Steve Hung

- BS, MS, PhD - Chemical Engineering
- Current responsibilities...
  - Pollution Prevention
  - Energy Efficiency
  - Materials Sustainability

GE Resource Efficiency Program

A team of technologists
General Electric Company (GE)

- Formed in 1892 through merger of Edison General Electric Co. & Thomson-Houston Electric Co.

- Some early Edison & GE innovations & advances:
  - Incandescent lamp
  - Power generation & distribution
  - Jet engines
  - Electric locomotive
  - Electric range
  - X-ray equipment
  - Radio & TV broadcasts
GE’s Industrial Businesses today

- Home & Business Solutions
- Power & Water
- Energy Management
- Oil & Gas
- Healthcare
- Aviation
- Transportation

300,000 employees
100’s of manufacturing sites & service centers
Business strategy driving innovation & growth of profitable environmental solutions

Products & Services with improved...

Environmental performance

Operating performance
GE ecomagination Commitments

Increase investment in R&D for cleaner technologies

Increase revenues from ecomagination products

Improve GE’s own operations.
Reduce: 1. Energy usage
2. Water usage
3. GHG emissions

Raw Materials → Emissions & Wastes

Product

End-of-Life
Examples of some GE ecomagination products

HOME APPLIANCES. Including new Energy Star® models and new hybrid hot water heater.

WIND TURBINES. Over 18,000 installations worldwide.

AIRCRAFT ENGINES. CFM LEAP(TM) aircraft engines will provide significant reductions in noise, CO₂ and NOₓ emissions.

LOCOMOTIVES. Evolution® Series Tier 3 Locomotive is the most fuel efficient locomotive in its class and with lower emissions.

HIGH EFFICIENCY CT and MR - New offering of imaging systems with improved energy efficiency.
Meeting GE’s internal goals
Meeting GE’s internal goals...

Ecomagination

A long journey, but.. WE DID IT!!! :)

- Original goals for 2012 were met

- New goals for 2015 and 2020

<table>
<thead>
<tr>
<th>Category</th>
<th>Goal</th>
<th>Achieved Goal</th>
</tr>
</thead>
<tbody>
<tr>
<td>Energy Usage</td>
<td>32% intensity</td>
<td>Goal was 30%</td>
</tr>
<tr>
<td>GHG Releases</td>
<td>32% absolute</td>
<td>Goal was 1% (would have grown 40%)</td>
</tr>
<tr>
<td>Freshwater Usage</td>
<td>46% absolute</td>
<td>Goal was 20%</td>
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</tbody>
</table>
Example: Energy Reduction

Background

• Reduce energy usage at 100’s of GE manufacturing sites & service centers

Solution

• Provide corporate leadership
• Develop process & tools for sites to identify opportunities themselves

Guiding principles:

1. Boots on the ground!
Example: Greenhouse Gas Reduction

Background

- HFC-134a used to make insulating foam
- Some of it escapes during manufacturing
- HFC-134a is a powerful GHG (GWP = 1300)

Solution

- Convert to alternative gas (cyclopentane) for foam blowing
What else is GE doing?
In addition to ecomagination initiatives… plenty of other activities

Some examples:

- **Raw Materials**
  - Improve sourcing decisions
  - Design for environment

- **Emissions & Wastes**
  - Improve awareness of life cycle considerations

- **Product**
  - Improve product stewardship

- **End-of-Life**
  - End-of-life reuse, recycle, recovery
  - Materials Sustainability

  Internal reuse, recovery
Example: End-of-Life Appliance Recycling

**Background**

- HFC-134a in the foam
- What happens to it at end-of-life?

**Solution**

- Collaborate with end-of-life appliance recycler (ARCA)
- Capture & destroy refrigerants & foam blowing agents in an enclosed system
- Also recycle other materials
Materials Sustainability
Prioritizing GE’s Needs

Impact

- Revenue impacted
- % of world’s use
- Substitutability (specific applications)
- Cost pass-through (specific applications)

Impact score computed using: Data from business units

Supply and Price Risk

<table>
<thead>
<tr>
<th>World reserves</th>
<th>Political factors</th>
<th>Competing uses</th>
</tr>
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<tbody>
<tr>
<td>Co-production</td>
<td>Human factors</td>
<td>Price volatility</td>
</tr>
</tbody>
</table>

Supply risk score computed using: Data from producers & public domain

Methodology references
- Erdmann and Graedel, EST 2011, 45, 7620.
Materials Sustainability

GE responses...

- Sourcing
- Manufacturing efficiency (Reduce use)
- Recycle, Reuse, Recovery
- Material re-design or substitution
- System substitution

Each material and each application will use a unique mix of options
Example: Improve Materials Recovery

**Background**
- High value materials in GE scrap & wastes
- Reclaimers don’t have capability to recover

**Solution**
- GE is developing our own solutions to fill the gap
- And, working to collaborate with external partners to implement
Opportunities across GE

• Research & Development
• Engineering
• Manufacturing
• Service
• New & emerging areas...

Wide variety of skills needed
Thanks

Presentation includes contributions from:
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