

# Hydrogen Technology and Energy Curriculum (HyTEC)

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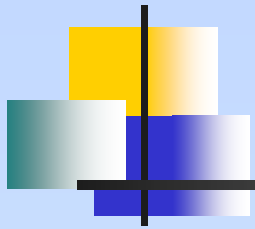
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**Project ID #ED5**



HyTEC





# HyTEC Collaborators



SCHATZ  
ENERGY  
RESEARCH  
CENTER



HyTEC





# Overview

## ■ Timeline

- September 1, 2004
- August 31, 2005
- 20% complete
- Extension planned

## ■ Budget

Total five year: \$3,015,955  
DOE share: \$2,399,150  
Contractor share \$616,805

Funding FY04: 410,395  
DOE share: \$324,983  
Contractor share: \$ 85,412

**Funding FY05: none**

## ■ Barriers addressed

- Lack of Awareness
- Institutional Barriers and Access to Audiences

## ■ Partners

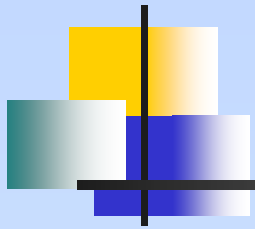
- SERC, Humboldt State
- AC Transit
- Chabot Space & Science Center
- NHA
- Lab-Aids, Inc.



# Goal

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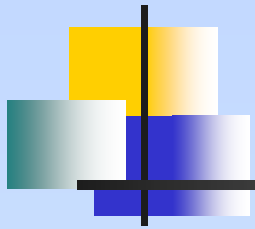
- Educate high school students and their teachers about the
  - Scientific and technological basis for hydrogen and fuel cells
  - Research and development currently underway to implement safe and cost-effective hydrogen and fuel cell transportation demonstration programs
  - Current challenges to and potential promise of a hydrogen economy in the broader context of energy use and resources.



# Goal

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- Develop and evaluate a comprehensive and sustainable program of high school curriculum materials and teacher professional development and to disseminate these materials to a large, national audience of students and teachers.
- We propose to do this through our existing instructional materials development approach and network of schools and districts throughout the U.S. that use SEPUP/LHS materials.



# Objectives

- Develop, field test in national centers, revise, publish, and disseminate three curriculum modules and integrate hydrogen and fuel cells into existing LHS high school materials.
- Develop and implement a professional development plan for teachers who will use the materials.
- Develop a model for collaboration among school districts, informal science centers, university scientists, local transportation agencies, and other leaders in the field.
- Disseminate the materials to a broad national audience.
- Evaluate the quality and effectiveness of the curriculum materials and professional development strategies.



# Objectives: The Curriculum Envisioned

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- Part of the SEPUP module series developed at UC Berkeley's Lawrence Hall of Science
  - Twelve modules currently available
  - Recognized for balanced treatment of issues
  - Marketed nationally by Lab-Aids, Inc.
  - Disseminated through numerous national, state, and regional workshops/presentations
  - Used with pre-service teachers in many schools of education
- Integrated into SEPUP's 2-year high school science program (funded by NSF)

# Objective: A SEPUP Instructional Module



Hazardous Materials Investigations Module

- Complete materials kit
  - Equipment
  - Consumables (chemicals)
  - Transparencies
- Teacher's Guide
  - Student Masters
  - Transparency Masters
  - CD of test and masters
- Web site for support, links to other resources, extensions



# Example module: Investigating Energy From the Sun

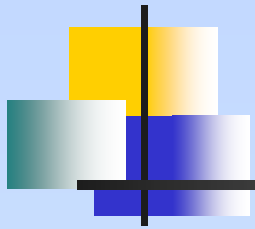




# Objectives: Year One

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- The plan has been modified to fit the greatly reduced funding level and uncertainty of future funding**
- Prepare a draft of one module that includes the most important ideas related to hydrogen and fuel cells
    - Related to National Science Education Standards and other standards
    - Able to fit into a typical high school chemistry and/or physical science course
  - Pilot the module in classrooms
  - Revise to prepare a version for piloting by expert teachers



# Approach

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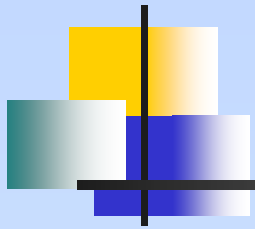
- Draft module outline prepared by developers
- Teachers, curriculum developers, and scientists on the team review and revise
- Draft core activities & assessments, develop kit materials, including student fuel cell
- Review of activities by teacher advisors
- Pilot by developers working in San Francisco Bay Area classrooms
- Collect teacher, student, and expert feedback
- Revise based on feedback



## Approach, continued

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- Team science centers, scientists, and schools to create a collaborative model for hydrogen and fuel cell education
- Include Stack-in-a-Box® activities facilitated by scientists, science center personnel, or participating teachers:
  - illustrate the use of fuel cells for real energy needs
  - investigate additional scientific concepts



# Progress

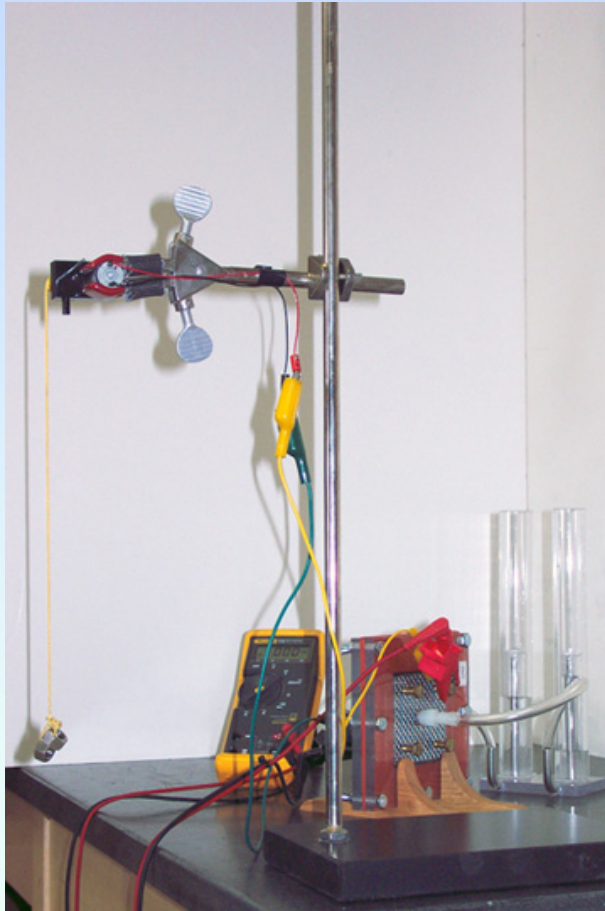
- Completed outline (15 activities) reviewed by team
- Outline correlated to National Science Education Standards
- Prepared with input of high school chemistry and physical science teachers who know what teachers teach and are likely to use
- Prototype kit materials (student fuel cell)
- Pilot testing of selected activities in Berkeley Unified School District
- Focus on solving technical problems



# Progress: Module outline example

Activity Title	Summary	National Science Education Standards
3. Using Hydrogen Fuel Cells	Students use a fuel cell to power a small motor. Students measure the mass the fuel cell can lift (mechanical work) or use multimeters to measure the fuel cell output.	5B4d: Most observable forces may be traced to electric forces acting between atoms and molecules.  5E2b: Science often advances with the introduction of new technologies.

# Progress: Activity 3



## Activity materials:

- Fuel cell
- Separate electrolyzer
- Motor
- Weights



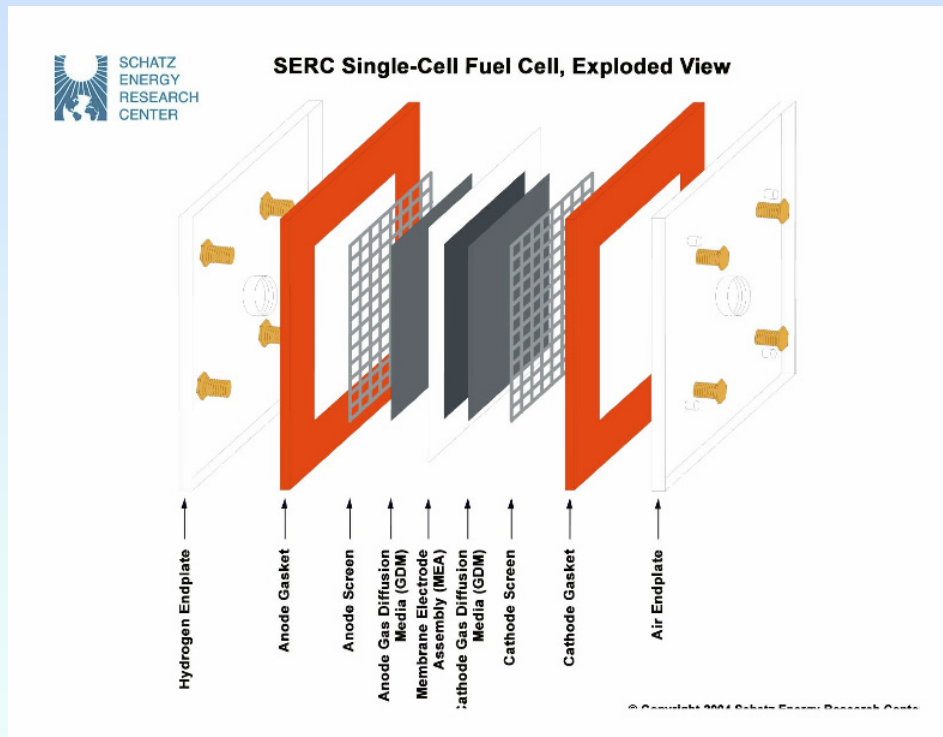
# Progress



- Students working with SERC hydrogen fuel cells
- Challenge is to bring eight fuel cells to a high school classroom at reasonable cost



# Student fuel cells



- One large fuel cell to be disassembled to study components
- Eight scaled down, operable student fuel cells
  - Not to be disassembled
  - Durable

# Stack-in-a-Box® Investigations



- In these photos, students and teachers use the Stack-in-a-Box®
- A Stack-in-a-Box® is in production for use by the Lawrence Hall of Science and in SF Bay Area classrooms



# Future work

## With current funding:

- 2004–2005 school year
  - Complete student fuel cell and kit prototypes
  - Pilot activities in Berkeley classrooms
- Summer
  - Completion of trial unit, with complete activities
  - Review and evaluation by team and external reviewers
- 2005–2006 school year
  - Classroom trial of complete unit and Stack
  - Revision based on feedback
  - Prepare an online field trip to a hydrogen fueling station and fuel cell bus facility



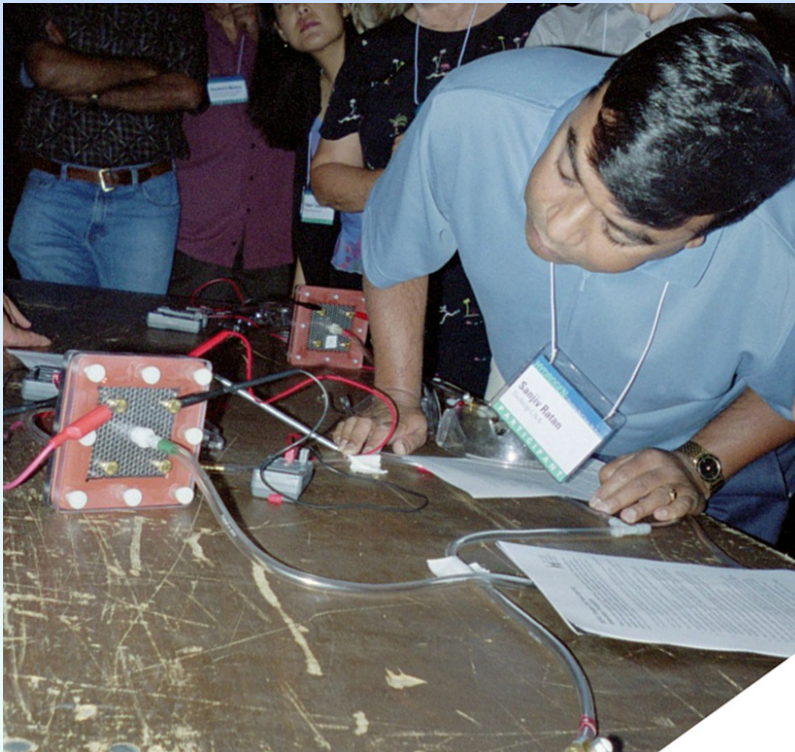
# Future work

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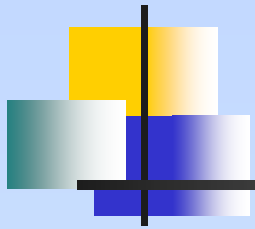
## **With continuing funding:**

- Expansion of program to three modules, for physical science and chemistry classes
- National field testing with diverse student populations, in a variety of sites
- Stack-in-a-Box® unit for each national field test site
- Professional development program, building on LHS, SERC, and CS&SC experience
- Commercial publication of module with kit
- Dissemination through LHS and established publisher network, catalog, and sales team

# Future work



- A student fuel cell in use at a teacher workshop
- Future work will reach a large, national audience of teachers through networks of LHS, CS&SC



# Hydrogen Safety

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- The most significant hydrogen hazard associated with this project is:  
The release of hydrogen from the Stack-in-a-Box® fuel cell system and the resulting combustion of the gas.



# Hydrogen Safety

Our approach to deal with this hazard is:

- Standard classroom safety procedures, with detailed safety information in the Teacher's Guide and on Student Sheets
- Use of the Stack-in-a-Box® fuel cell only for demonstrations by the teacher or with guided teacher supervision
- Use of the Stack-in-a-Box® fuel cell only in well ventilated areas
- Small volume of stored hydrogen (4 grams = 1 tablespoon of gasoline energy equivalent)
- Employ standard safety features, including pressure relief and pressure regulation
- High pressure gas is contained within a DOT approved gas cylinder