GE Materials Usage

- GE uses ~3 Billion lbs of material in our products annually
- For manufacturing companies typically one-half of their Cost of Goods & Services Sold is spent on raw materials, which for GE translates to ~$35 B in 2010
- GE uses at least 70 of the first 83 elements on the periodic table
GE Criticality Diagram

Impact on GE

Supply and Price Risk

Higher

Lower

Proportional to spend

Rare Earth Elements

Area

Impact on GE

Higher

Lower

Proportional to spend

Rare Earth Elements

Area

Supply and Price Risk

Higher

Lower
Material Sustainability Strategy

**Sourcing** ... ensure supply through fixed price contracts, forwards, options, etc.

**Manufacturing efficiency** ... reduced waste, recycled waste, advanced manufacturing (i.e. additive)

**Recycle** ... manufacturing shrinkage and end-of-life products, repair, re-manufacturing

**Material re-design or substitution** ... reduce or eliminate at-risk element, use alternate material

**System substitution** ... use an alternate technology to satisfy a customer’s need

Each solution is unique to the element and its use
GE Example – Rhenium in Superalloys

- Used in turbines: Aviation, Gas, Oil & Gas hot sections
- Rarest of elements: 1 oz Re per 120 Tons of Cu ore
- 2006: prices up 6X, sufficient availability uncertain

**Sourcing** ... developed suppliers and worked with suppliers for better recovery of revert of Re containing materials

**Manufacturing efficiency** ... improved handling of Re waste stream and developed chemical processes to recover Re from this waste

**Recycle** ... developed process to reclaim, clean, and re-use Re containing alloys from end-of-life turbine blades

**Material re-design or substitution** ... developed and certified N515 alloy with ½ as much Re for CFM56 HPT blades and N500 with no Re as CFM56 shrouds
Critical to energy generation, energy efficiency, and healthcare technologies
Example – Rare Earths

**Sourcing** ... working with global mines and separators to broaden sources

**Recycle** ... developing recycling strategies for fluorescent lamp phosphors, including phosphor rejuvenation for end-of-life lamps

**Material re-design or substitution** ... developing alternate phosphor systems to reduce the rare earth content. Using nano processing to reduce rare earth content in permanent magnets

**System substitution** ... LEDs for Lighting
Critical Materials – Industry Summary

• Materials are a critical cog in the manufacturing process

• Critical materials issues can be anticipated

• Tailored and multi-component solutions are required
  • Sourcing
  • Recycling
  • Manufacturing efficiencies
  • Material substitution and R&D
  • System substitution and R&D

• Legislation needs to be comprehensive