Formosa Plastics®

2008 Carbon Footprint Report

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2008 CARBON FOOTPRINT REPORT

Sections:

1. Introduction – Carbon Footprint Basics

The temperature of the earth is affected by many complex factors, including emissions resulting from both natural and man-made activities. Water vapor, carbon dioxide, methane and other compounds are collectively referred to as 'greenhouse gases' because they 'trap' heat that might otherwise escape the planet, like a greenhouse. When they exist in the upper regions of our atmosphere they can lead to global warming and subsequent climate change. On the other hand, natural and man-made emissions, such as particulate and sulfuric acid, act to cool the planet by blocking the amount of solar radiation that reaches the surface of the Earth. Also, carbon dioxide emissions in the lower atmosphere can be considered beneficial as they increase plant growth and the production of oxygen.

Not all greenhouse gases (GHGs) have the same greenhouse warming potential (GWP). See Table 1. Some GHGs, like water vapor, are relatively weak with relatively little GWP. Others, like carbon dioxide (CO_2) and methane (CH_4) have greater warming potential. A few, like chlorofluorocarbons (CFCs) and sulfur hexaflouride (SF_6), are mega-greenhouse gases. The total greenhouse warming effect is a combination of each compound's GWPl and the quantity of each respective compound in the upper atmosphere.

Cover photo: 'Dragonfly' by Tanya Kusak; used with permission.

Table 1
Greenhouse Gases and Their 100-Year Global Warming Potential (GWP), Relative to CO_2

Greenhouse Gas	GWP
Carbon Dioxide	1
Methane	21
Nitrous Oxide	310
CFCs (CF_4 – C_6F_{14})	6,500 – 9,200
SF_6	23,900

A carbon footprint is the total amount of GWP-weighted greenhouse gases produced by an activity – such as one's lifestyle, a community, a country or a commercial/ industrial operation within a given time frame, normally a year. Due to the various impacts of the diverse array of GHGs, a carbon footprint is expressed in either carbon dioxide equivalent (CO_2e) emissions or million metric ton (tonnes) of carbon equivalent (MMTCE) emissions.

For example, when you buy food and other goods, their production and transportation (and possibly use) often produce greenhouse gas emissions that may include CO_2 as well as methane. When you drive a car or travel in an airplane, train or bus, the engine burns fuel and emits CO_2, water vapor and possibly nitrous oxide; emissions from any specific travel event depends on the type of fuel, the engine's efficiency and the distance traveled. When you heat your home or office with oil, gas or coal, that activity also produces CO_2 and other GHG emissions, as does the electric power generated to power your appliances, lights and industrial process equipment. Carbon footprint calculations typically ignore the impact of water vapor emissions, which also contribute to the greenhouse effect in the atmosphere.

2. Carbon Equivalents

The carbon dioxide equivalent emission is merely a form of expressing actual emissions of the various greenhouse

gases having diverse greenhouse warming impacts into a single, normalized unit of measurement. Referring to Table 1, one metric tonne (2,200 lbs) of CO_2 emissions would be stated as one tonne of CO_2 equivalent emissions, CO_2e. One tonne of CH_4 emissions would be stated as 21 tonnes of CO_2e. The carbon dioxide equivalent emissions of the defined activities would then be the sum of all the respective greenhouse gas emissions, expressed in carbon equivalents. Adjusting for the atomic mass of carbon dioxide (44) to carbon (12), 3.67 tonnes of CO_2e equivalent emissions equals one tonne of carbon equivalent (CE) emissions.

Perhaps the greatest flaw with using carbon equivalents as a measure of one's greenhouse gas emissions, hence global warming potential, is that it does not include water vapor emissions. Water vapor is a greenhouse gas; even though it has a sufficiently low GWP to often be excluded, the amount of water vapor emissions is far, far greater than carbon dioxide, so may have an overall greater impact on greenhouse warming much greater than carbon dioxide or the other GHG emissions typically included in a carbon equivalent calculation. Reference 5 provides more complete information.

3. Uncertainties with Greenhouse Gas Emission Calculations and Comparisons

Calculations, bases and assumptions are becoming more standardized, though they still vary greatly among individual companies, facilities, communities and even governments. While international standards such as ISO14044 provide some commonality and consistency, one-to-one comparisons among diverse companies and products are difficult, or impossible, unless one fully understands and adjusts for their diverse bases, assumptions and supply chain structures.

For example, a company with integrated production may incorporate upstream carbon equivalent emissions into its downstream products while another company may not. Meanwhile, a third company without upstream integration might not even have a carbon footprint basis for that portion of their operation. Other firms may or may not include transportation carbon emissions between their sites, to their customers' sites and/or downstream to the use and disposition of their products.

Thus, there are few common bases upon which to make a 'better' or 'worse' comparison between individual companies, facilities, operations or products. The most important result is the trend direction for the same activity over time, using the same bases and assumptions - - is the carbon footprint of the defined activity increasing, staying the same, or decreasing?

4. Carbon Offsets, Credits and Trading

Various mechanisms and systems have been developed, proposed and, in some regions, implemented to encourage the proactive and voluntary reduction of greenhouse gas emissions. All of these systems include or involve one or more of the following features:

- Offsets – Increases in greenhouse gas emissions can be 'offset' by reductions elsewhere. Sometimes, the offset is generated by implementing projects that absorb ("sequester") CO_2, such as the reforestation of areas with trees having high CO_2 uptake rates.
- Credits – If a project can reduce greenhouse gas emissions over and above the reductions specified by a particular set of standards, those additional reductions can be converted to credits – a sort of greenhouse gas 'coupon' that entitles a purchaser to apply those reductions to its activities and operations without having to reduce its own emissions. This is supposed to encourage the cost-effective reduction of greenhouse gases across operational, governmental and regional boundaries.
- Trading – These credits can be bought and sold in certain regions of the world that participate in specific trading schemes and networks, primarily based in Europe. The advantage is that such credits work to produce cost-effective reductions beyond what would normally get created by normal financial consideration. The disadvantage is that these trading networks rely on a cumbersome, inexact process that has faced many volatility and credibility issues over the past several years.

Formosa Plastics Corporation, U.S.A. does not currently participate in the carbon offset/credit markets. Many U.S. companies do not participate in these markets for a variety of reasons, including a) continued market volatility and credibility issues and b) the absence of an established framework in the U.S. Many of the companies in the U.S. that do participate are U.S. affiliates of European-based companies, where carbon credits created in the U.S. can be credited and marketed through their European operating entities.

While there is increasing pressure to regulate carbon emissions, there are few definitive rules or regulations. While the greatest amount of regulatory activity in the U.S. is at the state and regional levels, such sub-regional efforts may be expected to provide to resolve the broader matter of climate change and global warming given their global nature and context.

5. Our Carbon Footprint: 2001 - 2008

As noted above, any carbon footprint calculation result is only relevant to the bases upon which it is founded. Results should never, or at least rarely, be used to compare one company, facility or product with another without fully understanding their bases, assumptions and supply chain structures.

Figures 1 and 2 present our annual production of final products, and our resultant overall carbon footprint, from 2001 through 2008. Since 2001 our carbon footprint has shrunk by about 13%, despite more than a 50% increase in production. As shown in Figure 3, this translates to almost a more than 40% reduction in carbon equivalent emissions per ton of final product produced. These accomplishments are primarily the result of our ongoing and significant energy efficiency improvements.

For the purposes of these calculations, our carbon equivalent emission calculations and estimates:

- Are for production-related processes only; our administration, personnel and transportation carbon emissions are not included. These other emissions can be considered negligible; for example, most of our products are shipped by very energy-efficient rail transport systems.
- Are from products produced at our Point Comfort, TX and Baton Rouge, LA manufacturing sites only. They do not include GHG emissions from Specialty PVC products produced at our manufacturing site in Delaware City, DE and our administrative operations at our headquarters site in Livingston, NJ.

Figure 1

Production of Final Products, 2001 – 2008

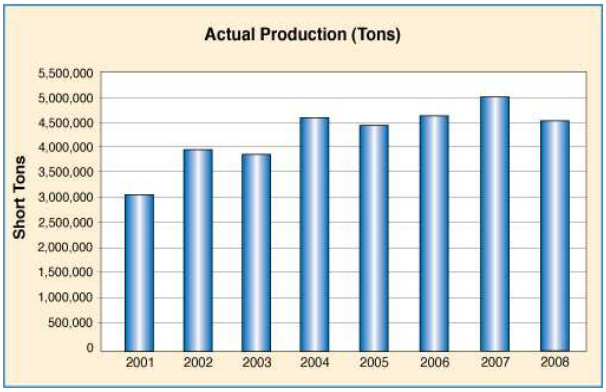


Figure 2

Carbon Equivalent Emissions, 2001 – 2008

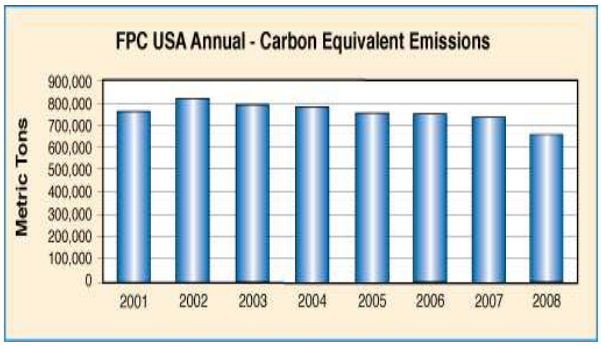
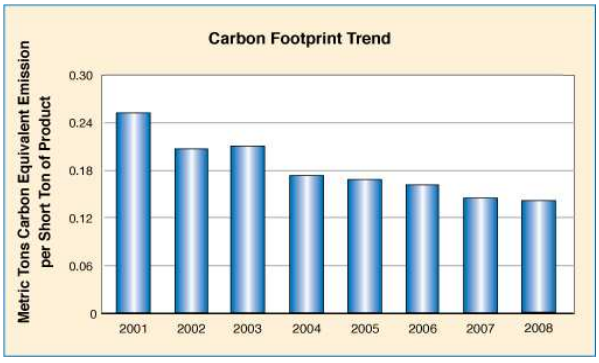


Figure 3

Carbon Footprint Trend, 2001 – 2008



- Use the standard conversion factor of 14.47 million metric tonnes carbon equivalent (MMTCE) per quad (10^{15} Btu) for electricity generated by natural gas.
- Include natural gas electricity and steam generated by general site utilities units, which are distributed equally among all products at their respective site in proportion to the quantity of respective product produced. Several units have their own additional electricity or steam generation; carbon equivalents for that electricity and steam are assigned wholly to those respective production units.
- Exclude offsite raw material production and transportation, offsite product transportation and the use, reuse and disposition of our customers' products. We produce no end-use products.

Results – By Product Line

Table 2 presents the normalized carbon footprint for each of our major products in 2008. Because VCM and PVC are so integrally linked[1], the normalized carbon equivalent emission for the combination of both products is also provided for reference. There are no trend results for 2006 and earlier because 2007 is the first year in which we included product-specific carbon equivalent emissions to our list of tracking metrics.

As expected, caustic is the product with the most significant carbon footprint, owing to the amount of electricity used in the dissolution of the saltwater to produce the caustic. Likewise, it is not unexpected that the carbon footprint for the polyolefins products -- HDPE, LLDPE and PP, are so similar.

These product-specific carbon footprints cannot be simply added together to produce an accurate aggregate carbon footprint for the company. This is due to the manner in which the carbon footprint for each product line was calculated, coupled with the high degree of process integration both a) within our Point Comfort, TX site and b) between our Point Comfort, TX and Baton Rouge, LA sites.

Table 2
Normalized Carbon Footprint; Lbs CE Emitted / Lb Product

Product	2007	2008
Caustic	0.45	0.43
EDC	0.01	0.01
VCM	0.09	0.09
PVC	0.05	0.05
Olefins	0.03	0.03
EG	0.03	0.04
HDPE	0.04	0.04
LLDPE	0.04	0.04
PP	0.03	0.03
VCM & PVC	0.07	0.07

Note: EDC = ethylene dichloride; VCM = vinyl chloride monomer; PVC = polyvinyl chloride; EG = ethylene glycol; HDPE = high density polyethylene; LLDPE = linear low density polyethylene; PP = polypropylene.

6. Frequently Asked Questions (FAQs)

Q: Why is the carbon footprint for your caustic (sodium hydroxide) product so much higher than your other products, especially since the primary feedstock is salt water, not carbon-based petroleum, and the production process requires no combustion heat source, hence carbon equivalent emissions?

A: *Caustic is produced by the electrochemical disassociation (separation) of salt water by electricity. This separation requires significant amounts of electricity, which is provided by natural gas-fired electrical generation units. The indirect carbon equivalent emissions from the combustion of the natural gas used to produce the electricity have been allocated directly to the caustic product.*

Q: How can carbon equivalent emissions go down while production goes up? This seems counter-intuitive.

A: *Formosa has invested heavily in energy efficiency projects such as waste heat recovery, low pressure steam utilization and process optimization. In addition, vertical integration and targeted production*

[1] Ethylene dichloride (EDC) is used internally to produce vinyl chloride monomer (VCM) and, subsequently, polyvinyl chloride (PVC). Because EDC can also be used for other purposes, as well as be sold as an end product itself, EDC has not been included in the combined VCM/PVC carbon equivalent emission presented in Table 2.

debottlenecking improvements often provide additional economy of scale and critical mass for greater operational production efficiencies that produce additional product at little or no increase in energy use (hence carbon equivalent emissions).

Q: What will the company's carbon footprint look like when you start using steam and electricity produced by the new Circulating Fluidized Bed (CFB) units?

A: *We are still evaluating the impact of that future change. While the pet coke fuel will have a greater carbon intensity content than natural gas, it will also have higher energy per pound-mass and the unit will be more efficient in its conversion of fuel to useful energy. We are in the process of determining the appropriate "metric tonnes of carbon equivalent emissions per quad of electricity" conversion factor appropriate for the type of pet coke that these units will be using as their primary fuel. A 'quad' of electricity represents 10^{15} Btus.*

Q: Why don't you include carbon emissions from your Delaware City, DE and Livingston, NJ sites in your carbon footprint calculations?

A: *Scoping calculations have shown that these facilities and operations have very minor carbon footprints compared with our two major production facilities at Baton Rouge, LA and Point Comfort, TX.*

Q: Some companies also include the carbon impacts of its products' transportation, use and disposition into their calculations. Why doesn't Formosa?

A: *There are many ways that companies, communities and governments both measure and report on their carbon footprints. At this time Formosa Plastics Corporation, U.S.A. has chosen not to include carbon emissions from materials, processes and activities external to our own onsite operations. Those carbon emissions may be included in other sources' calculations and reporting, so including them in our footprint might 'double count' the footprint in any regional or industry-sector compilations. Also, it's important to note that one company has been heavily criticized for taking carbon equivalent credit for its products that reduce others' energy use and emissions.*

Q: What is Formosa's carbon footprint reduction goal and position on global warming/climate change?

A: *Each year we set very aggressive internal energy efficiency improvement targets. We believe that this is the best overall way to a) reduce energy use, b) reduce costs, c) improve productivity and d) reduce carbon equivalent emissions – all at the same time. The results shown in Figure 3 demonstrate that if we take aggressive action on energy efficiency goals, we will also achieve significant carbon footprint reductions.*

7. Conclusion

Our results show that if we continue our rigorous efforts to reduce costs through improved energy efficiency, our carbon footprint will take care of itself. Significantly more sophisticated, resource-intensive efforts like addressing carbon emissions from employee commuting/ business travel or carbon sequestration projects would provide only small, incremental improvements. Also, emission credit markets and trading are not suitable areas for our participation at this time.

Our future opportunity is how to achieve sufficient energy efficiencies to offset carbon emissions from plant expansions due to come online in the near future. In addition, the startup and operation of our new CFB power generation units in Texas may have a notable impact on some segments of our carbon footprint.

8. Additional Resources

The following resources provide additional information on carbon footprints, carbon equivalents and related issues:

1. Appendix X to the General Reporting Protocol: Power/Utility Reporting Protocol. October 15, 2004.
2. Carbon Finance Newsletter. Fulton Publishing Ltd.; See www.carbon-financeonline.com
3. *Carbon Neutral*; See www.CarbonNeutral.com

4. *Climate Biz*; See *www.climatebiz.com*
5. "Just how much of the greenhouse effect is caused by human activity?" See *http://www.geocraft.com/WVFossils/greenhouse_data.html*
6. "Key Issues and Mandates: Climate Change – Frequently Asked Questions", National Energy Technology Laboratory; See *http://www.netl.doe.gov/KeyIssues/climate_change3.html*
7. "Our Operations – Vertical Integration". An interactive diagram that illustrates how Formosa Plastics' production chemistry and processes are vertically integrated for energy/resource efficiency and operational productivity. See *www.fpcusa.com/company/operations/vertical.html*.
8. Pew Center on Global Climate Change; See *www.pewclimate.org*
9. Regional Greenhouse Gas Initiative (RGGI); See *www.rggi.org*
10. U.S. EPA Climate Leaders Program; See *www.epa.gov/climateleaders/*
11. U.S. EPA Natural Gas Star Program; See *www.epa.gov/gasstar*
12. Voluntary Carbon Markets – An International Business Guide to What They Are and How They Work; R. Bayon, A. Hawn and K. Hamilton; 2007.

You expect more. And Formosa delivers.®

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