



## D3.2 Analysis of experiences and activities on hydrogen metering accuracy

### REPORT

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## Introduction & scope of tasks

This document serves as a reporting for the deliverable “D3.2 Analysis of experiences and activities on hydrogen metering accuracy” as part of the HyAC project.

An overall analysis has been conducted on past and ongoing activities on hydrogen metering accuracy approval and verification activities, mainly in EU and individual national member countries and secondary on international level. The aim has been to ensure inclusion of and basing of the HyAC project efforts on past experiences and lessons learned.

**Please note that scope of results have been impacted by a general delay in project activities, which could not be recovered as an extension of the project period was not granted by the FCH-JU.**

## 1. EU experiences

### 1.1 United Kingdom

There is currently no national legislation for the accuracy of metering hydrogen as a gas for fueling motor vehicles, in the UK, therefore it would be necessary to contact any (commercial) users to establish the methods – if any – related to metering accuracy including the processes and reference equipment used involved and the traceability of the measurements.

The HONDA Motor Company vehicle assembly plant, situated in Swindon (UK), have a fuel station which is used for re-fueling the forklift trucks operating within the plant. The station is not generally available to the general public.

London transport now has a fleet of eight hydrogen fuel buses running on route RV1 between Covent Garden and Tower Gateway.

### 1.2 Scandinavia

The main experience on hydrogen metering accuracy in Scandinavia is mainly based on Hydrogen Refuelling Stations (HRS) installed and operated in Denmark.

Denmark has implemented the The MID-directive Annex MI-002 “Gas meters and volume conversion devices” and the OIML R 139 “Compressed gaseous fuel measuring systems for vehicles” – however they are not used as basis for hydrogen metering in Denmark (as hydrogen is not included).

Since 2008 more than 10 fueling stations of various pressures have been demonstrated in Denmark. This has created basis for developing a pragmatic approach to handling hydrogen metering, despite no regulation or standard is in place.

The Danish Safety Technology Authority is handling metering accuracy in Denmark. Based on a dialogue a methodology has been developed that includes a third party validation of the hydrogen metering accuracy prior to installation of a HRS.

The validation is based on weighing the amount of hydrogen fuelled into a test tank, using precision scales. The tests are done prior to start of HRS operation and is monitored by a third party that calculates the accuracy (% deviation) and issues a test report. In general a consistent accuracy of a few % deviation have been observed on the HRSs installed.

The approach does not necessarily ensure a coherent approach to accuracy measurement but it ensure that attention is put on accuracy before installing an HRS.

When hydrogen at a later stage is included in European directives and/or standards, it is likely that this will be implemented in Denmark.

## 1.3 Germany

In Germany activities on hydrogen accuracy is in particular conducted under the public-private the Clean Energy Partnership (CEP). CEP is a joint initiative of government and industry lead-managed by the German Ministry of Transport and Industry with twenty industry partners.

Within the CEP a dedicated working group is active on various hydrogen metering topics:

- Assess fueling data and matching hereof between cars and fueling station
- Asses status on development and availability of metering devices
- Test the accuracy of current metering methods and asses technical feasibility
- Explore variants of Measuring Mass(transfer)

The aim is to establish a metering method in coordination with German authorities (Eichamt) and agencies (e.g. PTB - the National Metrology Institute of Germany).

In 2013 the CEP initiative published results from accuracy tests conducted at various HRSs in Germany. On average 35 % of all refuelings had a deviation above 9% and generally the higher the refueled quantities the lower the deviation. Presently the “Weights and Measures Act” applicable for CNG only allows +- 2% deviation.

CEP are at present executing a 3-step-development-program to further address the accuracy topic. This includes a feasibility study on measurement methods, development of prototype measurement equipment for laboratory and later for in-field testing.

CEP has also formulated some initiation boundary conditions for hydrogen accuracy (2013):

- Medium: CGH2
- Pressure: up to 87.5 MPa
- Temperature window : +50°C -40°C , high gradient (cool down from ambient temperature to -30°C in <30 seconds)
- Max. mass flow: 50 g/s, operating range between 33 - 34 g/s
- Min. mass flow: < 5g/s
- Pipe diameter: 3/8"
- Average refueling amount: 2-4 kg, a minimum amount has not yet been defined

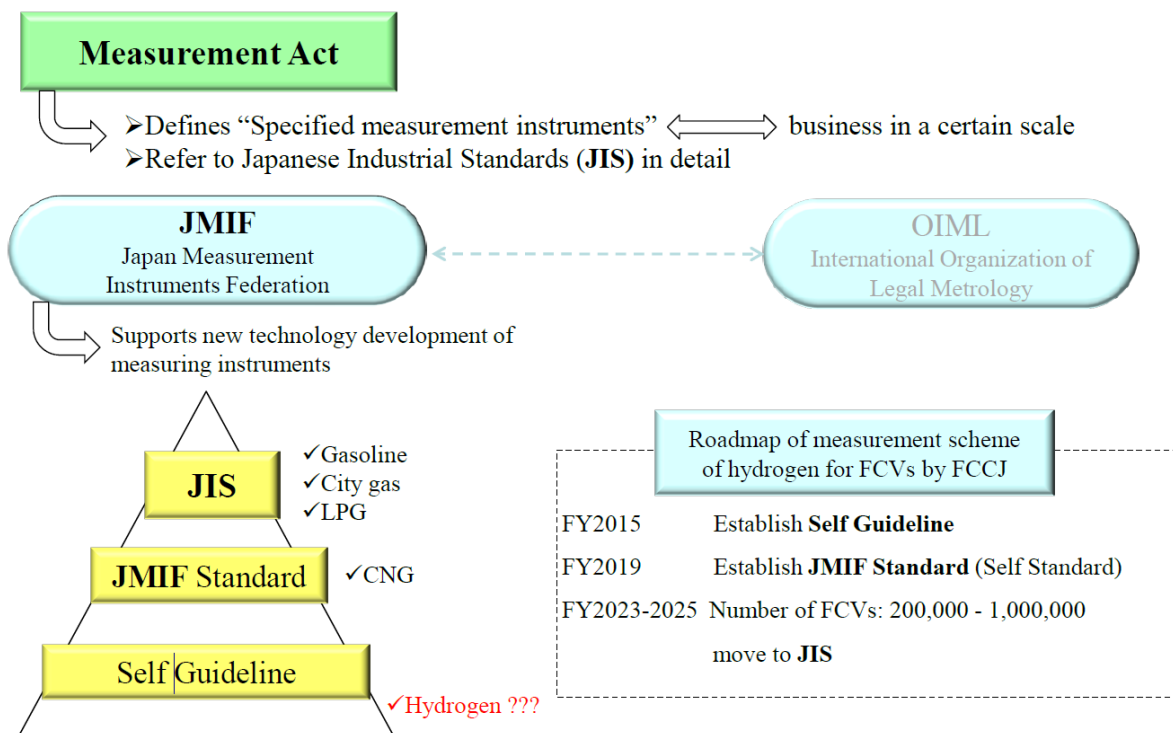
## 2. International experiences

### 2.1 Japan

At present there is no governmental regulations on hydrogen metering so instead suppliers are only to measure as accurate as possible.

In Japan NEDO is therefore facilitating a project with the aim to establish technical standards for Gravimetric and Master Meter Methods on hydrogen accuracy and metering.

The existing Measurement Act structure in Japan and the possible integration of hydrogen is outlined in the figure below.

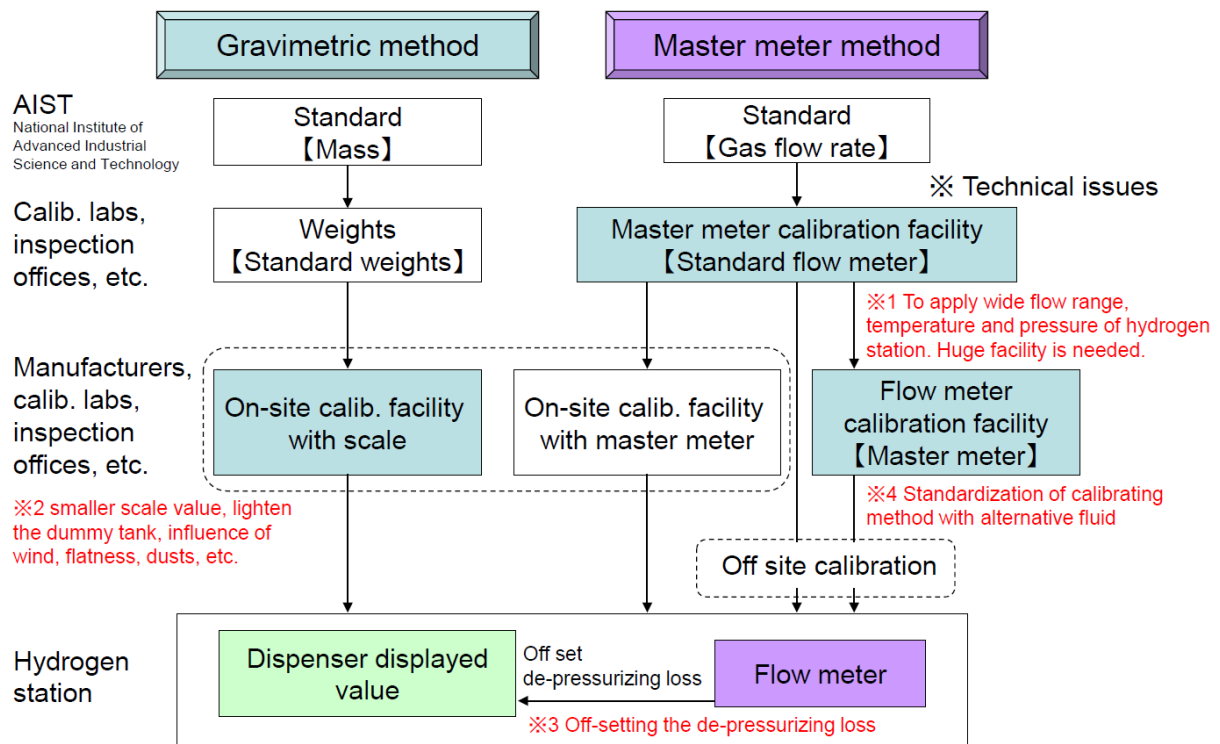


The aim of the NEDO project is to firstly establish a voluntary Self Guideline based on "Gravimetric method" before 2015. This can then be used for manufacturers own assessment of accuracy.

After collecting sufficient technical data and results from use of the voluntary guideline it is to be updated with a "Self Standard" based on "Master Meter method" scheduled onwards 2019.

The technical approach in Japan is firstly to use the Gravimetric method as this is technically feasible and achievable today. As the data and experience basis mass flow meters are increase this may enable a new and more simple approach using a calibrated master flow meter as measurement basis.

The approach is outlined in the figure below.



## 2.2 USA/California

The experience in USA on hydrogen metering is in particular linked to the HRS roll-out efforts in California.

In order to offer commercial sale of hydrogen, A HRS operate must receive a Certificate of Approval that indicates the dispenser accurately measures the amount of hydrogen it dispenses during sales to customers.

California’s Department of Food and Agriculture (CDFA) is the authoritative agency for motor fuel sales certification and also hydrogen. CDFA has adopted the standards outlined in the National Institute of Standards and Technology Handbook 44 (NIST 44).

The NIST 44 outlines weighing and measuring devices of which the section 3.39 is relevant for hydrogen dispensing and specifies a tolerance of 1.5% for acceptance (typically for commissioning) and 2% for maintenance (or continued operation).

The table below outlines the NIST 44 accuracy targets:

Accuracy Class	Commodity	Acceptance Tolerance	Maintenance Tolerance
2.0	Hydrogen as a Vehicle fuel	1.5%	2.0%

To support adoption of the standard several organizations have collaborated on designing, building and testing a “Hydrogen Field Standard (HFS) Metrology Testing Device”. It was built to follow the requirements of NIST 44 and has tested most of the currently-operating HRS.

Based on the results and analyses completed, CDFA is in the process of adopting regulation to establish three additional accuracy classes of 3%, 5%, and 10%, based on certification with the HFS device. The relaxed targets are outlined in the table below.

Accuracy Class	Acceptance Tolerance	Maintenance Tolerance	For Dispensers Installed Prior To
2.0	1.5%	2.0%	N/A
3.0	2.0%	3.0%	1/1/2020
5.0	4.0%	5.0%	1/1/2020
10.0	5.0%	10.0%	1/1/2018

HRS’s will be able to receive certification to one of these degrees of accuracy. Distinction will be made between accuracy of HRS at commission and testing conducted as part of normal operation. The intent is to relax today for the present HRS technology, and then to increase the targets as the technology progresses.