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**Low Emission Advanced Power Workshop on Fuel Cell Turbine Power Systems**

U.S. Department of Energy National Energy Technology Laboratory  
Morgantown, WV

**DRAFT AGENDA**

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**Monday, May 2, 2016**

Venue: B26- Room G51C except as noted

Objective: to provide technical seminar in the fundamentals of fuel cells, turbines, system integration, system modeling, and controls. Two parallel seminars will be organized, one for applications and one for controls. Providing a foundation in hybrid applications and controls will ensure adequate preparation for meaningful discussions on Tuesday.

	<b>Track 1</b>	<b>Track 2</b>
	<b>Hybrid Applications</b>	<b>Hybrid Controls</b>
<b>1:00 pm</b>	Solid Oxide Fuel Cells	Distributed Control
<b>2:00 pm</b>	Compressors and Turbines	State Space and MIMO Control
<b>3:00 pm</b>	System Integration	Non-linear Control
<b>4:00 pm</b>	System Modeling	System Identification
<b>~5:30pm</b>	Adjourn	

## **Tuesday, May 3, 2016**

Venue: B26- Room G51A, B, C except as noted

Objectives: 1) provide detailed introductions of participants, 2) identify opportunities for hybrids in future power generation, and 3) review technical challenges associated with implementation of hybrids. Participants will be offered an opportunity to present a couple of slides regarding their organization's involvement in the topic under discussion. The format will be interactive, and control of the active presentation will be passed to each speaker in turn during the discussion. In order to facilitate this form of interaction, those participating will be asked to bring their materials on a laptop with internet capability.

**7:30 am** Workshop Registration and Continental Breakfast

**8:00 am** Welcome and Introductions

**9:00 am** Opportunities for Hybrids in Power Generation-

The morning session will be focused on application opportunities for hybrid systems. Groups with experience in system simulation and analysis will be encouraged to participate. Some simulations will be run during the discussions. Some of the topics of discussion will include:

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|---------------------------|---------------------------|
| 1. Efficiency             | 7. Distributed generation |
| 2. Carbon management      | 8. Microgrids             |
| 3. Renewables integration | 9. Polygen applications   |
| 4. Load following         | 10. Fuel flexibility      |
| 5. Turndown               | 11. Water                 |
| 6. Islanding              | 12. Spinning reserve      |

**10:15 am** Break

**12:30 pm** Working Lunch

**1:00 pm** Technical Challenges-

The afternoon session will focus on identifying some of the technical challenges associated with the development and implementation of hybrid power systems. Industry participants will be encouraged to share experience with challenges and successes. Some topics of discussion will include:

- |  |                                     |
|--|-------------------------------------|
| 1. Component degradation               | 5. Flow imbalance in parallel loops |
| 2. System integration                  | 6. System pressure losses           |
| 3. Compressor and turbine dynamics     | 7. Power continuity                 |
| 4. Controls for highly coupled systems | 8. Fuel flexibility                 |
|  | 9. Fuel cell thermal management     |
|  | 10. Grid dynamic                    |

**3:30 pm** Break and move to B4-104

**3:45 pm** Introduction to cyber-physical systems (CPS) and the Hyper facility (tour)-  
Cold startup of the Hyper facility and demonstration of the Ames Laboratory MESA platform.

**~5:30pm** Adjourn

## **Wednesday, May 4, 2016**

Venue: B26- Room G51A, B, C except as noted

Objectives: 1) identify the strengths of approaches used to resolve technical issues associated with hybrid systems, 2) evaluate methods for economic analyses and technical challenges, and 3) demonstrate the use of cyber-physical systems in controls development.

**7:30 am** Workshop Registration and Continental Breakfast

**8:00 am** Approaches to Resolving Technical Issues-

The morning session will focus on research progress and research methods for solving the problems associated with the technical issues discussed on Tuesday. Steady-state and dynamic models will be setup for exploration during discussions. Changes in structure or operating parameters will be accommodated within the limits of feasibility, and the results will be presented on Thursday morning. Some topics to be explored will include:

1. System modeling
2. Real hardware
3. Hardware in the loop
4. Cyber-physical systems
5. Cycle Optimization

**10:00 am** Break

**12:15 pm** Working Lunch

**12:45 pm** Economic Analyses-

An overview of economic analyses will be discussed by workshop participants, including:

1. Assumptions
2. Uncertainties
3. Cost functions
4. Market opportunities
5. Dynamics and flexibility

**2:45 pm** Break and move to B4-104

**3:00 pm** Hardware CPS Simulations by NETL in B4-104

**4:30 pm** Hardware Simulation Discussion and Summary

**~5:30pm** Adjourn

**Thursday, May 5, 2016**

Venue: B26- Room G51A, B, C except as noted

Objectives: 1) Determine the technology requirements of hybrid systems of the future relevant to government program needs, 2) Gain insight to future market potential of fuel cell hybrid systems from industry participants, including an emphasis on technology development priorities, and 3) Summarize opportunities and technical barriers identified throughout the workshop as a basis for the technical note to be authored by participants.

**7:30 am** Workshop Registration and Continental Breakfast

**8:00 am** Review of Numeric and Hardware Simulations and Discussion

**9:30 am** Break

**10:00 am** U.S. DOE Programmatic Prospective on Low Emission Power Systems of the Future

Dr. Regis Conrad, Director, Division of Advanced Energy Systems, U.S. DOE  
Headquarters, Office of Fossil Energy

Dr. Robert Romanosky, Portfolio Manager, Crosscutting Research & Analysis, NETL

Dr. Sydni Credle, Federal Project Manager, Enabling Technologies & Partnerships, NETL

**11:00 am** Industry Prospective on Low Emission Power Systems of the Future  
Industry participants

**12:30 pm** Working Lunch

**1:00 pm** Discussion and Summary of the Workshop with an Outline of the Technical Note

**3:00 pm** Break

**4:00 pm** Adjourn