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The Italian hydrogen mobility scenario implementing the European directive on alternative fuels infrastructure (DAFI 2014/94/EU)

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ARTICLE INFO

Article history:

Received 30 June 2017

Received in revised form

25 August 2017

Accepted 28 August 2017

Available online xxx

Keywords:

Hydrogen mobility

Fuel cell electric vehicles

Hydrogen refueling stations

Hydrogen production

ABSTRACT

The European commitment to promote a sustainable (green and clean) mobility has been strengthening in recent years. An important milestone is the DAFI Directive 2014/94/EU, targeting the deployment of an alternative fuels infrastructure in the European Union, to be implemented through national policy frameworks. The DAFI Directive has been implemented in Italy through the Legislative Decree n. 257 (December 2016), including hydrogen in the list of alternative fuels. Concerning the hydrogen mobility, this paper describes the methodology and the main results of the Scenario MobilitàH2IT. On behalf of the Italian Ministry of Economic Development, it summarized the common vision of several stakeholders joined in the initiative “Mobilità Idrogeno Italia” (MH2IT), established in June 2015. Moreover, these results are reproduced in the Annex III of the Legislative Decree n. 257, thus representing an official reference. With a 2050 time horizon, the applied methodology considers: (1) Sizing of the FCEV fleet and hydrogen demand at the refueling stations; (2) Hydrogen production for the transport sector and integration of renewable electricity with hydrogen storage; (3) Sizing of the hydrogen refueling stations; (4) The consumer perspective; (5) Reduction of CO₂ emissions and other harmful pollutants; (6) Measures to support the national policy framework. This methodology can be replicated in other national studies and the Italian results can be checked as a comparison term.

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Introduction

In this section, the main recent European Union policies promoting a sustainable mobility are described. Among them, the DAFI Directive 2014/94/EU [1] is the one that inspired this paper. Moreover, an overview of the technological state-of-the-art of hydrogen, as an energy carrier for a green and clean mobility, is reported, based on a review of the most recent scientific publications.

European Union policies for a sustainable mobility

In the transport sector, (I) support innovation and efficiency, (II) cut the dependence on imports of fossil fuel, and (III) drive the transition to internal and renewable energy sources (RES), is the way to achieve key European objectives: stimulate economic growth, increase the employment level, and mitigate climate change. In this framework, Italy is particularly penalized by a level of energy dependence among the highest in Europe (76.9% in 2013). In 2012, imports of crude oil

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<http://dx.doi.org/10.1016/j.ijhydene.2017.08.203>

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Abbreviations

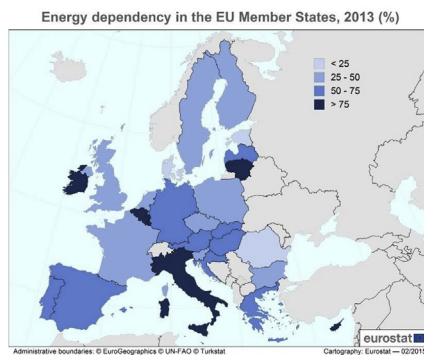
AL	annual load
BEV	battery electric vehicle
CAPEX	capital expenditure
EU	European Union
FC	fuel cell
FCEV	fuel cell electric vehicle
FCH JU	Fuel Cells and Hydrogen Joint Undertaking
GDP	gross domestic product
HRS	hydrogen refueling station
ICE	internal combustion engine
IEA	International Energy Agency
OPEX	operational expenditure
PHEV	plug-in hybrid electric vehicle
PV	photovoltaic
RES	renewable energy sources
SMR	steam methane reforming
T&D	transportation and distribution
TCO	total cost of ownership

amounted to 68.81 million tons, spending on gasoline and diesel about 24.63 billion euro [2] (Fig. 1).

Several studies ([3–6]) recognize that important European targets in the transport sector, concerning decrease of energy consumption from fossil fuels, reduction of CO₂ emissions, improvement of air quality, and reduction of noise, can be achieved through three key actions:

- 1) *avoid transport*, for example through a better urban planning and a significant increment in teleworking;
- 2) *shift transport demand*, towards more efficient modes such as public transport and rail freight;
- 3) *improve transport technologies*:
 - a. increase efficiency of traditional technologies
 - b. promote a rapid spread of alternative vehicles including battery electric vehicles (BEVs), fuel cell electric vehicles (FCEVs), plug-in hybrid electric vehicles (PHEVs), and biofuels vehicles.

The European commitment to promote a sustainable (green and clean) mobility has been strengthening in recent years.



The White Paper of the European Commission of 28 March 2011, “Roadmap to a Single European Transport Area - Towards a Competitive and Resource Efficient Transport System” [7], urges to reduce oil dependence in the transport sector. This objective can be achieved through a number of strategic initiatives, including the development of a sustainable strategy for alternative fuels and related infrastructure.

Based on the Communication from the European Commission of 24 January 2013, “Clean Power for Transport: A European alternative fuels strategy” [8], as well as the consultation of stakeholders and national experts, electricity, hydrogen, biofuels, natural gas, and liquefied petroleum gas (LPG), have been identified as the main alternative fuels with a considerable potential for long-term oil substitution.

Moreover, in this European commitment, an important milestone is the DAFI Directive 2014/94/EU [1]. The DAFI Directive establishes a common framework of measures for the deployment of an alternative fuels infrastructure in the European Union, to be implemented through national policy frameworks to be notified by 18 November 2016. These national policy frameworks shall contain the following elements:

- as regards alternative fuels in the transport sector, an assessment of the current state and future market development, including the development of infrastructure with cross-border continuity, where relevant;
- national targets for the implementation of alternative fuels infrastructure;
- measures to ensure the achievement of the national targets;
- measures that can promote the deployment of an alternative fuels infrastructure in the public transport.

The DAFI Directive has been implemented in Italy through the Legislative Decree n. 257 of 16 December 2016 [9], including hydrogen in the list of alternative fuels for which Italy is committed to develop an adequate network of refueling stations by 31 December 2025. The Italian future prospects of hydrogen mobility (Scenario MobilitàH2IT) have been identified and described, on behalf of the Italian Ministry of Economic Development, by “Mobilità Idrogeno Italia” (MH2IT). MH2IT is an association, established in June 2015, that brings



Fig. 1 – Energy dependence in 2013 and spending of European countries in petrol and diesel in 2012. Reference: Eurostat [61].

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