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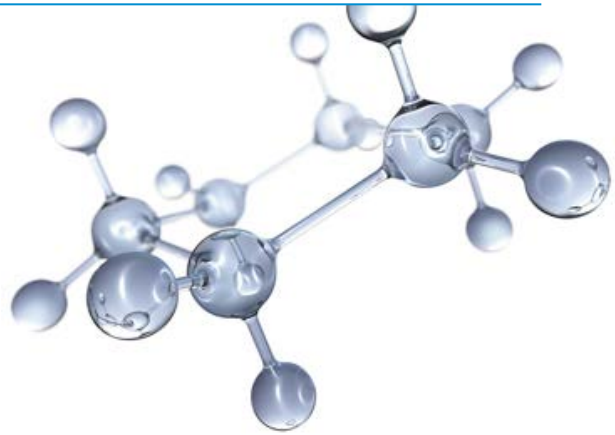
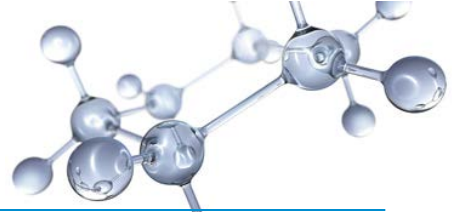
Materials Genome Initiative Grand Challenges and Perspective

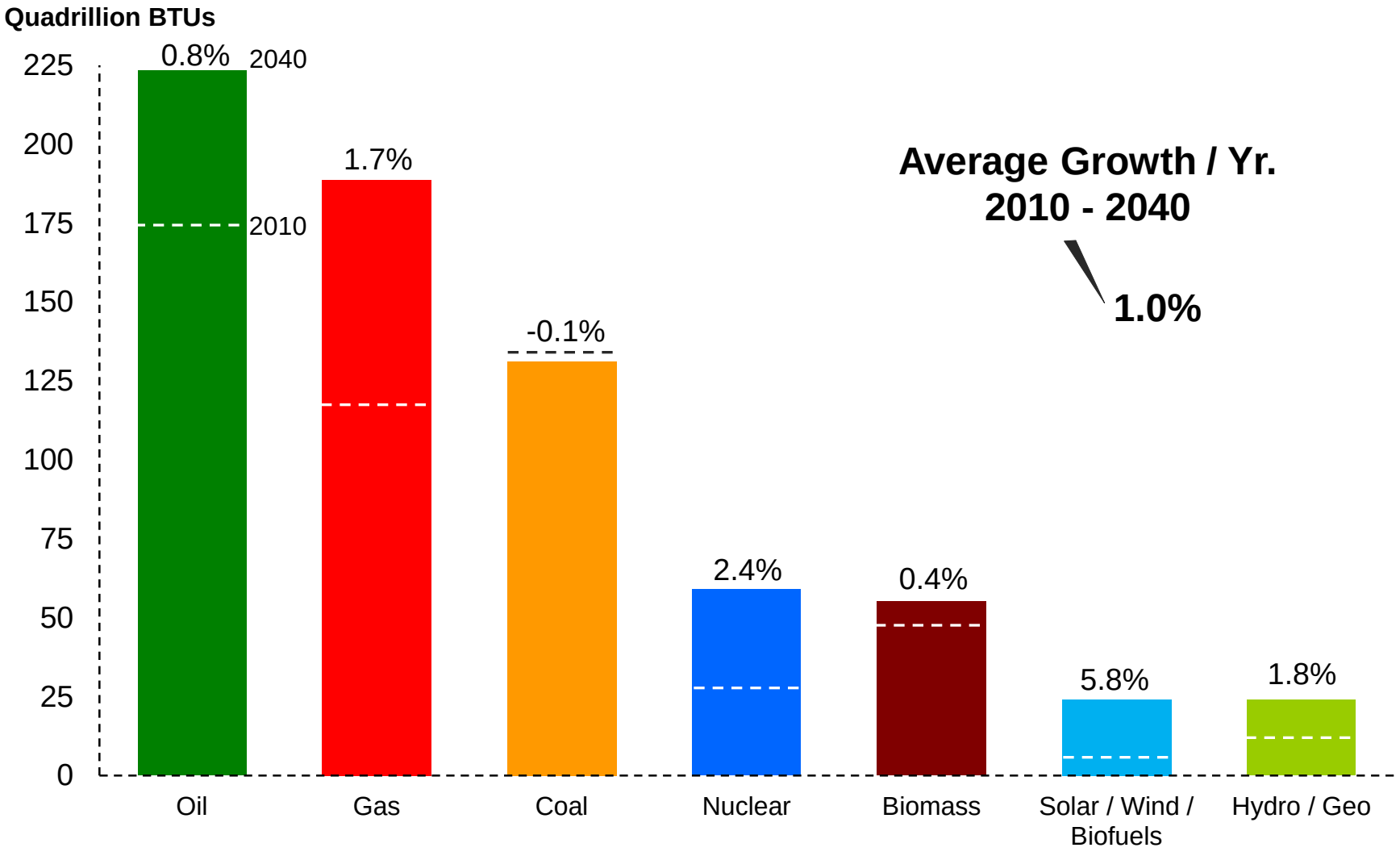


Dr. Hugh Helferty
Manager, Global Chemicals Research

November 19, 2013

Oil and Gas Remain Leading Energy Sources





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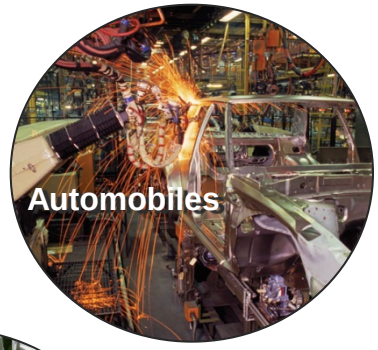
Importance of Materials to ExxonMobil

- Material integrity is critical to protect people and the environment
- Advanced materials are essential to our business
  - Enable operations under a wide range of conditions
  - Enable chemical reactions and separations
- ExxonMobil Chemical produces millions of tons of materials that our customers use to make products



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Materials Challenges

- How to design structural materials to enable performance under increasingly harsh conditions?
- How to enable hydrocarbon separations that are much more energy efficient?
- How to predict and control the properties and performance of polymers and polymer mixtures?

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Observations on Materials Challenges

- A product often incorporates multiple materials that form a system
- The effectiveness of a material depends on its interaction with other materials
- Accelerating the pace of materials-based innovation hinges on understanding interactions as much as speeding up discovery

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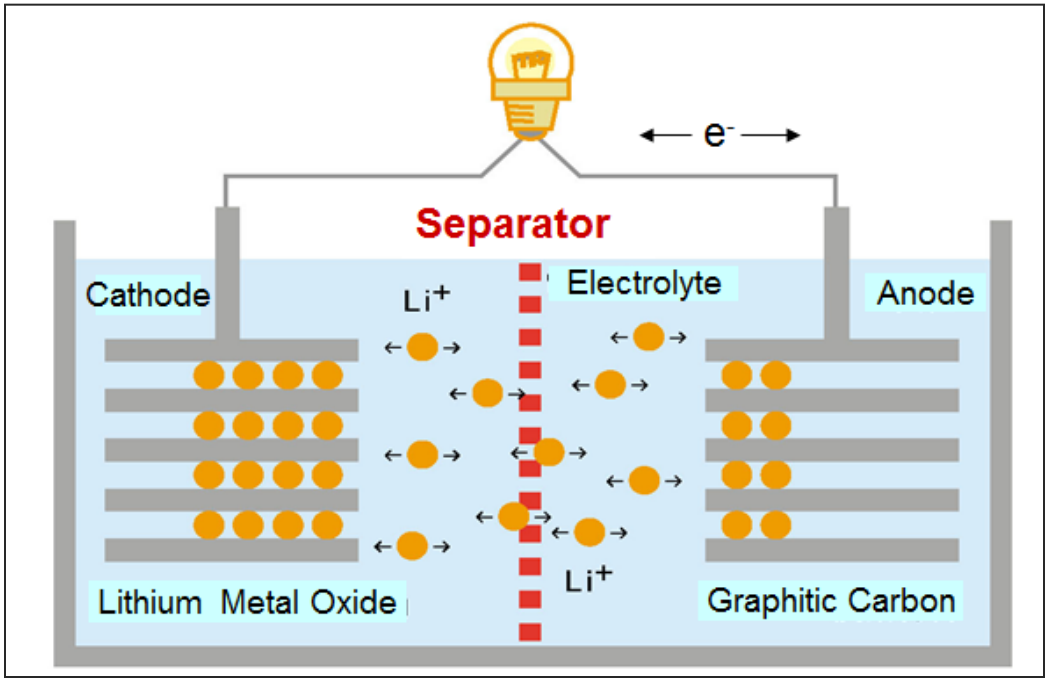
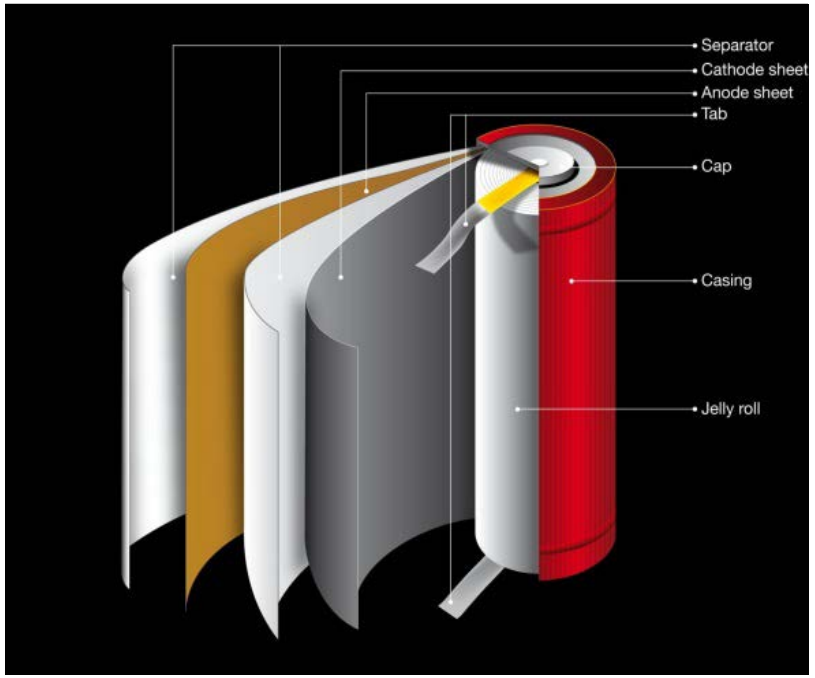
Basic Components in Lithium-Ion Battery





- From lab to commercial product requires many innovations

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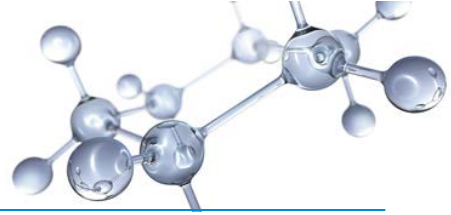
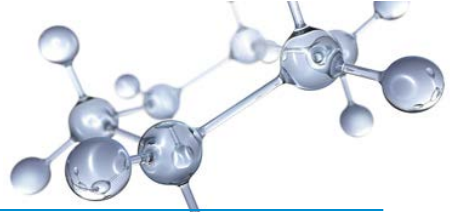
Lithium-Ion Battery Development History



- Li-ion battery proposed — mid-1970's
  - Whittingham, Exxon Corporate Research
- Critical cathode innovation — 1979
  - Goodenough and Mizushima, Oxford U
- Critical anode innovations — 1980, 1985
  - Yazami, Yoshino
- Critical separator innovation — 1991
  - Tonen Chemical (affiliate of Exxon and Mobil)
- First commercial Li-ion battery — 1991
  - Sony
- Li-ion cell production exceeds 1 billion units — 2003

Implications for MGI



- The Materials Innovation Infrastructure needs to be designed in a way that accelerates not just material development but also system (or product) development; material interactions are critical
  - Essential to significantly reduce time-to-market
- Future material scientists and engineers needs to understand not just how to create a material but how materials can be integrated to form a useful system
  - Implications for science/engineering education