# EPA's Computational Toxicology Communities of Practice Series: Using Life Cycle Assessment for Risk Management

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### Topics:

- Brief Description of LCA Methodology
- Risk Assessment Modeling compared to Life Cycle Impact Assessment
- Chemical Life Cycle Risk Assessment



#### **Toward Sustainability: The True North of EPA Research**

The Agency's focus on sustainability brings an integrated approach to research, partnerships, and seeking solutions to help society now - and in the future.

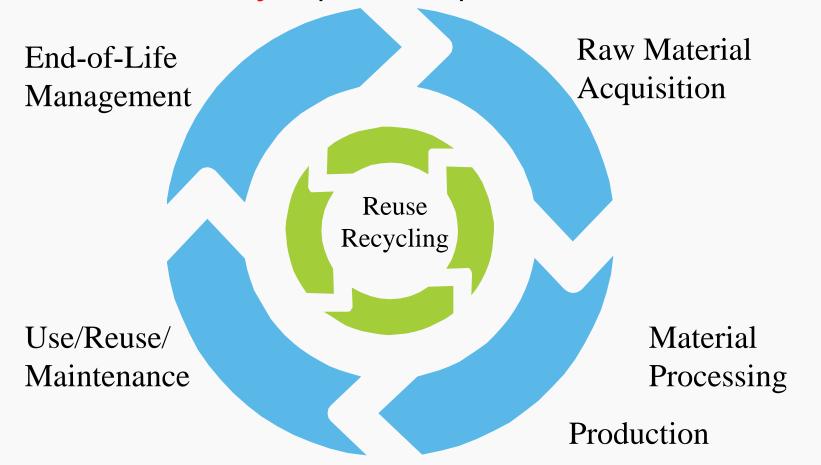
"Historically, environmental programs have largely focused on how to reduce air and water pollution, and how to identify and monitor chemical and environmental risks to human health and the environment. Today's challenges depend on the sustainable use of natural resources, and require solutions that stress the linkages between energy use, water use, land use, material consumption, environmental protection, human health, quality of life, and the global economy."

EPA Science Matters Newsletter, March/April 2011



# Life Cycle Assessment

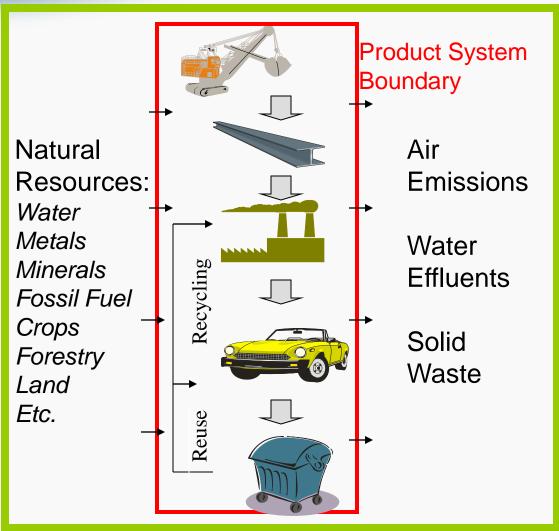
An **industrial** environmental management approach to look **holistically** at products, processes, and activities.





#### Life Cycle Stages

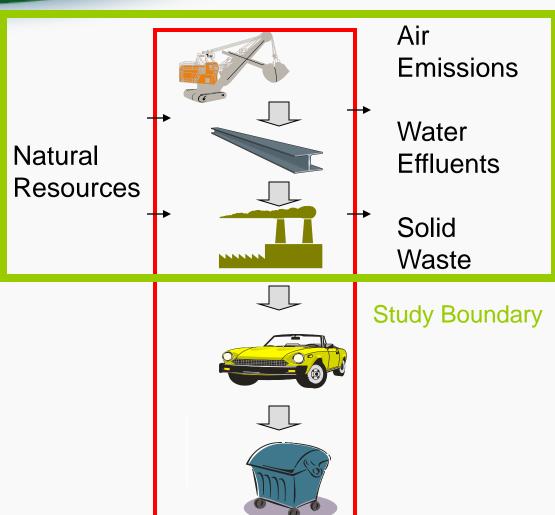
- Raw Material Acquisition
- Material Processing
- Production
- Use and Maintenance
- End-of-Life





# Cradle-to-Gate Studies

Exclude downstream activities past product manufacture - but conclusions must relate to what was studied and not be overstated. Such studies are helpful in improving the product supply chain but may miss important impacts that occur during use and at end of life.

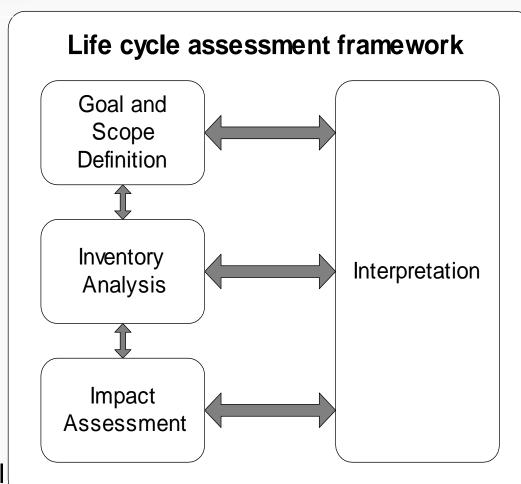




### ISO 14040/14044

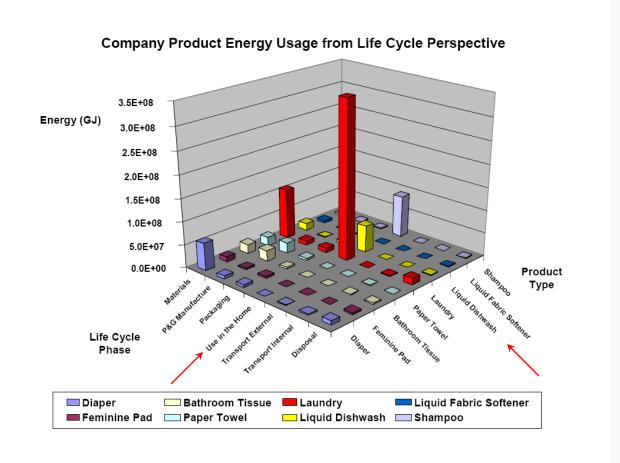
#### **Goal & Scope Definition:**

- Determine the scope and system boundaries
- **Life Cycle Inventory:** 
  - Data collection, modeling & analysis
- Impact Assessment:
  - Analysis of inputs/outputs using category indicators
  - Group, normalize, weight results
- Interpretation:
  - Draw conclusions
  - Checks for completeness, contribution, sensitivity analysis, consistency w/goal and scope, analysis, etc.









From "Sustainable Innovation Products" Len Sauers, PhD VP, Global Sustainability, Procter & Gamble



### Cold-Water Wash Savings

 According to P&G's calculations, if every U.S. household used cold water for laundry, the energy savings would be 70 to 90 billion kilowatt hours per year, which is 3% of the nation's total household energy consumption. These savings would translate into 34 million tons of carbon dioxide per year not released into the environment, which is nearly eight percent of the Kyoto target for the U.S.



#### **Functional Unit**

- The product system (boundary definition) is defined by the function that the product under study provides.
- A clearly defined functional unit allows for comparisons to be made on an equal basis.

So, how many volumes do you need to read on your e-reader to break even?

With respect to fossil fuels, water use and mineral consumption, the impact of one e-reader payback equals roughly 40 to 50 books. When it comes to global warming, though, it's 100 books; with human health consequences, it's somewhere in between.

Published: April 4, 2010

#### OP-CHART

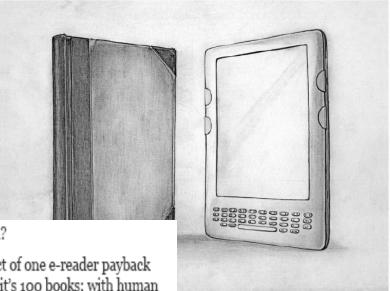
#### How Green Is My iPad?

By DANIEL GOLEMAN and GREGORY NORRIS

With e-readers like Apple's new iPad and Amazon's Kindle touting their vast libraries of digital titles, some bookworms are bound to wonder if tomes-on-paper will one day become quaint relies. But the question also arises, which is more environmentally friendly: an e-reader or an old-fashioned book?

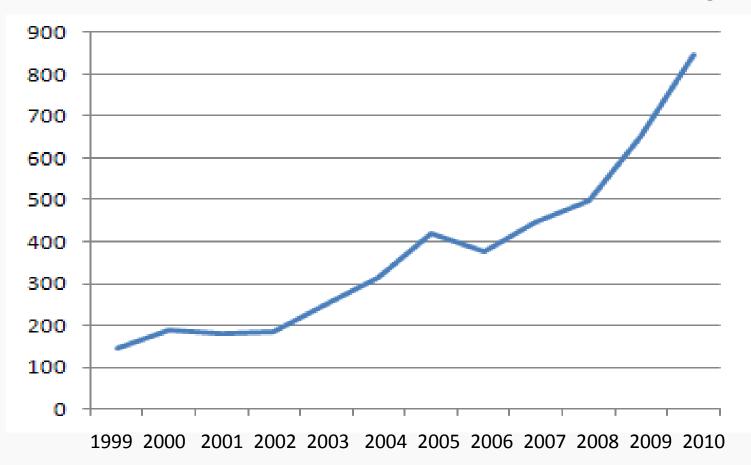
To find the answer, we turned to life-cycle assessment, which evaluates the ecological impact of any product, at every stage of its existence, from the first tree cut down for paper to the day that hardcover decomposes in the dump. With this method, we can determine the greenest way to read.

(A note about e-readers: some technical details — for instance, how those special screens are manufactured — are not publicly available and these products vary in their exact composition. We've based our estimates on a composite derived from available information. It's also important to keep in mind that we're focusing on the e-reader aspect of these devices, not any other functions they may offer.)





#### No. of published LCA-related papers is growing

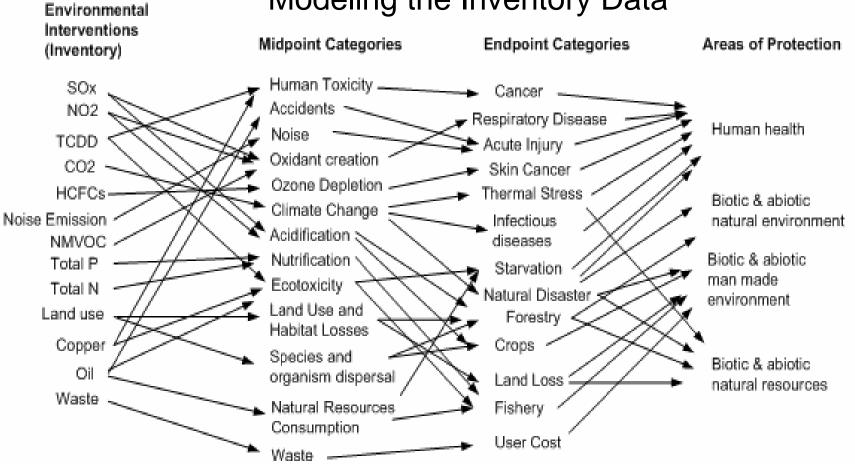


as reported by SCOPUS

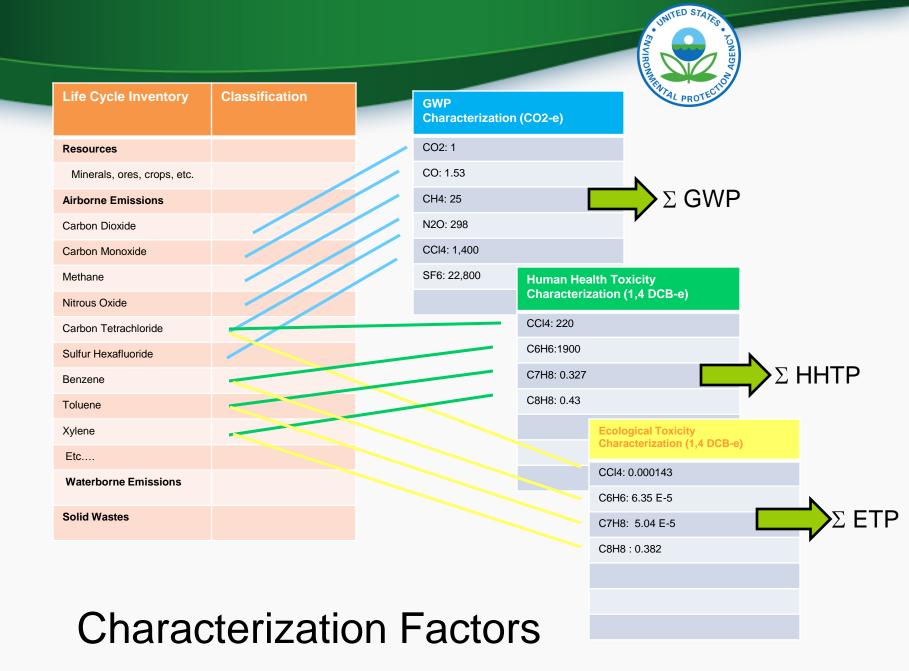


# Life Cycle Impact Assessment (LCIA)

Modeling the Inventory Data

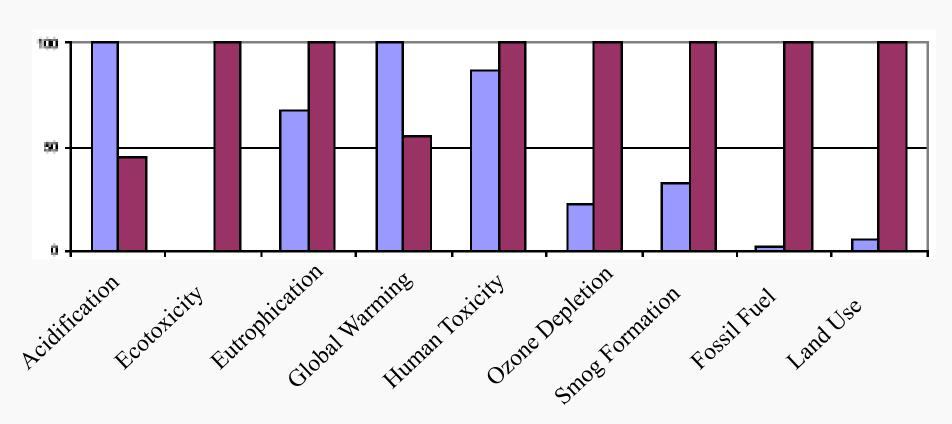


From Jolliet et al. (2004) The LCIA Midpoint-Damage Framework of the UNEP/SETAC Life Cycle Initiative, *IJLCA* **9** (5) 394-404.





## Sample LCIA Results

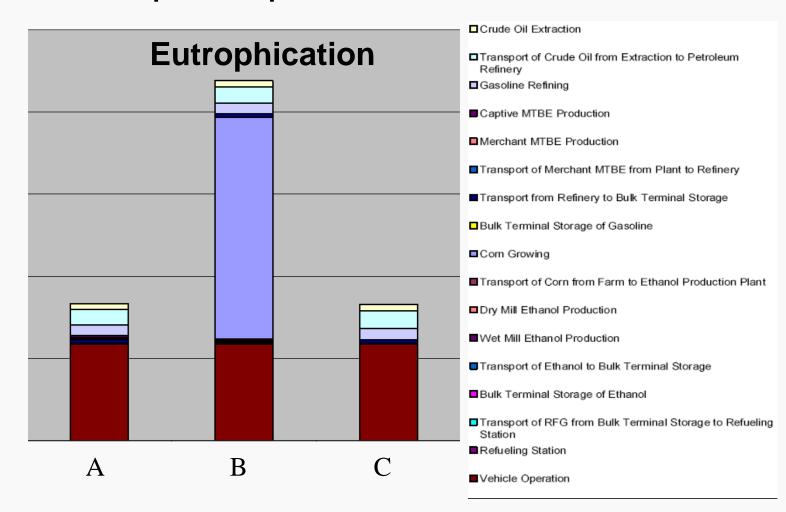


Impact Indicator Categories





### **Example Impact Indicator Results**





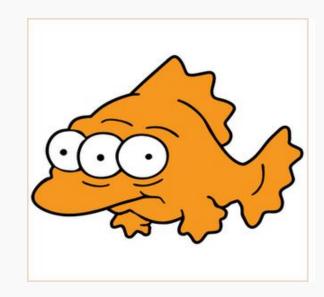
# An Effective Life Cycle Assessment

- Examines system-wide effects (cradle-to-grave)
- Analyzes *multi-media* (air, water, waste, etc.)
- Analyzes multi-attributes (all impacts)
- Helps identify trade-offs among alternatives
- Identifies opportunities for improvement
- Supports environmental decision making
- Provides the cornerstone of Sustainability



#### LCIA versus RA

- Life Cycle Impact Assessment (LCIA) characterizes emissions over a product's life cycle; it reports emissions at an aggregated level and for a chosen functional unit basis (e.g., 1,000 gal of product).
- Risk Assessment (RA) characterizes the nature and magnitude of health risks to humans and the environment from potential chemical contaminants and other stressors at the site-specific level.





### (Chemical) Life Cycle Risk Assessment

The focus is on identifying where release and exposure might occur in the life of a chemical.

#### Iterate

Describe
Material
&
Application

Profile Lifecycle(s)

- Properties
- •Hazards
- •Exposure

Evaluate Risks

Assess Risk Management Decide,
Document
& Act

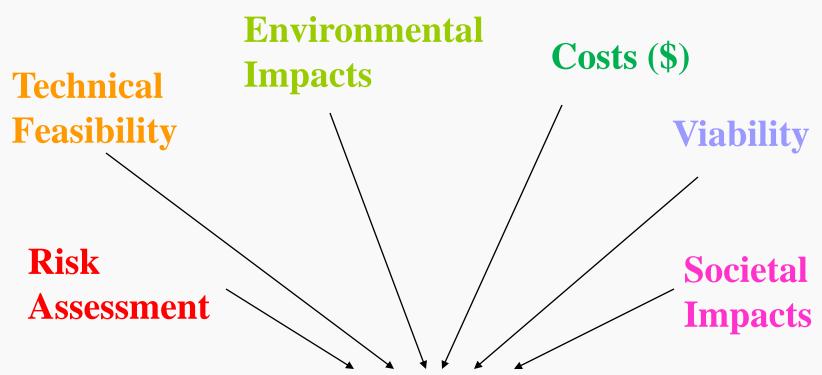
& Adapt

Review

Assess, prioritize & generate data



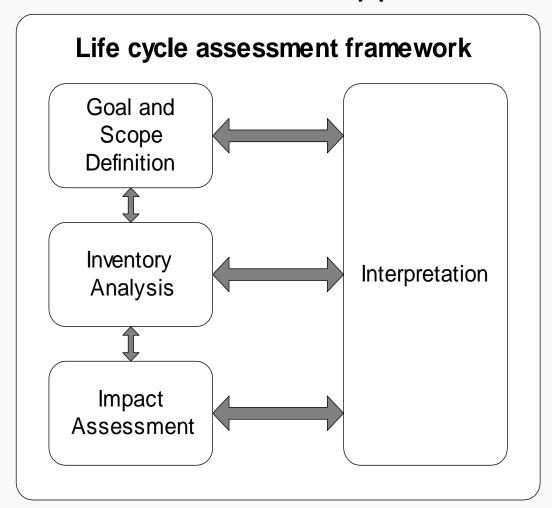
# **Integrated Decision-Making**



Sustainability



#### LCA is an Iterative Approach





### Suggested Reading

- Curran, M.A. (ed.) (1996) Environmental Life Cycle Assessment, McGraw-Hill, ISBN 0-07-015063-X.
- U.S. Environmental Protection Agency, EPA (2006). Life Cycle Assessment: Principles and Practice, EPA/600/R-06/060, available on-line, www.epa.gov/ORD/NRMRL/lcaccess.
- Horne R, Grant T, and Verghese K. (2009). <u>Life Cycle Assessment:</u> <u>Principles, Practice and Prospects</u>. ISBN: 9780643094529; 160PP; CSIRO Publishing, Australia.
- Guinee, J., Ed. (2001). <u>Life Cycle Assessment: An Operational Guide to the ISO Standards.</u>
- Society of Environmental Toxicology and Chemistry, SETAC (1990). A Technical Framework for Life Cycle Assessments. J Fava, R Denison, B Jones, MA Curran, B Vigon, S Sulke, and J Barnum (eds), 152 pages.
- Curran, M. A. (2008). Human Ecology: Life Cycle Assessment. 8 PP; Encyclopedia of Ecology, Five-Volume Set, ISBN-13: 978-0-444-52033-3; ISBN-10: 0-444-52033-3; Elsevier.
- ISO 14040 (2006). Environmental Management LCA Principles and Framework. International Standards Organization, Geneve, Switzerland.





LCA Home LCA 101 Why LCA? **Data Sources** 

LCA Resources

Sustainable Technology

Risk Management Research Home



U.S. ENVIRONMENTAL PROTECTION AGENCY

#### Life-Cycle Assessment Research

Go Search: OAll EPA ® This Area

You are here: EPA Home > Research & Development > Risk Management Research > Sustainable Technology + System Analysis

#### Life-Cycle Assessment (LCA)

Welcome to the National Risk Management Research Laboratory's Life-Cycle Assessment (LCA) web site. This site's purpose is to promote the use of LCA (see definition below) to make more informed decisions through a better understanding of the human health and environmental impacts of products, processes, and activities. The site is divided into four primary areas to help educate people new to the concept of LCA while serving as a focal point for LCA practitioners and decision-makers to stay current with the field of LCA. LCAccess provides information on why one would want to perform an LCA, an overview of LCA, how to find LCI data sources, and available LCA resources.



LCA is a technique to assess the environmental aspects and potential impacts associated with a product, process, or service, by:

- compiling an inventory of relevant energy and material inputs and environmental releases;
- evaluating the potential environmental impacts associated with identified inputs and releases:
- interpreting the results to help you make a more informed decision.

Office of Research & Development | National Risk Management Research Laboratory

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Last updated on Friday, October 17th, 2008. http://www.epa.gov/ORD/NRMRL/Icaccess/ Print Aprila

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