Manufacturing Climate Solutions in a Carbon-Constrained World

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This presentation highlights some key findings and the value chain method we employed.

http://www.cggc.duke.edu/environment/climatesolutions/index.php
What does value chain analysis tell us?

• Big picture

• Layers of information

• Issues of strategy

• Key players and leverage

For additional information about value chain analysis, see
Global Value Chains, http://www.globalvaluechains.org/ and
Value Chain Analysis to Identify Lead Firms and Leverage Points,
http://www.cggc.duke.edu/environment/valuechainanalysis/index.php
What is a value chain?
Manufacturing Climate Solutions Series

Technologies analyzed to date:

- Auxiliary Power Units
- High Performance Windows
- LED Lighting
- Concentrated Solar
- Hog Waste Treatment

Forthcoming:

- Heat Pump Water Heaters
- Recycling Industrial Waste Energy
- Carbon Capture and Storage
- Hybrid Delivery Trucks
Example of LED Package with Major Components

- Bond Wire
- Encapsulation
- Chip/Die
- Submount
- Reflector Cup
- Thermal Submount
High Performance Windows

**Raw Materials**
- **Lumber** (U.S., Canada, UK, Mexico)
- **Aluminum** (China, Russia, Canada, U.S.)
- **Fiberglass** (U.S., China)
- **Vinyl** (U.S., China, UK, Canada)
- **Argon** (U.S., Japan)
- **Nickel** (Russia, Canada, Australia, Indonesia)
- **Titanium dioxide**
- **Chromium nitrate** (South Africa, Kazakhstan, China, Russia, U.S.)
- **Steel** (China, Japan, U.S., Russia)
- **Polystyrene foam** (U.S., China, Japan, Hong Kong)
- **Silica** (U.S., Slovenia, Austria, Spain)

**Components**
- **Frames**
  - Sill
  - Sash
  - Stop
  - Stool
- **Gas filling**
- **Low-e, solar control coatings**
- **Insulating spacer**
- **Flat glass panes**
- **Other components**
  - Backer rod
  - Flange
  - Hardware

**GLOBALIZATION**
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High Performance Windows

Materials
- Silica
- Nickel
- Chromium
- Polystyrene foam
- Argon
- Aluminum
- Fiberglass
- Vinyl
- Lumber
- Other materials: krypton, titanium dioxide, silver

Components
- Low-e coatings
- Flat glass
- Spacer
- Gas fills
- Other components: backer rod, flange, hardware

Observers
- Frames
- Top Window Manufacturers
  - Andersen Corp
  - Jeld-Wen, Inc
  - Masonite International, Inc
  - Pella Corp
  - Atrium Windows & Doors
  - Fortune Brands
  - Marvin Windows & Doors
  - MI Windows & Doors
  - Milgard Windows & Doors
  - Ply Gem Industries
  - Weather Shield Windows & Doors/The Peachtree Cos., Inc

End Use
- Big Box Window Retailers
  - Lowe’s
  - Home Depot
  - 84 Lumber
- Window and Door Dealers and Wholesalers
  - Stock Building Supply
  - Renewal by Anderson
  - Detroit Door & Hardware
  - Jefferson Door Company
  - Bee Windows
  - Mathews Brothers
  - Pacific Mutual Door
- Contractors
  - Manufacturer direct sales

R&D

Manufacturers: Many component and window manufacturers employ research engineers.
LED Lighting Value Chain

Materials
- Sapphire: Synthetic sapphire produced in NC and FL
- Gallium: GaN primarily used for blue LEDs (China, Germany, Japan, and Ukraine). Two U.S. companies recover Ga from scrap: Eagle-Picher (OK) and Recapture Metals (UT).
- Indium
- Silicon carbide (SiC)
- Aluminum: Alcoa, Advanced Alloys
- Epoxy Resin: Abacus LED (UK), CRL (U.S.), OSRAM Opto (Germany)
- Copper: (Chile, U.S., Canada, Zaire, Zambia, Poland)
- Glass
- Plastic

Components
- Chip:
  - Cree, Inc. (U.S.)
  - Nichia (Japan)
  - Toyoda Gosei (Japan)
  - Epistar Corp (Taiwan)
  - SemiLEDs (Asia)
  - Philips Lumileds (U.S., Netherlands)
  - OSRAM Opto (Germany)
- Bond wire
- Connectors
- Diode
- Driver
- Epoxy Resin Encapsulant
  - Abacus LED (UK)
  - Cree, Inc. (U.S.)
  - OSRAM Opto (Germany)
- Optics (Lens): Dow Corning
- Printed circuit board (PCB)
- Reflector cup
- Terminal pins
- Wafer: Cree, Inc. (U.S.)

Finished Product
- Product Design:
  - Equally split between U.S., Europe & Asian regions
  - Cree, Inc. (U.S.)
  - Philips Lumileds & Color Kinetics (U.S.)
- Led Lamps and Luminaires:
  - Includes packaging
  - Primarily carried out in China (Shenzhen, Guangdong provinces)
  - Nichia (Japan): have patent license agreement with Cree for white light LEDs
  - OSRAM Opto (Germany)
- Fixtures:
  - Genlyte Thomas (Philips)
  - LED Lighting Fixtures (Cree)
- Marketing:
  - Typically U.S. & European companies
  - Philips Lumileds & Color Kinetics (U.S.)
  - Cree (U.S.) via Arrow Electronics
  - World Peace Industrial

Distribution
- Internet
- Direct to Builders
  - Cree: International House of Pancakes (IHOP), hotels, corporate campuses, universities, GE Lumination, United Supermarkets, Wal-Mart
- Big Box Retail Stores
  - Wal-Mart
  - Lowe’s
  - Home Depot
- Government
  - Cree LED City Programs: Raleigh, NC, Ann Arbor, MI, Toronto

End Use
- Residential
- Commercial
- Outdoor
- Industrial

NAICS Code 334413
Globalization
Governance & Competitiveness
Insight into the Geography of Activity

Global LED Lighting Industry

US LED Suppliers
How many jobs?
Windows Value Chain

**Materials**
- Silica: U.S. Silica Co., Wedron Silica Co. (IL), Shore Mountains Silica (TN)
- Nickel: Russia, Canada, Australia, Indonesia
- Chromium: Elementis Chromium (TX and NC)
- Polystyrene foam: Owens Corning (OH), Carpenter Co. (VA), Foamex Intl. (PA)
- Polyvinyl: Dow Chemical Co. (MI), E.I. du Pont (DE)
- Lumber: Weyerhaeuser Co. (WA), Jeld-Wen (OR), Pella Co. (IA)
- Other materials: Krypton, titanium dioxide, silver
- Argon: Praxair (CT), Air Products and Chemicals (PA)
- Aluminum: Alcoa Inc., A.M. Castle
- Fiberglass: U.S., China

**Components**
- Low-e coatings:
  - Seki-Sui-Lec: (Japan)
  - Emirates Glass: (Dubai)
- Flat glass:
  - Corning, Inc: (NY) 313 employees
  - Cardinal Insulating Glass: (ND) 280 employees
- Spacer:
  - Edgetech I.G.: (OH) 50 employees
  - GED Integrated Solutions: (OH) 110 employees
  - TruSeal Technologies: (OH) 40 employees
- Gas fills:
  - Praxair: (CT) 27,992 employees
  - Air Liquide: France
  - Air Products and Chemicals: (PA) 21,500 employees
  - Airgas: (PA) 14,500 employees
- Other components:
  - Backer rod, Flange

**Finished Product**
- Top window manufacturers:
  - Andersen: (MN) 14,000 employees, $1 billion+ sales
  - Jeld-Wen: (OR) 25,000 employees, $1 billion+ sales
  - Masonite Int’l: (Canada) 14,200 employees, $1 billion+ sales
  - Pella: (IA) 10,600 employees, $1 billion+ sales
  - Atrium Windows and Doors: (TX) 6,000 employees
  - Fortune Brands: (IL) 4,000 employees
  - Marvin Windows & Doors: (MN) 5,000 employees
  - MI Windows & Doors: (PA) 3,500 employees
  - Milgard Windows & Doors: (WA) 3,500 employees
  - Ply Gem Industries: (MO) 7,000 employees
  - Weather Shield/ Peachtree: (WI) 4,500 employees

**End Use**
- Leading U.S. window retailers:
  - Lowe's: (NC) 160,000 employees, $48.3 billion sales
  - Home Depot: (GA) 331,000 employees, $44.3 billion sales
  - 84 Lumber: (PA) 9,500 employees, $3.9 billion sales

**Window and door dealers and wholesalers**
- Stock Building Supply: (NC) 5,000 employees, $2.7 billion sales
- Renewal by Anderson: (MN)
- Detroit Door & Hardware: (MI) 130 employees, $30.2 million sales
- Jefferson Door Company: (LA) 80 employees, $67.8 million sales
- Bee Windows: (IN) 250 employees, $64.5 million sales
- Mathews Brothers: (ME) 100 employees, $20.1 million sales
- Pacific Mutual Door: (MO) 30 employees, $12.9 million sales

**Contractors**
- Manufacturer direct sales

**R&D**
- Manufacturers: Many component and window manufacturers employ research engineers.
In a carbon-constrained world, what do green jobs mean for *U.S. competitiveness*?
U.S. Competitiveness

Figure 4-1. Concentrating Solar Technologies

- Trough System
- Tower System
- Dish System
- Linear Fresnel System
“We chose Cree Xlamp LEDs because they provide industry-leading performance and the provide the reliability and design flexibility needed for this highly visual project.”

--XiGuang Fu, executive director
Grandar Landscape Lighting and Technology Group
Innovation is Crucial

“Will U.S. technology leaders be able to bring costs down before the lower-end Asian manufacturers can bring performance up?”

Morgan Pattison
Technology Consultant
DOE Solid State Lighting Research Program
Truly Innovative Companies

• Growing an industry, not just a firm

• “Think tank” department

• Proprietary AND open source
Waste Heat to Power

Exhaust heat (currently discarded) → Clean Electricity (no added fuel needed) → Factory → Grid
Which is cleaner?

...electricity produced by recycling waste energy

or

electricity produced by solar panels?
“Business Case Studies: Climate Solutions and Job Creation”

WS 45
9:45-11:00AM
Friday, February 6th