

The first edition of the International Zero Emission Bus Conference took place on 30 November 2016 in City Hall, London, followed by the 10th edition of the International Fuel Cell Bus Workshop on 1st December 2016. Over 250 high level stakeholders from 22 countries attended the event! Representatives from local authorities, transit operators, industry, and national and financial regulatory and funding agencies held lively discussions around zero emission bus (ZEB) technologies' readiness levels and commercialisation paths. It was agreed unanimously that ZEB technologies are ready to be deployed globally today.

All presentations and the full program are available here: http://www.cte.tv/zebc_presentations/

KEY TAKEAWAYS:

- ❖ **Industry, public sector players, and operators increasingly appreciate the value of both air quality and economics as drivers for deployments of ZEBs**
- ❖ **Major cities are committed to phasing out conventional buses and deploying ZEBs before 2025**
- ❖ **Today bus manufacturers have commercially available ZEBs using battery or/and fuel cell technology with 12 m, 18 m articulated and double decker vehicle offer.**
- ❖ **Over 80,000 ZEBs are in commercial operation worldwide**
- ❖ **Battery electric buses (BEBs) and fuel cell electric buses (FCEBs) are both electric drive vehicles with many parts in common. They complement each other offering bus operator flexibility based on their operational requirements**
- ❖ **Charging (depot or en-route) and hydrogen refuelling infrastructure solutions exist today to meet operational requirements**
- ❖ **Combining multiple advanced transportation technologies such as autonomous vehicles, emissions reductions, and mobility on demand cohesively and strategically is the way of the future**
- ❖ **FCEB offer a direct diesel drop in-able to perform 18 hour non-stop service and refuel in less than five minutes**
- ❖ **BEB offer energy savings of 80% (4 MPG diesel = 10 kWh/mi vs. 2 kWh/mile for BEB)**
- ❖ **Globally, fleets will evolve from an average of less than 1.5% electric drive today to an average of 41.5% electric drive in 2025**

Notes from Governmental Authorities:

- Cities across the world are committed to improving air quality by switching to ZEBs: The Mayor of London, Sadiq Khan, keynote speaker at the conference, announced that no more pure diesel double-deck buses will be added to the capital's fleet from 2018 and that all new single-decks for central London will be zero-emission. London has committed to procuring

roughly 300 ZEBs by 2020, and currently has 79 ZEBs in its fleet, and at least 20 new fuel cell buses being delivered imminently.¹

- The 20 London fuel cell buses are part of a larger European project, JIVE, foreseeing the deployment of minimum 142 fuel cell buses in European cities, across five main clusters which will be launched early 2017.
- More than 60 locations in Europe are indicating demand for fuel cell buses. From the current operating/near operating 91 buses in Europe, commitments are being secured to procure 645 buses by 2020.
- Eleven other major cities – including New York, Los Angeles, San Francisco, Amsterdam, Copenhagen and Cape Town – have agreed to begin phasing out procurement of pure diesel buses by the end of 2020. Paris, Madrid and Mexico City have committed to removing diesel buses from their cities by 2025.
- The European Commission and the European Investment Bank presented the “Cleaner Transport Facility” (CTF), aimed at financing the decarbonisation of the transport sector in Europe and is particularly suited for buses². In addition, the EIB explained that the sector should try to educate the institutions & public sector in order to move to whole life costs instead of separating CAPEX and OPEX.
- The Department of Energy in the United States announced the release of its new report³ showing that the average fuel economy of fuel cell electric buses is 1.4 times higher than conventional diesel buses.
- In the US, there are more than 300 ZEBs at 60 agencies (1/3 of which are in California). This number will grow to over 600 by 2018 based on current sales to date.
- The primary US national funding program for ZEBs is the Federal Transit Administration’s Low-No Program that is currently supporting 33 fuel cell and battery electric bus deployment projects in 17 states.
- In California, cap and trade funding is supporting the Zero Emission Bus Pilot Commercial Deployment Project that has funded 50 ZEBs plus infrastructure to date. This support includes 25 fuel cell electric buses to be deployed at three transit locations beginning in 2017.
- The UITP is leading the ZeEUS project to deploy about 70 BEBs. Demo cities will have access to tools and guidelines to assist with deployment and a single evaluation methodology will be used across all projects.
- European Mandate M/533 to standardise electric charging infrastructure set the stage for partners to agree on necessary interoperability.
- Korean roadmap: By 2030, hydrogen vehicle share to be more than 10% of new cars, and 520 hydrogen stations will be available

¹ <https://www.london.gov.uk/press-releases/mayoral/sadiq-to-stop-buying-dirtiest-diesel-buses>

² [http://www.eib.org/infocentre/press/releases/all/2016/2016-312-eib-and-european-commission-present-cleaner-transport-](http://www.eib.org/infocentre/press/releases/all/2016/2016-312-eib-and-european-commission-present-cleaner-transport-facility.htm?utm_content=buffer6b52b&utm_medium=social&utm_source=twitter.com&utm_campaign=buffer)

³ <http://energy.gov/eere/fuelcells/articles/doe-fuel-cell-bus-analysis-finds-fuel-economy-be-14-times-higher-diesel>

- By 2020, Korea anticipates a few hundred FCEBs to be deployed. Korea plans to replace 2,000 CNG buses per year with FCEB until entire 26,000 fleet is replaced.
- In China, total of 170,000 electric and plug-in electric buses produced from Jan 2015-July 2016
- Chinese regulators established the goal to reduce emissions by 2030 to 60-65% of 2005 levels

Notes from Industry Players:

- ZEBs are a market opportunity, as summarised by industry speakers: “We’re not here to talk about sustainability anymore, we’re here to talk about saving money”. “The highest share of production is still ICE but the share of electric vehicles is growing [...] and we are ready to go in this direction.” New regulations/political backing will help support the uptake of the technology “In 2030, zero emission drivetrains will have a share of 70% with the sold city buses”
- Fuel cell buses are definitively part of the electrification process. Electric drive buses will be mainstream by 2025 with both battery and fuel cell electric buses complementing each other.
- The very first double decker fuel cell bus, made by Wrightbus was unveiled at the conference⁴
- Some OEMs are taking a modular approach to chassis design that supports various battery electric and fuel cell bus configuration all within their product line. Thus, their customers can design procurements to their unique energy requirements (and mix and match technologies as needed)
- Hyundai has more than 10 years developing FCEB. In 2017-2019, the 3rd gen focusing on cost reductions will be released. By 2020 they will start commercial production of 4th gen.
- Chinese FCEB manufacturers’ plans:
 - o Foton and Yutong plan to manufacture 100 FCEBs for leasing and shuttle bus soon
 - o 8 Feichi FCEBs in Foshan now
 - o 100 FCEBs in Zhangjiakou in 2022
- In US, 14% of market deliveries will be ZEB in 2022 (825 of 5800 buses)
- Cost gap: the initial barrier for operators is the higher initial cost, but now that the TCO is lower, this is no longer a barrier. It is up to the industry to better explain TCO that justifies the initial cost.
- FCEBs have accumulated over 3 million km in service in the US and 10 million km in Europe
- Hydrogen infrastructure: Scaling up hydrogen infrastructure is feasible: the technology exists to fill 100 or more buses in one depot. Further progress is needed on total cost of ownership, footprint, reliability, operations, and harmonization of regulations, codes, and standards.
- Charging infrastructure: Standardisation is absolutely essential for the large scale deployment of battery electric buses (See Leah O’Dwyer Presentation)
- ZEBs require operators to make new considerations in order to move away from conventional bus deployment. ZEBs have new variables that affect performance and cost, thus operators need to explore a number of new implementation questions. (See Jason Hanlin Presentation)

⁴ http://www.wrightbusinternational.com/news/news_item/WRIGHTS-GROUP-SHOWCASES-GROUND-BREAKING-HYDROGEN-FUEL-CELL-TECHNOLOGY