Biomass Lifecycle Analysis

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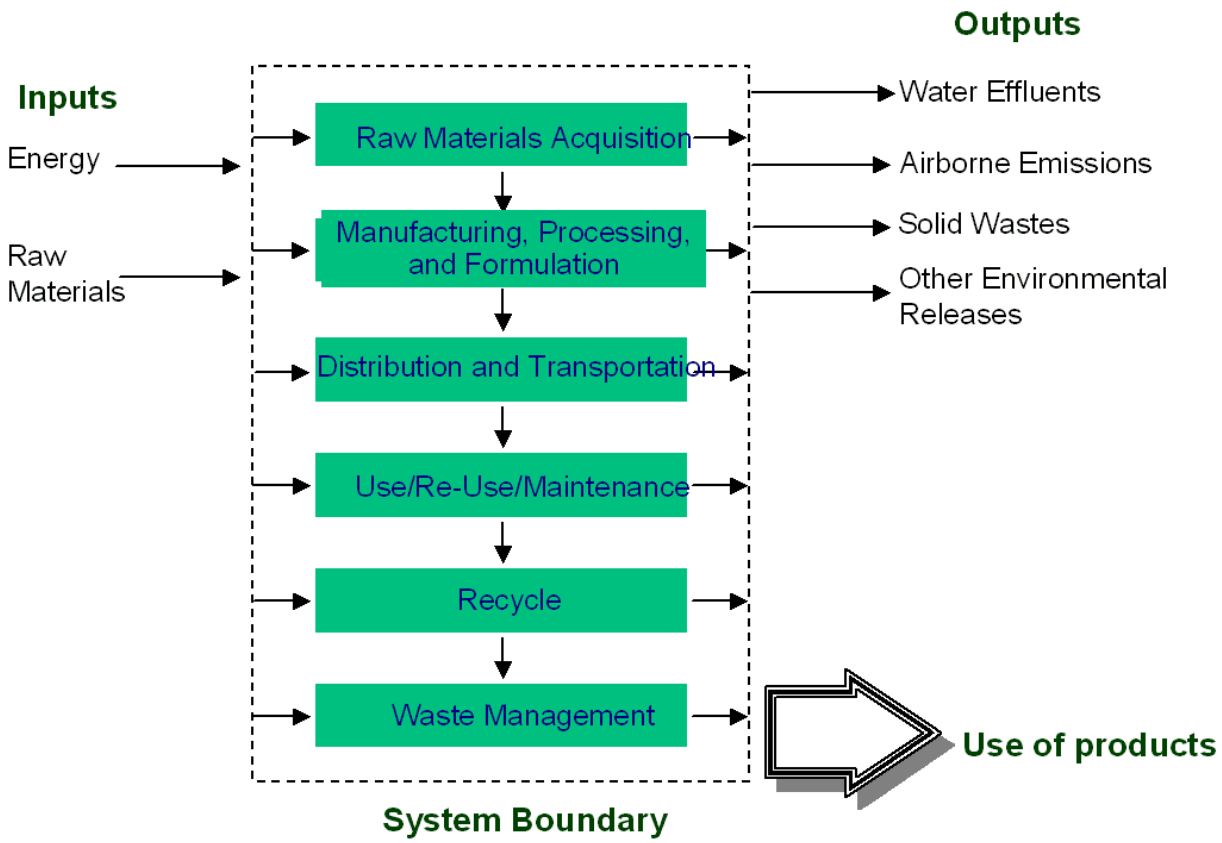
Agenda

- Lifecycle Analysis
  - What is it?
  - How do you do it?
- Biomass Systems
  - Special Considerations

Life Cycle Assessment

- Life Cycle Assessment (LCA) is a technique for assessing the potential environmental aspects associated with a product (or service), by:
  - ***compiling*** an inventory of relevant inputs and outputs,
  - ***evaluating*** the potential environmental impacts associated with those inputs and outputs, and
  - ***interpreting*** the results of the inventory and impact phases in relation to the objectives of the study.
  - Source: US EPA

Life Cycle Stages



Benefits Of LCA

- Helps decision makers select options that provide the lowest environmental impact
  - This is used with other information such as cost and performance to select a product or process
- Companies can claim one product is better than another on the basis of LCA
- LCA inventory process helps to narrow in on the area where the biggest reductions in environmental emissions can be made
- Can be used to reduce production costs

Limitations of LCA

- Can be time and resource intensive
  - Availability and accuracy of data can influence the results
- Most LCA's won't determine which product works the best or is the most cost effective
- LCA's need to be used as one component of the decision making process assessing the trade-offs with cost and performance

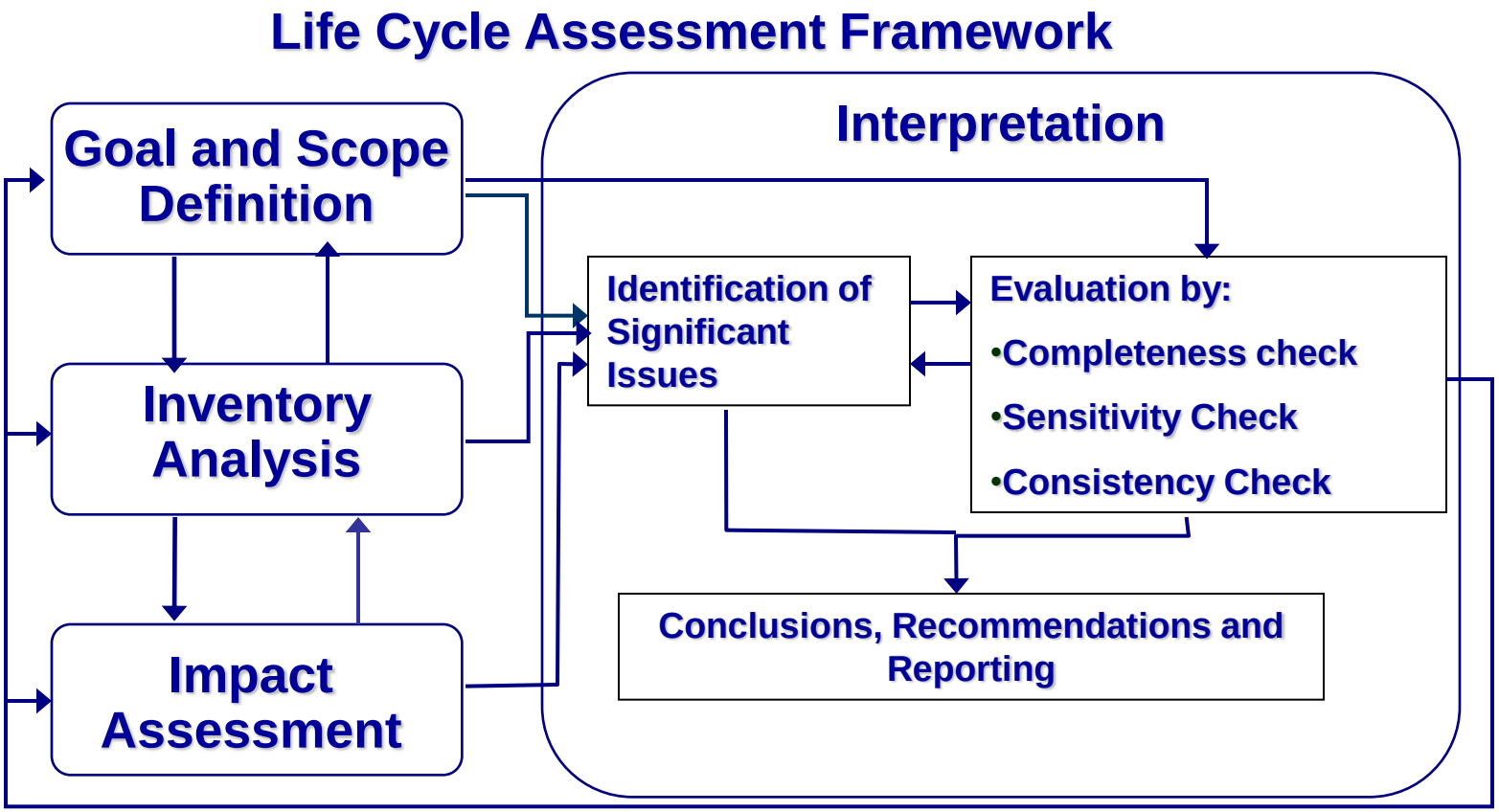
Life Cycle Assessment Principles

- The ISO 14040 standard for Life Cycle Assessment has seven principles:
  1. Life Cycle Perspective
  2. Environmental Focus
  3. Relative Approach and Functional Unit
  4. Iterative Approach
  5. Transparency
  6. Comprehensiveness
  7. Priority of Scientific Approach

Phases of LCA

- **Goal Definition and Scoping** - Define and describe the product, process or activity. Establish the context in which the assessment is to be made and identify the boundaries and environmental effects to be reviewed for the assessment
- **Inventory Analysis** - Identify and quantify energy, water and materials usage and environmental releases (e.g., air emissions, solid waste disposal, wastewater discharge)
- **Impact Assessment** - Assess the human and ecological effects of energy, water, and material usage and the environmental releases identified in the inventory analysis
- **Interpretation** - Evaluate the results of the inventory analysis and impact assessment to select the preferred product, process or service with a clear understanding of the uncertainty and the assumptions used to generate the results

Phases of LCA



LCA 101

- The US EPA has a program to expand the use of LCA in the United States.
  - http://www.epa.gov/ORD/NRMRL/lcaccess/

- LCA 101 document is available at
  - http://www.epa.gov/ORD/NRMRL/lcaccess/lca101.html

How Do You Do an LCA?

- The systematic approach and the large volumes of data required favour the use of software tools for undertaking an LCA.
- You can develop your own software and assemble your own data set, or
- Use a software tool specifically designed for the task.

LCA Software and Databases

- The US EPA lists 30 tools on their website and warns that the list is not complete.
  - http://www.epa.gov/ORD/NRMRL/lcaccess/resources.html#Software
  - 23 are European models.
  - Five are American.
  - One is Canadian (Athena, for building products).
  - Many have a specific focus, e.g. building products, transportation.

LCA Software and Databases

- Boustead Model 5.0
- ECO-it 1.3: Eco-Indicator Tool for environmentally friendly design - PRé Consultants
- EcoPro - sinum Corporate Environmental Management
- EDIP - Environmental design of industrial products - Danish EPA
- EIOLCA - Economic Input-Output LCA at Carnegie Mellon University
- GaBi 4 - (Ganzheitliche Bilanzierung) - University of Stuttgart (IKP)/PE Product Engineering
- IDEMAT - Delft University Clean Technology Institute Interduct Environmental Product Development
- KCL-ECO 4.0 - KCL LCA software
- LCAiT 4- CIT EkoLogik (Chalmers Industriteknik)
- LCNetBase - Life cycle assessment using traceable US data - Sylvatica
- SimaPro 7 for Windows - PRé Consultants
- SPOLD - Society for the Promotion of Life-cycle Assessment Development
- TEAM(TM) (Tools for Environmental Analysis and Management) - Ecobalance, Inc.
- Umberto - An advanced software tool for Life Cycle Assessment - Institut für Umweltinformatik

Transportation LCA Tools

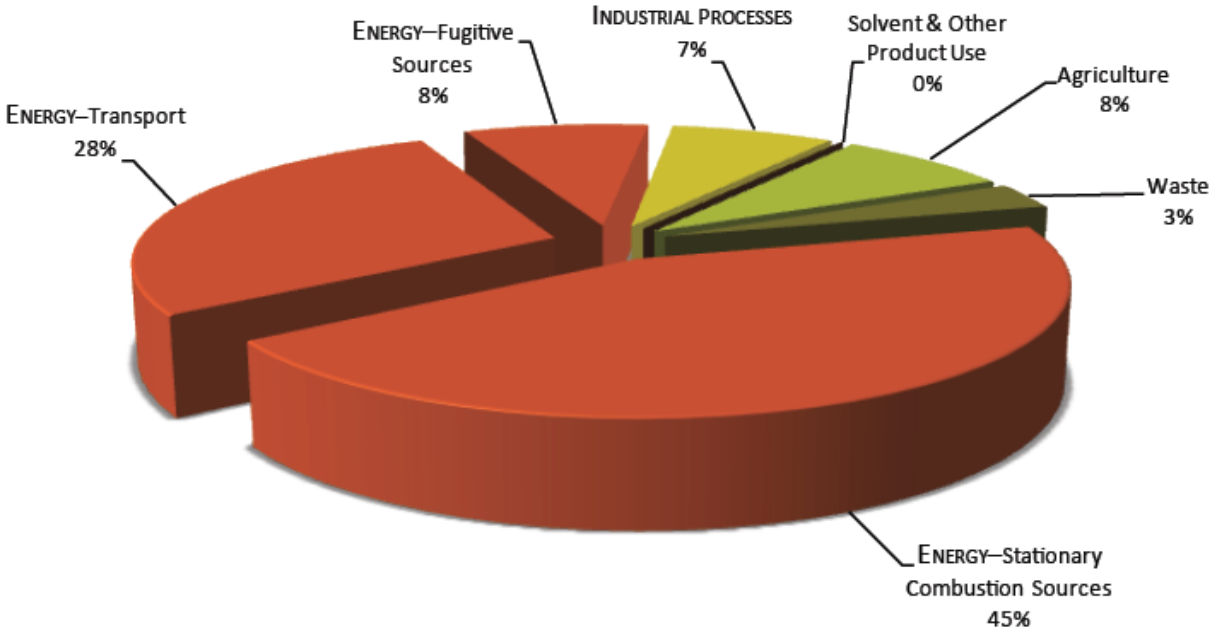
- GHGENIUS (NRCan)
- GREET (Argonne National Laboratory)
- LEM (Mark Delucchi, UC Davis)
- GEMIS (European)
- Gabi (European)
- SimaPro (European)

Why GHGenius?

- Follows an accepted LCA process.
- Transportation specific but covers most energy sources and many materials manufacturing processes and land use changes.
- Best Canadian database available.
- Good American database
  - Allows comparison of Canadian and US applications of the same process.
  - There are some significant differences in the industrial infrastructure between the countries.
- Has some economic tools incorporated.

LCA Inputs

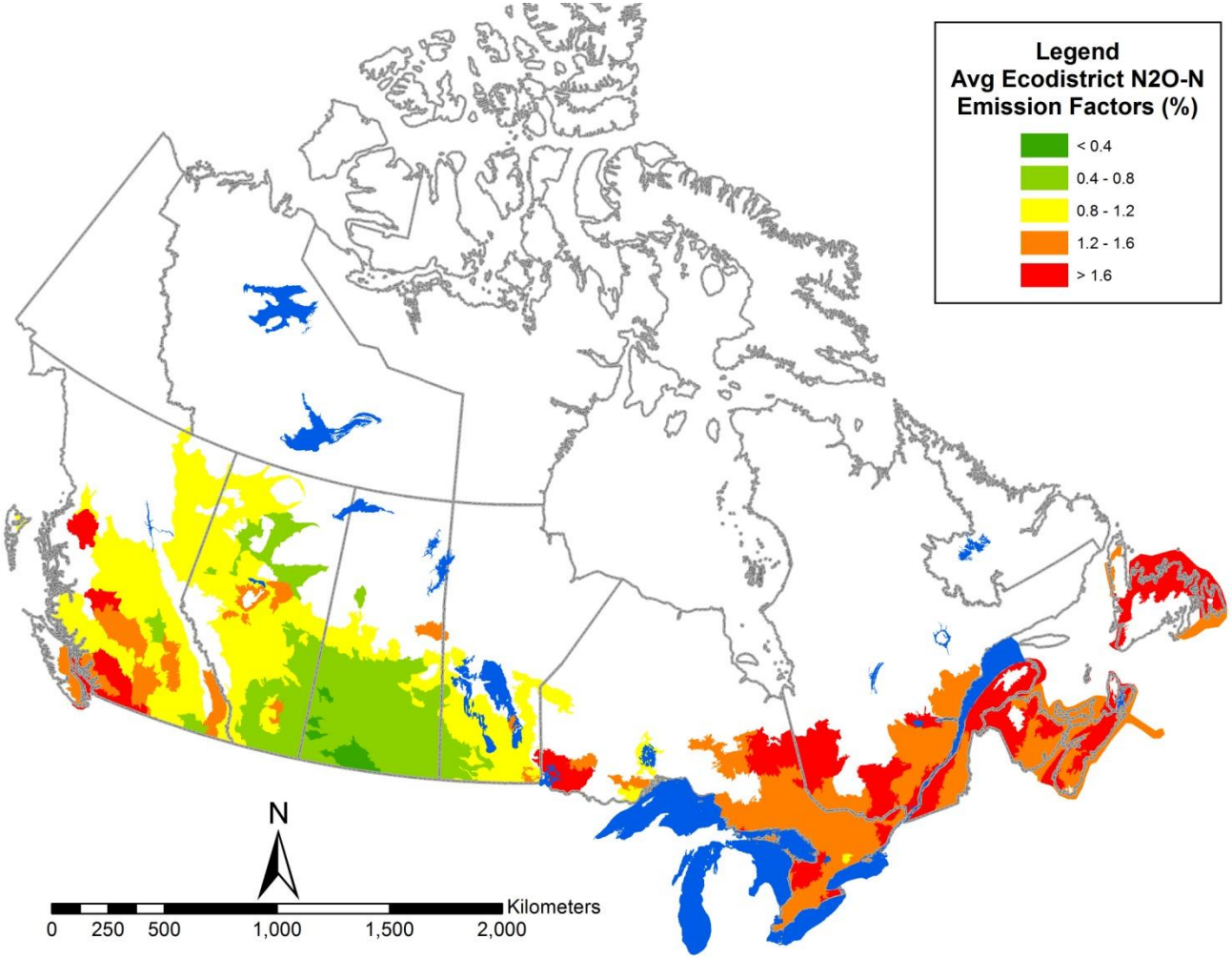
- In most systems one records energy and materials flows.
  - From this information you can determine the emissions created by the system.



Biomass Systems

- Biomass systems have important emissions and sinks that aren't energy related.
  - This makes biomass LCA analysis more complex and to a certain extent more uncertain.
- N_2O emissions
  - From the breakdown of nitrogen fertilizers and biomass residues.
  - ~300 times more powerful than CO_2
  - Globally a lot of uncertainty about the emission factors for N_2O, but a lot of good work has been done in Canada and western Canada has low N_2O emission rates.

W Canada N_2O Emission Rates



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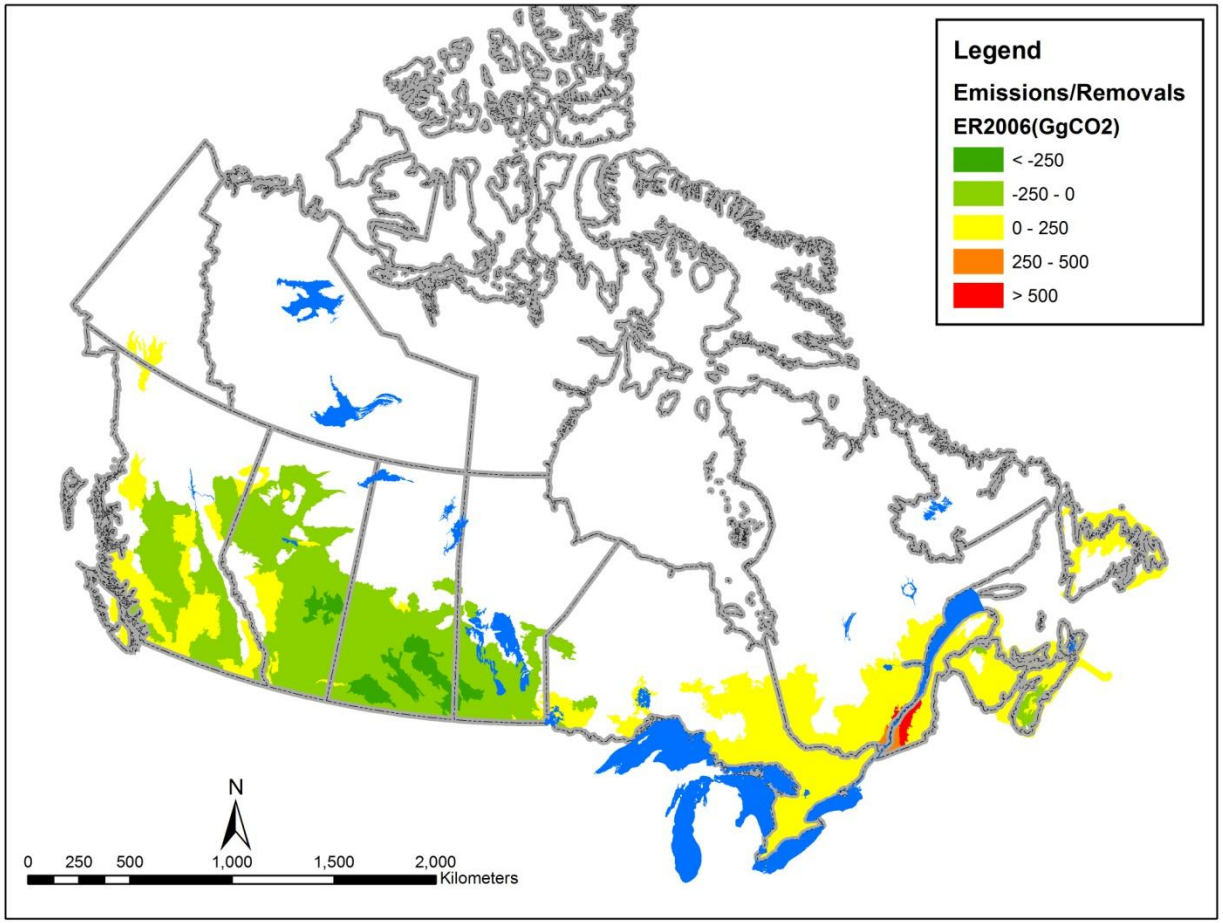
Carbon Stocks

- The big debate about bioenergy systems surrounds changes in carbon stocks.
  - Soil carbon
  - Above and below ground biomass.
- Changes in these stocks can be positive or negative for biomass systems.
  - Reductions in carbon stocks will have large negative impacts on LCA results.

Positive Changes



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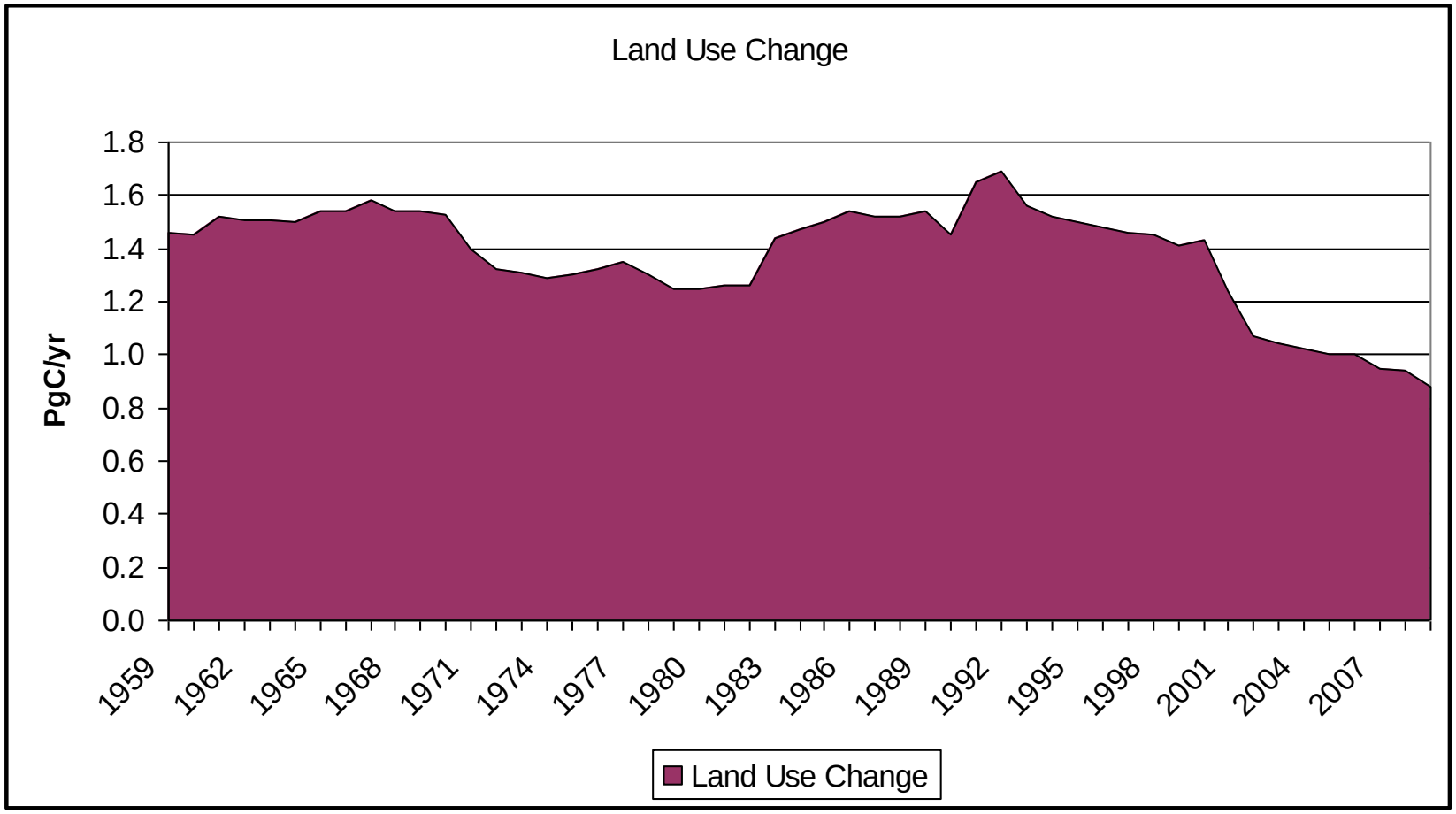
Negative Impacts

- Conventional agriculture practices that can lead to a reduction in carbon stocks include;
  - Aggressive tillage
  - Removal of most residues
  - Draining peat areas.
- Expansion of agriculture into pasture and forest areas (land use change).
  - This is the big Indirect Land Use Emission (ILUC) debate in the US and Europe.
  - Loss of forests will negate most of the GHG benefits of bioenergy and biomass systems.

Global Carbon Budget



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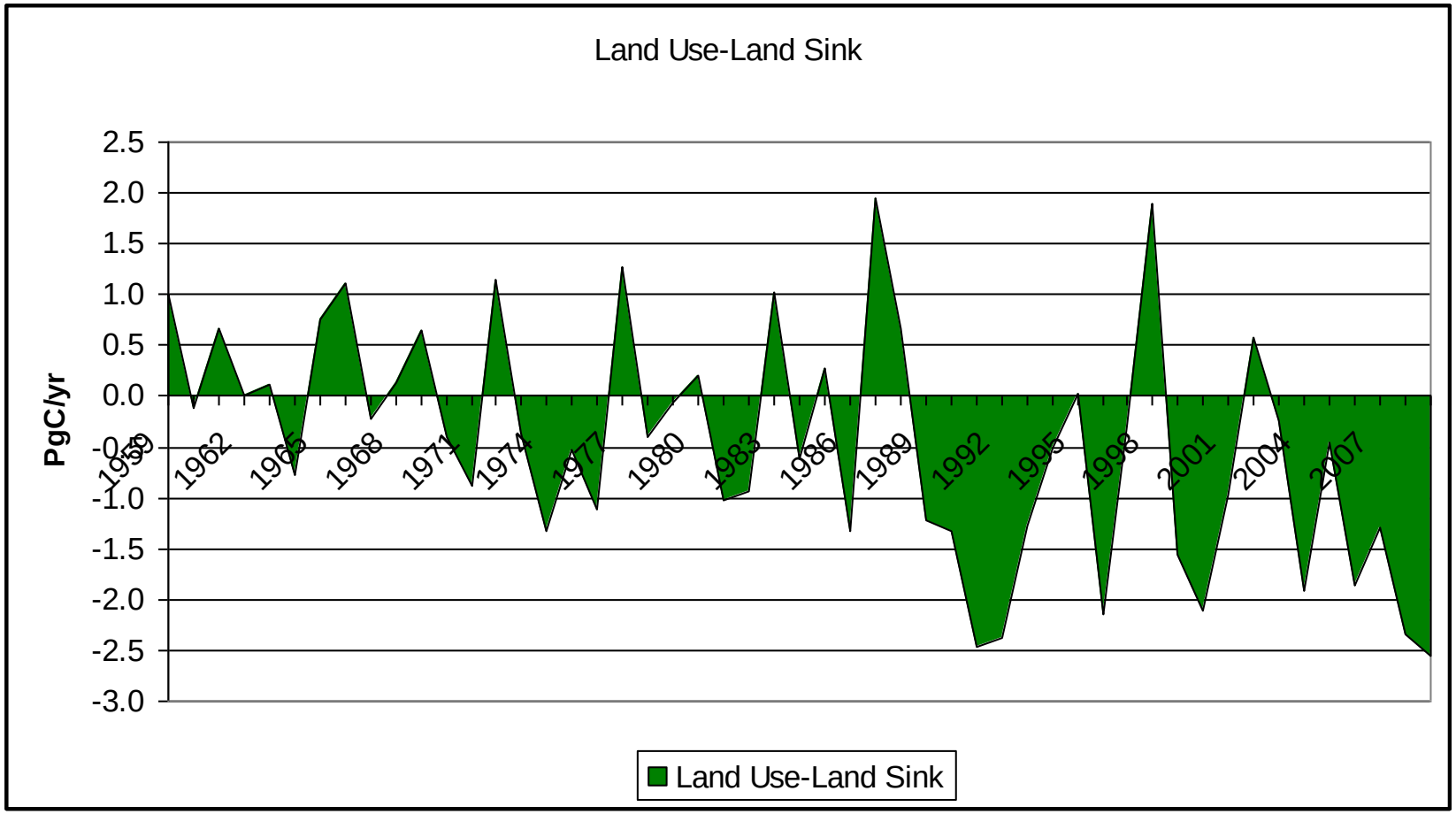

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Forestry

- Carbon stock changes in forestry are particularly controversial.
- Perspective is everything.
  - Do you look at it tree by tree?
  - A large area that is harvested sustainably?
  - What is the starting point?
  - Do trees live forever?
- Most Canadian forests don't meet the definition of renewable biomass that the US EPA has established for their Renewable Fuel program.
  - They are not plantations where the trees are manually planted.

Findings of Some Studies

- Emissions associated with the collection of crop residues are generally pretty small if done properly.
  - There is a correlation between cost and emissions. Economic collection systems generally have low emissions.
- Wood residues are usually considered to be a low emission source of biomass.
- The use of standing timber is not universally accepted as a source of sustainable biomass.

Thank You