

Climate Neutral Network Product Emissions Protocol

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Acknowledgement

Climate Neutral Network appreciates the contributions made by many individuals to the GHG protocol.

The following individuals were key in the development of this draft.

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A. Product Emissions Footprint

I. Overview

The Climate Neutral Network has developed a series of resources to aid you in developing a product emissions footprint:

- ***Climate Neutral Network Design principles*** - the Design Principles that are relevant to the establishment of a product emissions footprint are summarized below. These design principles guided the development of the decisions tools described below and provide the principles and intent of the Network’s rules to aid in making any necessary subjective decisions
- ***Summary of steps (blueprint)*** necessary to establish your emissions footprint (see Section II)
- ***Detailed discussion of each step of the blueprint.*** The blueprint includes a description of the emissions you must include, the default values you may use in your calculations, and provides appropriate methods of calculations (See Section III)
- ***Decision Tree*** – guides you through a series of questions that must be answered for each step of the blueprint (See [Appendix 1](#))

Climate Neutral Design Principles Relevant to Establishing a Product Emissions Footprint

Several Climate Neutral Network design principles guide the development of a product emissions footprint:

1. The boundary used by the Climate Neutral Network for a product is from “cradle to grave” throughout the value chain. This includes the upstream emissions from the sourcing of raw materials, transportation, manufacturing, and downstream emissions including emissions from the product’s use and disposal.
2. *Climate Neutral* products or services have been certified to have completely offset the greenhouse gases generated across each stage of their life-cycle—including the sourcing of their materials and their manufacturing or production, distribution, use, and ultimate end-of-life disposition.
3. *Climate Neutral* warranties would apply to products such as cars or appliances (which consume a lot of energy /fuel during use or have ambiguous lifetime durations) to cover the majority of emissions from both manufacturing and use (e.g. 60,000 miles for cars)¹
4. The boundary is expanded beyond the “cradle” for electricity and natural gas to include transmission losses associated with the cradle to grave fuel consumption
5. Materiality - emissions that are core to the production, use and disposal of the product and are estimated to be greater than 4% of the product’s total emissions should be included in the product footprint.
6. GHG emissions are quantified in metric tons CO2 equivalent according to the IPCC global warming potential for a one hundred-year horizon

There are three major Steps in the establishment of a product emissions footprint.

¹ [EAB – what warranties does this design principle refer to?](#)

Step 1: Establish Product Boundaries

Step 2: Identify and Calculate the Product Footprint

Step 3: Special Considerations - Adjustments to the Product Footprint Emissions

Each of these steps is summarized then described in detail in Sections II and III below. An example of a product emissions footprint calculation and description is included in Section IV. Appendices include a decision tree that provides a flow chart version of the steps described in Sections II and III. This flow chart guides you through the questions and decisions you must consider as you develop your product footprint. The Appendices also include tables of a variety of default factors for use in your product emissions calculations.

II. Summary of Steps (Blueprint) in the Development of a Product Emissions Footprint

Step 1: Establish Product Boundaries

- General
 - Upstream
 - Raw material extraction
 - Processing energy for raw materials
 - Transportation to manufacturing site
 - Manufacturing
 - Process energy (electricity and onsite fuels)
 - Overhead allocation of corporate emissions
 - Process emissions
 - Transportation to customer
 - Use Phase
 - Electricity or fuels consumed during product use
 - Disposal
 - Transportation to disposal site
 - Landfill gas emissions
- Shared Activities

Step 2: Identify and Calculate Emissions Footprint

- Cradle to Grave Product Emissions
 - Life cycle (LCA) models
 - Embodied energy
 - Purchasing costs of raw material inputs
- Corporate Overhead Emissions Allocation
 - Estimate Corporate Emissions
 - Determine Allocation to Product

STEP 3: Special Considerations - Adjustments to the Product Footprint Emissions

- Purchase of Climate Cool products

Each of these steps is described in Section III below.

III. Blueprint – Detailed Discussion of each Step

Step 1: Establish Product Boundaries

You must define your product boundaries and the emission sources that fall within each boundary. A product emissions footprint should include emissions from activities cradle to cradle – extending beyond the manufacturer or service provider up and down the supply chain to include the entire life cycle of the product as shown in the table below.

Table X: Typical Emission Sources Covered in Product Life Cycle²

Boundary	Emission Source
Upstream	Raw Material Extraction
	Processing energy for raw materials
	Transportation to manufacturing site
Manufacturing	Process energy (electricity & onsite fuels)
	Process Emissions
	Transportation to customer
	Overhead allocation of corporate emissions
Corporate	Electricity or fuels consumed during regular use of the product
	Transportation to disposal site
Use Phase	Landfill gas emissions
Disposal	

In addition – there may be activities undertaken during a product’s lifetime that result in product emissions but that are not undertaken by the manufacturer or service provider. Some or all the emissions from these “shared” activities must be included in the product’s lifetime footprint as discussed below.

Shared Activities – Intrinsic to any product certifications are likely to be other activities that suppliers or customers undertake in the life cycle of the product that contribute to the product’s GHG emissions. These emissions must be included in

² All of these emission sources are subject to the materiality test and therefore the sources covered in particular certifications may vary.

the product footprint in proportion to the amount of control the manufacturer has over the emissions. For example:

- If a manufacturer's product is sold only via the internet then distributed to the customer by a company such as FEDX, even though the manufacturer does not own FEDX, the product manufacturer does control how the product is distributed so should take 100% responsibility for the emissions resulting from FEDX's distribution of the product to the customer.
- If the product is carpet, periodic vacuuming is necessary to maintain the carpet over its life. However, the carpet manufacturer does not control how frequently the carpet is vacuumed and with what type of vacuum cleaner is used. Thus, the carpet manufacturer has partial responsibility for vacuum emissions. In this case the carpet manufacturer should take responsibility for 50% of the emissions resulting from vacuuming the carpet during its life³.
- For a paper manufacturer that sells printed paper - although the paper manufacturer does not own the printing operation it is integral to the manufacturing process since printing is a necessary component to make the paper of value to its customer. To be conservative (and because the emissions were rather small) the paper company assumed all the printing greenhouse gases were part of their product footprint.

For product certifications that are for "services" or fuel based products (such as Climate Cool air travel or Climate Cool hotel rooms) upstream emissions from processing of the fuel used and use phase emissions are the predominant emissions. There may not be "manufacturing" or "disposal" emissions except a share of corporate overhead emissions.

Step 2: Identify and Calculate GHG Emissions Footprint

This section outlines a broad approach to calculating a product's emissions footprint and includes the following steps:

- Methods to calculate the product's cradle to grave footprint
- Methods to calculate the portion of corporate overhead emissions that should be allocated to the product

Methods to Calculate the Product's Cradle to Grave Footprint

Methods to calculate the product footprint tend to be very custom designed and often incorporate several approaches. The basic steps you need to follow are:

³ EAB – see EAB issues. We need to decide how this % responsibility gets determined.

- Step 2.1: Develop categories of emission sources within each boundary and identify available sources of data on quantity and emissions for each
- Step 2.2: Determine the most appropriate methodology for calculating the emissions from each source
- Step 2.3: Gather the data and models needed and calculate cradle to grave emissions.

Each of these steps is described in more detail below.

Step 2.1: Develop the categories of emission sources within each boundary area for your product or service and the available sources of data on emissions for each of those sources.

For example, a consumer products company’s list of emission sources for its product and source of data on those emissions might look as shown in the following table.

Table X. Sample Company List of Emission Sources and Data Sources

Boundary	Emission Source	Potential Sources of Data
<i>Upstream</i>	1. Raw Materials including extraction 2. Transport of raw materials to facility	<ul style="list-style-type: none"> • Suppliers • Models such as GaBi • Industry Associations
<i>Manufacturing</i>	3. Electricity 4. Natural gas 5. Process emissions 6. Waste disposal	<ul style="list-style-type: none"> • Fuel consumption data such as utility bills • Company waste disposal records • GHG Protocol industry specific modules for process emissions • Fuel emission factors (appendices 6 & 7)
<i>Corporate Overhead</i>	9. Product related company employee air travel 10. Product related employee auto travel 11. Employee commute 12. Allocation of Corporate overhead	<ul style="list-style-type: none"> • Company data on use of company vehicles and airplanes • Company or travel agency data on employee travel • Employee data or national default data on employee commute • Corporate data on % allocation of overhead to product • Mobile travel emission factors (Appendix 8)
<i>Use Phase</i>	6. Transport of product to customer 7. Electricity for use & maintenance	<ul style="list-style-type: none"> • Company or hired transport company data (e.g. weigh of product transported, mileage, fuel use, etc.) • Product specifications on energy use, product life, product

		maintenance requirements etc.
<i>Disposal</i>	8. Product disposal	• Company knowledge of how their products are ultimately disposed

Considerations for what emissions must be included within each boundary area follow.

Upstream Boundary

In general, emissions from raw material extraction, raw material processing, and raw material transport on the upstream side of manufacturing must be included in your product footprint. Several special cases of this are described below

Fuel products (e.g. fuel cards, airplane tickets, etc.) - you must include the upstream emissions from refining in addition to the upstream emissions from combustion. Two examples follow”:

- 28%⁴ on top of tailpipe emissions was added for a fuel card product to account for emissions from fuel refining
- 8%⁵ of emissions from per passenger mile use of jet fuel for airline travel was added to a Climate Cool air travel product to account for refining of the jet fuel.

For energy consuming products (e.g. vacuum cleaners, washing machines) - include transmission and distribution losses that result from the consumption of energy over the lifetime of the product in the product footprint. Use 7%⁶ as a default unless you have more accurate local data.

Manufacturing Boundary

Emissions from process energy consumption (electricity and onsite fuels), process emissions from carbon producing processes (such as the production of cement or lime), and from transportation of the product to the customer should be included in the product footprint.

Corporate Overhead

An allocation of corporate overhead emissions must be included in a product or service footprint. This would include a share of emissions from energy consumed at a corporate headquarters, emissions from corporate and employee travel and emissions from employee commuting.

⁴ The 28% factor comes from the Argonne National Labs GREET model (NAL/ESD-39), August 1999.

⁵ Need source of this from NRDC

⁶ EAB – do we want to change this to 8% to be consistent with the California protocol or is 7% a better national number?

Product Use Phase

In determining the downstream boundary you must include emissions resulting from the consumer use of the product. There are several special issues to consider when establishing the downstream boundary.

For energy consuming products - you must include emissions consumed by the product during the life of the product. For example, if the product is a washing machine, you must include the average amount of electricity and associated T&D losses that an average washing machine would consume over its life time. If the product is an automobile, you must include the fuel consumed over the average miles of automobile life. The latter might be calculated as follows: average miles driven x average mpg for the type of car = gallons of fuel consumed. Gallons fuel x EIA fuel efficiency emission factor (for domestic driving) = lbs CO₂.

For products that consume energy either in their application or maintenance (e.g carpet, asphalt, etc.) - you must include all or a portion of the emissions resulting from the consumption of energy (and associated T&D losses) during the application and maintenance of the product over its life. The proportion of energy that must be included in the product's footprint depends on how much control the project manufacture has over the amount of energy used during the product maintenance or application. For example, a washing machine manufacturer designs an efficiency into a washing machine and thus has significant amount of control over the consumption of energy during the washing machine's use. However, the washing machine manufacturer does not control whether or not the consumer uses hot or cold water. In this case the manufacturer should **take 75%⁷ responsibility** for the product's use emissions over its life. The manufacturer should use product design data to determine product life.

For products in which energy is the largest source of GHG emissions - include transmission and distribution losses that result from the consumption of energy in the product footprint. For example, for an electric utility, energy production would be the largest source of GHG emissions in the utility's footprint. Use 7% as a default unless you have more accurate local data.

Disposal

Footprints for products end at the point of product disposal. Several rules apply:

1. You cannot take credit for the electricity which is generated from landfills in which the products are ultimately disposed since a) methane capture is often required by law; and the electricity generated on the grid system already assumes these sources of energy in its calculations of state emissions factors
2. In the case of materials that are recycled, the life cycle is cut at the recycling center. Emissions up to the point at which a product reaches the door of the recycling facility belong to the footprint of that product. The emissions that occur as a result of the recycling operation itself are considered part of the footprint for the product that uses that recycled material as part of its supply chain.

⁷ EAB – see issue paper. How do we provide guidelines on how to determine % responsibility?

3. For products that sequester atmospheric carbon, such as paper and other bio-based products, can may subtract from your product footprint any carbon stored long term in a landfill provided that the following two conditions are met: 1) the product sequestered carbon during its lifecycle, and 2) the carbon is not fully re-released in the landfill.

For forest products, which can assume a constant carbon balance, the carbon stored long term in a landfill can be credited to the footprint. However, non-biomass carbon stored long-term in landfills may not be credited, especially if the source of the carbon in the product is from petrochemical sources, since this carbon has been essentially drawn from our long-term carbon account (stored sunlight in the form of oil etc) not our current account (short-term carbon flows through the biomass system).

Step 2.2: Determine the methodology for estimating emissions for each source.

Essentially a life cycle, cradle to grave emissions footprint calculation for a manufactured product requires that you perform a mass and energy balance at each step in the process to track raw material, energy and waste flows. There are three previously tested approaches for doing this:

- Life cycle (LCA) models for greenhouse gas emissions, such as GaBi LCA⁸ Software, a variation on EPA's Waste Reduction Model (WARM)⁹ or internal company LCA models
- Embodied energy, based on chemical composition of products and raw material inputs
- Purchasing costs of raw material inputs – combined with CO₂/\$ ratios for carbon intensive materials

The three approaches are listed in order of preference, with the CO₂/\$ factor only being appropriate only for carbon intensive materials and small parts of the footprint. Implementing any of the approaches requires a significant and rigorous effort between product suppliers, the company, and often, professional GHG emissions consultants. Often a combination of approaches may be necessary to fully account for the life cycle emissions of a product. Each of these approaches is described further below.

Life Cycle Analysis Models

There are several models that can be used to develop the life cycle emissions of a product. In addition, many companies chose to develop their own internal life cycle model to estimate and track their product's GHG emissions. A commercially available

⁸ GaBi 3 Software System for Life Cycle Engineering has been developed by the [Institute for Polymer Testing and Polymer Science \(IKP\)](#) at the University of Stuttgart in co-operation with [PE Europe GmbH \(PE\)](#), Dettingen/Teck.

⁹ Microsoft Excel and Web-based versions of the WARM tool are available online at the following web site: <http://www.epa.gov/globalwarming/actions/waste/tool.html>.

model that has been used in past certifications is the GaBi software. This model includes a database of life cycle inventory information regarding all mass and energy inputs and outputs that go into the manufacturing of a product. Data inputs may be based on industry standard production methods internal company data, supplier data, etc.

Another available model is the U.S. EPA WARM model (described in more detail in Appendix 2). You can use this model if your product is on the list of materials included (see Appendix 2). If your product is not included but significant raw materials whose emissions can be calculated separately are included, EPA may be able to adjust its model to obtain absolute upstream emissions estimates for your product. (Contact Climate Neutral Network for contact information). In this case, for the remaining raw materials not included in the model and downstream emissions if the raw materials are separated and recycled, you must work with suppliers and value chain partner/customer data to estimate emissions. You must also include emissions from product transport, use phase and disposal and an allocation of corporate overhead emissions.

Embodied Energy Approach

If your product is made primarily of virgin materials – the embodied energy approach described in Appendix 3 may be used. If you are using this method, you must be sure to also include emissions resulting from the manufacture of the raw materials (energy consumption and processing emissions); any additional emissions from processing the raw materials (see GHG Protocol industry specific tools)¹⁰, emissions from product transport, use phase and disposal and an allocation of corporate overhead emissions.

CO₂/\$ Ratio Approach

The third method, the purchasing costs of raw material inputs combined with CO₂/\$ ratios for carbon intensive materials may be used as a last resort and only for carbon intensive materials or for small parts of the product's footprint. CO₂/\$ ratios (greenhouse gas emissions per thousand dollars of gross national product) have been developed for carbon intensive materials. This method is described in Appendix 4. As with the embodied energy method, if you use this method, you must still include other emissions resulting from the manufacture of the raw materials (energy consumption and processing emissions); emissions from product transport, use phase and disposal and an allocation of corporate overhead emissions in your product footprint.

Default Data Required:

- Regional electricity emission factors (or use as a default Average Electricity Emission Factors by State and Region as listed in the 1605B Reporting Form – See Appendix 6)
- Fuel and Energy Emissions Factors – See Appendix 7
- Transportation (mobile) emission factors and calculation methodologies – See Appendix 8

¹⁰ Sector specific tools for carbon producing sectors can be found at:
<http://www.ghgprotocol.org/standard/tools.htm>

Overhead Allocation of Corporate Emissions

To calculate corporate overhead emissions allocation, first estimate your enterprise overhead emissions as follows. Have you estimated your enterprise emissions footprint? If this has already been done (either using the Climate Neutral emissions footprint method or the GHG Protocol), then calculate the % of the overhead emissions that should be attributed to the product using the same method the company uses to allocate overhead to its products and services. General this will be using one of the following methods:

- By % of revenue that is attributed to the product
- By product CGS/total CGS for a merchandizing company; similarly cost of services, or cost of goods manufactured for a service company and a manufacturing company respectively
- By % of labor hours attributed to the product

Step 2.3: Gather Data and Models Needed and Calculate the Cradle to Grave Emissions

This step involves gathering the data needed and performing the calculations. Results should be summarized in a table or spreadsheet that shows by boundary area:

- Emission Source
- Sources of data used to estimate emissions
- Calculation methodology
- Quantity of emissions (tons CO₂)/year

Special Considerations and Adjustments to a Product Emissions Footprint

The following special considerations may require adjustments to the product emissions footprint.

Purchase of Climate Cool Products

If the enterprise purchases a certified Climate Cool™ product that would normally produce GHG emissions (such as Climate Cool™ certified product), and if the enterprise has ownership of the emission reductions from that product, then the emissions that would normally be attributable to that product would be assumed to be zero in the enterprise footprint.

IV. Example of a Product Emissions Footprint Calculation

Sample Climate Cool Hotel Room Emissions Calculations

	Actual Use 2000	Units	Emission Factor	Units	Emissions Tons per year
Electricity	1,220,579	kWh/yr	0.436	Tons/Mwh	532
Natural Gas	5,870	Mmbtu/yr	115	lbs/Mmbtu	338
Water	6,390,690	gals/yr	1376	kwh/mill gall	4
Town Cars	3,194	gals/yr	20.17	lbs/gal	32
Hotel Van	1,825	gals/yr	20.17	lbs/gal	17
Outside laundry	2,566	gals/yr	20.17	lbs/gal	33
Fireplaces	3	cords/yr	1.7	<u>Tons/cord</u>	<u>5</u>
				Total Tons	957.5
				Room Nights	48,038
				Tons CO₂/room	0.020

Sample Product Emissions Footprint Emissions Calculations

Note: this example is for illustrative purposes. The actual numbers were fabricated.

Boundary & Source	Lbs CO ₂ e per/ unit	Lbs CO ₂ e per/unit	Lbs CO ₂ e per/unit
I. Manufacturing Process			
1. Raw Materials	18.6	21.46	117.52
2. Transport	1.20	1.23	8.28
3. Electricity	0.17	0.21	5.05
4. Natural Gas	0.41	3.94	23.32
5. Waste Disposal	0.03	0.03	1.88
II. Product Use			
1. Electricity	1.92	1.92	10.95
III. End of Life			
1. Product Disposal	1.18	1.21	6.51
Total Product Life	23.51	32.22	173.51
1. Percent of total mix	10.0%	17.0%	73.0%
2. Weighted lbs CO ₂ /unit	2.35	5.48	33.90
Avg Emissions CO ₂ e / unit		41.73	

Corporate Overhead Emissions Allocation

I. Air Travel	Total miles	1.26 lbs CO ₂ /passenger mile	Production Units	lbs CO ₂ e/unit	
	6,211,277	7,826,209	12,014,452	0.65	
II. Auto Travel	Total	Gallons (@15 mpg)	lbs CO ₂ e @21.09 lbs/gal	Production Units	lbs CO ₂ e/unit
	535,356	35,690.4	1,033,910.54	15,414,452	0.06
III. Overhead	kWh/unit		lbs CO ₂ / unit	lbs CO ₂ e/unit	
	0.51		1.22	0.62	
Total Overhead Emissions			1.34 lbs CO ₂ e/unit		

Average Emissions CO₂e / unit = Product life emissions + allocation of overhead emissions = 41.73 + 1.34 = 47.07 CO₂e/unit

Appendix 1: GaBi Life Cycle Model

The GaBi 3 Software System for Life Cycle Engineering was developed by the Institute for Polymer Testing and Polymer Science (IKP) at the University of Stuttgart in cooperation with PE Europe GmbH (PE), Dettingen/Teck. GaBi 3 reflects the experience from balancing work in science and industry since 1989 and from over 100 person-years of industry-financed projects.

The professional version of the GaBi 3 software is one of the leading experts systems for balancing complex and data-intensive process networks. Parallel analysis of environmental problems in product life cycles according to DIN ISO 14040 ff. and the optimization of production sequences from an economic point of view. GaBi 3 offers the opportunity to carry out a consistent and detailed cost evaluation of the assessed system (Life Cycle Costing; LCC). The implemented, so-called cost assistants allow for an exact modeling of material/energy costs, personnel costs and machine costs.

The GaBi 3 Professional version includes approx. 650 sets of data (cradle to gate), generated by IKP/PE. This data is based on information from patent/specialist literature and industry which makes GaBi 3 to one of the leading databases in the world. These data sets include the decisive areas of the pre-chains to metals (steel, aluminum and non-ferrous metals), organic and non-organic pre-products, synthetics, mineral materials, provision of energy (steam, thermal energy, electricity mixes and power stations), end of life and disposal and processing with.¹¹

Numerous extension databases have been developed for customized use in the various areas (chemical industry, petrochemical industry, metalworking industry as well as the energy business and automobile industry), and they are available for solving sector-specific problems (only in combination with GaBi 3 professional version of the software).

¹¹ http://www.gabi-software.com/englisch/software_englisch.shtml

Appendix 2: EPA’s WARM Model – Background and Example

The WARM model from EPA can be modified to use company specific data and to include the appropriate elements of a product footprint to be used in a Climate Cool product certification. Below is a description of how WARM model was modified for use in estimating the emissions footprint of a paper product manufactured by a forest products company. EPA has committed to re-engineering the WARM model for other key applications in the future to enable the model to be used to calculate other product life cycle emissions.

Background

The Waste Reduction Model (WARM)¹² was created by EPA to quantify the greenhouse gas reductions that result from increasing the recycled content in products. EPA created WARM to help solid waste planners and organizations track and voluntarily report greenhouse gas emissions reductions from several different waste management practices..

WARM is available in a Web-based calculator format and as a Microsoft Excel spreadsheet. WARM is essentially a spreadsheet accounting tool that covers 21 types of materials and 5 waste management options – source reduction, recycling, combustion, composting, and landfilling. WARM accounts for upstream energy and non-energy emissions, transportation distances to disposal and recycling facilities, carbon sequestration, and utility offsets that result from landfill gas collection and combustion. . The model calculates in metric tons of carbon equivalent (MTCE), metric tons of carbon dioxide equivalent (MTCO2E), and energy units (million BTU) across a wide range of material types that compose municipal solid waste (MSW).

The MSW’s included in the model are shown in the following table.

MSW Materials Types Recognized by the WARM Model		
Aluminum Cans	Office Paper	Newspaper
Steel Cans	Phonebooks	Mixed Paper
Glass	Text Books	HDPE
Mixed Plastics	PET	LDPE
Medium Density Fiberboard	Corrugated Cardboard	Magazines/3 rd Class Mail
Mixed Metals	Leaves	Branches
Yard Trimmings	Grass	Food Scraps
Mixed Recyclables	Dimensional Lumber	Mixed Organics
Mixed MSW		

While the WARM model was designed for a different purpose than calculating a product emissions footprint, with a little modification it can be used to quantify the greenhouse gas footprint for a product. The WasteWise office of EPA, working with Climate Neutral

¹² <http://www.epa.gov/globalwarming/actions/waste/warm.htm>

Network, re-engineered the WARM model to measure the footprint for a paper product. A description of how we changed the model to serve our purposes follows:

The WARM model for paper is broken into 3 parts: Energy Use, Forest Carbon and Waste Management. The Forest Carbon portion was eliminated based on the understanding that this would be a net zero activity for the company. Because the company is a paper products company it was assumed that the company will replace all the trees that they harvest since this is in their business' best interest.

For energy consumption we were able to replace the generic data with data from the actual forest product company. We added to the lifecycle both up and down stream. On the upstream side we obtained average data from Environmental Defense on the emissions from harvesting trees for the virgin pulp and for collection, transportation and processing of recycled pulp. Downstream energy figures included embodied energy of other material inputs such as chemicals and fillers. Since these materials were much less significant in terms of GHG impact and getting exact data would have been difficult, we were able to estimate the per-ton of paper costs and use the CO₂/\$1000 method to estimate emissions. Energy use data for transportation, printing and converting has to be supplied by the company.

EPA created a system on the WARM model's Waste Management worksheet where we could choose which portions of the carbon flow we wanted included in the footprint. We included:

- Methane generation from landfilled paper (+)
- Carbon sequestered in landfill (-)
- Transportation to landfill (+)
- Gross GHG emissions per ton combusted (+)

We chose not to include:

- Avoided utility CO₂ (-)
- Combusted at mass burn facility (-)
- Recycled input credit – process and transportation (-)
- Recycled input credit – process non-energy (-)
- Forest carbon sequestration for recycled content (-)

Appendix 3: Embodied Energy Analysis – Background and Example

If detailed information is available about a product's composition the greenhouse gas footprint can be calculated using information about the embodied energy of the various components.

This approach has been used by a consumer product company that has received Climate Cool product certifications. For this company, while the company had good data for the manufacturing of its product much of the ghg impact comes from the production of the petrochemical raw materials which they purchase from their suppliers.

The company developed a list of all the material components and their mass in one unit of its product. They were able to find national average embodied energy figures, in BTUs per pound, for many of the raw materials. For other materials they used the figures for closely related materials. These embodied energy numbers came from several sources including Franklin Associates, and Potting and Blok¹³. In one instances a supplier was able to provide data for a new material. The total embodied BTU figure was converted to a greenhouse gas figure by dividing total US emissions by the total US energy production in BTU.

The embodied energy emissions were added to the emissions from manufacturing energy consumption, an allocation of overhead energy, product transportation, and installation to come up with the total per unit emission rate.

For a second product certification, the company honed this model. This time the emissions from the embodied energy were calculated using a sophisticated lifecycle analysis software tool, GaBI.

¹³ Potting, M.Sc. and Dr. K. Blok from the Department of Science, Technology, and Society at Utrecht University (Utrecht, the Netherlands). In 1993, J. Potting and K. Blok from the Department of Science, Technology, and Society at Utrecht University were commissioned by the Research Information Center of the same University to carry out a life-cycle analysis to assess and compare the environmental effects in the life cycles of four types of floor coverings: linoleum, vinyl, and wool and synthetic carpets.

Appendix 4: Carbon Dioxide per Thousand Dollars of Cost – Background and Example

For portions of a product for which no detailed energy information is available, or which make up only a small fraction of the overall greenhouse gas emissions, it is possible to estimate the greenhouse gas intensity of a material by using a ratio of greenhouse gas emissions per thousand dollars of gross national product developed from average US data.¹⁴

The following scheme provides a metrics foundation upon which a raw material or component’s impact can be estimated, without requiring a company to probe the data sheets of each and every supplier/vendor up and down an intricate value chain. While it is not appropriate to be used as the sole method for calculating all of a product’s emissions, it can be used in conjunction with the WARM model and the embodied energy approach to cover smaller portions of the footprint.

There are many materials and activities for which it is not easy to measure the direct GHG emissions but for which cost information is readily available. An example of this is the product transportation for a company that does not run its own fleet or an array of chemicals which are used in small quantity in the manufacture of paper. In these cases greenhouse gas emissions can be estimated by using an average GHG intensity per dollar for that material based on national data.

Following is an example of how average intensity factors could be calculated. This table should only be used for illustrative purposes as the data is old and may contain a conversion error. New data should be gathered and factors recalculated before this method is employed in a certification.

	1994		
	CO ₂ (only) MMTCE	GDP \$ bn	Factor tons/1000\$
ag,mining,constr	143	482.8	0.296
chemicals	98	140.6	0.697
primary metals	71	46.3	1.533
stone, clay, glass	37	28.8	1.285
Paper	31	51.3	0.604
petroleum	20	30.4	0.658 (covered in enterprise)
textiles	9	25.4	0.354
US Average (1996 data)	1473	7636	0.193

¹⁴ Currently trying to identify the source of this data so it can be referenced and hopefully updated.

Appendix 5: Direct and Indirect Emissions Organized by Industry Sectors (Insert and Reference from GHG Protocol Appendix 2)

**Appendix 6: Average Electricity Emission Factors by State and Region
INSERT**

**Appendix 7: Fuel and Energy Emission Factors
INSERT**

**Appendix 8: Transportation (Mobile) Emission Factors and
Calculation Methodologies
INSERT SECTION FROM ENTERPRISE FOOTPRINT PROTOCOL**