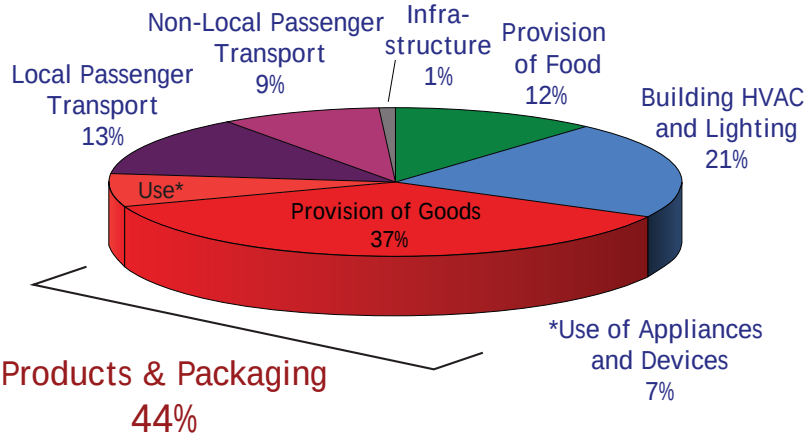
White Paper

Products, Packaging and US Greenhouse Gas Emissions

*by Joshuah Stolaroff - PhD** *September 2009*

Executive Summary

This paper builds on a new report from the U.S. Environmental Protection Agency, "Opportunities to Reduce Greenhouse Gas Emissions through Materials and Land Management Practices," which offers new insight into the impact of products and packaging on climate change. Based on the report, non-food products are associated with 37 percent of U.S. greenhouse gas emissions. **This paper extends the EPA analysis to include the impacts from producing products abroad that are consumed in the U.S. This brings the share of products and packaging to 44 percent of total U.S. greenhouse gas emissions.**



U.S. Greenhouse Gas Emissions: Systems-based view
including emissions embodied in international trade.
(Provision of Goods: all consumer goods including building components and vehicles.)

A comparison with these national-level figures is made with previous research on U.S. household carbon footprints, which similarly finds that products make up a large share of the average household's greenhouse gas impact and a significantly larger share when international emissions are included. Examples are given of how state and local governments can measure and reduce emissions associated with products. Extended Producer Responsibility is discussed as a policy option to reduce the greenhouse gas impact of products.

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Products and packaging are responsible for a large share of greenhouse gas emissions in the United States.

Products and packaging are an essential part of daily life for North Americans. Along with food, shelter, and transportation, products are the spoils of an industrial economy that fulfill the needs and wants of modern consumers. However, in its current structure, this economy has many environmental impacts, including a growing and dangerous influence on the Earth's climate.

Transportation, buildings, and, increasingly, food production, are known to contribute to global climate change. But products are an often-overlooked driver of global emissions.

The typical lens through which to view greenhouse gas emissions is through the economic sectors in which they are released. By allocating emissions according to economic sectors, we find the vast majority of greenhouse gas emissions occur in the electric power, transportation, and industrial sectors (34, 28, and 19 percent of emissions, respectively).[1] This view suggests that these three sectors are the most important to control in order to reduce overall emissions and address climate change.

Considering only emissions that are released within U.S. borders, the total share of U.S. greenhouse gas emissions associated with products and packaging is 37 percent.

Products do not play an obvious role in this picture. Most products do not emit greenhouse gas directly. The notable exceptions are appliances that run on natural gas and paper products, which emit methane as they decompose in landfills, but neither of these comprises a large share of total greenhouse gas emissions. On the other hand, if we view the impacts of products more completely, across the life cycle of extracting raw materials, processing, manufacturing, transporting, using, and disposing of products, a different picture emerges.

The U.S. EPA recently released a report, "Opportunities to Reduce Greenhouse Gas Emissions through Materials and Land Management Practices."[2] Instead of sectors, this report allocates U.S. greenhouse gas emissions to "systems" (see Figure 1). According to the report, "each system represents and comprises multiple parts of the economy that work together to fulfill a particular need." This systems view is "helpful for framing opportunities to reduce greenhouse gas emissions through prevention-oriented mitigation strategies that act across an entire system."

What the report calls "prevention-oriented mitigation strategies" include many of the strategies that can reduce the impact of products, like green design, waste prevention, and recycling. EPA's systems view is useful, then, for understanding the impacts of products and means of reducing those impacts.

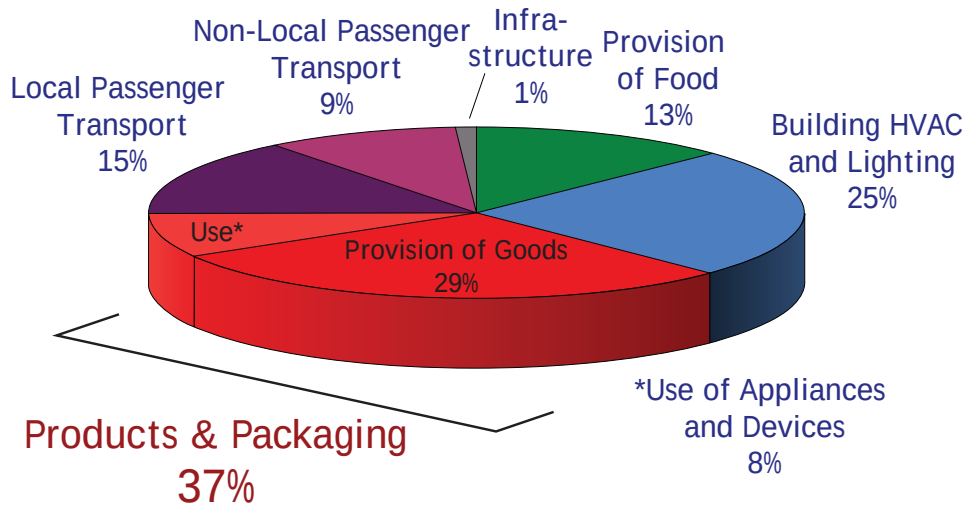

Figure 1: U.S. Greenhouse Gas Emissions: Systems-based view. Source: U.S. EPA, 2009.

(Provision of Goods: all consumer goods including building components and vehicles.)

The "Provision of Goods" system in Figure 1 is similar to what we consider the impact of products and packaging in the full life cycle sense, except for the use phase of the life cycle. It includes emissions from extracting raw materials, processing materials, manufacturing, transporting, and disposing of non-food goods, and accounts for 29 percent of U.S. greenhouse gas emissions. The goods in this system include all non-food products, all packaging (including for food), vehicles, and materials for buildings and construction (except for heavy infrastructure).

Emissions associated with vehicle manufacturing and building construction (including manufacturing of furnaces, hot water heaters, and air conditioners) cannot be separated from other products in the EPA data, so the Provision of Goods slice represents products in a very broad sense.

The use phases of products are split among various other slices in Figure 1. Aside from vehicles and buildings, the use phases of most products are included under "Use of Appliances and Devices." This system accounts for 9 percent of U.S. greenhouse gas emissions. Combining Use of Appliances and Devices with Provision of Goods, that is, combining the use phase with other phases of the product life cycle, gives us one picture of the impact of products and packaging. Considering only emissions that are released within U.S. borders, the total share of U.S. greenhouse gas emissions associated with products and packaging is 37 percent.

Based on EPA's formulation, the products represented in Use of Appliances and Devices represents a narrower set of products than what is represented in Provision of Goods. Depending on how broadly one defines products, the

combined estimate for the GHG impact of products either under-counts the impact of the use phase (because it excludes the use phase of air conditioners and cars, for instance), or an overestimate of the impact of the the production phases (because it includes those goods). Although 37 percent should not be considered a precise figure, we feel it is the best picture of the impacts of products and packaging available from the EPA data.

Products and packaging account for an even larger share of emissions when products imported for consumption in the U.S. are included.

When one includes emissions from producing goods imported into and consumed in the U.S., products and packaging account for 44 percent of greenhouse gas emissions.

The EPA report referenced above includes only direct emissions in the U. S. However, a great deal of the products consumed here are produced elsewhere. The environmental impacts, including greenhouse gas emissions, from producing those products originate in other countries. Emissions that occur elsewhere but are driven by local consumption are referred to as "indirect" emissions. In the context of U.S. national greenhouse gas impacts, the indirect emissions are international.

Many approaches for reducing greenhouse gas emissions, for example a cap-and-trade system or renewable electricity standard, act on direct emissions. Implementing these approaches requires knowing where the emissions are physically released. In these cases, only domestic emissions can be addressed. The sectors view is useful in these cases because it tells you the share of emissions coming from a particular type of facility, like electric power plants.

Other approaches reduce emissions by changing the ways we produce, consume, and dispose of products and packaging. Manufacturers may improve their design or production process to reduce greenhouse gas impacts. Recycling systems can be improved. Or consumers may choose to buy more sustainable products. All of these changes can reduce emissions in other countries. In these cases, it makes sense to consider the life cycle emissions of products, including international emissions. EPA's report, though it goes a long way to connecting these approaches to climate change by presenting the systems view, does not attempt to quantify the international impacts.

In the paper "Embodied environmental emissions in U.S. international trade, 1997-2004," Weber and Matthews estimate that the carbon dioxide emissions from producing goods imported and consumed in the U.S. were equivalent to 13-30 percent of U.S. direct emissions in 2004.[3] Using output from the same model of emissions associated with international trade used in that paper,[4] we can break out the emissions associated with imported goods into the various systems in Figure 1. **Figure 2** shows a version of the systems

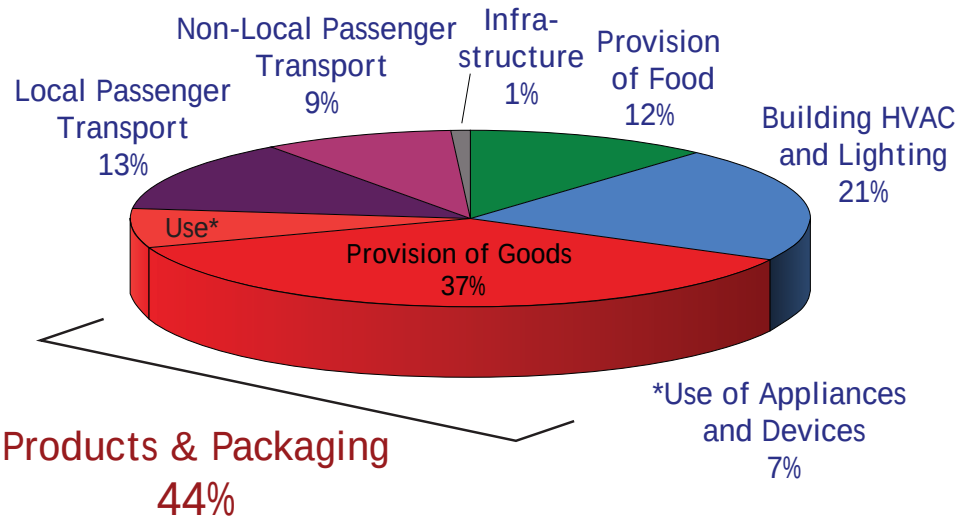

Figure 2: U.S. Greenhouse Gas Emissions: Systems-based view ***including emissions embodied in international trade.***

(Provision of Goods: all consumer goods including building components and vehicles.)

allocation of greenhouse gas that accounts for international trade. We can call this a consumption-based accounting of U.S. emissions, because it represents emissions from goods and services used and consumed in the U.S. (emissions from producing goods domestically that are consumed in other countries are subtracted).

From the consumption perspective, the U.S. greenhouse gas emissions pie is 12 percent bigger than the direct emission perspective in Figure 1. Also, products make up a larger share of this larger total. When one includes emissions from producing goods imported into and consumed in the U.S., products and packaging account for 44 percent of greenhouse gas emissions.

Previous research on household carbon footprints shows similar results.

The EPA report allocates greenhouse gas emissions at a national level. A similar accounting can be done at the state, local, or household level. Another recent study by Weber and Matthews assesses household carbon footprints using surveys of consumer expenditures.[5] Using data from that study,[6] we can show the shares of greenhouse gas emissions of various categories of consumption for the average U.S. household (see **Table 1**). By examining the components of each of Weber's and Matthews' consumption categories, we determined which categories best represent products and packaging. Grouping those categories together, we find that products and services account for 23 percent of the household carbon footprint when only U.S. direct emissions are considered.

Table 1: Average U.S. household carbon footprint by consumption category, **including international emissions embodied in imported goods.** Categories that best represent products and packaging are grouped to show total impact. Source: Weber and Matthews, 2008 and Weber, 2009.

Consumption Category	Total [tons CO_2/ household]	% Total
Food/Beverages	6.7	15%
Transportation	6.5	14%
Housing and Utilities	12.9	28%
Health	4.6	10%
Furnishings, Equipment, Maintenance	2.1	5%
Recreation and Culture	1.7	4%
Miscellaneous Goods/Services	7.6	17%
Clothing/Footwear	2.5	5%
Communications	0.7	1%
Education	0.6	1%
Total	**45.9**	**100%**
Products & Services Combined	**33%**	

By adding the international impacts of imports ... the share associated with products and services increases to 33 percent.

The value is not directly comparable to EPA's Provision of Goods slice discussed above for several reasons. The goods in EPA's slice include some products that are accounted for elsewhere in the household consumption categories, such as building materials and vehicles. The 23 percent value does not include energy used by appliances and devices, which is not separated from other building energy use in the household categories. Finally, the household consumption analysis does not account for government spending, which would shift the category shares. Overall, the systems view discussed above is most useful for framing broad government polices. The household view is most useful for consumers to understand and reduce their own footprints and for framing policies aimed at assisting or influencing consumers. However, given the very different perspectives (household versus national), differences in category definitions, and independent methodologies, the household carbon footprint study illustrates a similar point to the EPA report: products account for a large share of U.S. greenhouse gas emissions.

Weber and Matthews also find that by adding the international impacts of imports, the average household's carbon footprint increases by 54 percent, from 30 to 46 metric tons of carbon dioxide per year. The share associated with products and services increases to 33 percent, as shown in Table 1. Most of the 46 tons per year of emissions associated with the average household are indirect emissions. Only 8 tons of carbon dioxide per year are direct emissions, produced primarily by driving and home heating. A household "imports," in a sense, most of the goods and services that result in greenhouse gas emissions.

States and localities can control their greenhouse gas footprints by addressing products and packaging.

Most states and localities import a high proportion of products relative to what they produce. So, as with households, the difference between direct emissions and consumption-based emissions can be pronounced. Consumption-based emissions come with more uncertainty and are more complex to calculate than direct emissions, which is part of why most official greenhouse gas inventories use only the direct approach. However, using consumption-based accounting allows one to pursue many more options for reducing a greenhouse gas footprint. A household using direct emissions accounting, for example, can only reduce its carbon footprint by driving less and turning the heat down, or perhaps buying a more efficient car or furnace. A household using consumption-based accounting could reduce its footprint by choosing lower-impact products, by reusing devices rather than buying new ones, by recycling, and many other strategies, in addition to driving less and turning down the thermostat.

When developing a state or local greenhouse gas inventory, a full consumption-based accounting may not be immediately possible due to data or analytical limitations. Efforts to develop consumption-based accounting systems for communities are underway in Oregon and elsewhere. However, one can use a hybrid approach that doesn't involve the complexity and data demand of accounting for all types of goods consumed locally, but that does include some consumption categories that can be influenced to reduce greenhouse gas emissions.[7] For example, using a hybrid approach the township of Maplewood, New Jersey, found that "solid waste", a category that includes the impacts from only a portion of all products, accounts for 9 percent of the community's total emissions and 13 percent of emissions that can be addressed locally.[8] The City of Denver found that "embodied energy in materials," a category that covers only a portion of impacts from products and packaging, accounts for 10 percent of total greenhouse gas emissions.[9]

If accounting for emissions associated with products, a state or locality can use strategies like recycling and waste prevention to meet greenhouse gas reduction targets. The State of Connecticut, for example, identified recycling and waste prevention as one of its top ten strategies to reduce greenhouse gas emissions.[10] The City of Ft. Collins, Colorado, estimates that it will reach 17 percent of its greenhouse gas reduction goals in 2020 through recycling.[11]

State, local, and federal governments should adopt policies to reduce the greenhouse gas impact of products and packaging.

Products and packaging account for a substantial share of greenhouse gas emissions. In order to make the deep reductions in greenhouse gas emissions that are necessary to avoid catastrophic climate change, like the 83 percent reduction by 2050 that President Obama has called for,[12] emissions associated with products will clearly have to be reduced. Of the emissions under state and local control, those associated with products and packaging provide an opportunity for substantial and low-cost reductions. Most states and localities do not have influence over many sources of emissions in a sectors framework. They can not set their own regulations on industry, power plants, or vehicles. However, from a consumption standpoint, states and localities influence a much larger share of emissions.

Because product design influences all the stages of the product life cycle, improving product design has the most potential to reduce greenhouse gas emissions associated with products.

The EPA report "Opportunities to Reduce Greenhouse Gas Emissions through Materials and Land Management Practice" calculates the greenhouse gas reduction potential of a variety of scenarios in waste prevention, recycling, and waste management. It finds that substantial greenhouse gas reductions are possible from these strategies. States and localities can capture the benefits in a variety of proven ways. For example, instituting Pay-As-You-Throw pricing for refuse reduces waste and encourages recycling. Improvements in recycling programs and infrastructure can also be a cost-effective way to reduce greenhouse gas emissions.

Many additional opportunities for reducing emissions can best be realized by improving product design and production. For the vast majority of products and materials that end up in a landfill, most of the environmental impacts occur during the production phase. Similarly, most of the benefits from reusing or recycling a product come from avoiding the extraction of raw materials and production of a new product to replace it.[13] Because product design influences all the stages of the product life cycle, improving product design has the most potential to reduce greenhouse gas emissions associated with products. Designs which improve product durability, reusability, recyclability, and materials efficiency all can reduce impacts from the production, transport, and disposal of products and packaging while reducing waste management burdens on local governments.

States and localities can encourage this type of design with Extended Producer Responsibility (EPR) policies.[14] EPR makes producers responsible for their products at end of life. For example, with a product take-back mandate, manufacturers and/or retailers are required to take back products after use. The mandate is typically coupled with a recycling rate target that producers must meet. Another approach is to hold producers financially responsible for their products through producer-managed advanced recycling

fees. The fee is charged according to product sales to cover the cost of recycling, and may in turn be used to subsidize recycling over disposal.

Many states, communities, and countries have successfully implemented EPR policies for a variety of product types. EPR programs are well-known to reduce waste associated with consumer products and documented increases in recycling have occurred in all countries which have implemented it.[15]

States and localities can encourage this type of design with Extended Producer Responsibility (EPR) policies.

To learn more about EPR and other ways to reduce impacts from products and packaging, visit the Product Policy Institute at www.productpolicy.org.

Conclusions

This paper discusses two major findings. The first, supported by the new EPA report, "Opportunities to Reduce Greenhouse Gas Emissions though Materials and Land Management Practices," is that products and packaging are associated with a large share of greenhouse gas emissions. A life cycle or systems perspective is needed to understand this impact. The second finding, illustrated by extending the EPA analysis here and supported by previous research by Weber and Matthews, is that the full impact of products can only be understood using consumption-based accounting. The greenhouse gas emissions associated with products are greater when the global impact of making products is taken into account.

Both the systems and consumption-based perspectives are more complex and entail greater uncertainty than the conventional sectors and direct-emissions paradigms. However, both provide more opportunities to reduce greenhouse gas emissions at low cost and with co-benefits. State and local governments can especially benefit from systems thinking and consumption-based accounting. This paper suggests improved recycling practices and Extended Producer Responsibility policies among the many tools available to reduce emissions associated with products.

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Data for Figure 1:

U.S. GHG Emissions by System	MMTCO2E	% Total
Provision of Goods	2040	29.2%
Use of Appliances and Devices	581	8.3%
Provision of Food	895	12.8%
Local Passenger Transport	1019	14.6%
Infrastructure	72	1.0%
Building HVAC and Lighting	1719	24.6%
Non-Local Passenger Transport	666	9.5%
Total	**6992**	**100%**
Products & Packaging Combined		37.5%

Data for Figure 2:

U.S. GHG Emissions by System including Emissions Embodied in International Trade	Domestic [MMTCO2E]	Embodied In Trade [MMTCO2E]	Net [MMTCO2E]	% Total
Provision of Goods	2040	849	2889	36.9%
Use of Appliances and Devices	581	-20	561	7.2%
Provision of Food	895	11	906	11.6%
Local Passenger Transport	1019	16	1035	13.2%
Infrastructure	72	0	72	0.9%
Building HVAC and Lighting	1719	-61	1658	21.2%
Non-Local Passenger Transport	666	42	708	9.0%
Total	**6992**	**838**	**7830**	**100%**
Products & Packaging Combined				44.1%

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About PPI

Product Policy Institute is a North American non-partisan, non-profit research, communication, and educational organization. It promotes policies that advance sustainable production, consumption, and good governance. Founded in 2003, PPI works with communities and their local governments to advocate for public policies that protect public health and safety and address climate change by encouraging waste prevention and clean production. PPI has helped local governments establish Product Stewardship Councils in California, New York, Vermont, and Texas, and is currently working in other states.