Greening Food and Beverage Value Chains: the Case of the Soft Drinks Industry

A report for the UNIDO Green Industry Initiative

UNITED NATIONS
INDUSTRIAL DEVELOPMENT ORGANIZATION

Green Industry

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Executive Summary

As global carbon emissions continue to rise and natural resources become scarcer, industries are under increasing pressure to commit to more sustainable manufacturing processes, with the soft drinks industry being no exception. In the face of rising criticism regarding issues such as competition for water resources, water pollution and packaging disposal, some industry members have embarked on a number of initiatives to reduce their environmental footprint in the soft drinks value chain. However, there remains much scope within the industry for it to achieve greater environmental performance.

The soft drinks industry is an important player in the food and beverage industry, although health and nutritional concerns have led to diminishing demand in recent years in more developed economies. Many low- or no-sugar options are now surpassing traditional soft drinks as market leaders in many cases, along with a rise in energy drink consumption. This trend is likely to continue, as is the growing demand for new, natural plant-based sweeteners. Soft drinks companies are also diversifying into a wide range of beverage and food products, hence their global reach and impact on various supply chains is immense. Correspondingly, their impact on natural environments also leaves much room for greening the value chain. Furthermore, multinational companies also have the ability to positively influence their respective governments to commit to resource efficiency and climate change mitigation targets.

Globally, the sector is dominated by large multinational corporations such as the Coca-Cola Company, PepsiCo and Nestlé S.A. The Coca-Cola Company, in particular, has bought out a number of high-performing local brands around the world. Nevertheless, some countries and regions have a number of small to medium-sized companies which have carved out their own sizeable market share. The United States of America remains the largest market for soft drinks, however, future growth is expected to be strong in the developing regions of Latin America, the Middle East and Africa, while China is also forecast to see rising sales.

This report is a review of best practice greening opportunities for the soft drink industry and, as such, aims to serve as a point of reference for practitioners in the food and beverage sectors and sub-sectors in their adoption of green industry policies and practices. The report examines the various stages along the value chain, from the production of agricultural ingredients, to processing, packaging, distribution and consumption, making the case where possible for a 'closed loop' approach, whereby all by-products are recovered and reapplied.

The report emphasises that the soft drinks industry would benefit from greater cooperation along the value chain to improve resource efficiency and cut waste. It also highlights that useful interventions can be made in the areas of raw materials supply (sugar, citrus fruits, additives and sweeteners etc.); soft drink manufacturing (bottling); warehousing; distribution; retailing; and consumption. However, the areas with the most “greening” potential are to be found in water and energy use, packaging and agricultural ingredients.

A number of multinationals have been working for some years in collaboration with a range of stakeholders at the local level to ensure that scarce water resources are used efficiently. Many have companies committed to the Water Stewardship principles as defined by the World Wildlife Fund (WWF), the World Business Council for Sustainable Development (WBCSD) and the European Union (EU). Smaller companies that supply soft drinks at a national or regional level are also implementing a range measures to reduce their environmental footprint through measures such as committing to measurable reductions in packaging, the utilisation of renewable energy and the production of their own PET pre-form packaging.

The production of sugar and citrus fruit present the greatest source of waste in the agricultural supply chain, and are therefore viable targets to help reduce the soft drink industry's environmental footprint. The adoption of sustainability principles and certification schemes for sugar production are becoming increasingly utilised by industry members eager to lift their environmental performance and social responsiveness.

Citrus fruit production impacts on the environment through excessive water consumption and the use of fertilisers and pesticides at the farm level. Here steps are also being taken to curb the use of agrochemicals through measures such as integrated pest management (IPM). Much of the waste from sugar and fruit production is also reused as fuel or in the paper industry (bagasse), or in composting operations (fruit pulp).

Options for greening at the industry production stage include on-site reduction of water and energy usage as well as reduced waste generation. Around 10-20% of energy consumption in production processes can be reduced by implementing low- to no-cost investment improvements through simple energy efficiency measures. This is a viable option for older facilities or smaller companies. However, as the adoption of energy efficiency measures become more commonplace in the production process, this has in turn shifted the focus onto increasing the share of renewable energy in the larger bottling companies, a trend mostly discernible in the largest companies in developed regions such as Europe and the USA.

Water is essential in every component of the soft drinks value chain, hence its quality, abundance and availability is of paramount importance to the industry and the local communities in the vicinity of the water source. Efforts to reduce water consumption have intensified in recent times due to the growing spotlight on water scarcity. Significant water savings can be achieved by treating the wastewater with several advanced treatment technologies which render the water suitable for use in the production process. However, only a few bottling plants currently operate anaerobic wastewater treatment installations on-site to treat their wastewater, whilst also generating biogas and eventually electricity. It is hoped that wider uptake will improve industry water use efficiency.

Energy consumption constitutes the greatest environmental impact at the distribution and retail stages of the supply chain. The three main options to reduce energy consumption in this area are through the use of hybrid delivery trucks specifically for urban transport; the adoption of alternative fuels; and through increased training of delivery drivers to encourage them to utilise efficient driving techniques and improved route planning.

Refrigeration is the primary user of energy in the beverage retail sector. Most industry efforts are focused on the development and distribution of energy-efficient and HFC-free display cabinets. However, this has been slow to gain traction as it requires an overall revamping of retail stores.

Packaging comprises the largest source of greenhouse gas (GHG) emissions in the soft drink life-cycle. Efforts to reduce, reuse and recycle are therefore crucial to diminish the sector's overall environmental footprint. Several methods and practices are being employed in the industry to reduce the environmental impact of packaging. For example, suppliers and manufacturers are increasingly focusing on the sustainable sourcing of cardboard and paper, the density of packaging material and the type of bleaches and dyes used in the manufacturing of the packaging.

Whilst packaging recycling rates are growing, the increasing use of recycled material in packaging depends on enhanced cooperation between communities and governments and on the infrastructure available for recycling.

Industrial ecology is an important mechanism that links input or output streams from different stages of the soft drinks value chain to external processes. Examples of how this symbiotic relationship can benefit the soft drinks value chain include:

- waste materials from sugar processing can be reused in other industries as animal feed, fuel or to make compost;
- wastewater from the bottling plant measuring highly in chemical oxygen demand (COD) can then be used as a source of COD in public or privately owned treatment works; and
- waste materials such as glass, metals, cardboard or plastics that originate from the supply, the production, or the distribution and retail phases can be fed into the recycling circuit.

Hence, this report demonstrates that there are many opportunities for greening throughout the life cycle of soft drinks. Progress already made by larger companies can, in part, be replicated by smaller companies and other areas beyond manufacturing (e.g. the supply and distribution chains). Extensive communication, awareness-raising and increased cooperation are effective means by which to ensure that the soft drinks industry is both environmentally sustainable and sourced through ethical means.

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1 INTRODUCTION

As part of the UNIDO Green Industry Initiative, the UNIDO-UNEP Green Industry Platform has recently set out to analyse environmental practices in industrial value chains focusing on three selected sub-sectors: the meat industry, the fruit processing industry and the soft drinks industry. The result is a set of best practice compendiums, identifying greening opportunities which can be undertaken along the value chain, making the case for less resource-intensive ways of production and recycling. With this the platform aims to contribute to its global mandate to accelerate the uptake of green industry policies and practices in high-impact sectors.

This report identifies and showcases best practice in environmental management and resource efficient production in the soft drink industry and shall serve as a point of orientation in the adoption of green industry policies and practices and the improvement of the environmental performance along the value chain and within enterprises engaged in it. Greening potentials are identified particularly in the areas of: efficient energy use and generation of energy; reduced water consumption and treatment of contaminated water; air contamination and CO2 emissions; and waste management. These areas have a strong link to the four priority areas of the UNIDO-UNEP Green Industry Platform, which are: resource efficiency; industrial energy efficiency; water optimisation; and chemicals management.

The report is aimed at decision-makers of private entities, civil society, as well as policy-makers that are interested in exploring the greening potential within the soft drinks industry. The Green Industry Platform will serve as the forum to share the lessons learned among industry associations and governments and to ensure its wide dissemination.

The report starts from the premise that the greening potentials of an industry are best identified in the context of a value chain defined by the flow of products from primary production to consumption, passing various stages of processing and value addition. For this reason a value chain map is introduced at the beginning of the report and the subsequent chapters discuss greening opportunities in the various segments (processing steps) of the map.

2 OVERVIEW OF THE SOFT DRINKS SUPPLY CHAIN

The soft drinks industry is defined as an industry that produces non-alcoholic beverages, excluding pure fruit juice drinks. There are three key types of soft drinks:

1. **Flavoured:** The most common being cola and lemonade, but which also includes other fruit flavours, such as citrus or berry. This also includes energy drinks.
2. **Diet:** Low-or zero-calorie versions of regular flavours and brands, which include the use of both natural and artificial sweeteners.
3. **Mixers:** For mixing with alcoholic drinks, such as tonic water.

The global soft drinks industry is facing challenges on a number of fronts. Performance no longer depends solely on taste and presentation; rather many companies are finding that they need to diversify in response to issues that are increasingly global, such as concerns related to health and obesity levels, changing demographics with different tastes and increasing purchasing power, as well as environmental and ethical concerns.

From an environmental perspective, specific problems related to the soft drinks supply chain include dealing with packaging-related waste, energy consumption in the value chain and the impact of high water use, particularly during the agricultural production phase. There have already been efforts made to employ resource-efficient production processes; however, the greatest environmental impacts do not necessarily lie within in the manufacturing process itself. More effort will be required to integrate both upstream and downstream activities along the value chain to create a genuinely green industry.

Where possible throughout this report, greening opportunities are considered in the context of achieving a 'closed-loop', whereby waste streams from one process can be used as a resource for another. The implementation of closed-loop system in the soft drink industry will require collaboration from the farm-level, to bottlers, distributors, the soft drink companies themselves, as well as governments, communities and research bodies.

Developing a sustainable soft drink product in the future will depend on how well the industry responds to these challenges and to what extent is it able to ensure that “greening” takes place throughout its supply chain.

2.1 Key markets and players

The global soft drink industry's top four producers (outlined below) are estimated to account for 30% of industry revenue in 2014 (Ibis World 2014) with production facilities located around the world. Although not every country is exclusively dominated by multinational companies, these companies tend to dominate the markets in many countries, meaning that they also often directly control the bottling and distribution of their product. Correspondingly, they also have a great influence over most, if not all of the value chain through their superior bargaining power.

In terms of consumption, the United States remains the largest market for soft drinks in the world, with per capita consumption at 170 litres per year in 2012 (Check et al. 2012). Other major consuming countries include the Republic of Ireland, the United Kingdom, Australia and Mexico, which range between 85 and 140 litres per capita, per year. By contrast, consumption in developing and emerging countries is considerably lower, with Chinese consumers drinking only 10 litres per capita per year.

The biggest global soft drinks companies in the world are the Coca-Cola Company, PepsiCo, Nestlé SA and Groupe Danone (see Box 1).

Table 1: Top 10 Global soft drinks companies

Adapted from Euromonitor 2011

US $ Value rank	Company
1	The Coca Cola Company
2	PepsiCo Inc.
3	Nestlé SA
4	Suntory Holdings Ltd
5	Groupe Danone
6	Dr Pepper Snapple Group Inc
7	Red Bull GmbH
8	Tingyi Holdings Corp
9	Asahi Breweries Ltd
10	Kirin Holdings Co Ltd

Box 1: The world's largest soft drinks producers

The largest soft drink brands globally are Coca-Cola Classic, Diet Coke and Pepsi Cola (Check et al. 2012). Coca-Cola is a leading manufacturer, distributor and marketer of soft drink concentrates and syrups. It owns or licenses more than 500 brands across all categories of soft drinks.

The Coca-Cola Company sells its syrups and concentrates either to contracted independent bottlers that produce, bottle and distribute the final product, or to Coca-Cola-owned bottling companies. Its main products are Coca-Cola, Diet Coke/Coca-Cola Light, Coca-Cola Zero, Sprite and Fanta. Its biggest markets are the US and Mexico, followed by China. In February 2010, Coca-Cola bought out the remaining interests in Coca-Cola Enterprises, the main contracted US bottler, giving the Coca-Cola Company control over 90% of North American volume (Ethical Consumer, 2013).

PepsiCo's products include a variety of salty, sweet, and grain-based snacks as well as soft drinks. The company is responsible for the manufacturing, marketing, and sales of these goods. PepsiCo is divided into three business units: PepsiCo Americas Foods (PAF), PepsiCo Americas Beverages (PAB), and PepsiCo International (PI). These three business units are further divided into six reportable segments: Frito-Lay North America (FLNA); Quaker Foods North America (QFNA); the Latin American food and snack businesses (LAF); PAB; Europe; and Asia, Middle East, and Africa (AMEA) (Ethical Consumer 2013).

Nestlé SA is one of the world's largest food manufacturers. Its main drink product is bottled water (which is part of the soft drink category). The growth in bottled water has boosted the listing of Nestlé in the soft drinks industry. The company provides brands in this sector such as Perrier, Vittel, Poland Spring and Buxton. Nestlé's strategic emphasis on providing healthy food products places emphasis on growth in developing regions.

Suntory Holdings Limited is Japan's largest home-grown soft drinks company. Its portfolio is led by Boss Ready To Drink coffee and the local Pepsi license. Suntory moved into Europe with the purchase of Orangina Schweppes and agreed to buy Glaxo Smith Kline's Lucozade and Ribena in 2013.

Dr Pepper Snapple Group was spun off in 2008 from what was then Cadbury Schweppes. The company now operates solely in North America and the Caribbean.

Groupe Danone is the world's second largest bottled water producer that performs well in its core market of Europe, but is less dominant elsewhere. Global brands Evian, Volvic and Badoit are supported by regional products including Indonesia's Aqua and Dannon in the US.

Red Bull GmbH is the producer of energy drink Red Bull. Founded in Austria in 1987, it started a revolution in the global soft drinks market in the 1990s, becoming the leader in the growing energy sports drinks sector.

Tingyi Holdings is one of China's biggest food and drink brands. It is the clear local leader in the soft drink industry with more than 50% of the market share, as well as the leader in bottled water and fruit juice industries in the region.

Kirin Beverage Company controls a collection of soft drinks in Japan including Fire Coffee and the local license for Tropicana. It is also one of the biggest beverage companies in Australia, and the owner of Pura milk and Berri juice.

Asahi is best-known as a brewer, but also manages the second biggest soft drink business in Japan, with brands including Wonda coffee, Mitsuya Cider and Calpis. It has a strong presence in Australia as Pepsi's local licensee and owner of Cottee's, Schweppes and Solo.

2.2 The soft drink value chain

The typical product cycle that is used to produce most soft drink, include, in the following order (ChangeLab Solutions 2012):

- syrup production;
- bottling;
- distribution;
- retailing; and
- final consumption.

The materials in the different components of the value chain are briefly described in the paragraphs below. The production processes are described in more detail in the subsequent chapters.

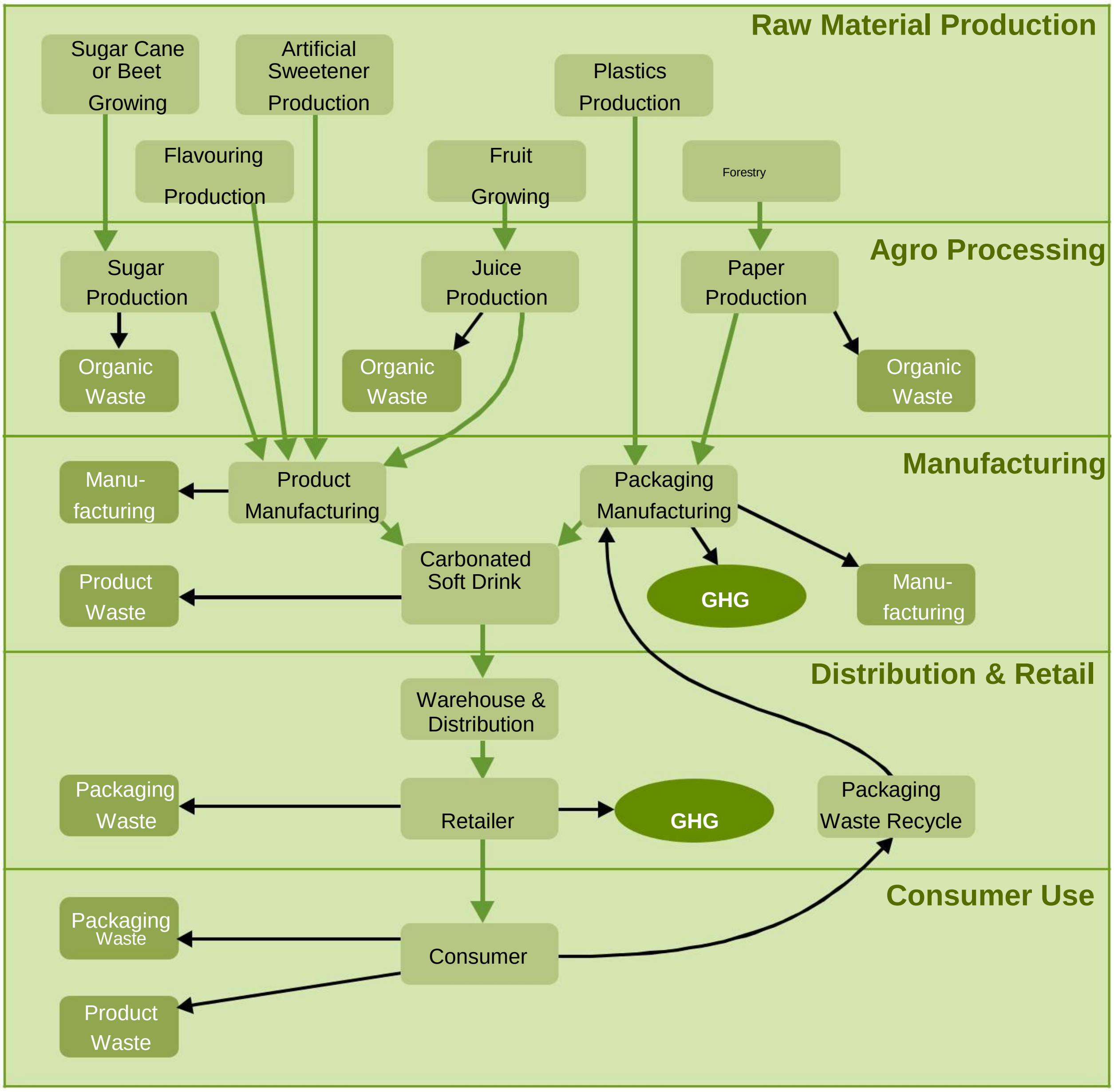

Figure 1: Product flow for soft drinks
(Defra 2012)

1. Raw material production

Agriculture provides the largest volume of raw materials in the soft drink value chain, supplying key ingredients such as sugar cane, sugar beet and fruit (citrus). The forestry and the petrochemical industries provide the raw materials for the production of packaging materials such as paper and plastic. The agricultural production of these components depend on a wide variety of variables, many of which like weather, soil moisture and disease are impossible or difficult to control. Production of citrus, sugar cane and wood mostly occur in large plantations where water availability, pollution from the application of chemicals and land use change are the main potential environmental impacts.

2. Agroprocessing

Sugar, or other sweeteners such as high-fructose corn syrup (HFCS), fruit and carbonated water (constituting on average 94% of a soft drink) are the main ingredients in soft drinks and are used in varying quantities, depending on each company's recipe. Other minor ingredients added in very low concentrations include flavourants derived from fruit (such as orange used in Fanta); acids (most commonly citric acid); additives to enhance flavour; texture; aroma; appearance; emulsions (most commonly gums and pectin) to enhance appearance; and preservatives and antioxidants (BHA, ascorbic acid, or other naturally occurring additives) to maintain colour and flavour.

Sugar production in mills requires a significant amount of energy and water and is only economically viable in very large scale sugar mill operations. Citrus fruit is the most processed fruit for soft drink production. More than half of the global production of citrus fruit comes from Brazil (18%), China (17%), the United States (9%), Mexico (6%), India (5%) and Spain (5%) (FAO 2013).

Wood is processed in large scale paper mills into cardboard and paper which are used as packaging materials. As in the sugar production, this is a water and energy intensive process.

3. Product and Carbonated Soft Drink Manufacturing

Most soft drinks are made at local bottling and canning companies. Brand name franchise companies grant licences to bottlers to mix the soft drinks in accordance with their formulas and manufacturing procedures. In this product manufacturing process (usually referred to as the bottling process) water purification takes place to ensure that the flavour and quality of the beverage are not affected by bacteria or unwanted substances. A series of water purification processes take place such as coagulation, flocculation, filtration and sterilisation. Reverse osmosis is increasingly used as the main final treatment process. Dissolved sugar, juice and flavour concentrates are pumped into batch tanks where they are carefully mixed making syrup. Some syrups, such as the fruit-based syrups, are sterilised while in the tanks using ultraviolet radiation or flash pasteurisation. The water and syrup are carefully combined by machines that regulate the flow rates and ratios of the liquids. Carbon dioxide is added in the same production stage. The amount of carbon-dioxide pressure used depends on the type of soft drink. In the filler machine the finished product is transferred into bottles or cans at very high flow rates. The containers are immediately sealed with pressure-resistant closures, either tinplate or a steel crown with corrugated edges, plastic twist caps or pull tabs.

The whole bottling process uses between 2 and 4 litres of water per litre of soft drink that is produced, and between 0.5 and 1.0 megajoules per litre of soft drink (Beverage Industry Environmental Roundtable, 2013).

4. Packaging manufacture

The main packaging materials used in the beverage industry are PET plastic (Polyethylene Terephthalate), paper and cardboard. Only a small and declining volume of beverages are packed in glass. PET bottles are produced from small and dense so-called PET “pre-forms” that are blown into different sizes of PET bottles in an extrusion process. Cardboard is processed to produce packaging materials, mostly in the form of trays. Paper is used for labels on bottles where pre-printed plastic sleeves are not possible.

5. Warehousing and distribution

Bottled soft drinks are distributed through different channels before reaching the consumer. A small proportion of goods go through distributors, who serve as middle-men, facilitating further distribution and warehousing. The largest volume is sold directly to merchants. If sent to a distributor, the goods may be repackaged into smaller quantities or sold directly to customers. The main environmental impact from the distribution phase relates to the consumption of fuel by distribution vehicles.

The bottled soft drinks leave the bottling plant in plastic crates or in cardboard trays, stacked onto wooden pallets. These are then transported by trucks to warehouses from where they are distributed to retail points. The main environmental impact in this phase of the product chain is the energy use associated with the transportation. Cooling of the soft drinks does not take place in this phase.

Box 2: Clever Packaging: Sustainability and Cost Cutting (Meryn 2014)

In a joint effort to provide wine to a greater consumer base and reduce production costs, Oregon based Union Wine Company offers wine in aluminum cans instead of the traditional glass bottles.

The aluminum packaging provides a more sustainable and environmentally friendly option than glass bottles, with no loss of material quality no matter the number of times spent cans are reintroduced into the value chain. Thereby, Union Wine Co. is able to utilize an established process of aluminum recycling towards wide increased in production gains and a reduction in the company's environmental footprint. The nearly 40% in production cost savings—due mainly to the comparative cheapness of material costs as well as the increased robustness of aluminum over fragile glass— provided an incentive for Union Wine to expand the percentage of its business currently developed and for other companies to follow suit in addressing economic and environmental concerns with market innovations. These gains also move past production facilities, with a lighter, more rugged product translating to cheaper net transportation costs as well as less en route breakage. Product confined to air-tight cylinders can also improve product quality and shelf-life. An expanded market of canned wines would therefore benefit enterprise balance sheets and sustainability in equal measure.

6. Retailing

Up to 50% of soft drinks are purchased by the consumer in supermarkets and general retailers. Other retail outlets include fast food and drinking venues; convenience stores and gas stations; vending machine operations; smaller outlets (such as drug stores, community centres); and exports.

The environmental impacts in the retail sector are manifested in the use of energy for transportation and storage (refrigeration) and in the transportation packaging in the form of wooden pallets, cardboard and polyethylene shrink-wrap. The energy consumption in the beverage cooling process constitutes the largest environmental impact in this phase, as well as the second largest environmental impact in the value chain after agriculture. The relatively energy intensive process of cooling the bottled soft drinks takes place at retail locations in small product displays or in larger cold storage rooms. The product display can either be cooled in the refrigerated storage or left uncooled at the place of retail.

7. Consumption

Almost 60% of carbonated soft drinks globally are sold in PET packaging, with 27% in aluminium cans and 10% dispensed on trade premises from bulk packaging. The packaging is almost immediately discarded after consumption.

8. Disposal and recycling

Finally, packaging is disposed of in a landfill site or is recycled. Upon recycling the packaging is sent for sorting and is then remanufactured into beverage containers or other products.

Box 3: The bottled water discussion

As bottled water use continues to expand around the world, there is growing interest in the environmental, economic, and social implications of that use. This includes concerns about waste generation, proper use of water resources and economic costs etc. The arguments are that in countries where tap water is of good quality, there is no need for bottled water and that the production, distribution and sale of bottled water consumes energy that would not be required if only tap water was used. Furthermore, the production of all the packaging requires large amounts of energy and raw materials. Finally, the packaging can create a waste problem when discarded.

Table 2: Resource use and environmental impacts across the fruit value chain (Adapted from UNIDO 2013)

Resource Use	Source of Environmental Impacts
• **Nutrients:** Inorganic fertilisers, organic fertilisers (manure, compost, cover crops, other soil amendments) • **Energy:** Diesel and petrol for machinery, pumps and transport, electricity, gas or other for processing equipment, refrigeration, lighting • **Ecosystem services** • **Water:** Rain fed, surface or groundwater irrigation, wastewater, town water for processing • **Genetic resources:** CO_2 • **Soils:** Substrate, moisture, carbon, filtering and minerals • **Living organisms:** Pollination, regulation of pests, recycling, sequestering and conversion of nutrients etc. • **Sunlight** • **Capital:** Irrigation delivery system, harvesting equipment • **Chemicals:** Pesticides - insecticides, herbicides, rodenticides, fungicides & miticides for farming, cleaning and sanitising chemicals for processing	• **Emissions to the atmosphere:** Carbon emissions from fossil fuels, direct and indirect denitrification of N and volatilisation of NH_4 from nutrient inputs • **Depletion of non-renewable resources:** Consumption of diesel, petrol, oil, phosphorous and other • **Pollution and eutrophication of water sources:** Toxic pesticide and nutrient runoff • **Land degradation and loss of biodiversity:** Habitat loss or fragmentation, erosion, salinity, etc. from poor irrigation practices and excessive tillage and land clearing • **Water depletion:** Especially of groundwater aquifers • **Wastewater generation:** Run-off from production and wastewater from processing • **Solid waste generation** - e.g. packaging and organic wastes generated across the supply chain

2.3 Trends

There are a number of trends emerging in the global soft drinks sector in terms of health, demographics, the economy and sustainability. Many developed economies are generally showing a decline or stagnation in soft drinks growth as consumers and governments are becoming increasingly concerned about the effects of sugar-containing carbonated drinks. Whilst this trend is occurring in some western companies, there is general growth in the soft drink markets of many low to middle income countries. This growth has been underpinned by factors such as an expanding younger population, growing middle classes, increasingly urban populations and faster-paced lifestyles which will mean strong demand for convenience products and functional beverages.

Shifts in consumer tastes and concerns regarding obesity (see Section 2.4) are compelling the larger companies to diversify and invest in a wider range of beverages such as spirits, bottled water, fruit juices, sports and energy drinks, ice teas, flavoured milk and coffee as well as ready to eat fruit and vegetable snacks and products. Therefore, the role that the global companies can play in mitigating their environmental impact and their suppliers' impacts across a wide range of environment, resource and rights-related areas is significant.

2.4 Economic and demographic trends

There is great diversity in each country's soft drinks market in terms of consumption, market share and production etc. Recent trends in consumption in a range of countries are outlined in Box 4 below.

Health

Unhealthy commodities such as soft drinks and processed foods that are high in salt, fat, and sugar, as well as tobacco and alcohol, are leading risk factors for chronic non-communicable diseases (Stuckler et al. 2013). In 2010, being overweight or being obese were estimated to cause 34 million deaths, 39% of years of life lost and 38% of disability-adjusted life-years (DALYs) worldwide (Ng et al. 2013). Thus, sales of carbonated soft drinks have been experiencing a decline in many developed economies due to concerns about obesity, diabetes and the health effects of artificial sweeteners.

Box 4: Overview of a range of countries' soft drinks-related trends 2013 (Euromonitor 2014)

Vietnam

- Increasing consumer demand for carbonated drinks.
- New product developments and investment in marketing and promotion will continue to be key to further growth.
- International brands continued to lead soft drink sales in Vietnam. Within the top 5 in 2013, four were multinationals, accounting for 49% of trade volume.
- Strong financial capacity allows these companies to employ modern technology and regularly launch new products.
- Sports and energy drinks and RTD tea are likely to be among the categories that will enjoy the fastest growth as the result of active efforts by manufacturers.

Cameroon

- Domestic players lead sales. As a result, some international brands are produced under licence of these domestic companies. Strong performance in 2013 was underpinned by population growth, rising disposable incomes and other favourable economic conditions and improvements in distribution.
- Smaller pack sized PET format continues to gain popularity with price sensitive consumers due to perceived reduced prices.
- The increasing popularity of energy drinks is expected to continue to drive the continued growth of soft drinks.
- Sales of bottled water are expected to grow at a faster pace in cities, driven by the poor quality of tap water, growing health concerns and increasing purchasing power.

Nigeria

- Innovation in the Nigerian soft drinks industry has been led by local companies who have been outperforming the multinationals in areas such as juices.
- Sales of bottled water are expected to grow due to population growth and lack of access to safe drinking water. At least 50% of the population purchase packaged water – particularly pouch and sachet varieties – on a daily basis.
- Increased health consciousness among Nigerians, who are becoming more concerned about their sugar intake, alongside a growing interest in novel drink flavours, has led to an increasing consumer preference for juice.

  Carbonates sales recovered in 2013 after a poor performance the previous year. This recovery was largely as a result of the development of fruit-flavoured carbonates. Improvement was due to population growth, with the younger population in particular demanding novel products.
- Recovery in the carbonates sector was also due to rising disposable incomes, urbanisation and formalised employment which spurs demand for convenient soft drinks, suitable for on-the-go consumption.

The United States

- Demand for carbonates continues to decline as Americans continue to be concerned about obesity and the safety of artificial sweeteners.
- Overall growth in sales of soft drinks is expected to be flat between 2013 and 2018. The maturity of the US soft drinks market makes it difficult to achieve growth, as Americans already consume high levels of packaged soft drinks.
- Carbonates have also found it difficult to compete in an environment with a wealth of beverage options available to consumers seeking new taste experiences.
- Beverage producers are introducing products that are lower calorie, zero calorie and/or stevia-sweetened (and thereby lower calorie).
- Market leader the Coca-Cola Co continued to expand beyond carbonates with acquisitions made in companies specialising in teas, coconut water, milk and coffee.
- Categories such as energy drinks and liquid concentrates, which offer added/functional value, including energy, vitamins and the ability to customise flavours, are likely to see continued demand amid ongoing efforts by consumers to maintain healthy lifestyles.

This in part has been due to governments in some countries making concerted efforts to drastically reduce the consumption of soft drinks, amongst other dietary recommendations. For example, the US Federal Government introduced the 2010 Federal Dietary Guidelines which recommend inter alia to drink few or no regular sodas, sports drinks, energy drinks and fruit drinks (US Federal Government 2010).

There have also been a range of restrictions applied to the sale of soft drinks in schools (Australian Capital Territory); an attempt was made by New York City to restrict the sale of "sugary beverages" at food-service establishments in New York City; and the Mexican government has restricted television advertising for high-calorie food and soft drinks and as well as introducing a tax on sugar-sweetened beverages.

The movement towards low-calorie drinks has resulted in the replacement of sugar with artificial and natural sweeteners. However, the use of sweeteners has been the subject of much debate due to concerns of possible detrimental health impacts (Euromonitor). This trend towards healthier beverage options has increased the pressure on soft drinks companies to provide alternatives to products that are high in sugar. As a result, beverage producers are introducing products that are lower calorie, zero calorie and/or stevia-sweetened beverages.

Box 5: The major sources of added sugars in American diets

(U.S. Department of Agriculture, U.S. Department of Health and Human Services, 2010)

As a percent of calories from total added sugars, the major sources of added sugars in the diets of Americans are soda, energy drinks and sports drinks (36% of added sugar intake). The major types of beverages consumed by adults, in descending order by average calorie intake, are: regular soda, energy and sports drinks; alcoholic beverages; milk (including whole, 2%, 1% and fat-free); 100% fruit juice; and fruit drinks.

The rate of consumption of unhealthy commodities, such as soft drinks is, fastest in low- and middle-income countries, with little or no further growth expected in high-income countries (Stuckler et al. 2012). This consumption is rising at an even faster rate than occurred historically in high income countries (Stuckler et al. 2012). The prevalence of overweight and obese children and adolescents has also increased in developing countries (Ng et al. 2013).

Obesity concerns from sugary drinks and processed foods are not just concerns restricted to developed economies; many middle-to-low income countries are witnessing trends of consumers becoming more health conscious that are now shifting from carbonates, to other types of beverages in search of healthier alternatives (Euromonitor).

Environment

The environmental impact of packaging remains an area of concern. Recent innovations in the industry have seen the development of new materials with improved resource efficiency, such as those with higher recyclability (rPET) and higher content of renewable materials (plant-based PET) that are being increasingly adopted throughout the industry. Plant-based PET has increased in popularity as it can be recycled in the normal PET recycling stream. Hence, the reduction in the use of virgin materials to ensure a "closed loop" system remains a major focus of the soft drinks industry.

Water

The use of water in soft drinks supply and production has become a major concern for consumers and the industry as water footprint discussions take place globally. The largest share of the total water footprint of a beverage is in the process of producing the agricultural ingredients in the supply chain. Agricultural ingredients are associated with considerable environmental and social impacts; for example, the sugar used in cola is often associated with water pollution as a result of fertilisers and pesticides sprayed on the sugar cane or beet. This in turn impacts on biodiversity in downstream water bodies. (Refer to Section 3.3.3)

2.5 Environmental standards and guidelines

Industry environmental and social standards and guidelines can encourage industry to improve its production processes with the aim of reducing the overall environmental and social impacts associated with its activities. In light of these objectives, governments of all levels have developed compulsory standards as contained in laws, bylaws and regulations and voluntary standards such as ISO standards (International Organisation for Standardisation), or standards and guidelines agreed to by companies in one specific industry sector or in a group of industry sectors.

One of the most important pieces of regulation on packaging is the European Parliament Directive 94/62/EC on packaging and packaging waste which came into effect in 1996, establishing aggressive recovery and recycling targets for packaging waste. The directive promotes the "polluter pays" principle with respect to financing the recovery and recycling of packaging waste, placing the onus on the producer as the polluter and not on the consumer.

ISO 14000 is a group of voluntary standards developed to help organisations reduce the environmental impact of their operations and is by far the most common environmental standard used. The recently developed energy standard (ISO 50 000) is also gaining industry buy-in with its focus on energy efficiency for manufacturing sites. The Eco-Management and Audit Scheme (EMAS), created by the European Commission in 1993, is similar to the ISO 14000 standard, but is applied only to manufacturing sites. Another tool for measuring performance is the Best Available Techniques Reference Document, or BREF.

Environmental standards and guidelines are not the only means by which to encourage the greening of a value chain. Many companies in recent times have implemented their own measures to improve their environmental performance. These companies are driven by cost reductions that can be achieved through efficiency improvements in the production process and in the product chain, or by pressure from consumers, communities or non-governmental organisations (NGOs).

Environmental charters and guidelines have also been developed by a range of organisations and businesses including international organisations, non-governmental organisations (NGOs) and national governments, with the aim of helping companies improve their environmental performance. Examples include:

- The Ceres Principles;
- The Business Charter for Sustainable Development;
- The Environment Business Forum;
- The United Kingdom's Soft Drinks Sustainability Roadmap;
- Business Principles for a Sustainable Future;
- Global Compact; and
- Chemical Industry Association's Responsible Care.

Box 6: The UK's Soft Drinks Sustainability Roadmap (Resource 2013)

The Department for Environment, Food and Rural Affairs (Defra) launched a voluntary industry agreement to help reduce the environmental footprint of the soft drinks sector and encourage the sustainable use of resources. The Soft Drinks Sustainability Roadmap, launched in July 2013, was developed in conjunction with the industry, trade associations and WRAP (Waste & Resources Action Programme).

Fifty per cent of 'major' soft drinks producers or suppliers, including Coca-Cola Enterprises, PepsiCo and Britvic, have already signed up. The Roadmap covers the entire soft drinks production process-from the supply of ingredients to recycling packaging. The plan sets objectives such as the following:

- reducing the amount of water used in manufacturing to help limit consumption and save money;
- improving refrigeration to boost energy efficiency;
- using low carbon fertiliser to reduce the footprint of fruit-based soft drinks by as much as 20 per cent; and
- improving co-operation between manufacturers, suppliers, retailers and waste management companies to improve recyclability and recycling of packaging by consumers.

Organisations such as the Food and Agriculture Organization of the United Nations (FAO) and the Sustainable Agricultural Initiative Platform (formed by Nestle, Unilever and Danone) have developed many guidelines on sustainable farming practices. There is also the Sustainable Agricultural Standard developed by the Sustainable Agricultural Network (SAN), the oldest and largest coalition of NGOs aiming to improve commodity production in the tropics. The SAN has also developed criteria for responsible farm management. The standards developed by the SAN Secretariat comply with the Code of Good Practice for Setting Social and Environmental Standards of the International Social and Environmental Accreditation and Labelling (ISEAL) Alliance.

The Better Sugar Cane Initiative, otherwise known as the Bonsucro Standard, has also been developed to promote measureable standards in key environmental and social areas related to sugar cane production and primary processing (Better Sugar Cane Initiative 2011). It has been widely promoted and is gaining momentum amongst the sugar cane farming sector.

3 GREENING THE SOURCING OF PRIMARY MATERIALS

3.1 Water

The soft drinks value chain commences with the production of the soft drink ingredients. The main raw materials for soft drinks are water, sugar and citrus fruit, with water being a common element in all of these key ingredients. It is here at the raw materials stage of the supply chain that the environmental impact is greatest.

Water footprint studies (Ercin et al. 2011) have shown that more than 95% of the water consumption for the production of soft drinks is in the supply chain, mostly in the agricultural production process. Even in the planting process, can the use of water and energy conservation technologies, such as the implementation of drip irrigation, improve the utilization of water resources. In addition, the production of packaging for soft drinks requires considerable amounts of water.

Water for the soft drinks industry is derived from a limited range of water sources, including groundwater, surface water, desalination and recycled water (treated wastewater). Each has its own associated supply vulnerabilities as well as environmental impacts. The main impact of water use for soft drinks is a potential reduction in water supply available to nearby communities, although cooperative schemes with local communities can mitigate this. Source water supply is thus a significant concern for the soft drinks industry.

Since water is a resource that is essential for human use and for natural systems, the quality and the quantities extracted are of utmost importance to all stakeholders. Many soft drinks companies have therefore begun projects to assess the vulnerability of their water sources. This includes an assessment of technical vulnerability (hydro-geological availability of water in the future), social acceptance by the community of the water use and obtaining regulatory permission to use water.

Larger soft drinks companies such as Coca-Cola and PepsiCo have committed to water stewardship through programmes such as “Water Neutrality” or “Positive Water Balance”. This means that water used by communities and required for nature will be replenished to achieve healthy watersheds and sustainable communities. Locally relevant initiatives could include reforestation, watershed protection, community water access, rainwater harvesting and agricultural water use efficiency. A number of these options could also be led by smaller companies at the local level.

Box 7: Six principles of world class water stewardship in the beverage industry
(BIER 2010)

BIER (Beverage Industry Environment Roundtable), consisting of members such as Danone, Pepsi and Coca-Cola, have defined six principles of world class water leadership principles by which they encourage their members to steer their work. They are as follows:

Responsible companies act with the understanding that:

1. Water is a finite and shared resource
2. Continuous improvement of water efficiency is fundamental to operational excellence

Responsible companies engage and communicate with the understanding that:

3. Community engagement is essential for sustained solutions
4. Partnership leads to more effective water management
5. Open and honest communication defines transparency

Responsible companies work to influence with the understanding that:

6. Responsibility for water stewardship extends throughout the value chain

Many organisations have also developed guidelines and standards for water stewardship, for example the European Water Stewardship Standard from the European Water Partnership (EWP), the World Wildlife Fund (WWF) and the World Business Council for Sustainable Development (WBCSD). Through the standard, the European Water Partnership is aiming to encourage business and agriculture to become water stewards by assessing and improving the way they use and manage water in a more holistic way. Companies can voluntarily implement the standard and in doing so join together with stakeholders such as investors, consumers and their communities to promote stewardship.

Table 3: Water saving opportunities in fruit processing

(Pagan, Prasad et al. 2004, Masanet, Worrell et al. 2008, Fresner, Waltersdorfer et al. 2014, UNIDO 2013)

Water management
• Appointment of water manager
• Use of production-related indicators
• Monitoring and controlling (install sub-meters)
• Conduct a water assessment
Water pre-treatment
• Control of chemical consumption
• Optimise backwash cycles on sand filters & ion exchangers
Refrigeration
• Avoid once-through cooling
• Reuse cooling water e. g. for site cleaning
Cleaning and housekeeping
• Remove solids without the use of water
• Use foam cleaning
• Use efficient spray nozzles & spring loaded valves
• Repair leaks
• Install smooth, cleanable surfaces
• Use high pressure rather than high flow
• Use of cleaning in place (CIP) plants and pigging
• Collect water from final rinse for pre-rinse
• Minimise water use cleaning floors and machines
Processing operations & utilities
• Reuse concentrated wastewaters and solid wastes for production of by-products or for the generation of biogas
• Procure clean raw fruit, thus reducing the concentration of dirt and organics (including pesticides) in the effluent
• Convert to dry peeling
• Separate and recirculate water used for transport or for washing (after sedimentation of solids)
• Use counter current cascaded systems where washing is necessary
• Use steam blanching instead of water blanching
• Use air cooling after blanching
• Use dry rather than wet conveying systems
• Recycle evaporator condensate
• Reduce cooling tower bleed and boiler blowdown
• Recycle compressor cooling water
• Stormwater collection e.g. for cooling towers

3.2 Energy & Co2 emissions

Energy consumption throughout the supply chain contributes significantly to the environmental impact of the sector through direct energy use, in particular in the processing of ingre-dients and manufacture of packaging and in fuel use in distribution and refrigeration. The manufacturing and transportation of packaging is the biggest contributor to GHG emissions. Almost 60% of the GHG emissions in the UK carbonated soft drinks supply chain are associated with primary and secondary packaging (Defra 2012). A large proportion of empty packaging is air, which is inefficient when trans-porting empty bottles and cans, using relatively large amounts of energy. It is thus clear that the primary means by which to reduce energy consumption in the supply chain is to reduce the amount of packaging materials. This is addressed in more detail in Chapter 6.

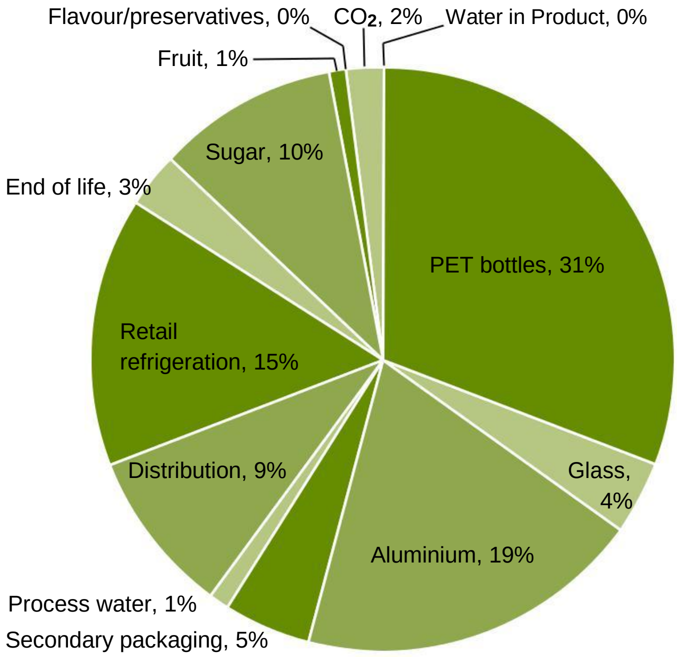

Figure 2: Estimated GHG emissions associated with the UK carbonates supply chain
(Best Foot Forward 2012)

There are several conceptual barriers that hamper the reduction of energy consumption and the associated GHG emissions in the supply chain (Defra 2012), including:

- a lack of implementation of appropriate technologies (e.g. blowers instead of air knives) to significantly reduce energy consumption;
- investment and running costs- the payback periods need to be commercially viable;
- a risk that energy markets might change, including government subsidies and support;
- food and safety requirements for the storage of foodstuffs;
- lack of knowledge or ability to improve skills to identify and/or implement reduction opportunities; and
- convenience resulting in apathy or resistance.

One area which offers a way to reduce energy-related environmental impacts is renewable energy. Like other industries around the globe, the soft drinks sector is increasing its use of renewables in the supply chain. Companies should endeavour to exploit this technology. Specifically, the larger soft drink companies should consider investing in technologies such as:

- solar panels on roofs of distribution centres;
- windmills on larger plants; and
- fermentation of wastewater in agricultural processing to produce biogas.

If companies lack the capacity to make such investments, cooperation with other stakeholders such as governmental organisations, donor organisations, or other soft drinks companies can help to achieve this objective.

3.3 Greening in primary agricultural production

The Sustainable Agriculture Initiative (SAI) defines sustainable agriculture as the ”efficient production of safe, high-quality agricultural products, in a way that protects and improves the natural environ-ment, the social and economic conditions of farmers, their employees and local communities and safeguards the health and welfare of all farmed species (SAI 2010).”

3.3.1 Greening of the sugar supply chain

The main sources of sugar that are used in soft drinks are sugar cane, corn and sugar beet with cane sugar accounting for around 80% of all sugar produced. Depending on where and how it is grown, cane sugar can have an estimated 63% lower carbon footprint than sugar beet. This is the case for sugar cane produced in Brazil for example, where straw residue from the sugar cane is used to run the sugar mills rather than burned in the fields. However, pre-harvest burning is still a standard practice in many countries around the world and is used in a diverse range of countries such as in Australia, the United States, South Africa and Thailand. Therefore, cane sugar still poses a significant risk to biodiversity, contributing to greenhouse gas emissions and impacting on human health as well as the more immediate pollution-related impacts.

Some of the most biodiverse regions in the planet have been cleared for sugar cane production. Although sugar cane is not used exclusively for soft drink - it has other notable uses such as in biofuels - it nevertheless poses both a risk to biodiversity and food security, with around a dozen countries around the world devoting more than 25% or more of all of their agricultural land to the production of sugar cane (WWF 2014). At the same time, sugar cane consumes more water than beet sugar (British Soft Drink Association 2011), with the former being one of the world's the world's thirstiest crops, which also has a significant impact on many environmentally sensitive regions (WWF 2012).

Research into product waste in the UK supply chain showed that the processing and manu-facture of soft drinks generates an estimated 5 million tonnes of waste from sugar beet processing (Defra 2012). Although there are resource efficiency initiatives already underway in the sugar beet industry, there is still additional scope to build upon further resource efficiency opportunities (Defra 2012).

Box 8: Bonsucro sugar cane sustainability certification scheme
(Bonsucro Production Standard 2011) (WWF 2012).

The largest global initiative to improve the sustainability of the sector is an organisation called Bonsucro. It is a not-for-profit initiative that operates in cooperation with retailers, investors, traders, producers and other NGOs, with the aim of increasing sustainability by reducing the environmental and social impacts of sugar cane production.

Bonsucro developed a standard with a certification scheme supporting continuous improvement for its members. The main objective of the Bonsucro Standard is to promote measureable standards in key environmental and social impacts of sugar cane production and primary processing while recognising the need for economic viability. The standard addresses sugar cane production in the field and processing issues in the mill, including all sugar cane derived products, as they incorporate economic, financial, environmental and social dimensions and reflect good industry practices for the sugar cane sector. These efforts are beginning to pay off, with the first certified sugar cane offered from a Raízen mill in São Paulo, Brazil and purchased by the Coca-Cola Company.

In the past few decades, many options for Resource Efficient and Cleaner Production (RECP) have been developed by sugar companies and technology suppliers in collaboration with industry, National Cleaner Production Centres and other RECP supporting organisations such as UNIDO and UNEP. Figure 5 shows some of the options for RECP in sugar production developed by The Swedish Royal Institute of Technology for the Sugar Corporation of Uganda (Nalukowe 2006). There are also some opportunities to minimise waste from sugar processing and to further develop appropriate alternatives and resource efficient mechanisms for disposing of the waste, such as increased use of sugar cane waste in the production of biopolymers/bio-based PET or the use of pith/peel as animal feed (Defra 2012).

Table 4: RECP in sugar production
(Nalukowe 2013)

Area	Cleaner Production options	Major benefits
Cane preparation	• Install conveyor to reclaim falling cane • Proper maintenance of cane carriers • Seal all openings in the cane carrier side plate • Increase mechanical off-loading	• Reduced sugar loss • Reduced sugar loss and savings on labour costs • Reduction of cane staling and crushing at the yard
Mill house	• Install steam injection pump to reclaim juice spillage/leakage from pumps • Replace the slates conveyors with a rake elevator • Use a central lubrication system	• Reduced sugar loss • Improved hygiene • Reduction of falling cush-cush • Reduced use of lubrication oil
Boiling house	• Install level sensors to A-machine and crystallisers • Replace the brushes in B and C machines • Interlock A-molasses pumps to the hopper • Use H2O2 instead of sodium hydrosulphide	• Eliminates spillage • Reduces leakages • Reduces spillages • Eliminates the need for a gas mask
Bagging house	• Connect the top screen at the sugar bin to the cyclone to suck sugar dust • Install a conveyor for rodi at the end of the dryer • Enclose the A-melter to reclaim spillage • Place at angle to stop sugar falling from dryer • Tile the floor of the bagging section • Provide the workers from bagging section with hygienic wear	• Healthier work environment due to reduced dust levels in the air • Reductions in sugar loss • Improved hygiene
Water use	• Reuse filter effluent and overflow from condensers and cooling water from cane wash • Monitoring and repair of condensate and water leaks • Provide for free to parties who can reuse it.	• Reduced water consumption and waste volume • Cleaner environment

Sustainability in the sugar industry is also promoted through its various international and regional organisations, such as The World Association of Beet and Cane Growers; the International Sugar Organization; UNICA (Brazilian Sugar cane Industry Association); Apex-Brazil (Brazilian Trade and Investment Promotion Agency); and SASA (Southern Africa Sugar Association). These organisations disseminate information on ways in which enterprises can engage in cleaner production technology and management.

3.3.2 Greening of the citrus fruit supply chain

Oranges are the main citrus fruit used in the production of beverages such as Fanta and Mirinda, with the majority of these oranges originating from Brazil. The greatest environmental impacts from the growing of citrus fruit stem from water consumption and the use of pesticides and fertilisers at the farm level.

Box 9: Orange juice yields
(Bonsucro 2011)

According to a life cycle analysis carried out for a large UK retailer, 1.96 kg of oranges are required on average to produce 1 litre of Not From Concentrate (NFC) orange juice and 10.2 kg of oranges are required to produce 1 litre of concentrated orange juice.

CitrusBR, an association of the four largest Brazilian producers and exporters of citrus juices (Cutrale, Citrosuco-Fischer Group, Citrovita-Votorantim Group and Louis Dreyfus Commodities) is also active in promoting sustainability issues in the citrus industry.

3.3.3 Fertiliser and pesticide use in the production of sugar and citrus fruit

As outlined above, the main environmental impacts from growing sugar cane and oranges-other than impacts on water availability-derive from fertiliser and pesticide use. Pesticides include insecticides, herbicides, rodenticides, fungicides and miticides. Around one-third of all agricultural products are grown using pesticides (Liu 2002), resulting in 4.6 million tons of pesticides being sprayed into the environment every year (Zhang, Jiang et al. 2011). Without pesticides, fruit losses have been estimated at 78% (Cai 2008). Whilst vital for crop protection, it is reported that only 1% actually reaches its target while the remainder finds its way into the atmosphere and non-target water bodies and soils where its toxicity threatens the health of the environment (Zhang, Jiang et al. 2011 cited in UNIDO 2013).

Research has shown that coordinated management could be more effective, rational and sustainable by, for instance, reducing the number of applications of pesticide or fertiliser. Furthermore, the use of agricultural methods such as interspersed planting has shown to provide a protective effect to plants, reducing pests and diseases and thereby reducing the amount of pesticide needed.

Sugar cane is a perennial plant that requires low fertiliser and pesticides when compared with most other food crops. Although the use of these agrochemicals per hectare may be low, the vast amount of hectares that are planted with sugar cane means that the total amount of pesticides used is still high. For example, although California has the lowest use of agrochemicals in sugar cane production in the world, the approximately 8 km2 (2,000 acres) of sugar cane planted in the region still need more than 1,000 kg agrochemicals (Pesticide Action Network 2010).

3.3.4 Integrated Pest Management (IPM)

Integrated pest management uses the best combination of chemical and biological controls along with cultural and mechanical practices to manage pests and diseases. The approach involves monitoring and understanding the pest to establish thresholds from when action should be taken. Less toxic options for pest control are utilised, with non-specific broad scale spraying only being a last option. The objective is to reduce the reliance on insecticides and thus the risk of pesticide resistance.

The Brazilian citriculture industry is taking steps towards integrated pest management in citrus fruit through rational use of pesticides through the Brazilian Association of Citrus Exporters (CitrusBR). Their Integrated Citrus Production list of pesticides complies with the laws of over 90 importing countries. The regional organisation Fundecitrus assists in the pesticide management process by implementing a concept of regional disease and pest management (Fundecitrus 2014).

3.3.5 Cultural management

Cultural management practices are often very cost effective. Practices include choosing tolerant or pest resistant varieties, crop rotations, planting pest free rootstock and good field sanitation. They are typically of little risk to the environment and help to reduce pest survival, dispersal and initial establishment.

3.3.6 Mechanical controls

Mechanical controls include barriers, traps and even the physical removal of problem pests which all can be relatively low cost options.

3.3.7 Management of nitrogen fertiliser to reduce N2O emissions

Nitrogen is the key limiting nutrient for most agricultural systems. Excessive nitrogen use via fertilisers directly and indirectly contributes to increased N2O emissions and climate change. Excess nitrogen in a water-soluble form can also leach from soils and flow into water bodies. The increased nutrient loads can create algal blooms which consume large amounts of oxygen needed by aquatic life to survive (UNIDO 2013).

3.3.8 Depletion of phosphorous stocks

Phosphorus is essential for biological growth. Plants take up phosphorous from solutions in the soil; however, the concentration of soluble phosphate is often very low. The agricultural industry has become heavily reliant on applying phosphate fertiliser made from finite reserves of rock phosphate to make up for the shortfall. Yet, only one fifth of the applied mined phosphate ever actually ends up in the food produced (Schroder, Cordell et al. 2010). This is unsustainable given the serious environmental impacts associated with the production and use of phosphate fertiliser. These impacts include: the production of toxic and radioactive waste and greenhouse gas emissions during mining and manufacturing; the eutrophication of rivers associated with phosphate leaching and runoff and the associated cadmium pollution to soils (Schroder, Cordell et al. 2010 cited in UNIDO 2013).

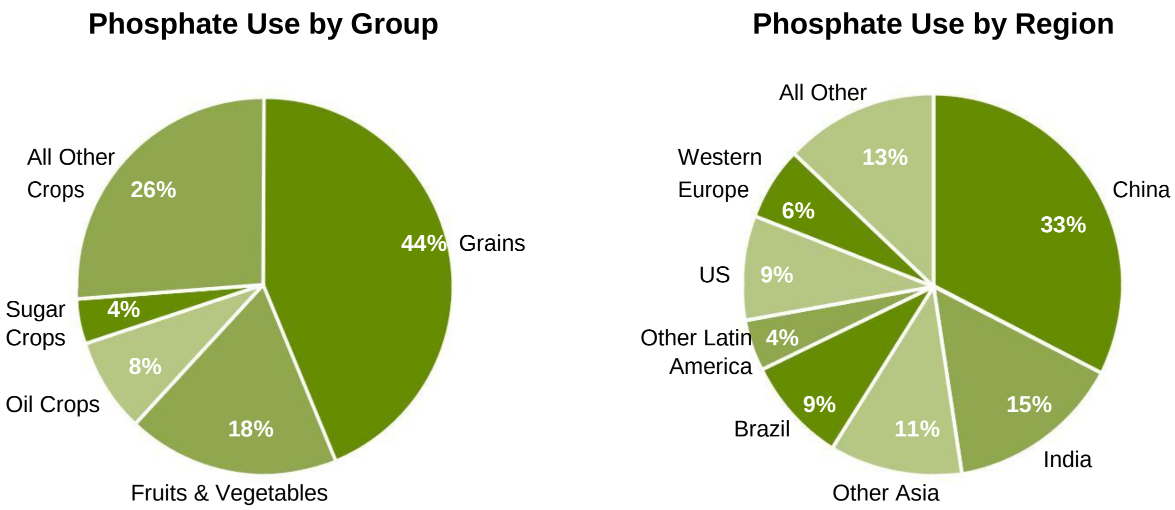

Figure 3: Phosphate Fertiliser Use by Crop and Region

(PotashCorp 2013)

World production is likely to peak in 2030 with the consequences exacerbated by biofuel production (Rhodes 2012). Already the price of rock phosphate has tripled since 2006 (PotashCorp 2013 cited in UNIDO 2013).

By focusing on improved and efficient fruit production, the environmental impact of fruit production for soft drinks could be reduced by examining the entire product chain and using low carbon fertilisers. PepsiCo and its Florida suppliers are testing multiple creative approaches using reduced-carbon fertili-sers. Specifically, Tropicana, in tandem with one of its long-time growers, SMR Farms, is launching a pilot study to test two alternative fertilisers to determine whether using either could significantly reduce the carbon footprint of fertiliser production and hence, of the agricultural production of oranges. SMR Farms will test lower carbon fertilisers produced by Yara International, the world's largest fertiliser producer, and ERTH Solutions, which provides low carbon fertility solutions (Yara, 2012; Noria, no year; PepsiCo, 2014).

3.4 The use of sweeteners (other than sugar)

The main sweeteners used in beverage production, other than sugar, are high-fructose corn syrup and high-fructose starch-based corn syrup, while the main sugar substitutes commonly used in foods are aspartame, cyclamate, saccharine, sucralose and stevia. The latter is made from the stevia plant, grown in South America and used in soft drinks by Coca-Cola and Pepsi in some countries (Roca 2011). Other sweeteners such as high-fructose corn syrup displace the use of corn as staple food and, as such, are controversial.

3.5 Waste generation

A study by Defra found that 52% of the total waste generated in the supply chain of soft drinks in the UK is derived from the agricultural and industrial phases of sugar production and 32% from the agricultural and industrial phases of orange juice production (Defra 2012).

Box 10: Truvia

Truvia is a stevia-based sugar substitute developed jointly by the Coca-Cola Company and Cargill. It is distributed and marketed by Cargill as a table top sweetener and as a food ingredient. Because it comes from the stevia plant, Cargill classifies it as a natural sweetener in addition to being a non-nutritive sweetener. (Check et al. 2012)

Truvia reported in January 2013 that its calorie-free sweetener is the first stevia-based sweetener to be awarded a product carbon footprint certification. The certification arm of the UK-based Carbon Trust measured the total greenhouse gas emissions at every stage of the supply chain, including cultivation, processing, packaging, transport, use and disposal before awarding the certification. Under the certification, the Truvia business has signed up to use the carbon reduction label in the future. By displaying this label, which in this case covers the UK, the USA, Mexico, Spain, France and Italy, the Truvia brand is demonstrating its commitment to reducing the carbon footprint of its sweetener over a two-year period.

In 2010, the Truvia business made a number of sustainability pledges. Commitments include:

- to reduce its carbon footprint by 50% by 2015 from its 2010 baseline to achieve carbon neutrality by 2020;
- to ensure all processed water is returned to the same quality in which it was taken and to reduce net depletion by 25% by 2020; and
- to reduce waste across the supply chain by 50% by 2015 in an effort to achieve zero waste by 2020.

The typical yield of sugar cane to sugar is 5%, which correspondingly results in a large volume of organic waste (bagasse) from sugar processing. This waste is often used in the paper industry to make paper. It can also be used to produce energy in steam boilers or returned to the fields as organic fertiliser and soil stabiliser.

3.6 Trends and challenges

One of the major trends in the supply chain is the rise in collaboration between actors throughout the production chain. This collaboration is especially active in the areas of water stewardship and in agriculture. As water is the primary component in soft drinks, soft drink companies are now moving to ensure that the water that they utilise in their production processes is sourced and used in a socially and environmentally responsible manner. Hence, it is essential that any cooperation on water between actors in the supply chain aim to safeguard the quality and quantity of watersheds. With this objective in mind, many beverage companies are working with a range of actors such as communities, NGOs, governments and other local water users to maintain or enhance water quality and to offset the water that is taken from the natural system where the water is sourced.

Some examples of cooperation in the agricultural sector related to soft drink inputs include:

- Cooperation between Coca-Cola and WWF to create Bonsucro, a non-profit organisation that seeks to foster sustainable practices in the sugar cane industry through sustainability standards and certification programmes.
- Citrus growers in Brazil (the world's largest producer of oranges) have organised themselves in Citrus BR to work with orange farmers and juice producers to improve agricultural and industrial processes.
- PepsiCo is aiming to produce a low carbon fertiliser and to reduce the carbon footprint of the fruit used by PepsiCo for its soft drinks.

Elsewhere, there is now an increasing trend to use natural rather than synthetic sweeteners. One example is the increased use of the stevia plant to produce a sustainable supply of sweetener.

In terms of packaging, Coca-Cola is a using plant-based material called PlantBottle© to replace synthetic materials. In this packaging, about 30% of the chemicals in the production of PET originate from plant origin. This will be further described in Chapter 6.

4 GREENING IN THE SOFT DRINK PRODUCTION PROCESS

4.1 Energy consumption and CO2 emissions from soft drink production

The main energy carriers in the bottling process in the carbonated soft drinks industry are used for heating (steam) and cooling. Boilers to generate steam run on wood, coal, fuel oil, gas or electricity. The determination of which fuel to use depends mainly on price, availability and, in some cases, on environmental regulations such as air emission standards.

Energy efficiency, particularly in the manufacturing process, offers many possibilities for cost savings. Measures that allow for higher degrees of energy efficiency in the soft drink production process include line optimisation, efficient heating and cooling technology and improving pressure systems. Research has shown that the industry can reduce 10-20% of its energy consumption with relatively simple low-and no-cost measures.

Compressed air is one of the most inefficient systems in any factory; this is due to its high electricity consumption. In many cases (e.g. with pneumatic valves) there is no alter-native to compressed air; however, to mitigate losses, it is recommended that companies:

- regularly and systematically check the complete system for leaks and repair these as part of a structural maintenance plan;
- look for alternatives to compressed air where possible; and
- enhance the compressed air system by optimising the compressor operation (for example, by reducing the temperature of the air inlet) and by improving the compressed air distribution system (for example, by eliminating unused pipes and “dead ends” in the system, or by reducing the pressure in the system).

Box 11: Air knives and blowers

During the bottling process, a thin stream flow of air is generated to dry bottles before a code is printed on the bottle. These so called air-knives are mostly run on compressed air. There are alternatives that use an electric blower fan to direct focused air flow at the bottle. Such a system is considerably more energy efficient than the use of compressed air generated by a compressor.

The ccooling system that cools the soft drink before the filling process can, for example, consist of an ammonia compressor system, or of evaporative cooling towers. Companies should check to ensure that the cooling system elements are not located near to heat-generating equipment such as the air compressor, or parts of the steam system. Furthermore, it is essential to ensure proper insulation of the whole distribution system, including all pipes, valves and flanges.

Steam is often generated with the cheapest fuel available. Only in a few cases in developed countries have companies considered installing more expensive renewable energy installations in order to reduce their carbon emissions. An increasingly utilised technology is Combined Heat & Power (CHP), or cogeneration. Here, the fuel is used to make both steam for production as well as electricity. In some cases in developing countries where CO2 is not readily available, the factories produce their own CO2 from burning fuel. In those cases, tri-generation technology can be used where steam, electricity and cooling are generated in the same installation. The most advanced systems implemented in Europe and Nigeria, are the so-called quad-generation plants to supply power, heat, cooling and carbon dioxide to the bottling plant, all from the same fuel burning installation.

Filling of carbonated soft drinks into bottles still generally takes place at a lower temperature than the ambient temperature. Filling close to room temperature reduces the need for refrigeration and is possible in most case; however, details of how to implement this option are often not well communicated. This creates an opportunity to improve the dissemination of information regarding this option to reduce energy consumption.

As stated above, the industry is increasingly looking at the use of renewable energy options. Some-but still very few-bottling companies- use thermal solar energy to pre-heat water before it goes into the boilers; however, there are more cost-effective ways to do this. A minority of companies use solar photovoltaic energy as their main source of energy. For example, in Europe several bottling plants already have their roofs covered with photovoltaic solar cells to provide a large part of the plant with electricity.

In most countries renewable energy is still more expensive than energy from the grid. The use of renewable energy in the manufacture of soft drinks is therefore mainly only considered by the largest soft drinks companies which have more financial leverage and resources. This initiative has largely been driven by consumer pressure.

Individual smaller bottling companies rarely implement renewable energy options. Therefore, increased knowledge about renewable energy options as well as investment support or support for renewables uptake by governments could increase the use of renewable energy sources by smaller companies.

4.2 Energy consumption and CO2 emissions from soft drink production

Water is an essential raw material in soft drink production. It is also the ingredient that attracts the most attention from consumers and communities, particularly as soft drink companies often have production or bottling facilities located close to communities which may be highly dependent on the same water source that the company is using. Therefore, most soft drink companies place the utmost importance on water consumption and sourcing and are thus implementing measures to protect and conserve this invaluable resource.

Most soft drink production plants have a specific water-use ratio of between 1.5 and 4.5 litres. This means that 4.5 litres of water are used per litre of soft drink that is produced. This water-use-ratio depends on the products that are made; for example, a plant with many small runs in differing returnable glass bottle (RGB) volumes will have a higher water-use ratio than a plant that only fills 1.5 litre PET bottles with the same product. A water-use ratio above 3.0 is seen as high and can often be lowered through the utilisation of water-saving measures.

Figure 4: Average water-use ratio in carbonated soft drink production
(BIE2010)

Some large European plants have achieved an almost complete closed water cycle, using only half a litre of water in the production of a 1 litre of soft drink (a water-use ratio of 1.5 litres of water per litre of soft drink). This can be achieved by treating the wastewater with several treatment technologies ending in reverse osmosis which renders the water suitable for drinking purposes.

The major contaminants in wastewater from the soft drinks industry are caustic soda and sweetener. The wastewater that is generated in the beverage industry mainly stems from bottle washing, filter backwashing, washing of bottling machines and washing of equipment, floors and pipe work during change of product (Ait Hsine 2005). The three main causes of product losses that end up in the wastewater are under or overfilling and set-up and run-down losses occurring during product changes (Defra 2012).

A reduction of wastewater volume from reduced water consumption, combined with the same pollution load, leads to smaller, more concentrated waste streams with high chemical oxygen demand (COD). The COD can also be used in a biogas-producing anaerobic wastewater treatment installation. There are also reports of ethanol plants running off the wastewater from soft drinks companies. The size and the pollution grade of the waste stream determines the feasibility of these plants. Some soft drink bottling plants operate an anaerobic installation on-site to treat their wastewater and to create biogas. However, few examples exist whereby the biogas is used for electricity generation and electricity use on-site, creating an opportunity for further greening of the soft drink production process.

4.3 Solid waste

The generation of solid waste in soft drinks manufacturing is low compared to the other stages. Most solid waste originates from broken or bad quality packaging materials from the packing of ingredients or waste at the end of the production line at the bottling plant. It is estimated that 80% of this waste is packaging waste, whilst 20% is general waste. The packaging waste is generally collected and recycled.

4.4 Trends and challenges

There is an increasing focus on the reduction of energy consumption in the bottling plant. Line optimisation, efficient heating & cooling technology and improving pressure systems are examples of ways in which energy efficiency can be achieved in manufacturing. There is also an increasing move towards the use of renewable energy sources and the use of low carbon energy at manufacturing sites. Solar technology, wind energy, CHP, biomass boilers and purchasing on-grid low carbon energy are among the options available when seeking to reduce carbon-intensive energy in manufacturing. However, finding suitable sites for wind turbines has already proved difficult and the availability of low carbon energy from the national grid is often low or non-existent (British Soft Drink Association 2011).

For a growing sector, energy efficiency as a means of reducing emissions is restricted as any improvement is likely to be exceeded by the increase in production due to growth. Newer manufacturing sites use more up-to-date and efficient technology, so increasing energy efficiencies further is difficult. Yet there is still scope to retrofit older buildings with new energy efficiency technologies.

Despite some efforts made in renewable energy uptake by some industry players, the main greening focus of the industry remains the enhancement of water efficiency efforts, with most large and medium-sized bottling companies actively pursuing a reduction of their water-use ratio. This is evident in the sustainability reports of the major companies.

5 GREENING IN THE DISTRIBUTION CHAIN AND RETAIL SECTOR

The largest environmental impact in the soft drinks distribution chain and in the soft drinks retail sector is energy use in transport, cold storage and retail refrigeration.

5.1 Transport

Much of the distribution of soft drink takes place between the warehouse and the points of sale in urban settings. The larger soft drinks companies have recognised the greening potential in urban distribution and are increasingly making use of use of hybrid delivery trucks. Coca Cola and Pepsi have been forerunners in employing electric trucks, which are mainly to be found on roads in the USA. The eStar electric vehicles used by Coca-Cola have zero tailpipe emissions and can reduce greenhouse gas emissions. The windshield design streamlines the truck and offers nearly 180-degree visibility, improving fuel consumption as well as safety. Each eStar vehicle can save a company up to 60% in fuel costs (Coca-Cola North America, 2011). However, barriers such as the limited range of these hybrid trucks and a lack of recharge points make the technology less suitable for long-range freight hauling and more suitable in an urban setting.

The global market for hybrid medium and heavy-duty trucks and buses is expected to increase from 9,000 vehicles sold in 2010 to more than 100,000 vehicles in 2015 (Berman 2010). One of the barriers for faster large-scale adoption of this technology is the higher initial capital outlay, which only the larger companies can afford to date. However, with the increase in the numbers of trucks on the road, the price is expected to come down, which will reduce the barrier for companies to buy and use such trucks.

Alternative fuels are fuels that have less CO2 emissions per kilometre driven. They present new fuel-supply opportunities and can help companies address concerns about fuel costs, energy security and emissions. The most widely used alternative fuels are natural gas, biogas, propane (LPG), hydrogen, alcohols, biodiesel or electricity, or a blend of conventional and alternative fuels.

The first alternative fuel that has been used on a larger scale is biodiesel, or a blend of diesel and biodiesel. This is the easiest option and requires the least conversion of the trucks' fuel system. However, the current limited availability of biodiesel means it is not being used on a global scale. Another alternative fuel is alcohol blended with normal fuel, which occurs on a larger scale in Brazil.

Efficient driving (sometimes called Eco-driving), is also an effective means by which companies can reduce their fuel consumption and carbon emissions. Efficient driving involves educating drivers to use driving techniques such as encouraging drivers to reduce slowing down and acceleration; driving with as low a number of revolutions as possible; speed governance; preventive maintenance; and reducing idling. Coca-Cola has a "smart driver" education programme to reduce idling. Before its implemen-tation at Coca-Cola, trucks were idling 30% of the time, but after the programme was implemented this dropped to below 10%; the ultimate goal is to reach 5% (Coca-Cola North America, 2011). This is a measure that can be implemented by companies of any size. Fuel can also be saved by creating more efficient routes and schedules that reduce total mileage. Factors like road speed, load weight and reducing unnecessary stops also help to increase mileage and reduce emissions.

5.2 Retail

Refrigeration accounts for an estimated 30% of electricity consumption in the industry and for this reason is an important area of focus in efforts to curb the associated environmental impacts. There are four main areas where refrigeration in the soft drinks distribution and retail phase occurs: bottling, distribution, retail (on-and off-trade) and in the home, by the consumer. Refrigeration of packaged soft drinks in the transport from the bottling plant to retailers is usually not required (Defra 2012).

More companies are increasingly moving towards HFC-free refrigeration by installing propane coolers with many large bottling companies actively encouraging their clients to use HFC-free refrigeration. This requires the replacement of refrigeration systems such as product displays in retail and other selling points where soft drinks are refrigerated to between 5 and 10oC. The HFC coolant R404a is the dominant refrigerant, with a small percentage of display cabinets still using R22. Larger soft drink manufacturers and supermarkets are now starting programmes to trial CO2 refrigeration which replaces the greenhouse gases R404a and R22.

Some of the most common measures to achieve energy and GHG reductions are the use of fridge doors and metallised blinds on retail fridges, adoption of leak prevention best practice and retrofitting of retail store refrigeration systems. Leak management practices are more likely to be lacking in smaller retailers, although large software brands have developed smarter, more energy-efficient branded displays. Leak management improvements can be achieved on their own by large retail chains, but changes in smaller stores often require cooperation with soft drinks companies (WRAP 2011).

Box 12: Green Vending Machines: Minimizing Refrigeration Impact
(Wojnovich 2009)

A not-for-profit initiative, Refrigerants Naturally, was launched in 2004 to promote a shift in food and drink industry sectors towards F-gas-free refrigeration technologies. Since committing to the initiative, multinationals, such as The Coca-Cola Company and PepsiCo, have introduced innovative vending machines employing green refrigerant alternatives. These green vending machines not only emit fewer greenhouse gases than HFC models but also, via reduced energy consumption (15% less than modern HFC options), bring about reduced operational costs far outweighing the initial investment. For the investing companies such investments also contain additional value: they are likely to boost the firm's environmentally sustainable image.

5.3 Trends and challenges

The most significant environmental impact in the retail phase stems from refrigeration, hence research and development is primarily focused on energy efficient and hydrofluorocarbon (HFC) free display cabinets. However, the uptake of these more efficient cabinets is relatively low due to the associated costs. Larger retail chains need to revamp their stores with the new technology and provide branded energy-efficient retail cabinets. It also requires many smaller retail outlets to replace their display cabinets, but they are often unable to do so due to a lack of investment capacity. In addition, there are very few countries where regulations ban the use of HFCs, and HFC replacement by hydrocarbon (often butane) is deemed unsafe by many governments.

In the transport of soft drinks, the main trend is to move towards hybrid vehicles, alternative fuels and so-called eco-driving. Hybrid trucks are most effective in urban areas with much stop-start driving. For long-range trucking the efficiency improvement is not as considerable.

There are several barriers that are hindering the uptake of the above, including:

- the initial high investment costs;
- there is a lack of infrastructure: for example, compressed natural gas (CNG) stations need to be built and the trucks need to be converted;
- there is no incentive if diesel fuel is readily available at a reasonable price;
- a lack of regulatory support can hold back change;
- eco-driving is not always practiced because the focus is on meeting delivery schedules, and resources are not always available to optimise logistics; and
- the increase in the use of hybrid trucks is slow because there is a significant premium for hybrid trucks over diesel vehicles and the existing fleet turnover is very low as trucks are kept for an extended amount of years.

6 GREENING SOFT DRINK PACKAGING

There are three types of packaging associated with the soft drinks industry: primary packaging, which is the soft drink container; secondary packaging, which is the packaging used to group together individual primary packaging; and tertiary packaging, which is used to group together secondary packaging. The vast majority of secondary packaging is paper or plastic, or more specifically, either cardboard or collation shrink film (Defra 2012).

Packaging constitutes the most significant proportion of the total greenhouse gas emissions in the life cycle of soft drinks. This is due to the raw materials, energy, water and waste involved in production/recycling and the impacts of disposal such as littering, landfill space and the pollutants produced when incinerated from waste to use as energy.

The strategy to minimise the impact of packaging follows the Reduce, Reuse, Recycle principles; that is to reduce the amount of packaging that is being used and to avoid packaging where possible, to reuse the packaging and then eventually to recycle it into useful products.

6.1 Reduction strategies

The "reduction" strategies pursued by soft drink companies have largely sought to reduce the amount of chemicals and the weight of packaging. Increasing amounts of bottling plants have begun to produce their own PET bottles; the so-called pre-forms are blown into PET bottles that are filled on-site. This limits the inefficient transportation of empty packaging to the bottling plant. Modern filling lines have a bottle blower and filler in one combined machine.

Large soft drink producers are collaborating with the packaging industry in the research and implementation of programmes to reduce the weight of packaging such as PET and glass. By redesigning the glass bottles, their weight can be minimised, while the same can be done with PET bottles through adjustments in the production process. The average weight of a half-litre single-serve PET plastic bottled water container has dropped by nearly 48% to 9.9 grams over the past 10 years (Defra 2012; WRAP 2011; IBWA 2013).

The concept of Coca-Cola's PlantBottle reduces the amount of non-renewable materials that are used in the production of a bottle. In the PlantBottle, one of the two chemical constituents used for the production of PET is derived from plants. This means that up to 30% of the PET originates from renewable resources. The difference with other plastics that are produced from renewable organic materials (e.g. bioplastics) is that the PlantBottle PET is chemically no different from non-renewable PET and can be mixed with the other types of PET without affecting the recycling process.

Box 13: Plant-based plastics
(The Coca-Cola Company)

Coca-Cola introduced the PlantBottle© which is a recyclable PET plastic beverage bottle made partially with materials derived from plants instead of the traditional petrochemical constituents. PlantBottle© packaging looks, functions and recycles just like traditional PET plastic. It is fully recyclable in the existing community recycling programs and can be introduced back into new bottles or the wide variety of other products made from recycled PET today.

The use of post-mix (soft drink concentrate) by many hospitality venues negates the need for individual bottles or cans, reducing the need for large amounts of packaging and transportation.

There are also opportunities to reduce the amount of secondary packaging. Stretch wrap consumption can, for example, be reduced through improved staff training on the correct set up of the machines.

Increasing numbers of suppliers and manufacturers of secondary packaging focus on the sustainable sourcing of cardboard and paper, the thickness of the material and the type of bleaches and dyes used in the manufacturing of the packaging. With much secondary packaging, but especially with plastic packaging, the focus is on minimising the plastic's density (Defra 2012).

Table 5: Reducing the impacts of packaging

(Pagan, Prasad et al. 2004) adapted from UNIDO, 2013.

Avoid unnecessary packaging
Eliminate unnecessary packaging via design
Order bulk delivery of products e.g. chemicals, food additives
Review handling and distribution measures e.g. clean-in-place systems, conveyors for bulk
Reduce packaging
Light-weighting of packaging
Minimise use of adhesives e.g. tapes, glues
Optimise packing lines e.g. canning, box construction, vacuum packing to minimise waste
Optimise receiving, handling and storage to prevent contamination and/or damage
Reuse packaging
Return to supplier for re-use e.g. drums, cartons, plastic containers
Reuse within the plant operation
Pass to third party for reuse
Avoid damage to promote reuse
Recycle packaging
Use recyclable packaging
Separate recyclable waste
Adopt purchase policies that include recyclables
Use bio-degradable packaging
Disposal
Dispose in a manner that minimises environmental impact

Table 6: Packaging used in fruit processing

(Pagan, Prasad et al. 2004) adapted from UNIDO, 2013.

Use	Type	Recycle Potential
Cans	Aluminium, tin, steel	commonly recycled
Bottles	Glass polyethylene terephthalate (PET)	commonly recycled
Boxes/cartons	Cardboard Virgin or recycled compostable, combustible Non-coated or coated Single or corrugated Combined with plastic or foil — liquid-proof	commonly recycled
Crates	Wood, plastic	commonly recycled
Flexible wraps	Cellophane (regenerated cellulose), polypropylene	difficult
Bags or sacks	Poly-vinyl chloride (PVC) Polypropylene Polyethylene Aluminium foil Poly-amide Nylon	difficult

6.2 Reuse strategies

In many countries the glass bottles are returned to the bottling plant where they are washed and cleaned for refilling. In some countries, for example South Africa, there are places where 1 litre bottles from very thick PET materials are also collected for reuse and refilling. Although the reuse of these materials is in itself a good thing, the transportation and cleaning processes require energy and water consumption and can cause water pollution. Thus, the environmental impact of the reuse of primary packaging materials must not only be evaluated against its economic benefits, but also on its environmental impact through life cycle assessments.

Box 14: Refillables in Latin America (ILSR, 2013)

In Mexico and other Latin American countries, refilling has made packaged beverages affordable to more people. Until the 1990s, refillable glass bottles dominated the packaging mix in Latin America. Refillable PET bottles entered the soft drink market in the early 1990s, but one-way (non-returnable) PET bottles are now conquering the markets of some countries in the region. Among packaged beer, meanwhile, the market share in cans is surpassing 20% in some countries. Indeed, these packaging trends indicate a decline in refilling in Latin America.

Plastic crates for transport of bottles are generally also transported back to the bottling plant, where they are washed and reused.

6.3 Recycling

A study to compare the environmental efficiency of three packaging materials for soft drinks, (aluminium, glass, and PET), was performed in 1995 by the National Association for PET Container Resources, 1995. “Cradle-to-grave” analysis was performed on all energy consumed and all wastes produced in the complete life cycle of each packaging system, from raw material through to finished product and recycling or disposal. The study showed that PET soft drink containers were the most environmentally efficient of the three systems.

At present, in many countries most plastic bottles are recycled. An increase in recycling rates depends on the quality of the materials that are collected, the infrastructure available for recycling and on the public's willingness to recycle. In addition, manufacturers must be willing to ensure that their packaging is recyclable. Increasing recycled content in plastic bottles depends on the availability of post-consumer recycled PET (rPET). However, this is currently difficult in many countries due to a lack of processing capabilities for rPET (WWF 2012).

Box 15: Sustainability Efforts in Thai Beverage Packaging
(TIPMSE)

The formation of the *Thailand Institute of Packaging Management for Sustainable Environment* (TIPMSE) in 2005, along with the *Beverage Carton Group* jointly founded by Tetra Pak and SIG Combibloc, has heralded an expansion of Thailand's capacity to provide sustainable solutions to packaging waste in the beverage industry. Innovation and research set into motion by TIPMSE, an organization based on the cooperation of Thai industries, aims to make waste reductions with “safe and sustainable methodologies” throughout all aspects of the value chain. The *Beverage Carton Group's* work in Thailand has also emphasized the importance of jointly enacted national campaigns towards greater recycling, with the ambitious target of doubling the global beverage carton recycling rate to 40% by 2020. For instance, the *Cut, Clean, and Collect campaign* has worked with local schools to emphasize the importance of recycling in Thailand's young generation and promote awareness amongst Thai communities. Simultaneously, the *Collecting Cartons Campaign* aspires to collect beverage cartons through awareness raising exercises, including students and monks in the carton collection and folding process en route to reprocessing in order to popularize the drive towards sustainability through recycling. Public awareness and participation remain at the core of simultaneous Thai recycling efforts and across the beverage industry, Thailand has made considerable gains in productivity and environmental sustainability.

In most countries there is still great potential to improve the collection of aluminium cans, plastic and glass for recycling. This requires different support initiatives to *inter alia*:

- design recycling collection bins and recycling facilities based on the packaging available in the area;
- improve communication, cooperation and consistency within and between manufacturers, suppliers, retailers, waste management companies and governments to improve recyclability and collection; and
- improve the availability and quality of disposal data specifically for soft drinks (Defra 2012).

A project in Brazil has improved the quality of the post-consumer recyclables by or-ganising landfill rubbish collectors into a cooperative. The certification of this cooperative guarantees a consistent stream of good quality material to the downstream user of the post-consumer recycled material (see Box 13). This example could be replicated in a range of countries where waste sorting at landfills is often under taken by private citizens as a means of livelihood.

Box 16: Project Phoenix
(Johnson & Johnson 2010)

The recycling cooperative Futura in São José dos Campos, Brazil, is a community of people otherwise invisible to society. Its members undertake work that provides a service to the larger community. The cooperative is formed by *catadores*, who collect and process waste material for recycling, living and working. The cooperatives create a purpose-filled way of life, providing a level of dignity for its members, who are poor and formally unemployed. In 2009, Project Phoenix was started to help Futura and other cooperatives in Brazil to support their livelihoods.

Project Phoenix helps cooperatives improve their operational processes, document policies and develop a stronger social infrastructure. The project is modelled on SA8000, a global social accountability standard for ethical working conditions, developed by Social Accountability International. SA8000 is based on the norms of the United Nations Universal Declaration of Human Rights, the Convention on the Rights of the Child and various International Labour Organization conventions. It includes nine basic principles, such as documented policies on child labour, discrimination and health and safety. The ultimate goal is to see the *catadores* achieve SA8000 certification.

6.4 Waste to energy

Many countries make use of waste incineration plants to convert waste to energy. This process requires close monitoring to make sure that the incineration components are managed optimally to ensure that no toxins (e.g. dioxins) are created in the incineration process and emitted from the smoke stacks. Most soft drinks packaging is either made from metal, glass, cardboard or PET and there is no risk of formation of dioxins from this packaging.

Organic waste generated in the supply chain or in the production of soft drinks can be used in anaerobic digesters to produce biogas. This happens with wastewater from soft drinks bottling plants, but is rarely seen in fruit processing plants or in sugar mills.

6.4 Trends and challenges

It can be difficult in many countries to achieve absolute reductions in the amount of packaging that reaches households due to the amount of material saved, as any reductions in packaging can be exceeded by any future growth in sales.

Most secondary soft drinks packaging is cardboard and plastic, while shrink wrap plastic contributes the most in terms of volume. Therefore, practices to optimise and reduce cardboard packaging should be a focus for reducing secondary packaging (Defra, 2012).

7 INDUSTRIAL ECOLOGY

Industrial ecology, also described as a 'closed loop' system, is an important concept that links input or output streams from different stages of the soft drinks value chain to external processes. It is a concept that focuses on the combination of sustainable business practices throughout value chains and between value chains of different products. In the case of soft drinks, there are links with the production, supply or distribution components of the value chain. As it spans these three sections, we present it in a separate chapter in this report.

The primary raw material inputs of a bottling company are water and sweetener, with the main outputs being product, unused or damaged packaging materials and wastewater. As the inputs are constituents of a food product, their quality and origin is strictly regulated. It is not likely that a waste or by-product from another industrial operation could be accepted as input into the production area of a beverage company. One option to overcome this could be to use recycled water in the non-product areas of the bottling plant, such as for irrigation or truck washing. However, since the bottling plant itself has an ample supply of recyclable water from its own operations, it is unlikely that it would need this supply from an outside source. A second greening option would be to use the waste energy of another company for use in the bottling plant. Another option would be to use excess steam capacity to supply another company. Both these energy-related options seem feasible, but we are not aware of any examples where this has been applied yet.

Effluent from bottling plants could be used to improve the efficiency of existing wastewater treatment operations, or for on-site or off-site energy generation. The chemical oxygen demand (COD) naturally present in domestic sewage is often inadequate for the denitrification and total phosphorus removal needs of Public or Privately Owned Treatment Works (PPOTWs). Many PPOTWs are located near soft drink bottling plants which dispose of these plants' highly concentrated waste at a considerable cost. The concentrated wastes from the bottling plants can be utilised as a source of COD for the PPOTWs. Some municipalities in the USA have already adopted the use of concentrated beverage wastes as the COD added to assist in denitrification and biological phosphorus removal (Bush 2009).

Box 17: Reuse of COD in wastewater (Bush 2009)

An example of the use of wastewater from a soft drink bottling plant in a publicly owned wastewater treatment works is the McDowell Creek POTW operated by the Charlotte-Mecklenburg Utilities District in the United States. This facility currently treats an average flow rate of 4.5 million gallons per day. The plant has partnered with the Independent Beverage Company (IBC) over the last 7 years to supply COD for use in their nitrification/denitrification biological phosphorus treatment system. IBC bottles and cans various soft drinks and collects in a 6,000 gallon tank truck the first flush of rinse water that precedes a flavour change.

Many of the waste materials from sugar processing are also reused; for example, beet residue is generally used for animal feed or other processed products. Sugar cane stalks (bagasse) are often used as a fuel to run the factory and even nearby towns, thereby reducing the carbon footprint of sugar processing. Another waste from the sugar mill, molasses, can be used for the production of alcohol. Part of the water used for cultivation of sugar cane can be sourced from the treated wastewater from manufacturing operations. Bagasse pith (a waste after the paper making) and other combustible agricultural wastes can also be used as an energy source in the production process (Erkman and Ramaswamy 2001; Defra 2012).

Waste materials such as glass, metals, cardboard or plastics that originate from the supply, production, distribution or retail phases can be fed into the recycling circuit. The effects of greening through recycling are covered in the next chapter.

8 THE GREENING POTENTIAL OF THE VALUE CHAIN THROUGH ITS MAIN INPUTS (ENERGY, WATER AND WASTE)

In the previous chapters we discussed the greening potentials within each separate component of the value chain and greening through the inter-linkage of the soft drinks value chain with other value chains through the concept of industrial ecology. In this chapter we will examine the options for further greening opportunities through actions that not only make an impact within each separate element of the value chain, but also those which act throughout the complete value chain.

Although the soft drinks industry has been proactive in its work to minimise its environmental footprint, there are still opportunities to enhance this work through improved focus and collaboration along the entire value chain. The three areas within the chain that have the greatest environmental impacts are:

1. **Energy consumption** – energy use is significant in the processing of ingredients and the manufacture of packaging; in fuel used in distribution; and in refrigeration and freezing. Because of the use of agro-chemicals in agriculture, the production and processing of fruit and sugar also contribute significantly to GHG emissions and to a rise in pollution levels.
2. **Water not-in-product** – water use is significant in the agricultural production of ingredients (especially fruit and sugar-based drinks).
3. **Product waste** – post-consumer waste (particularly PET bottles and aluminium cans) contributes significantly to resource consumption and is seen as more of a concern compared to waste arising elsewhere in the supply chain.

8.1 Energy and Climate Change

A major impact associated with energy consumption in the soft drinks industry is the emission of greenhouse gases and their contribution to climate change. A number of studies have assessed the carbon footprint of the full soft drinks value chain (BIER 2012) which have found that the PET bottle is the largest contributor at 35%, followed by sweeteners (sugar or artificial sweetener) at 33% and lastly, distribution and transportation at 17%. The largest contributors to carbon emissions have been found to be: aluminium cans (71%); sweetener (10%); and distribution transportation (9%). Sources with very small amounts of carbon emissions were the label, wood, water treatment and warehousing.

There is also a disparity between the different carbon footprints of similar drinks originating from different continents, for example, the overall carbon footprint of one 355 millilitre NorAth merican can was estimated at 195 grams CO2. In contrast, an assessment of the carbon footprint of a European 1.5 litre PET bottle was estimated at 251 grams of Co2.

The fact that raw materials production, product packaging and distribution activities were found to be the primary contributors to the carbon footprint of soft drink indicates that cooperation in the value chain between packaging manufacturers, sweetener producers and soft drink companies, is of vital importance. This would require a shift from isolated production elements in the value chain to an integrated approach where all links in the value chain cooperate to reduce the overall environmental impact of soft drinks. Both larger and smaller companies throughout the supply chain can get involved in this and can make substantial contributions to this goal.

8.2 Water

Previously, many companies only focused on the performance of their own bottling operations. Water issues were mainly addressed by efforts to reduce water consumption in the bottling factory through improving the water-use ratio (see Section 4). However, the broader water footprint-from sourcing, to production, consumption and then disposal-is now viewed as being an imperative consideration that must be addressed as an integral issue by all soft drink companies.

Besides water consumption in the bottling plant, it is also important to consider freshwater usage along the value chain. This means that the total water consumption over the life cycle, (the water footprint) must be considered and quantified. The water footprint is an indicator of water use that considers both the direct and indirect water use of a consumer or producer. The water footprint of a soft drink is defined as the total volume of freshwater that is used to produce soft drink consumed (Ercin 2011).

A study on the water footprint of a sugar-containing carbonated beverage showed that a 0.5 litre PET bottle has a water footprint of 150 to 300 litres of water per 0.5 litre bottle, of which 99.7–99.8% refers to the supply chain. The study also shows that agricultural ingredients that constitute only a small fraction in weight of the final product constitute the largest share of the total water footprint of the soft drink (Ercin 2011). Hence, it is imperative that producers aim to develop supplier relationships in which they stimulate a reduction in water use. This could work via certification and the introduction of good agricultural practice standards, such as those practiced by Bonsucro and CitrusBR (see Chapter 3).

Box 18: Example of water use reduction practices
(UNIDO 2013)

Znovini is a medium-sized producer of wine and vermouth, supplying approximately 5% of the Czech market. Znovin participated in a UNIDO project and developed an Environmental Management System (EMS) based on UNIDO's Cleaner Production Principles. The company was initially motivated to act due to its high water consumption (15,000 m³ per year). Znovini's management was also motivated to introduce an EMS in order to increase their employees' awareness of issues such as environmental protection, the impact of their work on the environment, as well as health and safety issues associated with their work.

The company introduced environmental activities, such as regular monitoring of its consumption of raw materials, water and energy. Through this work the company was able to identify points of loss and inefficient use. Measures were then proposed to counteract these losses, including the introduction of a new bottle washing line and a new bottle filling line.

The total specific water use (water-use ratio) could thus be reduced by almost 50%. Other measures included the installation of new jets in the bottle washing machine and reducing the frequency of the backwashing of the sand filters in the water treatment plant.

Parameter	Units	1995	1997
Production volume	m3	2,334	3,000
Water consumption	m3	21,377	15,000
Water-use ratio	litre/litre		

8.3 Waste

The main potential for the greening of waste comes from the processing of agricultural ingredients. One way that this can be achieved is through producers working with raw material processors in the country of origin. Bonsucro and some larger soft drink companies have initiated a programme to develop responsible sugar production, which include practices to reduce waste through reusing it in other parts of the sugar mill or in other factories.

There are several ways in which waste can be reused by closing the materials loop in the value chain including:

- Agricultural waste from the growing of sugar cane, sugar beet or other agricultural sweeteners can often be reintroduced to the fields as soil enhancer or as fertiliser.
- Bagasse, the waste from sugar production, can be used to make paper and cardboard which can then be used in the production of packaging materials.
- Wastewater from soft drink production often contains high levels of organic material, mostly sugar or other sweeteners. If the chemical oxygen demand is high enough then this wastewater can be processed and cleaned through anaerobic digesters. These not only improve the quality of the water, but also produce biogas that can be used as an energy source for the factory.
- Packaging materials such as glass, cardboard and PET that are collected and processed by the recycling industry can be used to make new glass, cardboard and PET.

Table 7: Summary of greening options

Area	Greening opportunity	Source	Key stake-holders	Ease of implementation	section of report
	Primary agriculture				
Source water	● Source water cooperative schemes		Farmers,NGOs, government, soft drink companies	Range from easy and low cost measures	3.1
Water use during planting process	● Water conservation technologies e.g. drip irrigation		Farmers,NGOs, government, soft drink companies	Easy and low cost measures	3.1
Fertilisers	● Reduce the amount of fertilisers used by means of inter alia IPM, cultural management and mechanical controls		Farmers,NGOs, government, soft drink companies	Mainly low cost and low risk	3.3.3
Fertilisers	● Utilise low carbon fertilisers	Yara, 2012; Noria; PepsiCo, 2014).	Farmers, researchers		3.3.5
Sugar production	● Refer to Table 5	Nalukowe 2006			Table 5
	Soft drinks manufacturing				
Energy efficiency	● Optimise lines, install efficient heating Install more efficient cooling technology ● Improve pressure systems		Soft drinks companies, governments	Initial expensive outlay	4.1, 4.4
Energy efficiency: compressed air	● Regularly check the system for leaks ● Enhance the compressed air system by optimising the compres- ● sor operation (e.g. reducing the temperature of the air inlet) ● Improve the compressed air distribution (e.g. by eliminating unused pipes and "dead ends" in the system)		Soft drinks companies	Easy and low cost measures, good housekeeping measures	Box 11, 4.1
Cooling system	● Check to ensure that the cooling system elements are not located near to heat-generating equipment ● Ensure proper insulation of the whole distribution system including all pipes, valves and flanges		Companies	Range from easy and low cost measures, good housekeeping to medium expense	4.1
Steam generation	Energy efficient technologies that can be utilised include: ● CHP or co-generation ● Tri-generation technology ● Quad generation plants		Companies with support of govt.	Expensive	4.1
Filling of bottles	● Fill close to room temperature		Bottling companies	Easy and low cost measures, good housekeeping	4.1

Area	Greening opportunity	Source	Key stake-holders	Ease of implementation	section of report
Factory energy source	• Renewable technologies that can be utilised include: • Solar photovoltaic • Wind • Thermal solar energy to pre-heat water before it goes into boilers • Biomass boilers • Purchasing of on-grid low carbon energy		Companies with support of government.	Expensive, Finding suitable sites for wind turbines. Availability of low carbon energy from the national grid is often low or non-existent.	3.2, 4.1 & 4.4
Water in fruit processing	• Refer to Table 3	Pagan, Prasad et al. 2004, Masanet, Worrell et al. 2008, Fresner, Walters-dorfer et al. 2014, UNIDO 2014	Companies with the support of donors	Range from good housekeeping to initial expensive outlay.	Table 3
Wastewater treatment technologies	• Treat wastewater with treatment technologies ending in reverse osmosis, which renders the water suitable for drinking purposes		Bottling companies, soft drink companies	May be expensive	4.2
Wastewater: COD	• Reduce wastewater volume from reduced water consumption, combined with the same pollution load which will lead to smaller, more concentrated waste steams with high chemical oxygen demand (COD) • Utilise COD in a biogas-producing anaerobic wastewater treatment installation	Bush 2009	Bottling companies, soft drink companies	Range from medium to high cost	Box 17, Sec. 4.2 & 7.
Wastewater on-site treatment	• Utilise anaerobic on-site installation to treat wastewater. Biogas from this process can also be used for electricity generation and electricity use on-site			Few examples exist	4.2 & 8.3
	Distribution				
Distribution	• Use e-star vehicles	Coca-Cola North America, 2011		• Probably only available to large, multinationals due to high initial outlay • Limited range and recharge points	5.1
Alternative fuels	• Utilise natural gas, biogas, propane (LPG), hydrogen, alcohols, biodiesel or electricity or a blend of conventional and alternative fuels		Soft drink companies	Some options require conversion of the fuel system. Limited availability of biogas. However, there are blending options.	5.1 & 5.3
Efficient driving	• Provide driver education on reduced slowing down and acceleration, preventative maintenance and reduced idling • Drive with as low a number of revolutions as possible		Soft drink companies	Can be implemented by companies of any size. Other issues are outlined at 5.3	5.1 & 5.3
	Retail refrigeration				
Retail refrigeration	• Use HFC-free refrigeration • Use fridge doors and metallised blinds • Prevent leaks • Retrofit refrigeration	Defra 2012, WRAP 2011	Retailers, governments, research and development	More of an option for larger companies. Expensive for small retailers.	5.2 & 5.3

Area	Greening opportunity	Source	Key stake-holders	Ease of implementation	section of report
Packaging recycling	● Design recycling collection bins and recycling facilities based on the packaging available in the area ● Improve communication, cooperation and consistency within and between manufacturers, suppliers, retailers, waste management companies and governments to improve recyclability and collection ● Improve the availability and quality of disposal data specifically for soft drinks ● Use PET and rPET ● Reduce stretch-wrap consumption through staff education on correct machine set-up	Defra 2012; WRAP 2011; IBWA 2013).	Governments, research and development, soft drink companies	Medium to expensive option	2.5, 3.2, 6.1, 6.6, Box 2, Box 15 & 8.1
Reuse packaging	● Encourage reuse of soft drink bottles where appropriate		Governments, bottling and soft drink companies	Energy and water intensive	6.2
Water	● Use recycled water in non-product areas of the bottling plant, such as for irrigation or truck washing	Bottlers			7
Waste energy	● Utilise excess steam capacity to supply another company with energy ● Utilise organic waste generated in the supply chain or in the production of soft drinks in anaerobic digesters to produce biogas	Bush 2009	Governments, bottling and soft drink companies	Only feasible in wealthier countries at this stage. Rarely seen in fruit processing plants or sugar mills.	7, 3.5 & 6.4
Waste materials	● Use effluent from bottling plants to improve the efficiency of wastewater treatment operations or for on-site or off-site energy generation ● Use concentrated beverage waste as the COD to assist in denitrification and biological phosphorus removal	Bush 2009	Bottlers		7
Waste materials from sugar processing	● Use beet residue in animal feed ● Use bagasse as a factory fuel ● Use molasses in alcohol production ● Source water from manufacturing operations to use in sugar cultivation ● Use bagasse pith and other combustible agricultural wastes as an energy source in the production process	Ramaswamy 2001; Defra 2012	Farmers, soft drink companies, bottling companies	Low to no cost	7
Water in production	● Undertake water footprint assessments-from sourcing, to production, consumption and then disposal ● Regularly monitor water use ● Install new bottle washing and filling lines ● Install new jets in bottle washing machine ● Reduce the frequency of backwashing sand filters in the water treatment plant		Bottlers and soft drink companies	From low cost to expensive	8.2 Box 18
Waste in value chain	● Use packaging materials such as glass, cardboard and PET that are collected and processed by the recycling industry to make new glass, cardboard and PET ● Reintroduce agricultural waste from the growing of sugar cane, sugar beet or other agricultural sweeteners to the fields as soil enhancer or as fertiliser ● Use bagasse to make paper and cardboard which can then be used in the production of packaging materials ● If the COD is high enough in the wastewater from soft drinks production, then this wastewater can be processed and cleaned through anaerobic digesters. It can also be used to produce biogas that can be used as an energy source for the factory		Farmers, soft drinks manufacturers, soft drink companies	Range from low cost to expensive	8.3

9 CONCLUSION

The main ways in which the soft drinks industry affects the environment are:

- in the growing and processing of fruit and sugar;
- in the packaging of materials;
- in the refrigeration of goods; and
- through water impacts (competition with other users, pollution and over-extraction).

This This report has shown that there are many opportunities for greening throughout the life cycle of soft drinks, including in the production of the primary ingredients (sugar, citrus fruit and water); in the production and bottling of the soft drink itself; and in the distribution, retail and consumption phases. Each phase has its own characteristic environmental impacts and greening opportunities.

A reduction in water consumption in the bottling process itself can largely be achieved through simple good housekeeping measures. Changes in the bottling process are under the direct control of the soft drink company. It is therefore often easier for soft drink companies that want to reduce the environmental impact of their product to begin to focus on improving their own processes, not only for "greening" objectives, but also for the potential cost-savings and to meet resource security objectives.

Large multinational soft drink companies are leading the way in addressing the main environmental impacts along the value chain. Many of these measures implemented by the large multinationals have been made possible by their ability to draw upon an extensive amount of resources, their market share and correspondingly, their links and leverage with a wide range of suppliers, communities, governments and civil society.

For smaller soft drink companies with less financial resources, it is more difficult to develop and initiate solutions that involve the supply chain. Instead, they could leverage off existing initiatives and thus enhance their environmental benefits and make cost savings. Smaller companies can also aim for the low to no cost options outlined in this report, as well as seek partnerships with international organisations or NGOs to support them in their greening efforts.

Water is the primary ingredient in soft drinks, from the ingredient level, to processing and packaging; hence, its conservation and quality is essential to not only the environmental integrity of the location where it is extracted, but also to the health and economic well-being of communities in the watershed. Threats to water availability or quality also pose significant supply, regulatory and reputational threats to beverage companies. In response, large multinational companies have established global water stewardship programmes to address water supply and quality issues.

Greening options at the local level are also available to smaller companies. Low-cost options include the monitoring of source water quality and assessing their own production processes with EMS standards based on freely-available information. Both large and smaller companies can and should engage with communities living near the bottling plant to address any issues that may have arisen from the factories' production activities.

Energy is consumed throughout the soft drinks value chain, with the largest use seen in the production of packaging materials. Soft drink companies can enhance their efforts in reducing primary, secondary and tertiary packaging materials through reducing packaging weight and improving the recycling of packaging to reduce the overall energy intensity of the value chain.

The refrigeration in the distribution, retail and consumption phases of the soft drink's life cycle also consumes considerable amounts of energy. To reduce the energy consumption in this part of the value chain requires the increased uptake of new concepts such as electric vehicles and alternative cooling technologies. Some of these measures are already being implemented at a small-scale by the large multinationals. However, most small companies do not have the investment capacity to implement these (often more expensive) solutions within their companies. In order to enable this, it would require the unit cost of these technologies to decrease, which would be best achieved through economies of scale through increasing the research and development and uptake of these technologies.

Hence, this report has shown that there are many examples where soft drink companies have initiated measures that look beyond the confines of the bottling plant to the production of agricultural raw materials and more broadly, to the impact of the value chain. A number of collaborative initiatives have been established with other organisations in the supply chain, with some supported and facilitated by international donor organisations or NGOs such as WWF. Increasingly, opportunities arise for other soft drink companies to join these initiatives or implement initiatives on a local scale.