Life-Cycle GHG Accounting Versus GHG Emission Inventories

Life-cycle greenhouse gas (GHG) accounting evaluates and reports the full life-cycle GHG emissions associated with the raw materials extraction, manufacturing or processing, transportation, use, and end-of-life management of a good or service. A life-cycle perspective accounts for all emissions connected to the good or service, regardless of which industrial or economic activities or sectors produce these emissions (e.g., energy, mining, manufacturing, or waste sectors) and when these benefits occur over time. This is fundamentally different from GHG inventories that quantify GHG emissions from different industrial or economic sectors on an annual basis.

EPA's Waste Reduction Model (WARM) is an example of a life-cycle GHG accounting tool. It differs from GHG inventories in a two important ways:

1. WARM assesses GHG benefits from a systems perspective—cutting across the traditional sectors used in inventories—to show how manufacturing, transportation, and end-of-life disposal practices relate to materials management.

2. WARM quantifies the full GHG benefits from materials management decisions, regardless of when the benefits occur.

In contrast to the perspective used in life-cycle accounting tools, GHG inventories identify and quantify human-caused sources and sinks of GHGs in order to develop an accounting of overall GHG emissions for a specific entity (e.g., organization, community, or nation). GHG inventories are used to establish baselines, track GHG emissions, and measure reductions over time for that entity. The perspective of inventories depends on the timeframe used to evaluate GHG emissions. In some cases, inventories may offer a narrower accounting of GHG emissions. For instance, an annual inventory that includes emissions associated with producing materials may not also include emissions associated with managing that material at end-of-life given that the material may still be in use. This prevents decision-makers from using inventories to assess the full life-cycle benefits of materials management options. This life-cycle view is exactly the perspective that GHG accounting tools, like WARM, are designed to communicate. The key differences between and uses of these two methods are described in the table below.

Table 1: Summary of key characteristics and uses of life-cycle GHG accounting approaches (such as EPA's Waste Reduction Model, or WARM) relative to GHG emission inventories

	Life-cycle GHG Accounting	GHG Emission Inventories
Characteristics	• Typically used to evaluate GHG emissions for a specific material or product. • Provides a systems perspective that evaluates GHG emissions from raw materials extraction, processing, manufacturing, transportation, through disposal of a product, material, or service. • Evaluates all GHG emissions or benefits over the full life-cycle of a product, material, or service, no matter in which sector or when they occur.	• Provides a comprehensive accounting of GHG emissions at an organizational, local, state, national, regional, or global level. • Evaluates GHG emissions from source categories or sectors, e.g., agriculture, energy, waste. • Estimates GHG emissions for a specific calendar year.
Uses	• Identify hot spots along the life cycle of a product, material, or service where emissions are large. • Establish GHG footprints and measure the effect of steps to reduce GHG emissions along a product, material, or service's life cycle. • Evaluate changes in policy decisions relating to production, transportation, use, and disposal of products, materials, or services. • Compare the impacts of alternative materials, methods, and practices.	• Identify large emitters of GHG emissions within an organization, community, state, region, or nation. • Establish baselines, goals, and targets for reductions. • Track GHG emissions to understand trends. • Measure annual reductions. • Meet reporting requirements. • Allow comparisons across entities.

Life-Cycle Versus Inventory Perspectives: An example

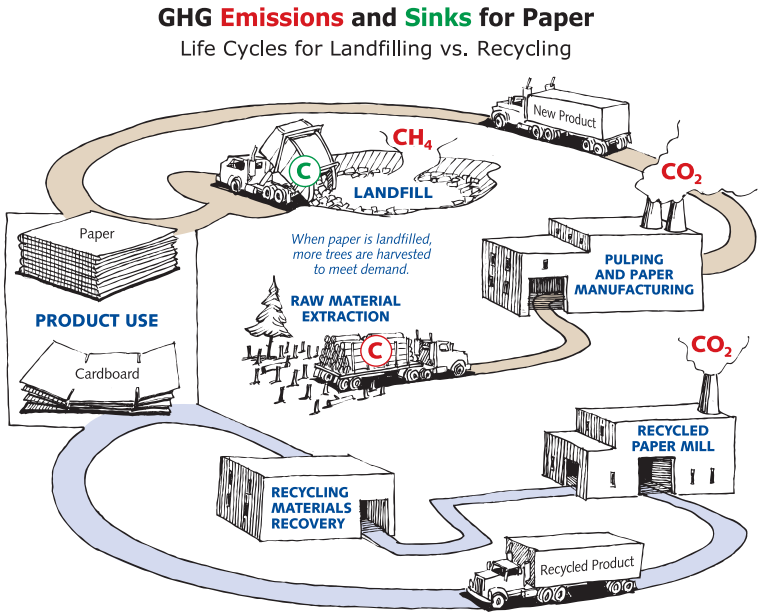

Figure 1: A life-cycle GHG accounting perspective of paper

Consider the production of paper. From a simplified life-cycle perspective, GHG emissions occur from the harvest of trees, sawing trees into logs, pulping, paper making, transportation for distribution and use, and landfilling at end of life (see top half of Figure 1). Instead of landfilling, paper can be collected and recycled into new paper, which reduces the need for harvesting wood and manufacturing virgin paper (see bottom half of Figure 1). Recycling also avoids the generation of methane emissions as the paper would have degraded over the next few decades in the landfill.

Now imagine the same system from a GHG inventory perspective. Instead of viewing GHG emissions from the *processes* used to make and manage paper, GHG inventories model the annual individual *sources* of GHG emissions. For instance, the GHG emissions associated with paper are quantified separately within each of the following GHG sources:

- Fossil fuel combustion (for heat and electricity used to harvest, manufacture and recycle paper; for distribution and disposal of paper at end of life);
- Natural gas and petroleum systems (to produce the fuels used to make paper);
- Wood biomass consumption (for heat and electricity used to harvest and manufacture paper);
- Land use, land-change, and forestry (for changes in the amount of carbon stored in forests);
- Soda ash production (for use in chemical pulping of paper);
- Wastewater treatment (for treating the waste produced by pulp and paper mills); and
- Landfills (for methane emissions from landfilling paper).

Recycling paper reduces the amount of wood harvested from forests, reduces GHG emissions from the combustion of fossil fuels in manufacturing and transportation, and avoids future methane emissions that would have occurred if the paper had been landfilled. It is challenging to relate these life-cycle reductions to the sector-based, annual perspective of inventories because these reductions often occur across a number of different sectors and over a varying or uncertain amount of time. To account for the full implications of producing, consuming, and disposing or recycling paper, a life-cycle perspective is required.