

Astris: focus on small scale applications

Pilot production of alkaline fuel cells starts in Czech Republic

By Henk Hirs

VLASIM - After a full 20 years, everything now seems ready for take off. \$17 million has been spent on research and engineering. Several types of (portable) generators and golf carts using hydrogen fuel have been successfully produced and sold. And, shortly, the pre-commercial pilot production of the alkaline fuel cell - Powerstack MC 250 - is about to be launched in Vlasim, a

town some 50 km south of Prague in the Czech Republic.

"We want to be the first to manufacture on a commercial basis, good and affordable fuel cells for small scale applications," says Jiri K. Nor, the man behind Astris Energy Inc. "The main challenge now is to find a strategic partner, preferably a Fortune-500 company, in order to get commercial production going."

Astris Energi was originally founded in 1983 in Mississauga, Ontario, Canada. The

Head Office and R&D facility, employing some 15 people, is still based there. The company is also listed in New York, on the OTC Bulletin Board of Nasdaq. Our main philosophy, says Jiri Nor, while we tour the production facility in Vlasim, is to always take a 'good-performance-at-low-cost' and low-tech approach to alkaline fuel cell (AFC) technology.

Jiri K. Nor



AFC has for the past decade widely been dismissed as an 'older technology'. According to Jiri Nor, this is a mistake. Due to its high performance and quality, he says, AFC is the preferred technology to produce electrical energy and water on board American & Russian spacecraft. "But, of course, they want the best cells at any cost. What I want to do, is bring this technology 'down to earth' and produce inexpensive, rugged fuel cells for every day use."

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A major break-through came when the company, halfway through the mid nineties, succeeded in producing AFC's using only

cheap materials like carbon, plastic, base metals and metal oxide. It is, Nor argues, one of the main advantages of modern AFC's over other smaller fuel cell types such as the so-called proton exchange membrane (PEM) fuel cells, which use expensive platinum for catalysts.

Other advantages are that AFC's operate and start instantly at low temperatures (up to -40 degrees Celsius) and have an electrical efficiency of 55 to 60%, which means less hydrogen fuel is needed to get the same output.

Cutting costs

In the past two years, Nor explains, Astris has experienced a steady increase in sales in such products areas as demonstration cells, scientific equipment, prototypes and custom built fuel cells. Among the early customers were scientific institutions, ministries and, also, some companies and individuals. The price of the cells though at \$10,000 per kilowatt (kW), was still very high.

Now, with the facility in Vlasim, Jiri Nor thinks Astris can cut the price to \$4000 per kW when pilot production starts and to \$1000 as soon as full pilot production volume (an annual production of 2 megawatts) has been reached. Further performance improvement and cost reduction to \$500 is to be expected when the next generation - BC500 Powerstack (9.6 kW) - currently under development, comes into production within the next three to five years. "Finally, in mature mass production, we believe costs of AFC stacks could be reduced to \$100-200/kW, but that will be some 10 years from now," Nor says.

Small scale applications

Astris Energi focuses on small-scale applications such as golf carts, boats, forklift trucks, wheelchairs and neighbourhood electric vehicles. But only one of these projects has met with any great success. In 2000-2001 the company developed the

Ovens to heat the carbon



Freedom I Golf Car in which the alkaline fuel cell generator replaced the conventional battery pack, giving it more power while halving the weight. The cruising speed of the car is 40 km/h with an endurance of three days of average golf course driving on one fill-up. You can actually drive for up to seven hours continuously at cruising speed. The car has a microcomputer-based controller and uses compressed hydrogen gas in a cylinder, capable of storing eight normal cubic meters of hydrogen. Refuelling from a filling station or larger tank takes only a few minutes.

In January 2005, Freedom II was presented during an investment conference in Vancouver (Canada). This new golf car uses Astris' new generator model, the E7 equipped with the MC-250 Powerstack. The Freedom II has almost twice the power of the first model.

Boats would be a very good application too, says Nor. A quiet, odourless, non-polluting and highly efficient motor is ideal for the use of small boats in nature reserves, in the canals of Amsterdam or Venice or for sports purposes. The International Olympic Committee approached Astris because it wanted to use hydrogen-fuelled boats during rowing competitions instead of the diesel-propelled boats that are being used to oversee these competitions now.

Electrical boats are not powerful enough for the acceleration that is needed, but the fumes and the noise of diesel engines are a nuisance for the rowers. "Our product would be perfect to solve this," says Jiri Nor,



Visual check of the carbon plates

From carbon black to fuel cell stack

"In the past year, we have been industrialising the lab processes. What we have set up is a comprehensive and automated production process of fuel cells and fuel cell stacks. We are now making final adjustments and will start full pilot production later this year," says Claude Rivoire, technology advisor and the man who is responsible for setting up the Astris facility in the town of Vlasim. In a first room of the factory, the carbon black is mixed with chemicals and catalysts, cooked in ovens and impregnated. The result is a dough-like substance, which is the basis of AFC.

In a second room, a specially developed machine rolls that dough into thin plates. The rolling process at the same time changes the structure of the substance in a way that is essential for the AFC's to work well.

In a third room, the thin carbon plates are framed into the anodes and electrodes that actually form the fuel cell. Their power and quality is then checked and tested, first visually and then, in the factory's laboratory, chemically as well.

Finally, several cells are put together and framed to form the Powerstack MC 250, which has an output of 24 Volt, 100 Ampere and 2400 Watt, a life expectancy of 2000 life hours, a size of 21x22x72 cm's and a weight of 33.2 kg.

These Powerstacks, in turn, can be assembled into generators of which Astris has developed several types. Among the older models was the E5B, a portable generator developed for the Czech military in the year 2000. Model E6 was a 1 kW generator that, amongst others, was used in the first Astris golf car (2001).

The MC 250 Powerstacks are used in new and more powerful generator models: the E7, which produces 1.8 kW and is also used in the new golf car, and the E8, the new portable generator that has an output of 2.4 kW.

"but the problem was that the Committee is looking for an order of 600 boats at once, partly to be used during the Olympic Games and the rest to be divided afterwards amongst the national Olympic Committees. At the moment, we can't handle an order like that without a reasonable prospect for continued production afterwards."

Strategic partner

It is a good illustration of the problem Astris currently faces. The leap to full-scale commercial production requires a new level of investment and commitment. "We don't want to get involved in the commercial building of boats or forklifts or whatever," says Nor. "Our business is fuel cells and generators, that's what we are good at. To produce the actual applications, we need co-operation with one or more strategic partners. We are currently talking to several potential partners. Our aim is to find a major partner, preferably a company on the Fortune top-500 list, that gives us access to a market without us having to give up our independence."

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The factory on the outskirts of Vlasim would be the preferred location but there are at present only a dozen people working there and the building as it stands is not huge. There is enough space, however, to get started and Astris bought enough land with the building to enable expansion. "This place can double or triple in size and the capacity can increase tenfold if need be." Skilled labour in the Czech republic is still very cheap compared to Western Europe, Canada or the States and the country has a rich industrial and engineering history and capacity.

Also, Czech authorities are keen on a high tech development and they have assisted Astris with various subsidies from a Technology Program in the mid nineties

and later two grants from the Ministry of Defence to the support for a joint project with the University of Ostrava (Czech Republic) and a substantial subsidy from the Ministry of Industry in December 2002.

"Our future," Nor says, "is not tied to that of the hydrogen economy in general." Of course, Astris would profit if the overall

development were positive. But the niche markets that Astris is targeting can also prosper even if the hydrogen economy as a whole would develop below expectations.

Space and the Czech connection

Jiri K. Nor (65) was born and raised in Prague, where he also went to Technical University and became an engineer. But when, a few years later, the Soviets crushed the Prague Spring in August 1968, he fled his country and settled in the United States. Though his dream of becoming an astronaut turned out to be unattainable, he did play a role in American space industry, working for a company that supplied high tech satellite instruments for NASA to measure environmental pollution and other data. "It was then that I became aware of the world wide effects of pollution caused by the use of fossil fuels," Nor says.

Later, he moved to Toronto (Canada) to work for the University's Aerospace Department. It was a colleague there who got him interested in the development of fuel cells. At the same time, he had set up his own electronics firm. "I sold that in 1981 and after two more years of managing it, I could have retired easily. But in fact, after a week on the beach, I decided I'd had enough and with a friend, we founded Astris Energi."

Astris was set up to research and commercialise the alkaline fuel cell technology, but things went much more slowly than originally expected. First, there was Black Monday, the stock market crisis in 1987, which made funding extremely difficult. That changed in the mid nineties, when high tech companies became ever more popular to invest in. Due to several circumstances though, among them personal ones, Astris didn't get into the loop of big funding. But, it did manage to gradually acquire more and more finances, from private funds, angel investors and government grants. And while others were hit very badly in 2000 when IT-bubble burst, Astris survived without too much damage. It has now become the world's leading company in the development of the alkaline fuel cell technology and last year, it was able to raise a total of \$2 million.

The fact that Astris is also based in the Czech Republic has, of course, everything to do with Nor's personal background. After the fall of the Berlin Wall and Czechoslovakia's Velvet Revolution in 1989, Nor decided to visit his home country and his family again (he had been unable to return before, as the communist regime had sentenced him in absentia to two years of imprisonment). He, then, also got in touch with the Institute of Physical Chemistry of the University of Prague, established a working relationship with them and in 1993 decided to set up a Czech affiliate of Astris to conduct R&D here, as well.

"Actually," he says, "there is a healthy R&D competition between the Canadian and the Czech lab, with the first now concentrating on system engineering and the second on our core technology."

