FCEV: Growing momentum and challenges of mass market deployment

Third International Workshop: The Energy Transition in Land Transportation, Energy & Prosperity Chair
2015 → 2017
The confirmation of a growing momentum
2015 → 2017: Building up scale all over the world!
US / California – the ZEV effect

Anaheim H2 station

FCEV’s:
- 2015: 100
- 2016: 1,200
- 2017: 5,000
- 2020: 18,000

H2 stations:
- 2015: 13
- 2017: 49
US - Conquering the Northeast

Network of 12 Stations
Start-up over Q3-Q4 2017
Dedicated H₂ supply chain by
Project in collaboration with

New York
Bronx, NY
Hempstead, NY
Brooklyn, NY

Connecticut
Hartford, CT

Massachusetts
Braintree, MA
Mansfield, MA

New Jersey
Site location TBA

Rhode Island
Site location TBA

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Air Liquide, Daimler, Linde, OMV, Shell and Total have agreed an action plan for the construction of a Hydrogen station network in Germany.

- **400 Hydrogen Stations by 2023**
  (100 by 2017)
- **350m € investment**
- **Max. 90 km distance between each station on motorways**
- **10 Hydrogen Stations** in each metropolitan area
H2 Mobility: A fully operational company

2017

Hydrogen Company

The world leader in gases, technologies and services for Industry and Health

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2017

Hydrogen Company

The world leader in gases, technologies and services for Industry and Health

100 stations by 2018

20 stations in 2015

Phase 1A

Build / operate 7 HRS

Phase 1B

Build / operate 53 HRS
Take over / operate 40 HRS (from CEP)

Phase 2

Build / operate 300 HRS

Proof of concept

Unconditional ramp up

Depending on # of FCEV

100 stations by 2018
Deployment status of 53 new stations as of Dec 2016:

- 3 // in operation
- 3 // under construction
- 7 // permitting
- 15 // planning
- 25 // identified

Offenbach H2 station
Germany infrastructure: Joint Venture H2 Mobility

- **State**
  - HRS CAPEX and OPEX subsidy ~25%

- **Industrial gas Co.**
  - Oil & Gas Co. Equity ~50%

- **OEM**
  - Small contribution

- **Banks**
  - Expected loan ~25%

- **Network Planning**
- **HRS Procurement, Ownership & Operation**
- **H2 Procurement & Sales to end customer**
- **Customer value proposition & Branding**
Japan: Largest H2 station infrastructure in the world

FCEV’s:
- 200 in 2015
- 1,500 in 2016
- 3,000 in 2017
- 40,000 by 2020

H2 stations:
- 40 in 2015
- 92 by 2017

2017

Nagoya Atsuta
Japan infrastructure: Joint Venture under construction

- **State**
  - HRS and cars CAPEX and OPEX subsidy ~40%

- **Industrial gas Co. Oil & Gas Co.**
  - Equity

- **OEM**
  - Equity depending on cars ramp up

- **National Infrastructure Consortium**
  - Network Planning
  - HRS Procurement, Ownership; Operation outsourced
  - Search for external stakeholders to secure financial support

- **Investors**
  - Equity depending on cars ramp up
France: Innovative business models for clean mobility

HYPE Taxi Fleet Project - Paris

Launched in Dec. 2015, during COP 21

Air Liquide
Key Enabler of the project

An emission-free Paris

FCEV taxi fleet

10 70
2016 2017 2020

600
France infrastructure: Captive fleet within taxi business

- **Industrial gas Co.**
  - Equity

- **OEM**

- **Europe funding**
  - Cars CAPEX subsidy

- **Investors**
  - Equity

- **hype**

- **Cars ownership & operation**
- **Fast and significant HRS charge from D1**
- **Aligned deployment of cars and infrastructure**
- **External stakeholders secure financial support**
HyBalance: green hydrogen source planned for Q4 2017

Country-wide HRS network by 2015 | DENMARK

- Copenhagen
- Aalborg
- Holstebro
- Herning
- Esbjerg
- Vejle
- Odense
- Korsor
- Malmö (SE) →
- Hamburg (DE) ↓
- Berlin (DE) ↓
- Oslo (NO) ↑
- Gothenburg (SE) →

- Existing 70MPa HRS's
- DHF HRS Opened in 2015
- HRS's planned for 2016
- HyBalance: green hydrogen source planned for Q4 2017

Denmark – A nationwide H2 network powered by wind
Denmark – A nationwide H2 network powered by wind

Industrial Power-to-H2 demonstrator

http://hybalance.eu/

Grid services spot price arbitration

Surplus RE

1,25 MW PEM Electrolyser

Country-wide HRS network by 2015 | DENMARK

Refueling stations

Complete Wind-to-H2 supply chain

Start-up in October 2017

Industrial off-takers

Local industrial customer

Filling center

H2

H2

H2 @ 200b

H2 @ high pressure
Korea – Rolling out an ambitious roadmap!

- Green Car roadmap being actively implemented
- Innovative fleet business models
- Creation of H2 Korea to accelerate infrastructure investments
Middle East – 1st H2 station in Dubai!

- 1st H2 station started in September 2016, with first Mirais deployed
- Scale-up of FCEV deployment in Dubai until 2020 World EXPO
- Collaboration between Air Liquide, ADNOC, Al Futtaim Motors / Toyota & Masdar (green power provider) to develop a H2 mobility roadmap in the USA
FC Buses: EU and China showing the way

**FC Buses in EU:**

1 000

40

100

2015 2017 2020

**Next stops:**

**Ongoing EU-funded fuel cell bus projects**

- **CHIC**
  - Augsburg, CH – 5 FC buses (2011)
  - Bolzano, IT – 5 FC buses (2013)
  - London, UK – 8 FC buses (2011)
  - Milan, IT – 3 FC buses (2013)
  - Oslo, NO – 5 FC buses (2013)
  - Cologne, DE* – 4 FC buses (2011/14)

- **HyTransit**
  - Aberdeen, UK – 4 FC buses (2015)
  - Antwerp, BE – 5 FC buses (2015)
  - Ban Remo, IT – 5 FC buses (2016)

- **High VLO-City**
  - Antwerp, BE – 3 FC buses (2017)
  - Ban Remo, IT – 2 FC buses (2017)
  - Helsinki, FI – 2 FC buses (2017)

- **Current national/regional-funded fuel cell bus projects**
  - Karlshulme, DE* – 2 FC buses (2013)
  - Stuttgart, DE* – 4 FC buses (2014)
  - Frankfurt, DE* – 1 FC bus (2016)
  - Arnhem, NL* – 3 FC buses (2017)
  - Groningen, NL* – 2 FC buses (2017)
  - Eindhoven, NL* – 2 FC buses (2016)

**3Emotion**

- Cherbourg, FR – 5 FC buses (2017)
- South Rotterdam, NL – 2 FC buses (2017)
- South Holland, NL – 4 FC buses (2017)
- Antwerp, BE – 3 FC buses (2017)
- Rome, IT – 5 FC buses (2017)

Legend:

- Countries with (upcoming) fuel cell buses in operation
- Planned operation
- (2015) Operation start / planned start
- Co-financed by regional / national funding sources

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Looking beyond 2017…

- Hydrogen and Fuel Cell Electric Vehicles are at the **Tipping Point**!

- Early movers have proven that **it is sustainable**!

- **More players need to join the game** to further increase the momentum: Car OEM’s, Energy companies, financial investors, governments…
January 17, 2017 – Davos – Launching of the Hydrogen Council

13 Companies and their CEO’s joining forces to voice the vision and the ambitions of the Hydrogen industry

Hydrogen acknowledged as a key solution to empower the energy transition

A further lever to accelerate H2 infrastructure & FCEV deployments!
2015 → 2017: Building up scale all over the world!

From 1 000 to 10 000 FCEVs!

From 100 to 300 H2 Stations!