



The Effects of Impurities on Fuel Cell Performance and Durability

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**Project ID
#FCP15**



FuelCell Energy



Hamilton Sundstrand

A United Technologies Company



Overview



Timeline

- Start March 2007
- End February 2011
- New Start ~0% Complete

Budget

- Total project funding
\$2,335,725
 - DOE share \$1,868,580
 - Contractor share \$467,145
- No Funding Received in FY06
- Funding for FY07 - \$70K

Barriers

- Establish Tolerance to Air, Fuel and System Derived Impurities

Partners

- United Technologies Hamilton Sundstrand – Historical Contaminant Data
- FuelCell Energy, Inc., - Contaminant Test Support
- UConn CGFCC – Project Management



Objectives



- **Overall Objective – Develop an Understanding of the Effects of Various Contaminants on Fuel Cell Performance and Durability**
- **Specific Task Objectives Shown Below**

Task	Objectives
1.0 Contaminant Identification	<ul style="list-style-type: none"> • Identify specific contaminants and contaminant families present in both fuel and oxidant streams.
2.0 Analytical Method Development	<ul style="list-style-type: none"> • Development of analytical methods to study contaminants. • Experimental design of analytical studies. • Novel <i>in situ</i> detection methods.
3.0 Contaminant Studies	<ul style="list-style-type: none"> • Develop contaminant analytical models that explain these effects. • Establish an understanding of the major contamination-controlled mechanisms that cause material degradation in PEM cells and stacks under equilibrium and especially dynamic loading conditions
4.0 Contaminant Model Development	<ul style="list-style-type: none"> • Construct material state change models that quantify that material degradation as a foundation for multiphysics modeling • Establish the relationship between those mechanisms and models and the loss of PEM performance, especially voltage decay
5.0 Contaminant Model Validation	<ul style="list-style-type: none"> • Validate contaminant models through single cell experimentation using standardized test protocols.
6.0 Novel Mitigation Technologies	<ul style="list-style-type: none"> • Develop and validate novel technologies for mitigating the effects of contamination on fuel cell performance.
7.0 Outreach	<ul style="list-style-type: none"> • Conduct outreach activities to disseminate critical data, findings, models, and relationships etc. that describe the effects of certain contaminants on PEM fuel cell performance.

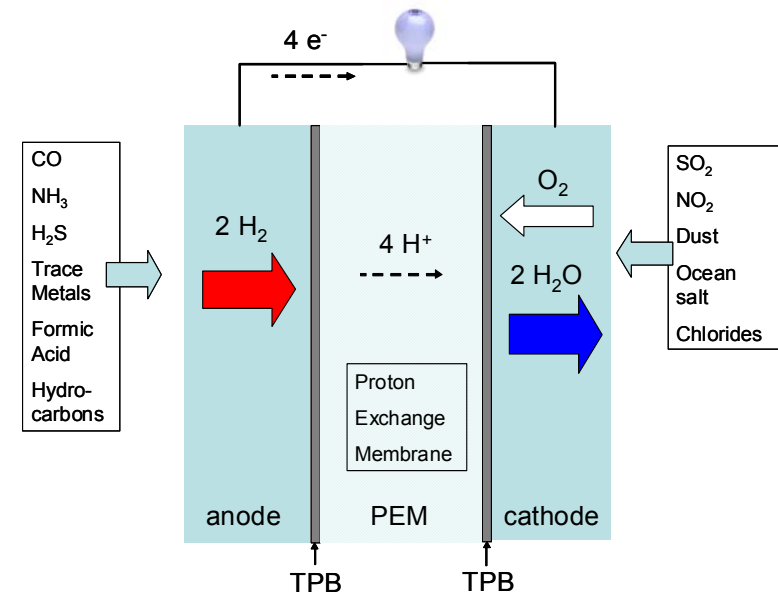




Approach

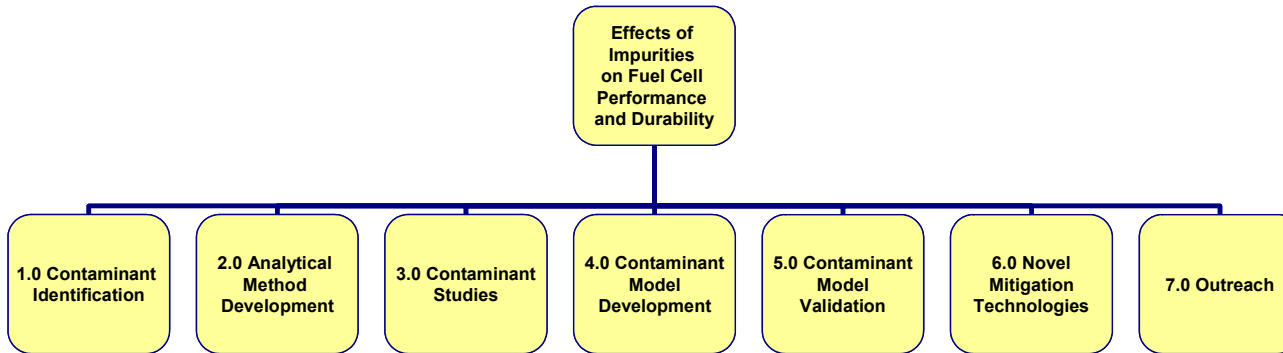


- **Initiate Studies by Leveraging Existing Database From Prior Work**
 - DOE Sponsored Activity
 - USFCC Data
 - Prior Electrolysis Product Experience
- **Focus on Specific Contaminants/Concentrations Identified by DOE/Others**
- **Use Standardized Test Protocols Where Appropriate to Investigate Contaminant Effects**
- **Develop Empirical Models Based on Our Findings**



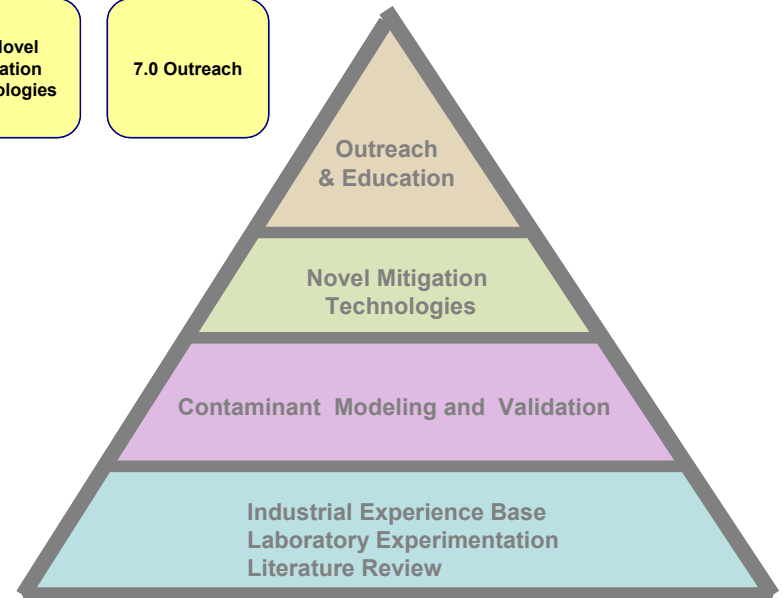


Project Work Plan/Deliverables



Deliverables

- Validated Contaminant Models
 - New Mitigation Technologies
- Outreach: Papers, Workshops, Technical Interchange, Etc.





Future Work



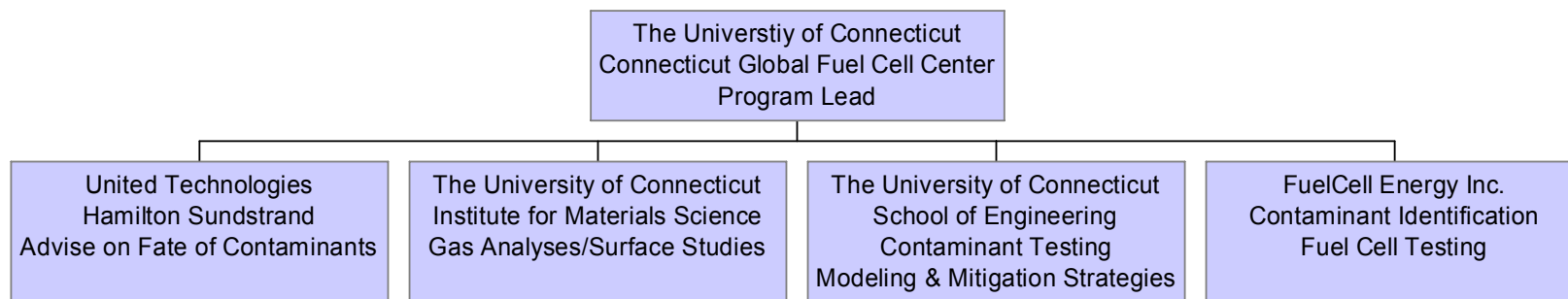
Task	Yr 1				Yr 2				Yr 3				Yr 4			
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
1.0 Contaminant Identification	█	█														
2.0 Analytical Method Devt.		█	█	█												
3.0 Contaminant Studies				█	█	█	█	█								
4.0 Contaminant Model Devt.							█	█	█	█	█	█				
5.0 Contaminant Model Validation													█	█		
6.0 Novel Mitigation Tech.													█	█	█	█
7.0 Outreach	█	█	█	█	█	█	█	█	█	█	█	█	█	█	█	█
8.0 Project Management and Reporting	█	█	█	█	█	█	█	█	█	█	█	█	█	█	█	█

- 4 Year Project
- Time Phased Milestones Activities and Expertise

Task	Milestone	Date Year/Quarter
1.0 Contaminant Identification	<ul style="list-style-type: none"> Contaminant Identification Review With DOE Sponsor & Industry Focus Group 	Y1/Q2
2.0 Analytical Method Development	<ul style="list-style-type: none"> Validate Analytical Methods For Studying Contaminants With Ersatz Gases 	Y1/Q4
3.0 Contaminant Studies	<ul style="list-style-type: none"> Establish an Understanding of the Major Contamination-Controlled Mechanisms that Cause Material Degradation 	Y2/Q4
4.0 Contaminant Model Development	<ul style="list-style-type: none"> Determine the Relationship Between Contaminant Mechanisms and the Loss of PEM Performance, Especially Voltage Decay. 	Y3/Q4
5.0 Contaminant Model Validation	<ul style="list-style-type: none"> Validate Contamination Models Through Single Cell Experimentation Using Standardized Test Protocols and a DOE Approved Test Matrix 	Y4/Q1
6.0 Novel Mitigation Technologies	<ul style="list-style-type: none"> Demonstrate Novel Technologies for Mitigating the Effects of Contamination on Fuel Cell Performance 	Y4/Q4
7.0 Outreach	<ul style="list-style-type: none"> Dissemination of Results Through Reports (DOE Approved), Papers and Workshops 	Continuous
8.0 Project Management and Reporting	<ul style="list-style-type: none"> Program Written Reports and Program Reviews 	Continuous



Roles of Participants

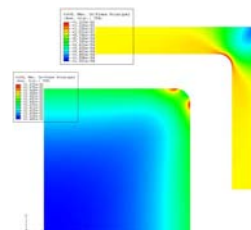
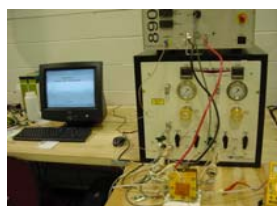
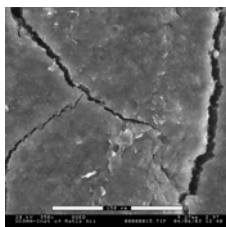


- Electrolysis Contaminant Experience
- Prior Contaminant Studies

- Surface Studies/Equipment
- Gas Purity Analyses

- Fuel Cell Testing
- Modeling/Transport Expertise
- Industry Relationships

- Gas Contaminant Experience
- Fuel Cell Test Experience





Project Summary



- **Relevance - A Deeper Understanding of the Effects of Specific Contaminants on Fuel Cell Performance is Necessary for Successful Commercialization**
- **Approach - Our Experienced Team Will:**
 - Leverage Existing Knowledge and Will Systematically Investigate Certain Fuel Contaminants of Interest
 - Create Empirical and Detailed Analytical Models to Predict the Fate of Specific Contaminants and Their Effect on Fuel Cell Performance
- **Technology Transfer - Data Will Be Shared Through Papers, Workshops, Working Groups, Etc.**
- **Collaboration – Active Partnership with UTC and FCE**

