

## Question 3:

# How were environmental and health impacts evaluated?

The environmental and health impacts of computer displays throughout their life cycles were evaluated through two sequential processes: a life-cycle inventory (LCI) and a life-cycle impact analysis (LCIA).

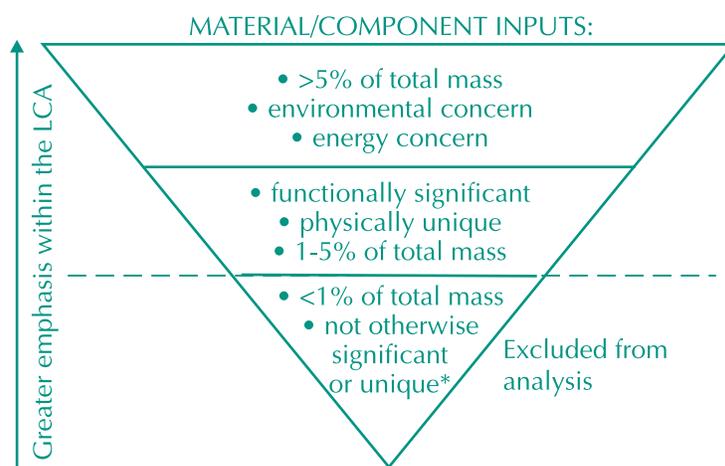
### *LIFE-CYCLE INVENTORY*

The LCI is the process of collecting information about the quantity of materials used (inputs) and outputs of processes in each life-cycle stage. Quantitative inventory data for the processes in the life cycles of the displays were provided by 22 display manufacturers. Input information included the materials found in the actual display, as well as energy requirements and ancillary materials used during manufacturing. Because there are not established guidelines in standard LCA methodologies for determining where boundaries should be drawn for the analysis, it was decided the study would evaluate the impacts of inputs that met one or more of the following criteria:

- constitutes more than one percent to the mass of a display;
- is known or suspected to have environmental significance (e.g., it is toxic);
- is known or suspected to have large energy requirements;
- is functionally significant to the display; and
- is physically unique to one of the displays (i.e., the material is found in a CRT but not in an LCD or vice versa).

The following diagram demonstrates this selection process graphically.

Figure 3.1. Criteria for selecting inputs



\*For example, materials are excluded if they are not of known environmental significance (e.g., toxic) or are not physically unique.

EPA also determined the outputs from each of the five life stages (i.e., materials extraction, materials processing, product manufacturing, product use, and end-of-life; see Figure 1.1) for each process included in the analysis. These outputs included air emissions, solid waste releases, and water effluents whenever appropriate and possible. Some information was collected specifically for this study; for example, much of the material and energy use data for the product manufacturing stage was provided by display and component manufacturers. Other data, such as outputs from material extraction, were obtained from existing information sources.

### *LIFE-CYCLE IMPACT ASSESSMENT*

Life-cycle impact assessment (LCIA) is the process in which the input and output data from an LCI are aggregated across all life stages and translated into impacts on human health and the environment. There were two steps in the CDP LCIA: classification and characterization.

#### **Classification**

In order to evaluate similar impacts together, each input and output in the LCI was placed into one or more of 20 impact categories. These categories cover a range of effects that address natural resource impacts, abiotic ecosystem impacts, and human health and ecotoxicity. Some inputs and outputs can have multiple effects or impacts and are included in multiple categories. For example, methane is both a global warming gas and a photochemical smog contributor; this material is therefore represented in both of these impact categories.

#### **Characterization**

The impacts of inputs and outputs are not necessarily commensurate with their weight or volume. For example, methane and carbon dioxide are both global warming gases, but methane is much more potent on a mass basis. Conversion factors or scoring systems were therefore used for some impact categories to place different inputs and outputs in common units.

The 20 impact categories and a description of each are presented in Table 3.1.

Table 3.1. Impact categories

Impact Category	Inventory Type		Description
	Input	Output	
<b>Natural Resource Impacts</b>			
renewable resource use	material, water	----	Materials found in nature that are replenished through natural processes.
nonrenewable resource use/depletion	material, fuel	----	Materials, such as metals or fossil fuels, that are not regenerated naturally.
energy use	electricity, fuel	----	The amount of energy consumed. The impacts associated with energy are included under other impact categories.
solid waste landfill use	----	solid waste to landfill	The volume of landfill space required for solid waste.
hazardous waste landfill use	----	hazardous waste to landfill	The volume of space required in a hazardous waste landfill.
radioactive waste landfill use	----	radioactive waste to landfill	The volume of waste disposed of at a radioactive waste disposal facility.
<b>Abiotic Ecosystem Impacts</b>			
global warming	----	air	The mass of greenhouse gases emitted (chemical amounts are weighted according to their potency relative to carbon dioxide).
stratospheric ozone depletion	----	air	The mass of ozone depleting chemicals emitted (chemical amounts are weighted according to their potency relative to CFC-11).
photochemical smog	----	air	The mass of smog-producing chemicals emitted (chemical amounts are weighted according to their potency relative to ethene).
acidification	----	air	The mass of acidifying chemicals emitted (chemical amounts are weighted according to their potency relative to sulfur dioxide).
air quality (air particulates)	----	air	The mass of particulates emitted that have a diameter less than 10 micrometers.
water eutrophication (nutrient enrichment)	----	water	The mass of eutrophication chemicals released (chemical amounts are weighted according to their potency relative to phosphate).
water quality: BOD	----	water	Amount of oxygen-consuming material released to water [converted to Biological Oxygen Demand (BOD)].
water quality: TSS	----	water	Amount of suspended solids released to water.
radioactivity	---	radioactivity to air, water, or land	The amount of radioactive chemicals released (measured in Bequerels).
<b>Human Health and Ecotoxicity</b>			
chronic human health effects - occupational	material	----	Weighted score based on the amount and toxicity of releases affecting workers.
chronic human health effects - public	----	air, water	Weighted score based on the amount and toxicity of releases affecting the general public.
aesthetic impacts (odor)	----	air	Volume of air released that is above odor detection threshold.
aquatic ecotoxicity	----	water	Weighted score based on the amount and toxicity of releases affecting fish.
terrestrial ecotoxicity	----	air, water	Weighted score based on the amount and toxicity of releases affecting terrestrial organisms.

In addition to the general considerations of the LCA method discussed in Question 1, it should also be noted that because display technology is constantly improving, displays often are discarded while they are still functional. To reflect this situation, the analysis was based on the "effective" or typical life span of a display rather than the designed life span. Also, due to a lack of transportation data for the manufacturing, use, and end-of-life stages, transportation impacts were excluded for these stages, but in some instances were included in the existing data used for the materials extraction and materials processing stages.