Webinar:
International Hydrogen Infrastructure Challenges Workshop Summary – NOW, NEDO and DOE

December 16th 2013

Partner:

Timetable

• Introduction to the Webinar (2 min)	Erika Sutherland
• Remarks (10 min)	Sunita Satyapal, Klaus Bonhoff, Eiji Ohira
• Speaker Introduction (3 min)	Erika Sutherland
• General country overview (15 min)	Hanno Butsch
• H2-Fueling (15 min)	Jesse Schneider
• H2 Quality (15 min)	Jesse Schneider on behalf of Georgios Tsotridis
• H2-Metering (15 min)	Tetsuji Nakamura
• H2-Fueling Hardware (15 min)	Peter Ehlers
• Q&A (30 min)	

Welcome

From:
Dr. Sunita Satyapal (DOE)
Dr. Klaus Bonhoff (NOW)
Dr. Eiji Ohira-san (NEDO)

General country overview

Cooperating Partners:

Hanno Butsch*	NOW
Erika Sutherland	DOE
Aiichiro Kashiwagi	NEDO
Marc Steen	EC

*Presenter

Germany

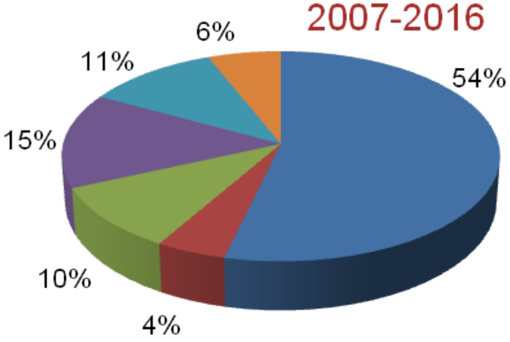
NIP – A success story

BMVBS-funding Status 01/2013

Programmme area	LoI & approved k€	In discussion €k	total k€
	Total number of projects: 206 approved / LoI: 138 projects (313 applications)		
transportation	226.306	46.075	272.380
H_2-production	15.040	8.537	23.577
industrial applications	33.623	16.858	50.480
residential cogeneration	58.347	16.074	74.421
special markets	34.116	21.586	55.701
cross-cutting issues	18.976	11.664	30.640
product line	**386.407**	**120.793**	**507.200**

Total Budget: 1,4 billion €

2007-2016



Stratigic plan until 2016 and beyond

Climat Targets in Germany:

- 80% reduction in CO2 emissions compared to 1990.
- Until 2050 about 80% of electricity will be supplied by renewable energies.

Hydrogen in the Context of the "Energiewende":

- Great need to store energy and to connect RE with the transport sector. Hydrogen is the most feasible link.

Strategic documents:

- National Innovation Program 3.0
- Mobility and Fuel Strategy of the German Government

Lighthouse Projects

Demonstration of HRS and FCEV fleets

Demonstration of FC house energy systems

Demonstration UPS, smart grids, back-up systems and virtual power plants.

Germany

NIP – Activities within the Lighthouse Projects

50 HRS Programm

- joint Letter of Intent to expand the network of hydrogen filling stations in Germany
- overall investment more than €40 million (US$51 million)
- market-relevant testing of filling-station technology
- ensure a needs-driven supply for fuel cell vehicles
- coordination by NOW GmbH in the frame of the Clean Energy Partnership (CEP)

Status Quo

- 15 public available HRS are currently running.
- Currently there are application for funding for 22 HRS, the remaining 13 HRS are in the planning phase.
- More 100 FCEV's are currently on the road.

H2-Mobility action plan until 2023

Air Liquide, Daimler, Linde, OMV, Shell and Total agree on an action plan for the construction of a hydrogen refueling network in Germany.

- 400 HRS until 2023 (100 HRS until 2017)
- 350 mio. € investment.
- Max. 90 km distance between two HRS at the motorway
- 10 HRS in each metropolitan area.

callux

Praxistest Brennstoffzelle fürs Eigenheim

Ein Projekt im Nationalen Innovationsprogramm Wasserstoff- und Brennstoffzellentechnologie

Research and Development → Demonstration / Field Test → Market Ramp Up → Volume Market

Status

CALLUX | "Manufacturer Program" | Technology Introduction Program (TEP)

By the end of 2012 the following was achieved:

- 340 units installed
- 2,3 Mio operating hours
- 1,3 Mio kWh el. energy generated

500 units will be installed until end of 2013

Focus Areas:

- Research & Development
- Education (Craftsmen)
- Learning / Experience
- Market Research
- Cost Reduction
- Reliability Improvement

Projects for uninterrupted power supply:

- 14 projects
- 280 fuel cells in field test operation across Germany

In 2012 about 800 units have been sold world wide.

In 2017 the prognosis is to sell 25.000 units world wide.

USA — Policies, Incentives, and Funding

National Policies and Incentives

- DOE's Fuel Cell Technologies Office
  - Addresses barriers to widespread commercialization of hydrogen and fuel cell technologies
- President Obama's All-of-the-Above Energy Strategy
- H2USA
  - Public-private partnership launched to address barriers to FCEVs and hydrogen infrastructure
- Tax credits
  - Investment tax credit (ITC)
  - Hydrogen fuel infrastructure tax credit

Examples of state-Level hydrogen and fuel cell initiatives underway in:

- California
  - State funding for stations - 9 existing public stations and $100M planned for new stations.
- Northeastern U.S. – CT/NY/MA – preliminary plan underway for infrastructure
- Many other states also have initiatives (e.g. Hawaii)
- ZEV (zero emission vehicle) Mandate

Funding *($ in thousands)*

Key Activity	FY 2013 Enacted (C.R.)	FY 2014 Request
Fuel Cell R&D	41,266	37,500
Hydrogen Fuel R&D	31,682	38,500
Manufacturing R&D	1,899	4,000
Systems Analysis	2,838	3,000
Technology Validation	8,514	6,000
Safety, Codes and Standards	6,808	7,000
Market Transformation	2,838	3,000
NREL Site-Wide Facilities Support	0	1,000
SBIR/STTR	2,139	2,404
Total	$97,984	$100,000

Planned FOAs	Funding*
Production & Delivery (FY14)	~$8M
Hydrogen Storage (FY14)	~$4M
Technology Validation and Market Transformation (FY13 & FY14)	~$9M
Manufacturing (FY14)	~$3M

* Subject to appropriations

USA

Status of H2 Infrastructure & Fuel Cell Markets

Current Status

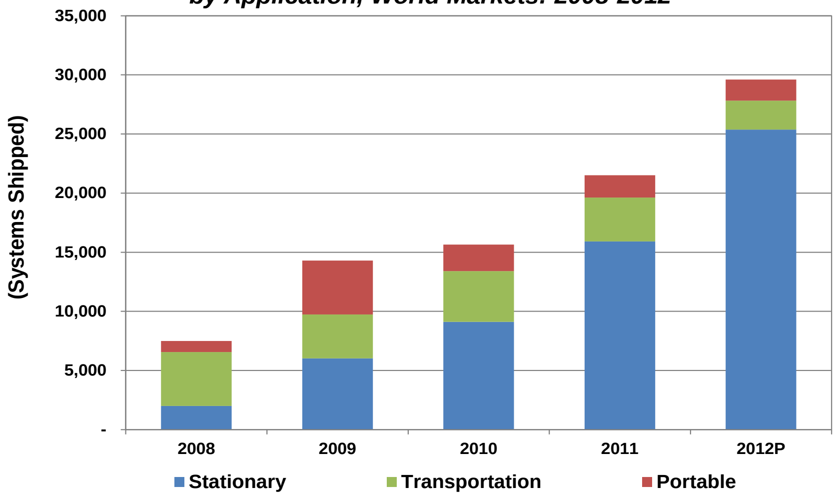
- ~**9MMT** of H_2 produced per year
- Over **1,200 miles** of H_2 pipelines in use (CA, TX, LA, IL, and IN)
- Over **50 fueling stations** in the U.S.

Market Growth

Fuel cell markets continue to grow:

- > 45% increase in global MWs shipped
- > 35% increase in systems shipped

Fuel Cell Systems Shipped
by Application, World Markets: 2008-2012



Sources: FuelCells2000, Navigant Research, Fuel Cell Today, ANL

Fueling Station* Projections (high volume)		
	2011 Projected Cost	2020 Target Cost
Centralized Production	\$1.70-\$2.20/kg	<\$0.70/kg
Distributed Production	\$2.50/kg	<\$1.70/kg

* Includes compression, storage and dispensing costs

Completed FCEV & Hydrogen Demonstration

with 50-50 DOE-Industry cost share

- **>180 fuel cell vehicles** and **25 hydrogen stations**
- **3.6 million miles** traveled; 500,000 trips
- **~152,000 kg of hydrogen** produced or dispensed *(some of this hydrogen used by vehicles not in the learning demonstration)*
- **>33,000 refuelings**

	Status	Project Target
Durability	~2,500	2,000
Range	196 – 254*	250*
Efficiency	53 – 59%	60%
Refueling Rate	0.77 kg/min	1 kg/min

*Independently validated a vehicle that can achieve a 430 mile range.

Policies

Japan Revitalization Strategy (June 14, 2013)

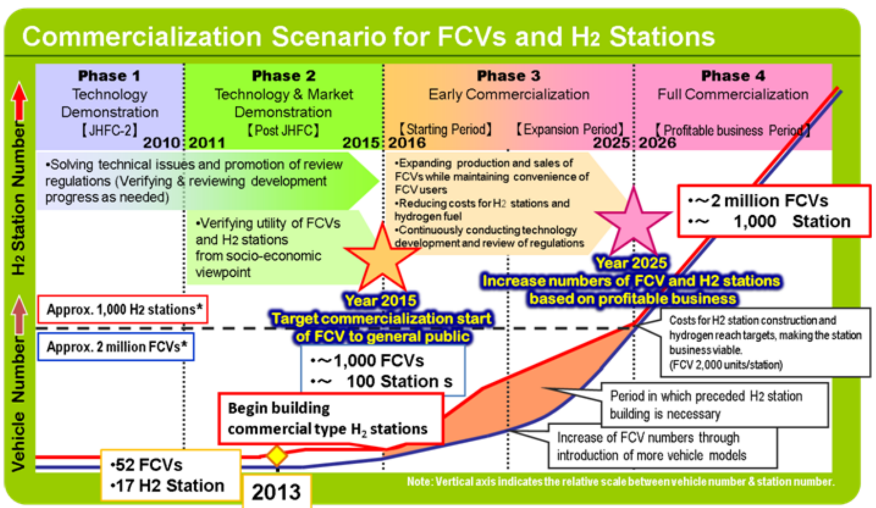
- Introducing 5.3 million "ENE-FARM" by 2030 / Achieving world's fastest dissemination of FCV

Strong Promotion to install H_2 Station : 100 Hydrogen Refueling Station by 2015

- New subsidy scheme for installation of H_2 Station start (JPY 4,600 M in 2013 FY for 19 station)
- Encouraging streamlining regulation for H_2 Station and FCV in Japan

Continuous support for R&D / Demonstration activity

- R&D activity for cost reduction of PEFC / focus on MEA: new catalyst (less or non Pt), enhancing durability of membrane, etc
- Demonstration program (JHFC3) with <u>17 HRS</u> and <u>50 FCV</u> (including Bus) in 2013



* Precondition: Benefit for FCV users (price/convenience etc.) are secured, and FCVs are widely and smoothly deployed

Source: Fuel Cell Commercialization of Japan (FCCJ)

Roadmap and Milestone - FCV & H_2 Station -

Million JPY

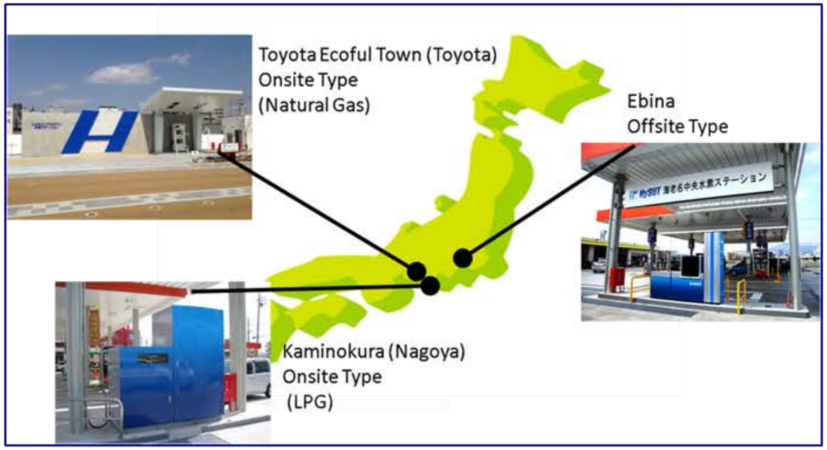
		JFY 2012	JFY 2013	Million €
R&D Activities: NEDO				
	Development of PEFC technologies	3,500	3,190	22,5
	Development of SOFC technologies	1,520	1,240	8,8
	Hydrogen Utilization Technology Development	2,300	2,000	14,1
	FCV and H_2 station demonstration project	3,000	750	5,8
Support to Installation: METI				
	Subsidy: installation of H_2 Station	---	4,600	32,5
	Subsidy: installation of ENE・FARM	10,090	25,050*	176,9

**: Started in Dec. 2012*

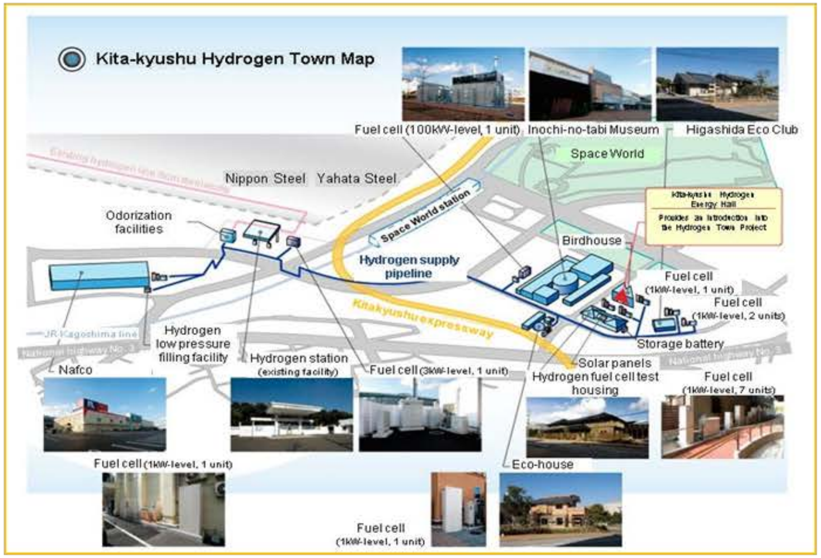
Budget for FC and H2 in 2013

Japan

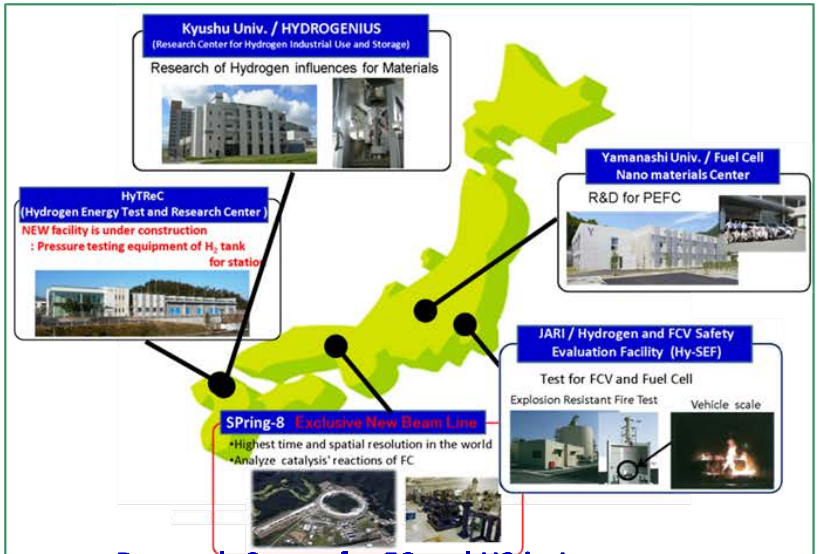
Topics / Activities



3 Commercial model station (70MPa) were constructed in 2013

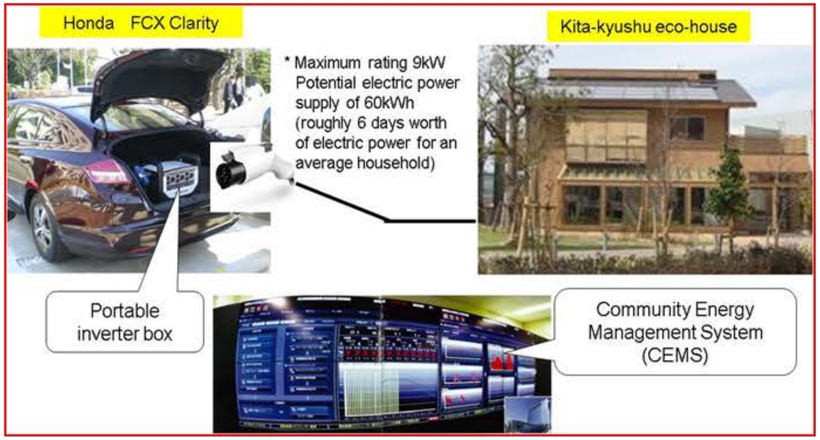


Kita-Kyushu Hydrogen Town Project



Research Center for FC and H2 in Japan

(New Facility for Pressure testing of H2 tank will open in 2014)



FCV2H demonstration started in April, 2013

A European Alternative Fuels Strategy COM(2013)17

(1) Provides a framework including

- minimum infrastructure
- common EU standards
- consumer information

(2) Identifies options for the different modes (see next slide):

Liquefied Petroleum Gas (LPG), Natural Gas and Bio-methane (in the forms of CNG, LNG and GTL), ***Hydrogen***, Electricity, Biofuels (only solution applicable to all modes but availability remains an issue)

(3) Guidance on investments and technological development

- specific technology roadmaps for alternative fuels will be developed in the frame of the Strategic Transport Technology Plan
- PPPs to be further developed based on experience gained *(for H2: FCH-JU)*



Proposed Directive on Alternative Fuels Infrastructure COM(2013)18

Barriers identified for hydrogen as an alternative fuel:

- High retail cost of vehicles → R&I in FCH-JU
- **Lack of infrastructure** → Proposal for directive AFI
- Low level of consumer acceptance

Proposal for a Directive on Alternative Fuels Infrastructure COM(2013)18

- **Focus on current obstacles: 1) infrastructure 2) standards**
- **Developed in close consultation with Member States and industry**
- **Targets unlocking private investment = a pro-business initiative**
- **Full freedom given to Member States for implementation**


EUROPEAN COMMISSION

Brussels, 24.1.2013
COM(2013) 18 final

2013/0012 (COD)

Proposal for a

DIRECTIVE OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL

on the deployment of alternative fuels infrastructure

(Text with EEA relevance)

{SWD(2013) 5 final}
{SWD(2013) 6 final}

Proposed Directive on Alternative Fuels Infrastructure COM(2013)18

1. Targets hydrogen infrastructure build-up *by end 2020*

- Only address countries with already existing H2 infrastructure
  (currently under discussion by EU council and parliament)
- Set out minimum level of infrastructure coverage necessary to:
  - ✓ enable cross-border mobility in-between Member States
  - ✓ support commercialization of hydrogen vehicles in the 2020 horizon
- hydrogen refueling stations along TEN-T Core Network, with maximum distance of 300 km, plus 1 HRS per 250.000 inhabitants in urban areas.
- cost = x refueling stations * 1.6 M€ = x M€

2. Common technical specifications EU-wide *by end 2015*

COM(2013)18 – Annex III Technical specifications

2. Technical specifications for hydrogen refuelling points for motor vehicles

2.1. Outdoor hydrogen refuelling points

2.2. hydrogen purity

2.3. fuelling algorithms and equipment

2.4. Connectors

Relevant ISO TC 197 activities:

- WG24 on HRS / ISO TR 19880-1
- ISO 14687-2 published Dec 2012; harmonized with SAE-J2719
- connector standard ISO 17268 published Dec 2012 based on SAE-J2600
- NWIPs for dispenser and components to be launched; new WGs to start late 2013

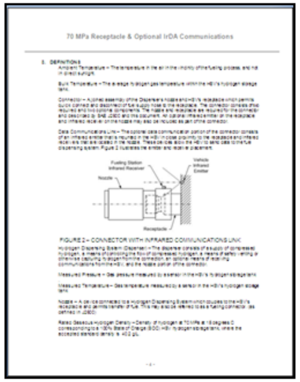
H2-Fueling

Cooperating Partners:

Jesse Schneider	BMW
René Kirchner	Total
Norikazu Yamaguchi	TN Sanso
Tim McGuire	Daimler
Jesper Boisen	H2-Logic
Baetrize Acosta	JRC

SAE Guidelines to protocols
Path to H2 Fueling standardization

SAE TIR J2799
70MPa Coupling
& IrDA Comm.Guideline
2007


70 MPa Receptacle & Optional IrDA Communications

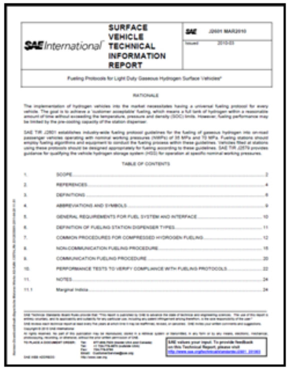
7 years of Field data + Additional Optional Data Field

2014 SAE STANDARDS RELEASE

Standard J2600 (2012)

**Standard J2799 (IrDA)*

SAE TIR "L.D. H2 Fueling" Guideline
2010


SURFACE VEHICLE TECHNICAL INFORMATION REPORT

3 years of Field data. Lessons Learned & Relaxed Tolerences and easier to implement.

**Standard J2601 (CGH_2 Fueling)*

2

*Under Ballot at SAE / Source: Jesse Schneider, SAE

Status Quo: Hydrogen Fueling

- TIR SAE J2601 (Current Guideline), for 35 & 70MPa from 2010 is currently being used for specifying hydrogen fueling worldwide: Japan/US/EU (Germany, Austria, Scandinavia, UK, etc.) A few refueling protocols in Germany still in place
- Some performance issues were found in the field in the German CEP stations regarding the time needed for the station to arrive at the proper precooling temperature. This and other lessons learned were brought to SAE J2601 committee for consideration in new document.
- The <u>new</u> Standard SAE J2601, currently under ballot in 2013, will be published in early 2014, includes lessons learned from the field, new relaxed targets, and has been validated by laboratory and field tests in the US and Japan
- Currently no Hydrogen Dispenser Test Apparatus is available that can deliver all information to validate SAE J2601.

Status-Look Up Table Creation & Validation for SAE 2601

2013

J2601 Look-up Table Creation from Validated Simulation Model/ Lessons Learned

→

Table Lab Validation with Extreme Temperatures and FCEV Tank Volume Sizes

→

J2601 Protocol Field Validation at H2 Stations in Field with real FCEVs

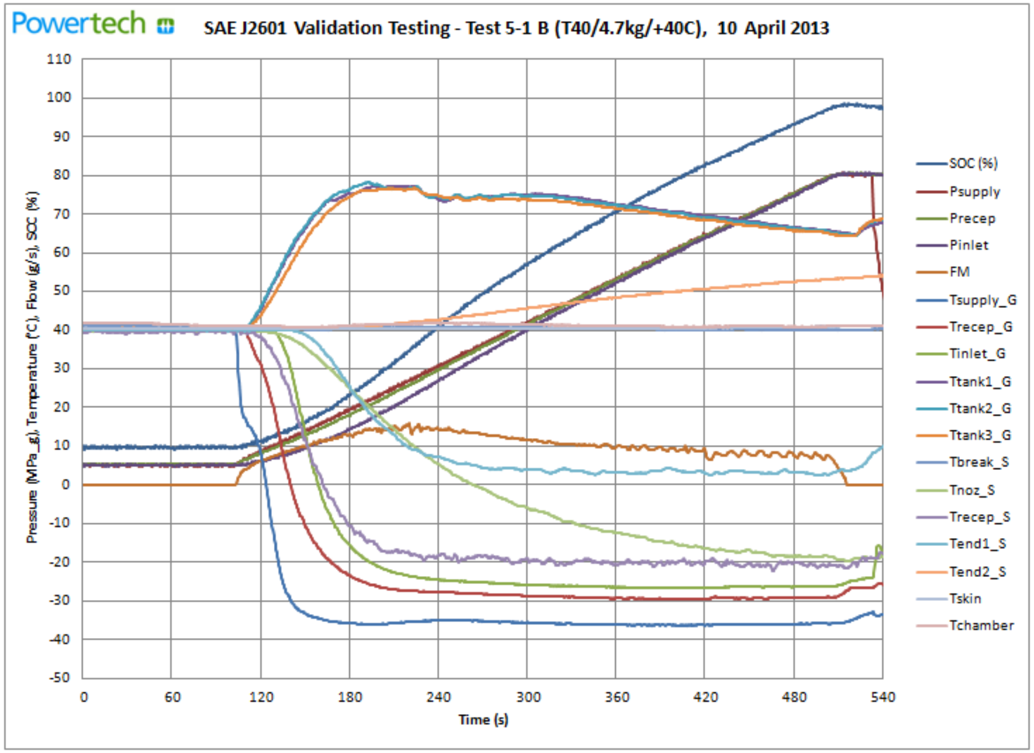
- Model Tests
- Table V.75

- 37 Lab Tests
- Tables Validated

- Denmark
- Japan

Source: Jesse Schneider, SAE

J2601 Lab validation Tests with Real H2 fueling & storage systems



- Extreme Temperature Tests: -40 ℃≤x<+50 ℃
- Real Station Hardware
- Real Vehicle Hardware

Source: Graham Meadows Powertech/ J. Schneider-BMW

Field Testing J2601 in 2013

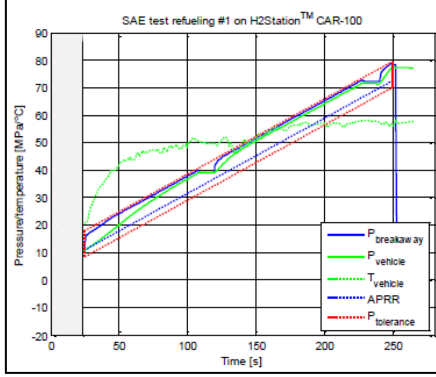
SAE J2601 field testing on H2Station® CAR-100

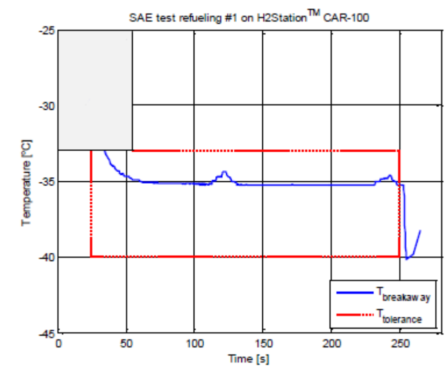
1. Tests planned and performed in close cooperation with Daimler and Hyundai
2. Some tests were witnessed by representative from Shell Global Hydrogen
3. A total of 18 refueling tests were performed, where 10 was com-refuelings
4. Test vehicles: 2 pcs. Daimler F-CELL B-class and 2 pcs. Hyundai ix35

Example of Fueling Validation with Comm.

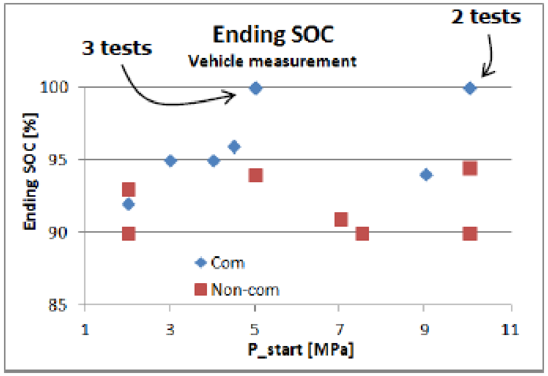
Station data

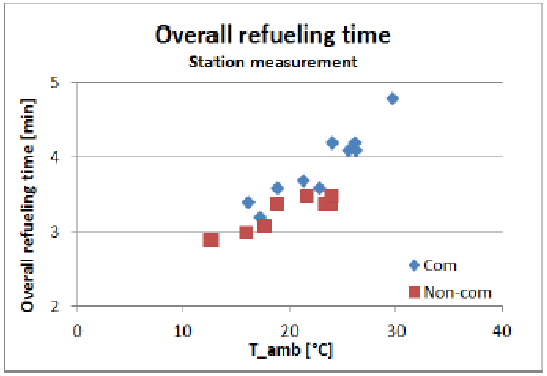
Date and time	Vehicle type	T_amb [°C]	Refueling time [min]	Non-refueling time [s]	P_start [MPa]	P_start (IrDa) [MPa]	T_start (IrDa) [°C]	SOC start [%]	P_end [MPa]	P_end (IrDa) [MPa]	T_end (IrDa) [°C]	SOC end [%]	P_target [MPa]	Peak mass flow [g/s]
13-05-2013, 09:45	Daimler F-CELL B-Class	23.9	4.2	29	10.6	9.8	15.4	19.3	78.9	77.3	56.5	97.3	86.7	26.3





All Tests:
SOC 90%<x<100%
Fueling Time: 3-5 mins.





Source: Jesper Boison, H2Logic

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H2 Fueling: Going Forward

- There is an immediate industry need for a global standard for the first generation commercial hydrogen infrastructure: SAE J2601/ J2799

- A new ISO 19880-1 standard group (ISO TC 197 WG 24) has started in 2013 for fueling stations and will have a normative reference to SAE J2601 and J2799. Final Voting for an international standard will be at the end of 2015.

- There is a need for each geographical region to create a hydrogen dispenser testing with a validation process for hydrogen fueling stations. Vehicles should not be used for this purpose.

- Future generations of vehicles and infrastructure, international research is needed to continue optimizing system design including hydrogen storage and fueling protocols and validation of H_2 Fueling - with the ultimate goal of reducing costs and industrialization of FCEV and infrastructure.

H2-Quality

Cooperating Partners:

Georgios Tsotridis	JRC
Jesse Schneider	BMW
Andres Fernandez-Duran	Air Liquide
Hiroyuki Endo	Idemitsu
Tim McGuire	Daimler
Ulf Hafsel	HYOP

Hydrogen Quality Status:
Regional Updates 2013

- Japan and US, Acceptance of Hydrogen Quality Fuel Specification in ISO 14687-2 and SAE J2719 and is a law in California (SB 76).
- Hydrogen Quality has been tested in the field with Analytical methods in Japan and US
- ASTM has done most of the standards on their detection methodologies but <u>not</u> complete
- Germany has not yet been able to test the ASTM methods as the methods there have not been adopted in the EU.
- Hydrogen quality testing can be expensive and there is no guidance yet on the frequency needed for testing

H2 Quality:
High Level Needs

- ❑1. International Acceptance of Hydrogen Quality Fuel Specification in ISO 14687-2/ SAE J2719

- ❑2. ASTM finalizes and standardizes their detection methodologies through accelerated-round robin testing

- ❑3. Further development of H2 Quality requirements in the framework of C&S (ISO TC 197 & SAE J2719) Determination of Guidelines of a minimum set of constituents to validate per station type- see example.

H2 Quality:
High Level Needs

- 4. Harmonization Adoption of ASTM Sampling and Detection methods between EU/ US

- 5. "Status Quo" Round Robin Hydrogen Quality Sampling of H2 Stations in use today

- 6. Harmonization of Cost Analysis Methodology and agreed upon cost of “Status Quo” H2 fueling and analysis

ISO TC 197 Action Item: Minimum H2 Quality Validation vs. Station Source -DRAFT-

Basis: Hydrogen Quality for stations is specified in ISO 14687-2.

Goal: Determine the minimum amount of hydrogen impurities that a station needs to validate and test as a first step for a realistic “Quality Control” of ISO 14687-2. Determine minimum set of constituents to validate per hydrogen station type.

This is only a first step which needs to be investigated further in coordination with the ISO TC 197 “Technical Program Manager” on Hydrogen Quality

ISO TC 197 Action Item: Quality Control: Minimum H2 Quality Validation vs. Station Source –Example DRAFT (to be developed in ISO TC 197)

Minimum Hydrogen Quality Validation vs. Station Source Matrix

Source of CH2 Fuel	Alkaline Electrolysis	PEM Electrolysis	Ethanol	Methanol	Natural Gas	Liquid Hydrogen
Impurity Constituents						
Ammonia						
CO						
CO_2						
HCHO						
HCOOCH						
He						
H2O	X					
Inert Gas						
K+	X					
N_2						
O_2						
Particulates	X					
Total Halogenated Compounds						
Total Sulfur Compounds						
Total Hydro-Carbons						

H2-Metering

Cooperating Partners:

Tetsuji Nakamura	Iwatani
Alexander Zörner	Linde
Rob Burgess	NREL
Jesper Boisen	H2-Logic

Present Ability of the FLOW Meters

	Manufacturer	Specifications			Issues
		DP(MPa)	Range(kg/hr)	Error	
Germany	Rheonik	86,8	~ 5	±0.1%	Low limit (8g/s) is too high for top off or Fall Back Fueling.
	Endress & Hauser	40	~ 450	±0.5%	
Japan	TATSUNO	99	～300	±0.5%	Material restriction according to High Pressure GAS Safety Act
	OVAL	120	2.4～240	±1%	
	TOKICO※	90.2	6～216	±1%	
United States	GE Sensing	90	12～600	±0.5%	MicroMotion has developmental meter and is working toward production model.
	MicroMotion	TBD	TBD	TBD	
Scandinavia					

※TOKICO will not provides flow meter only, provides whole dispenser.

Legislative and Standards-Germany

Legislative obligation	Weights and Measures Act allows ±2% deviation for CNG. To get the permission of the PTB an accuracy of ±1% is needed at the beginning
Activities to make or adjust standards	Internal research projects at Linde collaborations between manufactures and industrial companies Negotiations between CEP and manufacture to clarify development potentialities
Issues for the standards	Development of flow meters or changes of Weights and Measures Act is necessary.

Legislative and Standards-United States

Legislative obligation	National Institute of Standards and Technology, NIST Handbook 44 allows ±1.5% for certification and ±2% for field calibration. NIST handbook 44 is adopted by state jurisdictions, including California Code of Regulations (CCR).
Activities to make or adjust standards	California Division of Measurement Standards has contracted NREL (National Renewable Energy Laboratory) to build metering device for exploring dispensing capability. Proposal for CCR amendment to allow ±3%, ±5% & ±10% accuracy classes for early station certification.
Issues for the standards	Development of flow meters or changes of Weights and Measures Act is necessary.

Legislative and Standards-Scandinavia

Legislative obligation	Denmark MID-directive Annex MI-002 applies also for automotive gas meters Norway and Sweden OIML R139 is applicable on voluntary basis
Activities to make or adjust standards	Both standards should be updated to be applicable for gas meters and hydrogen.
Issues for the standards	

Technical Approach

	General	Method	Terms
Germany	Matching between cars and stations has been done at several stations. High deviation was observed. Calibration activities using dummy tank has been done.	Gravimetric PVT	Deviation
Japan	NEDO project started to establish technical standards for Gravimetric and Master Meter Methods.	Gravimetric Master Meter	Uncertainty
US	NREL metering project consists of providing a metering apparatus to the state of California that is capable of gravimetric, PVT and mastermeter measurements. California is developing a project management plan for station testing and new classification.	Gravimetric PVT MasterMeter	Tolerance Error Accuracy Uncertainty
Scandina via	HyAC project will start on Sept 2013. "Recommendations for the measurement of the quantity of hydrogen delivered and associated regulatory requirements"		

Schedule

Germany	Establish a metering method in cooperation with German Eichamt and Physikalisch-Technische Bundesanstalt (PTB), Braunschweig, in 2015.
Japan	Establish voluntary standard based on Gravimetric method before 2015. After collecting technical data for Master Meter methods, voluntary standard will be updated with Master Meter method, hopefully on 2017. If spread of FCV follows FCCJ scenario, Measurement act will cover FCV fueling around the year of 2025.
US	NREL will complete metering apparatus testing then deliver to California in 2013. Station testing in California is being planned for 2014. DOE is reviewing hydrogen metering proposals for R&D funding opportunity.
Scandinavia	

H2-Fueling Hardware

Cooperating Partners:

Peter Ehlers	CSA
Daniel Hustadt	Vattenfall
Koji Okada	Toho Gas
Jesper Boisen	H2-Logic

Agenda

- Station Uptime
- Hardware – Current State
  - Compressors
  - Nozzle/Hose/Breakaways
- Root Cause Activities
- Inconsistent Requirements from Region to Region
  - ISO TC197 Update

Station Uptime

- Station Uptime identified as the most critical issue by the Hardware Issues Panel at June Meeting
  - Fuel cell vehicle operators did not have a favourable experience when the station was down when they went to refuel
- INTERIM Solutions
  - CEP and Scandinavia have placed lights on the dispensers to show station is operable
  - CaFCP has developed Station Operational Status System which is a smart phone app that gives the FCV operator advance notice of when the station is not functional. There are special equipment required to be installed at station to support this.

Other Issues

- Current dispenser duty cycles are very low (compared to gasoline) and station reliability and uptime will need to scale up as FCV fleet increases
- Current lack of support from component manufacturers to solve current performance issues limits rate of improvement
- Excessive operational costs due to unplanned maintenance and stocking of repair parts limits station's economic payback

Hardware – Current State

- Hardware Issues – Current State
  - Premature Hose Failures (Leakage or Rupture)
  - Excessive Wear and leakage issues of Nozzles
  - Ongoing changes to Station dispensing pressures and temperatures demands Hardware Design revisions
    - New O-rings to support lower dispensing temperatures
  - Premature Separation of the Hose Breakaway

Hardware – Root Cause Analysis

- Hardware Issues – Ongoing Investigations
  - Japan has embarked on nationally funded project for the development of a fit-for-purpose 70 Mpa hose for Hydrogen Dispensing. Currently in research and development phase.
  - USA has issued publicly funded projects (FOAs) for new product research and development for Compressors, hoses, and meters
  - CEP has initiated 3rd party studies on failed products from the field independent of manufacturer's support

International Requirements

- Lack of universal requirements for component and system performance
  - ISO TC197 is a possible avenue
    - New WGs recently formed
      - ISO/TC 197/WG 19 Gaseous hydrogen fueling station dispensers
      - ISO/TC 197/WG 20 Gaseous hydrogen fueling station valves
      - ISO/TC 197/WG 21 Gaseous hydrogen fueling station compressors
      - ISO/TC 197/WG 22 Gaseous hydrogen fueling station hoses
      - ISO/TC 197/WG 23 Gaseous hydrogen fueling station fittings
      - ISO/TC 197/WG 24 Gaseous hydrogen fueling stations General requirements
    - EU considering it's own requirements
    - HySUT working on developing Harmonized Japanese requirements

Thank you for your attention.

Questions?

Today's webinar recording will be made available at:
http://www1.eere.energy.gov/hydrogenandfuelcells/webinar_archives_2013.html