

Summary and Outlook of the WHEC 2010

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This document appeared in

Detlef Stolten, Bernd Emonts (Eds.):

18th World Hydrogen Energy Conference 2010 - WHEC 2010

Speeches and Plenary Talks

Proceedings of the WHEC, May 16.-21. 2010, Essen

Schriften des Forschungszentrums Jülich / Energy & Environment, Vol. 78

Institute of Energy and Climate Research - Fuel Cells (IEK-3)

Forschungszentrum Jülich GmbH, Zentralbibliothek, Verlag, 2010

ISBN: 978₃ – 89336 – 658 – 3

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For this presentation, I was asked to present a synopsis of the proceedings and discussions surrounding the 18th World Hydrogen Energy Conference. In agreement with the Conference Chairperson, Professor Detlef Stolten, we agreed to attempt to identify highlights in terms of progress (developments since the previous conference in Australia) and, potentially, the impact of these in terms of near-term prospects for when we next meet in Canada.

WHEC-18 encompassed some 2200 participants (scientific delegates, exhibitors, students and scholars), approximately 330 papers, 240 posters and 150 exhibitors at 70 stands, with the scientific programme organised into 49 themes in 10 parallel sessions and, I dare say, an accurate assessment of the Conference at this point is no simple feat. Consequently, whilst I will rely on my own impressions from the plenary day, it has been necessary for the technical sessions to consolidate the views of the session chairs and importantly, given the limited time, to constrain my comments to a few prominent positions. In many ways, I am acting here merely as reporter for the session chairs and I wish both to acknowledge their contributions as well as thank them for their role as chairs, without which WHEC-18 could not have proceeded in the patently professional manner that it has.

Going back to Monday in the plenary session, my overwhelming impression was one of excitement, enthusiasm and commitment - in a way that strikes one as a step-change in the implementation of hydrogen energy and fuel cell technologies. This conclusion derives from the contributions of all the key sectors necessary for such an ambitious new technology roll-out, namely from central and local government, from the key industrial corporations as well as from the community of users – us, the public.

Specifically, Germany has committed itself as part of the Hydrogen Mobility Programme to set up a national hydrogen infrastructure grid by 2015. Starting this year within cities, progressing in 2012 to a network between cities and, in the period 2013 – 2015, to a minimum national grid comprising approximately 1 000 hydrogen fuelling stations, this is to be undertaken with a commitment of some 1,7 billion Euro. What is important about this 2015 objective is that it is concrete, it has short-term deliverables and that it is currently already in progress. In other words, this is not another general statement about the future, but rather a most immediate programme about now.

And speaking of NOW, the German National Hydrogen and Fuel Cell Technologies Programme, it is critical to note that also in 2010 the greater Europe is considering a continent-wide extension of the German programme. We also learned of the German-Japanese agreement between NOW and NIDO to exchange information in the field of hydrogen technology – an exchange in support of these implementation programmes. Likewise, we have learned of the Japanese programme for hydrogen fuelling roll-outs and, indeed, also of a similar programme in the United States, the latter both with 2015 targets. In the case of California, here too it is important to take note of the immediate near-term objectives, namely 7 additional refuelling stations under construction in 2010/11 with an

additional extension and upgrade of 4 refuelling stations, such that by 2012 some 400 - 500 private vehicles would be in service. Moreover, the programme comes with the anticipation of a further 10-fold increase in the serviced vehicle fleet by 2015.

These key initiatives confirm an acceptance of the need to provide hydrogen fuelling infrastructure as the key imperative to effect a substantial roll-out of hydrogen technologies. In my view, these developments, together with the excitement and commitment with which they are being prosecuted, represent the single most significant development since the Australian WHEC meeting and one which in many ways may possibly in future be seen as the watershed event for the commercialization of hydrogen energy and fuel cell technologies. Indeed, in the words of one of the session chairs, the mobile / vehicle application, which has long been seen the pre-eminent embodiment of hydrogen technology, is once again returning to the fore-front of the field, perhaps after some years of hiatus.

Whilst still on the subject of vehicles, it may further be argued that the battery versus fuel cell competition is to a large extent becoming resolved, with batteries being preferred for short-range (perhaps up to 100 km) applications but, importantly, with fuel cells clearly the only current opportunity for a full substitution of existing passenger vehicles. Consequently, the associated hydrogen fuelling infrastructure will likely be implemented in a semi-decentralised fashion as is the case for hydrocarbon fuels. Importantly, battery and fuel cell embodiments are not competitive but, rather, complementary - both being electric vehicles and, consequently, both requiring similar balance of plant such that they are synergistic and their parallel implementation will, through economies of scale, support an overall reduction in cost barriers for both vehicle types.

Fuel cell vehicles have been fully demonstrated and the implementation of the large hydrogen refuelling networks already discussed will now realise a concomitant return to a focus on cost reduction, in particular as brought about by the expected large increase in the numbers of vehicles manufactured.

Taking the German roll-out as an example, the roughly 2 billion Euro required for a national 1 000 station network is expected to support a million vehicles, such that the per vehicle capitalisation of 2 000 Euro will represent less than 10% of the average vehicle cost, again indicating that the cost of introducing hydrogen vehicles is already well within practically managed values and further improvements will readily be forthcoming as a consequence of these networks. Likewise, technical developments, e.g. the well-demonstrated and accepted 3-minute refuelling cycle, have already made the technology practically acceptable to the public.

But it is not only in the case of vehicles that significant mile-stones are being reached. Many stationary applications have been in the field for a long enough period that reliable performance data is available both for improved system costing as well as for directing performance, life and cost improvements in existing hydrogen technologies.

At a very basic level, non-precious metal catalysts, in particular those of the Ta-carbide/nitride/oxide type, may now be considered possible competitors to conventional PGM catalysts for the oxygen reduction reaction in PEM fuel cells, and it may surely be expected that this development will be a substantial issue when the Conference next meets in Canada.

Solid oxide fuel cells of up to 250 kW have logged 30 000 hours. Smaller 1 kW systems in a field study of 45 units have logged a collective 250 000 hours. The European CALLUX Programme is rolling out some 800 units and good progress is being made towards the commercialisation of other unique applications, e.g. jet fuel processors and fuel cell auxiliary power units for aircraft applications. It is to be expected that, by the 2012 WHEC meeting, commercial SOFC products for distributed power generation may well be in the market.

The focus in hydride storage systems is by some considered to be moving away from materials towards engineering issues, a move - if it is true - which may suggest that the existing materials, though not perfect or necessarily close to the desired target performances, are already sufficiently attractive that implementation rather than continued research seems to drive developments. Here too, novel or niche applications such as the implementation of hydride systems, not for storage but for cooling purposes, are starting to see the light of day.

In the general field of hydrogen generation a number of trends are becoming apparent. Practicable technologies for sustainable or green hydrogen production are forging ahead via a number of alternative routes such that, by 2012, we may expect a substantial bedding down of a few practical and robust embodiments.

PEM electrolyzers are approaching 100 kg/day capacities with an expectation that perhaps already by 2012, the Canadian Meeting may well hear reports of 500 kg/day PEM electrolyzers. Similarly, substantial progress is being made in the greening of fossil hydrogen generation technologies, including also a range of hybrid generation systems with or without electrolysis steps, the aim of which is an improved overall energy efficiency and consequent reductions in capital and operational costs. Also, in the field of high temperature electrolysis, it has been demonstrated that the use of planar cells is feasible.

It has further been suggested that, in the arena of thermo-chemical water splitting for large scale hydrogen production, the hybrid sulphur process is beginning to show evidence for a clear leadership position in terms of early implementation. In this regard several developments, including improved membranes and catalysts for sulphuric acid splitting, and silicon carbide heat exchangers for overall cycle containment are adding greatly to the pace of development.

Well, it has been a long week and I don't wish to belabour you at this hour with further details. In closing, I wish to return to something else from first day which in my view represents a crucial change of emphasis in the manner in which hydrogen energy and fuel cell technologies are being viewed. In addition to a route to environmental protection, to the amelioration of climate change and the reduction of oil consumption – all well-established drivers for a hydrogen economy - it is important to note in both the US Department of Energy programmes and in the German Hydrogen Mobility Programme, that there are clear business / industrial / employment imperatives such that hydrogen energy and fuel cell technologies are increasingly driven by factors of economic gain and opportunities for employment. Indeed, this has become a key driver for the German Ruhr area in which we find ourselves today - to re-invent itself, still as a world industrial centre and exporter of engineered goods, but of the new hydrogen technologies, the NOW way forward. At this time, when the hydrogen infrastructure deployment programmes of several nations are being implemented,

we of the hydrogen community are to take pride in the successes already achieved such that we may re-invigorate our efforts to master and perfect a hydrogen energy future.

Borrowing from another presentation, I can say its HY-time and that, at least in Germany, the time is NOW!

I thank you for your indulgence...