PROJECT REPORT

On

CARBON FOOTPRINT



For

NEWSPAPER INDUSTRY

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BACKGROUND

A literature search in June 2007 for the term "carbon footprint" (i.e. where these two words stand next to each other in this order) in all scientific journals and all search fields covered by Scopus1 and ScienceDirect2 for the years 1960 to 2007 yielded 42 hits; 3 from the year 2005, 8 from 2006 and 31 from 2007. Most articles deal with the question of how much carbon dioxide emissions can be attributed to a certain product, company or organization, although none of them provides an unambiguous definition of the term carbon footprint. In most cases 'carbon footprint' is used as a generic synonym for emissions of carbon dioxide or greenhouse gases expressed in CO2 equivalents.

Source	Definition
BP (2007)	"The carbon footprint is the amount of carbon dioxide emitted due to your daily activities – from washing a load of laundry to driving a carload of kids to school."
British Sky Broadcasting (Sky) (Patel 2006)	The carbon footprint was calculated by "measuring the CO_2 equivalent emissions from its premises, company-owned vehicles, business travel and waste to landfill." (Patel 2006)
Carbon Trust (2007)	"… a methodology to estimate the total emission of greenhouse gases (GHG) in carbon equivalents from a product across its life cycle from the production of raw material used in its manufacture, to disposal of the finished product (excluding in-use emissions). "… a technique for identifying and measuring the individual greenhouse gas emissions from each activity within a supply chain process step and the framework for attributing these to each output product (we [The Carbon Trust] will refer to this as the product's 'carbon footprint')." (CarbonTrust 2007, p.4)
Energetics (2007)	"… the full extent of direct and indirect CO_2 emissions caused by your business activities."
ETAP (2007)	"…the 'Carbon Footprint' is a measure of the impact human activities have on the environment in terms of the amount of greenhouse gases produced, measured in tonnes of carbon dioxide."
Global Footprint Network (2007)	"The demand on biocapacity required to sequester (through photosynthesis) the carbon dioxide (CO_2) emissions from fossil fuel combustion." (GFN 2007; see also text)
Grub & Ellis (2007)	"A carbon footprint is a measure of the amount of carbon dioxide emitted through the combustion of fossil fuels. In the case of a business organization, it is the amount of CO_2 emitted either directly or indirectly as a result of its everyday operations. It also might reflect the fossil energy represented in a product or commodity reaching market."
Paliamentary Office of Science and Technology (POST 2006)	"A 'carbon footprint' is the total amount of CO_2 and other greenhouse gases, emitted over the full life cycle of a process or product. It is expressed as grams of CO_2 equivalent per kilowatt hour of generation (gCO_2eq/kWh), which accounts for the different global warming effects of other greenhouse gases."

INTRODUCTION TO CARBON FOOTPRINT

The **carbon footprint** is a "measure of the impact that human activities have on the environment in terms of the amount of greenhouse gases produced, measured in units of carbon dioxide". These gases are produced by the burning of fossil fuels for our everyday living. For example- heating and electricity; its purpose is for individuals, nations and organizations to conceptualize their personal (or organizational) carbon dioxide contribution. A conceptual tool in response to carbon footprints are carbon offsets, or the mitigation of carbon emissions through the development of alternative projects such as solar or wind energy or reforestation. The carbon footprint is a subset of the ecological footprint, which includes all human demands on the biosphere including the carbon, food and fiber footprint.

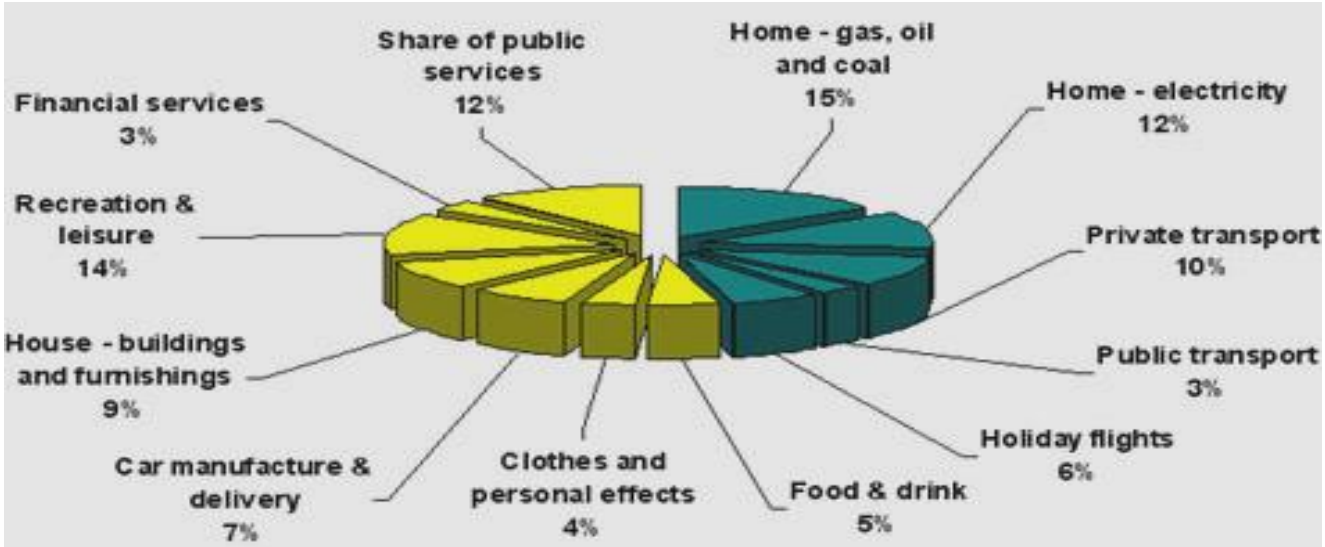
Defining a carbon footprint

The carbon footprint is a measure of the exclusive global amount of carbon dioxide (CO_2) and other greenhouse gases emitted by a human activity or accumulated over the full life cycle of a product or service.

The life cycle concept of the carbon footprint means that it is all-encompassing and includes all possible causes that give rise to carbon emissions. In other words, all direct (on-site, internal) and indirect emissions (off-site, external, embodied, upstream, and downstream) need to be taken into account.

Normally, a carbon footprint is expressed as a CO_2 equivalent (usually in kilograms or tones), which accounts for the same global warming effects of different greenhouse gases (UK Parliamentary Office of Science and Technology POST, 2006). Carbon footprints can be calculated using a Life Cycle Assessment (LCA) method, or can be restricted to the immediately attributable emissions from energy use of fossil fuels. In both cases however, as the term usually indicates the amount of emissions generated through the actions of people, what is important is not only the total amount of energy use, but also how the energy was produced in the first place (e.g. from fossil fuels or renewable resources).

An alternative definition of the carbon footprint is the total amount of carbon dioxide attributable to the actions of an individual (which includes emissions through their energy use, but other unforeseen emissions as well) over a period of one year. This definition underlies the personal carbon calculations. The term owes its origins to the idea that a footprint is what has been left behind as a result of the individual's activities. Carbon footprints can either consider only direct emissions (typically from energy used in the home and in transport, including travel by cars, airplanes, rail and other public transport), or can also include indirect emissions (including CO2 emissions as a result of goods and services consumed). Bottom-up calculations sum attributable CO2 emissions from individual actions; top-down calculations take total emissions from a country (or other low-level entity) and divide these emissions among the residents (or other participants in that entity).



Percentage Share of Carbon Footprint in various sectors

Reducing a carbon footprint

The carbon footprint can be efficiently and effectively reduced by applying the following steps:

- Life Cycle Assessment (LCA) to accurately determine the current carbon footprint
- Identification of hot-spots in terms of energy consumption and associated CO_2-emissions
- Where possible, changing to another electricity company to switch to buying electricity from renewable sources (from wind turbines, solar panels or hydroelectrical plants -or- from nuclear power plants
- Optimization of energy efficiency and, thus, reduction of CO_2-emissions and reduction of other GHG emissions contributed from production processes
- Identification of solutions to neutralize the CO_2 emissions that cannot be eliminated by energy saving measures. This last step includes carbon offsetting; investment in projects that aim at the reducing CO_2 emissions, for instance tree planting.

EVOLUTION OF THE CONCEPT

The world is facing a serious problem of Global Warming. Every individual or an organization uses energy in the form of electricity, coal, oil etc. in its day to day activity. In a way we are emitting carbon dioxide into the atmosphere which is considered to remain suspended in the environment for a period of over hundred years or so. In a way we are leaving our footprints in the atmosphere and making it difficult for the younger generation to survive.

Hence, it is a responsibility of each and every individual to assess and reduce its carbon emissions into the atmosphere during its own life time.

The concept of Carbon Footprint is becoming a buzzword in many organizations in the West. They are constantly assessing their carbon emissions and finding ways to minimize their footprints.

The Changing Climate

Climate change can be defined as a long-term significant change in the “average weather” of a region or the earth as a whole. Average weather may include average temperature, precipitation and wind patterns. It involves changes in the variability or average state of the atmosphere over durations ranging from decades to millions of years. These changes can be caused by dynamic processes on Earth, external forces including variations in sunlight intensity, and more recently by human activities.

In recent usage, especially in the context of environmental policy, the term "climate change" usually refers to changes in modern climate.

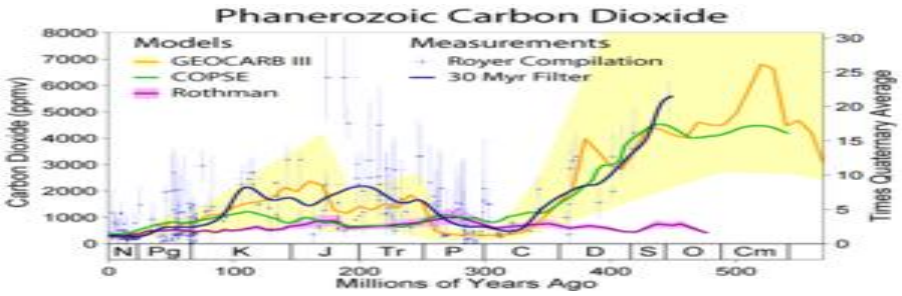
Non-climate factors driving climate change

Effects of CO_2 on climate change

Current studies indicate that radiative forcing by greenhouse gases is the primary cause of global warming. Greenhouse gases are also important in understanding Earth's climate history. According to these studies, the greenhouse effect, which is the warming produced as greenhouse gases trap heat, plays a key role in regulating Earth's temperature.

Over the last 600 million years, carbon dioxide concentrations have varied from perhaps >5000 ppm to less than 200 ppm, due primarily to the effect of geological processes and biological innovations. During the modern era, the naturally rising carbon dioxide levels are implicated as the primary cause of global warming since 1950. According to the Intergovernmental Panel on Climate Change (IPCC), 2007, the atmospheric concentration of CO_2 in 2005 was 379 ppm compared to the pre-industrial levels of 280

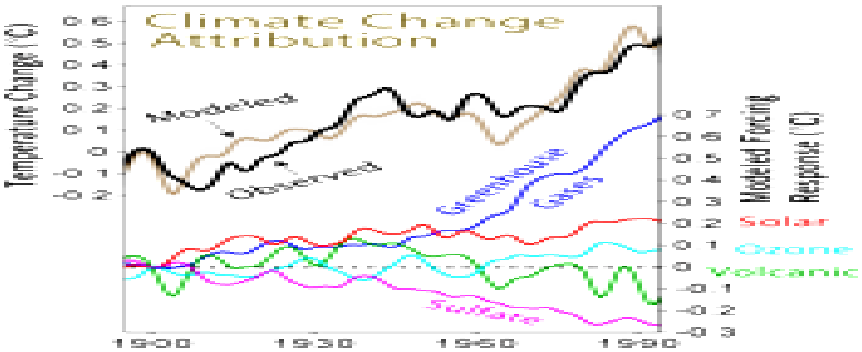
ppm. Thermodynamics and Le Chatelier's principle explain the characteristics of the dynamic equilibrium of a gas in solution such as the vast amount of CO_2 held in solution in the world's oceans moving into and returning from the atmosphere. These principles can be observed as bubbles which rise in a pot of water heated on a stove, or in a glass of cold beer allowed to sit at room temperature; gases dissolved in liquids are released under certain circumstances.



Human influences on climate change

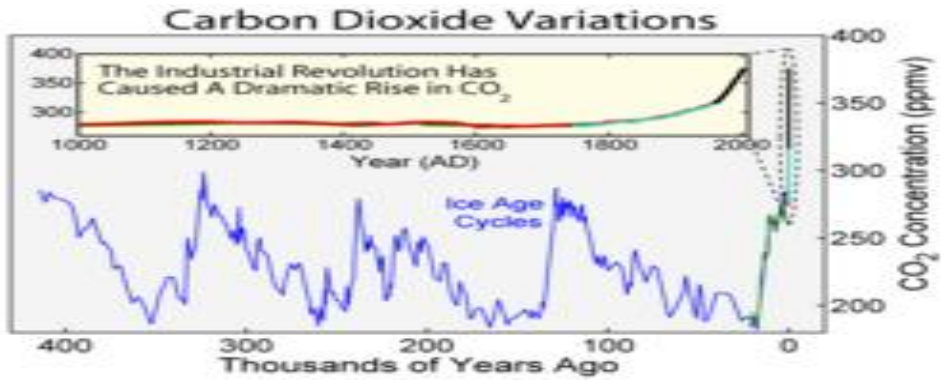
Anthropogenic factors are human activities that change the environment and influence climate. In some cases the chain of causality is direct and unambiguous (e.g., by the effects of irrigation on temperature and humidity), while in others it is less clear. Various hypotheses for human-induced climate change have been debated for many years, though it is important to note that the scientific debate has moved on from skepticism, as there is scientific consensus on climate change that human activity is beyond reasonable doubt as the main explanation for the current rapid changes in the world's climate. Consequently in politics, the debate has largely shifted onto ways to reduce human impact and adapt to change that is already in the system.

The biggest factor of present concern is the increase in CO_2 levels due to emissions from fossil fuel combustion, followed by aerosols (particulate matter in the atmosphere), which exert a cooling effect, and cement manufacture. Other factors, including land use, ozone depletion, animal agriculture and deforestation, also affect climate.



Fossil fuels

It is known that carbon dioxide levels are substantially higher now than at any time in the last 750,000 years. Beginning with the industrial revolution in the 1880s and accelerating ever since, the human consumption of fossil fuels has elevated CO_2 levels from a concentration of ~280 ppm to ~387 ppm today. The concentrations are increasing at a rate of 2-3 ppm/year. If current rates of emission continue, these ever increasing concentrations are projected to reach a range of 535 to 983 ppm by the end of the 21st century. Along with rising methane levels, these changes are anticipated to cause an increase of 1.4–5.6 °C between 1990 and 2100. In the interest of averting drastic climate change, some scientists and international coalitions have set goals to limit concentrations to 450 or 500 ppm.



Land use

Prior to widespread fossil fuel use, humanity's largest effect on local climate is likely to have resulted from land use. Irrigation, deforestation, and agriculture fundamentally change the environment. For example, they change the amount of water going into and out of a given location. They also may change the local albedo by influencing the ground cover and altering the amount of sunlight that is absorbed. For example, there is evidence to suggest that the climate of Greece and other Mediterranean countries was permanently changed by widespread deforestation between 700 BC and 1 AD (the wood being used for shipbuilding, construction and fuel), with the result that the modern climate in the region is significantly hotter and drier, and the species of trees that were used for shipbuilding in the ancient world can no longer be found in the area. An assessment of conterminous U.S. biomass burning speculated that the approximate 8 fold reduction in Wildland Fire Emissions (aerosols) from the preindustrial era to present caused by land use changes and land management decisions may have had a regional warming affect if not for fossil fuel burning emission increases occurring concurrently.

Manufacturing

Cement manufacture contributes CO_2 when calcium carbonate is heated, producing lime and carbon dioxide, and also as a result of burning fossil fuels. The cement industry produces 5% of global man-made CO_2 emissions, of which 50% is from the chemical process, and 40% from burning fuel. The amount of CO2 emitted by the cement industry is nearly 900 kg of CO2 for every 1000 kg of cement produced.

GLOBAL STATUS OF CARBON REGULATIONS

In US:

Currently the U.S. government does not mandate control of carbon emissions. But the government has the power to change the regulations in the future, either because the scientific evidence implicating carbon emissions in dangerous levels of global warming becomes stronger or because the political winds change and power shifts to those who feel the existing evidence is compelling enough. An electric utility that makes its investment decision solely on the basis of today's regulations may find—if regulations change—that it has saddled itself with plants that must either be retrofitted at high cost or that entail high charges for uncontrolled emissions.

In CANADA:

- Clean Air Regulatory Agenda – April 2007
- Emission-intensity target: reduction of 6%/year from 2007 to 2010 and 2% reduction/year from 2010 to 2015
- Committed to reduction of 20% by 2020 (relative to 2006)
- New facilities (first operation 2004 or later): 3 year grace period, 2% annual reduction, cleaner fuel standard
- Compliance options:
- Reduce own emissions
- Inter-firm trading
- Credits from non-regulated activities, (offsets)
- Certain Kyoto CDM credits (limited to 10%) "actively explore linkages to a Canada-U.S, U.S., regional or state- level trading system"
- Technology fund

In UK:

- The UK Renewables Obligation (2001): 15.4% renewables by 2015 based on estimated load
- EU Emissions Trading Scheme (2005)
  - Cap & Trade System (smokestack) limits CO2 from the power sector to 130 million tons (MT) in first phase of the scheme (2005-2007)
  - In 2005, the UK power sector emitted 36.5 MT more CO2 than it was allocated
  - 99.6% compliance rate
- Penalties for noncompliance:
  - €40/ton (~$50) in first phase
  - €100/ton (~$120) in second phase

Nowadays products in UK implement the concept of **Carbon Labeling**.

Carbon Labeling

A carbon label, which shows the life cycle carbon emissions or carbon footprint embodied in a product in bringing it to the shelf, was introduced in the UK in March 2007 by the Carbon Trust. The label is closely linked to collaboration between **The Carbon Trust** and **The British Standards Institute**. The label is intended to comply with a new British Standard, PAS2050, and is being actively piloted by The Carbon Trust and various industrial partners.

Examples of products which already feature this carbon footprint label include Walkers Crisps, a smoothie product from Innocent Drinks, and a shampoo product produced by Boots Group.

GLOBAL STATUS OF CARBON FOOTPRINT IN MEDIA

Missouri Newspaper Publishers Hit 50% Recycled Content Target

The state of Missouri is one of a dozen US states that has established incremental goals to boost the amount of recycled content in newsprint. By achieving the goal to have all newsprint used in the state average at least 50% recycled fiber, Missouri has demonstrated what can be done when targets are in place.

In 2005, Missouri newspapers used 52% recycled content for their publications, exceeding the goal. In 2006, this number dipped slightly but remained near the target at 49%. Of the 169,219 tons of newsprint used by the state's 105 newspaper publications, 83,431 tons contained recycled content and 54 newspapers reported that they met or exceeded the 50% goal. Of those 54 publications, 37 reported using 100% recycled content newsprint. And amongst the four largest newspapers, recycled content averages ranged from 65 to 99%.

Atlantic Newsprint Offers First 100% Recycled, FSC-Certified Newsprint

Atlantic Newsprint opened Canada's first 100% recycled newsprint that is processed chlorine-free in Whitby, Ontario in 1991. Among its customers are some of North America's largest and most influential daily newspapers. In late 2007, the Forest Stewardship Council certified Atlantic's newsprint sheet making it the first 100% recycled newsprint to be FSC-certified in North America. They recycle 200,000 tonnes of used newspaper and magazines annually and produce 150,000 tonnes of newsprint a year with 80-90% typically made from post-consumer sources. Atlantic also donates the by-product of their processing to area farmers to use for soil enrichment. The facility has its own secondary water treatment that recycles in excess of two million gallons daily. It was the first newsprint company to be awarded the right to use the EcoLogo certification in Canada and has also received the Green Seal environment commendation in the US.

TEMBEC TARGETS AND ACHIEVES FSC CERTIFICATION

Note: Tembec is profiled here for its leadership in FSC certification. However, Tembec's March decision to eliminate its use of ONP feedstock at their Pine Falls, Manitoba mill has both a negative environmental impact and social impact. The authors of this report strongly encourage Tembec to continue manufacturing newsprint that has optimal environmental qualities from both a biodiversity and carbon perspective.

Beginning in 2001 Canadian forest products company **Tembec** became the first newsprint producer to make a commitment to pursue FSC certification for their logging operations. Seven years later, the commitment has been met with the achievement of FSC certification on 24 million acres of public lands in four Canadian provinces where the company has sustainable forestry management responsibilities.

Using FSC tools such as pre-industrial condition analysis and High Conservation Value Forest assessment, forest managers have refined the patterns of forest harvesting to more closely approximate natural conditions, in a region where fire has historically been dominant. Retaining trees across harvest areas for wildlife habitat has been an important focus in the past several years. And FSC's strong emphasis on conservation planning has resulted in the establishment of large new reserves totaling tens of thousands of acres for the protection of wildlife, water quality, aboriginal values and recreation. As FSC forest management certification progressed on the ground, FSC Chain of Custody (COC) certification was implemented at all company facilities. In excess of 35 facilities hold FSC COC and Controlled Wood certification to meet the needs of pulp, paperboard and newsprint customers worldwide.

While the original commitment has been met, Tembec is now spearheading new FSC forest certification projects on public lands in northern British Columbia, Ontario and Quebec in collaboration with forest sector partners.

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PROBLEM STATEMENT

Sharing of knowledge and information has become an integral part of our day to day life. Every morning we get up and search for the latest happenings around us in the newspaper. But do we bother at what cost the newspaper reached us?

Thousands of trees are being felled to produce the paper. Trees help to maintain the carbon dioxide balance in our atmosphere. Indiscriminate destruction of our ecosystem came at a dear price of **Global Warming.**

As forests store roughly 50 percent of all terrestrial carbon stocks, harvesting trees to produce newsprint has a direct and significant contribution to climate change. In fact, according to the United Nations **Intergovernmental Panel on Climate Change (IPCC),** as much as 25 percent of the world's human-caused greenhouse gas emissions come from forestry and deforestation.

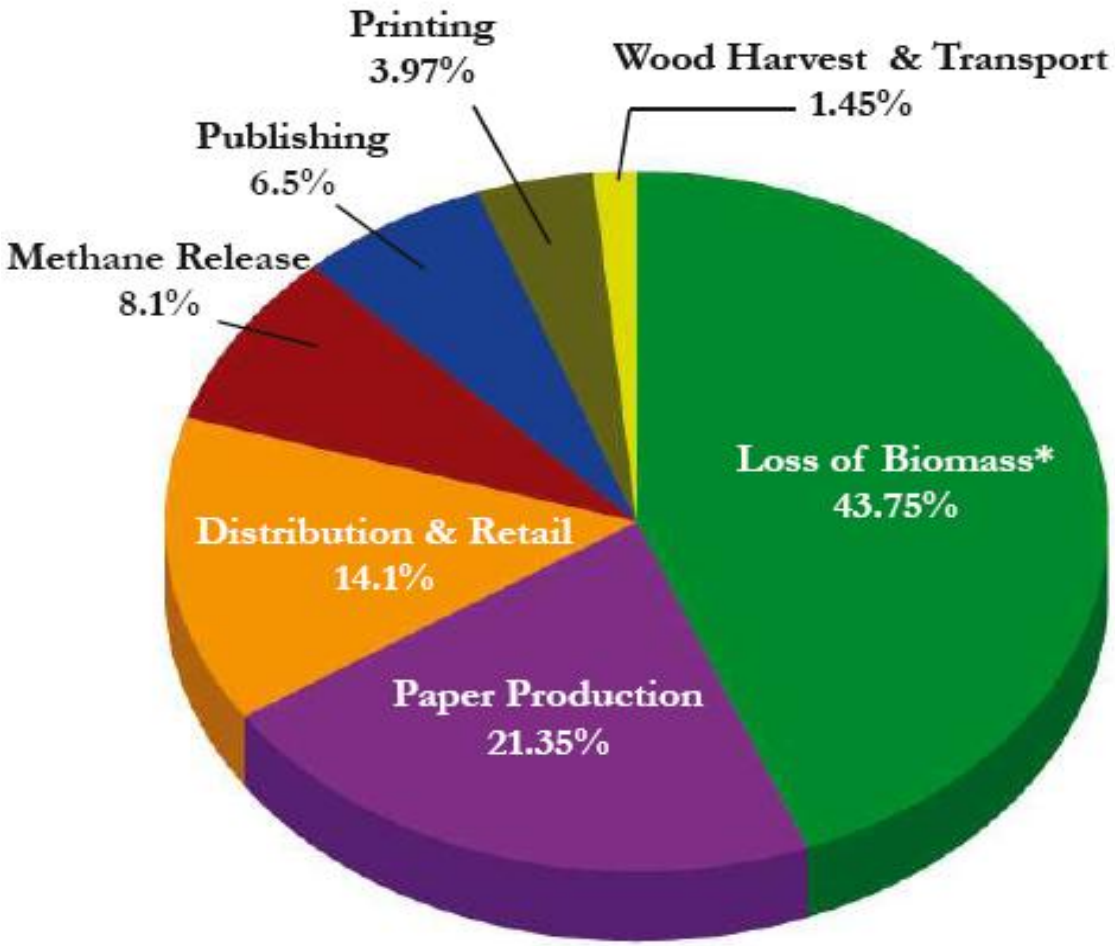
It is of prime concern now that we take the problem of Climate Change seriously and do something tangible in this direction. Every individual or an organization uses energy in the form of electricity, coal, oil etc. in its day to day activity. In a way we are emitting carbon dioxide into the atmosphere which is considered to remain suspended in the environment for a period of over hundred years or so. In a way we are leaving our footprints in the atmosphere and making it difficult for the younger generation to survive.

Hence, it is a responsibility of each and every individual to assess and reduce its carbon emissions into the atmosphere during its life time. The concept of **Carbon Footprint** is becoming a buzzword in many organizations in the West. They are constantly assessing their carbon emissions and finding ways to minimize their footprints to save the Earth and mitigate Climate Change.

Hence the scope of study hovers around finding the potential areas of carbon emissions by such an industry which extends its influence in both print as well as electronic media. Assessment of carbon emissions from such an industry will be an example in itself in India. It will open an avenue for such Indian industries to reduce their power requirements and become **Carbon Neutral** in future.

RELEVANCE OF CARBON FOOTPRINT IN MEDIA

Media is not untouched with this grave problem. It is also emitting carbon dioxide into the atmosphere in some form or the other. The print media uses paper to circulate the news among the common masses. This paper what they are using comes at a premium price of cutting down the trees. There can be many ways to reduce the energy consumption in a printing facility. It is a high time that this industry thinks about mitigating the climate change and reducing its emissions into the atmosphere.



Percentage Distribution of Emissions from various sources

Let us have a brief idea of the entire paper production and paper printing press before we proceed with our study.

Paper Production Process

Basic Stages of Paper Manufacturing:

- **Procurement of logs of wood.**
- **Preparing the wood pulp**

  Pulping of wood is done in two ways:

- Mechanically
- Chemically

  In Mechanical Pulping, the wood chips are passed through rapidly rotating grinding discs. This type of pulping; produces paper which are used in paper industry as newsprint.

  In **Chemical pulping**, the chips are boiled with chemicals. When these are boiled, around half of the wood dissolves into the boiling liquid. The remainder becomes pulp - a paste consisting of wood fibers 1.5-3 cm in length. This pulp is used to make copy paper and paperboard.

- **Bleaching the pulped wood**

  Bleaching of wood pulp is done to produce a whitened, yet strong pulp for both hardwood and softwood pulps.

  Bleaching process is divided into three stages:

1. The wood fiber is chemically attacked with chlorine dioxide to remove the color degradation products. This indirectly attacks the lignin that is present in the pulp.
2. In the second stage, the remaining lignin is treated with Hydrogen Peroxide.
3. In the final stage, the pulp is treated with Chlorine dioxide to ensure brightness in the paper.

- **Processing the bleached pulp in the paper machine**

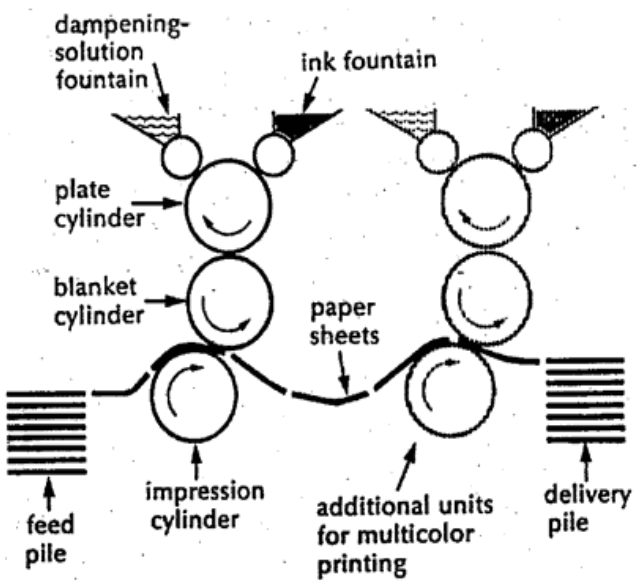
The bleached paper pulp is now treated in the paper mill. In the stock preparation department the pulp is mixed with other kinds of pulp and with clay, glue or other additives.

- The liquid pulp is then spread over wire gauze, in the paper machine.
- The water is pressed out of the pulp which is then dried on a series of drying cylinders.
- Eventually, the paper web reaches the reeling drum at the end of the paper machine.
- The paper is now ready to be reeled into smaller rolls that are ready for sale.
- Sometimes paper with a smoother surface is required, so coat it is with a mixture of pigments, such as chalk, to obtain an even finish that is suitable for multi-color printing.

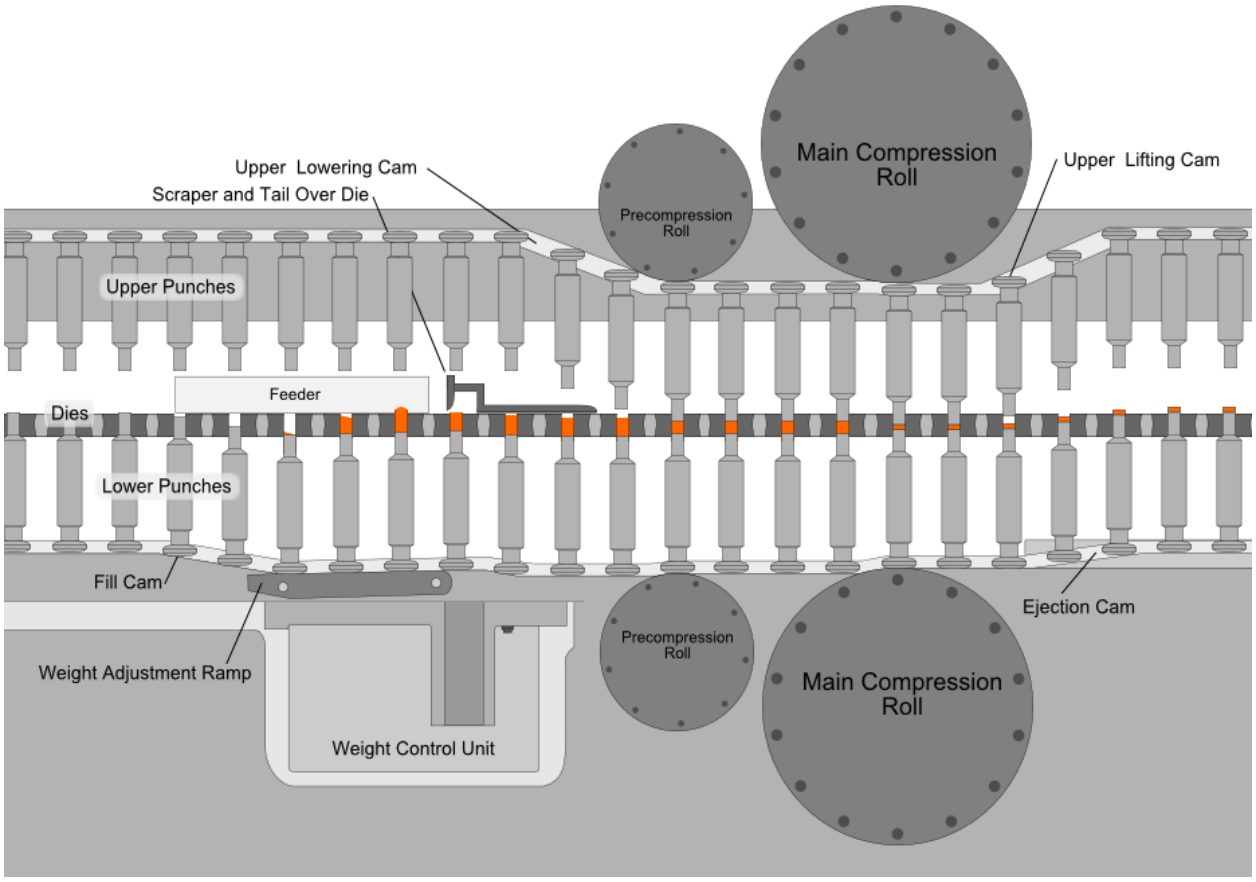
- **Production of paper**

Newspaper Printing

After the paper is being dispatched to the newspaper printing unit, it is being stored for sometime in the warehouses. Generally lithography technique is being used for printing purposes. The printing machinery consumes energy in the form of electricity during printing. **Lithography** is an "offset" printing technique. Ink is not applied directly from the printing plate (or cylinder) to the substrate. Ink is applied to the printing plate to form the "image" (such as text or artwork to be printed) and then transferred or "offset to a rubber "blanket". The image on the blanket is then transferred to the substrate (typically paper or paperboard) to produce the printed product. On sheet-fed presses, the substrate is fed into the press one sheet at a time at a very high speed. Web fed presses print on a continuous roll of substrate, or web, which is later cut to size.



Lithography Printing



Printing Press Operation

After the printing has been done, the newspapers are being stored temporarily in warehouses. These are transported to distant areas for distribution purposes. These are transported via ships, aircrafts, railways etc.

Emissions in every step are being taken into account for calculating the carbon footprint.

In the US, there are nearly 1,500 daily newspapers, with a combined circulation of more than 52 million copies per day. And over the course of a week, eight in ten adults still read a newspaper.

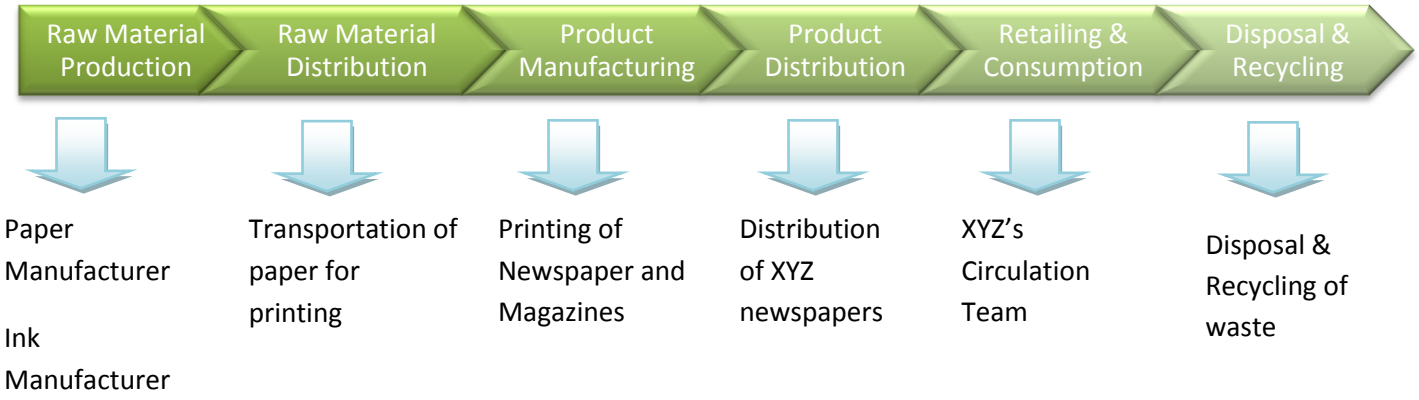
Consequently, in 2006 the US consumed approximately 9.6 million tons of newsprint, which is nearly 25 percent of all newsprint produced globally. Of this, over six million tons were made using virgin wood fibers.

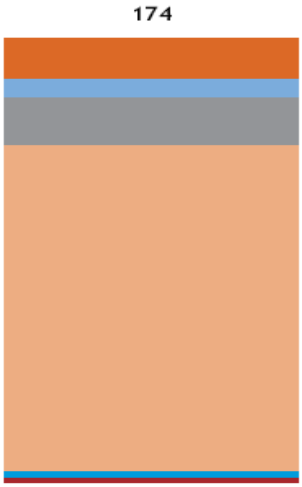
CARBON FOOTPRINTING OPPORTUNITIES

Introduction

The **XYZ** is a leading English-language broadsheet daily newspaper in India. The newspaper has the widest circulation among all English-language broadsheets in the world.

Besides having its influence in the print media, it is very much diversified in electronic media as well. Various printing presses in the facility of XYZ consume electricity for printing the newspaper. Also the offices of XYZ consume energy in a significant amount. Emissions from such activities are significantly high and must be curbed. The process sheet shown below gives us an idea of the stages in the newsprint facility.





The bar graph shown here is a rough estimate of carbon dioxide emissions per newspaper. Emissions from paper manufacturing facility are significantly high as compared to other processes. Printing operation constitutes the second major emission source.

- Disposal (transport of waste, returns & collections)
- Newspaper distribution (transport & warehousing)
- Printing
- Paper manufacture
- Transport (raw materials to mill, paper to printer)
- Ink production

The newspaper supply chain is relatively complex because a significant portion of the post-consumer waste is collected for recycling. Some of that paper ends up back as raw newsprint at the start of the supply chain.

Key insights

- Emissions from printing operations make up less than one fifth of the total carbon footprint per newspaper. 80% of the carbon footprint is added by processes and raw materials used by other companies in the supply chain. This shows the value to be gained from a collaborative supply chain approach.
- Paper manufacturing is the most energy intensive process in the supply chain accounting for more than 70% of the total energy use.
- Increasing the percentage of recovered fiber in paper manufacturing reduces energy usage.

- Energy source, rather than energy use, in paper manufacturing is the main driver of carbon emissions. Using a lower emission energy source has a greater impact on carbon emissions than increasing the recycled fiber content.

Thirteen years ago, the newsprint market in the United Kingdom was in the same situation as the North American market is today, with an industry average of 34% recycled content. With early pressure from the environmental sector, UK newspapers entered into a voluntary agreement with government to establish industry-wide targets for increasing recycled content. The initiative created a guaranteed demand for domestic recovered fiber, thus lessening the need for imported virgin fiber. The goals were incremental: 60% average of recycled content for the end of 2001, 65% by the end of 2003 and 70% by the end of 2006. Remarkably, the sector has surpassed its final goal.

APPROACH AND METHODOLOGY

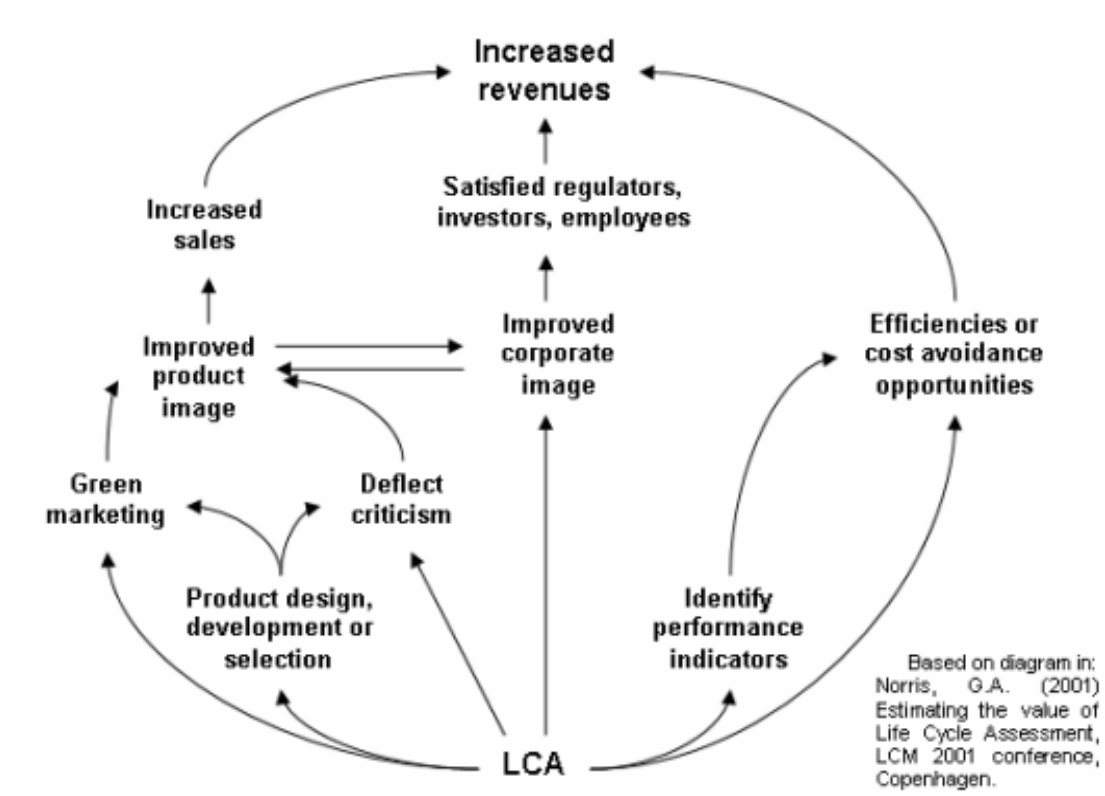
The task of calculating carbon footprints can be approached methodologically from two different directions: **bottom-up**, based on Process Analysis (PA) or **top-down**, based on Environmental Input-Output (EIO) analysis.

Process analysis (PA) is a bottom-up method, which has been developed to understand the environmental impacts of individual products from cradle to grave. The bottom-up nature of PA-LCAs (process-based LCAs) means that they suffer from a system boundary problem - only on-site, most first-order, and some second-order impacts are considered. If PA-LCAs are used for deriving carbon footprint estimates, a strong emphasis therefore needs to be given to the identification of appropriate system boundaries, which minimize this truncation error. PA-based LCAs run into further difficulties once carbon footprints for larger entities such as government, households or particular industrial sectors have to be established. Even though estimates can be derived by extrapolating information contained in life-cycle databases, results will get increasingly patchy as these procedures usually require the assumption that a subset of individual products are representative for a larger product grouping and the use of information from different databases, which are usually not consistent.

Environmental input-output (EIO) analysis provides an alternative top-down approach to carbon footprinting. Input-output tables are economic accounts providing a picture of all economic activities at the meso (sector) level. In combination with consistent environmental account data they can be used to establish carbon footprint estimates in a comprehensive and robust way taking into account all higher order impacts and setting the whole economic system as boundary. However, this completeness comes at the expense of detail. The suitability of environmental input-output analysis to assess micro systems such as products or processes is limited, as it assumes homogeneity of prices, outputs and their carbon emissions at the sector level. Although sectors can be disaggregated for further analysis, bringing it closer to a micro system, this possibility is limited, at least on a larger scale. A big advantage of input-output based approaches, however, is a much smaller requirement of time and manpower once the model is in place.

The best option for a detailed, yet comprehensive and robust analysis is to combine the strength of both methods by using a hybrid approach, where the PA and input-output methodologies are integrated. Such an approach allows preserving the detail and accuracy of bottom-up approaches in lower order stages, while higher-order requirements are covered by the input-output part of the model. Such a Hybrid-EIO-LCA method, embedding process systems inside input-output tables, is the current state-of-the art in ecological economic modeling. The literature is just emerging and few practitioners so far have acquired the skills to carry out such a hybrid assessment. However, rapid progress and much improved models can be expected over the next few years.

Life Cycle Assessment



A **life cycle assessment** (**LCA**, also known as **life cycle analysis**, **eco-balance**, and **cradle-to-grave analysis**) is the investigation and valuation of the environmental impacts of a given product or service caused or necessitated by its existence.

Four main phases

Goal and scope

In the first phase, the LCA-practitioner formulates and specifies the goal and scope of study in relation to the intended application. The object of study is described in terms of a so-called functional unit. Apart from describing the functional unit, the goal and scope should address the overall approach used to establish the system boundaries. The system boundary determines which unit processes are included in the LCA and must reflect the goal of the study. In recent years, two additional approaches to system delimitation have emerged. These are often referred to as 'consequential' modeling and 'attributional'

modeling. Finally the goal and scope phase includes a description of the method applied for assessing potential environmental impacts and which impact categories those are included.

Life cycle inventory

This second phase 'Inventory' involves data collection and modeling of the product system, as well as description and verification of data. This encompasses all data related to environmental (e.g., CO2) and technical (e.g., intermediate chemicals) quantities for all relevant unit processes within the study boundaries that compose the product system. Examples of inputs and outputs quantities include inputs of materials, energy, chemicals and 'other' - and outputs in the form of air emissions, water emissions or solid waste. Other types of exchanges or interventions such as radiation or land use can also be included.

Usually Life Cycle Assessments inventories and modeling are carried out using dedicated software packages. Depending of the software package used it is possible to model life cycle costing and life cycle social impacts in parallel with environmental life cycle.

The data must be related to the functional unit defined in the goal and scope definition. Data can be presented in tables and some interpretations can be made already at this stage. The results of the inventory is an LCI which provides information about all inputs and outputs in the form of elementary flow to and from the environment from all the unit processes involved in the study.

Life cycle impact assessment

The third phase 'Life Cycle Impact Assessment' is aimed at evaluating the contribution to impact categories such as global warming, acidification, etc. The first step is termed characterization. Here, impact potentials are calculated based on the LCI results. The next steps are normalization and weighting, but these are both voluntary according the ISO standard. Normalization provides a basis for comparing different types of environmental impact categories (all impacts get the same unit). Weighting implies assigning a weighting factor to each impact category depending on the relative importance.

Interpretation

The phase stage 'interpretation' is the most important one. An analysis of major contributions, sensitivity analysis and uncertainty analysis leads to the conclusion whether the ambitions from the goal and scope can be met. More importantly: what can be learned from the LCA? All conclusions are drafted during this phase. Sometimes an independent critical review is necessary, especially when comparisons are made that are used in the public domain.

Variants

Cradle-to-grave

Cradle-to-grave is the full Life Cycle Assessment from manufacture ('cradle') to use phase and disposal phase ('grave'). For example, trees produce paper, which is recycled into low-energy production cellulose (fiberized paper) insulation, then used as an energy-saving device in the ceiling of a home for 40 years, saving 2,000 times the fossil-fuel energy used in its production. After 40 years the cellulose fibers are replaced and the old fibers are disposed of, possibly incinerated. All inputs and outputs are considered for all the phases of the life cycle.

Cradle-to-gate

Cradle-to-gate is an assessment of a *partial* product life cycle from manufacture ('cradle') to the factory gate (i.e., before it is transported to the consumer). The use phase and disposal phase of the product are usually omitted. Cradle-to-gate assessments are sometimes the basis for environmental product declarations (EPD).

Cradle-to-Cradle

Cradle-to-cradle is a specific kind of cradle-to-grave assessment, where the end-of-life disposal step for the product is a recycling process. From the recycling process originate new, identical products (e.g., glass bottles from collected glass bottles), or different products (e.g., glass wool insulation from collected glass bottles).

Gate-to-Gate

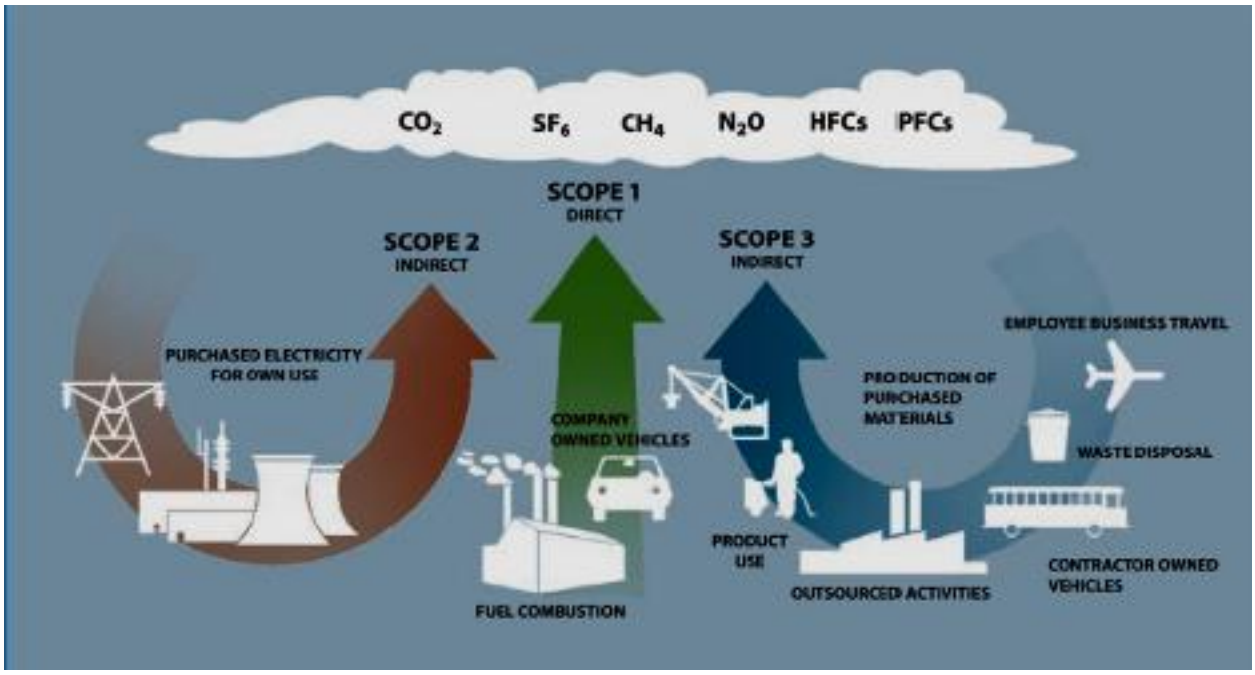
Gate-to-Gate is a partial LCA looking at only one value-added process in the entire production chain.

Well-to-wheel

Well-to-wheel is the specific LCA of the efficiency of fuels used for road transportation. The analysis is often broken down into stages such as "well-to-station" and "station-to-wheel, or "well-to-tank" and "tank-to-wheel".

The factor "T_p = Petroleum refining and distribution efficiency = 0.830" from the DOE regulation accounts for the "well-to-station" portion of the gasoline fuel cycle in the USA. To convert a standard Monroney sticker value to a full cycle energy equivalent, convert with T_p. For example, the Toyota Corolla is rated at 28 mpg station-to-wheel. To get the full cycle value, multiply mpg by Tp=0.83 to account for the refining and transportation energy use - **23.2 mpg full cycle**. The same adjustment applies to all vehicles fueled completely with gasoline, therefore, Monroney sticker numbers can be compared to each other with or without the adjustment. A recent study examined well-to-wheels energy and emission effects of various vehicle and fuel systems.

GHG accounting for any industry is carried out with respect to various **Scopes**. Scope here means the boundary or the area of emission calculation for the particular facility. Given below is a self explanatory diagram for the same:



Scope 1 Emissions

Scope 1 Emissions are also known as **Direct Emissions**. Any emissions that occur on-site or from company owned assets falls under Scope 1 emissions. It includes combustion of fuels, process emissions, refrigerant leakage etc.

Scope 2 Emissions

Scope 2 emissions are also known as **Indirect emissions**. Any emissions created directly on behalf of the company in the generation of electricity or the delivery of energy via hot water or energy.

Scope 3 Emissions

All the remaining emissions resulting from the company's activities come under Scope 3 emissions. Scope 3 emissions often focus on supply chain and customers using their products. Many firms choose not to account for and report Scope 3 emissions. Scope 3 emissions sometimes become bit difficult to calculate or monitor. Few examples of Scope 3 emissions are as follows:

Examples:

- Business travel (most commonly reported)
- Shipping of goods - inbound and outbound
- Contracted activities - outsourced production
- Resource extraction

Global Standards for Carbon Footprint

Green House Gas Protocol

The Greenhouse Gas Protocol (GHG Protocol) is the most widely used international accounting tool for government and business leaders to understand, quantify, and manage greenhouse gas emissions. The GHG Protocol, a decade-long partnership between the World Resources Institute and the World Business Council for Sustainable Development, is working with businesses, governments, and environmental groups around the world to build a new generation of credible and effective programs for tackling climate change.

It provides the accounting framework for nearly every GHG standard and program in the world - from the International Standards Organization to The Climate Registry - as well as hundreds of GHG inventories prepared by individual companies.

The GHG Protocol also offers developing countries an internationally accepted management tool to help their businesses to compete in the global marketplace and their governments to make informed decisions about climate change.

PAS 2050

PAS 2050 has been developed in response to broad community and industry desire for a consistent method for assessing the life cycle GHG emissions of goods and services. Life cycle GHG emissions are the emissions that are released as part of the processes of creating, modifying, transporting, storing, using, providing, recycling or disposing of goods and services. PAS 2050 recognizes the potential for organizations to use this method to deliver improved understanding of the GHG emissions arising from their supply chains, and to provide a common basis for the comparison and communication of results arising from the use of PAS 2050. Although there is no requirement for communication or standardization of communication techniques in this specification, this PAS supports the assessment of life cycle GHG emissions of goods and services that can be later reported and communicated to stakeholders, including consumers. Where an organization implementing this PAS chooses to communicate specific result of the assessment of GHG emissions, it is required to make other information available as specified in this PAS.

Let us continue with our example of **XYZ**:

Calculating the Carbon Footprint of such an industry is a tedious and a cumbersome task. However, with a proper methodological approach we can approximately find out the emissions from such facility.

The following flow chart gives us a brief idea about our approach for accounting the emissions:

1. Defining the scope or boundary for accounting the emissions

2. Identifying all the emission sources falling under the project boundary

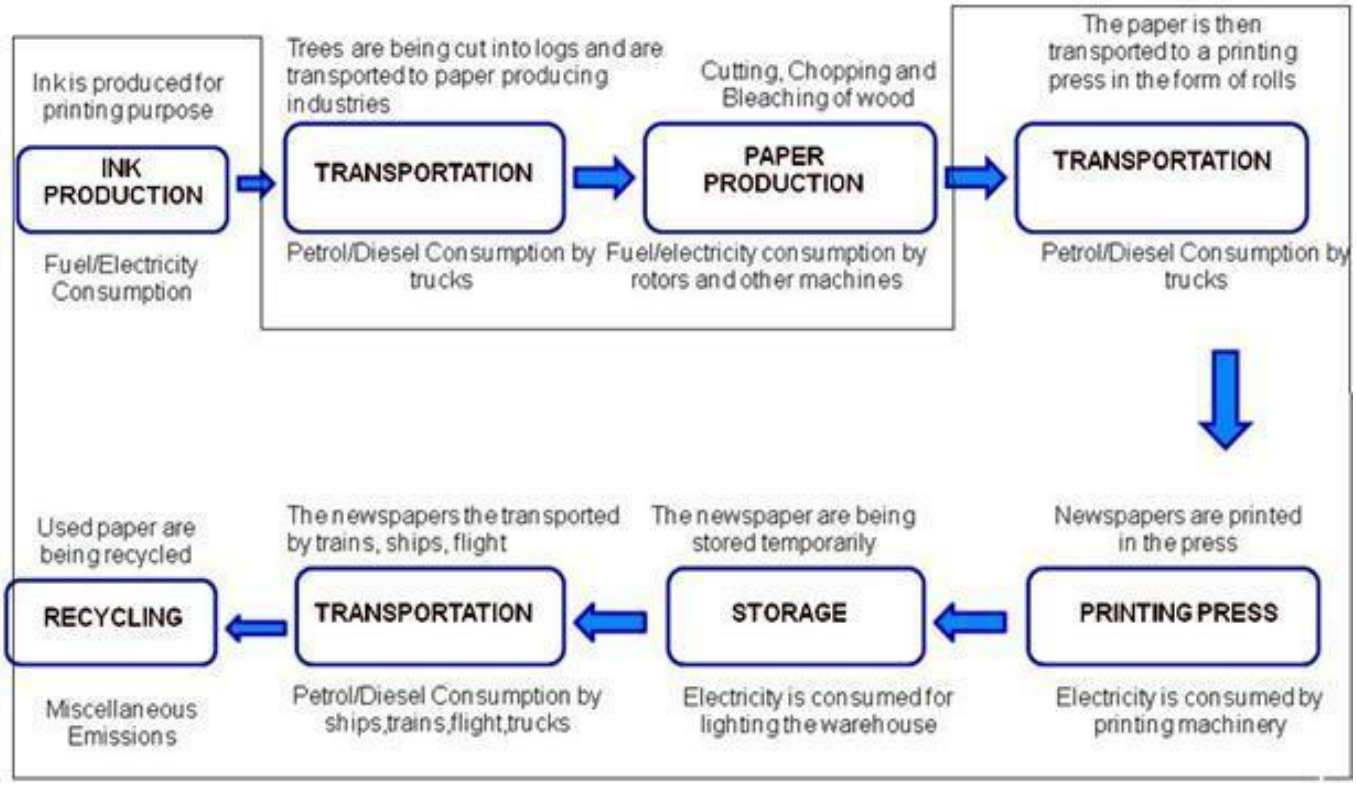
3. Identifying the source of energy (fuel/electricity)

4. Accounting the energy consumption in each area

5. Combining all the data to arrive at the final figure

In the above flow chart we see the various possible emission sources in the newsprint facility in XYZ:

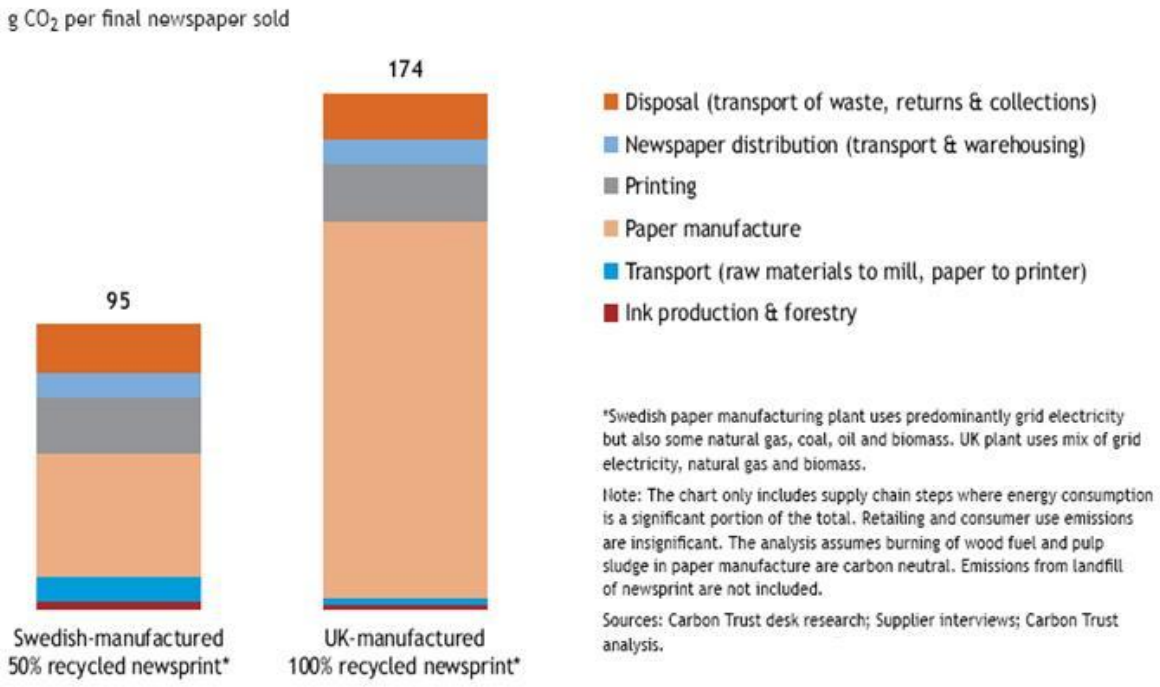
1. **SCOPE OF GHG ACCOUNTING FOR XYZ**



The above flow sheet shows us the scope for GHG Accounting in XYZ for its printing press. Emission occurring from its offices throughout the country and emission from the servers must also be included to arrive at the total figure of GHG Accounting.

Emissions occurring from paper production process and emissions from transportation of logs of wood to the paper production facility fall outside the scope of our calculation, to avoid **double counting**. These emissions are taken into account by the paper producing facility and not by XYZ.

Emissions from paper producing unit constitutes the highest percentage of emissions in the entire cycle.



The above bar graph gives us an idea of contribution of CO_2 per final newspaper sold due to various process. Paper manufacturing constitutes the highest percentage, the second being **Printing** exercise. XYZ must target in minimizing emissions arising from its printing facility to mitigate the climate change.

2. IDENTIFICATION OF ALL THE EMISSION SOURCES

1. The newsprint facility requires ink for printing purpose. Ink is manufactured in some other unit which utilizes electricity to produce ink. This electricity consumption from this unit falls under the scope of XYZ for GHG accounting as it use ink for its printing purposes.

2. Paper in the form of rolls arrives at the warehouse of XYZ's printing press. The amount of fuel consumed in transportation from the paper producing facility to printing press falls under the scope of XYZ's GHG accounting and hence should be taken into account. The warehouse utilizes electricity for lighting tube lights, bulbs etc. for illumination purposes. So the total electricity consumed by these instruments should also be taken into account.

3. The printing press also consumes energy in the form of electricity. The modern Computer to Plate technology takes help of a computer. So power consumption of the computer must also be taken into account.

4. After the papers are being printed these are stored in warehouses for distribution. The warehouse again consumes electricity for lighting purposes. So the total electricity consumption in such case must be accounted.

5. The newspapers are distributed to the entire nation by aircrafts, ships, trucks etc. to the main distribution center. In this process a lot of fuel is consumed in transportation. Burning of petrol/ diesel emits carbon dioxide and hence must be accounted for GHG accounting.

6. After the newspaper goes as waste and is recycled for manufacturing a paper. The energy consumption in recycling also falls under the scope of XYZ's carbon footprint.

7. Operating the internet also leads to electricity consumption both from desktop/laptop and also from the servers. The electricity consumption from the servers should also be taken into account for calculating the carbon emissions.

8. Also emission occurring from the offices and use of stationeries must also be taken into account.

3. INDENTIFICATION OF THE SOURCE OF ENERGY

PROCESS	SOURCE OF ENERGY
PRODUCTION OF INK	ELECTRICITY
TRANSPORTATION	PETROL/DIESEL
STORAGE	ELECTRICITY
PRINITING OPERATIONS	ELECTRICITY + PETROL DIESEL
STORAGE	ELECTRICITY
DISTRIBUTION	PETROL/DIESEL
DISPOSAL/RECYCLING	ELECTRICITY + PETROL DIESEL
WEBSITE SERVERS	ELECTRICITY
LIGHTING THE OFFICE	ELECTRICITY

4. ACCOUNITNG FOR ENERGY CONSUMPTION IN EACH AREA

Energy is consumed in some form or other in the entire process. Quantifying the amount of energy expenditure in each area is the next step in GHG Accounting.

1. **Ink Manufacture**: Manufacturing of Ink for printing purposes is an area where energy is consumed in the form of electricity. It can be quantified by calculating the amount of electricity required to produce 1 liter/kg of ink.

2. **Transportation:** Transportation of paper rolls to the printing facility involves movement of trucks, railways, ships etc. which utilizes petrol/diesel/coal to run their engines. Energy consumption in this area can be quantified by calculating the amount of fuel consumed per km of their travel.

3. **Printing Press Operation**: Quantification of energy consumption in a printing press can be achieved by calculating the average amount of electricity consumption in printing per ton of paper roll. It must be noted that while printing of advertisements power consumption in printing press increases slightly and hence an average figure should be taken while assessing the power consumption.

4. **Storage**: After the printing of newspaper is over it is temporarily stored in the warehouses for distribution purposes. Storage in warehouses consumes power in the form of electricity by bulbs, lights etc. and other lighting equipments. It can be quantified by noting the power consumption in each lighting equipment

5. **Distribution:** Transportation of newspapers over vast distances is also an area where emission level is significantly high. . Energy consumption in this area can be quantified by calculating the amount of fuel consumed per km of their travel.

6. **Disposal and Recycling:** Quantification can be achieved by calculating the energy consumption required in recycling per ton of disposed paper.

Rank	Path Description	Average paper	Recycled paper	Unit
1	Pulp and paper > Paper	305.9	140.7 a)	kg CO_2 / t
2	Pulp and paper > Pulp and paper > Paper	30.34	13.95 a)	kg CO_2 / t
3	Electricity > Pulp and paper > Paper	11.63	4.85 b)	kg CO_2 / t
4	Pulp and paper > Pulp and paper > Pulp and paper > Paper	3.01	3.01	kg CO_2 / t
5	Road transport > Pulp and paper > Paper	2.57	2.57	kg CO_2 / t
6	Wood and wood products > Pulp and paper > Paper	2.46	- c)	kg CO_2 / t
7	Electricity > Electricity > Pulp and paper > Paper	2.26	0.94 b)	kg CO_2 / t
8	Paints, varnishes, printing ink etc > Pulp and paper > Paper	2.05	2.05	kg CO_2 / t
9	Inorganic chemicals > Pulp and paper > Paper	1.29	1.29	kg CO_2 / t
10	Wholesale distribution > Paper	1.22	1.22	kg CO_2 / t
11	Plastic products > Pulp and paper > Paper	1.20	1.20	kg CO_2 / t
12	Electricity > Pulp and paper > Pulp and paper > Paper	1.15	1.15	kg CO_2 / t
13	Mechanical machinery and equipment > Pulp and paper > Paper	0.93	0.93	kg CO_2 / t
14	Retail distribution > Paper	0.88	0.88	kg CO_2 / t
15	Plastics & Synthetic resins etc > Pulp and paper > Paper	0.69	0.69	kg CO_2 / t
16	Road transport > Wholesale distribution > Paper	0.68	0.68	kg CO_2 / t
17	Furniture and miscellaneous manufacturing > Pulp and paper > Paper	0.57	0.57	kg CO_2 / t
18	Electricity > Electricity > Electricity > Pulp and paper > Paper	0.44	0.44	kg CO_2 / t
19	Electricity > Retail distribution > Paper	0.43	0.43	kg CO_2 / t
20	Motor vehicle distribution and repair, automotive fuel retail > Paper	0.35	0.35	kg CO_2 / t
>20	All other paths	16.4	16.4	kg CO_2 / t
	Total	**386**	**194**	**kg CO_2 / t**

The table above gives the brief idea about the energy consumption in every step in a general newsprint facility.

9. Apart from GHG accounting of the printing press of XYZ, emission from its other sources must also be accounted for. The offices of XYZ group across the country uses electricity for various uses. Laptop, computers, lights and other office equipments which consume electricity must be taken into account.

Appliance	Power Consumption (in Watts)
Desktop	80-150
Laptop	20-50
Television	20-150
Satellite dish	30
Printer	100
AC room	1000-5000
Lights	22-100

The above table shows the power consumption of few types of equipment that are generally used in the XYZ office.

10. The XYZ group maintains its own website. The servers consume electricity for running the website 24 hours. So the electricity consumption from all such servers also falls under the scope of XYZ's GHG emissions. Most of the servers are generally located in US. Total direct power consumption for all servers in the U.S. in 2005 is about 2.6 million kW. Including cooling and auxiliary equipment increases that total to about five million kW, which is equivalent (in capacity terms) to five 1000 MW power plants. Total server electricity consumption in the U.S. is 23 billion kWh in 2005. When electricity use for cooling and auxiliary equipment is included, that total rises to 45 billion kWh, or about 1.2% of retail electricity sales in that year2, resulting in a total utility bill of $2.7 billion (2006 dollars) when valued at U.S. industrial electricity prices. Total server power and electricity consumption for the world as a whole is about two and a half times bigger than for the U.S.

After taking into account all the emission sources for XYZ we convert all the emissions in equivalent tones of carbon dioxide. The total emission of XYZ in a year is then defined as Carbon Footprint of XYZ for the concerned year. XYZ can then assess its total emissions and find ways to minimize it carbon footprint.

CARBON FOOTPRINTING REDUCTION OPPORTUNITIES AND ASSOCIATED BENEFITS

In the newspaper industry, where challenges exist for many, this shift in consumer expectations heralded as the new era in consumer environmentalism – presents an unparalleled opportunity. Taking steps to reduce one's carbon footprint and other environmental impacts is not an overnight process. Ultimately, however, it offers the potential to not only provide meaningful cost savings through greater operational efficiencies and avoidance of costly regulatory penalties, but also potential revenue growth by attracting environmentally aware consumers.

After successfully done the GHG Accounting the industry takes measures to reduce the emissions from their facilities. For this purpose it incorporates latest technologies and various energy efficiency measures in its machineries and other power consuming equipments.

However, XYZ can reduce its carbon emissions by other ways also. This can be achieved by:

- Reducing the number of pages in each edition
- Reducing the volume of glossy magazine pages in favor of standard newsprint pages.

Both changes would reduce the carbon emissions and the energy costs for XYZ. There are wider impacts, however, which mean they are unlikely to be implemented.

In both these cases, the cost savings from reduced energy consumption across the supply chain are offset by the loss in revenue from advertising or sales.

Description of opportunities for product change

Opportunity	Carbon emissions and energy costs		Product revenues		Overall profits	
Reduce the number of pages in each edition	Reduces the emissions from each stage in the supply chain by reducing the volume of paper	✓	Reduces the space for advertising so reduces advertising revenue	✗	Loss of profits: Energy cost savings less than loss in advertising revenue	✗
Reduce the volume of glossy magazine pages in favour of standard newsprint pages	Newsprint paper manufacturing and printing both use less energy than glossy magazine paper	✓	May harm sales and advertising revenues from glossy pages	✗	Loss of profits: Energy costs savings less than loss in sales and advertising revenue	✗

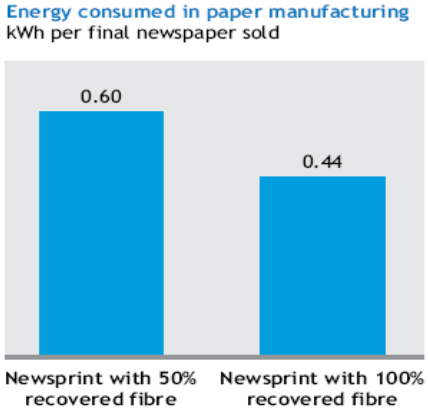
At present, this opportunity is not lucrative as XYZ would not like to part with its profit and incur a loss. But with the advent of **National Action Plan for Climate Change**, economists predict that implementation of Carbon Taxes is not far off. In such cases XYZ might have to consider this opportunity in the near future.

Supply chain reconfiguration:

XYZ can reduce its carbon footprint its newsprint facility by:

- A: Buying paper from a supplier using minimum energy in its production; where
- B: The energy comes from a low-emission source.

The chart shows energy used in paper manufacturing, so excludes energy used in distribution, disposal and other steps.



XYZ can also bring down its emission levels by adopting the following technologies in its printing facility and supply chain:

Energy Efficiency Measures

- Plug-In to eCycling (Recycling Consumer Electronics):

  This approach stresses on reusing and recycling the electronic devices used in a printing press.

- Print STEP:

  The goal of Print STEP (Printers' Simplified Total Environmental Partnership) is helping the printing industry and the public achieve cleaner, cheaper, and smarter environmental protection through the creation of a simpler regulatory "framework." Print STEP does not change the existing environmental emissions or release standards for the printing industry. Instead, it changes the process of implementing those standards. Print STEP should improve environmental performance, be more efficient, and make the regulatory process easier. This new approach encourages all stakeholders in the printing industry to become involved and contribute positively. Pilot projects with extensive evaluation (including gathering baseline information at the initiation of the pilot projects) will be the primary means of determining the effectiveness of Print STEP.

- Pollution Prevention in Printing

  A barrier to identifying and implementing P2 projects is the lack of expedient access to reliable and up-to-date P2 information. In the printing industry, this problem is compounded by the fact that most print shops are small and not able to dedicate a staff person to environmental issues.

Specific tasks in the P2PRINT project include:

- Developing a comprehensive database of pollution prevention information for printers, creating a centralized location for information developed specifically for the printing industry

- Creating an E-mail based forum that will link printing companies with technical experts, vendors, trade associations, and regulatory programs.

- Creating a CD-ROM system that will enable printers to answer specific questions related to their unique situation by providing a user-friendly interface and format for locating pollution prevention information.

Business Opportunities:

- Implementing computer-to-plate technology (CTP). CTP allows for faster press make-ready, which reduces paper wastage.
- Reducing the basis weight of its stock if this will not compromise the overall quality of the magazine. Checking the selection of environmentally friendly papers available to determine which lighter weight papers have opacity and caliper comparable to heavier stocks. Reducing the basis weight may also save postage costs.
- Buying paper cooperatively. Several publishers using the same printer may significantly reduce paper costs by allowing the printer to buy specific environmentally friendly paper in large volumes, usually by the truckload. Approach this strategy with your printer, as warehousing may be an issue. If this paper is popular with several clients, the printer may begin to stock it as a house sheet.
- Investigating the willingness of subscribers to switch to digital subscriptions. Providing magazines digitally reduces print costs and will definitely reduce increasing postal costs.
- Replacing the incandescent bulbs with compact fluorescent bulbs. They use about 66% less energy, and can save Rs. 2000.00-3000.00 per bulb over their lifetime.
- Replacing T12 fluorescent lights with T8 or T5 fluorescent lights. This requires installing new fixture but can reduce the energy needs for each bulb by half.
- Turning off computers at night. It is best to totally shut down a computer at night. Screensavers protect the screen from dam age but do not save energy.
- Using timers or motion sensors so lights are not on when a room is unoccupied.
- Upgrading to an efficient heating, ventilation and air conditioning (HVAC) system that is the right size

CONCLUSION

Managing the carbon footprint of products across the supply chain is the next step for business to take in the effort to reduce carbon emissions and mitigate climate change. As we move to a more carbon-constrained world, business will have to meet customer needs in a way that generates fewer carbon emissions. Business energy efficiency has played, and will continue to play, an important role but more fundamental solutions are also needed. Managing carbon footprints of products across the supply chain is just such a solution.

There are several different issues which are driving companies to take further action on climate change, including:

- Increases in direct energy costs and the energy costs of suppliers
- Existing and planned legislation which penalizes high energy consumption and rewards emissions reductions

Indeed, as many forward-thinking companies have realized, greener business practices no longer represent a threat to profitability. On the contrary, greater consumer awareness of environmental issues – and climate change in particular – has led to a growing expectation that companies demonstrate a genuine and ongoing commitment to reducing their impacts. Consumers' choices are also showing that commitments to the environment will often, if done right, be rewarded in the marketplace.

Additionally, with the increasing likelihood of legislation stipulating an economy wide cap on greenhouse gas emissions this is a right time for an industry to shift towards greater environmental responsibility. To avoid the high cost of compliance XYZ has a unique opportunity to make investments that will significantly reduce the industry's emissions.

The Government of India has recently announced the **National Action Plan on Climate Change**. There are Eight National Missions which form the core of the National Action Plan, representing multi-pronged, long term and integrated strategies for achieving key goals in the context of Climate Change. National Solar Mission, National Mission for Enhanced Energy Efficiency, National Mission on Sustainable habitat, National Water Mission, National Mission for a Green India etc. are few such names which form Eight National Missions. So, with the implementation of these reforms paper industry is bound to get into the picture. It is the best time when **XYZ** assesses its emissions and find ways to reduce them to avoid penalty from the Government in future in the form of **Carbon Tax**.