Welcome To Colorado!
Ruthie C. Swartzlander
October 25, 2005
Colorado as the Fuel Cell Capital of the World

Colorado Fuel Cell Industry = Silicon Valley Semiconductor Industry

What does it take to reach critical mass?

CFCC (Nucleus) + Industry Partners (More Neutrons)

At Critical Mass:
Chain reaction becomes self-sustaining (no external neutron source needed)

http://www.npp.hu/mukodes/lancreakcio-e.htm
• Resolve fundamental scientific questions
• Develop phenomenological understanding

• Convert fundamental scientific theory to viable product
• Build and test prototypes, refine

• Scale prototypes and fabrication methods
• Integrate individual components

• Identify customers/market segments
• Deliver bundle of want satisfying attributes to customers
Colorado Fuel Cell Center - Collaborations
<table>
<thead>
<tr>
<th>FCV Systems Analysis: Freeze Solutions</th>
<th>Non-Nafion Membranes</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Corrosion Resistant Bi-Polar Plates</strong></td>
<td><strong>Application of Advanced CAE Methods for Quality and Durability of FC Components</strong></td>
</tr>
</tbody>
</table>

- Fuel cell used in testing bipolar plates (left); sample of corroded electrode material (right).
NREL's FY06 H2 Technology Validation Activities

- ~125 light-duty vehicles
- Ratio of FY06 effort: ~75% Cars, ~25% Buses
- ~30 H2 production & refueling infrastructure sites
- 5 geographic sites
- Data templates
- Automatic processing of data

Vehicle Data Analysis GUI

Vehicle Data Analysis GUI

1. Data Conversion (Raw Files to Raw Converted)
2. Data Conversion (Raw Converted to Analysis Specific)
3. Analysis
4. Analysis Results Figures

Fuel Economy
Range
Stack Degradation

On-Road Fuel Economy Table

<table>
<thead>
<tr>
<th>Time (oper hrs)</th>
<th>Voltage (V)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>350</td>
</tr>
<tr>
<td>10</td>
<td>340</td>
</tr>
<tr>
<td>20</td>
<td>330</td>
</tr>
<tr>
<td>30</td>
<td>320</td>
</tr>
<tr>
<td>40</td>
<td>310</td>
</tr>
<tr>
<td>50</td>
<td>300</td>
</tr>
<tr>
<td>60</td>
<td>290</td>
</tr>
<tr>
<td>70</td>
<td>280</td>
</tr>
<tr>
<td>80</td>
<td>270</td>
</tr>
<tr>
<td>90</td>
<td>260</td>
</tr>
<tr>
<td>100</td>
<td>250</td>
</tr>
</tbody>
</table>

Actual
CurrentFit
95% CI Observation
Mean CurveFit

On-Board Hydrogen Production Efficiency Summary

<table>
<thead>
<tr>
<th>Operating Time (hrs)</th>
<th>Predicted Voltage (V)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>427.9</td>
</tr>
<tr>
<td>10</td>
<td>412.1</td>
</tr>
<tr>
<td>20</td>
<td>396.4</td>
</tr>
<tr>
<td>30</td>
<td>380.6</td>
</tr>
<tr>
<td>40</td>
<td>364.8</td>
</tr>
<tr>
<td>50</td>
<td>349.0</td>
</tr>
<tr>
<td>60</td>
<td>333.2</td>
</tr>
<tr>
<td>70</td>
<td>317.4</td>
</tr>
<tr>
<td>80</td>
<td>301.6</td>
</tr>
<tr>
<td>90</td>
<td>285.8</td>
</tr>
<tr>
<td>100</td>
<td>270.0</td>
</tr>
</tbody>
</table>

V_{pred} = 427.9 - 15.78 \log(current) - 0.3370 \times current

10.0 hours of data per curve fit
12000 data points per curve fit
Fuel Cell Commercialization Opportunities and Challenges
Dr.-Ing. John Coors
October 25, 2005
Vision, Mission, Values

We make the world *measurably* better

**Vision**

CoorsTek Purpose
We make the world *measurably* better.

Core Business Strengths
We excel at commercializing technology solutions through our
- Custom engineering
- Materials expertise
- Operational excellence
- Rapid execution

**Mission**

Our strategy is to provide value in many diverse markets by employing our Core Business Strengths in expanding or developing technology niches.

**Values**

In everything, we do to others what we would have them do to us.

We do what we say, and say what we mean.

We create outstanding value for our customers.

We work together to make our company the best.
Worldwide Presence

Legend
- Corporate Headquarters
- CoorsTek Manufacturing Facility
- CoorsTek Sales Office
- Authorized Agent
Our research explores the limits of electrical efficiency
Introducing New Energy Production Technologies

70 kW PV System in Burbank, CA

Avoid Technology Push

<table>
<thead>
<tr>
<th></th>
<th>PV</th>
<th>SOFC</th>
</tr>
</thead>
<tbody>
<tr>
<td>Power Density</td>
<td>15-25 mW/cm²</td>
<td>100 mW/cm²</td>
</tr>
<tr>
<td>Efficiency</td>
<td>12-18%</td>
<td>60%</td>
</tr>
</tbody>
</table>
July 15, 2005

**Soldier survives attack; captures, medically treats sniper (Video)**

During a routine patrol in Baghdad June 2, Army Pfc. Stephen Tschiderer, a medic, was shot in the chest by an enemy sniper, hiding in a van just 75 yards away. The incident was filmed by the insurgents.

Tscheiderer, with E Troop, 101st “Saber” Cavalry Division, attached to 3rd Battalion, 156th Infantry Regiment, 256th Brigade Combat Team, 3rd Infantry Division, was knocked to the ground from the impact, but he popped right back up, took cover and located the enemy’s position.

After tracking down the now-wounded sniper with a team from B Company, 4th Battalion, 1st Iraqi Army Brigade, Tschiderer secured the terrorist with a pair of handcuffs and gave medical aid to the terrorist who’d tried to kill him just minutes before.
1,000 metric tonnes of powder
To make 1 GW of fuel cells

= 1 month CoorsTek current capacity
Planar FCs - Roll Compaction

3,000 ft/hour
Planar FCs – Dry Press

800-Ton Press
15" x 17" Bipolar Plates

High-Fire

Machine Plate