

Environmentally Friendly SCs



Outline

- ◆ Sustainability
- ◆ Environmentally Conscious SCM = ECSCM
 - Operations
 - Product Design
 - Sourcing
- ◆ Reverse Logistics
- ◆ Directives and Standards

Sustainability vs. Environmental Impact

- ◆ **Does your company define sustainability?** (sample size 138 respondents)
 - 67% Yes among Large companies, >\$1000 M annual sales
 - 47% Yes among Medium companies, \$100 M < • < \$1000 M annual sales
 - 33% Yes among Small companies, <\$100 M annual sales
- ◆ **What do companies include within sustainability?** (ss 62 respondents)
 - 84% Environmental Impact
 - 76% Social Responsibility (child labor, inhumane working conditions)
 - 69% Business Process Improvement
 - 65% Health & Safety
 - 53% Ethics
- ◆ **Conclusion:** Companies often equate sustainability to environmental impact.
- ◆ Above questions come from “*Environmental Sustainability Benchmark Study: Leaders Prepare for the “Greening” Supply Chain*” by J. Blaeser. Published by American Shipper www.americanshipper.com in Feb 2011. This document is referred to as *Sustainability Survey* in the remainder. Respondents were about 200 shippers and third party logistics providers. 36% in 3PL; 23% in Retail/Wholesale; 29 % in Manufacturing, and so on.

Compete on Environment

- ◆ **Environmental excellence** for competition, in addition to price, quality, delivery time.
 - Environmental excellence important for consumers
 - » Consider the TV ads dealing with environment
 - » In surveys by DYG Inc. (www.dyg.com) made in 2009, the proportion of respondents who say they have **shopped for products for "social, political or environmental reasons" rose by 10 percentage points, to 51%**, over the past year. Although DYG's president, Madelyn Hochstein, is dubious that many people are actually shopping for such lofty reasons, "consumers are telling us this is the way they want to be seen," she said.

By L. Bannon and B. Davis. "Spendthrift to Penny Pincher: A Vision of the New Consumer", WSJ Dec 18, 2009.
 - **3 Bottomlines: Profit, People, Planet.**
 - » **Tradeoff between environmental responsibility and traditional metrics**
 - ◆ In the absence of innovation, reducing carbon emissions may mean reducing production
- ◆ Pollution is a waste. Avoid it to increase profits.
 - **Lean** manufacturing is **Green** manufacturing.
 - » Nestlé draws less than 1.8 liters of water per dollar of sales in 2009. The same number was 5 liters/\$ in 1999.

P. Brabeck-Letmathe, Nestlé Chairman, McKinsey Quarterly Dec 2009
 - **Poor decisions lead to waste**
 - » Excessive leftover inventory; Inventory spoilage; Low quality

1. Internal Operations

- ◆ Environmentally conscious manufacturing
 - Sony’s “**care for the environment**” program
 - » Reduced material use, Energy savings, Shorter product disassembly times, Increased recyclability.
 - » Reduced use of harmful substances: Keep a database of all environmentally sensitive materials used in production
- ◆ Environmentally conscious transportation
 - Nestlé’s **efficient supply chain** explained by chairman P. Brabeck-Letmathe in McKinsey Quarterly Dec 2009:
 - » In a traditional milk supply chain—with open, uncooled containers from farm to consumer, on oxcarts or bikes — **losses of milk are on the order of 16-27%**. When Nestlé collects milk directly from farmers and uses refrigerated trucks to transport it, these losses go down to less than 0.6%. Based on the total amount of milk Nestlé purchases directly each year in countries such as Pakistan, India, and China (that is, in relatively difficult climatic conditions) and further on the average water requirements for producing milk on farms, this reduction in waste means saving $815 \cdot 10^6$ - $1,375 \cdot 10^6$ m³ water per year. ... the positive impact of our efficient supply chain for milk happens to be greatest in countries where the water situation is most dire.

1. Internal Operations

- ◆ Accounting and Goal setting for the environment
 - Measuring the benefit of environmentally sound management
 - » ECSCM Metrics: Energy savings; Carbon footprint
 - **Herman Miller**, a furniture manufacturer, monitors
 - » gallons of oil used,
 - » number of trees cut,
 - » wasted fabric, foam, leather, paper and polyvinyl film.
 - A Korean consumer products company, received \$30M fine for non-compliance, is implementing an environmental program with quantitative goals

ECSCM

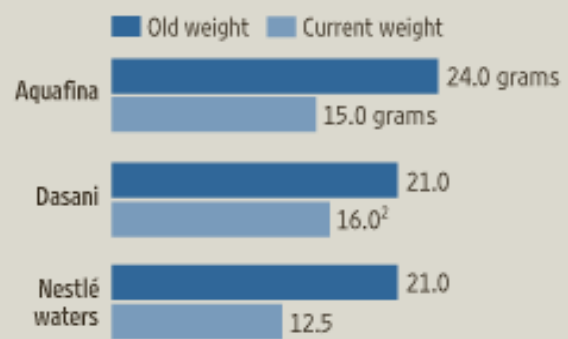
2. Product Design

- ◆ A high-end furniture manufacturer worked with its paint supplier to eliminate **solvent-based painting**. They developed **water-based and powder-based paints**, which requires no solvents for cleanup. 3M also adapted **water based coatings**.
- ◆ **Lighter PET** (polyethylene terephthalate) **bottles** used by water bottlers: Aquafina, Dasani and Nestle.

Lightening Up

Beverage makers are shrinking the weight of their polyethylene terephthalate (PET) water bottles, but the recycling rate of PET bottles and jars has slowed.

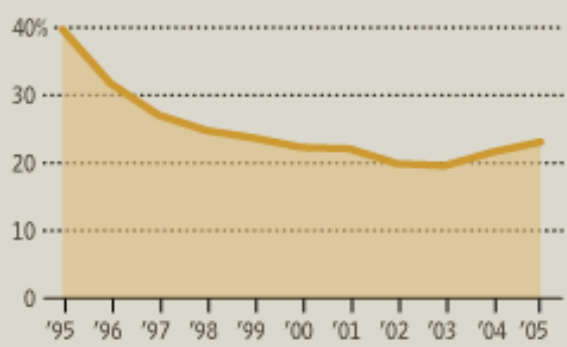
Weight of select U.S. PET water bottles¹



¹For half-liter bottles ²Reducing to 14.8 grams by May 2008

Sources: the companies (weights); The National Association for PET Container Resources (recycling rate)

U.S. PET container recycling rates



Bottled Up

Only 11 states have deposit laws to encourage consumers to recycle beverage containers. Such laws are drawing increasing attention as public concern about waste and the environment mounts.



- ◆ UTD Business idea competition in 2007: MBA students Sriram Jayaram and Ritesh Shah created “**Hara Bhara**” environmentally friendly tableware made of leaves. Hara Bhara means “Go Green” in Hindi.

ECSCM

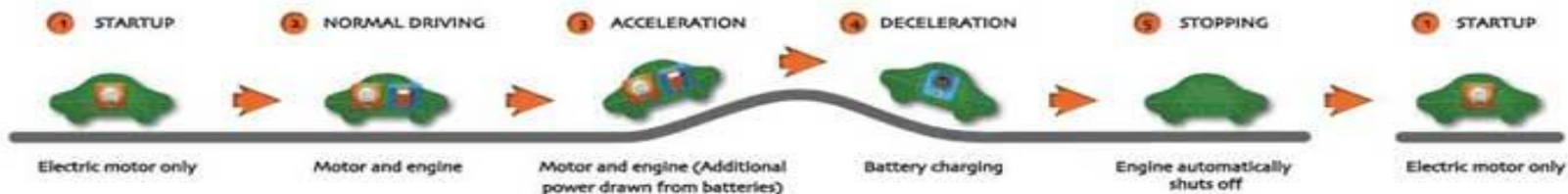
2. Product Design

- ◆ **Woven Shoes.** Knit the top of the shoe from a several **threads** of different colors.



Old method used cutting and stitching pieces of textiles, plastics and leather. This led to leftover textiles, plastics and leather pieces. The new method does not have such leftovers. The manufacturer claims 6mm of thread waste per shoe. Shoe is also lighter.

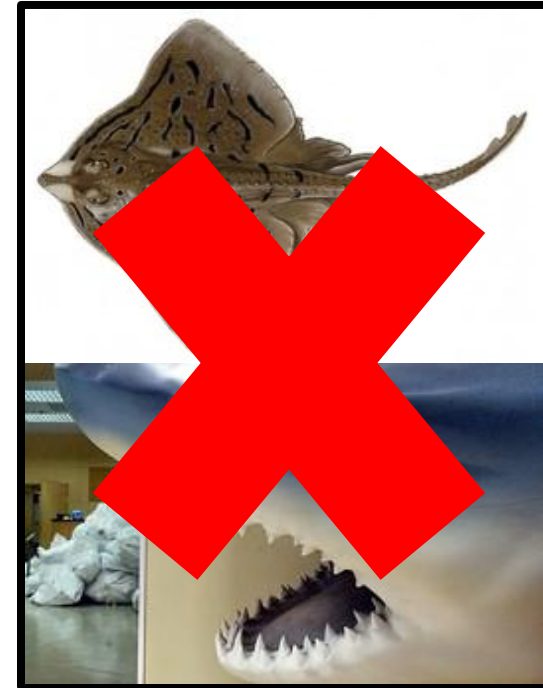
- ◆ **Electric/gas powered cars.** **Hybrids** charge the battery with kinetic energy.



ECSCM

3. Sourcing

- ◆ Examine **environmentally sensitive components**
- ◆ List components / suppliers
 - Whole Foods stops selling some fishes (gray sole and **skate**) and restricts others (Atlantic code if caught with trawlers)
 - Cathay Pacific stops carrying unsustainably sourced **shark** and related products (e.g., shark fin used in soups).
 - Environmental record, previous fines, databases; Towards a “**green score**” for each company like credit score for individuals.
 - » Chrysler, Quad Graphics, Baxter and AT&T have a database of “green” measures for their major suppliers
- ◆ Integrate “green” measures into strategies?
 - **Transportation of hazardous materials** (gasses, explosives)
 - » Away from public places, as fast as possible
 - » Haz(ardous) Mat(erials) transportation received big attention after 9/11. Dow corporation realized that environmental hazards happen not in manufacture but in transportation. It spent over \$800 M to educate drivers about emergencies.
 - **Price of resources**
 - » **Air**: Locally scarce resource. What is the cost **\$\$** of reversing a typical burning reaction?
 From forward $\text{CH}_4 + 2\text{O}_2 \rightarrow \text{CO}_2 + 2\text{H}_2\text{O} + \text{$$}$ to reverse $\text{CO}_2 + 2\text{H}_2\text{O} + \text{$$} \rightarrow \text{CH}_4 + 2\text{O}_2$
 - » **Water**: Regionally scarce but subsidized for farmers. What is the cost of replenishing water?

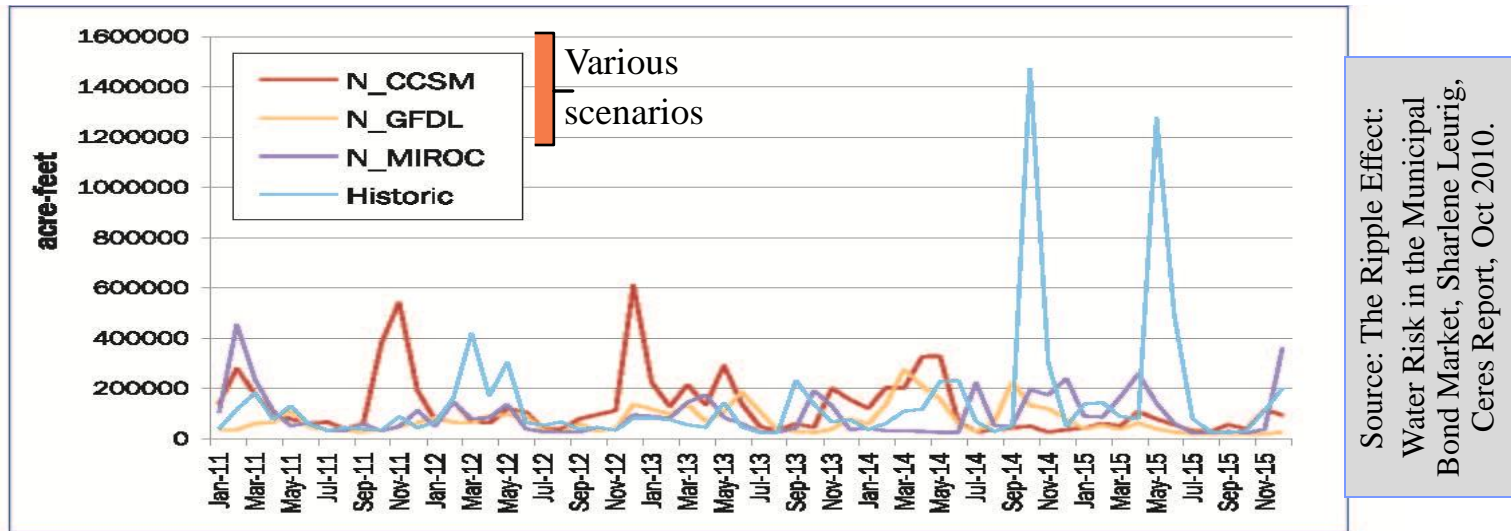


3. Sourcing. Water as a Resource

- ◆ Public utilities deliver more than 80% of USA's water to residential / industrial consumers and issue billions of dollars' worth of bonds to fund infrastructure.
- ◆ Few participants in the bond market (investors, bond rating agencies, utilities) are accounting for growing water scarcity, legal conflicts and other threats.
- ◆ How much does the water cost? 1000 gallons cost \$2 in Plano.
http://plano.gov/Departments/CUS/General_Information/Pages/water_sewer_rates.aspx. The same amount costs \$2.88 in Las Vegas; \$5.28 in Atlanta; \$7.60 in Seattle. Atlanta has 10 times more rainfall than Las Vegas and it rains everyday in Seattle. The cost of water does not reflect its scarcity.
- ◆ States are fighting for water rights.
 - Colorado River Basin
 - Apalachicola-Chattahoochee-Flint (ACF) River Basin
 - Red River Basin
- ◆ Risks: Amount of water and Quality of water.
- ◆ Utilities do not account for risks properly when issuing bonds!

Case in Point: Dallas

- ◆ The City of Dallas delivers water to more than 2.5 M in around two-dozen cities. Major industrial users include Texas Instruments and UT Southwestern Medical Center.
- ◆ The system relies exclusively on surface water. It has six active reservoirs (lakes) and an optional one supplied by three rivers (triple-sourcing):
 - Trinity river supplies 54% of the water to Ray Roberts, Lewisville, Grapevine, Ray Hubbard;



Source: The Ripple Effect: Water Risk in the Municipal Bond Market, Sharlene Leurig, Ceres Report, Oct 2010.

- Sabine river supplies 46% of the need to Tawakoni and Fork. The city holds water rights to a 7th reservoir Lake Palestine, supplied by Upper Neches River.
- ◆ Risk factors: Population up to 3 M in 2030; One of the highest per capita usage in USA.
- ◆ Dallas, in need of more, is in a court suit against Oklahoma Water Resources Board to buy Red River water. After a favorable outcome, Dallas needs to invest \$189 M into infrastructure to bring the water. Moody’s credit rating of Dallas Aa1 on June 7, 2010.
- ◆ With strong financials, ample storage, and competitive water rights, the largest challenge:
 - building the **will to achieve conservation gains** that can offset the need for supply expansion.

Another Case in Point: Forth Worth (Tarrant County)

- ◆ The Tarrant Regional Water District delivers water to more than 1.8 M in around 40 municipalities. Major industrial user is Brazos Electric Power Cooperative.
- ◆ The Tarrant water system relies exclusively on surface water. It has five active reservoirs (lakes). All supplied by a single river (single-sourcing).
 - Trinity river supplies 100% of the water need to Bridgeport, Eagle-Mountain, Benbrook, Cedar Creek, Richland-Chambers.
- ◆ Single sourcing implies higher scarcity score than Dallas.
- ◆ Tarrant per capita water usage is 30% less than that of Dallas.
- ◆ Tarrant (along with Dallas) wants to buy more resources and is in a court suit against Oklahoma Water Resources Board to buy Red River water. After a favorable outcome, Tarrant needs to invest \$ 441 M into infrastructure to bring the water. Moody's credit rating of Tarrant Aa1 on May 7, 2010.

3. Sourcing. Forests as Resource

◆ Integrate measures into strategy?

- Herman Miller works only with suppliers who have forest sustainment programs
 - » Forests are divided into lots. Lots are cut cyclically. Cycle may repeat every 50 years: the same lot is cut once in 50 years.

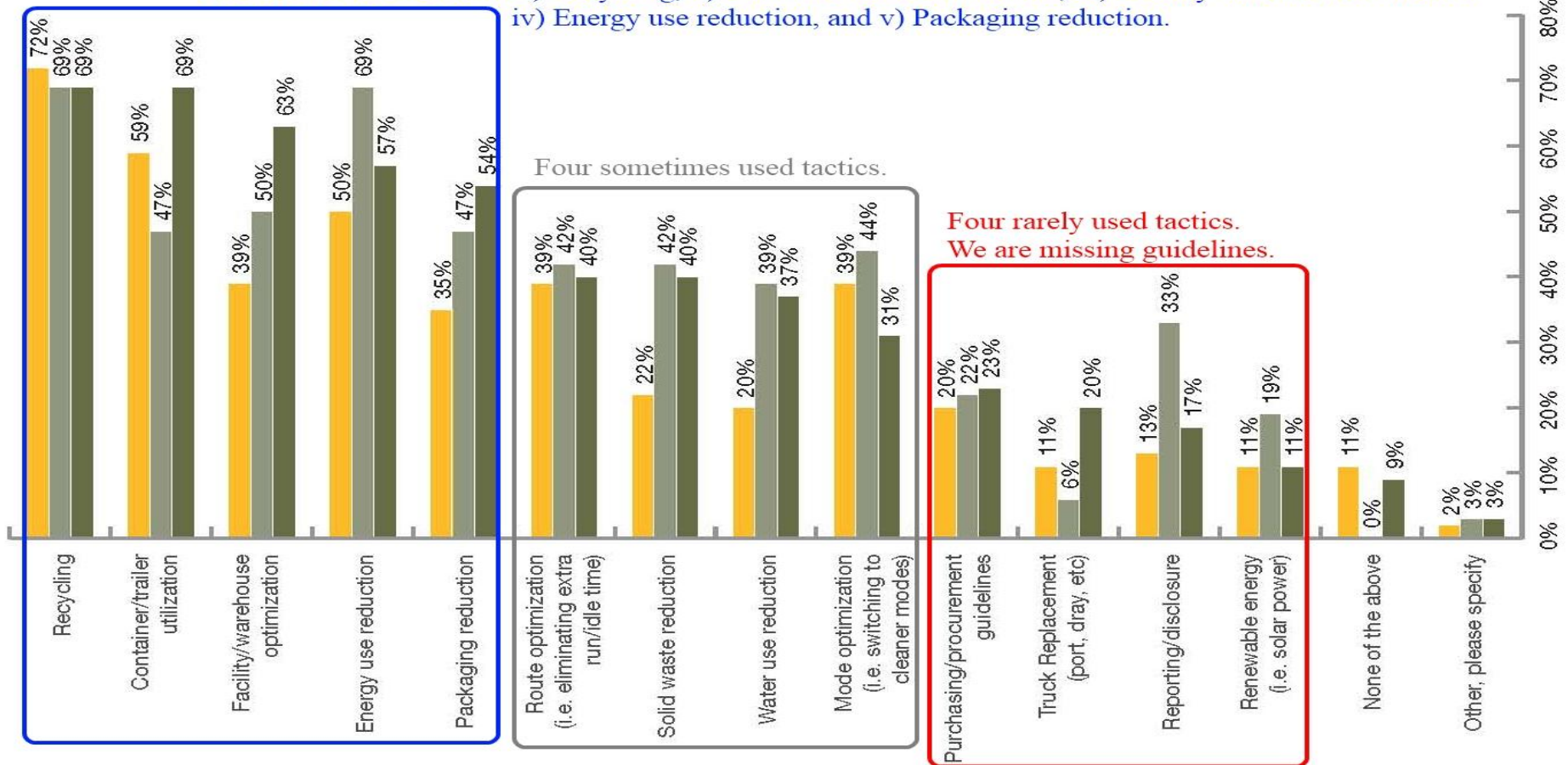


- ◆ Continue to monitor suppliers

Green Tactics



Green tactics employed by 136 respondents of AmericanShipper Sustainability Survey in 2011.
 Five often used tactics are i) Recycling, ii) Container/trailer utilization, iii) Facility/warehouse utilization
 iv) Energy use reduction, and v) Packaging reduction.



Reverse Logistics

Supply Chains are becoming Supply Cycles

- ◆ Instead of selling goods **rent/lease** them. When the rented items are returned, they may need refurbishing so send them to upstream supply chain (reverse logistics).
- ◆ At the end of the lease term, the manufacturer is responsible to **collect goods**
 - » Investigated by car manufacturers / tire manufacturers
 - ◆ How many tires are left to decompose in nature in the US every year?
 - » European companies accept used packaging at the store
- ◆ **Inspection** of incoming used products is a challenge
- ◆ This inspection also provides **useful information**
- ◆ Manufacturer can easily **recycle** used goods
- ◆ Recycling is a profitable business, one with **minimum material costs**

Closed-loop Supply Chains

Goods are brought back from consumers to suppliers

- ◆ Closed-loop supply chains as a result of reverse logistics
 - 1: **Technical remanufacturing**. How to best remanufacture/reuse returned items, with little regard to how they come back or where they go after remanufacturing.
 - 2: **Valuing reverse logistics**. How items coming back to a supplier can create value for that supplier. How to address the front end acquisition of items.
 - 3: **Coordinating decisions**. Marrying the forward supply chain with the reverse supply chain.
 - 4: **Dynamic decisions over the lifecycle of products**. One aspect of this is the need to spend money to make money. Consider a "recycled" computer: one that is only a few weeks old is much more valuable than one that is months old. Investments to increase the speed of the reverse supply chain.
 - 5: The final phase of research, which should have been the first one, is: **Is there a market?**

- ◆ How can these insights be made more popular in application.
 - Accounting: how to value the returns
 - Marketing: how to handle cannibalism between original and remanufactured products?

ISO 14000, WEEE, RoHS Standards and Directives

- ◆ ISO 14000 - International standards for assessing a firm's environmental performance
- ◆ According to ISO 14000 **companies can be held accountable for their waste**
- ◆ Standards in three major areas
 - Management systems: Systems development and integration of environmental responsibilities into planning
 - Operations: Consumption of natural resources and energy
 - Environmental systems: Measuring, assessing and managing emissions, effluents, and other waste
- ◆ The **Waste Electrical and Electronic Equipment (WEEE)** is a EU directive on recycling regulations became effective in Aug 2005.
- ◆ **Restriction of Hazardous Substances (RoHS)** is another legislation that started on July 1, 2006. It limits the amount of several elements that can be used in products. Some examples of hazardous elements are lead, mercury, cadmium.



Carbon Footprints of Milk

- ◆ To measure the environmental impact of a product, use carbon footprint.
- ◆ Add up the carbon emissions made during operations (source, produce, transport, store) to deliver a product to consumers.
- ◆ Divide the operations into categories. Consider milk.
 - Growing **crops** for cows: Due to fertilizers and tractor use to grow the plants.
 - **Farming**: Cows' eating, burping, flatulence, manure at the farm, fuel and electricity used by the farm. Bovine burping is the biggest contributor of to the total carbon print of the milk, about 1/3 of the total.
 - **Processing**: Taking the milk to processing plant, pasteurization, energy used at the plant.
 - **Packaging**: Making the plastic jugs or cartoon boxes.
 - **Transportation**: Taking the milk to stores.
 - **Retailing**: Electricity to refrigerate the milk in stores.
- ◆ Wal-Mart in USA and Tesco in UK are working on measuring milk footprints.
- ◆ For updates, check Dairy Business Innovation Center at dbicusa.org and ISO at iso.org.

Milk Footprint		For 1 kg
Operations	Percentage	of Milk
Crops	20.7%	269 gr
Farm	58.9%	766 gr
Process	7.1%	92 gr
Package	6.8%	88 gr
Transport	2.9%	38 gr
Retail	3.6%	47 gr

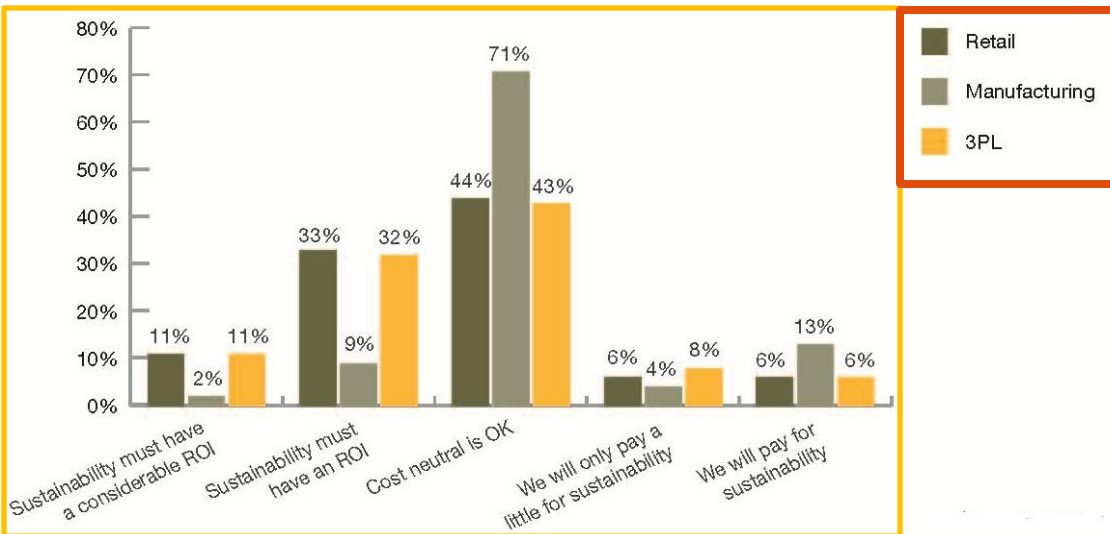
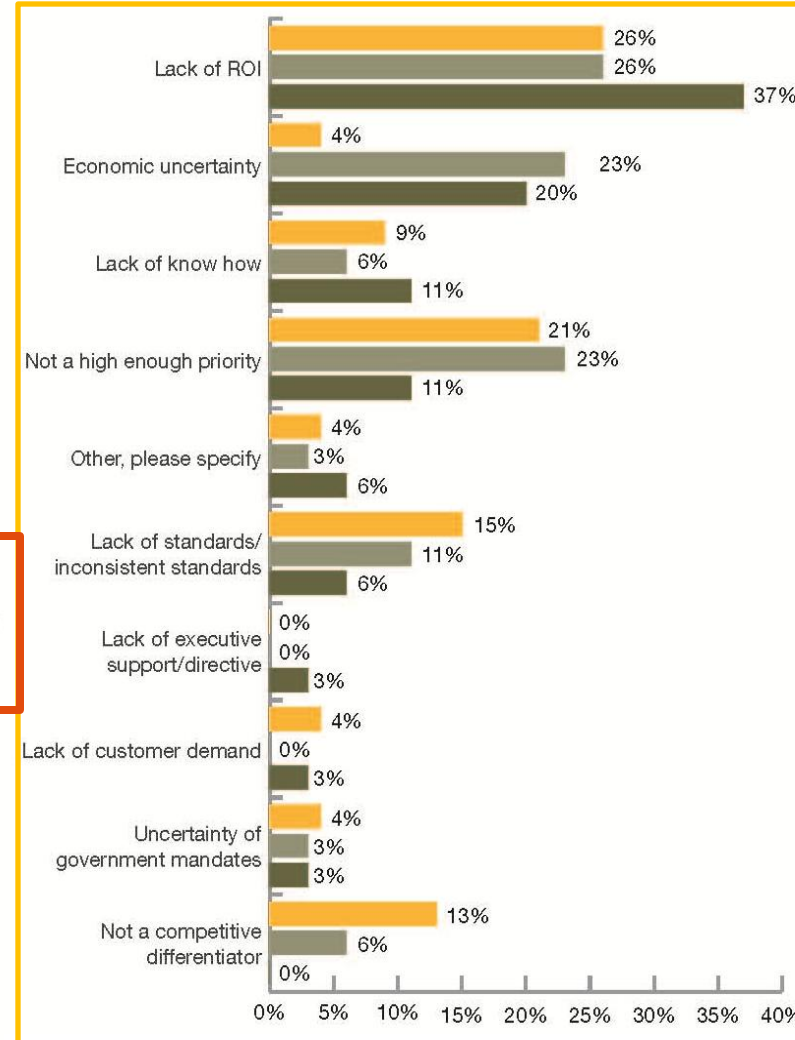
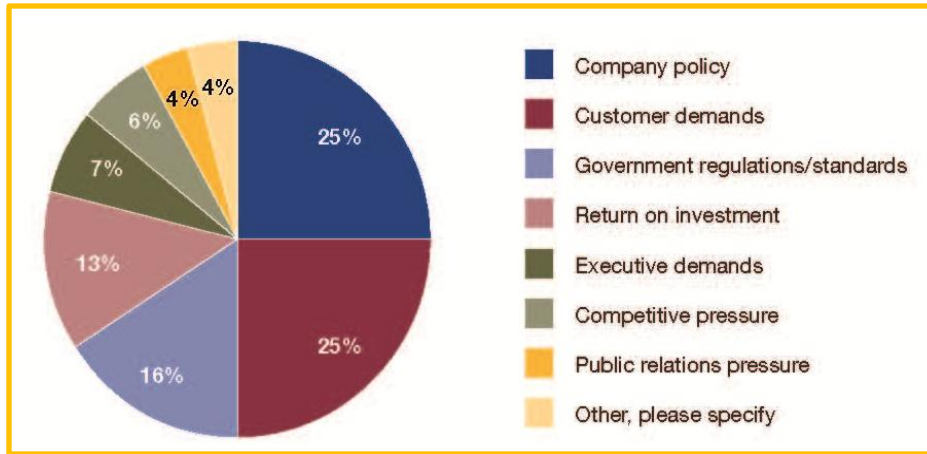
Carbon Footprints of iPhone

- ◆ Carbon footprints for iPhone over its lifetime (about 2 years)

iPhone Footprint		For 1
Operations	Percentage	iPhone
Production	45%	24.75 kg
Transportation	5%	2.75 kg
Customer use	49%	26.95 kg
Recycling	1%	0.55 kg

- ◆ Besides, Apple claims
 - ◆ No **arsenic** in glass; No **brominated flame retardant**;
 - ◆ No **PVC**; No **mercury** in LCD display
 - ◆ Packaging material made from **post-consumer recycled fiberboard and bio-based materials**

Drivers, ROI and Obstacles for Sustainability Adoption



Summary

◆ Environmentally Conscious SCM = ECSCM

- Operations
- Product Design
- Sourcing

◆ Reverse Logistics

◆ Directives and Standards

- ISO
- WEEE
- RoHS
- Carbon Footprint

How committed is your industry?



"Our industry is committed to the environment.
All our lobbyists are 100% recycled congressmen."

Aside from High School Chemistry: Volume of 1300 gram Carbon Dioxide

- ◆ We found out that 1000 gram milk creates 1300 gram Carbon Dioxide.
- ◆ 1 mole of gas contains 6.0221×10^{23} molecules,
This number is known as Avogadro's number.
- ◆ 1 mole of Carbon Dioxide weighs 44 grams
 - 1 mole of Carbon weighs 12 grams
 - 1 mole of oxygen gas (two oxygen atoms) weighs 32 grams
- ◆ 1300 grams of Carbon Dioxide have $29.54 = 1300/44$ moles
- ◆ Recall Boyle's ideal gas law: $PV = nRT$
 - P: pressure in terms of atmosphere
 - V: Volume in terms of liters
 - n: Number of moles
 - R: Universal gas constant, 0.08205 in terms of (liter*atmosphere)/(moles*Kelvin)
 - T: Temperature in terms of Kelvin. 0 Celsius is 273 Kelvin. Add 273 to convert Celsius to Kelvin.
- ◆ We solve for the volume by using the Boyle's law:

$$V = nRT/P = (29.54)(0.08205)(273)/1 = 661.7 \text{ liters}$$
- ◆ 1300 gram Carbon Dioxide fills a volume of 661.7 liters under 1 atmosphere pressure and 0 Celsius.
- ◆ 661.7 liters equal to 0.6617 cubic meter: Think of a cube whose sides are 0.87 meters.

ECSCM 2. Product Design

Cost of owning a Hybrid

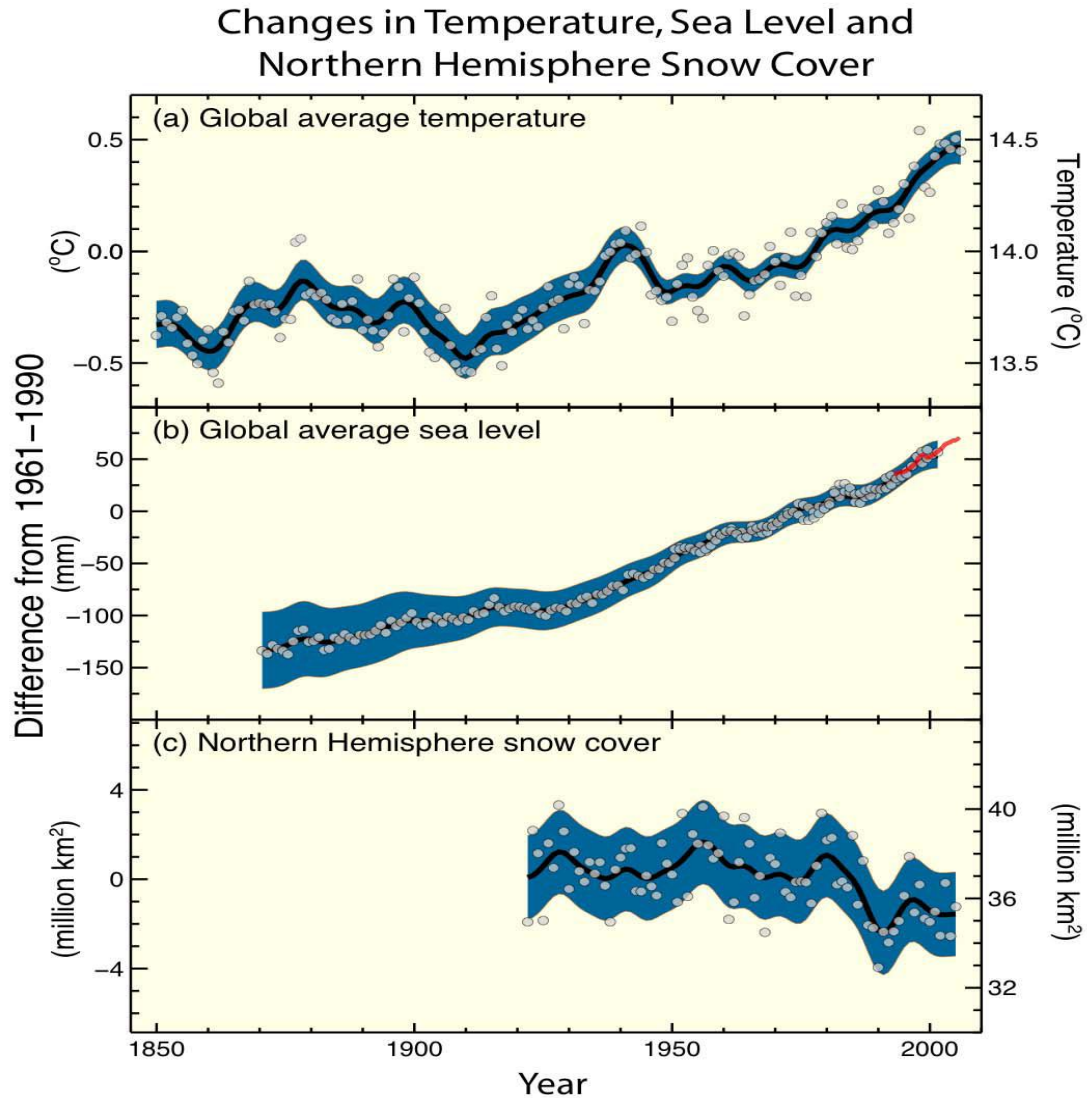
Table adapted from <http://green.yahoo.com>.
 Suppose the net present value of the gas price remains at \$4/gallon for three years. Maintenance cost has 13 oil changes, each at \$30. It has 15K and 30K miles service at \$210. These total to \$600.

Car	Prius	Accord	Civic
Buy	23,384.00	21,250.00	17,751.00
Sell	18,135.00	13,975.00	12,290.00
Loss	5,249.00	7,275.00	5,461.00
Gas - MPG	46.00	24.00	29.00
Gallons for 3 years	815.22	1562.50	1293.10
Gas at \$4/gallon for 3 years	3260.88	6250.00	5172.40
Maintenance – all the same	600.00	600.00	600.00
Down payment	0.00	0.00	0.00
Amount borrowed	23,384.00	21,250.00	17,751.00
Interest rate, %	6.99	6.99	6.99
Loan length in months	24.00	24.00	24.00
Monthly payment	1046.86	951.32	794.68
Total payment	25,124.54	22,831.70	19,072.26
Interest cost	1740.54	1581.70	1321.26
Total cost	10,825.41	15,681.70	12,529.68

- ◆ Carpool lane privileges by CA, FL and VA.
- ◆ Federal tax credit \$3400 for the first 60,000 of a certain brand. Honda or Toyota cars do not qualify anymore.

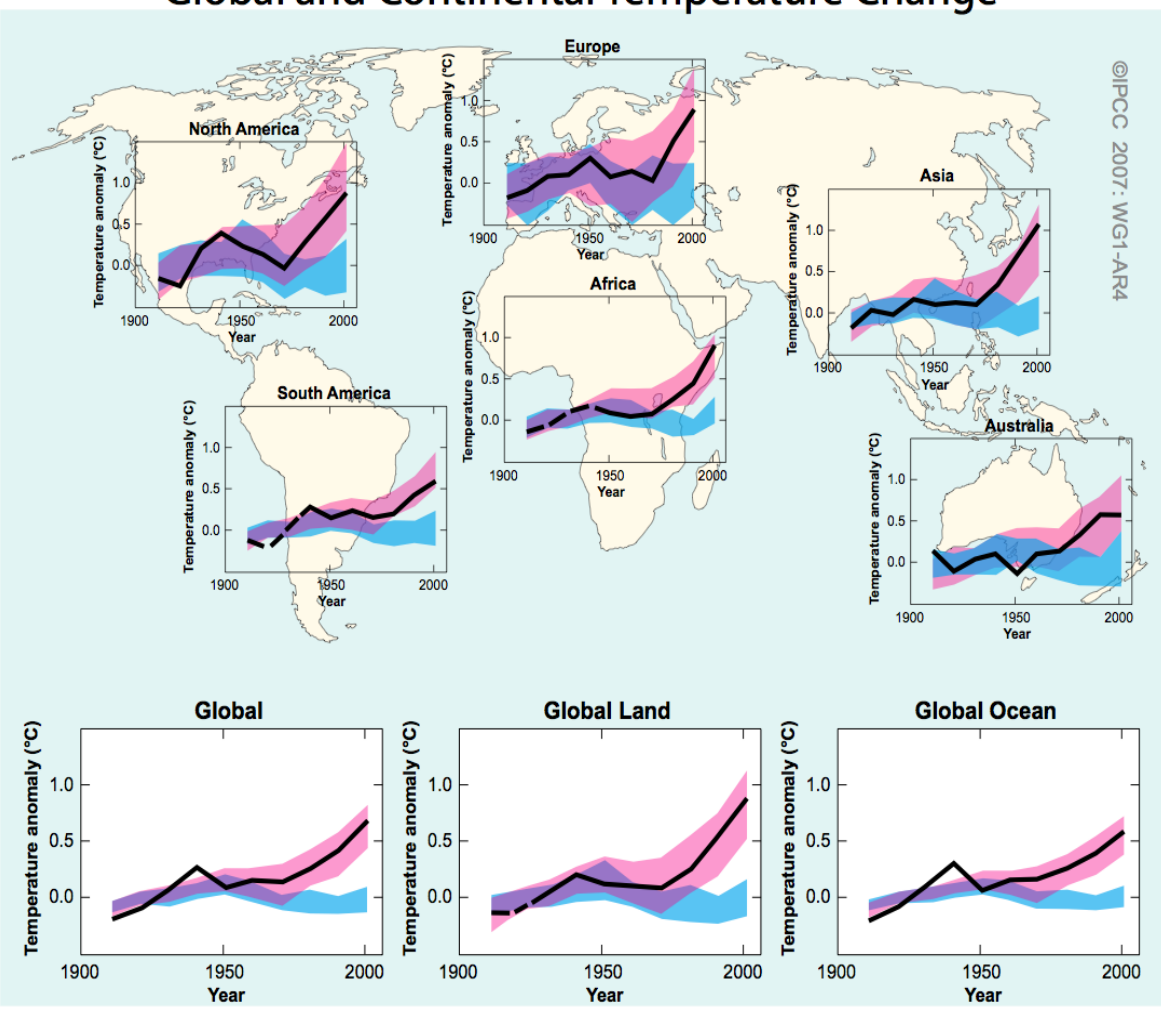
Aside

The Alternative: Global Warming. Fact or Fiction?



Can the Warming be Explained by Natural Forces (Volcanoes/Solar Activity) or Human Factors?

Global and Continental Temperature Change



Black line is the observed temperature

Blue band is 5-95% confidence interval based only on natural forces

Red band is 5-95% confidence interval based on natural forces and human factors

Source: Climate change 2007: The physical science basis. www.ipcc.ch.