IEA-HIA Activities on Small-Scale Reformers for On-Site Hydrogen Supply

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IEA-HIA Activities on Small-Scale Reformers for On-Site Hydrogen Supply

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Summary

Task 23 is a collaborative task on small scale reformers for on-site hydrogen supply under the IEA Hydrogen Implementing Agreement. Sixteen experts from nine member countries participate in this task, constituting a unique group of international gas suppliers, reformer technology suppliers and researchers. The task was kicked off in 2006 and is a continuation of previous activities. This paper describes the scope, goals and preliminary results for the task.

1 Introduction

Hydrogen production by on-site reforming is an important stepping stone towards the development of a hydrogen infrastructure for the transport sector. Today, on-site production units can be developed in any required size and capacity. It is important for vendors that norms for size, capacity and footprint exist to enable mass production and reduce costs. Therefore, a harmonization of the technology is essential.

Hydrogen by on-site production cannot be provided at a reasonable cost when including CO_2 capture and storage. However, choice of feedstock and improved energy efficiency can contribute to a reduction of emissions and thereby enable hydrogen production by small scale reforming. Task 23 performs studies on feedstock and possibilities for on-site hydrogen supply, based on suppliers operation experience, research and development activities supporting suppliers of on-site production units in future technology development.

Establishment of a market for hydrogen is a challenge as the number of cars and service stations is highly coupled and depending on a strong collaboration between car producers and gas suppliers. Task 23 constitutes a unique group of experts addressing the challenges of harmonization, emissions handling and market development. The experts represent international gas suppliers, technology suppliers and research institutes. This type of international collaboration across disciplines and industrial segments is essential to facilitate industrialization and hydrogen infrastructure development. A market guide based on results from Japan, Europe and California studies with respect to quality and quantity will facilitate the infrastructure development and produce a decision basis for end-user.

2 Harmonised Industrialisation

One of the main goals of Task 23 is to develop a harmonised framework for design of reformer units for on-site production. It is important for suppliers and end-users that norms and standards for size, footprint and capacity exist for hydrogen refuelling infrastructure to reduce costs. Six suppliers of which two are of the world's major suppliers of reformer technology participate in the work. The goal shall be reached through the development of harmonized capacities, identification and application of relevant standards, regulations and codes.

Small scale reformer suppliers world wide have been identified and system data has been collected by use of a questionnaire, internet and Task 23 expertise. Available on-site reformers systems have been categorised into five different size ranges equivalent to those reported previously by NRELs study on state of the art of electrolytic hydrogen production [1]. The defined sizes are related to the number of hydrogen cars that can be served:

- Home: serves fuel needs of 1 – 5 cars with a hydrogen production rate of 200 to 1000 kg H_2/year (0.25 to 1.5 Nm^3/h)
- Small neighbourhood: serves fuel needs of 5 – 50 cars with a hydrogen production rate of 1000 to 10 000 kg H_2/year (1.5 to 15 Nm^3/h)
- Neighbourhood: serves fuel needs of 50 – 150 cars with a hydrogen production rate of 10 000 to 30 000 kg H_2/year (15 to 45 Nm^3/h)
- Small forecourt: serves fuel needs of 150 – 500 cars with a hydrogen production rate of 30 000 to 100 000 kg H_2/year (45 to 150 Nm^3/h)
- Forecourt: serves fuel needs of more than 500 cars with a hydrogen production rate larger than 100 000 kg H_2/year (larger than 150 Nm^3/h)

The study will result in recommendations for size, footprint and capacity.

3 Sustainability and Renewable Sources

A study is under development on the various fuel paths on when to convert a feedstock to hydrogen and when to use it directly. Available European [2] reports have been taken into account as well as Task 23 expertise.

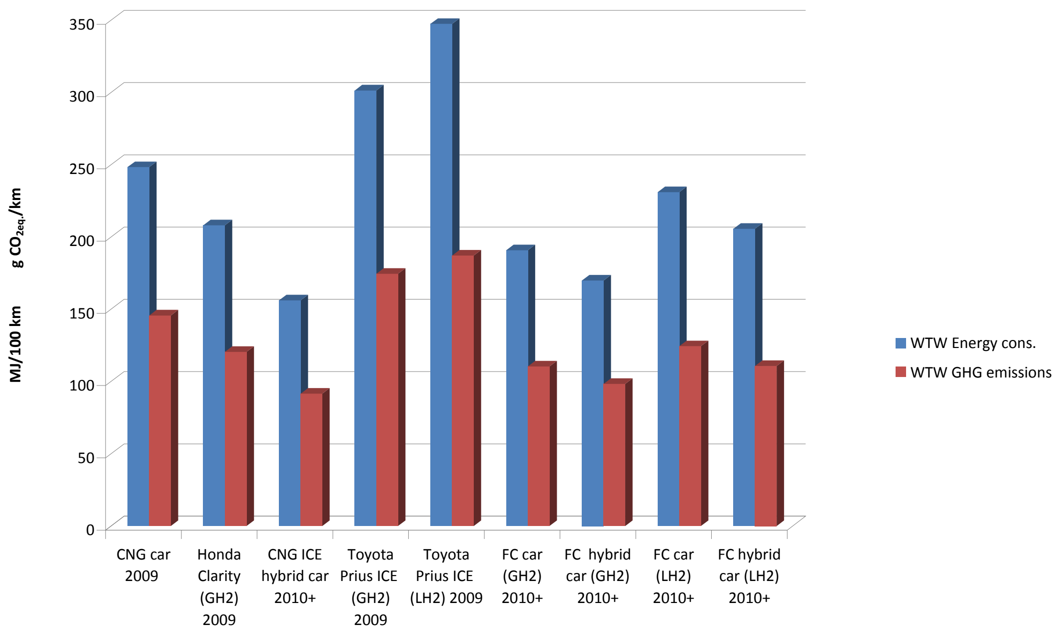

Figure 1: Fuel paths for CNG, hydrogen supplied by reforming.

Figure 1 shows an example of one of the fuel paths generated in the project. The figure shows a large variation in the WTW energy consumption. The energy consumption and emissions of the CNG ICE hybrid car (best available technology in 2010) is lower than for the fuel cell car. However, the fuel cell car is to be prefered compared to the CNG car (best available technology in 2009). This shows that small scale reforming can contribute to reduce emissions in an early market development. Various fuel paths will be presented in the final report of Task 23 in 2011.

Technology exists for small scale CO_2 capture. However, capturing CO_2 is an energy intensive business, unlike many other clean-up technologies (e.g. NOx, SOx) and in addition transportation costs and infrastructure for decentralized sources is required. The general consensus is that CCS at large point sources can be justified and hydrogen may be supplied from large plants with CCS.

4 Market Studies

Cheaper and more efficient small scale reformers, fewer and more compact components and growth in the hydrogen refuelling market will reduce the price of hydrogen. Three markets (US, Europe and Japan) has been evaluated and compared using existing studies based on medium and long term scenarios [3]-[5] as well as data supplied by the Task 23 experts. The parameters applied in the analysis are LHV, natural gas price, electricity price, process water consumption, plant capacity, efficiency, capital investment and operating costs. The goal of the analysis is to give an estimation of hydrogen supply cost, energy efficiency and CO_2 emission on WTT basis and substantiate the use of small-scale reformers in early market development.

5 IEA-HIA Task 23 current experts.

Country	Organization	Expert
Denmark	Haldor Topsoe	J.B.Hansen
Germany	Mahler AGS	R. Stauss
Japan	Tokyo Gas	I.Yasuda
Japan	Mitsubishi Kakoki Kaisha	A. Obuchi
Norway	Statoil	B.T. Børresen
Norway	Statoil	E.Ochoa-Fernández
Norway	SINTEF	I.Schjølberg
Netherlands	HyGear	D. Lieftink
Netherlands	ECN	E. van Dijk
Sweden	SGC	C.Nelsson
Sweden	Catator	F. Silversand
Italy	ENEA	E.Calo
Turkey	TÜBITAK	A.Ersoz
France	N-GHY	D.Grouset
France	N-GHY	P.Marty
France	GDF Suez	J.Saint-Just

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[3] www.hyways.de

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[5] www.jhfc.jp