Fuel Cells and North Carolina

First Annual Hydrail Conference

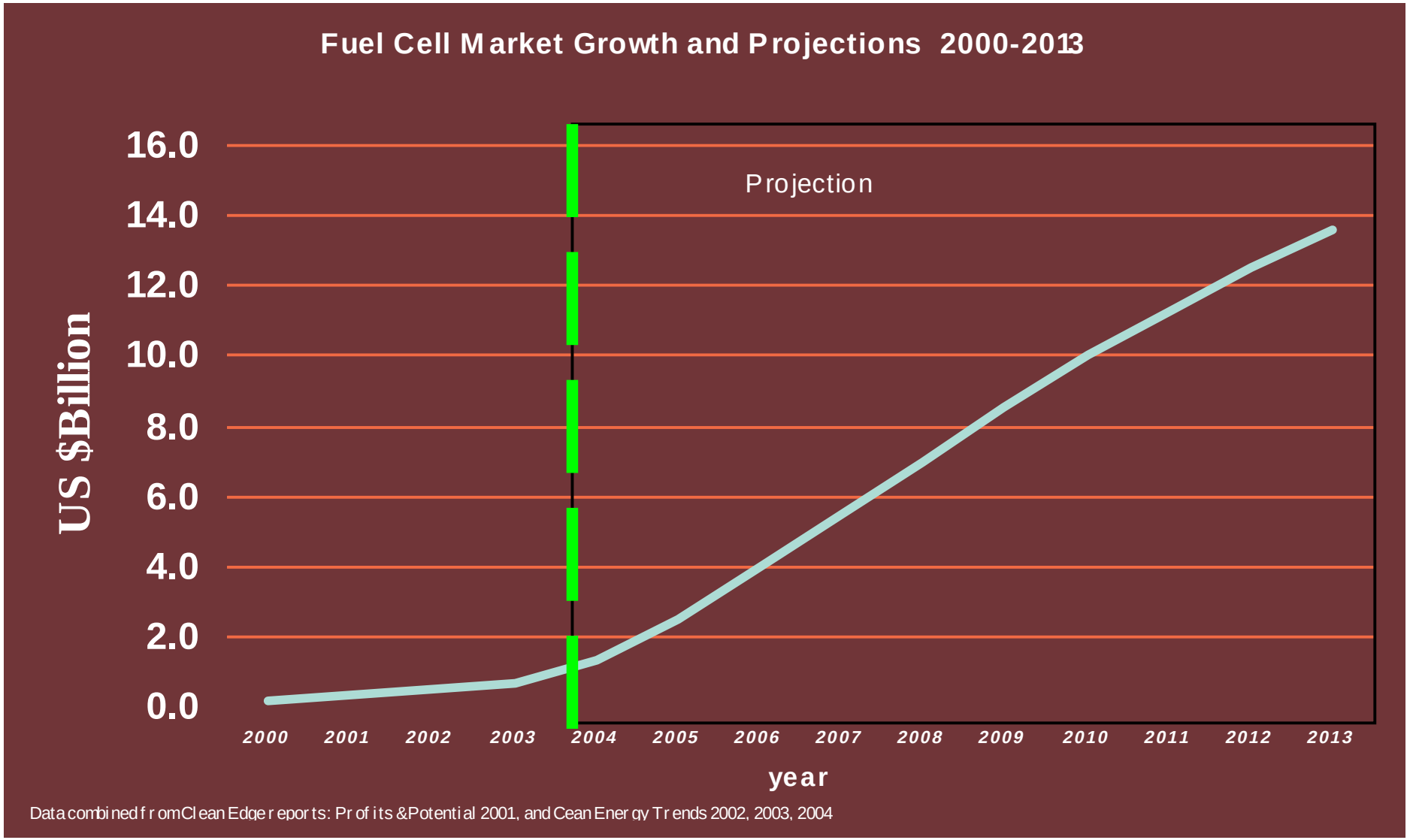
Larry Shirley

State Energy Office

"Hydrogen and fuel cell technologies have the potential to solve the major energy security and environmental challenges that face America today—dependence on petroleum imports, poor air quality, and greenhouse gas emissions."

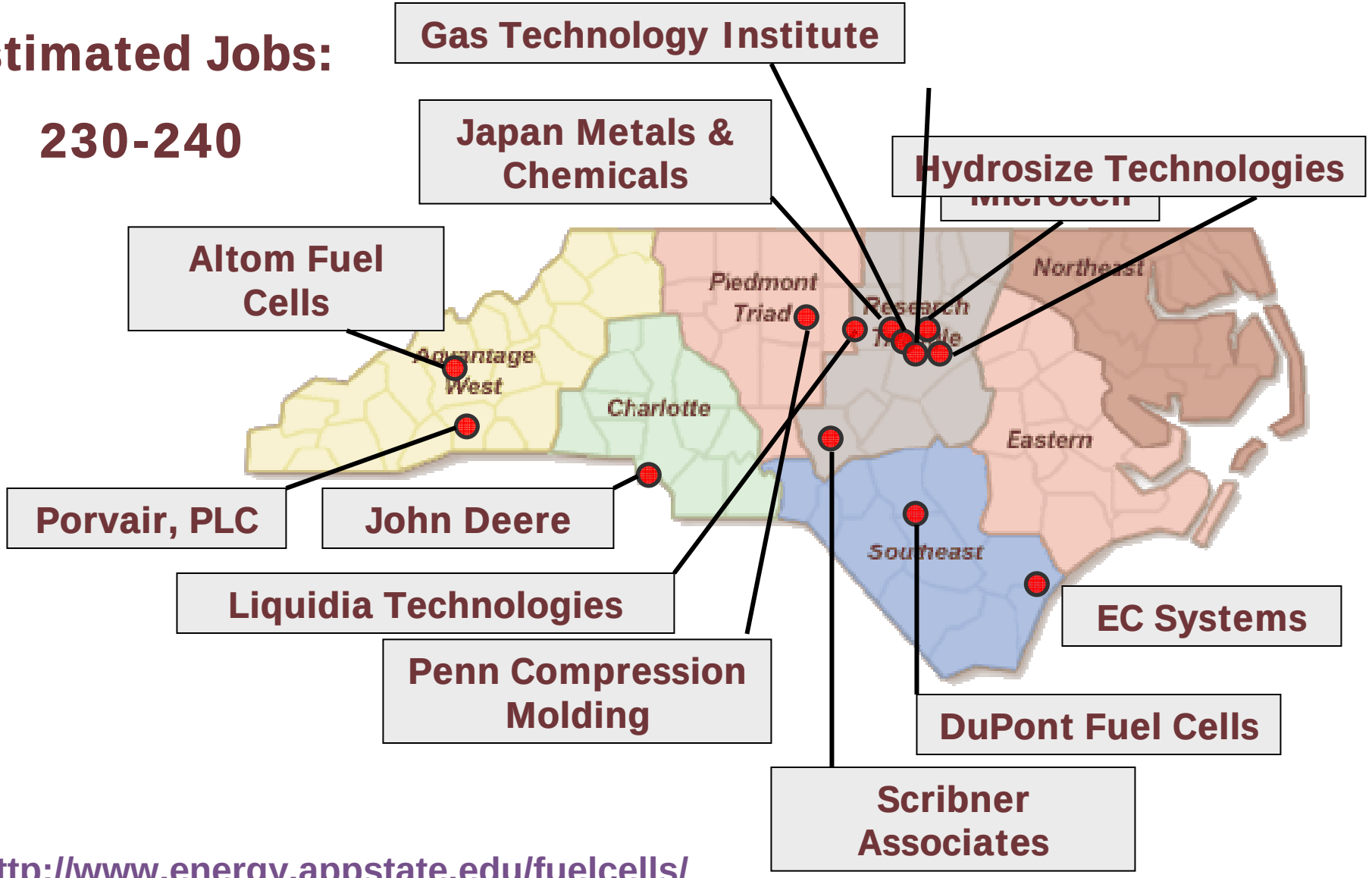
http://www.eere.energy.gov/hydrogenfuelcells/about.html

Fuel Cell Markets Today



Estimated Jobs:

230-240



http://www.energy.appstate.edu/fuelcells/

Products Overview

Toshiba DMFC laptop

Image source: Fuel Cells Today
http://www.fuelcellstoday.com

Audi A2 Fuel Cell
Hybrid concept

UTC Fuel Cells' 5kW
Alpha prototype

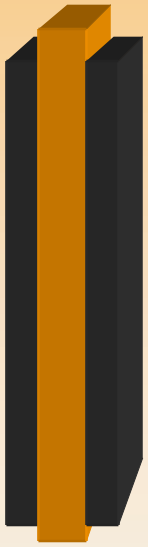
Siemens Westinghouse
250kW SOFC

NC Energy

Hydrail Conference 5/6/05

State Energy Office
ENERGY
www.energync.net 1-800-662-7131
N.C. Department of Administration "Ensuring a sustainable energy future"

NC Component Manufacturers

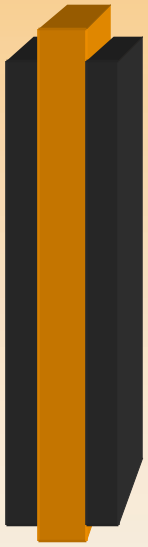


Outer Backing Plates

- Porvair Fuel Cells
  - » Henderson County
  - » Carbon-based advanced material
  - » Provides flow channels and electrical circuit
- Penn Compression Molding
  - » Guilford County
  - » Molds used to form backing plates
  - » Process equipment

NC Component Manufacturers

Membrane Material



- DuPont Fuel Cells
  - » Cumberland/Bladen Counties
  - » Nafion® industry leading fluoropolymer materials platform
  - » Global market leader
- Liquidia Technologies
  - » Orange County
  - » Innovative, proprietary fluoropolymer materials platform
  - » Recent spin-off of UNC-Chapel Hill research

Fuel Cell System Researchers

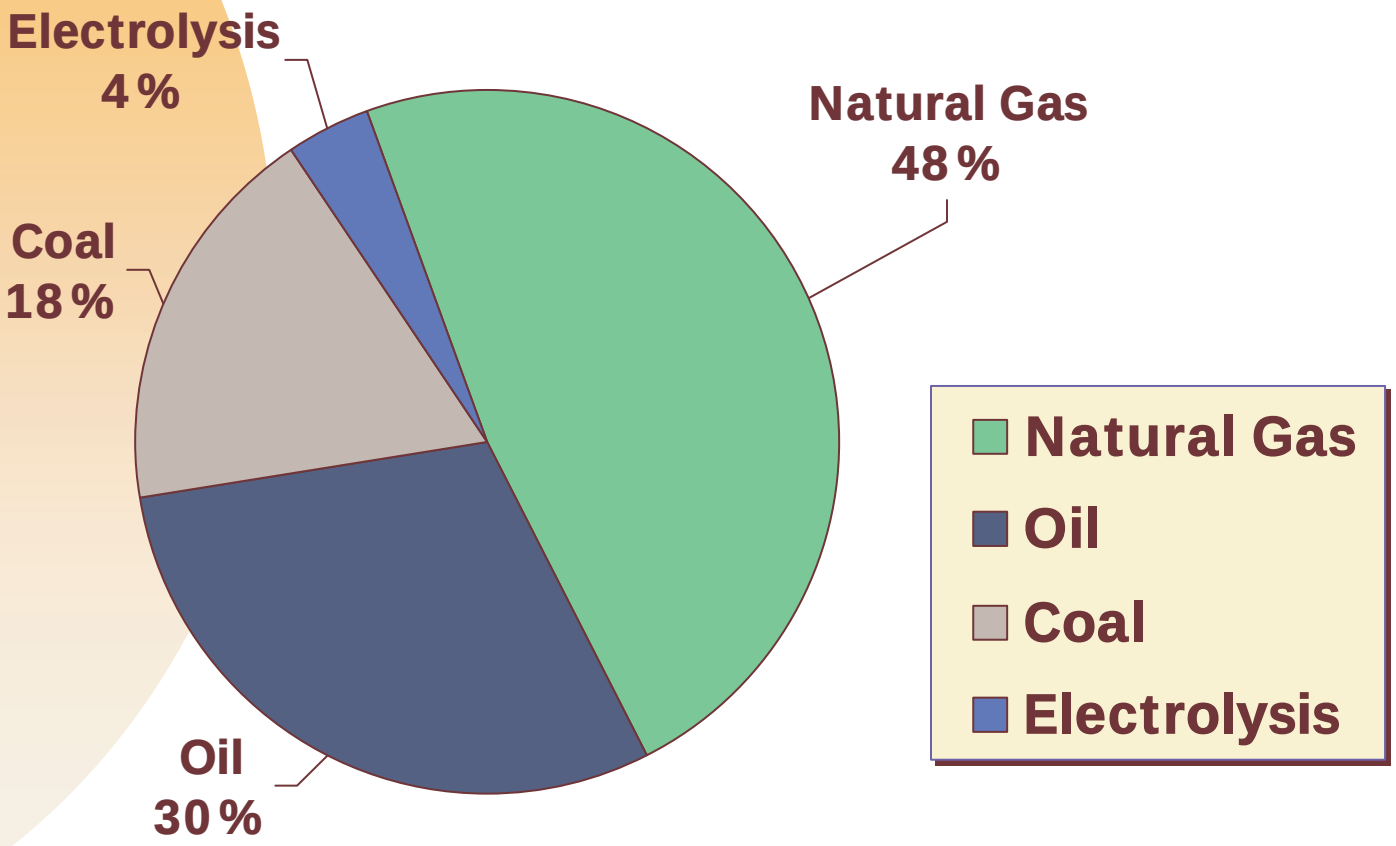
- Microcell
  - » Wake County
  - » Novel design, non-planar
  - » R&D firm moving to production
- INI Power
  - » Wake County
  - » Research project for military
  - » Integrated DMFC for personal power

Hydrogen's Role

- Hydrogen is an energy carrier, the fuel cell converts this energy into usable electricity
- The purest form of hydrogen is produced by using electricity to split water molecules
- Mature hydrogen production technologies primarily use fossil fuels
- Emerging technologies utilize renewable electricity sources and bio-based solutions
- Hydrogen storage and infrastructure technologies are in a demonstration phase

Why 'Emerging' Technology?

- Storage and distribution infrastructure lack standardization and development
- Membrane corrosion remains an issue for fuel cells using atmospheric oxygen, especially in heavily polluted areas
- Production curve progress – mass production, materials cost will decline as experience and manufacturing increases
- Market transformation process in energy industry as a whole; some oil companies have embraced hydrogen



http://www.eere.energy.gov/hydrogenandfuelcells/mission.html

- **Production**
  - » Methane reformation
  - » Biomass gasification
  - » Photoelectrochemical
  - » Photobiological
  - » Electrolysis

- **Storage/distribution**
  - » Compressed gas/liquid
  - » Metal hydride
  - » Chemical hydride
  - » Carbon materials

- **Methane**
  - » Landfills – 129 potential sites & 14 projects
  - » Animal feed operations – 547 animal sites
  - » Wastewater treatment plants – 18 facilities
- **Other Resources**
  - » Industrial methanol releases – over 5 tons/yr
  - » Electrolysis – splitting water
  - » Biomass and crop residue
  - » Chemical and biological production

- Tech-based economic development with the potential to replace declining industries such as textiles, furniture and tobacco
- Abundance of in-state hydrogen resources
- Significant industry footprint already
- Capitalize on intellectual and knowledge assets within the University system
- Continue a long tradition of innovative economic development targeted at high-technology

- Partnerships – 11 states
  - » Illinois, Texas
- Recruitment efforts – 5 states
  - » New Jersey, Pennsylvania, Ohio
- Interconnection standards – 22 states
  - » Louisiana
- University research – 28 states
  - » Georgia, Virginia, South Carolina

- North Carolina Fuel Cell Alliance
- Public-private partnership: Industry, Academia, Government
- Research at NC A&T, NCSU, Chapel Hill, Duke
- NC has no incentives for fuel cell use or manufacture

- www.energy.appstate.edu/fuelcells

Policy Questions

- Should NC concentrate on fuel cells and other clean energy technologies as it already has on biotechnology and microelectronics for 21st Century economic development?
- Should NC create specific incentives for fuel cell and distributed generation companies?
- Should NC encourage technology transfer by recruiting a critical mass of UNC-system scientists focused on fuel cell research and development?

Policy Questions

- Where will the hydrogen come from? How will it be made?
- Will the source of hydrogen be renewable or non-renewable?
- Will the net energy balance be positive?
- What emissions will result?

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