

Integrated Breakout Group Notes

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Review/Critique Name

- Proposed New Name:

**Power Electronics and Fuel Cell
Component System Integration
(PEFCCSI)**

- Current Name:

Power Electronics for Fuel Cells (PELFC)

Review/Critique Mission

Revised Mission Statement

Promote and support the rapid growth of the power electronics application for fuel cells by providing technological leadership within a vigorous program of research, development and demonstration, by serving as a resource of academic talent of highest caliber for addressing key scientific and technology barriers, and promoting information dissemination and technology transfer with industrial collaboration.

Review/Critique Goal

Revised Goal (#1)

- Become a focal point for advancing power electronics technology for fuel cells by:
 - supporting industrial research and development
 - creating partnerships with State and Federal agencies
 - overcoming key technical obstacles to fuel cell utilization
 - promoting education and awareness for the role of power electronics in fuel cells
 - facilitating multi-market enabling standardization for power electronics.

Review/Critique Objectives

Revised Objectives :

- Support optimization of power electronics for integration and use in fuel cell systems
- Foster Connectivity to Technical Societies
- Enable and promote standardization to assure smooth market transition
- Identify sources of funding, promote new funding opportunities for power electronics
- Facilitate the evolution of power electronics technologies for fuel cells to address and overcome technology barriers

Review/Critique Objectives (cont'd)

Revised Objectives (cont'd)

- Facilitate development of seamless interfaces and controls between fuel cells and applications (including electrical power systems)
- Develop dissemination of resources and serve as a information clearinghouse for universities, industry, federal agencies, and education of all ages
- Serve as a bridge and foster closer integration between university research and industrial applications
- Foster long-term relationships between academic institutions, agencies, and industrial partners

Review/Critique Activities

Proposed Activities

- Present Power Point presentations from this workshop on the web as a specific task, more generally – publicize the activities of this group
- Establish linkages with other professional societies.
- Establish a web site which will provide information and resources for people who are working and wish to work in this area – people in the group can post their work on the website for others in the group. Can use existing website as a model – **Power globe as a model** – provide linkages to other relevant websites, (DOE, DOD including ONR, international)
- Connect existing work in other areas that can be utilized and applied to this work, esp. in the DOE, need to link to these resources, look at DER website

Review/Critique Activities (cont'd)

- Form a Research Consortium with membership from universities and national labs
 - Develop PEL for FCL Research Road Map for agencies (DOE EE and FE, CEC, NSF, NYSERDA, DARPA, ONR,)
 - For Universities for Fuel Cells, support
 - Education targeted proposal (NSF, NSF IGERT)
 - NSF ERC for Fuel Cells? NSF
- Sponsor joint activities with US Fuel Cell Council and other fuel cell industry organizations
- Sponsor and facilitate special technical journal issues, conference technical and tutorial sessions on power electronics for fuel cells (e.g., Transactions in Power Electronics)

Review/Critique Activities (cont'd)

- Organize annual workshop, publish proceedings
 - Future Energy Challenge Workshop (APELC, February, Miami): Dinner! Present PELFC!
- Promote public interest by creating multimedia video, TV, demonstrations.
- Attract students at high school, undergraduate levels to the power electronics field.
- Play active role in development of IEEE standards for power electronics and fuel cell interface
- Consult with and advise industry and government agencies

Key PEL for FCs Research Needs

Fuel Cell Characteristics:

- Strive to study fuel cells from more experimental bases and theoretical/analytical models for fuel cells (timescales, applicability, complexity).
- Look at effects of different parameters and fuel cell response. Need to develop a basic educational model in conjunction with more detailed research models
- Visualization models as an educational tool.
- Different models should be developed for different situations and areas of the fuel cell system. Models for integration, and models for components.
- Understand the need for the models. There are many models already developed. Try to extend these models to what we need. Apply the existing mathematical models.
- Categorize mathematical models relevant to the time scales of interest – steady state, transient, sub-transient
- Interface between FC and Power Inverters

PEL for FCs Research Needs (cont'd)

Communication.

- Attempt to coordinate industry to provide standardized interface requirements for inverters.
- Integration of the inverter with the fuel cell – important because of cost, user requirements
- Need to include more interfaces than just inverter.
- Need for specifying functional requirements and parameters for both fuel cells and inverters to establish a standard.
- Promote the investigation of alternate power electronic topologies for the interface between the fuel cell and the ultimate application.
- Promote design of interface to minimize effects of disturbances from the fuel cell to the ultimate application and vice-versa.

PEL for FCs Research Needs (cont'd)

Interconnect with Grid

- Provide features that meet interconnecting system requirements provided in IEEE 1547 and international standards
- Investigate issues of islanding, protection, and reliability.
- Operating dynamics different than with other DG systems.
- DG interoperability with other DGs
- Investigate energy and power management

Operation In Stand Alone Mode (non-grid)

- Similar to interconnection to grid, but specific to features of the local loads.
- DG interoperability with other DGs
- Investigate supplying ancillary services.
- Investigate energy and power management

PEL for FCs Research Needs (cont'd)

Other

- Real-time protocol for fuel cell interfaces
 - Executor, Supervisor, Actuator, etc.
- Dynamic modeling of fuel cells systems
- Modeling of fuel cell components
- Fuel cell specific PEL topology
- Fuel cell specific PEL device design
 - packaging
- Fundamental understanding of fuel cell/PEL interaction(s), and identification of degree to which resolution should/can be integrated into the FC/I design

PEL for FCs Research Needs (cont'd)

- Modeling and architecture of multiple and hybrid systems, microgrids, storage,...
- Understanding of fuel cell characteristics germane to PEL (e.g., ripple,...)
- Systems integration (stability, reliability, economics, policies,)
- Parasitic effects of FCs, relation to PEL, EMC
- Interface between FC and Power Inverters
- Interconnect with Grid
- Mass Customization

Collaboration and Team Efforts

How to facilitate in education and research?

- Promote utilization of results of research into education
- Textbooks (fuel cells)
- Student project competition
- Educational animation and visualization tools for fuel cells.

Consortium Issues

- We should pursue NSF-sponsored ERC or IUCRC?
- Formalize the present university group and add others.
- Identify FC stakeholders willing to sponsor (annual funds)

Collaboration and Team Efforts

Industry involvement

- In the proposal for ERC or IUCRC.
- Publicize activities of this group to industry and invite them to meetings
- Workshop of this group with industry presentations of current fuel cell systems and applications
- Survey industry for PEL issues
- Engage in annual meeting

Should have an Annual UFFC workshop,
APELC meeting, NSF proposal

PEL for FCs Funding Needs

Funding:

- Applied research: DC/DC; DC/AC; topology & control; modeling & simulation; active filters; energy management & power quality
- Workshops & meetings
- Multimedia tools and website development
- Establish fellowships
- Standards development
- Acquire demo units
- Instrumentation and equipment

PEL for FCs Funding Needs

- **Explore NSF center (distributed) proposal**
- **Increase awareness of Federal and state legislators to FC technology**
- **Work through technical societies (e.g., IEEE-USA “care”) to increase FC visibility**
- **Promote FC in state deregulation funding pools**

PEL for FCs Funding Agencies

- DOE
- DOD
- NSF
- CEC
- Utilities, EPRI
- Industry
- Others: State, Regional....

PEL for FCs Funding Work

How can we best increase FUNDING OPPORTUNITIES?

- Work with existing fuel cell lobbying groups to insert line item on power electronics development
- Provide input on proposal concepts (BAA – all Fed agencies) & help to develop RFPs
- Encourage industry (fuel cell, power electronics, OEMs {i.e. automotive, personal electronics, etc}) to provide match funds for NSF grants (or any other agency that requires)
- Coordinate international funding opportunities

PEL for FCs Funding Work

- One FC for each FC university
- Develop multidisciplinary systems-based courses
 - Develop anchor course, complementary courses
 - Schedule two-week summer camp for faculty (Hawaii) 2004 January, HICSS conference opportunity (Prof. Meliopoulos)
(Universities for Fuel Cells)
 - Post resources on web
 - Funding? (NSF, Universities for Fuel Cells,...)
- Develop tutorials (EE, CE, ME, ChE, MatSci, ..)
 - Faculty, Students
- Use Net-conferencing for student/other participation (e.g., SECA Core Meeting)

Breakout Group Summary

ACTIONS:

- Review/approve presentations - ALL
- Check on PEL for FC special issue in Transactions in Power Electronics – Prof. Smedley
- Address HICSS meeting for special session (Hawaii) – Prof. Meliopoulos
- Short-course (tutorial) for PESC '03, and APEC '04 (similar to HICSS '04 session) – (Mexico) Prof. Batarseh
- Standards Committee Representation/Leadership – Prof. Lai (include input from Dick DeBlasio, Don Collins, Jack Brouwer)
- Fuel Cell Seminar – 1 hr. Prof.'s Smedley, and Lai? (18 November short course, 19-21 November – conference) (Palm Springs, CA), www.gofuelcell.com