Fuel Cell Bus Development Status in Korea

Soonil Jeon
Hyundai Motor Group
3 POTENTIALS

WTW Efficiency
Energy Carrier
Air Purifier
History of Development at Hyundai

'98 Beginning of FCEV Development

'04 Tucson FCEV (80kW)

'06 Tucson FCEV I (80kW)

'07 Tucson FCEV II (100kW)

'02 Santa Fe FCEV (75kW)

'04 - '09 US DOE Fleet (32 SUVs)

'06 - ’10 1st Domestic Fleet (30 SUVs, 4 Buses)

'09 - '13 2nd Domestic Fleet (100 SUVs)

'13 Small Series Production (World 1st)

'14.6 Launching in U.S.A

~ 700 SUVs & Buses
Over 10 million km

'06 German World Cup
## History of Development at Hyundai

**More than 10 years experience developing FCBUS**

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<tbody>
<tr>
<td><strong>FCBUS</strong></td>
<td></td>
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<tr>
<td></td>
<td><img src="image" alt="1st Generation Technology Development" /></td>
<td><img src="image" alt="2nd Generation Public Demonstration" /></td>
<td><img src="image" alt="3rd Generation Pre-commercial &amp; Cost Reduction" /></td>
<td><img src="image" alt="4th Generation Start of Production" /></td>
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</table>

- **Incheon International Airport** (‘12.9 ~ ‘14.6)
- **Ulsan Metropolitan City** (‘15.5 ~ )
- **Gwangju Metropolitan City** (‘15.6 ~ )
Fuel Cell Bus System

Multiple Power Sources and Motors $\rightarrow$ Enhanced Fail-Safe & Efficiency

- FPS (Fuel Processing System)
- TMS (Thermal Management System)
- APS (Air Processing System)
- FC Stack

$\text{Motor 100kW} + \text{Motor 100kW} + \text{Motor 100kW} = \text{FC Power Plant for BUS}$

or

- Super-Capacitor
- Battery
Hyundai’s Fuel Cell Bus

Pre-commercial Fuel Cell Bus (2017~), Start of Production (2020~)

- Improved power train (Stack, Balance of plant, Hydrogen tank)
- Cost-effective components, enhanced durability

**Specifikation**

<table>
<thead>
<tr>
<th>Category</th>
<th>Current</th>
<th>Next</th>
</tr>
</thead>
<tbody>
<tr>
<td>FC Stack</td>
<td>200 kW</td>
<td>200 kW</td>
</tr>
<tr>
<td>Aux. Power</td>
<td>Super capacitor</td>
<td>Battery</td>
</tr>
<tr>
<td>Motor System</td>
<td>PM Motor / 300 kW</td>
<td>PM Motor / TBD</td>
</tr>
<tr>
<td>H₂ Tank</td>
<td>350 bar, 8EA</td>
<td>700 bar, 6 ~ 8EA</td>
</tr>
</tbody>
</table>

**Performance**

<table>
<thead>
<tr>
<th>Category</th>
<th>Current</th>
<th>Next</th>
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</thead>
<tbody>
<tr>
<td>Acceleration</td>
<td>8.4 sec</td>
<td>-</td>
</tr>
<tr>
<td>Max. Speed</td>
<td>100 kph</td>
<td>-</td>
</tr>
<tr>
<td>Fuel economy</td>
<td>10.75 kg H₂/100km (Local Mode)</td>
<td>-</td>
</tr>
<tr>
<td>Mileage</td>
<td>440 km (Local Mode)</td>
<td>300 ~ 450 km (Local Mode)</td>
</tr>
</tbody>
</table>
Ultra Low Floor City Bus

General Specification

<p>| | |</p>
<table>
<thead>
<tr>
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</thead>
<tbody>
<tr>
<td>Length</td>
<td>11 m</td>
</tr>
<tr>
<td>Gross Vehicle Weight</td>
<td>16 ton</td>
</tr>
<tr>
<td>Number of Passengers</td>
<td>App.~50</td>
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</tbody>
</table>

Component Sharing with Passenger Cars

- Fuel Cell System
- Hydrogen Tank
- Traction Motor
- Battery

Material Cost Reduction

<table>
<thead>
<tr>
<th>Year</th>
<th>2012</th>
<th>2020</th>
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</thead>
<tbody>
<tr>
<td>Cost Reduction</td>
<td>100%</td>
<td>30%</td>
</tr>
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</table>
Current Status of Bus Business in Korea

**Plans for Replacing CNG Buses with Hydrogen Fuel Cell Buses**

- Total number of registered CNG buses nationwide: 26,000 (Annual replacement: 2,000)
- Revision of legislation for new 200 hydrogen station at existing CNG station sites

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**Current Status**

✓ **Air Pollution Issues**
  
  (NOx, PM, CO, CO2 & HC)


✓ **Diesel Bus → CNG Bus → Fuel Cell Bus**

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**PM Emission [mg/km]**

- Diesel Bus: 50
- CNG Bus: 0
- FC Bus: 0

**NOx Emission [mg/km]**

- Diesel Bus: 12,000
- CNG Bus: 65%
- FC Bus: 35%

**CO2 Emission [g/km]**

- Diesel Bus: 1,000
- CNG Bus: 0%
- FC Bus: 100%

[Reference] The emission test data for diesel and CNG buses under NIER test mode reported by Korean Ministry of Environment in 2012 were cited from the Website of Korean Association of Natural Gas Vehicles (www.kangv.org) (May 13, 2016).
Korean Government Policy

Korean Roadmap Announced by Ministry of Environment (’15.12.15)

- Hydrogen vehicle share to be more than 10% of new cars, and 520 hydrogen stations by 2030

Government Roadmap;

✓ Hydrogen vehicles 10,000 by 2020, 630,000 by 2030
✓ Hydrogen Station 100 units by 2020, 520 units by 2030

Anticipated Fuel Cell Bus Deployment by 2020;

✓ Spread over large cities and area around
✓ Total of a few hundreds of FCBUS to be deployed

- Ulsan City (Around a hundred)
- Seoul Metropolitan Area (A few hundreds)
- Pyongchang Olympics (A few tens)
- Chungnam Province (Around a hundred)
- Gwangju City (Around a hundred)
- Changwon City (Around a hundred)
Responsibility
Pride