Research in energy storage technologies: a University perspective

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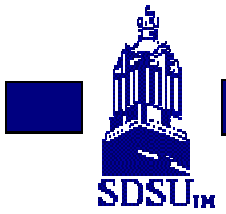


South Dakota State University
College of Engineering
Electrical Engineering Department

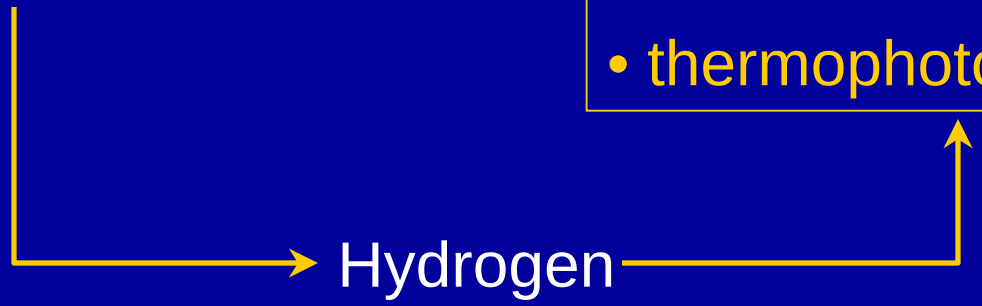
Two separate approaches

Research in energy storage technologies

- to enable the use of "ambient energy"
- to improve power system and drivetrain efficiency

Research in chemical energy converters

- the energy storage problem is already solved!
- fuel cells
- combustion engines
- thermophotovoltaics



Technologies of interest for solar storage

- ☑ Electrochemical batteries
- ☑ Flywheels
- ☑ Ultracapacitors (or supercapacitors)
- ☑ Thermal energy storage
- ☑ Hydrogen (connects back to chemical conversion devices)

Not considered here:

- ☒ Pumped hydro
- ☒ SMES

Status of University energy storage work

- High levels of activity in all technologies
- Large numbers of dedicated University Centers working on energy storage problems (although the definition of “Center” is variable)
- Most applications are for space or transportation
- Interdisciplinary nature of the subject is a problem for Universities, but one that can be overcome

University centers—electrochemical

Penn State University: Graduate Automotive Technology Education (GATE) Center

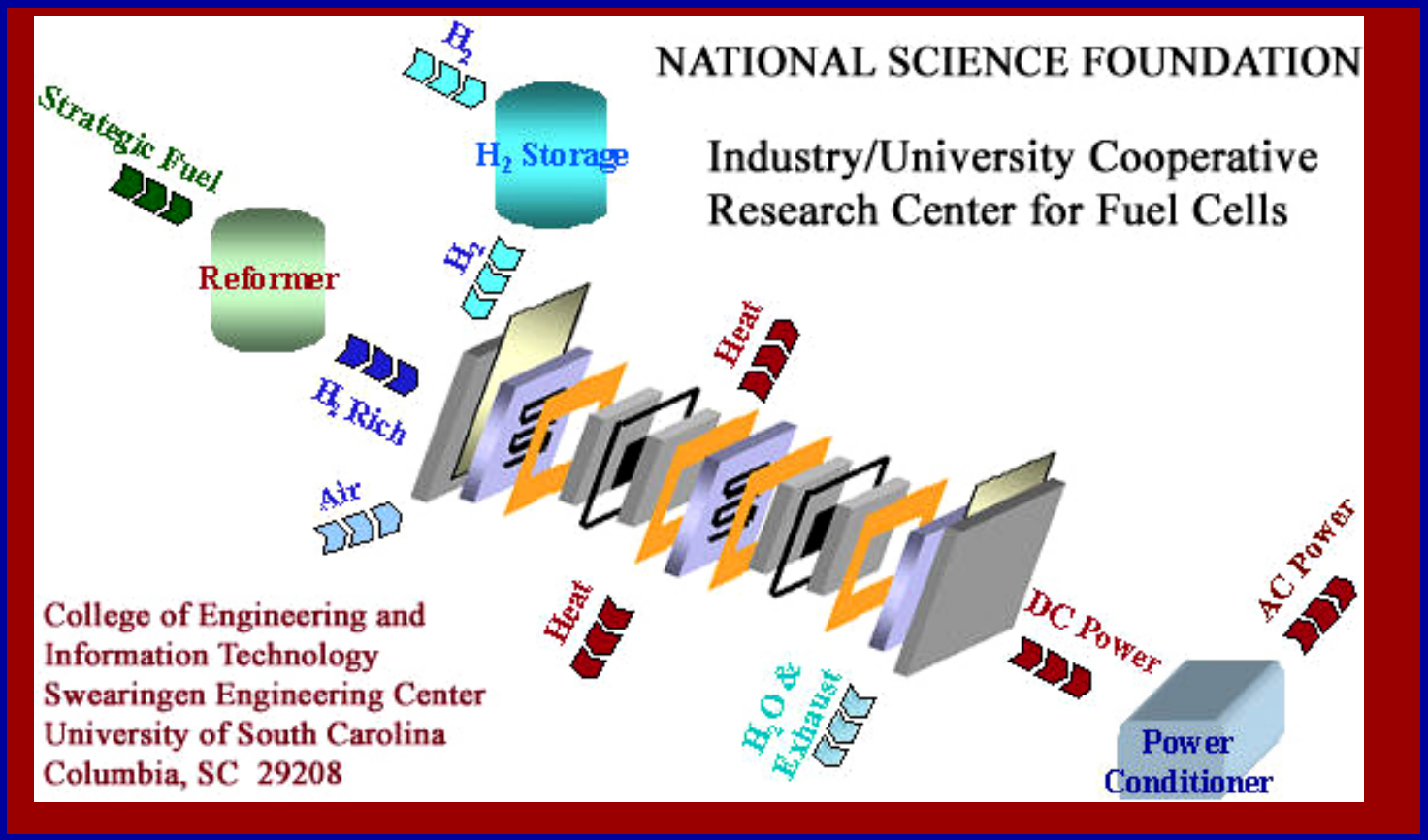
- One of ten GATE centers nationally, but the only one with a heavy energy storage emphasis
- Within GATE:
  - Advanced Energy Storage Center
  - Electrochemical Engine Center
- Research on Li-Ion batteries, fuel cells, battery charging algorithms and techniques, ultracapacitors
- Interdepartmental center

University centers—electrochemical

University of South Carolina: Center for Electrochemical Engineering

- "Official" University center recognized by the state of SC
- Works with Li-ion, NiMH, and silver vanadium oxide batteries; fuel cells; and ultracapacitors
- Ten faculty and three research professors (!)
- Single department (chemical engineering), but primary ***focus***
- Also on campus……

University centers—electrochemical



Started by institutional seed funds; now NSF funded

University centers—kinetic

Texas A&M: Center for Space Power

- Power systems for spacecraft
- Flywheels (bearings), lithium-ion batteries
- Also active in MQW PV devices and AMTEC

Auburn University

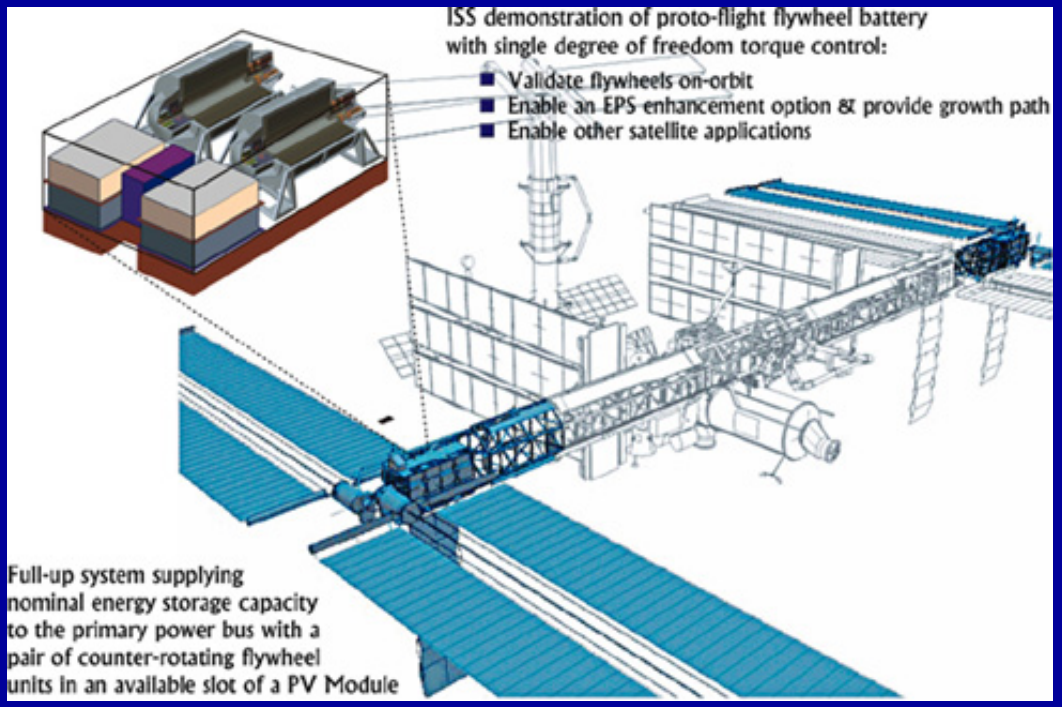
- Active in Aerospace Flywheel Development Project

University centers—kinetic

University of Texas-Austin: Center for Electromechanics

- Extensive work on flywheels
- Supported by NASA

Flywheel energy storage for the ISS



University centers—thermal

University of Nebraska—Architectural Engineering program

- Program shared across two campuses (Lincoln and Omaha)
- Significant levels of publication and activity, but no center
- Interesting model—extremely strong and direct industrial ties, and very applied research (program actually housed in a building housing architectural firms)
- No visible support from Federal agencies

University centers—hydrogen

Florida Solar Energy Center: Hydrogen Research and Applications Center

- FSEC already well established in solar (PV) technologies
- H_2 Center supported by NASA and recently established

University challenges

- Interdisciplinary work is difficult—"which department is it in?"
- Startup money from institutions or states
- "Institutional schizophrenia"—research is important and deserves funding, vs. research should be self-supporting. Leads to funding instability.
- Multiple demands on the same people—teaching + research + outreach + service +…

University challenges

- ☑ Key ingredients:
  - ✓ Critical mass of researchers
  - ✓ At least some support from the University—a “buy-in” (often in-kind), or a “seed money” investment
  - ✓ Often, state support (especially at first)
  - ✓ University officials willing to bend tradition (possibly an entirely new University structure?)

University challenges

"The majority of the problems today, for which there is funding for research, are multidisciplinary. It is a well recognized and growing challenge to universities that their traditional departmental structure gets in the way of multidisciplinary research. The multidisciplinary research centers are, in some situations, an effective transitional tool to whatever the new university structure will be."

--Robert Hebner, Ph.D.
Director, Center for Electromechanics, UT-Austin

University challenges

"Our program is 'hardware rich but cash poor'. It's easy to get equipment and facilities, but very difficult to get money for students and personnel."

--Joel Anstrom, Ph.D.
Director, GATE Center, Penn State University

University challenges

One subject on which there was universal agreement from all Directors:

A critical problem is "funding schizophrenia"—the funding is not long-term stable. A sustained, long-term funding source is a critical key ingredient.