Household Detergents

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The Procter & Gamble Company

P&G's Purpose, Values & Principles

P&G Purpose:

We provide branded products and services of superior quality and value that improve the lives of the world's consumers, ***now and for generations to come***.

Principle:

We incorporate **sustainability** into our products, packaging and operations.

Long-Term Vision

Powering our plants with 100% renewable energy

Using 100% renewable materials or recyclate for all our products and packaging

Having zero consumer or manufacturing waste go to landfills

Designing products that delight consumers while maximizing the conservation of resources

2020 Goals for Products

Replace Petroleum-Based Materials with Sustainably Sourced Renewable Materials	25%*
Cold Water Washing	70% of washing machine loads
Packaging Reduction	20% (per consumer use)*
Consumer solid waste	Pilot studies in both developed and developing markets to understand how to eliminate landfilled/ dumped consumer solid waste

** vs. 2010 baseline*

2020 Goals for Operations

Renewable Energy Powering our Plants	30%
Manufacturing Waste	< 0.5% (disposed)
Truck Transportation Reduction	20% (km/unit of volume)*

** vs. 2010 baseline*

Summary of P&G Goals

P&G Sustainability Goals

Conserve Resources
- Energy
- Water

Reduce Waste

Increase recycling

Increase use of renewables

P&G Safety Goals

Safe for all uses

P&G Financial Goals

AB 1879

A. Product function or performance
B. Useful life
C. Materials and resource consumption
D. Water conservation
E. Water quality impacts
F. Air emissions
G. Energy inputs
H. Energy Efficiency
I. Greenhouse gas emission
J. Waste and end of life disposal
K. Public health impacts (sensitive subpopulations, infants, and children)
L. Environmental impacts
M. Economic impacts

Practical, historical alternatives efforts

Old Technology	Replacement Technology	Why change?
ABS	LAS	nic surfactant Foaming in rivers/improved biodeg profile
APE	AE	nionic surfactant Marginal to complete biodeg/tox/ED issues
Phosphate	DTPA	ry detergent legislation

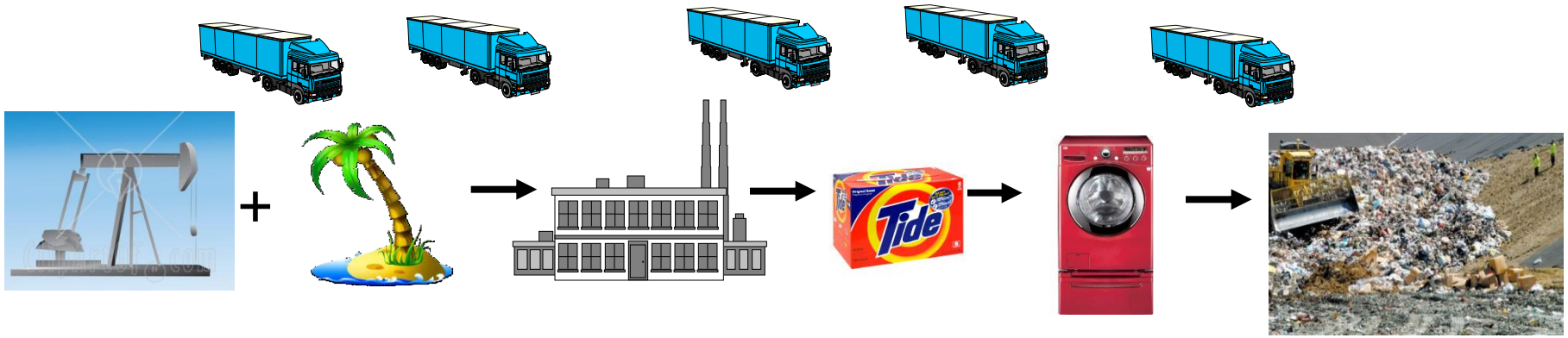
Circa 1963

Circa 1970

Circa 1970

What is Life Cycle Assessment （LCA）?

- LCA is a holistic framework that helps us understand the ways in which a product or service could impact the environment from its very beginning to end （cradle to grave）
- It is a technique to account for energy and chemical inputs and outputs throughout a product or chemical's "life cycle"
- It inventories the extraction of resources from the earth, their processing into raw materials, manufacturing of finished product and packaging, transportation, consumer use, and disposal



Raw material sourcing + production

P&G product manufacture

Consumer use

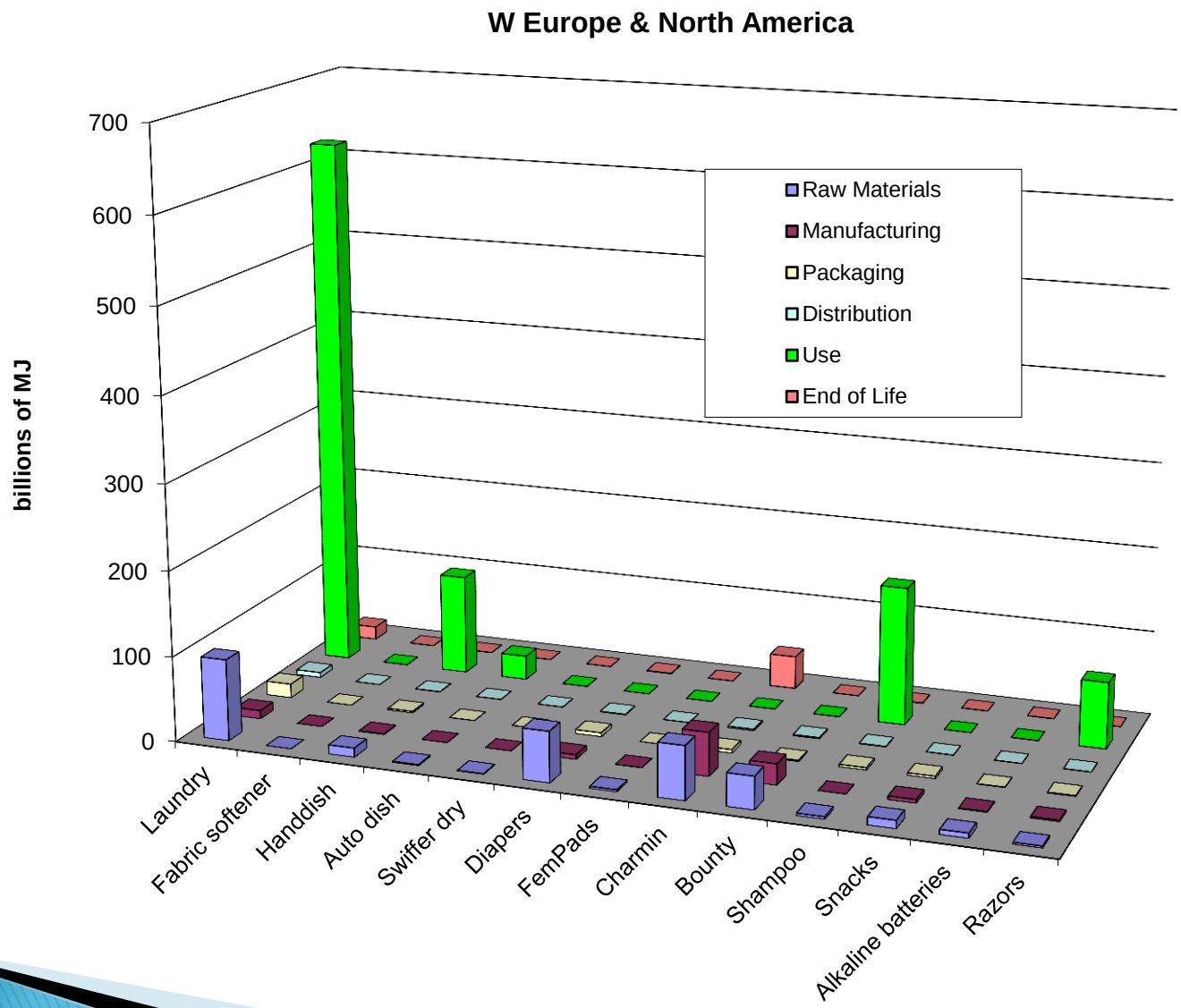
Disposal

CRADLE → GATE → GRAVE

LCA

- LCA is good for:
  - Energy Use
  - GHG production
  - Acidification
- LCA is not very good for
  - Human toxicity
  - Environmental impacts
  - Water quality impacts
  - Water Use

Energy Usage from Life Cycle Perspective



Is a full LCA Needed?

- Full LCA
  - $75,000
  - 6-8 months to complete
- LCA vs. LCA Tools
  - The right tool for the right job
  - Screening/Streamlined LCA
    - $15,000
    - 1-4 months

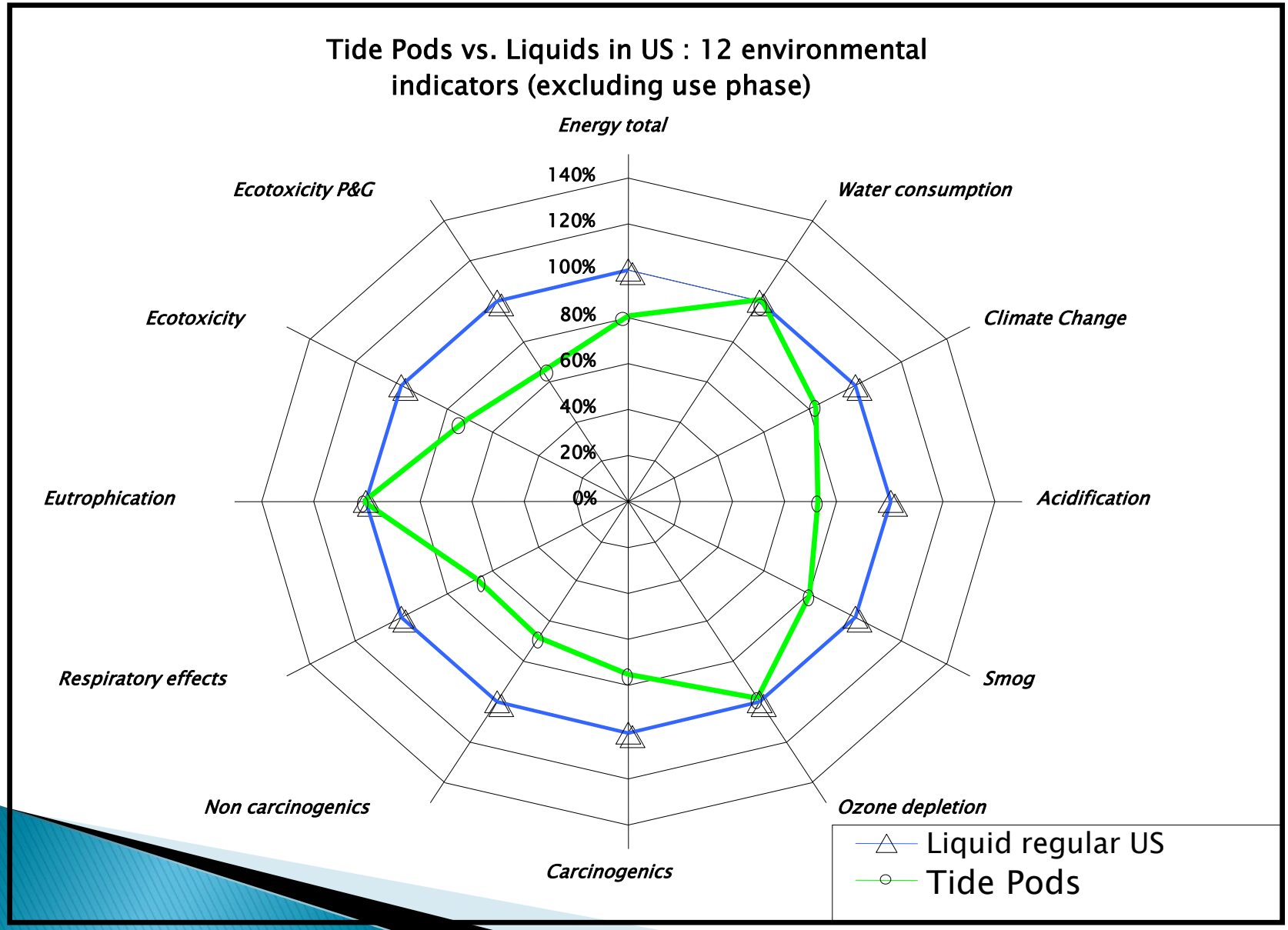
LCAs

- Full LCA, which model, what data
  - US EPA TRACI
    - Does not include land use as an impact area
    - Do we use EU models, EU data????
- How to value metrics with different units
  - GHGs vs. eutrophication
  - LC50 vs. Liters of water consumed
- What is an “LCA tool”?
  - Can simple tools be used?
  - How about LCA thinking?

LCA Tools

- Exploratory / Screening / ISO LCA
- Should Cost Analysis
- Chemist & Engineering Tools & Expertise
  - BPJ
  - iSustain
  - ACS Green Chemistry Standard
    - Supplier Questionnaires

LCA Results


Tide Pods vs. Liquids in US : 12 environmental indicators (excluding use phase)
Energy total
Water consumption
Climate Change
Acidification
Smog
Ozone depletion
Carcinogenics
Non carcinogenics
Respiratory effects
Eutrophication
Ecotoxicity
Ecotoxicity P&G
140%
120%
100%
80%
60%
40%
20%
0%
Liquid regular US
Tide Pods

Contribution Analysis

Impact Factor	Units	Product 1	Product 2
Energy total	MJ primary	3.2	2.6
Water consumption	litre	1.8	1.8
IPCC GWP 100a	kg CO2 eq	0.15	0.13
Smog	g NOx eq	0.00039	0.00032
Ozone depletion	kg CFC-11 eq	1.0E-08	9.3E-09
Human toxicity	kg toluene eq	2.97	3.28
Respiratory effects	kg PM2.5 eq	0.00021	0.00018
Eutrophication	g N eq	0.00016	0.00049
Ecotoxicity	kg 2,4-D eq	0.22	0.24

Normalization – how important is each factor?

- Convert into people equivalents
  - i.e., amount of that factor used or generated by an average person per year
- Difficult to compare 1,000 liters of water used with release of 0.3 kg of air emissions
- We know how much water is used in the state by business and consumers
- We know how much air emissions are released in the state by business and consumers
  - Use this information to Normalize the Impacts

Normalization – annual product use

Impact Factor	Product 1	Product 2	People Equivalents *
Energy total	3.2	2.6	-40,000
IPCC GWP 100a	0.15	0.13	-32,000
Smog	0.00039	0.00036	-3,000
Ozone depletion	1.0E-08	9.3E-09	-88
Human Toxicity	2.97	3.28	+16,000
Respiratory effects	0.00021	0.00018	-250
Eutrophication	0.00016	0.00049	+22
Ecotoxicity	0.22	0.40	+3,200

*Difference between products 1 & 2, annualized

Normalization – Energy/Water

- Normalization tells us the overall increase or decrease in water and energy use by moving from product 1 to product 2
  - The value is expressed as people equivalents
  - If positive, the energy/water use in the state would increase. The amount of the increase would be like that many people moving into the state
  - If negative, the energy/water use in the state would decrease. The amount of the decrease would be like that many people moving out of the state

Normalization – Impacts

- Normalization tells us the overall increase or decrease in each impact category by moving from product 1 to product 2
  - The value is expressed as people equivalents
  - If positive, the overall burden on the environment of ozone, smog, toxicity, etc. would increase
    - The amount of increase would be like that many people moving into the state

LCA & Decision-Making

- Product Level LCAs
  - We use other approaches to address key endpoints outside the LCA
    - Quicker, better, cheaper
  - One ingredient rarely significantly changes the LCA since impacts throughout the lifecycle are combined
  - LCA best performed when production commences
    - That is the wrong time to change marketing & production plans

Large scale brings opportunity & complexity

- P&G produces detergent for billions of consumer wash loads per year

- Requires a global supply chain
  - Natural fatty alcohol raw materials from Sacramento
  - Synthetic surfactants and polymers from US Gulf Coast
  - Synthetic and natural raw materials from WE, Africa, Asia
  - Detergent production at multiple plants
  - Complex distribution network across North America

AA: What is the role of Phosphate in ADW (automatic dish washing detergents)

Phosphate is multi functional & cost effective.

STPP Multi functionality	Areas of consumer impact
A builder & source of alkalinity	Shine Stains
Cleaning	Hard to clean soils
A dispersant	Protects machines
A crystal growth inhibitor	Filming and spotting (glasses)
A metal protection agent & corrosion inhibitor	Iridescence/tarnishing of metal surfaces
A process aid	Product aesthetics

Nil P Technology Strategy

Area of Consumer Impact	Nil P Technologies
Tough Food Cleaning	4 – 5 materials
Shine	2 materials
Metal Care	2materials
Stain Removal	2 materials
Gel product aesthetics	1 material

Why was P to Nil-P such a huge challenge?

- There was no single “magic bullet” technology available
- We qualified >10 new raw material supply chains. Many were new raw materials for P&G or completely new to the dish plant
- We developed a completely new process to make one of our products
- We installed >25 new raw material/plant handling systems across multiple manufacturing sites
- Introduced >100 new pieces of artwork
- The nil P conversion & qualification work was completed in parallel with continuing to support the “P” current business

Laundry detergent formulations are complex

Diverse selection of actives = robust cleaning across diverse soils

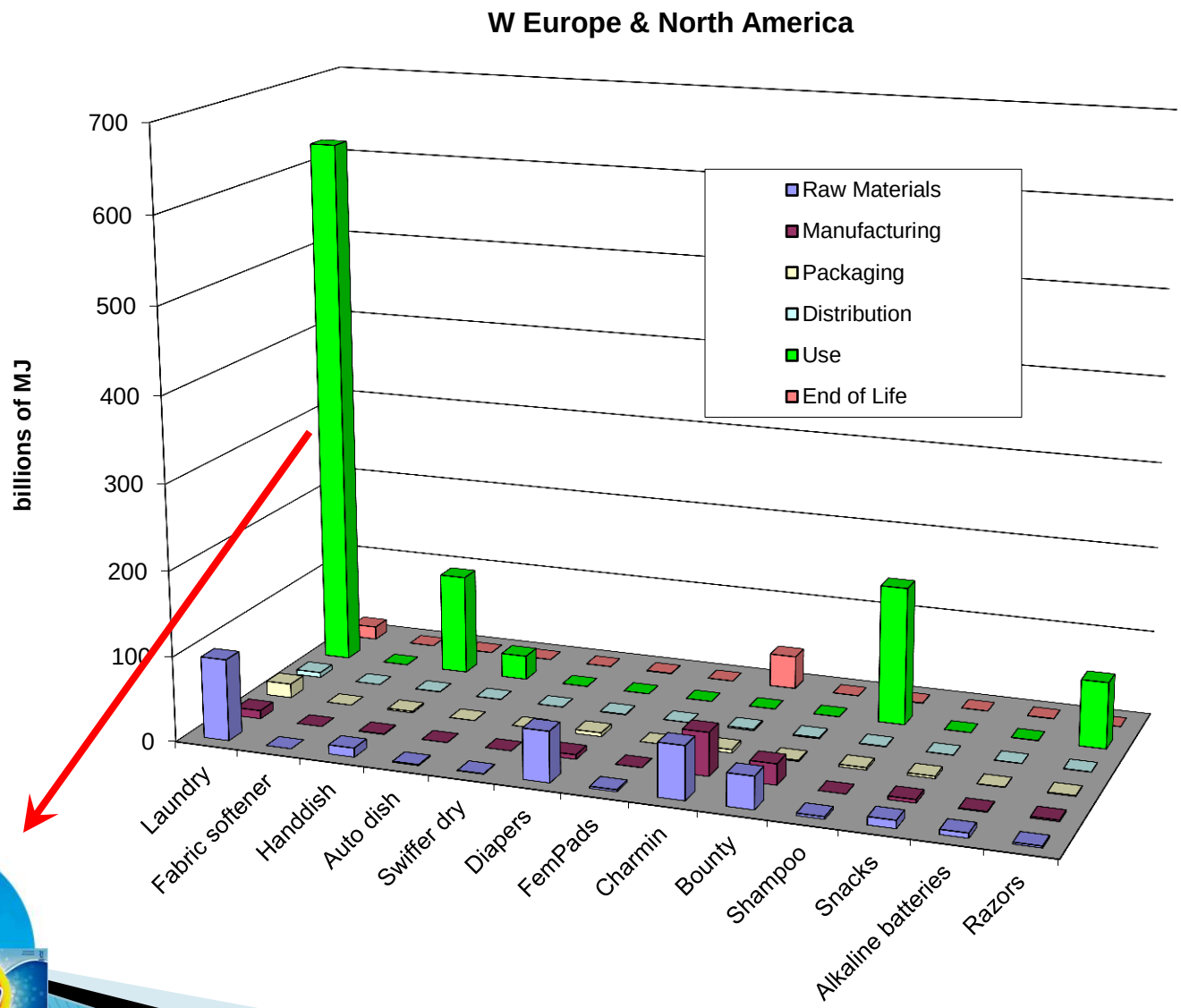
Composition is carefully balanced to achieve all goals

Some ingredients have multiple functions!!

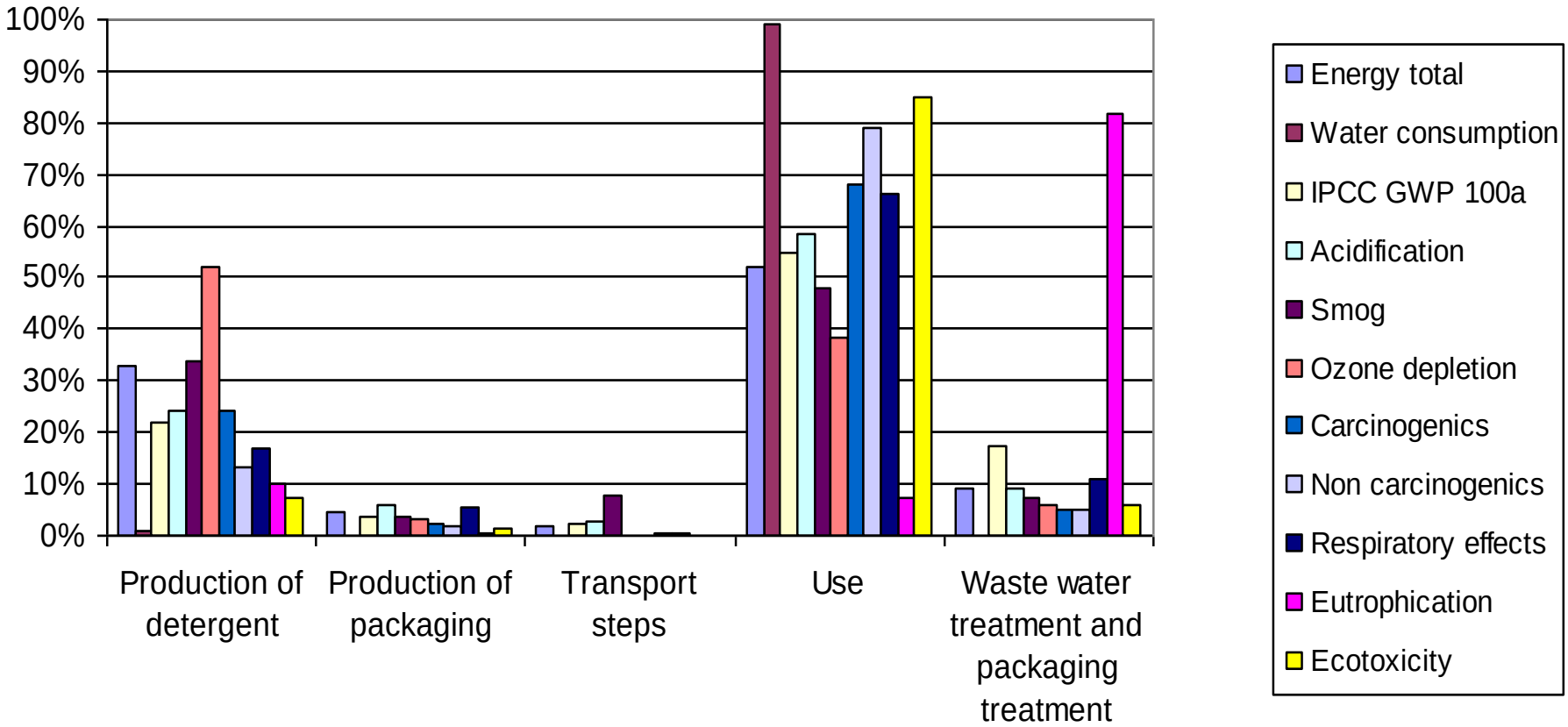
Formula Example: Premium Compact Liquid Laundry Detergent

Alcoholethoxy sulfate	20.1%	Diquaternium ethoxy sulfate	1.6%
Linear alkylbenzene sulfonate	2.7%	Polyethylene glycol-polyvinyl acetate	0.4%
Alkyl sulfate	6.5%	Polyethyleneimine propoxyethoxylate	1.0%
Laureth-9	0.8%	Diethylenetriamine pentaacetic acid	0.4%
Citric acid	3.8%	Disodium diaminostilbene disulfonate	0.01%
C12-18 fatty acids	2.0%	Ethanol	2.6%
Protease (stock)	1.5%	Propylene Glycol	4.6%
Amylase (stock)	0.3%	Diethylene Glycol	3.0%
Mannanase (stock)	0.1%	Polyethylene glycol	0.2%
Pectate Lyase (stock)	0.1%	Monoethanolamine	2.7%
Xyloglucanase (stock)	0.3%	Dye	0.01%
Borax	3.0%	Perfume	0.5%
Calcium formate	0.1%	NaOH	to pH 8.3
Sodium formate	0.1%	Water	to 100%

Energy Usage from Life Cycle Perspective



Cold Water Washing
Better for Environment



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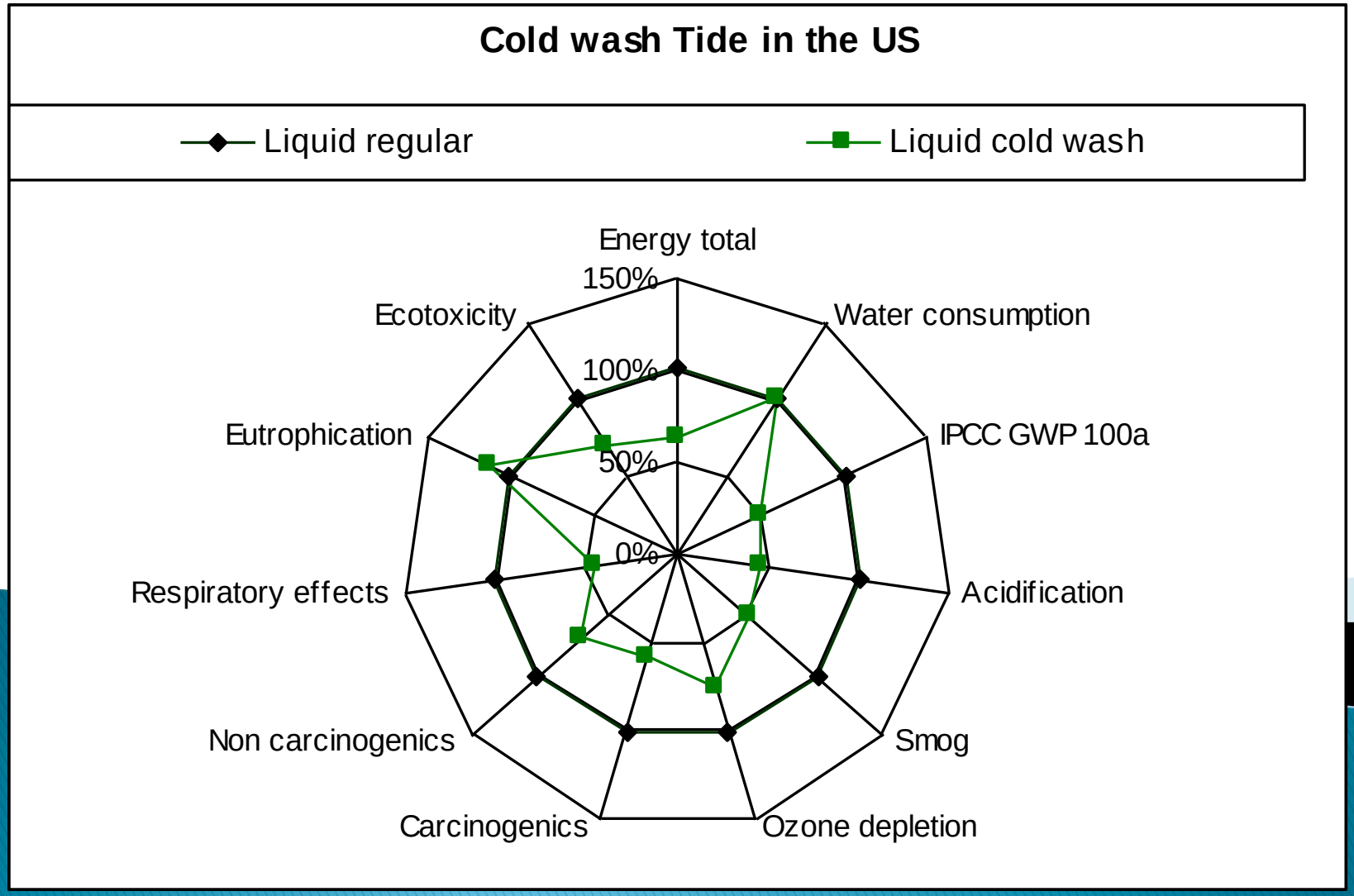


If Everyone in the US Switched to Cold…

Energy Savings

- Up to 1.7% of total household energy consumption
- Up to 5% of energy consumption by appliances
- Up to 10% of energy used for household water heating
- 34-45 billion kWh/year nation-wide
- 13-17 million tons of CO_2 equivalents/year nation-wide
- *=3-4% of the Kyoto target for the US*

Warm vs. Cold Water Surfactant

Property	Warm Surf	Cold Surf
Persistence	Ready	Ready
Bioaccumulation	Low	Moderate
Toxicity (aquatic)	Moderate	More toxic

- The warm water surfactant wins in a hazard assessment

- But, both compounds are **safe** based on risk assessment and the cold water surfactant is needed for cold water solubility = energy & GHG savings

Ingredient Performance
Ingredient Supply
Ingredient Cost
Worker Safety
Chemical Hazard
Acceptable Alternative
Ingredient Safety
Ingredient Aesthetics
Ingredient Sustainability
Ingredient Compatibility

Other experience with AA in P&G

- Chelators
  - Chemicals that bind calcium & metals allowing surfactants to work better
  - >35 year search
    - Several new materials developed and commercialized
      - None that adequately replace EDTA, DTPA, phosphates
- Enzyme stabilizers
  - >5 year search
  - PMN needed (multiple years)
  - Capacity

Alternatives from Green Chemists in Regulatory Agencies

- Recommended new solvent
  - Hazardous waste
- Low molecular weight amine
  - P&G rejected due to lack of biodegradation
  - Would create new materials
    - 4-7 years to get approved under TSCA
    - The agency later revoked this recommendation
      - Found other issues with the substance

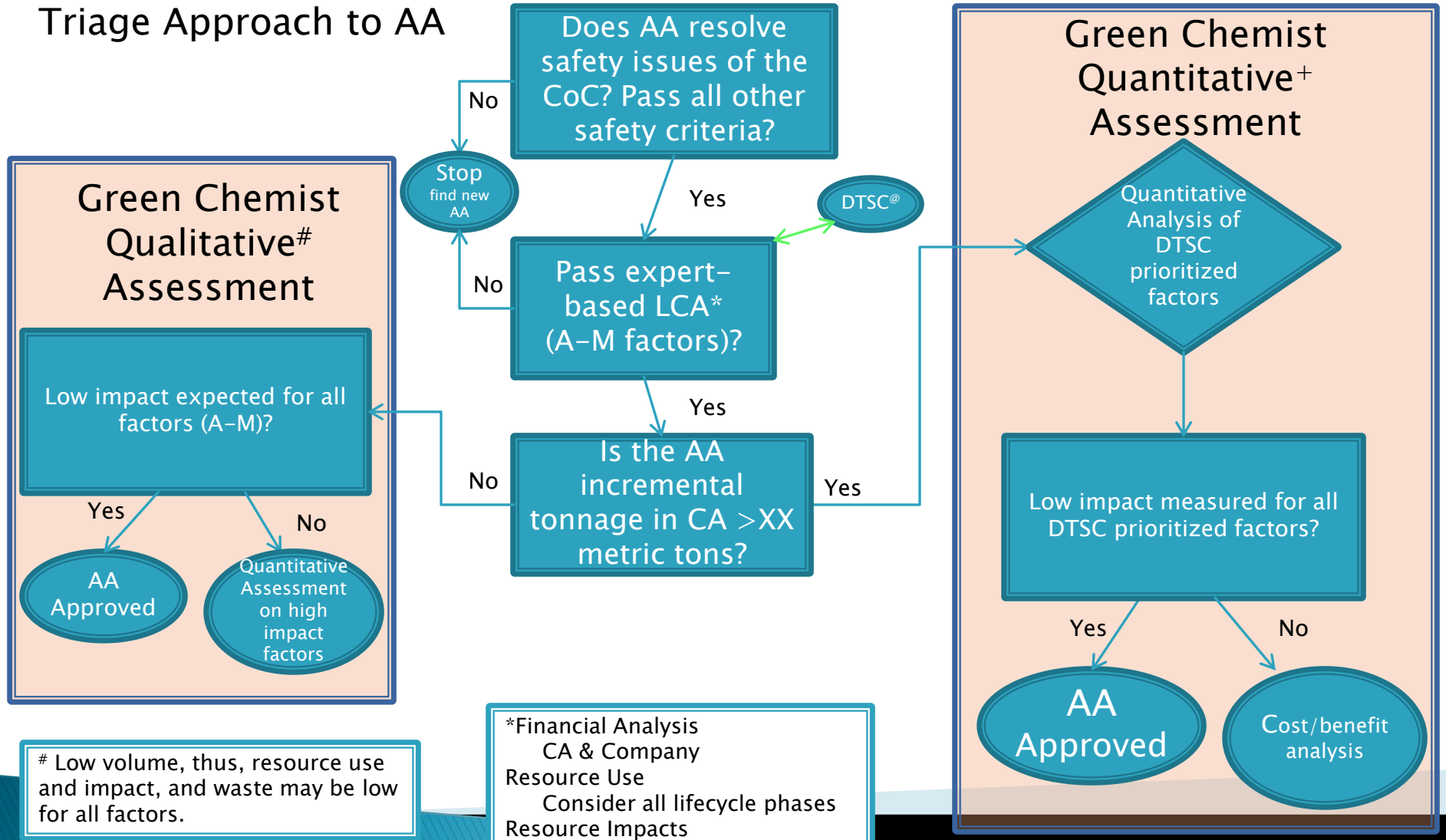
Meeting the Goals

- Human & environmental safety needs
  - Does the AA resolve the safety issues with the CoC?
    - Data quality & quantity to ensure not a regrettable substitution
- Financial Analysis
  - CA & Company
- Resource Use
  - Linked to costs, impacts also linked to use
- Resource Impact Proportional to Volume
  - Many impacts tied to energy use
    - 50-90% of the cost of an ingredient is energy
    - Energy use leads to GHG, air emissions, water impacts

Principles

- KISS
  - Cost & Volume correlated with Resources Used, Impacts, Waste
- Use full range of LCA Tools (tiered)
  - Expert analysis, iSUSTAIN, etc.
  - Exploratory → Screening → ISO-LCA
- Company Experts Drive the Analysis
  - Supply, performance, compatibility, consumer acceptance
- Integration & evaluation of hazard and exposure leading to improvements in public health and environmental protection → A Company Must
- Not all AAs will be fast, not all will identify one or more new chemicals

Triage Approach to AA



Low volume, thus, resource use and impact, and waste may be low for all factors.

*Financial Analysis
- CA & Company

Resource Use
- Consider all lifecycle phases

Resource Impacts
- Consider all lifecycle phases

@Meeting with DTSC prioritizes impact areas to identify priorities for quantitative analysis. Quantitative analysis compares data on CoC or related compounds and AA.

+ Tools depend on factors prioritized. Select best tools.

Expert Based LCA

- Are there any showstoppers?
  - CMR/PBT or other critical hazard (fire, pH)
  - Known risk due to expected exposures
  - Cost, performance, consumer acceptance
  - Significant resource use or resource impacts
  - Sufficient supply
  - Compatible with other ingredients
  - Compatible with manufacturers processes
  - Endangered or threatened species impacts
  - Etc.

Why Use Tonnage?

- Tonnage is used only after all *direct* safety concerns are addressed
  - Direct refers to effects due to the material itself (not due to other materials in the supply chain which are part of the A-M factors)
- Tonnage and A-M Factors
  - Pros
    - ↑ tonnage ↑ resources used
    - ↑ tonnage ↑ resource impacts
    - ↑ tonnage ↑ costs
  - Cons
    - Tonnage does not include 'potency'
      - Not a perfect surrogate for resources, impacts, costs
- Our Experience → Cost

Why Use Tonnage?

- CoC vs. Alternative Chemical
  - Frequently same processes used to generate both
    - Same supplier, same raw materials, same chemical plant
    - Similar costs, resources used and impacts
      - How similar? → Depends on incremental tonnage
  - When chemistry & processes differ
    - Supplier differences in cost, energy & raw materials used, emissions, and wastes CoC vs. AA

Qualitative vs. Quantitative: General Questions

- Is the AA chemically similar to the CoC?
  - Is the manufacturer the same?
  - Is the processing the same?
  - Are the raw materials similar?
  - Petroleum, mined, or biomass?
  - Is the AA similar or more efficacious?
  - Are the energy sources different through the lifecycle?
  - Are hazardous or toxic materials used throughout the lifecycle?
- Does the AA cost significantly more than the CoC? Why?

Qualitative vs. Quantitative:
Examples of specific questions

Impact	Raw Materials	Manufacturing	Packaging	Distribution	Use	Disposal
Energy: Overarching question: Is significantly more energy used by the AA vs. the CoC in any phase? Need to factor in performance of AA vs. CoC.						
Energy: Are there energy intensive processes used in this phase vs. the CoC?						
Energy: Are there energy intensive materials used in this phase vs. the CoC?						
Environmental Impact: Will use of the AA lead to significantly greater impact vs. the CoC? Need to factor in performance vs. CoC.						
Environmental Impact: Do processed used in this phase lead to greater emission of chemicals into the environment for the AA vs. the CoC?						
Environmental Impact: Would these materials be release continuously or intermittantly?						
Environmental Impact: Would these materials cause a violation of any environmental permits?						
Environmental Impact: Are any of the materials released to the environment highly toxic, endocrine disruptors, or capable of long range transport?						
etc						

Summary

- The AA process is similar to the PD process that manufacturers use
- Manufacturers integrate safety and sustainability metrics into decisions
  - Many other considerations
- Ensuring the safety of the AA is highest priority
  - Ensuring low impact of A-M factors can often be done using simple tools
    - Impacts on A-M likely reflected in increased costs

Sustainable Innovation

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