **Torino – IVECO FC Buses, Europolis FC busses, Panda FC , Electric vans and cars**
- **Other Regions under involvement: Abruzzo, Liguria, Puglia, Veneto**

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)



Regions Demo Program for Hydrogen



Torino

- H2 Refuelling Stations
- Europolis FC Hybrid
- Panda FC



Pescara

- H2 Refuelling Stations
- Panda H2-CNG
- Daily H2-CNG



Autostrada del Brennero SpA
 Brennerautobahn AG



Trento, Bolzano

- H2 Refuelling stations
- FC Busses



Milano, Mantova

- H2 Refuelling stations
- Panda Hydrogen
- FC Busses

HyChain Mini-TRANS project

Testing of small urban vehicles (up to 158) in four European regions:

- Rhône-Alpes in France
- Castilla y León in Spain
- North Rhine Westphalia in Germany
- Emilia Romagna (Modena) in Italy



The first FC utility van developed by VEM, in collaboration with Axane and Air Liquide, has been shown in Modena, on June 27th, 2007

FC Van in HYCHAIN Project –City of Modena

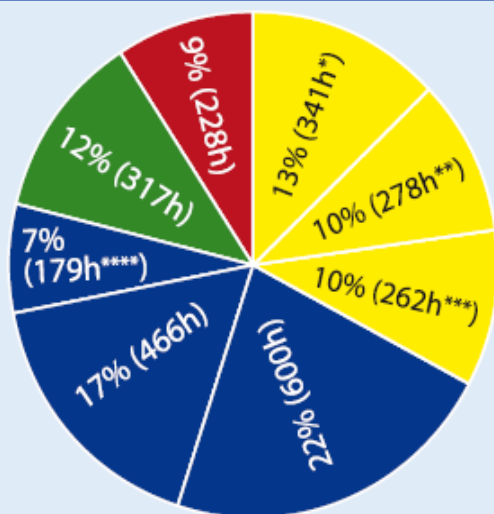


VEM Hybrid H2Van used
in Modena

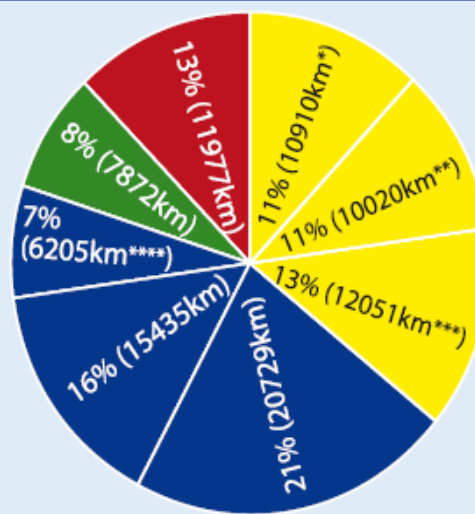
In total 158 FCV in 4
European Countries

TIPO	PEM FC
TENSIONE D'USCITA	48 Vcc / 1230 Vca
POTENZA MAX	+1°/+45° C
TEMPERATURA D'ESERCIZIO	
DIMENSIONI ESTERNE (LXPXA)	63X55X71 cm
PESO	75 kg
TEMPERATURA DI DEPOSITO	+1°/+45° C
PERIODO MAX DI DEPOSITO	6 settimane
INDICE DI PROTEZIONE	IP 23

ZERO Regio Project in Mantua – 3 Panda FC

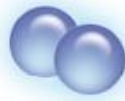


Service hours



Travelled distance

ZERO Regio EU Project in Mantova – other results



Mantova

- 3 Fiat Panda FC-Vehicles
- On-site H_2 production

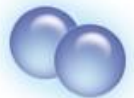
2 Years of Demonstration Experience

Vehicle

- 3-7 FCV's, 100 Vehicle months, 42000 km driven
- 505 Kg H_2 consumed, 7,2 tons of CO_2 emission saved
- Vehicle availability 98%, high reliability

Availability Infrastructure

- Dispensers (350 bar) > 95%
- Dispenser (700 bar) > 55% (outage due to accident)
- Ionic Liquid Compressor > 77%
- Public service stations in use for H_2 -Vehicles outside the project (Hyundai, Toyota, BMW & Buses)



EU HighV.Lo-City – Sanremo (5 FC Buses)



Van Hool FV Buses in operation in Spring 2014



Since September 2014 a fleet of 10 Hyundai ix35 Fuel Cell can be rented at 870 €/month per private users and at 1100€/m for companies and are refueled only with «green hydrogen» produced from renewable energy sources

CHIC - Clean Hydrogen in European Cities Project

Cities of Milano and Bolzano involved

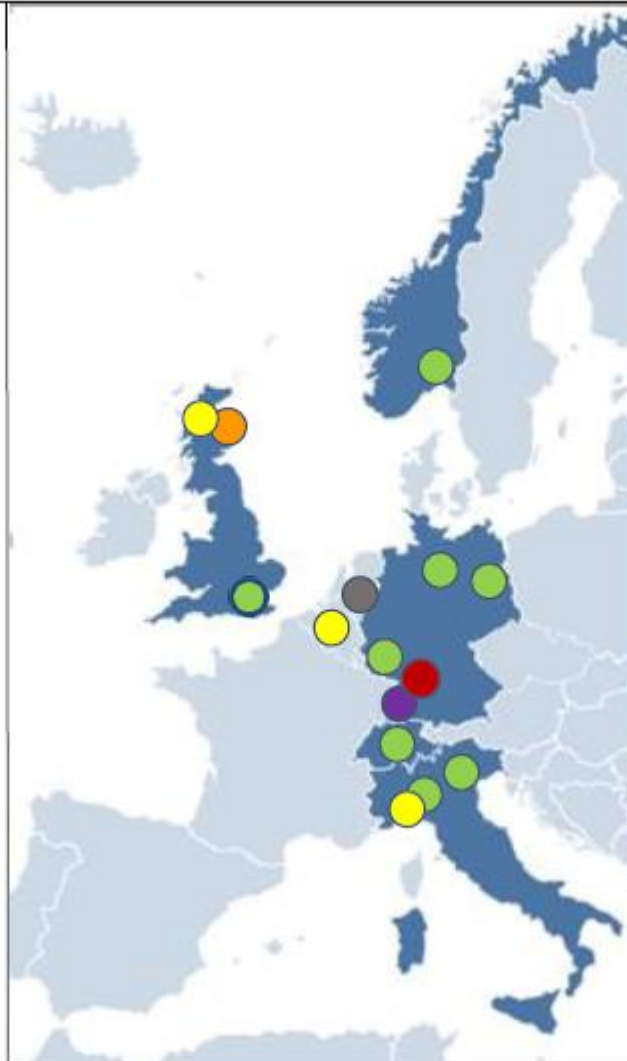
- Demonstration of the operation of over 60 fuel cell buses, mainly through 3 EU-funded demonstration projects
- An additional project deploying 21 fuel cell buses will start soon

Current national/regional-funded fuel cell bus projects:

- ✓ Karlsruhe – 2 FC buses
- ✓ Stuttgart – 4 FC buses
- ✓ Amsterdam – 2 FC buses

Legend:

- CHIC countries
- ✓ In operation
- ✓ Planned for operation



Current EU-funded fuel cell bus projects

● CHIC

- ✓ Cologne – 4 FC buses
- ✓ Hamburg – 4 FC buses
- ✓ Bolzano – 5 FC buses
- ✓ Aargau – 5 FC buses
- ✓ London – 8 FC buses
- ✓ Milano – 3 FC buses
- ✓ Oslo – 5 FC buses
- ✓ (Berlin – 4 H₂-ICE buses)

● High V.LO-City

- ✓ Liguria – 5 FC buses
- ✓ Antwerp – 5 FC buses
- ✓ Aberdeen – 4 FC buses

● HyTransit

- ✓ Aberdeen – 6 FC buses

CHIC - Clean Hydrogen in European Cities Project

Cities of Milano and Bolzano involved - Some results

Average consumption of the FCH buses

