Advanced Battery Manufacturing

James Miller & Tien Duong
Vehicle Technologies Program
US Department of Energy

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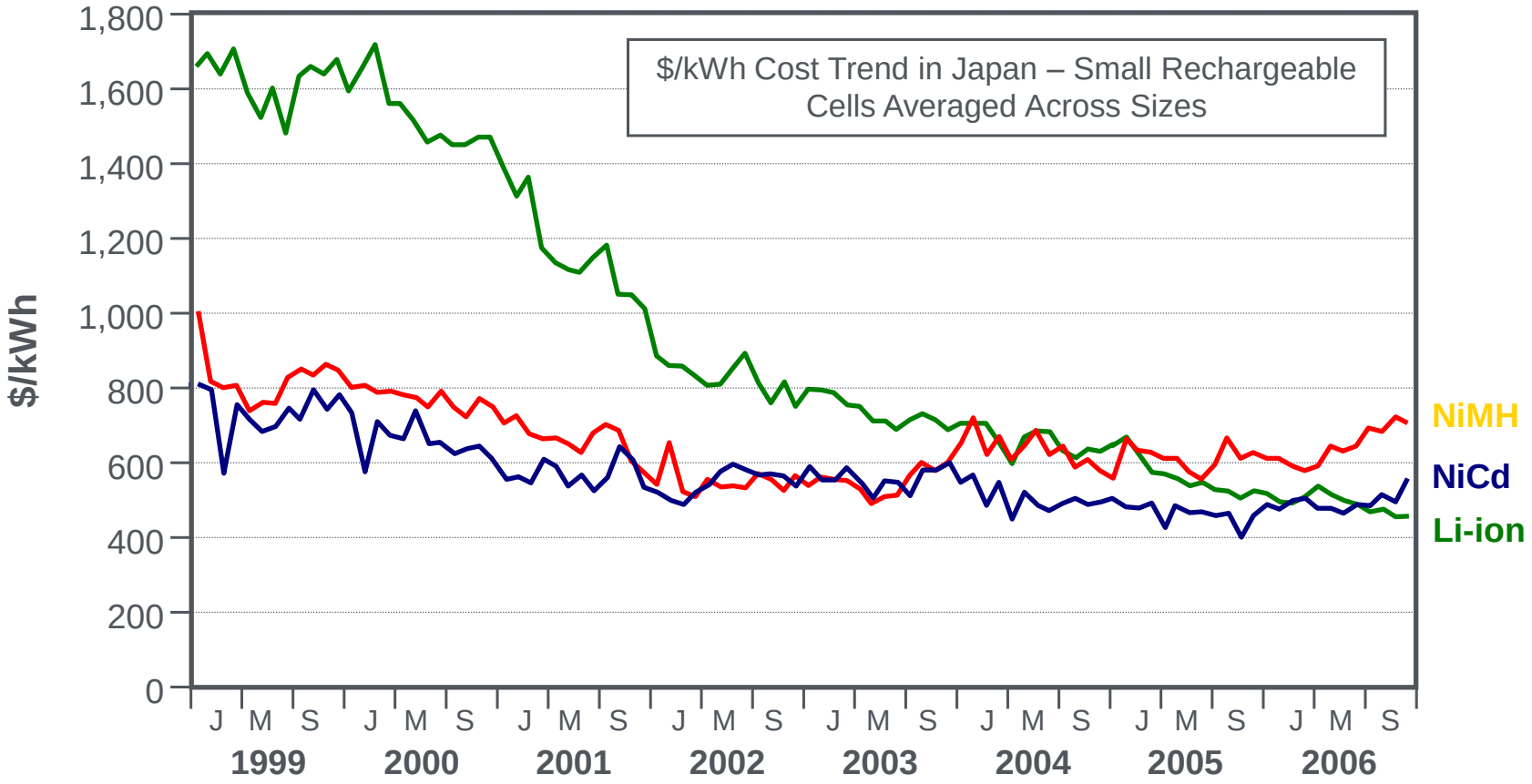
Advanced Battery Landscape

- Lithium batteries represent the most important advance in battery technology in recent years
- Lithium batteries now power a diverse range of devices:
  - consumer electronics (laptop computers, cell phones, etc)
  - cordless tool and appliances
  - medical devices (cardiac pacemakers, defibrillators, pumps, etc)
  - defense and homeland security (army vests, remote sensors, etc)
  - aerospace (Mars exploration rovers, telecommunications, etc)
- The next major (multi-billion dollar) market being targeted is transportation
  - hybrid electric vehicles
  - plug-in hybrid electric vehicles & all-electric vehicles

Cost of lithium-ion batteries for consumer electronics continues to decline



Source: TIAX, based on METI data

US Industry was falling behind

- **Battery manufacturing is dominated by Asian producers**
  - No US company is among the top nine lithium battery manufacturers
    - ***Market share for lithium-ion batteries (2005):***
      Japan (57%), South Korea (17%), China (13%), Others (13%)
    - **data from Japan's Ministry of Economy, Trade, and Industry**
      http://www.meti.go.jp/english/information/downloadfiles/PressRelease/060828VehicleBatteries.pdf

- In the absence of an expanded US R&D effort, and a vastly expanded manufacturing industry with its borders, **the US is vulnerable** in the supply of lithium batteries for strategic (defense and aerospace) and other applications (telecommunications and transportation).

- Further lithium battery R&D, that increases energy storage capacity and reduces battery size, will lead to **new business opportunities and breakthroughs** that could significantly reduce US dependence on foreign oil.

Why major manufacturers of lithium-ion batteries are primarily in Asia?

- **Lower cost of capital (particularly in Japan)**
  - **can tolerate lower return-on-investment**
- **Access to product design opportunities**
  - **significant time and costs associated with establishing relationships with consumer electronics industry**
- **Investment relies more heavily on loans rather than stock sales**
- **Government coordination of research, development, and commercialization**
- **Labor costs are significantly less**
  - **production is largely automated, so less important**

**** from "Factors Affecting U.S. Production. Decisions: Why are There No Volume Lithium-Ion Battery Manufacturers in the US?" NIST/ATP Report, June 2005, www.atp.nist.gov/eao/wp05-01/wp05-01.pdf***

Battery Markets

- Hybrid vehicle battery market: $1.1 billion (2009)
- Current world market for lithium batteries: $6-8 billion
- Projected future market for automotive lithium batteries
  - $1 billion in 2015
  - $8 billion by 2020

Recovery Act Funding

U.S. DEPARTMENT OF ENERGY | Energy Efficiency & Renewable Energy

$1.5 Billion for Battery Manufacturing Facilities for Electric Drive Vehicles

Material Supply	Cell Components	Cell Fabrication	Pack Assembly	Recycling
Lithium Supply Chemetall Foote	Cathode Prod. A123 BASF Toda	Iron Phosphate A123	Iron Phosphate A123	Lithium Ion TOXCO
	Anode Prod. EnerG2 Pyrotek FutureFuel	Nickel Cobalt Metal JCI SAFT EnerDel	Nickel Cobalt Metal JCI SAFT EnerDel	
	Electrolyte Prod. Novolyte Honeywell	Manganese Spinel CPI-LG DOW-Kokam	Manganese Spinel GM DOW-Kokam	
	Separator Prod. Celgard ENTEK/JCI		Advanced Lead Acid Batteries Exide East Penn	
	Other Component H&T Waterbury			
$28 M	$259 M	$735 M	$462 M	$10 M

Lithium-ion battery capacity outlook

	Estimated US Production Capacity (25-kWh batteries)	Estimated World Production Capacity (25-kWh batteries)
2010		172,000
2011	20,000	
2013	200,000	
2015	640,000	1,500,000

Conclusion

- **US retains a leadership position in lithium battery research**
- **Government can strengthen US competitiveness by:**
  - **creating centers of excellence for battery research**
  - **fostering transfer of scientific and lab-scale advances to pilot-scale and commercial practice**
  - **supporting a market for domestic production capacity**
- **Battery technology represents a significant economic and strategic opportunity for the US.**