Part 1: Welcome & context

13.05-13.20: Welcome to FCB OSLO18 by Ms. Anette Solli, County Mayor Akershus

Notes:
- We are facing a great challenge
- Public transport is behind 75% of pollution in Akershus
- Akershus has one of the largest number of battery electric buses and battery vehicles are on the rise
  - This is an important step in phasing out fossil fuels
- To encourage fuel cell electric vehicles for taxi drivers in Akershus, 11000€ grant given
- In 2020, first non-emission contracts will be in place
- Next generation of fuel cell buses are expected to be more reliable than early generation buses

13.20-13.40: Zero emission transportation for Norway by Mr. Steffen Møller Holst, Vice President - Marketing, SINTEF

Notes:
- By 2025, new private cars, city buses and light vans are to be zero emission
- Measures are in place for zero emission solutions in several transport segments
- Support scheme for enhanced public procurement
- Technologies are developing very fast
- Public transport is increasing due to continued urbanization
- Norway is one of the countries with the highest number of battery electric vehicles
- Buses will likely remain a central element of public transportation in Europe
- Two true zero emission solutions: Battery electric buses and fuel cell buses (with biogas as another valuable solution)
- Increasing the of number of buses will decrease the price
- Hydrogen can play a role in the overall economy
- A flexible range extender is in development
- Transportation is behind 1/3 of all GHG emissions
- Hydrogen a pivotal part of reaching zero emissions in several transport segments
- Hydrogen solutions complement battery technology

Q: What number of jobs do you see created in Norway?
A: That’s difficult to answer on the fly. I would like to see an assessment and a project looking into that as an argument to the financial political environment. I don’t have numbers on hand. Pretty high numbers.

Q: I was wondering if you chose not to include passenger cars when talking hydrogen?

A: I was asked to focus on buses. I expect passenger cars to be increasing by 2025. I think half of them will be fuel cell passenger cars

Part 2: Experiences, Lessons Learned & Future Ambitions


Notes:

- Lord Provost, Barney Crockett, Aberdeen:
  - Fuel cell activities:
    - Bus project – largest group of buses currently (private bus companies)
    - We want to produce green hydrogen
    - We intend to increase number of hydrogen buses and other projects
    - Infrastructure alignment and planning is very important – teething issues, but improved now
    - Using the bus drivers as ambassadors has huge success
    - Aberdonians enjoy fuel cell buses – some wait for the hydrogen bus and let the diesel buses pass
- Pernille Aga, Ruter:
  - We do not drive or own buses. It’s tendered out in markets.
    - Currently own 5 hydrogen buses and a hydrogen fuel station
  - Emission free by 2028
  - It’s been challenging to roll out the new tech, so strategies are important, especially during the overlap period
  - We would like to see buses for longer range drives to fill a gap
  - We want an innovative market that provides the solutions that we need
- Martin West, Transport for London
o We participated in the Chic participation
o Zero emission tailpipe technology is very important in London
o Lessons learned (14 years of experience)
  ▪ Try not to solve all environmental problems in one go – scale up instead (economy of scale)
  ▪ Think about the life cost
  ▪ Be open to technologies
  ▪ It may be very similar to diesel bus, but it is different. Don’t just cross out diesel and but in hydrogen – e.g. auxiliary loads are different (think about e.g. heat and efficiency)
  ▪ Consider carrying out maintenance in-house
  ▪ You have to expect some risks
o It’s no longer about demonstrating the buses. We want to spread the knowledge and increase competition to increase number of tenders
o Aim to co-locate diesel and hydrogen – one line to decrease space needed
o Push to decrease fueling time
o Push for London style buses

Couch time

Q: In Aberdeen you also have the energy situation (similar to Oslo) – can you emphasize a bit about the motivation?

A: In London it is important because of the intensity – Aberdeen has ambitious energy change targets and is a mostly private sector city. We have to work a lot with private companies. We have a low proportion of local UK companies – targets more about energy change than increasing employing.

Q: So, Norway and Aberdeen have a similar focus on energy?

A: Yes, very much so

Q: Would you like to comment on the value chain?

A: We believe it has come quite far – during Chic, Ruter had hydrogen production, this time we expect the market to deliver. We still need infrastructure to deliver the hydrogen to the buses. That’s a big step forward towards commercialization.

Q: Can you comment on the London space constraints?
A: It’s a huge concern in London – 80 bus garages, most at capacity (24/7 operation), trying to find locally available green energy to produce hydrogen, but currently having it delivered. Hydrogen being delivered is the best solution for London, with focus on who produces.

Q: Speaking of the buses themselves. You just launched a new plan for BeB - 70 next year, which is a huge increase. From the bus riders’ perspective, there is not a big difference between BeBs and FCBs, but can you elaborate a bit about your new BeB project, its challenges and how FCBs might play a role?

A (PA): We had 6 buses with different charging solutions, producers etc. We’re still on the learning part, in order to allow the actors involved to gain knowledge so we can get zero emission contracts. After public tenders, we purchase many buses, so we need the learning to be able to do this. There will be lots of adaptations, we will need spare buses during the transition from today’s tech to zero emission. Reliability etc. cannot be influenced. We write on the bus that it is zero emission to create buzz amongst passengers. It needs to be a step in the right direction for the customers.

A: For London, passengers are focused on where to go in the morning – not focused on what is written on the side. They are familiar with zero emission tech. For TfL, one of the advantages is the core network, core business, but also other business activities that buses are used for (train down, accidents etc). Limited BeB range can make it difficult, so in these cases, diesel buses are still used. Protest markets, closed roads etc. can cause route changes, where routes might suddenly be longer, so BeBs may be challenged and may not be able to get back home.

A: We work hard on branding hydrogen. The two private bus companies are competitive, so we have a strong hydrogen identity in the city, which also includes hydrogen taxies. The recognition of hydrogen is high in Aberdeen.

Q: It seems that you may allow for a certain number of BeB to run on short routes, but other tech for longer runs – minimizing risk and ensure that passengers are transported?

A: We are taking small steps in the direction of all zero emission. We are looking at hydrogen for longer regional lines (longer routes and higher speeds), so this needs to be tested and commercialized asap.

Q: Norway is probably different from the rest of Europe – power surplus, long country, - lots of discussion about power and electric production?

A: There are advanced within BeB – ironing out issues, smart charging, and figuring out how to give back to the energy grid, need to figure out infrastructure, after decarbonization of vehicles, its necessary to be mindful of the energy grid as other things need to be zero emission
A: Aberdeen – hydrogen has a higher profile than BeB. We do have charging points, we have an usually sizable power scheme, hoping to have hydrogen involved in that, we have the world’s biggest wind power

Q: Any advices for new authorities considering fuel cell buses?

A: LPBC: Lessons:

- You need to align infrastructure before buying the buses. Different countries have gotten in wrong in different ways.
- Staff training is important – specialist people is an important element. They need to be well-trained to advocate for the change. It has proven to be important for Aberdeen to work with the public.

A: MW: Best advice – we’ve seen tight time scales, if we are to achieve zero emission, people need to get used to the new infrastructure – don’t leave all to the last minute, next year, you’re going to have one hell of a steep learning curve and get a nasty shock. Start now, you’ll probably make small mistakes, work on them.

A: PA: Knowledge is key. Supply chain issues can be problematic – few, far behind, can lead to issues as they can take a long time delivering and thus getting buses back on the road. Build a resilient supply chain.

Q: Key learnings for reducing cost and investments for next stage of FCB?

A: MW: Make sure you standardize as much as possible and always go with a competent supplier that you know. The more you make it like a diesel bus, the easier it will be and the shorter the lead time will be.

A: LPBC: Scale – things are more expensive because of scale. People need to be prepared, because it’s advancing more than provisions. Consider having more parts than you usually do for a diesel bus. Because it’s not standardized, parts may take longer times coming.

A: PA: Companies like us don’t necessarily want to own the buses and risks, so you can perhaps look at renting

Q: Will there be copies of the presentations? (A: they will be made available) Are there any benchmarks about the fuel costs compared? (A: This will be addressed after the break)
Part 3: Hydrogen Infrastructure & Storage
14.50–15.10: Hydrogen infrastructure and how to implement fuel cell bus fueling in the Nordic cities? by Mr. Jon André Løkke, CEO, NEL ASA

Notes:
- We are providing technology – working to be the cheapest and most compact
- Soon hydrogen buses will be competitive with diesel buses
- The new element is not hydrogen. It’s transport.
- Hydrogen is just another fuel.
- The big transition is going electric, whether you go pure BeB or FCEB is a choice that can be made later
- Fossil parity = 5€/kg
- You need to think about the infrastructure in an integrated way
- There needs to be a certain scale
- To deliver hydrogen, it’s not a matter of distance, but time – maximum 2.5 hours from production, which needs to be centralized
- It is possible to share hydrogen infrastructure

15.10–15.30: Hydrogen storage solutions and safety for bus and infrastructure by Mr. Vegard Fredheim, Manager Sales and Projects Hydrogen Business Development, Hexagon Composites and Mr. Vegar Løkken, Product Manager, Agility Fuel Solutions

Notes:
- The cylinders are performing far above the requirements
- Agility: We have the infrastructure in place and we have the experience
- Cost is a question about volume.

Part 4: Buses & TCO examples
16.00–16.30: Which Fuel Cell buses are available? Mr. David Barnett, Business Development Manager, Wrightbus Ltd | Mr. Geert Van Hecke, Sales Public
Notes:
- DB:
  - Focus on long-term relationships
  - The fuel cell bus has the potential of leading the zero-emission bus market
  - The key thing, the key winning point, is the time to refuel
- GVH: For the moment, we only see two solutions. It’s the fuel cell solution or even the trolley solution.
  - It’s not only about the supply, but also about support strategy
- TP: These are not prototypes anymore

Q: Town with a lot of tourism. Are any of the manufacturers looking at tourist buses?
A: At Solaris, we only have the plan for the city/inter-city bus. It’s interesting, but only low-floor city buses for now.
A: We had a project in Cologne and Ubertahl – small towns connected with regional buses.
A: Similarly, at Wrightbus we focus on low-floor buses.

Q: How many buses must be in order to make a cost in the city?
A: For Solaris, we cannot answer at the moment. We are first of all a city bus manufacturer; inter-city is the project for the future.
A: Same for Van Hool. Focus on a standard. We want to see large scale projects that work like diesel buses.
A: For us at Wrightbus, the UK market doesn’t typically look at high-floor buses.

Q: Cost reduction? For the next gen buses, how far down can you go?
A: Depends on the scale effect. The market is growing up, but it needs to grow up farther. We need supplier competition. We need a scale effect to go lower. There is the possibility on the horizon.
A: I can confirm. It is politically driven. Nobody earns money on the fuel cell buses. Compare to Tesla, they still haven’t made any money, but that’s no problem because we are preparing for the future. The price will continue coming down.
Q: We have seen on the passenger car, that the volume hasn’t been delivered. Will the bus industry be able to deliver the thousand buses?

A: VH: That would be a nice problem to have. It is all about how you build and manufacture.

A: From Wrightbus’ point of view, we started building with this problem in mind. We took our core tech and adapted it into this. So, a module might be unique to the FCEBs, but the majority of parts will be standard.

16.30–16.50: Service model build to support the mobilization period by Mr. Jesper Thomsen, CEO, Ballad Power Systems Europe A/S

Q: 1) reliability – what’s the main reason behind the increased reliability?

A: Long period of building up. Service has improved greatly within the last few years. The experience that we have gained also helps to improve our methods.

Q: 2) Is it possible for you to mention the additional costs?

A: It’s not really up to us, but we are focusing on reducing the costs and how we can reduce cost on the fuel cell modules.

Q: 3) Can you tell us more about the lifetime of stacks?

A: Stacks in London that have more than 400,000 km, 28,000 hours so far. That’s something that we continue to improve. On other components it can be difficult to define lifetime, but there is scheduled maintenance where smaller components can be changed.

Q: NEL showed cost parity, from the fc pow, how far are we from cost reductions?

A: The fuel cell module is one component of a bus, we have some numbers that are being targeted with our partners. They see the potential of getting the TCO cost below BEB and comparable to diesel.

We are not just trying to reduce the price, but total cost of ownership. The comparability is on the TCO level.

NEL: We just want to add to that. The point is that it’s now about volume, it’s not about the technology. If we get focus on the 1000 buses, we can promise TCO competitive to diesel.

Notes:
- In Europe, 4000 zero emission buses are going to be needed per year
- There's a lot of work to be done to hit the target prices
- Scale of demand is needed on a number of different levels
- It's about having hydrogen at the depot
- It's about scale at the depot
- Top tips:
  - Scale
  - Maintenance arrangements
  - Procurement should be simple
  - Some depot modifications
  - Ensure that drivers are positive about the change

Q: Could you go back to the cost? I was curious about your assumptions about the lifetime of batteries and fuel cells.

A: These numbers and assumptions have come forth after many conversations with different manufacturers.

Q: Railway has been benefitting from the green profile. The bus segment is much more dynamic than rail. We've heard about fossil parity, but we also heard of some challenges and bottle necks about hydrogen and we haven't heard about safety.

Fossil parity is not enough. There should be something between fossil parity and green parity.

Solaris showed pantograph. Buses are scheduled for routes, you can supply grid power for part of the route. The Riga example is something to look into.

A: The right solution is location specific. There's a continuum of options. It's a very interesting time.