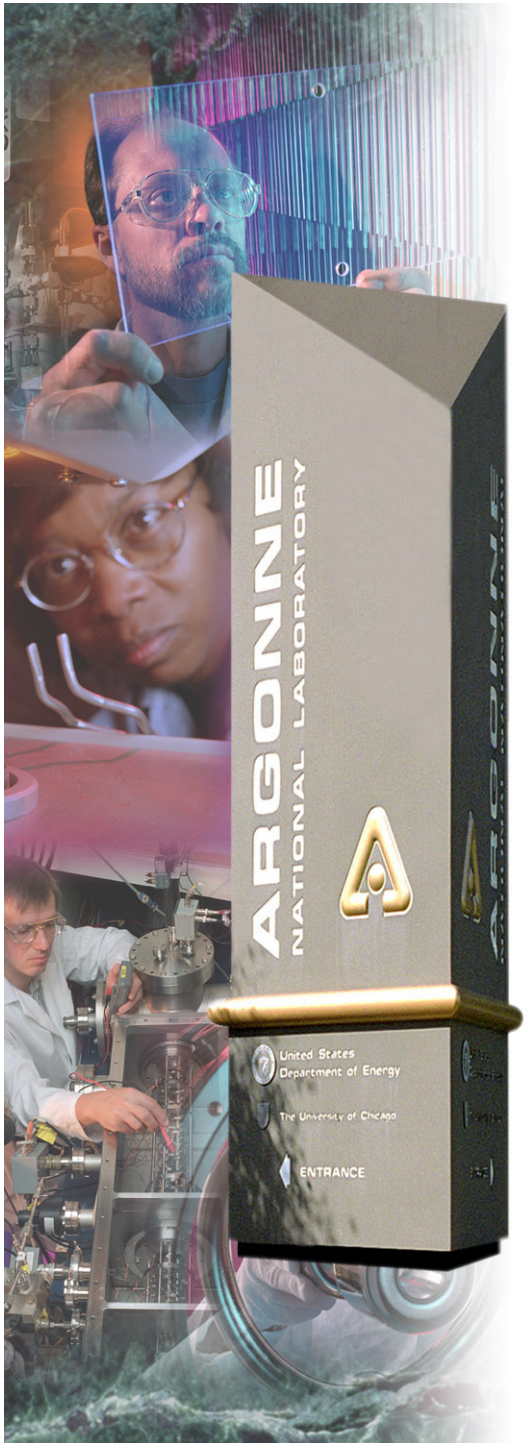



# *Advanced Power Sources for Emergency Telecommunications Applications*

*Ira Bloom*

*Emergency Power Conference*
*November 22, 2004*
*Washington, DC*

***Argonne National Laboratory***

*A U.S. Department of Energy Laboratory*
*Operated by The University of Chicago*

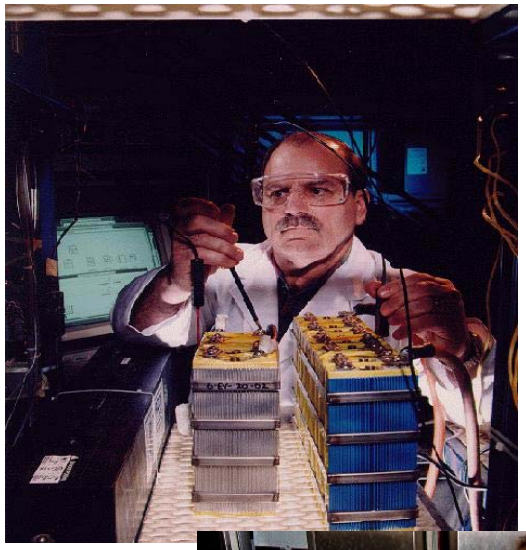
# *Emergency Power Options*

- **Electrochemical energy conversion devices**

- **Batteries**
  - Easy to site, but limited energy storage per charge
  - Types
    - *Na/S, LiAl/FeS, LiAl/$FeS_2$, Li/polymer, Li-Ion, Zn/$Cl_2$, Zn/$Br_2$, Ni/Fe, Ni/Zn, Ni/MH, Ni/Cd, Pb-Acid, Fe/Air*

- **Fuel Cells**
  - Energy generated as long as fuel and air are available
  - Types
    - *Alkaline, Phosphoric Acid, PEM, MCFC, SOFC*

# *Examples of Advanced Battery Technologies*



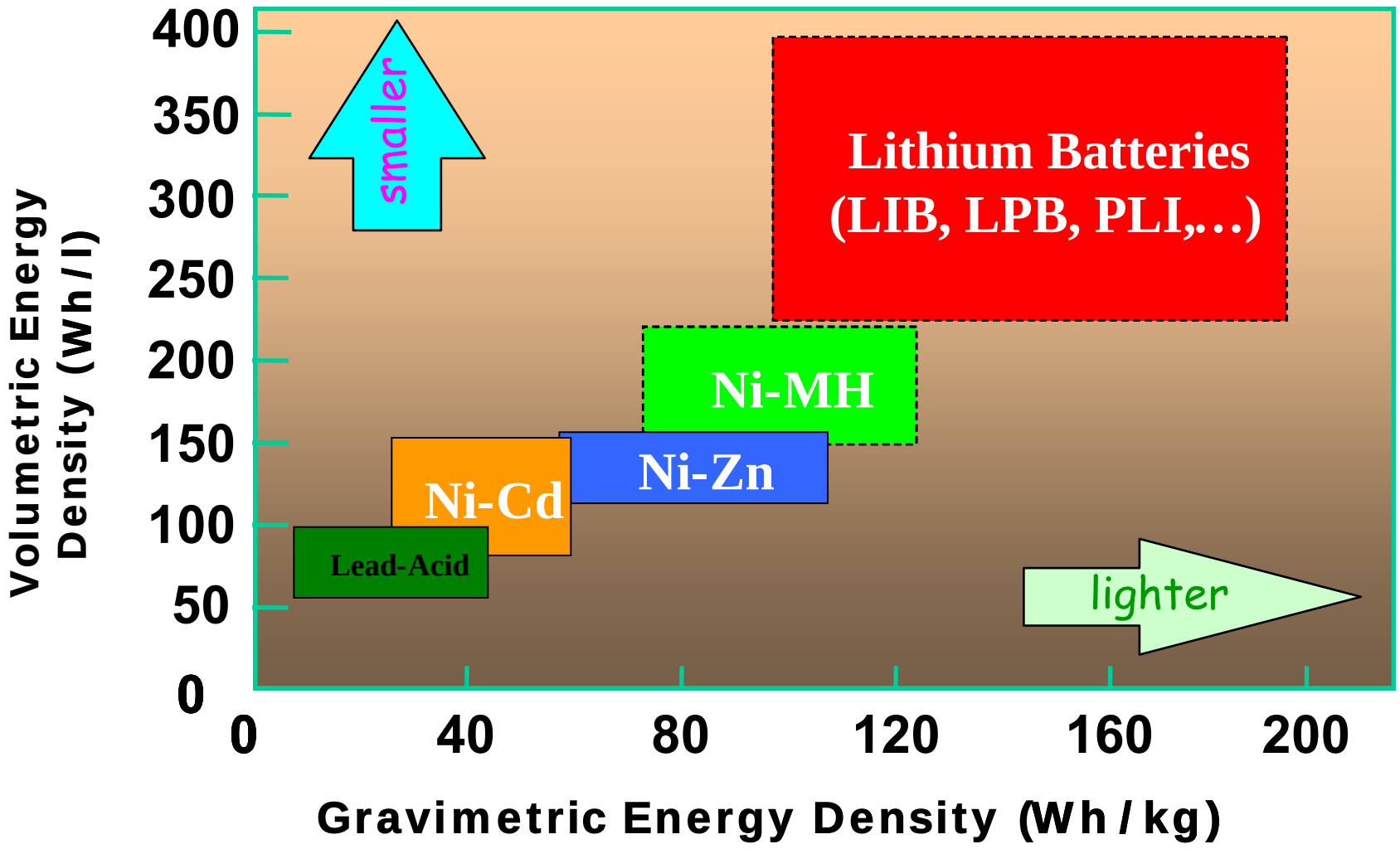
Ni/MH modules


Li-ion

Li-polymer


Na/$NiCl_2$

# Properties of Advanced Batteries



# *Pros and Cons of Using Batteries*

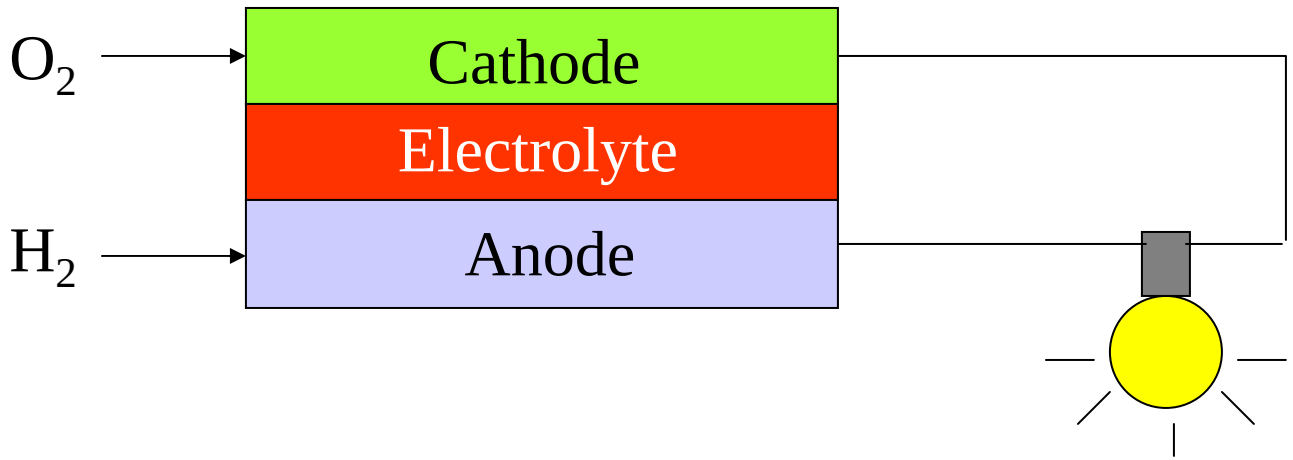
| Technology | Advantage | Disadvantage |
|---|---|---|
| Pb/Acid | Very mature technology<br>Inexpensive | Low specific energy (Wh/kg) |
| Ni/MH | Higher energy density than Pb/Acid | Expensive. Immature technology for this application |
| Li-Ion<br>Li-Polymer | Very high specific energy | Even more expensive. Immature technology for this application. Li-Ion has low-temperature performance limitations |

- **Li-ion batteries have the potential for reducing cost by using advanced, less-expensive materials. Cost reduction for the Ni/MH batteries is much more challenging.**

# What Is a Fuel Cell?

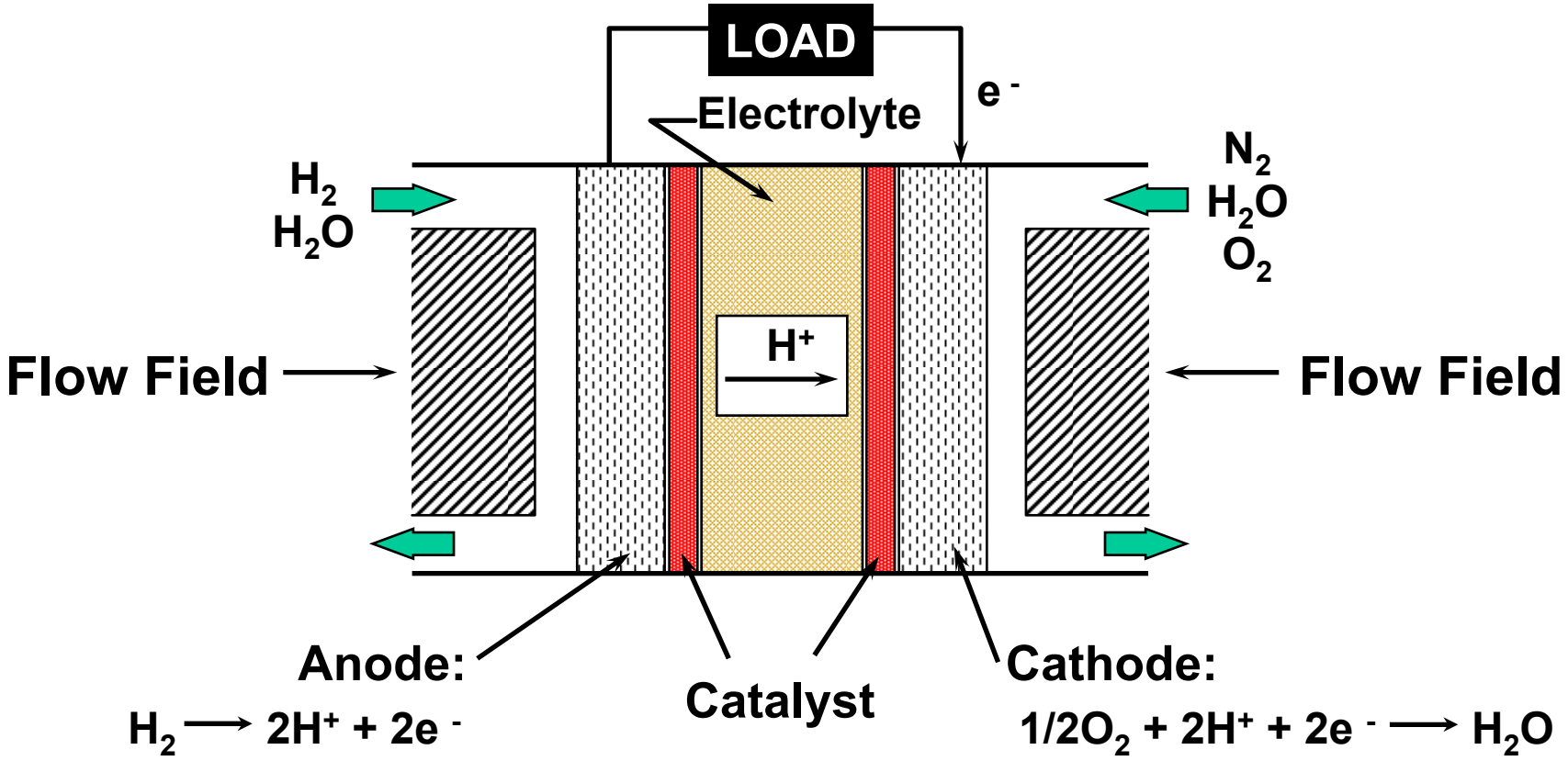
- **An electrochemical device that combines $H_2$ and $O_2$ to generate electricity from the free energy change of the cell reaction:**

$$H_2 + 1/2\ O_2 \rightarrow H_2O\ (l, g)$$



# How a Fuel Cell Works

**Example: Polymer electrolyte fuel cell**




**Overall Cell Reaction: $H_2 + 1/2O_2 \longrightarrow H_2O$ (Cell Potential ≈ 1 V )**

# *Fuel Cell Technology*

| Type | Electrolyte | Conducting Ion | Temp., °C | Maturity |
|---|---|---|---|---|
| Polymer | $CF(CF_2)_nSO_3^{2-}$ | Hydrated $H^+$ | 60-80 | Immature |
| | High power density; Pt catalyst; must be kept wet; poisoned by CO | | | |
| Alkaline | KOH | $OH^-$ | 90 | Mature |
| | High power density; cannot tolerate $CO_2$ | | | |
| Phosphoric Acid | $H_3PO_4$ | $H^+$ | 200 | Mature |
| | Medium power density; Pt catalyst; sensitive to CO | | | |
| Molten Carbonate | $(Li,K)_2CO_3$ | $CO_3^{2-}$ | 650 | Mature? |
| | Low power density; high temperature; Ni catalyst; needs $CO_2$ recycle | | | |
| Solid Oxide | $Zr(Y)O_2$ | $O^{2-}$ | 700-1000 | Immature |
| | Medium-to-high power density; high temperature; accepts CO as a fuel | | | |
| Direct Methanol | $CF(CF_2)_nSO_3^{2-}$ | $H^+$ ($H_2O$, $CH_3OH$) | 90-120 | Immature |
| | Medium power density; low efficiency; Pt content | | | |

# *Examples of Fuel Cell Technology*

**Complete PEMFC system**

**Bare PEMFC stack**

# *Summary*

- **Batteries and fuel cells can be used in the emergency power application. Which technology is used depends on a combination of siting requirements and cost**

- **Acknowledgment**

  **This work was performed under the auspices of the US Department of Energy, FreedomCAR and Vehicle Technologies Program and Hydrogen, Fuel Cells and Infrastructure Technologies Program, under Contract No. W-31-109-Eng-38.**