Polymer Fuel Cells: A Commercial Challenge

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Outline

- Commercialization status of PEMFC
- Research themes and the UK Advantage
- Some significant remaining challenges
- What the PFCC must achieve to make a real difference

Commercialization Status of PEMFC

- Fuel Cell technology has been slow to commercialize
  - Traction in back-up and materials handling
  - Financing entities are sceptical
- Existing commercial entities have limited finances
  - Reduced internal and external R&D
  - Decelerated development in mid- and long-term applications
  - New mantra: CLEAN energy, not *necessarily* GREEN energy
- Fragmented supply chain and unfocussed product strategy
  - Too much competition
  - Product design proliferation

PEMFC: A Changing Industry

- Until 2005, most of the advances in PEMFC were driven by academia and SMEs
- Significant focus placed on the auto application
  - Breakthroughs have been achieved
  - Demonstration fleets in the low hundreds of units
  - HEVs, PHEVs, BEVs are being commercialized
  - R&D is back with the OEMs and academia
- SMEs focused on near-term applications
  - Leverage existing technologies to produce products
  - Product development, M&S and in-field support
  - A potential technology gap is now building

Broad Areas of Technical Expertise

- US DOE has funded technology and demos in auto application
  - US National Labs and “selected” universities have significant expertise
  - China has also focused on transportation applications
- Canada has an established base of PEMFC SMEs and Institutes
- Japanese government has advanced residential co-generation
  - Japanese auto and battery companies are working on PEMFC technology related to their core businesses
- The EU has focused on broad-based technology barriers and large scale demos
  - Germany has a critical mass of Institutes and some MNCs
  - The UK has built a strong base in academia, with a cluster of SMEs, with JM as a global leader in catalyst and MEA

The UK Advantage

- The UK has core competencies in
  - Fundamental understanding
  - Materials development
  - Unique cathode designs
  - Advanced components (MEA) and hardware
  - Engineering companies well positioned to provide BOP components, system design and end product construct
- SMEs and MNCs developing products and advanced stack components and for near-term applications
  - These entities have the necessary analytical and testing capabilities to validate technology and product capabilities
- PFCC provides resources and business expertise to accelerate breakthrough technology to commercially-viable product offering
  - CT now needs your best efforts to produce the BREAKTHROUGHs

Significant Remaining Challenges

- System level cost reduction
  - Individual component cost reduction must be evaluated at the system level
  - Need cooperation in the early stages with partners skilled across all major system elements
- Stack and BOP simplification
  - Drive high yields, reduce manufacturing costs, increase reliability and facilitate serviceability
- Increased efficiency
  - Enhances the value proposition to end user relative to competitive technology options
- Water and thermal management
  - Starting at the unit cell level

N.B. Fuelling infrastructure is still a barrier to end user acceptance

Intellectual Property as a Barrier

- In 2004 Ballard Power Systems had over 800 US patents
  - Significantly complicating partnering, while decelerating technology and product development
  - Today there are less than 200 patents
- As you consider your partnerships it is critical, of course, to value and protect your background IP, but....
  - Understand what is really important
  - True “white space” in PEMFC IP is more and more limited
  - Products that provide value to end users, and profits to the value chain, attract financing and foster sustainable business

Leveraged Breakthroughs in PEMFC

- Supported catalysts and catalyst alloys that reduce cost and enhance performance and durability
  - Further PGM loading reduction, with stabilization of supports and overall catalyst structure
- Stable PFSAs and composite membranes
  - More work on water management in membrane and catalyst layer
- Fundamental understanding of structure and functionality relationships to performance and durability
  - More work on GDL and BPP flow-field design to enhance performance and durability
- System simplification and hybridization
  - Consider the total system when computing the $/kWh value of a technology breakthrough

Polymer Fuel Cells Challenge

- Holistic approach to accelerating PFC technology into a product offering
  - Technology breakthrough linked to a commercial product
  - Significant cost reduction without sacrifice to functionality and durability
- Breakthrough technology as opposed to incremental improvements
  - Some demonstrable level of progress should already be established
- Establishing the right partnerships will be critical
  - Partnering early
  - Balanced skill set
  - Critical mass of resources
  - Reduced learning curve

Thinking Outside the Box

- Breakthrough technology implies a new approach to what has been done in the past
  - Look for partners from outside classical fuel cell areas to add value
- Increase in W/cm^2 translate to reduced $/kW
  - Innovation around existing materials can constitute a breakthrough
- Synergistic improvements across the system can provide a significant breakthrough in cost
  - A truly multi-disciplinary team will be required
- Breakthroughs can come from technology outside of the fuel cell domain
  - Dow membrane developed for chlor-alkali industry

Important Qs to Ask – Top Down

- What is your intended application and who are your end customers?
- Do you clearly understands their needs? If so,
  - What advantageous solutions do you have to offer them?
  - How do these solutions rank relative to competitive options?
- How much will it cost and how long will it take to provide your solutions to the customer
  - What partnerships do you need to achieve this?
  - How can the cost be reduced and the timeline accelerated?
- What does the detailed technical risk analysis indicate
  - Do you have the best team to achieve and implement breakthrough technology within the agreed budget and timeline

Final Thoughts

- Breakthroughs can originate from any discipline
- Seek expertise from outside the PFC community
- Consider the value of the breakthrough at a product level
- Look for a mix of expertise
- Challenge “status quo” thinking
- Avoid “incrementalism”