Workshop C: Commercialisation Strategy

1st December 2016 (13:15 – 15:15)

Moderator: Nicolas Brahy, Hydrogen Europe

Panelists:

Thorsten Herbert, NOW
Nico Bouwkamp, CaFCP
Nicolas Pocard, Ballard
Rob Del Core, Hydrogenics

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FUEL CELL BUS 10th edition WORKSHOP DECEMBER 1, 2016
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Today's Objective

A **Five topics will be introduced by a member of the panel:**

2 questions related to <u>cost:</u>

- Real cost trajectory for FCB ownership
- What is the interplay of bus volume, passenger car volume, and technology development?

3 questions related to <u>policies</u>

- How should national and international policymakers affect commercialization?
- Use of local regulations in zero emissions
- How can we convince policy makers of value of these regulations?

B **Panelists will discuss each topic**

C **After panel discussion, open questions to group**

D **Discussion points will be synthesised into key messages for each topic**

Starting with the 2014 FCH JU & Roland Berger study

Cost trajectory: a nice start …but

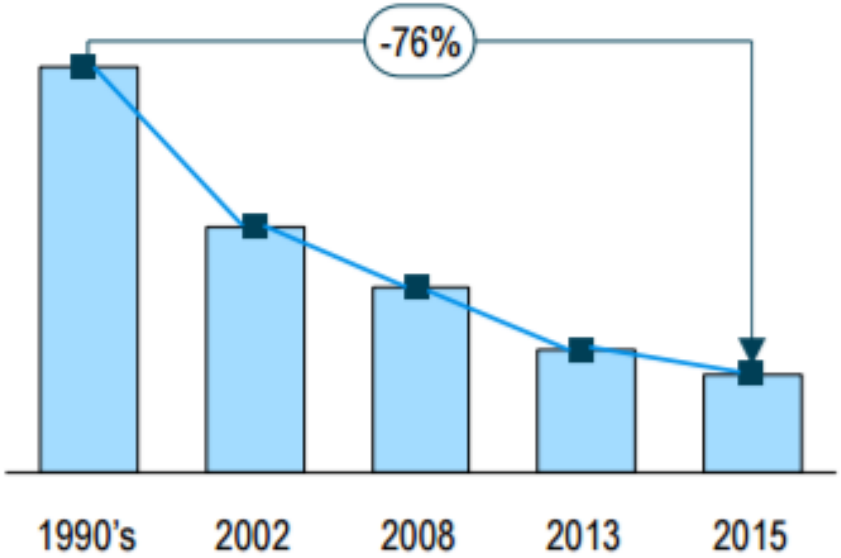
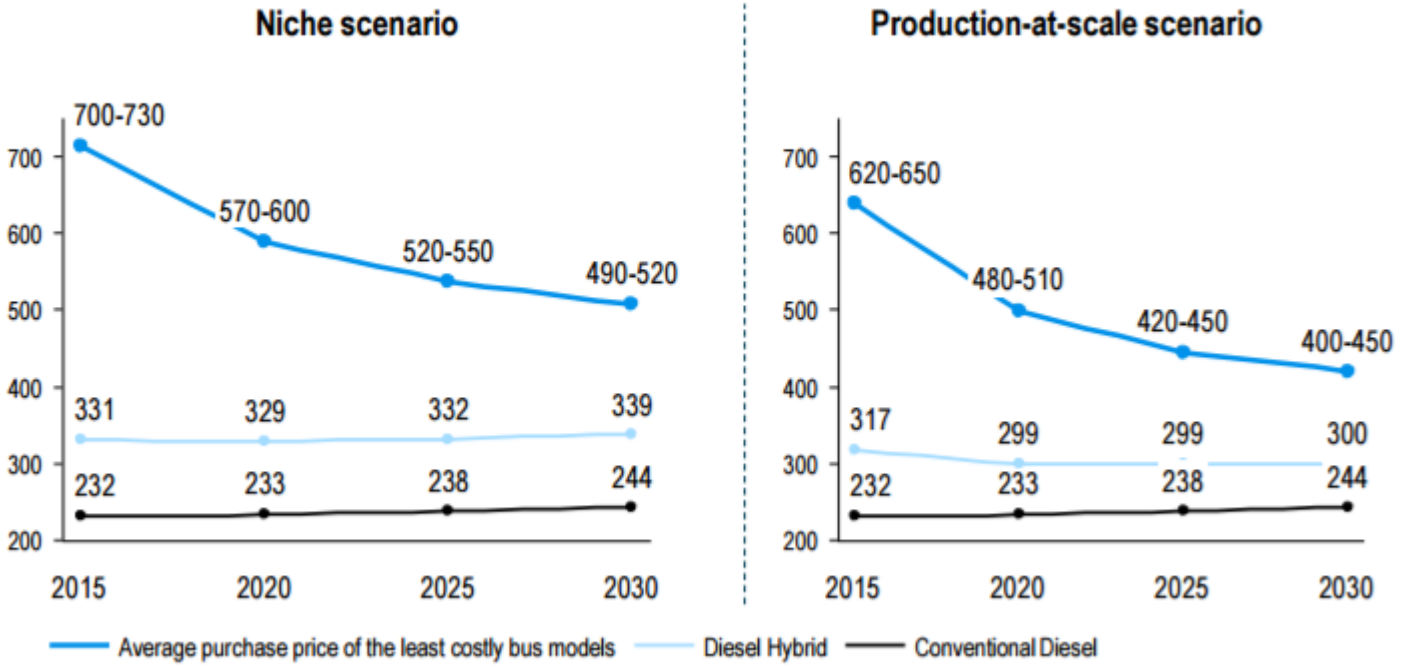


Figure 6: FC bus purchasing cost development since the 1990s [%]

Starting with the 2014 FCH JU & Roland Berger study

Cost trajectory: the next steps. Is it realistic ? Is it enough ?



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Starting with the 2014 FCH JU & Roland Berger study

Cost trajectory: the next steps. Is it realistic ? Is it enough ?

Scenarios	2015-2016	2017-2020	2021-2025	2026-2030
Niche				
No. of FC buses produced yearly by each bus OEM	30-50	50-80	80-120	80-120
Total # FC buses	180-300	600-900	1,200-1,800	1,200-1,800
Production-at-scale				
No. of FC buses produced yearly by each bus OEM	80-120	120-500	500-1,500	500-1,500
Total # FC buses	480-720	1,440-6,000	7,500-22,500	7,500-22,500

Price of the bus

€ 490-520K

€ 400-450K

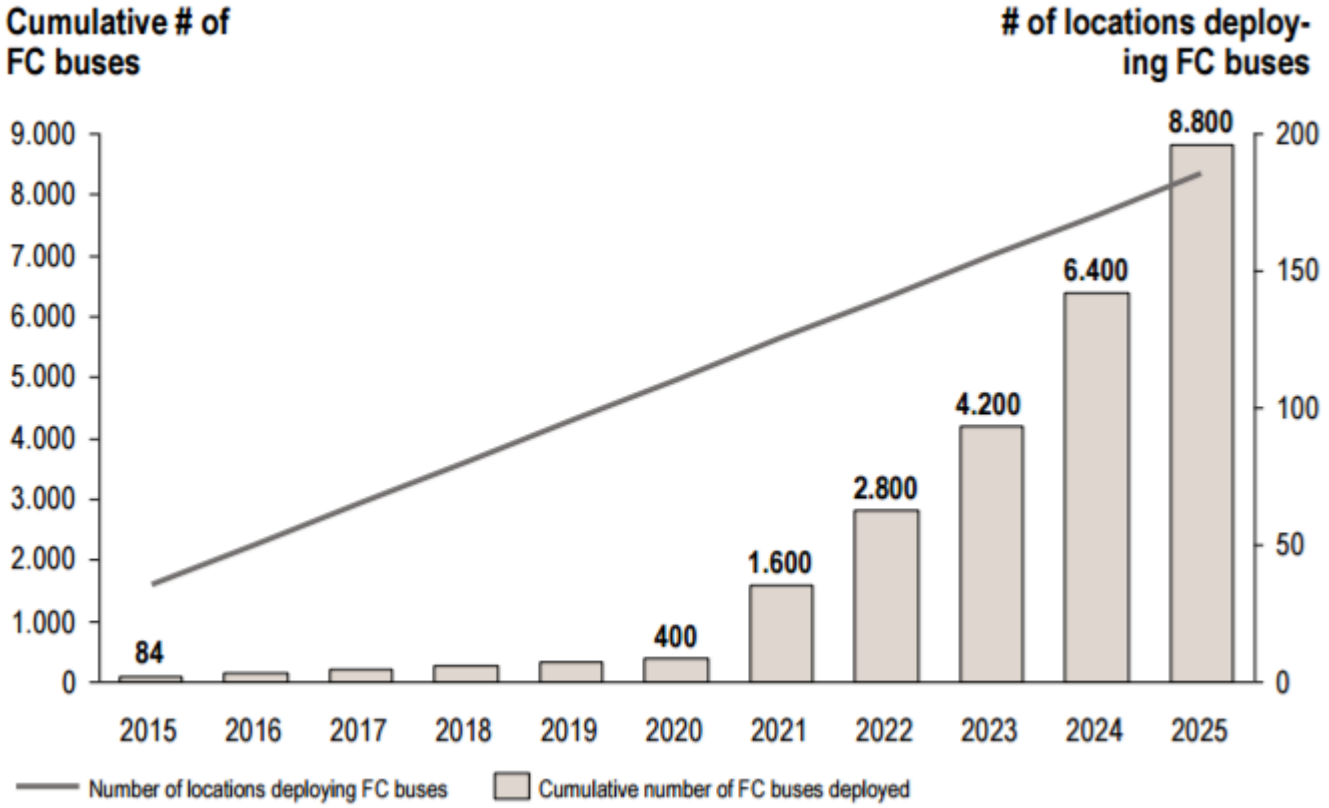
€320-350

At scale + synergies

FC system + batteries (10.000-100.000 FC/year)

Starting with the 2014 FCH JU & Roland Berger study

Cost trajectory: the next steps. Is it realistic ? Is it enough ?



Starting with the 2014 FCH JU & Roland Berger study

Explanations and levers for improvement

- **Cost premium due to**
  - Capex (bus) + associated financing + Warranties
  - During first years : Infrastructure/fuel and maintenance also source of higher costs
  - After a few years (2020)
    - maintenance is on par with diesel
    - Infrastructure /fuel can be on par with diesel (taxation and diesel price evolution?)

- **Future costs of the bus depends on**
  - Volume (size of the market)
  - Synergies

- **Besides synergies with cars, other factors (often local) that can help**
  - Low feedstock (electricity)/hydrogen prices
  - Low financing costs
  - Longer bus lifetime (12-18 years). Argument: trolley buses are usually depreciated over a longer

In 2016

Is this realistic ?
Is this enough?
Can we do better ?

The core of the debate

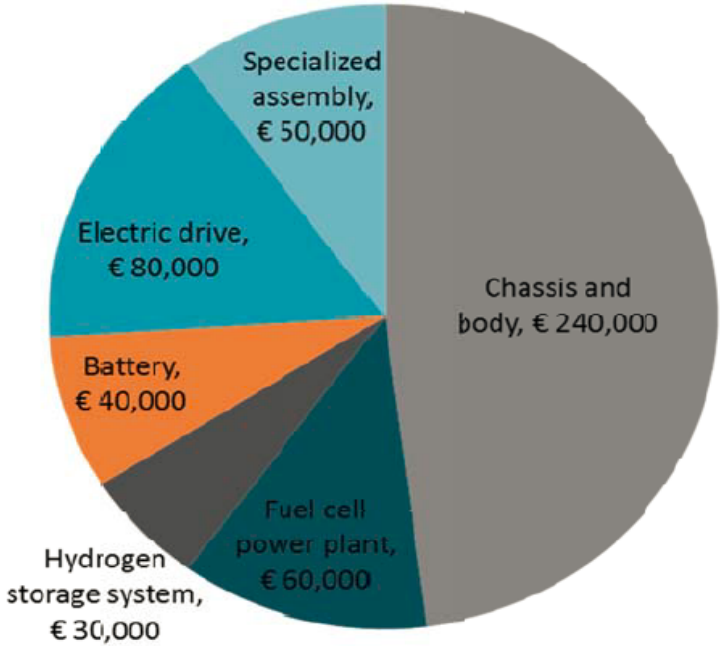


Figure 6: Fuel cell electric bus component cost estimate with 60kW fuel cell power module (2020)

Answers

- We are on track
- Demand is bigger than expected.
- FC systems can do their part in the coming years
- Good news: bus could be cheaper than expected/feared

No answer

- The bus and the integration
- The long term evolution: final target price
- New comers

Challenge: how to tackle these "no answers" ?

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How should national and international policymakers affect commercialization?

- National level: The Netherlands have a sort of political deal saying that from 2025 all new buses should be zero emissions

- EU level: the EU adopted in 2009 a directive on green vehicles procurement proposing a methodology to monetize externalities and hopefully favour greener vehicles. The directive has had no or little effect. The EU will envisage its revision next year

- US? No regulation but funding programmes
- China ? Clear national ambitions + funding => CHINA will take over Europe as first market for FC buses ?

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How can we use of local regulations in zero emissions?

- Local level: some cities have announced that from a certain date they will only procure zero emission buses.
  - City trap or city power ? (with Bus cities have to pay for the costs resulting from their regulation ?)

- Local/national/European: Some European cities and countries have been sued for not complying with EU air quality norms. Is sufficient to make cities act? Are buses sufficiently important in terms of air quality to be part of the first actions?

- joint procurement and standardisation of technical specifications.

- Others ?

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How can we convince politicians of value of regulations?

Politicians have many requests for action: why giving priority to buses

1. Real impact.

   Can we demonstrate that zero emission buses will have a major impact on city air quality ?

   - Seem to be the cases in London
   - Can we demonstrate this as a general rule?

2. Social justice

   – Incentives to purchases new technologies (eg Zero emission cars) are often de facto subsidies for the wealthy. Bus are for everybody

3. Visibility

   1. Citizens can see the actions of their politicians
   2. Future consumers can be exposed to the technology

Workshop C :: Commercialization Strategy
Additional Summary Notes

REAL COST TRAJECTORY & RELATIONSHIP TO VOLUME

- **Volume trajectory ahead of schedule** due to 2016 Chinese demand
  - Chinese market speed from contract to commercial service is a "game changer"
  - FCBs could be cheaper sooner than expected

- **Price per bus guarantee at a given purchase volume** will drive up demand volumes relatively easily (As recently used by FCH JU)

- Remaining areas for savings:
  - **On-board hydrogen storage** costs are a key area for savings.
  - At present, the FCB chassis by itself equals the complete cost of a diesel bus. Reduce these costs:
    - **Integration** cost savings can be improved
    - **Additional integration research** needed to bring down costs.
  - **Supply chain cost reductions** can be achieved through firm purchase volumes from OEMs

- **FCBs offer an advantage over BEBs in terms of known life cycle costs**
  - Fuel cell providers offer warranties that win out over the unknown degradation issues and costs that batteries face
  - Fuel cells offer more predictable performance over time than batteries

REGULATION & POLICY TO AFFECT COMMERCIALIZATION

- **Consistency and predictability is needed** - It is hard for an OEM to strategize towards a target because the rules are constantly changing.

- **City level action allows for speed and flexibility** in solution implementation. Regional/national level regulation would equal greater standardization, but greatly sacrifices speed of change (even paralysis)

- **Points appealing to politicians:** (1) jobs, (2) regional/local specifics, and (3) Combined solutions that can be implemented together – emission reductions, mobility, and energy transition