



New Bus Fuel



WORKSHOP B: HYDROGEN INFRASTRUCTURE

1st December 2016 (13:15 – 15:15)

Moderator: Alastair Hope-Morley **elementenergy**

*A project co-funded by
under the Grant Agreement n.671426*



FUEL CELLS AND HYDROGEN
JOINT UNDERTAKING



Six panellists representing major hydrogen infrastructure developers



NewBusFuel

Markus Bachmeier, Linde



Frank Schnitzeler, Air Products



Graham Cooley, ITM Power



Mark Kammerer, Hydrogenics



Bruno Forget, Air Liquide



Uffe Borup, NEL Hydrogen



1. Can infrastructure be made 100% reliable?

➤ Current status & evidence:

- CHIC recommends that HRS designs should **exclude compressors** or include **multiply redundant systems**.
- Linde's HRS in Aberdeen (with ionic compressors) has performed with **99% reliability** during the first 1.5 years of operation.

➤ Key messages to bus operators from workshop:

- Articulate the value of each availability % point to inf. Suppliers.
- Establish dialogue with infrastructure suppliers to develop appropriate **contractual framework** for adequate **redundancy, spare parts supply, planned outages**.
- Adopt **online monitoring** to identify issues early and enable information sharing between different stations.

2. Can diesel parity be reached?

➤ Current status & evidence:

- Buses in Cologne are currently refuelled with **'brown' by-product hydrogen** at cost parity to diesel fuel.
- €5-6/kg hydrogen price at the nozzle achieves diesel parity but this is linked to **fuel economy** and **diesel price**.
- Average hydrogen consumption from CHIC FC buses is **9 kg/100km**.

➤ Key messages to bus operators from workshop:

- Most appropriate solutions will be **location specific**.
- Seek out **low cost primary energy** (electricity, methane, biogas, etc.).
- **Maximise utilisation** of stations (especially smaller stations).
- Automation...?

3. Are there clear and affordable pathways to 100% carbon free H₂?



➤ Current status & evidence:

- Today there are examples of electrolyzers powered by the grid with **certified 'green' tariffs** as a proxy for low carbon electricity, or connected **directly to renewable generators**.
- SMR+CCS, biogas, biomass could yield low carbon hydrogen in future.

➤ Key messages to bus operators from workshop:

- Clear: yes! Affordable: in certain locations
- Short-term focus should be to **bring down bus and station capital costs**, and then focus on ensuring 'green' fuel (at the system level).
- Timed use, grid balancing, avoided renewable curtailment can help improve economics of on-site electrolysis.
- Engage new stakeholders (utilities, regulators, investment banks).⁵

4. How can fleet ramp-ups be appropriately managed?

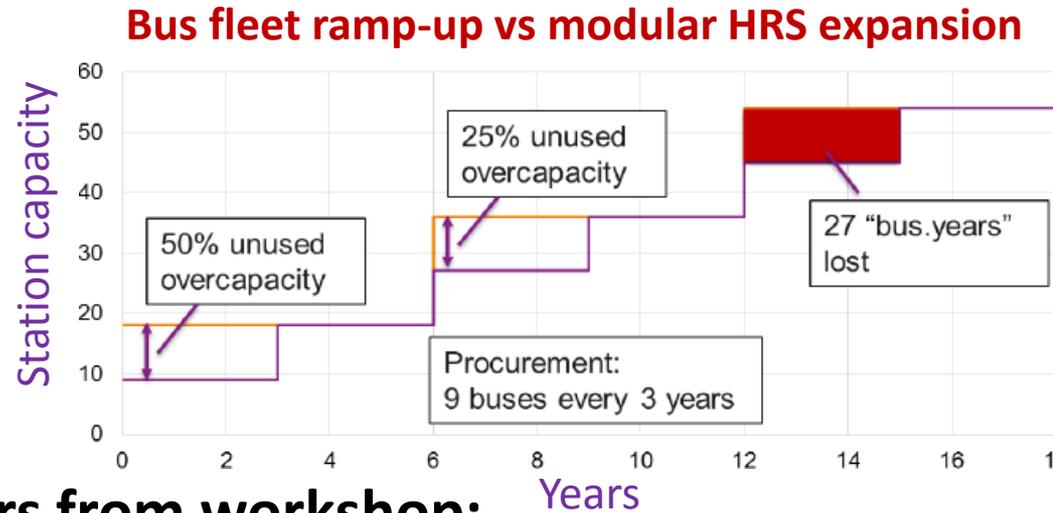


➤ Current status & evidence:

- Current fleet sizes are between **5-10 fuel cell buses**.
- Station components are designed to be **modular**.

➤ Key messages to bus operators from workshop:

- Avoid continuous ramp-up to **minimise underutilised equipment**.
- Understand that hydrogen infrastructure requires different procurement approaches to diesel (e.g. longer contracts).
- Work closely with suppliers to develop cost effective and flexible ramp-up plans with equipment modularity (supplier dialogue).



Thank you!

