Aberdeen Hydrogen Bus Project

Valentine Willmann - HyER

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HIGHVLOCITY HyTransit FCH FUEL CELLS AND HYDROGEN JOINT UNDERTAKING

Content

I. General introduction to hydrogen and fuel cell buses

II. The Aberdeen Hydrogen Bus Project

III. Achievements so far and lessons learned

IV. Next steps / EU context

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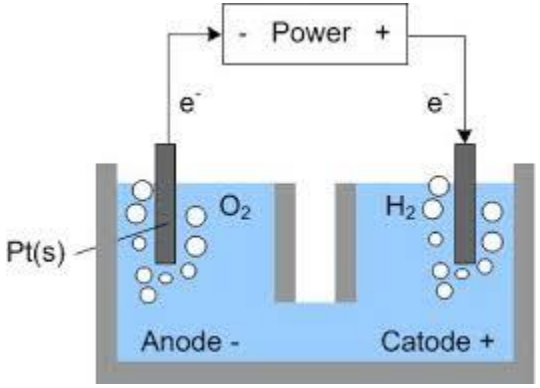
WHAT IS HYDROGEN?

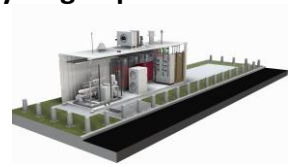
A zero emission fuel



- Hydrogen is a gas which is used as a fuel: the fuel cell converts hydrogen into electricity in the vehicle
- Hydrogen can be produced from renewable electricity → zero emissions during energy production + during use

Renewable electricity

Hydrogen production



Hydrogen applications

Potential for complete decarbonisation of the transport system – well to wheel

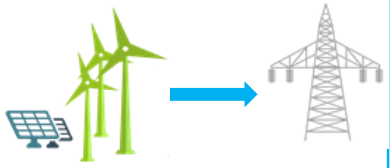
Medium & light duty transport

Heavy duty transport

Maritime applications

Stationary applications

Energy systems



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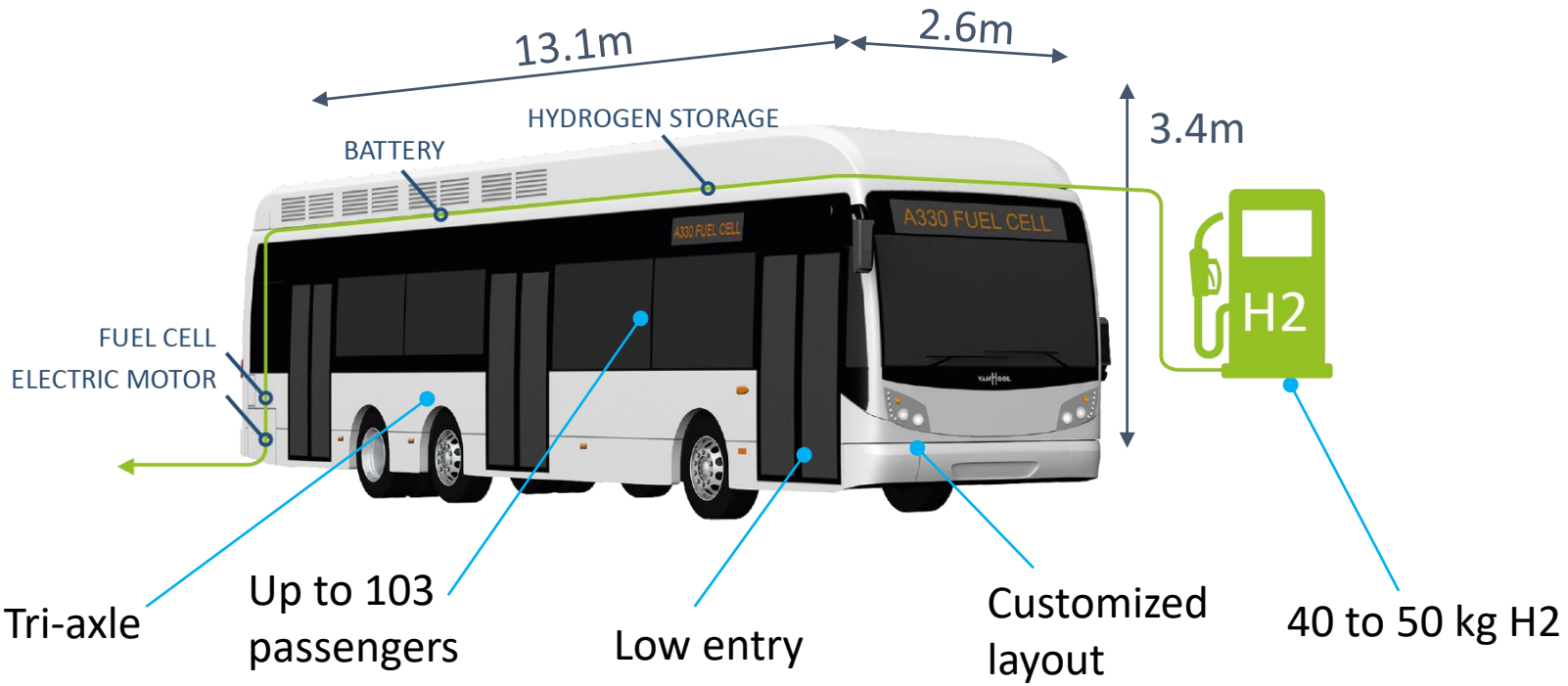
FUEL CELL BUS – SPECIFICATIONS

Van Hool A330



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WHY FUEL CELL ELECTRIC BUSES?

Fuel cell electric buses are a zero-emission solution ready for commercialisation

- ONLY EMIT WATER VAPOUR
- REDUCING CO2 EMISSIONS AND IMPROVING AIR QUALITY
- REDUCED NOISE AND VIBRATION LEVELS
- PASSENGERS AND DRIVERS ENJOY THE BUSES
- LARGE RANGE WITH ONLY 1 REFILL A DAY (<12 MINUTES)
- READY FOR MARKET DEPLOYMENT

From greenhouse gas emissions to clean cities

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POLICY FRAMEWORK

Developing a hydrogen economy

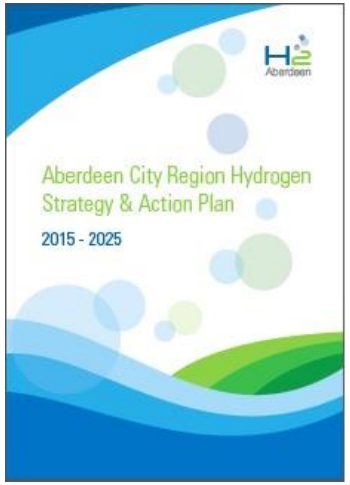
Strategic aim : to become '*a world-class energy hub leading a low carbon economy and at the forefront of hydrogen technology in Europe'*

Local drivers

- Highly skilled workforce in energy sector (oil and gas industry)
- Accustomed to the use of hydrogen in industrial processes
- Production of excess renewable energy (wind)

Policy drivers

- Reduce cross-sector greenhouse gas emissions by 42% by 2020 and 80% by 2050 (Scotland)
- Aberdeen City and Region Hydrogen Strategy 2015-2015



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THE ABERDEEN BUS PROJECT

An innovative public-private partnership

Europe's largest fuel cell electric bus fleet to date: 10 buses in total

- 4 buses First
- 6 buses Stagecoach
- 1 production & refuelling station

PROJECT DEVELOPMENT	NEGOTIATION	PREPARATION	LAUNCH	OPERATION
2010-2011	2011	2012-2013	June 2014	March 2015

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PROJECT FUNDING

Aberdeen HydrogenBusProject

Total budget: £19m

£8.3m — **EU FUNDING** → FCH FUEL CELLS AND HYDROGEN JOINT UNDERTAKING → HIGHVLOCITY, HyTransit

+

£6.7m — **NATIONAL FUNDING** → Innovate UK, The Scottish Government, Scottish Enterprise, SGN (Your gas. Our network.), SSE

+

£4m — **LOCAL FUNDING** → Aberdeen City Council, Stagecoach, First

PROJECT OBJECTIVES

Deployment of 10 FC buses + 1 production and refuelling station

	Reduce hydrogen consumption to 7-9kg/100km
	Reduce the cost of hydrogen production
	Reduce the total cost of ownership of the buses
	Increase overall operational availability
	Further increase of bus lifetime
	Contribute to commercialisation of FCEBs in Europe

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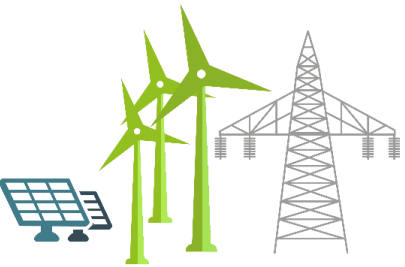
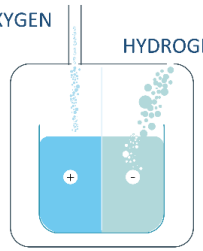
ABERDEEN

Hydrogen supply chain



ELECTRICITY



WATER ELECTROLYSIS

DIRECT

REFUELLING STATION

99% AVAILABILITY

REDUNDANT DESIGN

BUSIEST REFUELLING STATION IN EUROPE

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Dedicated bus maintenance facility

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ACHIEVEMENTS SO FAR

Operational details

More than
KM DRIVEN **1 million**

9-10
KG HYDROGEN PER 100 KM

>99%
AVAILABILITY OF STATION

>87%
BUS AVAILABILITY

>97% FUEL CELL AVAILABILITY

10-12 mins refuelling time

Around
TONNES OF CO_2 SAVED* **150**

*COMPARED TO EURO VI VEHICLES

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AVAILABILITY OF THE BUSES

3 periods can be observed

Period	Duration	Nb of failures	Time off per fail
1 – Teething period	Around 6 months	Decreases	Constant
2 – Further initialisation	Around 10 months	Constant	Constant
3 – Wear	16 months onwards	Decreases	Increases

→ During the teething period, a lot of technical failures but which are fixed rapidly

→ During the wear period, much less technical failures but they take longer to fix

- The number of technical failures is decreasing for all sites.
- In Aberdeen most of the failures are bus failures rather than FC failures (standard wear of components). A number of bus failures are related to the previous experience of the maintenance team.
- Batteries have been a point of concern earlier in the project. **Mitigation**: having a spare battery stored on site

FIRST CONCLUSIONS

Lessons learned – project management

The deployment of vehicles needs to be aligned with the infrastructure construction

Roles and responsibilities need to be **clearly defined** at the beginning of the project

Bus drivers are your best ambassadors: ensure they are **well informed** to answer passenger questions

Communication is key!

Manage expectations about technology, especially in a commercial environement

Inform passengers about the buses: passengers are curious about new bus technologies

Training of drivers: essential before but also during the project

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SOCIAL SURVEY RESULTS

Aberdonians enjoy the buses

Most people keen to use the buses- no safety issues

Most people believe it is important or very important that PTOs invest in clean buses

Drivers like to know enough about buses to be able to answer passengers questions

Passengers enjoy the buses – less noise and vibrations

PASSENGERS

Concerns about breakdowns: improving

DRIVERS

What people want to know: which routes buses are running on + what benefits for the city and the citizens, but also if there will be more of these buses in the future

Majority thinks more buses should be deployed, but with adequate training

«I love driving hydrogen buses, they are nice and quiet and comfortable. Feedback from passengers is unbelievable. They don't have to shout when they are taking to me!»
Ron, bus driver in Aberdeen

- Very good acceptance of the buses and positive attitude towards innovative and environmental friendly technologies

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PROJECTS ACROSS EUROPE

What's next?

FUEL CELLS AND HYDROGEN JOINT UNDERTAKING

Already deployed: total 77 buses

CHIC HIGHVLOCITY HyTransit 3EMOTION

To be deployed in 2019-2020: 291 buses

JIVE H_2 ZERO EMISSION

JIVE 2 H_2 ZERO EMISSION

10 more buses will be deployed in Aberdeen through JIVE 1 (but political approval for 30 more buses)

Aim: advance the **commercialisation of fuel cell buses** and **boost the deployment of hydrogen as an alternative fuel** in the EU through large-scale deployment of vehicles and infrastructure

- Large-scale deployment project (fleets of 10-30 buses)
- Joint procurement exercise per country
- Indications of a number of suppliers interested in delivering buses below the JIVE 2 price target (€625,000)

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IN CONCLUSION...

Opportunities

- Zero emissions
- Flexible solution, well adapted to long routes
- Refuelling infrastructure can be located at bus depot, similar to conventional fuel buses
- Refuelling stations: mature and reliable technology
- CAPEX prices will continue to decrease
- Very good customer acceptance
- Can easily be scaled up

Challenges

- Technical availability not quite at the level of conventional fuel buses
- Maturity of supply chain
- Cost of vehicles
- Cost of infrastructure/ hydrogen production
- Training
- Introduction of new technologies in general

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THANK YOU FOR YOUR ATTENTION!

valentine@hyer.eu / + 32 285 40 94

Websites:

- **www.highvlocity.eu**
- **www.fuelcellbuses.eu**

Twitter:

@HighVLOCity
@Fuelcellbus

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