Interview fuel cell specialist Jan van Dokkum

‘Hydrogen fuel cells are part of the solution’

The promise of the hydrogen fuel cell has been a long time in the making. Where do we stand today? Is this the techology of the future – or will it stay a dream? EER talked about this with Jan van Dokkum, fuel cell expert and until a few months ago President of UTC Power, world leader in fuel cell technology. According to Van Dokkum, stationary fuel cell applications are already competitive today, as opposed to fuel cells for use in automobiles. Perhaps most importantly, his message is that fuel cells should be regarded as part of a total energy solution that is different in each situation.

by Hughes Belin

Where do we stand as far as commercialisation of fuel cells is concerned?

The industry as a whole has still a lot of work to do. Let's start with stationary fuel cells. Since the early 1990s, UTC shipped around the world the "pure cells 200", which are phosphoric acid fuel cells. We tracked all the performances of all these units over the last 10-15 years and we used that input to design a new “commercial fuel cell” that has a 10-year life i.e. twice the life of the old fuel cell. It has the same electrical efficiency, which is 38%, over the lifetime of the fuel cell. It is built for CHP (Combined Heat & Power) applications, where you can use the waste heat for domestic hot water or heating and cooling cycles depending on the application of the fuel cell. Then you can get up to 80 to 95% efficiency. If you can do it for 3,000 $/kW, it is about half of the cost of our original fuel cells. Now you have a fuel cell that can compete with incumbent technologies. A lot of people say that is not a great improvement against carbon. But if you run a fuel cell on natural gas in a CHP mode, you lower the carbon footprint of this machine about 50% against the grid. That is really where we need to be. As I need to compete against the grid, the electrical efficiency is very important, and so are the CHP mode, the cost of the fuel cell and its maintenance. I can produce power for 11 $c/kWh in CHP mode and I can tell you, as far as the US is concerned, that gives me about 65% coverage of the total market. That is a pretty good position for a commercially viable product.

What about fuel cells for transportation? Are they still a dream?

They are not a dream. Most people sometimes refer to them as a nightmare – just kidding. In transportation, you still have two issues for fuel cells. One is durability – making sure you that can last for longer than 10,000 hours, which is a requirement for transportation – and the other one is costs. The transportation fuel cell is a PEM (Proton Exchange Membrane) fuel cell, because you really need that response and power density to put it under the hood of a car or to put it in the back of a bus. There are still technological innovations that need to happen to get the costs down. We need to lower the platinum content

Photo: UTC Power

and we need to get a more cost-competitive position on the membranes and the total assembly. Most of it will come with mass production, but not everything because you cannot lower platinum costs by mass production. A lot of work has to be done and we are working with our automotive partners to lower the platinum content and to improve the durability of the membrane. But I have to say it is not here yet, which is why we do demonstrations. We work with all the automotives and with transit buses to get demonstrations going, to get these buses on the road, to get the cars on the road, to get the experience and take that experience in and redesign our fuel cells for more cost-effectiveness. That is how we have to do it. I would say that fuel cells by 2015 will go into early commercialisation. I also believe that we need about a five-year time period to really work through that early commercialisation phase and then from there we can go onto mass production.

What would bring the commercialisation breakthrough, for both stationary and transportation?

Cleary, stationary is beyond that point. I think that with stationary, we can go directly to a commercial customer – with the government incentives from some countries (Korea and the US right now) – and we can compete very effectively against the incumbent technology, either the grid or an internal-combustion engine. So from a stationary point of view, we are getting there. When it comes to transportation, it's very different. We need to get fleet applications going first. Most of the world is talking about whether we can get our automotive power (the cars that you and I drive) to fuel cells. It is not too late to do it because you're highly dependent on the infrastructure to support that. If you do transit buses – which are one of the largest polluters in inner-city applications – their nice part is the drive cycle: they drive inside the city, where pollution is the highest. They normally are diesel buses, which emit a lot of particulates and CO_2. But they are easiest to refuel since you can do a central refuelling station for a bus fleet and make it very productive. At the same time, fuel cells are well suited for very heavy-load, low-speed applications, such as transit buses. We will get to passenger cars once we can get their ability and the cost-effectiveness working, while at the same time building on the infrastructure. Thus transit buses could be the first adopters, as well as delivery vans, government fleets and cars to get the industry going and get some of the pain off start-ups.

What about the hydrogen's carbon footprint?

I personally do not like the conversion of natural gas to hydrogen. I think that is an in-between step that we have to take to make this business work. I advocate "green hydrogen"

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from wind, solar or geo-thermal energy converted into storable hydrogen. We are going to have a strategy that is two-fold: green hydrogen from renewables and hydrogen from reforming natural gas, coal or whatever hydrocarbon. We will have to play both, but we should put more emphasis on the green hydrogen so that we can really lower the carbon footprint. Indeed, if you take it out of natural gas, it is an easy process with steam reforming, but it does not help a lot with the carbon-footprint reduction. Fuel cells are clearly far more efficient – e.g. a PEM fuel cell in transportation has a 65% electrical efficiency, which is much better than an internal-combustion engine. So your carbon footprint definitely goes down. But if you run it on green

hydrogen, meaning from hydro- or geo-thermal, there is no carbon footprint. That is where we are trying to drive the industry to.

But so far the bulk of hydrogen still comes from reforming natural gas. For how long?

Well, not quite. Actually, there are quite a lot of installations going on that are from renewable hydrogen. For instance, UTC's operation in Hartford (Connecticut) is entirely run on green hydrogen out of the Niagara Falls area. Now the only carbon footprint that I have is the truck that brings the hydrogen from Niagara Falls to Hartford, which is not too far. So they use hydropower to make hydrogen and then they ship it throughout the country. But if you want to do localised, you need a large volume and steam-reforming is still the way to do it. Or go with an electrolyser and then you use the grid to make hydrogen, but that doesn't help because the carbon footprint of the grid is not that great.

'I would say that fuel cells for transportation will go into early commercialisation by 2015'

What would be a good business model for fuel cells?

If you look at how I structured UPC, it really takes an energy-solution profile. Fuel cells are only part of the offering. If I take a facility, I look at the roof space: solar panels on the roof for peak power and fuel cells for base loading are a perfect combination. I look at the energy profile: what can be conserved, what can be done with energy efficiency? And you can also take a little bit out of the grid or feed back into the grid depending on the time of use and the time of day. I combine fuel cells and CHP as one unit to increase overall efficiency. So I consult the client on those areas and then I bring all those solutions into the building and give them a very cost-effective energy solution. Supermarkets are different from hotels; hotels are different from data centres. Thus you customise your energy solution to it. I agree that, if you just concentrate on fuel cells, you're missing the boat. You need to look at it as a holistic system for your clients. Ultimately we've got to bring, for instance, buildings to "zero energy" buildings. Large corporations can more easily bring holistic solutions. If you are a smaller company that has a singular focus on fuel cells, you really need to partner with companies that can help to make the whole solution.

What lessons could Europe draw from US support to fuel cells?

The American support system consists of a number of different solutions. One is supporting basic research as well as funding basic research that can be shared across the industry. This means they work on proposals of what are really the key issues that prevent the commercialization of fuel cells, such as platinum loading, carbon support, membrane technology, seals or catalysts. They bring best-in-class companies together to collaborate with the universities as well as with private industry, a cluster type of arrangement so that you get the best and the brightest people together to bring a solution. It is very successful, very focused, drives solutions and gets new technologies going. That's one way of doing it. The other one is government buying the products. Definitely the government should be an early adopter to create an industry in their country. And last but not least is to provide incentives for commercial companies to buy the new technologies by giving them a tax break or relief against their taxes for doing so, because ultimately those new technologies are more expensive. This, because we don't make them in the same kind of volume as an incumbent technology and therefore you pay a premium for that. If you can take the tax deduction, that would lessen the pain and get more companies, commercial companies, buying the product. Those are some of the ways of a government really successfully working to create an industry and I think it is the US model that seems to be very successful. ■

Jan van Dokkum

Jan van Dokkum was President of UTC Power from October 2002 to January 2009. He left UTC unexpectedly as part of a reorganisation. He is a member of the advisory Board of the European Hydrogen and Fuel cell's technology platform and fulfils the same kind of role with the department of energy in the US. UTC Power, based in South Windsor, Connecticut, is the world leader in developing and producing fuel cells for on-site power, transportation, space and defence applications.


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