Title: Enhancing corporate environmental performance through reporting and roadmaps

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Abstract

Managing the carbon footprint of companies and addressing their respective decarbonisation plans is a challenging endeavour. The aim of this study is to help companies' better understand the issues around decarbonisation and environmental performance by suggesting a holistic management process they could embark on. This process comprises two crucial steps which are: a) sustainability reporting and b) low-carbon roadmaps. These steps are covered and further developed based on a detailed study of the UK food retail sector. This sector is relevant due to its economical and environmental importance, but most importantly it has a significant record of available environmental reports in the public domain and a large potential to influence consumers, policy makers, and multiple supply chains.

Sustainability reporting is assessed by analysing environmental KPIs disclosed in Corporate Social Responsibility (CSR) reports and then these are compared against industry standards. This analysis highlights a general lack of consistency and transparency in CSR reporting of UK food retailers. Consequently, a low carbon roadmap based on relevant KPIs and on the 'backasting' framework is presented as a case study in order to showcase how a hypothetical UK food retailer can employ a low carbon roadmap to meet strategic targets. The case study demonstrates that ambitious environmental targets are achievable if robust corporate action plans are followed and steered adequately to meet long term targets. Furthermore, the case study also indicates capital might be misallocated in favour of highly visible environmental stores and on-site energy generation technologies with expensive carbon abatement potential whilst in theory more could be done by applying cost-effective energy efficiency measures which have the potential to deliver substantial carbon savings.

Highlights:

- General lack of consistency and transparency in CSR reporting of UK food retailer
- In average, no real improvement of transparency in CSR reporting since 2005
- Energy saving measures have a greater potential compared to on-site generation
- A learning process from the lighthouse store results is required
- Ambitious environmental targets are achievable

Key words: Environmental indicators, KPI, Corporate Social Responsibility, Supermarkets, Roadmap, target

1. Introduction

A significant share of worldwide Greenhouse Gas (GHG) emissions is emitted by companies, either directly or indirectly, during their operations that usually involve the manufacturing or provision of products or services. Because of the multiple activities and sheer size of routine operations businesses face, measuring, reporting and taking action on a company's environmental performance is a challenging endeavour. Indeed, managing the carbon footprint of companies and addressing their respective decarbonisation challenges involves in-depth awareness of regulatory frameworks and policies while also requiring a detailed understanding of technical issues ranging from energy efficiency measures up to the latest trends on low carbon technologies. Based on the principle that for it to be managed, the environmental impact must first be measured, frameworks have been developed by governmental and non-governmental organisations to guide companies through the steps of measuring and reporting their environmental performance. However, the literature suggests a substantial disregard for environmental reporting standards since significant gaps and inconsistencies can be found in the publicly available information disclosed by companies; this concern has been raised in multiple publications (Gouldson and Sullivan, 2007), (Sullivan and Gouldson 2012a) and (Roca et al. 2012).

Within the above context, this paper aims at enhancing corporate environmental performance by emphasising the lack of consistency in reporting and highlighting the usefulness of devising strategic decarbonisation roadmaps. In this work, these subjects of concern are addressed by having a better understanding of the shortfalls of environmental reporting policy and through the robust design and implementation of environmental action plans. To do so, this paper points out the most widely used environmental Key Performance Indicators (KPIs) reported and likewise stresses data gaps and lack of transparency. Furthermore, a case-study based on the 'backcasting' methodology showcases how relevant KPIs can be used to design a roadmap that improves environmental performance. Thus, this paper fulfils its aim by proposing a holistic approach so stakeholders can achieve a better understanding of the salient issues and bottle-necks towards achieving sustainability.

Figure 1 illustrates an environmental performance virtuous cycle which organisations could embark upon to achieve strategic environmental targets once a GHG inventory has been conducted – thus empowering decision makers to implement corporate governance. As a first step, in order to achieve far reaching environmental goals, a steering committee with in-depth knowledge of all business areas need to envisage and develop low carbon roadmaps that address all areas composing the carbon footprint of the business. The roadmaps should define and assess the different pathways and action plans that can contribute in delivering environmental strategic targets. After action plans are devised relevant managers should engage with internal stakeholders to get their support on the initiatives to be applied. Implementation of actions, while following a methodical approach towards data capturing, would be the first applied step in this sustainability journey while the second step would consist of conducting periodical internal reviews of the initiatives – this attitude should permeate the business culture. Once results are abundant, and before making available external reports for voluntary or mandatory motives, a third party to the process – either an internal or external auditor – should provide data assurance on the manner results have been determined; only then should reports be released**.** By making Corporate Social Responsibility (CSR) reports available to internal and external stakeholders it allows them to

provide feedback and this in turn allows managers to document learning's from their actions. Consequently, the steering committee would then review the impacts of their strategies by assessing the progress achieved on GHG emissions in each area of the business. This final step allows the organisation to re-focus on determining how best to steer the business in order to meet its environmental long-term objectives.

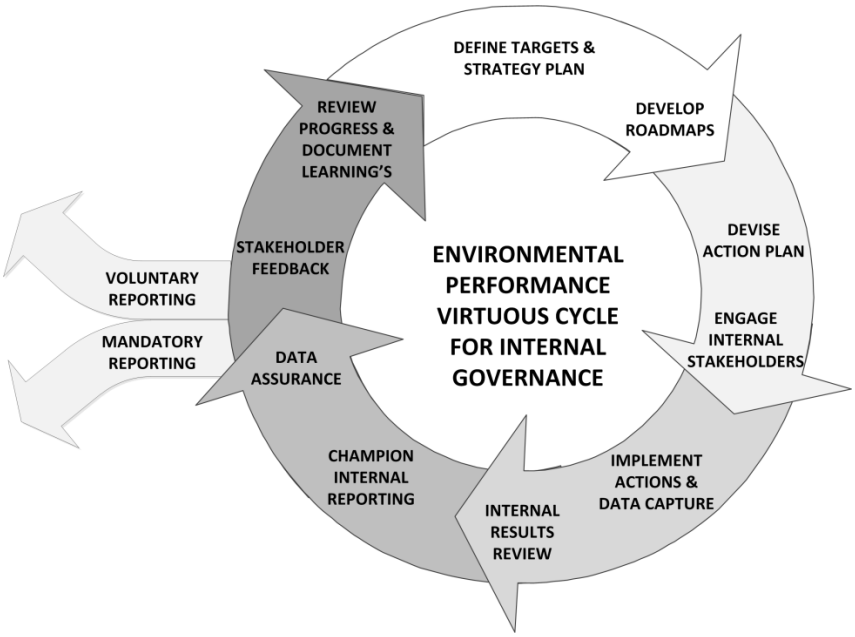


Figure 1: A virtuous cycle towards organisational environmental performance best practices.

In this work, the UK food retail sector was studied to address the research issues at hand for the following reasons. Firstly, the economic and environmental weight of the retail sector is significant. Total annual combined revenue from retailers in 2012 was £163.2 billion (IGD, 2013). Meanwhile, according to the Food Climate Research Network the food system accounts for approximately 19% of total UK GHG emissions (Garnett, 2008). Furthermore, food retailing accounts for approximately 3.5% of total electricity consumption and 1% of total UK GHG emissions (Tassou et al., 2010). Secondly, due to its competitive nature, most food retailers are keen to publicise their environmental credentials and thus publicly disclose information of their environmental activities that result from stakeholder pressure. The first published Corporate Sustainability Report (CSR) by an UK food retailer was Sainsbury's in 1996. This report began a trend and currently all of the major UK food retailers are publishing annual sustainability reports. For a thorough historical analysis on corporate reporting as well as how each retailer compares on environmental targets see (Gouldson and Sullivan, 2013). Lastly, food retailers are strategically placed to coordinate improvement across myriad supply chain pressures as they have market power to drive improvement (JRC, 2011a). All policy instruments identify retailers as an activity with high influence on consumers; for instance 20 million customers shop at Tesco every week (Tesco, 2012). Therefore, retailers are positioned to play a big role in implementing many environmental initiatives and directives (JRC, 2011b).

This paper is structured as follows: Section 2 provides some key insights on frameworks and initiatives impacting environmental reporting. Section 3 compares UK food retailers Corporate Social Responsibility (CSR) reports regarding environmental performance and highlights the most commonly used KPIs. The analysis also highlights limits and shortfall of these KPIs. Section 4 presents a decarbonisation roadmap framework on gas and electricity consumption that can be used to develop environmental action plans by making best use of the KPIs previously discussed. This section also stresses the challenges that can be encountered when implementing sustainability programmes. Furthermore, an energy decarbonisation case-study based on a fictional supermarket chain is detailed to illustrate how roadmaps play a key role in steering and determining the effectiveness of initiatives. Section 5 provides concluding remarks.

2. Research context

2.1. Frameworks and guidelines for accounting and reporting

It is well established that the first step for companies to take action on their environmental performance is to develop an inventory of their GHG emissions. Many frameworks and initiatives are available to guide companies through this process.

The Greenhouse Gas Protocol is the most widely used international accounting and reporting framework (WBCSD and WRI, 2004). This protocol considers all six of the Kyoto Protocol greenhouse gases: Carbon dioxide (CO_2), Methane (CH_4), Nitrous oxide (N_2O), Hydrofluorocarbons (HFCs), Perfluorocarbons (PFCs) and Sulphur hexafluoride (SF_6) and is measured in tonnes of carbon dioxide equivalent (tCO_2e). By employing this well-established framework, organisation's emissions can be categorised into three 'scopes':

- *Scope 1 - Direct:* emissions resulting from activities within the organisation's control including on-site fuel combustion, manufacturing and process emissions, refrigerant losses and travel from company vehicles.
- *Scope 2 – Indirect electricity:* emissions from electricity supplied by third parties and used by the organisation.
- *Scope 3 – other indirect:* Any other indirect emissions from sources not directly controlled by the organisation. Some examples include employee business travel, outsourced transportation, embodied carbon of products sold, waste disposal, and water usage.

Another salient reference is ISO 14064-1 (ISO, 2006) which provides guidance at the organisation level for quantification, monitoring, and reporting of GHG emissions and removals. This framework emphasises the importance of setting robust organisational and operational boundaries to consolidate GHG emissions arising from different sources and clarifying which of the emissions are quantified and reported. In addition, it advocates for a base-year GHG inventory to be established.

The Global Reporting Initiative (GRI, 2011) offers sustainability reporting guidelines that are also widely used. The latest reporting guidelines G3.1 include a list of performance indicators spread over seven categories: economic, environmental, labour practices & decent work, human rights, society and product responsibility. GRI environmental indicators are structured to reflect the inputs/outputs and modes of impact an organisation has on the

environment. The three standard types of inputs are energy, water and materials. These inputs result in outputs of environmental significance which are captured and classified under emissions, effluents and waste.

The Carbon Disclosure Project (CDP) provides a universal system to measure, disclose, manage and share environmental information. The Climate Disclosure Standards Board (CDSB) is a special project of the CDP that works as a collaborative forum to improve existing standards and practices by offering a Climate Change Reporting Framework (CCRF) that adopts the approach used in the GHG protocol. Five major UK food retailers have joined this initiative: Tesco, Sainsbury's, Marks and Spencer, Morrisons, and Asda/Walmart.

At EU level, the EU Eco-Management and Audit Scheme (EMAS) is a management tool for organisations to evaluate, report and improve their environmental performance. From this voluntary scheme, reference documents on best environmental management practice have been drafted. Therefore in 2011, the European Commission Joint Research Centre published the final draft version Pilot Reference Document on Best Environmental Management Practice (BEMP) in the Retail Trade Sector (JRC, 2011c). This document contains sector-specific environmental performance indicators and in some cases benchmarks of excellence.

At UK level, the government via The Department for Environment, Food & Rural Affairs (DEFRA) in partnership with the Department of Energy & Climate Change (DECC) offers "Guidance on how to measure and report your greenhouse gas emissions" (DEFRA, 2011). The guidance sets are based on the GHG Protocol. DEFRA also provides specific guidelines on "Environmental Key Performance Indicators" (DEFRA, 2006a), detailing KPIs for the retail sector: greenhouse gases and waste.

Out of the six frameworks described above, BEMP is the only framework recommending food retail specific KPIs for internal management and for reporting. This paper does not aim to recommend or propose a new framework for reporting but in the following sections will review current practices and assess benefits and shortfalls of KPIs.

2.2. Sustainability reporting initiatives and regulation

At the EU level, an interesting initiative is the Retail Forum "developed with the aim of exchanging best practices on sustainability and to identify opportunities and barriers for the achievement of sustainable consumption and production." (JRC, 2013). In the framework of the Retail Forum, the Retailers' Environmental Action Programme (REAP) was launched and some mechanisms were provided to enhance the dialogue with the European Commission and other stakeholders; as a consequence of this effort retailers voluntarily committed into achieving environmental targets. The REAP commitments database is located at the Commission webpage and is divided into three broad categories (REAP, 2012):

- *What we sell*: actions from selling lower-impact products;
- *How we sell*: actions from reducing environmental footprint and the supply-chain;
- *Communication*: actions designed to inform and empower consumers.

An assessment of large European companies' response to regulatory pressure on climate change policies has been detailed in (Sullivan 2010). The paper states that most large

companies have been actively working on establishing the management systems and processes necessary to effectively manage their emissions, although more work is needed as some of them lag behind in GHG management. Nevertheless, the capability of companies to start quantifying their carbon footprints allows them to have governance over their GHG emissions and hence take meaningful actions. These actions are usually disclosed via either voluntary or mandatory reporting.

In the UK, voluntary reports on environmental initiatives from companies are facilitated, particularly on energy issues, because there are regulations that require management of energy use and their associated emissions. Part L2 of the Building Regulations calls for energy meters so operators of new buildings can classify their annual energy consumption (e.g. lighting, heating, ventilation etc.). Complementing the metering initiative, the mandatory CRC Energy Efficiency Scheme was announced in 2007 in order to incentivise energy efficiency and emissions reduction in large public and private sector organisations (DECC, 2012). This scheme ensures that organisations, using over 6,000 MWh per year of electricity, are aware of their energy use and that management is responsible for this reporting. To offset its CRC emissions each participant must purchase and surrender "allowances" which equate to a tonne of CO_2. The allowance price of £12 for 2011-12 rose to £16 in 2014-15, and from 2015-16 onwards it should increase in line with the retail price index (HM Revenue & Customs,2013). Therefore, an economic incentive in the form of a carbon tax is what the CRC scheme is becoming. Overall, Part L2 and the CRC showcase how from regulation mandates UK companies have taken a hands-on approach into managing their GHG emissions.

UK food retailers usually describe how they manage their GHG emissions and their "environmental actions" via their voluntary Corporate Social Responsibility (CSR) reports. These reports are worthy of appraisal as they recognise climate change and regulation could influence the way they do business. Sullivan (2011) explains: "there is a growing expectation among companies that most, if not all, governments will at some point adopt policy measures directed at reducing GHG emissions" and that "in anticipation, companies have taken a variety of actions: establishing corporate management systems and making public commitments to emission reductions".

Recent events suggest retailers are right to be proactive in addressing GHG emissions. This is because during the Rio+20 United Nations Conference on Sustainable Development, UK Deputy Prime Minister Nick Clegg announced mandatory emissions reporting rules would come into effect on April 2013. The incoming legislation will require all UK based companies listed on the London, European or US Stock Exchange to report their annual GHG emissions. Whereupon it is most likely that annual reports published after April 2013 will be obliged to disclose emissions information (Carbon Credentials, 2012) and (DEFRA, 2012). Mandatory reporting will have to cover all six Kyoto's gases, scope 1 and 2 emissions and it will have to be published in the Director's report of the Annual Report and Accounts (Carbon Trust, 2013). This regulation initiative is likely to enhance reporting standardisation and represents an opportunity for external stakeholders to conduct comparative analysis on how well each company is doing on an issue of major public interest (Sullivan and Gouldson, 2012b). One can only wonder if it will only be a matter of time for other UK institutions (e.g. unquoted companies and governmental agencies) to be obliged to report GHG emissions as well.

3. Environmental performance reporting survey

This section first details how large retailers classify their GHG emissions and then presents a survey on CSR reports that has two key goals: analyse reported environmental indicators and compare how retailers fare on disclosing GHG emissions.

3.1. Setting inventory boundaries

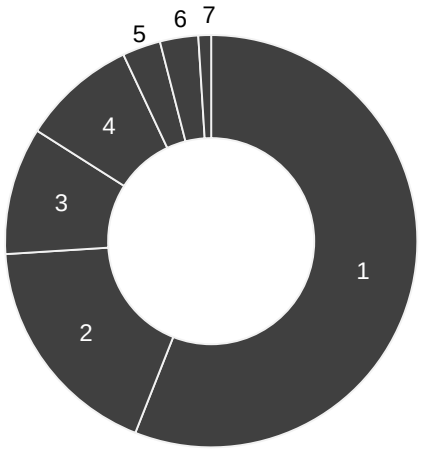
In any business, setting appropriate inventory boundaries is essential to assess what are the companies actual GHG emissions; thus allowing them to track their environmental performance. To do so, the GHG Protocol considers two elements: the organisational structures and the operational boundaries (WBCSD and WRI, 2004). The organisational structures enables consolidating GHG emissions based on operational and/or financial control. The operational boundaries refer to the scope categorisation detailed in section 2.1. Most UK food retailers report emissions within their operational control, that is scope 1 and scope 2 emissions, meanwhile scope 3 reporting level varies significantly.

Table 1 summarises the relevant areas of emissions for supermarkets, their respective sources and corresponding scope, as defined by the GHG Protocol. This classification is based on the EMAS classification (JRC, 2011d) with the exclusion of *Material Efficiency* and *Biodiversity. Material Efficiency* was disregarded because retailers directly manufacture very few products. *Biodiversity* was also omitted as few quantitative indicators are available in the literature. Additional Scope 3 emissions could have been considered such as the one associated with food production, construction, customer transport, etc. However these emissions are more difficult to quantify, retailers have less control over them and their reporting is not mandatory under the GHG protocol.

Table 1: Emissions allocation per category and corresponding scopes

Category	**Energy**		**Refrigeration**	**Transport**			**Waste**	**Water**
Source	Purchased electricity	Fuel combustion	Refrigerant leakage	Company -owned vehicles	Contractor -owned vehicles	Business Travel	Waste sent to landfill	Supply and treatment
Scope	2	1	1	1	3	3	3	3
Type	Indirect	Direct		Indirect				

Since UK food retailers are diverse for example in terms of sales area space, number of stores, and location; their corresponding GHG emissions split will vary but not significantly. Figure 2 illustrates the emissions distribution pie of Morrisons Supermarkets as published in their 2011 Corporate Responsibility Review (Morrisons, 2011).



1.	Electricity	56%
2.	Refrigeration	18%
3.	Haulage	10%
4.	Gas	9%
5.	Waste	3%
6.	Employees work travel	3%
7.	Business miles	1%

Figure 2: Food retailer typical emissions split by source (Morrisons 2011).

From the figure above it is evident that indirect emissions from grid electricity use is the single most important contributor to total GHG emissions. Direct refrigerant emissions come second, while haulage is third and refers to the emissions associated with product delivery and transportation. Emissions associated with natural gas being burnt in boilers for space heating and hot water usage is the fourth largest contributor to emissions. Waste and employee travel have a lower burden on the companies carbon footprint. Meanwhile, emissions due to water supply and treatment are generally not reported, but they appear to be not that significant (0.3% for Waitrose, 2011).

3.2. CSR Survey Methodology

UK food retailers were surveyed and assessed on the basis of their public domain CSR reports available on their websites; these voluntary reports are unique opportunities for each retailer to describe their sustainability journeys. There are currently ten food retailers in the UK: Aldi, Asda/Walmart, Co-operative, Lidl, Iceland, Marks and Spencer, Morrisons, Sainsbury's, Tesco and Waitrose. However, the 3 less important retailers (in terms of market share) Aldi, Lidl and Iceland do not publish CSR reports. Thus, only the seven largest supermarket retailers were considered in the analysis.

An environmental indicator is defined as "a parameter, or a value derived from parameters, which points to, provides information about, describes the state of the environmental performance of a technique or measure" (JRC, 2011c); these indicators should meet the following criteria (JRC, 2011d):

a) give an accurate appraisal of the organisation's environmental performance;
b) be understandable and unambiguous;
c) allow for a year on year comparison to assess development of the organisation;
d) allow for comparison with sector, national or regional benchmarks as appropriate;
e) allow for comparison with regulatory requirements as appropriate.

Reports from 2005 to 2012 were reviewed and environmental KPIs were searched by categories (as shown in Table 1) as keywords in the reports, however when indicators had the same meaning but different wording they were classified under the same group. To

complement this study several interviews were conducted with environmental consultants that collaborate with food retailers; thus allowing the authors to actively discuss the research findings.

3.3. Survey results and discussion

To illustrate the diversity of KPIs used in reports, the repetition rate of environmental indicators found in 2011 CSR reports is listed in Table 2. Out of the 64 different indicators recorded, 42 indicators were used only once. In average indicators are used 1.3 times across the dataset.

Table 2: UK food retailers Environmental indicators disclosed in CSR reports

Indicator	Score
Energy	**24**
Electricity from renewable sources (%)	3
Energy consumption (MWh)	2
Energy consumption per sq ft of trading floor space (kWh/sq ft)	2
GHG emissions (tCO_2e)	7
GHG emissions ($kgCO_2/m^2$)	1
Investment in Energy programme (£m)	1
New stores GHG emissions compared to baseline	1
Number of stores refurbished by Energy Efficiency Program	1
Number of stores with biomass boilers	1
Number of wind farm operated	1
On-site renewable energy (% of energy requirements)	1
On-site renewable energy production (MWh)	1
Solar panel on roofs (MW)	1
Stores operational carbon intensity (kg CO_2/m^2)	1
Refrigeration	**14**
Composition of gases (split %)	2
Doors on fridges installed	1
GHG emissions (tCO_2e)	6
GHG emissions (tCO_2e/ft^2)	1
Number of stores with CO_2 based refrigeration	1
Number of stores with low-carbon refrigeration	1
Number of stores with 'Natural Refrigeration'	1
Refrigerant leakage rate (%)	1
Transport	**30**
Company cars emissions ($kgCO_2/km$)	1
Company cars miles per gallon (mpg)	1
Fuel use for food delivery (l/store/month)	1
Fuel use for general merchandise (l/product delivered)	1
GHG emissions (tCO_2e)	5
GHG emissions (tCO_2e/£m sales)	1
GHG emissions (tCO_2e/case delivered)	3
GHG Emissions due to Business travel (tCO_2e)	4
Mileage due to business travel (kms)	1
Mileage of company-owned vehicles (kms)	2
Mileage reduction (kms)	5
Number of flights per Full Time Equivalent employee	1
Total Mileage (kms)	2
Vehicles with Euro V engines (%)	2
Waste	**39**
Cardboard processed (tonnes)	1
Carrier bags (million)	1
Carrier bags reduction (million)	1
Construction waste recycled (%)	1
Cooking oil collected to be used for biofuels (tonnes)	1
Food non-glass packaging (g/item sold)	1
Food waste diverted to energy (tonnes)	1
Food waste sent to AD (%)	1
GHG emissions (tCO_2e)	4
Packaging - Home delivery (g/parcel)	1
Packaging - Primary by material (tonnes)	1
Packaging - Primary (tonnes)	2
Packaging - secondary and tertiary (tonnes)	1
Paper use (reams)	1
Waste disposed to landfill (tonnes)	3
Waste disposed to landfill (tonnes/store)	1
Waste diverted (tonnes/store)	1
Waste diverted from landfill (%)	3
Waste diverted to energy from waste facilities (tonnes)	1
Waste generated (tonnes)	3
Waste generated (tonnes/store)	1
Waste reused or recycled (%)	5
Waste reused or recycled (tonnes)	3
Water	**8**
GHG emissions (tCO_2e)	1
Water consumption (m^3)	3
Water consumption (m^3/site)	1
Water consumption (m^3/ft^2)	2
Water savings through water harvesting (m^3)	1

3.3.1. Energy indicators

All the UK food retailers are reporting the GHG emissions due to energy consumption. However the relative importance of electricity and gas usage is not always given and perhaps most importantly the absolute energy consumption figures are only disclosed by two companies even if this information is easily accessible by companies and encouraged to be disclosed by the GRI.

DEFRA and DECC recommends the reporting of intensity ratios for Scope 1 and 2 emissions, this can either be an activity ratio or a financial ratio. The guideline supports that normalising the data is useful because it facilitates "comparison over time and comparison across different business sectors and products" (DEFRA,2009). Two companies are reporting and have ambitious targets regarding the energy efficiency of their supermarkets based on specific energy consumption (kWh/m^2). Although its use is recommended by BEMP (JRC,2011c), it is important to emphasize the limits of the indicator with respect to DEFRA's statement of temporal comparison and comparison across different business sectors. Firstly, the definition of surface area is unclear and therefore retailers are sometimes vague when using this indicator as it can include or exclude areas concerning check outs, food and non-food space, depots, and back offices. Secondly, stores cannot directly be compared to one another if their sales areas are significantly different. Unlike what is suggested by comparing specific electricity use against sales area (Tassou, 2010), large stores are not necessarily more energy efficient. This is because larger stores usually have relatively larger space dedicated to non-food items and these products do not require refrigeration, thus the specific energy consumption indicator will be lower for these large supermarkets when compared to smaller ones. Thirdly, the average size of major UK food retailers' stores has been changing over time (DEFRA, 2006b). Many supermarket chains have store extension programs and others have grown their convenience store space within the last few years. As a consequence, the historical comparison of the indicator as DEFRA intended could also be misleading.

Another interesting take on reporting environmental KPIs is by using turnover (£m sales) to normalise absolute GHG emissions. Two companies (Asda and Waitrose) use this KPI. The main drawback of this indicator is that like any financial ratio it can be distorted by inflation (Peavler, 2013). In addition, at the corporate level, Walmart needs to take into account currency exchange rate that can positively or negatively impact the ratio (Walmart, 2011). Lastly, this type of metric misrepresents the GHG emissions from its physical source by considering how good the retailer's revenue is and thus makes it harder to understand the underlying factors driving GHG emissions.

Concerning the sourcing of energy, three companies (the Co-operative, M&S and Sainsbury's) are reporting the share of electricity they purchase from renewable sources; also known as green power purchase agreements. However, only one company, the Co-operative, reports separately their on-site renewable energy production as a function of their total energy requirements. This indicator is closer to the BEMP recommendation of specific energy generation (kWh /m^2 yr).

3.3.2. Refrigeration indicators

BEMP recommends using specific (linear) consumption of refrigeration (kWh/m). This study verified that this indicator is not embedded into UK retailers reporting policy yet. Moreover, although refrigeration leakage is the second largest contributor to retailer's GHG emissions, just 8 different indicators where reported 14 times across the reports. The survey shows only one retailer, Sainsbury's, does not disclose GHG emissions due to refrigerant leakage in their corporate reports. Worryingly enough there seems to be a lack of details in the carbon footprint of this area of the business across the whole food retail sector. The Co-operative is the only company giving a breakdown of their leakage rate whilst Asda has started disclosing information on the average leakage rate of their new stores.

GHG metrics aside companies are starting to report on two salient refrigeration issues. Firstly, they are implementing the use of alternative refrigerants such as "low-carbon refrigeration" or "natural refrigeration" (McMullan,2002). Secondly, the "number of stores with doors on chilled and frozen cabinets" as this measure saves large amounts of energy (Van der sluis, 2007).

3.3.3. Transport indicators

Five companies report transport related GHG emissions. However, organisational structures vary greatly as companies don't necessarily account for emissions associated from third-party distribution contractors. Only two companies (the Co-operative and Waitrose) report total mileage of their distribution fleet. The second most reported indicator is mileage reduction achieved by the transport fleet mostly due to logistics optimisation. Overall, there is poor reporting and consistency detailing the energy efficiency of the fleet as defined by the department of transport and as recommended by BEMP: "millilitres of fuel consumed for standard pallet equivalent carried per kilometre travelled" (Department of transport, 2003).

3.3.4. Waste indicators

This area of the business reports the most environmental KPIs and it is believed to be because retailers have abundant experience in managing waste. Yet, only four companies report their GHG emissions due to waste being sent to landfill. Three companies report their generation of waste (usually in tonnes) and five of them specify the re-used or recycled rate indicators as recommended by BEMP. Three companies report the diversion rate from landfill which is an insightful indicator as long as they also specify which share of it is being recycled, reprocessed or used for energy.

A few companies report on their efforts to reduce the weight of packaging as it shows the effort they are making to reduce the amount of generated waste by the business. Companies are also starting to report an increasing number of KPIs on how they help customers reducing and recycle their waste, but it was disregarded from further analysis as it does not affect the companies' direct GHG emissions and environmental performance.

3.3.5. Water indicators

Only one company is reporting GHG emissions associated with water treatment and supply and only three companies are reporting absolute water consumptions. It appears that water is by far the less reported area on the environmental agenda of UK food retailers. Furthermore, an important issue is that giving an absolute water consumption figure does not reflect appropriately the pressure on water resources that businesses have; mainly due

to the fact that water is more of a local issue. Appropriate set of indicators should be used to better reflect companies actual pressure on water resources. This could be done by introducing more spatial granularity in the data reported and by reporting GRI water specific indicators EN8, EN9, EN10, EN21 and EN25 that encompass “water withdrawal by source” and “water sources significantly affected by withdrawal of water” (GRI,2011).

3.3.6. Key results

Firstly, the survey outputs support the statement that there is a significant lack of standards and consistency in the indicators being reported in all the areas of environmental performance relevant to food retailers. Results show indicators are used only 1.3 times in average across the indicators recorded of 2011 CSR reports. Some areas are more consistent than others. Transport is the most consistent as indicators are repeated 2.1 times in average. Water is the lowest with an average of 1.6. These results coincide with the conclusion drawn by Roca et al. (2012) after studying CSR Canadian reports in which the food retail sector: “the low repetition rate of indicators is an indication of a lack of standards on reporting”.

Secondly, the analysis done signals that the most reported areas are not necessarily the most significant in terms of GHG emissions. Figure 3 details reported KPI incidence per category on the y-axis, while the x-axis shows the GHG emissions relative weight (based on data from Figure 2 and estimated for water). The size of the bubble reflects the repetition rate of the indicators – the bigger the bubble gets, the higher the repetition rate.

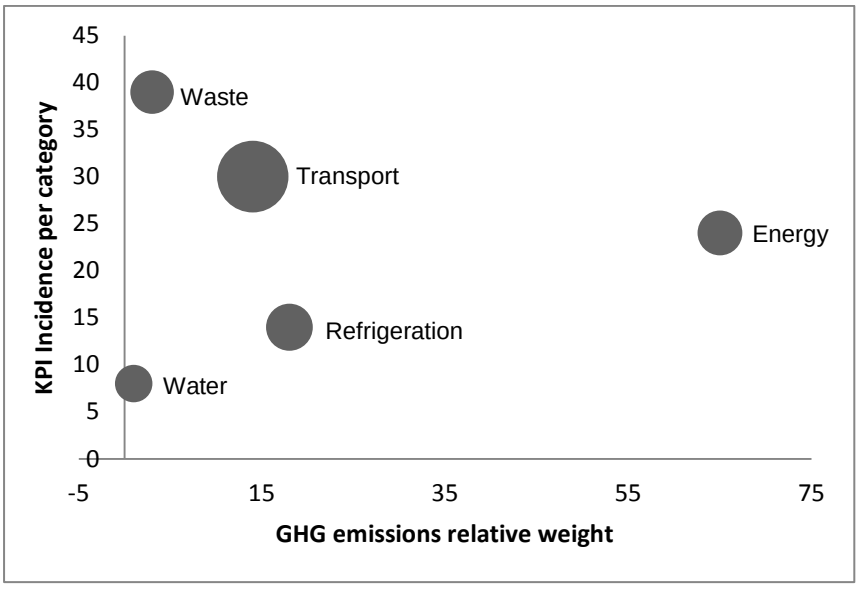


Figure 3: Number of indicators per category – size of the bubble proportional to the repetition rate

Waste and transport are the categories with the highest KPI incidence. However their relative contributions to overall GHG emissions are less significant than refrigeration leakage and energy use. Refrigeration which is the second largest GHG contributor, only scores 6 more indicators than water. Based on the assumption that the amount of indicators reported reflects the actual concern of retailers towards a particular issue, these results suggest that UK food retailers are probably not allocating sufficient resources to pressing needs. On the contrary, the high scores of the waste and transport categories could also be explained by the fact that they are a much more regulated area of the business and consequently

businesses are acting accordingly. Finally, the survey activity has also shown that some environmental indicators being used can be biased. The fact that some companies have set themselves relative targets based on these indicators can be a point of concern as they may misrepresent the progress being done on reducing actual GHG emissions (Gouldson and Sullivan, 2013).

Besides comparing KPI incidence, a historical tracking of 'core' KPIs was done for CSR reports between 2005 and 2012 with the goal of assessing companies' transparency on actual figures. The indicators logged were absolute consumption figures and GHG emissions per category. Table 3 shows the matrix of key climate change KPIs used to compare companies historical transparency. Retailers were awarded one point whenever one of the 'core' indicators was disclosed. An additional bonus point was given if they specified that any type of internal or external data assurance was conducted to verify their figures – therefore 11 points is the possible highest mark in any year.

Table 3: Rating matrix

Category	Energy	Refrigeration	Transport	Waste	Water	Other
Indicator	Absolute consumption (MWh)	Refrigerant leakage (kgs)	Distance travelled (miles)	Waste generated (tonnes)	Absolute consumption (m^3)	Internal or external data assurance
	GHG $kgCO_2e$	GHG $kgCO_2e$	GHG $kgCO_2e$	GHG $kgCO_2e$	GHG $kgCO_2e$	

Figure 4 illustrates how the companies compare historically on data disclosure that accurately determines GHG emissions. Each company has had their particular journey and overall there are mixed results on where the industry is at present. As of 2012, there are some companies at the forefront like Waitrose and the Co-operative, while Tesco and Sainsbury's seem to not give relevance to actual environmental KPI figures. Overall, UK food retailers CSR transparency has improved slightly over the time period considered. Companies reporting in 2005 achieved an average score of 5. Meanwhile, in 2011 they averaged 5.5.

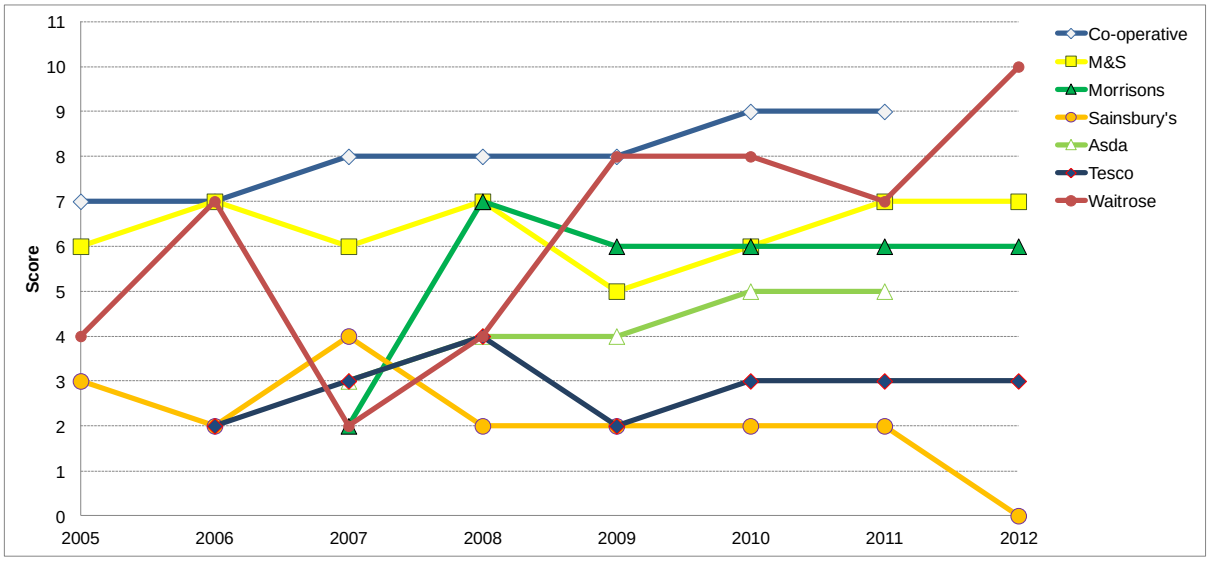


Figure 4: UK Food retailers - Historical comparison of GHG related KPI external reporting performance

A closer look into Figure 4 shows the Co-operative as the most consistent and transparent retailer on environmental KPIs. Then there are some companies which have improved significantly since 2005 (Waitrose, Morrisons, Asda, M&S). Nonetheless, the poorest performers are the largest retailers: Tesco and Sainsbury's. The results presented here does not imply companies do not disclose actual GHG information via other channels, such as the CDP where some of this information could be found; however avoiding disclosing relevant data in CSR reports gives the impression companies are not confident in their figures and therefore do not take their environmental targets seriously.

What is clear is the fact that reporting and measuring is the first step towards environmental progress, but an action plan is then needed to successfully deliver emissions reduction targets. The next part of this paper intends to showcase how to best use the KPIs discussed in order to build a robust low carbon action plan.

4. Low Carbon Roadmap

This section presents a decarbonisation roadmap framework on gas and electricity consumption that can be used to develop environmental action plans by making best use of the KPIs previously discussed. Furthermore, an energy decarbonisation case-study based on a fictional supermarket chain is detailed to illustrate how roadmaps play a key role in steering and determining the effectiveness of environmental initiatives.

4.1. Roadmap Methodology

Hughes and Strachan (2010) explain that most low carbon scenarios fall into two categories: qualitative trend-based studies and technology deterministic studies often operating within a 'backasting' framework. The second approach is particularly suited in the following situation (Dreborg,1996): when the problem to be studied is complex and there is a need for major change, dominant trends are part of the problem, the problem to a great extent is a matter of externalities, the scope is wide enough, and the time horizon is long enough to leave considerable room for deliberate choice.

Therefore, the 'backcasting' framework has been identified as most relevant for the following roadmap case-study. This study does not "intend to reveal or indicate what the future is likely to be but to indicate the relative feasibility and implications of different policy goals" (Robinson,1990) - reduction of GHG emissions. Its main added value consists in enabling to identify the decisions and actions that must be taken at critical points in time if the objective is to be achieved. Indeed, as suggested by Miola (2008), the purpose of this method is less to predict the future but more to "assist decision-making under uncertainty"; by answering questions such as: "when is it the right time to invest?" or "when is it too early to adopt a technology?"

This paper has identified two step-by-step guides to conduct a 'backcasting' study (JRC, 2012 and The Natural Step, 2012). The two guides have been combined here and can be summarised under the following sequence of steps:

1. Setting the timeframe and define problem orientation;
2. Establishing baselines of the current state (i.e. business as usual (BAU) scenario);
3. Developing a vision for the future by setting strategic targets;

4. Performing ‘backcasting’ by working backwards and identifying actions to meet targets;
5. Getting down to action and implementing the action plan.

The following case study aims to illustrate how the above framework can be applied in the context of decarbonising a supermarket chain and how the adequate selection of KPIs can help throughout the process.

4.2. Case study

4.2.1. Context

The case study is a hypothetical UK Supermarket chain that understands the risks climate change poses to its current business model and therefore wishes to cut seriously its GHG emissions. This supermarket company currently has 500 stores; half of them are supermarkets and the other half are convenience stores. The company also desires achieving strong business growth through opening of new sales space (i.e. stores) as detailed in the BAU section. To meet its environmental target a steering committee has been formed to define the pathways to deliver carbon reduction whilst not impacting negatively the growth of the business.

4.2.2. Problem orientation & timeframe

This step is essential to define precisely which problem is to be tackled and to determine its boundaries. In this case, the steering committee is only keen in reducing scope 1 emissions related to gas use and scope 2 emissions related to electricity use; thus any other GHG related emissions from the food retailer are out of scope. Additional areas (such as refrigerant leakage, waste and transport) could have been included but are not in order to simplify the case study.

In terms of timeframe, it is essential to set a baseline year to calculate emissions and relevant indicators. To fulfil this goal the steering committee should ensure the data is robust since it can influence deeply the following steps of the methodology. An end point – relative to targets – needs to be considered. Furthermore, it is essential to establish a time horizon long enough to leave enough room for deliberate choices to be made and which allows sufficient data to assess performance and trends. Based on the above requirements, the company has decided to use 2005 as a baseline year and 2030 as the end year to meet its target.

4.2.3. Business as usual scenario

The next step for the company is to forecast as best as possible their GHG emissions based on a thorough analysis of current business growth trends, energy efficiency trends and external factors which are outside the control of the business. To clarify which factors are important, a decomposition methodology, similar to the Kaya (1989) identity, proves to be useful: Total greenhouse gas emissions (GHG) can be equalled to the product of GHG intensity of energy ($\frac{GHG}{E}$), specific energy consumption of the estate ($\frac{E}{S}$), average sales area of the estate ($\frac{S}{N}$) and number of stores in the estate (N) as shown below (equation 1):

$$GHG = \sum_{i,n} \frac{GHG_n}{E_n} \times \frac{E_{i,n}}{S_{i,n}} \times \frac{S_i}{N_i} \times N_i \quad (1)$$

This equation needs to be applied separately for the different energy supplies the business uses (e.g. electricity and gas, subscript n), and to each of the relevant categories of buildings in the estate (subscript i).: new build stores generally have a different specific energy consumption factor than older stores and similarly stores in different size categories will also have different specific energy consumption factors (see section 3.3.1.).

After conducting a data analysis, the company decided for the specific energy consumption ($\frac{E}{S}$) of their stores to be classified into three groups according to building type; these are: *existing*, *extensions* and *new builds.* After calculating the baseline specific energy consumption, the business projected different improvement rates up to 2030 for each building category that leads to an overall performance illustrated on Figure 5. As the figure shows, the business assumes that each store category is to improve its energy performance over time as it reflects energy efficiency initiatives undertaken as part of BAU procedures. However, as time elapses and the business gets closer to 2030 it was assumed that progress in energy consumption becomes more difficult as most easy energy wins have already been applied.

It is worth noting that store categorisation could also employ other criteria; such as store type, age of the estate, sales floor area size, or geographical location. The selection of the preferred criteria is up for the stakeholders to decide as long as it enables them a better estimation of past variations and future potential improvements. Suitable analytical resources and estate knowledge is essential to offer realistic estimations when conducting these studies. For example, stores electricity demand is indeed highly correlated to external temperatures during the hottest months of the year as refrigeration demand increases. Hence, based on realistic hourly future weather files developed by (Eames et al,2011) and processed with neural network algorithms (Mavromatidis et al.,2013) it was estimated that future weather patterns would contribute to increase stores electricity demand ranging from 0.63% to 3.94% by 2030 with an 80% level of confidence. Lastly, the impact of store closures could also be factored into projections of future performance.

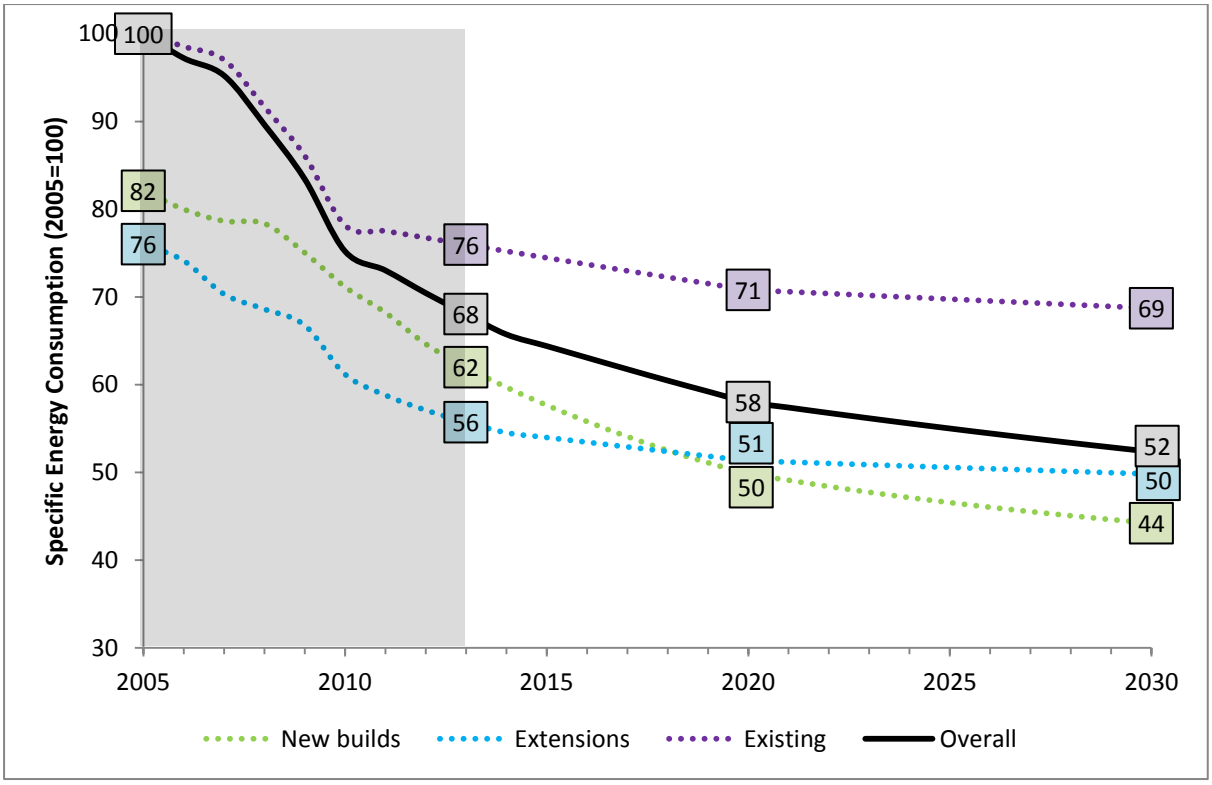


Figure 5: Historical and forecasted energy performance of different categories of stores

The two additional variables discussed in equation 1: average sales area of stores ($\frac{S}{N}$) and number of stores (N) are determined by corporate strategy. Thus, the steering committee requires adequate market research, real estate knowledge and insights on business strategic decisions. For this case study, the supermarket chain projects that the average sales area of stores are to be decreasing slowly as the company plans to invest strongly in convenience stores. The number of stores (including convenience stores) is predicted to increase by an average of 20 per annum.

The last term of equation 1, GHG intensity of grid electricity ($\frac{GHG}{E}$), is an external factor dictated in this example by the UK energy fuel mix (Hawkes, 2010). UK retailers have little control on the evolution of this factor that has nonetheless a very significant effect on overall GHG emissions and targets for all companies. Although the UK government has ambitious decarbonisation targets (80% reduction by 2050 (HM Stratonery Office, 2008)), little certainty exists regarding the forecasted evolution of this factor. To address this uncertainty, five different scenarios were created to capture the variability of the grid carbon intensity up to 2030 – see Figure 6. The most optimistic carbon factor scenario by DECC is the "medium scenario" proposed in the 4th carbon budget (CCC, 2010) and the most pessimistic scenario is a stagnated value from today's levels.

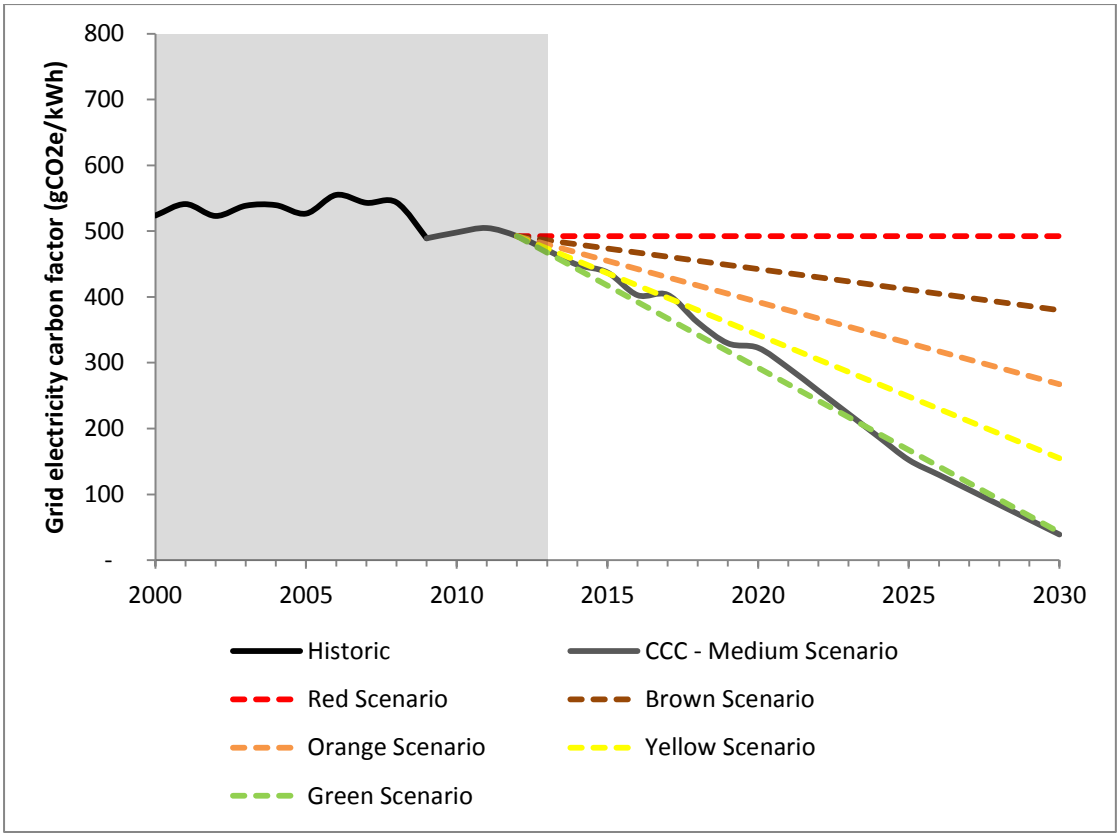


Figure 6: UK grid electricity decarbonisation scenarios

At this stage the company is ready to run a roadmap model to forecast annual performance up to 2030; concerning energy demand, GHG emissions and energy bills as shown in Table 4. In this case study, as energy costs and CRC tax are likely to increase, the total energy bill of the company is projected to raise 120% by 2020 and 220% by 2030 compared against 2005 baseline. Projecting future energy bills is a powerful indicator to highlight the BAU trajectory and the consequences of inaction. Accordingly, this key KPI can be used by the steering committee to drive change and thus attract stakeholder's attention to increasing costs that could threaten the profitability of the business.

Table 4: BAU key results

Business as usual	**2005**	**2013**	**2020**	**2030**
Energy demand (GWh)	950	1000	1150	1300
Energy Bill (£m)	50	70	110	160
GHG emissions (kT CO2e): Red	450	440	520	580
GHG emissions (kT CO2e): Brown			470	460
GHG emissions (kT CO2e): Orange			420	340
GHG emissions (kT CO2e): Yellow			370	230
GHG emissions (kT CO2e): Green			320	110

4.2.4. Future Vision

The steering committee after establishing its carbon baseline is now positioned to define corporate targets going forward on GHG management. These targets could be either

absolute or relative (e.g. per unit of floor area or per unit of sales). Gouldson and Sullivan (2013) state that in the food retail sector: “many of the targets are expressed in relative rather than absolute terms” as companies do not want to see emissions associated with business growth outweigh efficiency and intensity gains. However, to be fully transparent, this study recommends using absolute targets that would reflect companies’ actual impact on the environment and commitment towards sustainability. Hitchcock et al. (2008) argues that setting audacious targets usually produce more significant improvements than setting realistic targets as ambitious goals will more likely generate more radical innovations. Therefore, audacious mandates have the power of making businesses re-think their current practices. In accordance with this principle, the supermarket steering committee sets an absolute GHG emissions reduction of 50% by 2030 from its 2005 benchmark. This long-term target could be complemented with short-term targets that contribute to the final goal, such as gradually improving building and equipment specifications.

4.2.5. Work backward and identify actions

After the target has been defined, it is important to prioritise the deployment of initiatives, technologies and cultural changes to meet the targets; this stage represents the core part of the low carbon roadmap. The list of actions to be implemented by the business usually involves giving top priority to the most financially attractive measures. Thus, it is essential to determine GHG abatement potential and associated costs of different measures. Such analysis generally indicates energy efficiency measures should be considered first followed by on-site renewable energy projects. Now, it is important to differentiate these actions from the ones taking part in the BAU energy efficiency improvements as this could lead to double counting savings. Once energy efficiency actions are identified, it is important to keep in mind the physical limits every technology has to decarbonise the estate (*e.g.* space on roof available to install PVs). The design of the action plan and its impact on GHG emissions is then linked to the grid decarbonisation scenarios conceived at the BAU stage.

Concerning energy efficiency, the roadmap proposes the application of a wide range of sub-system specific measures. For these measures to be effective, it is implied that the supermarket organisation is able to quantify how its energy use is constituted per system in each store.

After work is done consulting with technical experts and keeping in line with retail best practice documents, the supermarket chain lists the energy efficiency strategies to be implemented across the business. Outcome of the research identified significant savings could come from the refrigeration systems where the progressive implementation of night blinds and eventually doors on cabinets in 2020 would enable saving of up to 30% in refrigeration demand. With regards to lighting, the gradual implementation of dimming systems in stores can allow savings of up to 22% of demand. Furthermore, it was considered enhanced setting control of the HVAC system would allow saving of 15% in HVAC demand. Behavioural changes on the Bakery and Hot food areas could enable 10% saving of its electricity demand. Finally, reducing store temperature set points by one degree could save 25% of total heat demand throughout the year. Concerning on-site generation, the following list of technologies were considered: PV panels, bioenergy CHP engines, solar thermal panels in small stores, biomass boilers in medium sized stores and ground source heat pumps in the largest stores. Their gradual deployment across the estate would enable

the supermarket chain to generate 8.7% of its energy requirement on-site by 2020 and 17% by 2030.

For this case study a carbon factor for the orange scenario was assumed by the steering committee to assess the decarbonisation potential of the action plan. Figure 7 details the carbon benefits over time that are possible to achieve by the supermarket chain as energy saving strategies and on-site low carbon technology implementation programmes kick-in.

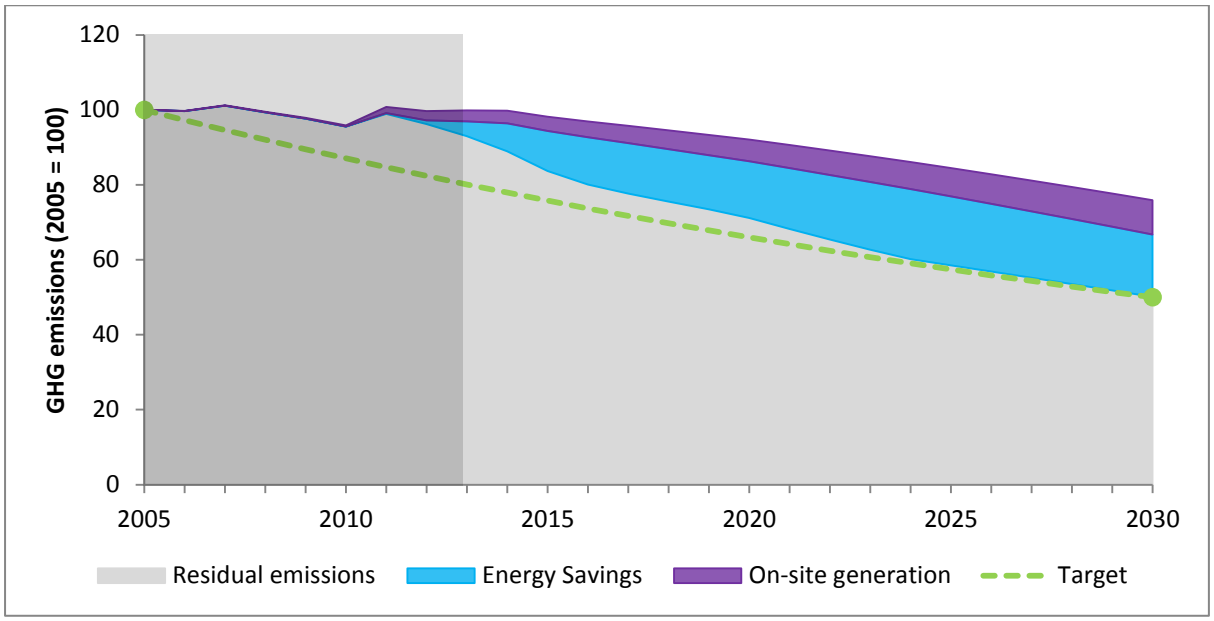


Figure 7: GHG emissions savings in the Orange decarbonisation scenario

The roadmap simulation should be able to forecast projected energy demand, net GHG emissions, expected return on investment of the different initiatives and the resulting energy bill; these results if favourable to the business should drive the case for actions to take place.

Table 5: Low Carbon Roadmap key results

Annualised figures	2005	2013	2020	2030
BAU energy demand (GWh)	950	1000	1150	1300
New energy demand (GWh)	950	1000	850	800
BAU energy bill (£m)	50	70	110	160
New energy bill (£m)	50	68	90	110
Energy bill savings (£m)	-	2	20	50
Energy savings investments (£m)	-	2	5	2
On-site generation (% of demand)	0.1	2	8.7	17
On-site generation investments (£m)	1	12	12	25
GHG emissions gap (% of total emissions)	-	14%	2%	0%

Table 5 shows that the combination of energy efficiency measures and on-site low carbon technologies would enable to greatly reduce projected energy demand. Consequently, the energy bill would be reduced as much as £500m on the 2013 – 2030 period. It appears that energy savings measures would deliver very large benefits for relative minor investments.

On-site generation comes at a higher cost but will help nonetheless meet the target by producing as much as 17% of total demand by 2030. As a result, the gap with the target would close rapidly, getting on track by 2023 and successfully meeting the 2030 target.

4.2.6. Action plan implementation

Many challenges arise to conduct these activities in the food retail sector. Firstly, major food retailers manage a very large estate which is geographically dispersed; therefore, doing works in each store is challenging and likewise engaging with employees requires large resources. UK food retailers as of 2005 had a work force of 1.2 million (about 5% of the UK labour force), with a high turnover intrinsic characteristic (DEFRA, 2006b). Tesco has reported the difficulty in communicating and rolling-out energy messages its labour force (McMullen,2013) Secondly, in the retail environment space is a constrained resource that limits the alternatives available. For example, sustainability managers wanting to display sustainability messages have to compete with other areas of the business that look to place advertisements. Thirdly, like any large organisation, food retailers face additional sociological barriers: the fact that employees do not necessarily feel responsible to do their best in reducing energy use and the lack of desire to change ingrained behaviours (Davis, 2012). Being able to monitor closely the action plan results is also key. It is absolutely essential to keep a good monitoring of the indicators used in the roadmap to be able to take adequate action.

Down the ladder on the ground, where the success of initiatives is to be dictated it appears that video messages and vouchers are effective means of communication to drive behavioural change. This kind of communication tends to be much more effective as messages will be delivered with the same enthusiasm and meaning. In addition, it's already well embedded in the business culture to use league table to improve performance by driving competition for different indicators such as customer satisfaction. This study recommends including some sustainability aspects in these type of league tables to increase engagement.

It is largely agreed that commitment and leadership must come from the top of the company. The business should also seek to get key personnel (e.g. managers, directors, etc.) that understand the business and who get actively involved in order to enable change to happen (Yeates, 2013) and (Hitchcok et al. 2008). However, senior managers are sometimes not aware of sustainability issues but should be encouraged to do so (Stringer, 2013). Therefore, an appropriate structure should be implemented by the business to guarantee action plans are executed effectively by assigning a sustainability director, steering committees, and dedicated task forces (Hitchcok et al. 2008). Just like retailers incentivise sales performance, product availability and good customer service; this work suggests incentivising sustainability performance and thus not treating the initiatives differently from what is normal day to day activities.

4.3. Results and discussions

The case study concludes emphasising the following ideas. Firstly, energy saving measures have a greater potential compared to on-site generation both in terms of total carbon abatement potential and in terms of cost.

Secondly, major energy initiatives need to be easy to replicate and tight project management is key to deliver results over a long period of time. CSR reports show some retailers only apply the most innovative technologies to one or a few 'environmental' stores. Public image and reputation make these retailers go for highly visible 'lighthouse' projects. The environmental relevance of this kind of unique stores is negligible if compared to the overall performance of the company. Nevertheless, these projects can contribute in obtaining knowledge and deriving new measures to be systematised. Therefore, “a learning process from the lighthouse store results is required” (JRC, 2011b); thus allowing transferring the knowledge across the business.

Thirdly, achieving ambitious carbon targets is possible even in the most pessimistic grid decarbonisation scenarios and even without external offset such as green power purchase agreements. Large retailers just need to carefully plan and execute cost-effective energy savings opportunities and adequately invest in low carbon technology across their estate. But most importantly of all, these changes are possible without detrimental change of the business model of supermarket companies.

5. Conclusions

Managing the carbon footprint of companies and addressing their respective decarbonisation plans is a challenging endeavour that requires corporate leadership, stakeholder engagement and adequate reporting. The aim of this study focused on reviewing the issues around corporate decarbonisation and environmental performance by suggesting a management process that could realistically be implemented. Two crucial steps of this process consisting of a) championing sustainability reports and b) developing low-carbon roadmaps that meet strategic environmental goals were further discussed in this paper. The UK food retail sector was used as an example to showcase the relevance of this approach in enhancing corporate environmental performance.

Based on a thorough study of environmental KPIs in corporate social responsibility reports of UK food retailers, this paper concludes that there are still hard miles to go in improving the standardisation and consistency of indicators. It was also found that most companies do not necessarily disclose information in line with their environmental impact and in some cases lack transparency; nevertheless there are some retailers showing various degrees of progress since they started reporting. If implemented and re-in forced, standardisation and transparency would enable stakeholders to better assess performance of retailers in the different environmental areas and would enable companies to better focus on the most salient issues; such as GHG emissions associated with refrigeration leakage where almost no one in the industry is currently disclosing.

This paper also detailed the use of environmental KPIs to drive the design of a low carbon roadmap of a fictional supermarket chain by using the ‘backcasting’ methodology. The roadmap exercise focused on reducing operational carbon emissions and described that substantial improvement margins exist to reduce environmental impact if required resources and attention are allocated toward the issue. Results from the case study illustrate energy saving measures posses great potential compared to on-site generation both in terms of total carbon abatement potential and in terms of cost.

Managing and reducing corporate GHG emissions is not a meaningless task and if organisations are serious about this issue they should try to avoid being reactive in their approach (reactive to systems breakdown and to regulation) and instead embrace best sustainability practices and longer term strategic environmental goals. These environmental initiatives need to be effectively applied, closely monitored and eventually reported to evaluate periodical performance. These environmental reports could be either for internal or external audiences and it is paramount these reports are audited so organisations can sustain their credibility. All in all corporations should feel proud to disclose their environmental journey to stakeholders and customers as these will appropriately reflect the commitment and challenges carbon mitigation entails in a resource constrained world. And it is large organisations, such as retailers, who by embarking on environmental initiatives have the potential to be a powerful agent of change not only for consumers but also for all the supply-chain agents, competitors and public authorities they interact with.

Acknowledgments

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