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Polymer Fuel Cells: A Commercial Challenge

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- 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 PFSA 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 understand 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”