INITIATING HYDROGEN TRANSPORT DEMAND IN THE NORTH WEST USING HYDROGEN BUSES

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Initiating hydrogen transport demand in the North West using hydrogen buses

NW Hydrogen Showcase

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Element Energy Ltd
Element Energy, a consultancy focussed on the low carbon energy sector

- Element Energy is a **specialist energy consultancy**, with an excellent reputation for rigorous and insightful analysis in the area of low carbon energy

- We consult on both **technical and strategic issues** – our technical and engineering understanding of the real-world challenges support our strategic work and vice versa

- Element Energy covers all major low carbon energy sectors:
  - Smart Electricity and Gas Networks
  - Energy Storage
  - Carbon Capture and Storage
  - Hydrogen
  - Low Carbon Transport
  - Built Environment
Mobilising the hydrogen at INOVYN’s Runcorn plant for the transport sector can catalyse hydrogen mobility deployment

INOVYN Chlor-Alkali plant at Runcorn produces hydrogen as a co-product of chlorine and sodium hydroxide production.

• Up to 20 tonnes per day could easily be made available from the plant.

• This is enough hydrogen to fuel over 1,000 buses or 40,000 passenger cars.

• To get started, a considerable demand for the fuel is required – more than 1,000kg/day.

• Of all the demands, buses appear the most viable in the short term.

As a result, INOVYN asked Element Energy and Costain to study the potential to create a near term project based on demand from buses.
The study involved consideration of the work at the INOVYN plant (Costain + INOVYN) and the potential to supply to bus operators.
Fuel cell bus capital cost reductions enable a plausible case for fuel cell buses if a sufficient scale order is achieved.

** See [http://hydrogenvalley.dk/white-paper/](http://hydrogenvalley.dk/white-paper/).

### Capital costs of fuel cell buses ordered in different years (non-articulated single deck buses)

<table>
<thead>
<tr>
<th>Year of bus order &amp; relevant project</th>
<th>Capital cost per FC bus (EUR m)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2009</td>
<td>1.5</td>
</tr>
<tr>
<td>2012</td>
<td>1.0</td>
</tr>
<tr>
<td>2014</td>
<td>1.0</td>
</tr>
<tr>
<td>2017/18</td>
<td>0.5</td>
</tr>
<tr>
<td>2020</td>
<td>0.0</td>
</tr>
<tr>
<td>2023</td>
<td>0.0</td>
</tr>
</tbody>
</table>

- **Scandinavian FC bus proposition (orders of 100+ vehicles): €450k**
- **Range indicated by certain OEMs considering commercial roll-out <€350k per bus, assuming >100 buses per year**

* *FCH JU MAWP* is the Fuel Cells and Hydrogen Joint Undertaking’s Multi-Annual Work Plan, the document that sets out the work plan and strategic targets for the second phase of the FCH JU’s programme of research and innovation.
The two leading UK bus builders can supply double and single deck fuel cell buses as integrated and fully OEM backed products.

**Wrightbus**
- Double and single deck vehicles – prototype operational today - available for order in 2019

**Alexander Dennis**
- Operational prototype recently unveiled – now selling a double deck model

**Solaris 12m buses**
- Operational prototype available in 2019, orders in 2020

**Van Hool**
- 40 buses on order in Cologne and Wuppertaal

Other new models coming from **Evobus** (12 and 18m), **VDL** (12m single deck), **Solbus**, **Ursus** and others.
There are over 1,100 urban buses operating in the greater Liverpool region.
Site surveys were carried out at the main operators – initial conclusion there are options for locating refuelling facilities at each depot

**Arriva Speke depot**
A strategy based on two routes for the two leading operators is proposed. This will require two in depot fuelling stations.

<table>
<thead>
<tr>
<th>Route Details</th>
<th>Arriva at Speck</th>
<th>Stagecoach Liverpool</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Route 79</td>
<td>Route 86</td>
</tr>
<tr>
<td>Yearly mileage</td>
<td>77,248</td>
<td>77,248</td>
</tr>
<tr>
<td>Hydrogen fuel economy</td>
<td>0.075</td>
<td>0.075</td>
</tr>
<tr>
<td>Total Hydrogen demand/route</td>
<td>349</td>
<td>381</td>
</tr>
<tr>
<td></td>
<td>730</td>
<td>666</td>
</tr>
</tbody>
</table>
A trailer swap solution will be used to move hydrogen from the Runcorn facility to the hydrogen stations.
The trailer swap strategy allows for low footprint refuelling solutions (images from Nel)

Easy expansion

<300m²

<100m²
There are no technical obstacles to installation of compression and purification equipment at INOVYN.

The design based on 2 x 5 tonne/day compressors and PSA for gas clean-up allows for substantial expansion with no extra costs.
Conclusion - A viable large scale project operational by 2022

An initial 90 bus project which enables the conversion of the Liverpool bus fleet

- There are no major technical obstacles
- **UK based bus builders** are ready to supply
- **Bus operators are willing to act**
- There is a requirement for **public sector leadership**

Main benefits:

- This will offer **truly zero emission public transport** for the region
- Bringing **new employment** to the region
- A **major differentiator and enabler** for the region
- A **catalyst for the entire hydrogen mobility sector**