

Environmentally-Sensitive Energy Conversion

ME Department
Review

16 August 2006



Energy and Environment

- Current Research
 - Turbulent reacting flows
 - Environmental control
 - Renewable energy development
 - Advanced conversion (fuel cells)
 - Life cycle assessment: "Cradle to Grave design"
- What is in the future?
- Where do we fit in?

Turbulent/Reacting Flows

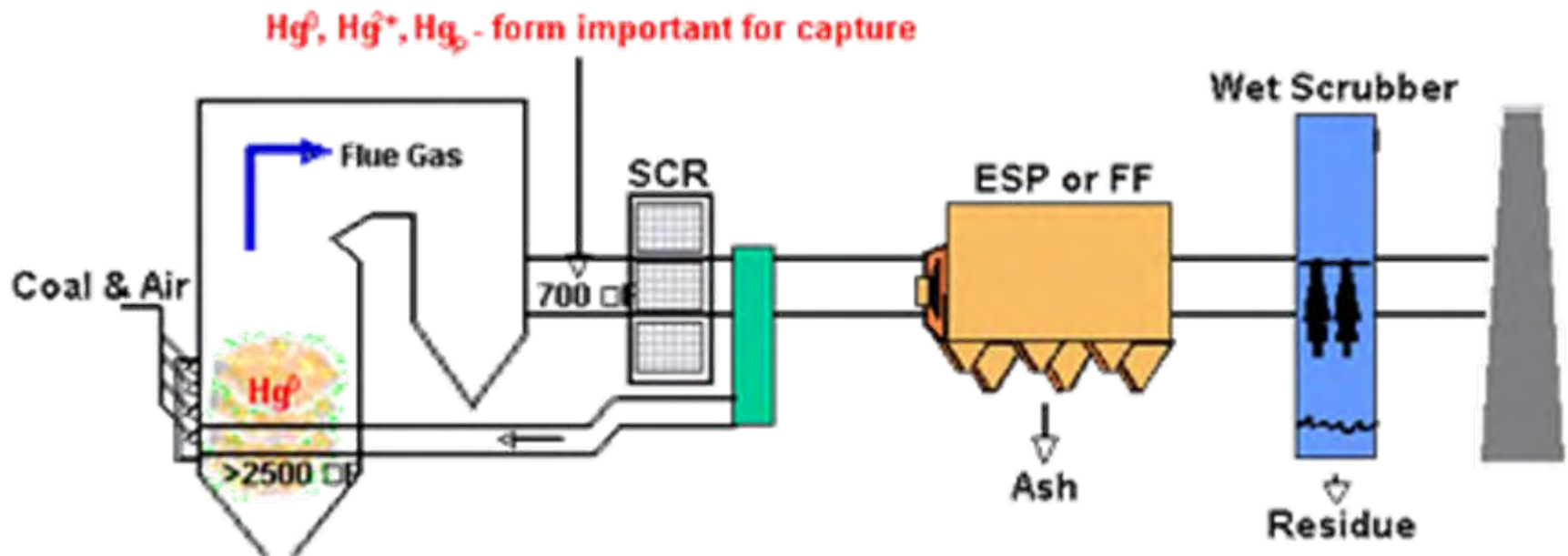


- Goals:
Stability, less emissions, more efficient.
- State of art:
Combine turbulence and chemistry
(Riley, Kosaly, Kramlich)
- Funding: NSF, AFOSR, GRI, NASA

QuickTime™ and a YUV420 codec decompressor are needed to see this picture.

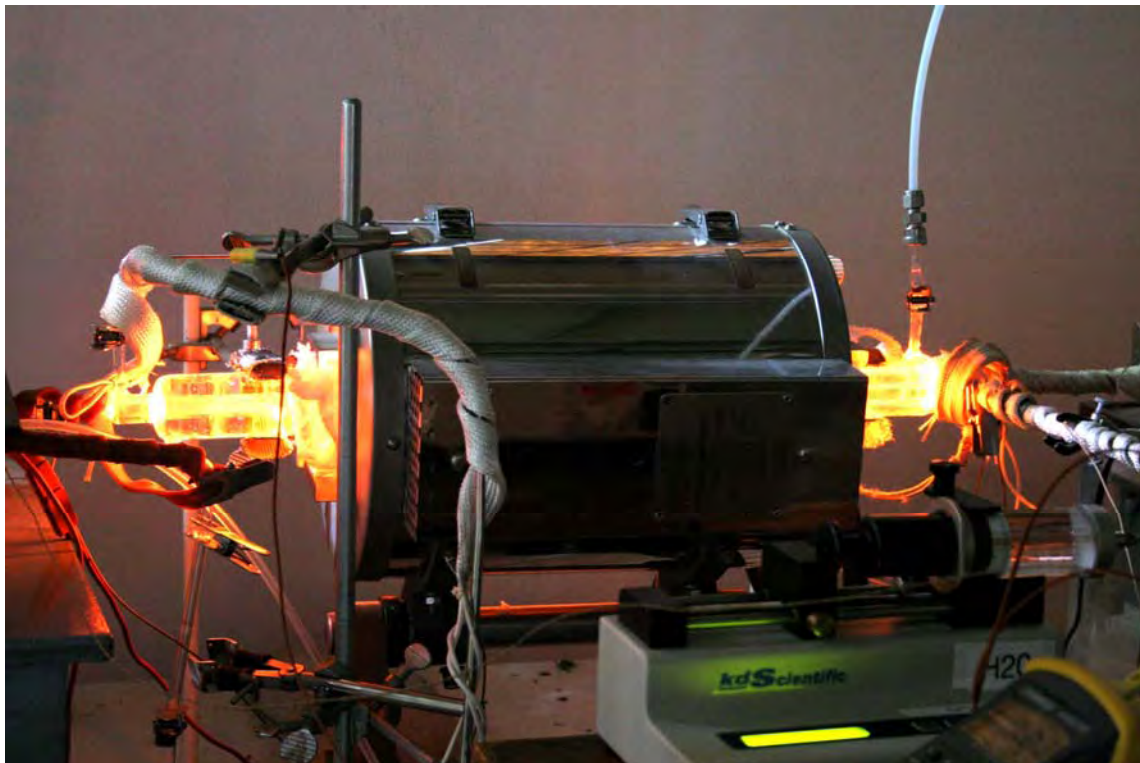
Environmental Control: Mercury

- 50 tons emitted per year
- Oxidized Hg captured, elemental not
- How to make chemistry force oxidation?



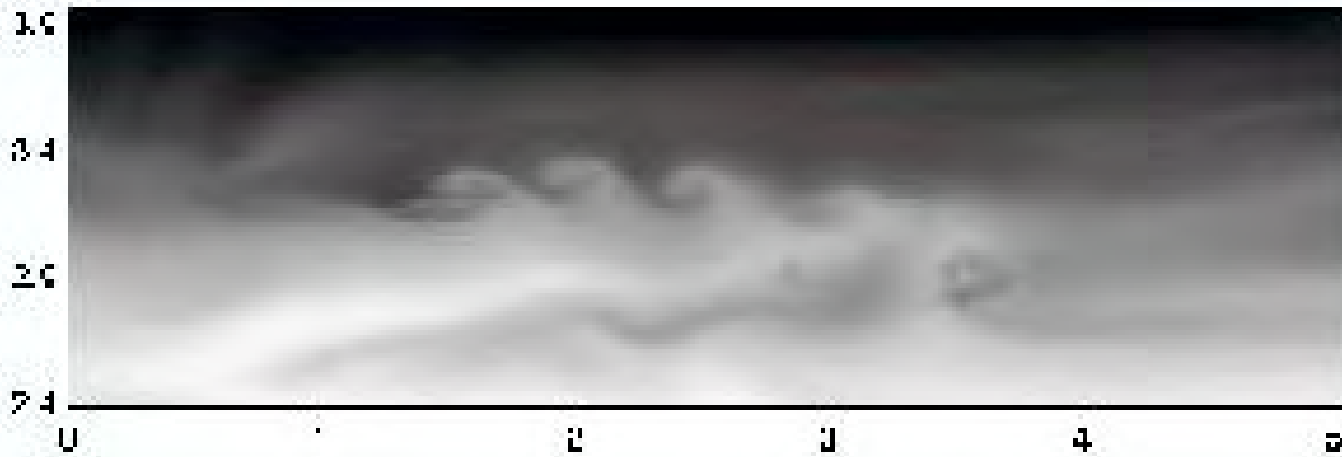
Environmental Chemistry

- Combustion experiments, modeling (Kramlich, Malte) (NSF, ONR, GRI, DOE, Weyerhaeuser)



Environmental Modeling

- Simulation, modeling of environmental turbulence



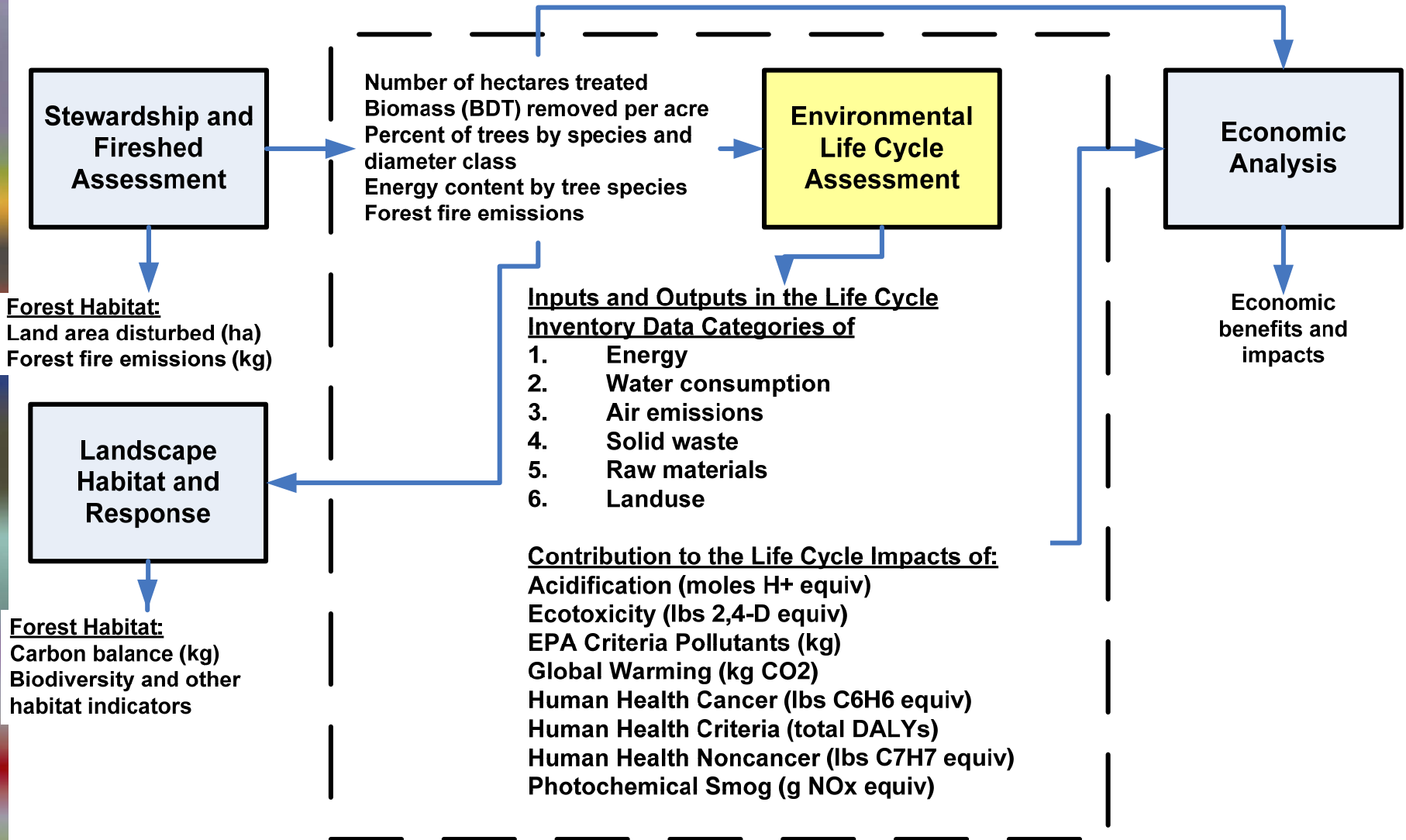
Important for modeling dynamics, dispersion in estuaries, oceans, atmosphere

Renewable Energy

- Malte: Forest fuels, Solar PV, Micro-hydro, Wind turbine, Water turbine siting
Funding: Park Service, Vulcan, Institute for Environmental Research and Education

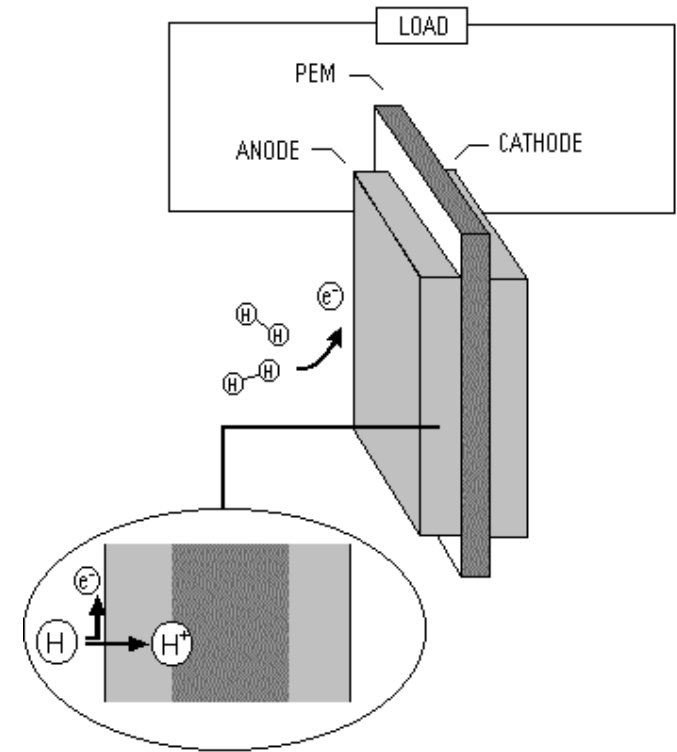


Forest Remediation Biomass to Electricity



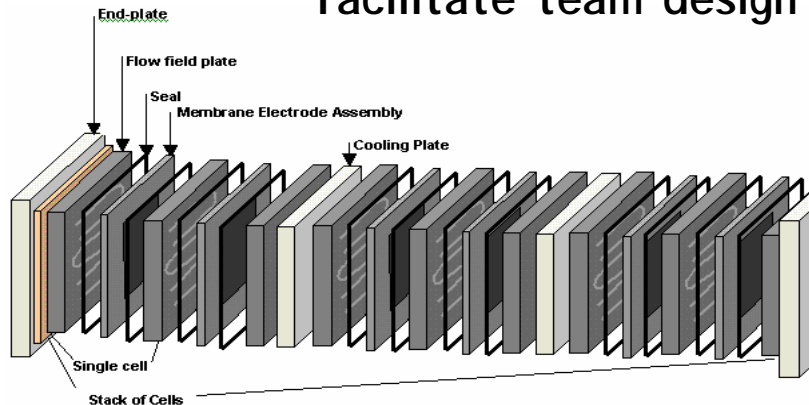
Fuel Cells

- Solid oxide fuel cells
(Stuve, Kramlich, Cooper,
Adler, Reinhall)



PEMFC LCA: focus on design

- Funded by Plug Power, the design tool will be:
 - Sensitive to a wide variety of design parameters specific to Plug Power current and emerging technology platforms (hardware materials and configurations as well as fuels and fuel production scenarios), and
 - Able to rapidly produce baseline results, given system configuration and performance data, and scenario results on-the-fly to facilitate team design analysis.



What drives the future?

- The efficient and environmentally sensitive use of energy is a critical national and international issue
- It will become a central technical issue in the 21st century
- Changes in cost and availability of various energy sources are driving technological change
- Higher costs and environmental constraints drive more highly-engineered technologies
- Topic identified by President Emmert as a main research goal

Changing Sources of Energy

- Electric generation, transportation, heating roughly 1/3 each
- Electric: Now mostly coal, nuclear, hydro, natural gas
 - Most new capacity has been natural gas
 - Unstable prices driving new investment elsewhere
 - Coal gasification
 - Supercritical Rankine
 - New generation nuclear
 - Advanced: Fuel cell and Renewables growing but not ready

Changing Sources of Energy

- Transportation:
 - Alternates to petroleum: biofuels, liquid coal
 - Environmental control for Diesels
 - Advanced power plants (fuel cells, battery)
- Heating
 - Building design for conservation
 - Advanced heat pump and cogeneration