



**Fuel Cell Seminar 2007 -
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2007 Fuel Cell Seminar - San Antonio, Texas, USA

Day 1

Kerry-Ann

This year the Fuel Cell Seminar and Expo rolled into San Antonio Texas. Yep, Texas. The State famous for Oil. How would a State that has spawned, a generation of large shoulder pad wearers through a dodgy soap opera (Dallas), a fair few US Presidents and, according to one local, the only State in the US that has the right to fly its flag at the same level of the Stars and Stripes take to a large conference basically looking at using substantially less of its most lucrative resource?

The Seminar officially started this morning but as the same over the last couple of years yesterday was a pretty full day of short courses and meetings and an evening reception.

The plenary session saw a very large (and chilled) room pretty full to hear Mike Binder and Dan Rastler present to the Seminar award to Subhash Singhal who presented a romp through the history of SOFC development, and John Trocciola who presented a personal take on the problems and challenges facing the building of a stationary fuel cell market.

Subhash, whose career developed within Siemens SOFC group highlighted that Siemens original SOFC unit produced 100kW CHP and has run for 36,750 hours of operation, to date, with no significant degradation. The current trends in SOFC research and development in decreasing operating temperature and use of metallic interconnects, decrease in cost and a substantial increase in the interest of using coal as fuel. As always though the downside to this development is that there is still some way to go in terms of cost and lifetime. Though costs are coming down there is still some way to go. A message we have heard before and suspect that we will hear a number of times again!

John, from Fuel Cell Perspectives, gave one of the rare presentations in which I sat back and went "yes", "yes", "yes". There are a number of things that we find bugbears in the industry which John, and later Bob Rose, highlighted. These included companies putting out far too many press releases on subjects which are basically not news. "We have had an order for fuel cell.", "we have built the fuel cell.", "we have shipped the fuel cell.", "we have installed the fuel cell.". The impact of these releases is to create something of a false perspective in general and a sense of disillusionment in the industry in general. False expectations are not good. Apart from this problems of cost and actually adopting the units are also non trivial. The industry is competing against the embedded technologies, primarily for stationary fuel cells this is the grid, and it is against this that the industry as a whole has to challenge. This was also something echoed by Bob later. We are still far too small, too vulnerable to be squabbling amongst ourselves. Working together we need to encourage adoption, which John promoted, in the US at least, by levying a small nation wide grid charge which would raise significant levels of fees that could be used by the federal government to invest and buy a batch of large stationary fuel cells per annum. It was pointed out that this would not be the first time that the government has stepped in to help a new industry that could have large positive impacts for the country.

I have to admit that when I first heard that Joel Bluestein would be talking about Climate Change being a driver for fuel cells I did think "oh no not another one" but instead he focused on the drive by the different States within the US in terms of GHG reduction and the potential for a cap and trade system to raise funds for new technologies.

Bob Rose finished the first session with a industry health check, which as already mentioned again presented a really good overview of the fact that yes the industry is progressing and yes costs are coming down and yes more and more real products are in the market place and yes some governments are finally starting to take a real interest but..... The most interesting point during the talk was when Bob asked how many of the people in the room, i.e. the fuel cell industry, had actually bought a fuel cell. As far as I could see not a single hand went up, including mine. We, the industry, haven't even yet put our own cash on the line and yet we expect others to do it. Fair point Bob.

Jon

The plenary session continued with talks on San Francisco's fuel cell bus demonstration project and, interestingly, the 'clean coal' and nuclear industry's perspective on fuel cells. Ben Yemagata from the Coal Utilisation Research Council spoke of the implications of 'clean' coal technology for fuel cells. There has been much talk lately of the renaissance of the coal industry, driven by the need for energy security, and lower CO₂ emissions, which the coal industry claims it can now achieve by carbon capture and storage (CCS) either pre- or post-combustion. A technology roadmap developed by the Council in 2001 has

recently been updated (both in 2006 and 2007) as the energy landscape changes and clean coal becomes increasingly competitive with other energy technologies, particularly as the price of crude oil hovers around the \$80 mark and the political will to reduce CO₂ emissions becomes more apparent. With successful research and development, the Council hopes to have coal-based power generation with CCS on a commercial scale by 2025. What is more surprising is that the Council hopes that the cost of this 'clean' coal will be the same as the cost of today's unsequestered coal based generation. The present funding situation for clean coal, although very generous by most standards at \$425m, is claimed to be inadequate and \$911m is said to be required for sufficient R&D. Ongoing US legislative developments, some of which are covered in Fuel Cell Today's Legislation Quarterly Review, such as the Liberman-Warner Bill (due for discussion in the US Senate this week) and the Lieberman-Specter Low Carbon Economy Act, aim to make funds available for sequestration. Nothing specific to fuel cells is currently contained within these bills and it remains to be seen whether the bills will have any impact on CCS, let alone fuel cells. The hydrogen produced from co-generation plants using CCS could in future be used in fuel cells although no US utilities are seriously looking at CCS combined with fuel cells for power generation. Perhaps it is too early (or too late!) to pin the hopes of the fuel cell industry on a related technology that at best has co-benefits for fuel cells.

Energy's Stephen Melancon concluded the plenary with a talk on how nuclear power's apparent renaissance could benefit fuel cells. Once again, this talk focused on a technology which, although while attracting political attention, is still a long way from generating the hydrogen needed for large scale fuel cell adoption. Nuclear power plants capable of producing hydrogen are still a good way off – 2018 at least. 24 nuclear reactors are said to be under construction worldwide, with 138 in the planning stage. Many of these are said to be being built by the 'private' sector, although it is interesting to speculate that if fuel cells had anything like the level of de-facto government subsidy that the nuclear industry has had (to pay for decommissioning, cleanup and storage of radioactive waste), we probably would have seen fuel cells in a variety of commercial applications long before now. The USA, China and India all have 25 or more reactors currently planned. None of these however are planned to produce hydrogen, although the next generation of high temperature nuclear reactor (likely to see commercialisation around 2020) could produce hydrogen fairly efficiently by electrolysis. The two talks gave an interesting insight into how hydrogen could be produced in the future, but as yet there is no silver bullet technology to do this that is free of drawbacks. It is good to see a variety of speakers discussing how fuel cells may play an increasingly important role in the wider energy and environment debate.

Kerry-Ann

This afternoon both Jonathan and I were in the first of the new track on Fuel Cell Commercialisation. As well as our two presentations there were talks by Omata-San from the Japanese New Energy Foundation (NEF) updating the information on the Large Scale Residential fuel cell programme., Steven Medwin on the requirements by forklifts manufacturers, Kevin Spitznagel (Logan) talking about operational data of using PEM units as a backup power and finally Frank Holcomb from the US Army. Whilst all the presentations were interesting the two that stood for me was the update from Japan which showed data that per unit per year carbon dioxide savings were around 28% of average and over 30% of all units installed so far have only needed to be restarted no more than once. The programme is now entering its potentially final year with another large batch of units going in, some 950 units with a subsidy of 3 million yen per unit.

Steven gave a very interesting presentation from a forklift designer and manufacturer. What was really interesting from our perspective is that this was the first time this information had come from this side and not the side of the fuel cell companies selling the concept of using fuel cell in materials handling. One point that certainly stuck was that batteries have a very obvious centre of gravity. Forklifts have been designed around this with weights and fulcrums worked out. With fuel cells the centre of gravity is not obvious as it is not a homogenous unit. Now that a larger number of fuel cell units are being targeted for forklifts then one solution being presented is that the units have a sticker on showing where the centre of gravity is. Real world uses providing simple real world solutions!

Day 2

Increasingly the Seminar has to tread a fine line between becoming an overly technical conference, ignoring the commercial aspects, and a market based conference ignoring all the excellent R&D still being done. This year this split between research and commercial was highly evident. The new commercialisation track was again very well attended and so was the highly technical high-temp SOFC development track. This year the poster hall is predominantly technical R&D with a lot of work on SOFC interconnects, GDLs and membrane conductivity in evidence whilst the exhibition hall was almost exclusively (supply chain) commercial.

Jon

It was an early start on Day 2 for me, with my talk on Fuel Cells in India being moved forward to kick off the global overview session. The Lila Cockrell theatre, venue for the session, is mightily impressive with seating capacity for over 2,500 – although I am glad to report that there were only a couple of hundred attendees this morning! The session also focused on the development of fuel cells in the USA and Japan, more details of which will be available in the full report of the Seminar, but sufficed to say that increasing numbers of units are being deployed in these markets for stationary and transportation applications

although challenges of durability, cost and codes and standards remain.

The transport track gave a number of useful and interesting updates from various old, and some new to us, projects. This included a talk on the PURE energy centre on Unst, Shetland, UK. Some readers may remember we featured PURE (Promoting Unst Renewable Energy) in our low carbon communities report earlier this year, and this talk was a useful opportunity to catch up with the latest on the project. Unst is unique in that it represents a grid-locked island energy network at the end of the consumer fossil fuel supply chain, with the highest transport fuel prices in the UK (petrol currently costs around £1.09 per litre or \$2.22 - prices which might come as a shock to our Texan hosts). The energy landscape of the Shetlands is intimately tied up with social issues - over half of Shetland islanders spend more than 20% of their income on energy (and hence are in what the UK government calls fuel poverty), and the islands suffer a declining population. The PURE project, which links hydrogen generation powered by wind to a small fuel cell car and stationary fuel cell unit. The main work of the PURE centre has been to share lessons learned from renewable hydrogen generation, and supply renewable energy systems and knowledge with groups from as far away as Ghana and Bhutan. The project claims to have created 10 jobs, links with 40 businesses, and generated 250 additional hotel bookings – not insignificant on islands as small as the Shetlands. The PURE centre has also brought the first rock band fuelled by renewable H₂ to the Shetlands, an event that was featured in Time magazine.

The afternoon transport session got underway with J. Kallo from the Deutsches Zentrum für Luft und Raumfahrt giving a talk on the experimental PEM APU currently being tested on an Airbus A320. The system is being stress tested under various extreme inclination, vibration, acceleration, low pressure, and climatic conditions. Tantalisingly, we were told that more details of the testing at altitude will soon be released – look out for Fuel Cell Today's daily news on the subject. J. Skulason from Icelandic New Energy (INE) gave a glimpse on the hydrogen transport projects currently under development in Iceland. Like the Shetlands, Iceland suffers from high energy prices and an isolated grid. It operates 3 fuel cell buses with a combined mileage of over 150,000 km which have saved over 70,000 litres of diesel and 200 tonnes of greenhouse gases. INE hopes to have 12 hydrogen ICE cars running by the end of the year, including some that will be available for the public to rent from Hertz rental car. The hydrogen station that will service these vehicles took just 8 weeks to construct and permits took just 2 weeks to obtain – Iceland's codes and standards regarding hydrogen seem to serve as a model for the rest of the world. In April 2008, a hydrogen powered whale watching boat is due to be launched. The boat will use a 10kW PEM for normal propulsion, with a conventional diesel engine used for peak loads such as pulling in the anchor chain (up to 45kW power required). Issues with hydrogen storage onboard and refuelling of the boat seem to have been taken care of and the world looks forward to the launch of this exciting niche transport application.

Next, Don Erikson from the US Air Force Research Laboratory (US AFRL) gave an overview of the Small Unmanned Aerial Vehicles (SUAV) programme. SUAVs are used by all 3 forces for aerial reconnaissance, and SOFC and PEM powered units are being developed by Protonex and Millennium Cell for the US AFRL together with Aerovironment who are developing the DC/DC converter and battery packs. A hybrid PEM/battery 'PUMA' SUAV with 8.5 foot wingspan was recently tested by the AFRL and flew for 7 hours 3 minutes, considerably better than the 2.5hrs by a rechargeable battery-powered SUAV or 4hrs primary battery-powered SUAV. From the air to the land, to the ocean and back again, fuel cells have great potential in a variety of transport applications.

Exhibition Hall

Apart from the companies such as CMR, IdaTech, AeroVironment and Gore, which we would expect, a number of large stake integrators and developers are missing with other smaller companies supply chain companies taking their place. Also this year Ohio and Connecticut are once again putting on a good show of force and so, we have to say is the UK / Scotland with their large group stand. Whilst footfall in the exhibition is sporadic this is more, we suspect, to do with clashes with the excellent talks. Unfortunately there is not much pure exhibition hall time built into the programme so many people are operating on something of a tag team working in relays between the track sessions, the exhibition hall and the poster sessions. It would be nice to have more time for the attendees to spend quality time in the exhibition hall and not have to miss a talk but maybe this is something for next year.

Turning attention to the exhibition hall there are lots of product on display but the product is test stations, pumps, humidifiers, sensors etc. This is not balanced out with fuel cell product. Following Bob Rose's call for all fuel cell stakeholders to go away and buy a fuel cell it is not that easy to come straight into the hall and buy one. Fuel Cell Materials, which is here showing its new hydrogen sensor, and H-Tec are both here with mini fuel cells for sale but apart from Arcotronics, Nanodynamics and America Hydrogen Corporation there are few actual fuel cell end use products here. Intelligent Energy and IdaTech, working on transport and small stationary (CHP and UPS) space are here, both with literature on increasing products lines but no product here. The question being asked by some of the attendees is how this exhibition hall will develop. The general feel from some of the talks is that the products being tested work, sometimes better than expected, so now does this event become a trade show showing the potential adopters what can be bought or does it carry on like this of advertising internally to the industry its supply chain components?

Presentations

During the presentations the various US departments involved in fuel cell R&D having been giving their excellent succinct and to the point presentations. This afternoon was the turn of Nancy Garland who outlined the breakdown of the current sets of aims and objectives for durability and membranes. The FY2008 request is some healthy US\$62,700,000 (fuel cell stack component US\$44,000,000) with a large focus on catalyst R&D with 4 strategies (lower PGM content, Pt alloys, non-Pt catalyst, novel support structure). Current stack cost US\$107 per /KW (for a 80kW stack under high volume manufacturing) and durability of 2000 hours.

The Gore presentation from Jeffery Kolde, which followed was very interesting and also gets the award for the most photographed set of slides. It was difficult to concentrate on the presentations when so many people were simply sitting in the audience photographing each slide. Maybe in the future one way to avoid this would be to have copies of the slides available in advance. Whilst giving away no technical secrets on their MEA development Jeffery gave, to my mind, the best presentation of the conference, on the challenges we are facing in MEA development. Catalyst loading and durability being something of a centre piece. With the DOE targets demanding, for automotive stacks at least, increased durability and decreased Pt loading, down to 0.15 g/cm² to meet the cost targets, the issue now is how to balance what has historically been a trade off. To increase durability traditionally has seen an increase in Pt loading. This has to be addressed and from what we heard from this, other speakers and general industry gossip it is being addressed. More presentations of this quality and approachability would be very welcome.

Day 3

Jon

The third and final day of the 2007 Fuel Cell Seminar and Expo got underway with two fascinating tracks – residential scale fuel cell applications and government incentive programmes. After talks on the Southern Fuel Cell Coalition demonstration project, and demonstration projects in Connecticut and California, an introduction was given to the 'Fuel Cell State' by Jennifer Gangi from Fuel Cells 2000. A range of policies and initiatives are currently underway on hydrogen and fuel cells at state level in the USA. Fuel Cells 2000 has put together a database covering these state fuel cell and hydrogen policies and demonstration projects, which is freely available as a tool to government, policymakers and the public. Currently 47 states plus the District of Columbia have some activity in the hydrogen and fuel cell arena and the database aims to provide support for industry as well as educating decision makers and the public on the wide range of activities currently ongoing. State champions in particular areas of fuel cells include Ohio and South Carolina for fuel cell research, California for vehicles and infrastructure, New York for stationary FCs, and Connecticut for the fuel cell industry. The Federal government has committed \$1.2 billion over 5 years to fuel cells, plus certain states have additional hydrogen and fuel cell funds (including \$103m in Ohio, \$6m in California and \$11m in Connecticut). Fuel cells could mean future good business opportunities for states, and 15 states currently offer tax incentives for fuel cells and for fuel cell companies to locate in their state. State activity appears to be moving the industry forward by laying the groundwork for future widespread fuel cell adoption –including addressing codes and standards, co-operating with utility authorities and zoning of both stationary fuel cells and hydrogen infrastructure for transport.

Developing countries and the potential for distributed generation (DG) by fuel cells was the focus of the next presentation by Stacy Swann. DG is currently provided in many developing countries by diesel gensets, with all the pollution, noise, and energy security implications associated with them. As I emphasised in my India presentation yesterday, there is a very real potential for fuel cells to 'leapfrog' conventional energy technology in many developing countries. Grants are now available from the World Bank and IFC under the Fuel Cell Financing Initiative (FCFI) for Distributed Generation Applications. The programme makes \$54m available in 2 stages: stage 1 provides almost \$10m in funds for 3 distinct projects - \$3m has already been committed for the development of fuel cells for DG in developing countries. Potential countries eligible for the funding need to be signatories on the UN Framework Convention on Climate change, and must be in geographical areas with 'good future market potential'. The discussion section at the end of the talks was an opportunity for the panel to answer questions such as why up until now we have not seen more deployment of fuel cells for DG in developing countries. Apparently this is not for want of applications (there have been over 30 proposals in response to the FCFI), but more that potential projects have been rejected at the due diligence stage due to deficiencies either on the commercial or the technical side. FC projects in developing countries need to be self-sustaining; that means that the technology needs to be fit for purpose, well-tested and come with warranty or service agreements with local partners so that the project does not fail as soon as there are technical hitches. This is a problem all too common in non-fuel cell projects; witness the rusting tractors, once part of bold development projects, now lying idle in the fields of many developing countries for want of fuel or maintenance. The panel discussion moved on to the need for the industry to move into the wider world and show off its benefits to the green and development lobby – there are upcoming opportunities for the fuel cell industry to exhibit at renewable energy and financing conferences in the next few months, opportunities that the industry cannot afford to let pass by. The Seminar will always provide an important opportunity for members of the fuel cell industry to talk to each other, and long may it continue. But the industry also needs to talk to the outside world, and to show it is open for business, particularly in the green energy and sustainable sectors.

Kerry-Ann

This morning I went to the residential fuel cell track – something of a favourite of mine. First up was a presentation on the development of a 6kW AFC generator. The presentation was a collaboration between VITO, the Flemish Technological Institute, and Intensys, the fuel cell developer. The unit under development is currently being trialled in a building in Vilvoorde. It will be interesting to see if Intensys, which is linked with Independent Power Technologies of Russia, has more luck with AFC than companies such as Astris. Andreas Mai (Hexis) and Karl Foger (Ceramic) both gave superb overviews of the status of development of their units and companies. Hexis, with a new funder as of the start of 2006, is continuing to develop the Galileo stationary unit in Europe. At present the unit has a demonstrated lifetime of 6000 hours (at system level), with 5% degradation per 1000 hours. The target lifetime of the stack is 40,000 hours. Whilst the unit is still some way from being commercial the company does believe that they are on the right track with degradation down and a new electrolyte material due for testing.

As we have already covered Ceramic Fuel Cells in the recent Grove report and upcoming Small Stationary survey we will side step Karl's presentation here.

Aki-San of the National Institute of Advanced Science and Technology (AIST), Japan, once again highlighted how far ahead of the rest of the world Japan is in terms of residential fuel cell development and planning. AIST, in cooperation with Osaka Gas and KRI, are working on integrating PEM and SOFC units, either as a hybrid mix of the two (a world first?) or PEM stand alone as mini-grids serving an apartment block or a number of homes. The 1kW units are operated in a system where they run in series providing electricity and hot water to a number of residences and can be added to in a modular fashion as and when needed. Interestingly this idea was extended to linking up a hydrogen grid in much the same modular fashion. Whilst the idea is some way from being practical in the houses concepts tests have shown that it is close to being feasible now in apartment buildings. Tests are currently underway in Osaka using this concept to provide around 70% of electricity and most of the hot water of the apartments. Reductions in CO₂ levels have also been recorded from this test with nearly 10% primary energy reduction over the test period to date.

The afternoon session on a Thursday has always to compete with the exhibition hall close and the start of the drifting away of those who have to travel far. Whilst we were only able to dip into and out of the manufacturing track, which surely could have been given more prominence, it was heartening to see the number of attendees that had not only made the effort to stay but also to attend this really interesting session.

Final thoughts

It is easier, and possibly less controversial, to talk first about the Seminar itself. Better than feared but not as good as hoped is the best way to sum it up. Numbers up, exhibition hall ok but in comparison to two years ago in Palm Springs the event was still subdued. Also the gap between engineering / technical and commercial is getting wider and wider. Well over half of the presentations were engineering based (and over half of these SOFC) and highly technical whilst the commercial seemed sidelined. Track 4, the new pathways to commercialisation track, was a beacon of hope in this and many of the presenters including ourselves, voiced strong opinions that this should be built upon for future events. Still evident was something of a parochial feel in some of the comments and the financing track. It seems that no companies could be looking for finance outside the good old US of A.

The exhibition hall, on the other hand, needs to work out what its identity is. As already noted many of the large integrators and developers were very noticeable by their absence with the gap being filled up by supply chain companies. This internal looking feeling, suppliers advertising to the fuel cell industry, though useful did not generate the same level of momentum that has been felt in the past.

Looking outwards slightly the actual mood of the Seminar seemed to have something of a split personality. Whilst many of us having taken up the cry of just get the damn things out there into the market place and let people buy them, the other side was debates on whether the technical challenges are still too high. Stacy Swann's presentation from the IFC / World Bank can be used as something of a litmus test here. The IFC have US\$54 million to give away to fund projects using fuel cells in selected developing countries or countries in transition. In fact they have been trying to give away the first tranche of this money for some time now and apart from one project (IST/Plug Power in South Africa) have been unable to. Some of the clauses on the funding is that it should be used to develop a long term market for the product in the country, so no demonstration project with an off-switch at the end and then nothing, that the products should have a reasonable performance guarantee, that the companies should be stable enough that they will be around for a length of time and that the project should have a local partner. Not unreasonable criteria and yet only one company to date has submitted a project proposal that was successful. Worrying. If the companies themselves do not have the confidence in their own technology or have no desire to actually commercialise the product but are instead living off government grants for R&D, then the industry itself could be in real trouble. Losing momentum now could be disastrous for our industry which, let's be honest, has something of a history of losing momentum. Investors are back in the space and are willing to help but we have to stop focusing purely on R&D and start pushing the product into the market. There are an increasing number of companies with near to or market ready products but they have to start selling them.

In the future the Seminar could either become purely technical, maybe leaving a space for a new event to come that is commercial, or it could carry on developing Track 4 into something really exciting. Personally we hope that it is the latter ensuring the event works at the interface between technical and commercial. The industry needs to keep moving forward and though this year we feel that it took a somewhat grudging step it wasn't the large jump that we usually see.