

Dynamic development of carbon reduction strategy and performance measurement systems

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Abstract

This study broadly considers the relationship between performance measurement systems (PMS) and environmental strategy. In particular, it examines developments in the carbon reduction strategy and PMS subsequent to the case organisation's enrolment into CEMARS – an external carbon reporting scheme. Using data collected via interviews, public seminars and document analysis, this study shows that developments in carbon reduction strategy and the carbon related performance measures are mutually constitutive and impact one another. The case findings show how increasing sophistication of the PMS facilitated refinements to carbon reduction strategy, which necessitated further changes in the PMS. Additionally, the CEMARS measures were integrated into decision making processes alongside existing PMS measures, thus enhancing the sophistication of the PMS and revealing integration as an additional factor impacting PMS use. The research contributes to the strategy-PMS literature by elaborating on the dynamic nature of this relationship over time. Moreover, the findings suggest practitioners seeking to develop and implement carbon reduction strategies will need to supplement the systems for external emissions reporting with systems for carbon emissions management.

Key words: performance measurement system (PMS), CEMARS, carbon reporting, wine industry, carbon reduction strategy, sustainability

1. Introduction

With the increasing number of organisations making voluntary or mandated disclosures of their environmental performance (International, 2015, Economist Intelligence Unit, 2010), the academic community has turned its attention to examining different facets of sustainability reporting (Hahn and Kühnen, 2013, Burritt et al., 2002). Carbon accounting has emerged as a subset of this research stream following global initiatives to reduce greenhouse gases and increase awareness of climate change impacts (Schaltegger and Csutora, 2012, McKinsey, 2007, Verdantix, 2010). This is an area of interest to both practitioners and academics. However, a large portion of the existing research has adopted a stakeholder and/or regulatory focus while internal issues of carbon accounting have so far rarely been investigated in depth (Gibassier and Schaltegger, 2015). Similarly, Lodhia and Jacobs (2013) argue research needs to move beyond legitimacy considerations and focus on the internal context and practices organisations use to produce environmental reports and improve their environmental performance.

Recent studies have begun to address the relationship between externally focused environmental reporting, and organisations' environmental strategies and internal processes (Kumarasiri, 2015, Biswas and O'Grady, 2016, Hartmann et al., 2013, Bouten and Hoozee, 2013). Environmental strategy refers to the organisation-wide recognition of the legitimacy and importance of considering and integrating environmental issues into organisational strategy (Banjaree, 2002). As organisations formalise their environmental strategies, performance measures are needed to effectively execute them (Perego and Hartmann, 2009). Our research considers the relationship between the performance measurement system (PMS) and environmental strategy focusing specifically on carbon reduction strategy, and how it influences the management of environmental performance.

The extent to which companies develop environmental strategies and incorporate environment related performance measures into decision making and control processes varies. Perego and Hartmann (2009) consider factors influencing the use of environmental performance measures for implementing environmental strategy. They model the impact of strategy on the use of environmental performance measures for decision control purposes, arguing that both the sophistication of the PMS design and the attributes of the measures influence use of the indicators. Sophistication of the PMS relates to the quantification, scope and timing of the information provided. In their model, environmental strategy determines the design of the environmental performance measurement system (PMS). This paper complements the work of Perego and Hartmann (2009) by elaborating on the relationship between an organisation's PMS design and its environmental strategy, and in particular, its carbon reduction strategy. Drawing on the MCS literature, which recognises a two-way relationship between strategy and management control systems (Kober et al., 2007, Kloot, 1997), this research proposes that environmental strategy and performance measures interact and influence each other's development.

A case study approach is used to address two specific research questions:

1. How does the case organisation's PMS influence the initial and on-going development of its carbon reduction strategy?
2. How does the case organisation's carbon reduction strategy influence the development of its PMS?

The remainder of the paper is structured as follows. The relevant literature is reviewed in the next section and key theoretical concepts are explained. Section 3 explains the methodology. Section 4 outlines the background of WineCo, the case organisation, and CEMARS¹, the carbon reduction scheme in which the organisation enrolled. The subsequent two sections describe the influence of the PMS on carbon reduction strategy and the influence of carbon reduction strategy on the PMS, respectively. The final sections discuss the findings then the conclusions.

2. Relevant literature

There is an extensive literature on the general topic of sustainability. Within the accounting domain sustainability research addresses, for example, sustainability/environmental accounting and reporting, climate change accounting, corporate social responsibility reporting, carbon accounting as well as sustainability education for accountants. This body of literature has identified different understandings of sustainability accounting (Schaltegger and Burritt, 2009), developed a sustainability accounting framework to guide comprehensive reporting (Lamberton, 2005) as well as investigated the critical success factors for social responsibility reporting (Fuzi et al., 2015). Some authors have argued that accounting education needs to explicitly address the sustainable business model (Sharma and Kelly, 2015) along with theories such as Buddhist economics (Sharma, 2013b) as it is believed the integration of Buddhist economics and neo-classical economic views could increase attention to the moral and ethical aspects of business decisions (Sharma, 2013a). Relating to this, authors have considered the rhetorical role of carbon offsets in helping individuals navigate conflicting moral and ethical demands (Killian, 2013). Additional research in this area have questioned whether environmental reporting is beneficial or does more harm than good (Aras and Crowther, 2009, Gray, 2010, Gray and Bebbington, 2000), suggested the need for sustainability accounting and reporting to be linked to management decision making (Burritt and Schaltegger, 2010) and queried how environmental accounting information assists managers with their decisions (Gabel and Sinclair-Desgagne', 1993, Ferreira et al., 2010, Burritt et al., 2002).

¹ CEMARS is the acronym for Certified Emissions Measurement and Reduction Scheme. It is owned and operated by Enviro-Mark Solutions Limited, a wholly owned subsidiary of Landcare Research, which is 100% owned by the NZ government.

To organise the accounting-based sustainability literature, categories such as external environmental reporting (EER), internal sustainability management practices (Tilt, 2006), carbon regulation, carbon disclosure and carbon management (Hartmann et al., 2013) have been developed. The vast majority of this literature addresses the external reporting aspect of sustainability and environmental information; however, knowledge about the operation of internal processes to support carbon management is limited. Perego and Hartmann (2009), for example, state that current knowledge about the role of the performance management and control system in supporting the adoption and success of environmental strategies is minimal. Furthermore, few accounting studies explicitly focus on carbon accounting or carbon management (Hartmann et al., 2013) despite the recent special issues on these topics².

Carbon management is a multi-faceted concept. Research in this area is varied and has considered topics such as the carbon footprint, carbon reporting, carbon (management) accounting as well as carbon reduction strategies and their implementation. The carbon footprint, frequently equated with carbon accounting, is acknowledged as a key environmental issue (Rugani et al., 2013), viewed as an environmental performance indicator for business activities (Laurent et al., 2012) and used as a measure of sustainability (de Haes, 2006, Weidema et al., 2008).

Extant carbon accounting research is focused mainly on carbon regulation and external reporting (Hartmann et al., 2013) which addresses the provision of information about an organisation's greenhouse gas emissions to the public. However, areas such as carbon (management) accounting (CMA) remain under researched and not yet well defined. Of the few studies seeking to clarify the meaning of carbon management, one concluded the term is contested both within and across disciplines (Ascui and Lovell, 2011) while another defined it as "the recognition, the non-monetary and monetary evaluation and the monitoring of greenhouse gas emissions on all levels of the value chain and the recognition, evaluation and monitoring of the effects of these emissions on the carbon cycle of ecosystems" (Stechemesser and Guenther, 2012, p. 35).

The internal management of carbon emissions is an overlooked research issue (Hartmann et al., 2013). According to Hartmann et al. (2013), there is a dearth of knowledge about internal carbon measurement and management practices. The few studies in this area have investigated the internal processes and performance measurement systems companies use to facilitate carbon management activities (Burrill et al., 2011, Biswas and O'Grady, 2016, Kumarasiri, 2015, Zvezdov and Schaltegger, 2015, Ratnatunga

² e.g. *Critical Perspectives in Accounting*, 2008, 19(4); the *European Accounting Review*, 2008, 17 (4); *Accounting, Organisations and Society*, 2009, 34 (3–4) and the *Accounting, Auditing & Accountability Journal*, 2011, 24(8).

and Balachandran, 2009), or how organisations align their carbon reduction strategies and performance measurement systems (Hartmann et al., 2013). An overview of these studies is presented next.

Kumarasiri (2015) investigated the management accounting practices used to manage carbon for 69 Australian companies that participated in the Carbon Disclosure Project (CDP) 2009 survey. The responders were asked whether the participating companies (1) had emission reduction plans, (2) developed forecasts of emissions, energy use and related costs, (3) had key performance indicators for emissions (4) measured emissions, and (5) used incentives to motivate climate change actions. The authors found that most of the companies did not use these management accounting practices to deal with decisions related to GHG emissions.

Burritt et al. (2011) considered how carbon management accounting (CMA) systems emerged within organisations. They defined CMA systems as the tools, structures and procedures designed to provide managers with information to make decisions about carbon emissions. The research investigated how companies collect, manage and communicate carbon related information. CMA activities were expected to vary in terms of type (financial or non-financial), scope (short or long term), range (past, present or future) and periodicity (routine or ad hoc) of the information gathered. The researchers also expected the volume of information needed to vary according to the number and type of departments and professionals seeking carbon accounting information. Interviews were conducted with 33 managers in ten listed German companies known to be leaders in sustainability. The study found that considerable climate change-related information beyond cost data is collected throughout the organisation to support different decision making purposes.

Zvezdov and Schaltegger (2015) conducted a literature review to identify the types of decision making situations supported by carbon information. They organised the carbon management articles published in the accounting literature around the CMA framework proposed by Burritt et al. (2011). They found that CMA information is typically historic data produced on an ad hoc basis and used “either for producing an account of the carbon performance of a company (e.g. calculating product carbon footprint; typically in physical units) or, less frequently, for identifying important strategic and operational business issues (typically in monetary units)” (Zvezdov and Schaltegger, 2015, p. 38). The authors noted that there is rarely a connection between the external and internal uses of carbon information.

Biswas and O'Grady (2016) provide a case study illustrating how internal carbon management practices are used to embed external carbon reporting information within an organisation. The research considered how external carbon reporting impacted internal production, capital expenditure and budget

processes. The study found that embedding external reporting information in internal processes encourages an eco-validation, rather than an eco-efficiency decision making perspective.

Perego and Hartmann (2009) consider the relationship between environmental strategy, PMS design and the use of environmental performance indicators. They observe that as new environmental objectives emerge new environmental performance measures are needed to maintain alignment between strategy and the PMS. The researchers expect the design of the PMS, in terms of its sophistication, to indirectly impact the extent to which performance measures are used. They consider three attributes of PMS sophistication in their study, namely quantification, scope and timeliness.

Quantification considers the form of the measures and can be categorised as either financial or non-financial comprising physical or operational measures of environmental performance. Scope, refers to the breadth of the PMS information and can be narrow or broad. Narrow scope information reflects the organisation's internal environment, has a financial focus and a historic orientation. Broad scope information reflects the internal and external environments, focuses on financial and non-financial dimensions, and reflects the impact of historic and future events. Environmental PMS that are broad in scope provide information about environmental performance of the past, anticipated future events, and actions both within and beyond the boundaries of the organisation. Finally, timeliness refers to the frequency and speed of internal environmental reports. Sophisticated PMS will quantify the environmental impacts of activities and processes in financial and non-financial terms, provide broad scope information on a timely basis and support the management of environmental impacts across the supply chain.

In summary, the extant literature on carbon management practices acknowledges a link between carbon reduction strategies and PMS design (Perego and Hartmann, 2009), specifies the attributes of information used to manage carbon emissions (Perego and Hartmann, 2009, Burritt et al., 2011, Kumarasiri, 2015), and identifies the types of decisions supported by carbon emission measurements (Zvezdov and Schaltegger, 2015, Biswas and O'Grady, 2016). The literature has not specifically addressed how carbon emission strategy and PMS interact. Hence, this study draws on the carbon management accounting literature, and the concept of an interactive relationship between strategy and control systems (Kloot, 1997, Kober et al., 2007), to investigate interactions between carbon reduction strategy and the PMS and to identify their influence on one another. The research method is explained next.

3. Method

This research examines the developments in one company's environmental strategy and PMS following enrolment in CEMARS, a carbon emission reporting scheme. CEMARS is a New Zealand greenhouse

gas (GHG) certification programme that provides online tools for measuring GHG emissions, i.e. the carbon footprint, at the organisational, product, service or event level.

A case study method was chosen as the appropriate approach to explore the relationship between environmental strategy and performance measurements in its contextual setting (Ryan et al., 2002, Scapens, 1990, Yin, 2009). The case organisation was selected because it was listed as a member on the CEMARS website and operated in the wine industry, known to be concerned about carbon emissions and the efficacy of tools available for measuring them (Sinha and Akoorie, 2010, Alonso, 2010). Furthermore, the company's recent enrolment in CEMARS provided an opportunity to investigate the unfolding of its environmental strategy and performance measures.

Data was collected through semi-structured interviews with key informants at WineCo. Interviewees were selected according to their roles within the organisation and all were knowledgeable about the CEMARS program. The positions held by interviewees at different organisational levels included the:

- Executive Director who drove the company's overall sustainability efforts. While his primary responsibility was business infrastructure, he also acted as a Project Manager for two of the company's wineries.
- Cellar Manager who led the winemaking team and was heavily involved with the effective operation of the wine making plant and equipment.
- Operations Coordinator who acted as the administrative assistant to the Executive Director. His key roles included the compilation of CEMARS reporting data and the coordination of the independent audit required to maintain CEMARS certification.

Interview questions addressed the developments in the carbon reduction strategy and performance measures prompted by CEMARS enrolment. The questions were used as a general guide to address key themes while allowing interviewees to elaborate on associated issues. Interviews lasted between one and one and a half hours and were recorded and transcribed. A copy of the transcript was returned to interviewees for verification. Additional data was collected from the company's website, during a seminar hosted by WineCo for a sustainability special interest group, through informal discussions about CEMARS and its impact on performance measures and operational processes with other WineCo personnel, participation in guided tours of WineCo's production facility, reading on-site fact boards, and observing a demonstration of the SoFi and Schneider information systems (discussed later in the paper) and their reports. The secondary sources enabled data triangulation.

Data analysis involved repeatedly reviewing the collected data, and coding, grouping and classifying it to reveal key themes about developments in WineCo's carbon reduction strategy and PMS. The following section describes the company's background and introduction to CEMARS.

4. Company Background

WineCo is a fifty-year old family owned company with a long history of sustainable operations. The company currently has 250 permanent staff working in its vineyards and wineries throughout New Zealand. The company exports over 70% of its wine to more than fifty countries located in Europe, North America, Australasia, the Caribbean and Pacific Islands. It is one of New Zealand's most awarded wine companies. Recent awards include the Sustainability Champion, Sustainable Business Network Awards, the Supreme Green Ribbon Award Winner as well as Sustainable Business Network Awards.

WineCo has been committed to environmental sustainability since the 1990s and was a founding member of Sustainable Winegrowing New Zealand (SWNZ) in 1995. Sustainability is seen as essential to the company's long-term survival. According to WineCo's Managing Director (MD), "as a family company, the desire to leave something for the next generation is an ever-present and overriding business objective." The MD seeks to embed sustainability throughout its operations and he described it as "finding ways to minimise the impacts of our business on our environment... a continuous journey of improvement". The company's sustainability efforts include establishing a network of worm farms to support vineyards and wineries; feeding scraps from the winery restaurant kitchen, staff lunchrooms and organic wastes to the worms to create nutrient rich material for fertilising the vineyards; planting wildflowers between the rows of organic vineyards to add diversity, improve the soil structure and attract beneficial insects that ward off pests and reduce the need for synthetic pesticides; and grazing flocks of sheep in the vineyards after grapes are harvested to provide natural fertiliser and assist with leaf plucking in the summer. The company's commitment to sustainable business practices is formalised as a business objective to operate in an environmentally responsible manner.

WineCo is involved in several formal sustainability programmes to promote best practice sharing and provide industry leadership. It has achieved accreditation for its vineyard and winery sites from Sustainable Winegrowing New Zealand (SWNZ) and new sites are in the process of gaining it. The company has BioGro organic certification for its winery and bottling facilities meaning it can trace and verify the source of its organic wines from grape to bottle. CEMARS is the most recent of the company's sustainability initiatives.

WineCo enrolled in CEMARS in 2008 and received its first certification in 2010. The aim of the programme is to help organisations reduce their carbon emission. The CEMARS certification process requires organisations to measure their GHGs and develop an active management plan for reducing

emissions. An independent third party must verify the CEMARS measures before organisations are awarded their certification.

CEMARS produces information about the three categories of emissions specified by the GHG Protocol. Scope 1 is direct emissions generated from sources owned or controlled by the organisation (e.g. vehicles). Scope 2 is indirect emissions arising from goods or services purchased by the organisation (e.g. electricity consumption) while Scope 3 is indirect emissions generated from sources not directly owned by the organisation but relevant to the operation of its business (e.g. air travel, car rentals, domestic road and rail freight). CEMARS organisations put significant resources into measuring, managing and continuously reducing their carbon emissions.

To measure its carbon footprint, WineCo recorded data on local operational activities associated with GHG emissions. The calculation does not include emissions associated with international shipping to import ingredients or export wine. WineCo captured data for electricity, gas, fuel, air travel, and local freight via rail, air and sea as well as the volume of wine produced. Recorded figures were then multiplied by a carbon emissions factor drawn from the annually updated emissions factors database³ to calculate WineCo's annual total carbon emissions in tonnes of carbon dioxide equivalents (tCO₂e). The following section considers developments in WineCo's carbon management strategy and the PMS prompted by enrolment in CEMARS.

5. Influence of PMS on carbon reduction strategy

WineCo's MD had a broad vision to operate sustainably. He encouraged sustainability because he believes it is the right thing to do. However, the company lacked a strategy to guide sustainability choices and to prioritise proposals. Consequently, projects were initiated on an ad hoc basis driven by individual interests. Burritt et al. (2011, p. 83) comment on uncoordinated approaches to sustainability noting that "the isolated approach to managing ... various issues ... results in inefficiencies that increase the amount of resources spent on carbon management and thus negatively affects the economic performance of the company". WineCo also lacked a structured approach to measuring the impact of the sustainability initiatives. When the Executive Director learned about CEMARS, he viewed it as an opportunity to both structure the company's sustainability activities and assess their impact. His initial views on CEMARS are as follows:

"I found out about CEMARS ... I was introduced to the people at CEMARS and subsequently made a presentation to the senior leadership team proposing we should be involved with this. That was around 2008. We got involved because we quite liked the

³ The emissions factors used by E-Manage are drawn from those maintained by carbonZero Holdings Ltd and comply with the emission calculation standards of carbonZero and international greenhouse gas quantification standards.

idea of having an independent annual audit. It introduces rigour and discipline into what we are doing. So, that is where our involvement started.”

WineCo perceived multiple benefits from CEMARS. First, the process of collecting data on carbon emitting activities and measuring their impact was viewed as worthwhile, over and above the CEMARS certification itself. The process was expected to provide the discipline for measuring and managing sustainability as noted in the following quote:

“Certification is important from the point of view that it is the end result of a disciplined process.”

The Directors also felt there would be financial benefits from reducing carbon emissions. According to one Director:

“Carbon emission is basically about using resources. If you can reduce your use of resources, there will be benefits to your business and benefits to the environment. To us it was common sense”.

Finally, CEMARS was expected to provide information that could help prioritise the sustainability proposals generated throughout the company so that the company’s limited resources could be applied to the most beneficial initiatives.

In 2008, the company began recording CEMARS data and the first carbon footprint measure was calculated for the 2009 financial year end. The summary report (see Appendix 1) presents WineCo’s CO² emissions by source category in graphical form and reveals the three highest sources of carbon emissions, namely bottling, road freight and electricity use.

The results surprised WineCo. The company had previously identified electricity as a key source of carbon emissions and had negotiated with the electricity company for bulk rates for day and night electricity consumption. While this tactic helped WineCo mitigate electricity costs, it did not specifically motivate efforts to reduce consumption. The bottling and road freight emissions figures were totally unexpected. WineCo had not previously recognised their environmental impacts or attempted to manage them. While the CEMARS results could potentially damage WineCo’s image as a leader in sustainability, the company chose to continue with the programme. Based on the CEMARS measures a four-point carbon reduction strategy was proposed. The specific areas identified for reduction efforts after the first CEMARS rounds (2009-2010) were the use of glass wine containers, the mode of transportation for freighting wine, the use of refrigerants in wineries and the criteria for new vehicle purchases.

The CEMARS information thus influenced the development of a coherent carbon reduction strategy. According to the Executive Director, the action plans derived from the annual CEMARS measures clarified where their sustainability efforts should be focused:

“CEMARS helped us put together new projects. We are able to put all the information together and be more structured in how we approach it. So, rather than just going on the basis of it [*a sustainability initiative*] being a good idea, we assess how it contributes to our plan and whether we are better off focusing our efforts in other areas. It has helped us prioritise.”

WineCo introduced a number of mechanisms to facilitate development of its carbon reduction action plans. The company’s existing sustainability committee, comprising representatives from departments and geographical areas along with the Executive Director, was responsible for reviewing and discussing CEMARS emission measures, formalising reduction plan and setting reduction targets. The ‘opportunity for improvement’ (OFI) system enabled everyone in the company to submit improvement ideas including carbon reduction initiatives. The committee considered sustainability suggestions throughout the year and approved those expected to benefit the company. While the carbon impact of selected initiatives would not be known until year end, the projects were nonetheless considered vital to ongoing operations. The Operations Coordinator summarised the committee’s view as follows:

“The key concern is that we are moving in the right direction and are actually making improvements as we go”

The progression of WineCo’s carbon management strategy can be traced via its CEMARS reports over the period 2009-2014. The reports provided carbon emissions measures first from 10 source categories (2009-2012) then expanded to 20 source categories (see Appendix 1 for 2013 report categories). The carbon management strategy for the first two years included four action points as noted above. While these areas were marked for improvement, no specific targets were set at this time. In the third year (2011), the carbon management plan expanded to include electricity and set reduction targets for all action points including reductions in electricity use per metric tonne of harvest handled by wineries (2% per year on-going). In 2012, reduction targets were set for two additional sources of carbon emissions namely domestic air travel (5%) and fuel usage by company cars (1%). From 2013, CEMARS began reporting 20 measures which reflected previous and new carbon emission categories; some items reflected finer delineation of previous categories. Reduction targets were set for electricity usage per bottle of wine produced (5%) and the volume of waste sent to landfill (10%). WineCo also sought to eliminate refrigerant leaks.

The CEMARS information provided the initial measures of carbon performance and arguably established the foundation for the PMS. The level of sophistication of this PMS was arguably low. The

aggregated measures of CO² quantities were produced only at year-end and reflected the impact of past decisions. However, the measures did include the impact of activities beyond the boundaries of the firm such as emissions associated with air travel. At this early stage, the environmental measures were not used to evaluate managers. The low level of sophistication notwithstanding, Operational Managers used the PMS measures, and later the carbon reduction targets, to guide and refine their carbon emission strategy. This illustrates that PMS can be used to actively shape, not just implement, environmental strategy. The carbon reduction strategy and targets motivated developments in the PMS used to implement the strategy. These developments are discussed next.

6. Influence of carbon reduction strategy on PMS

CEMARS provided aggregated measures of carbon emissions by key activity areas. These figures lacked the detail management needed to make specific decisions about operational activities and motivated further development of the PMS. These changes are described in the following sub-sections.

6.1 Measuring energy usage

In 2011, the reduction target for electricity use was set at 2% a year. To support this objective, operating budgets for electricity were reduced at a corresponding rate. The CEMARS measure for overall electricity use did not inform management about the specific operational activities giving rise to the emissions. Managers therefore could not act on the information to modify activities. For example, Operational Managers were aware that the two most energy intensive processes in wine making were cooling the fermented wine to clarify it and reheating the cooled wine to ambient temperatures before bottling it. Yet, they were unable to act on the CEMARS electricity measure because it did not indicate the extent and timing of energy usage for these processes. The company invested in a new electricity monitoring system to provide this information.

WineCo invested in Schneider a web-based electricity management service. The system recorded real time data on energy usage using meters fitted at specified measuring points throughout the company. Eight measuring points were established in the wine making operations, bottling hall, warehouse, head office and winery. Schneider tracked electricity consumption by key activities in each of these areas, uploaded the data to a cloud server every fifteen minutes and provided graphs of daily and monthly electricity usage and availability. The increased number of reporting categories for which electricity usage was measured and the frequent reporting enhanced the sophistication of the PMS. Managers used the Schneider measures to make operational decisions to reduce electricity consumption throughout the company. The PMS information was further enhanced when a second new system called SoFi was introduced.

SoFi is an internet-based sustainability reporting software tool used to streamline the routine recording of sustainability data and to provide frequent sustainability reports. The decision to operate SoFi alongside CEMARS was explained by Executive Director as follows:

“Previously [*with CEMARS*] we were getting results once a year, which was too late for anything to be done. We needed to be able to compare each month to the same month last year. That way, if we were off track we could deal with it... [waiting for] the audit at the end of the year, it is often too late to take action.

According to the Operations Coordinator, SoFi provided managers with more frequent, and therefore more timely reports to inform their operational decisions. Moreover, the reports it produced were more detailed. The system retained extensive histories of monthly measures and managers could draw on this data to generate reports comparing their current and past performance. Moreover, it allowed the integration of forecast measures of CEMARS emissions alongside other performance measures, which enhanced the sophistication of the PMS. The generated reports quickly revealed which activities were on track and which needed attention. These changes improved the timeliness and quantification of information produced by the PMS.

The combination of measures provided by Schneider and SoFi enabled WineCo’s management to justify the acquisition of a sophisticated new heat reclaim system and to optimise its use. The physical measures of electricity consumption supported calculations of carbon emissions from wine production activities. The capital expenditure decision about the heat reclaim system considered these measures alongside the financial cost. Based on the expected reductions in future carbon emissions, the purchase was approved despite the relatively long payback period.

Figure 1 shows how the heat reclaim system operates. The new system allowed reclaimed heat to be used during the 24-hour period following recovery. It involves a large tank of glycol which is a cooling medium and effectively operates as a battery. During the wine cooling process, the heat from the fermented wine is captured by the heat reclaim system and is then available for the subsequent reheating of the wine to ambient temperature. Schneider recorded the amount of heat captured by the reclaim system to supplement the existing electricity information thus increasing the sophistication of the PMS.

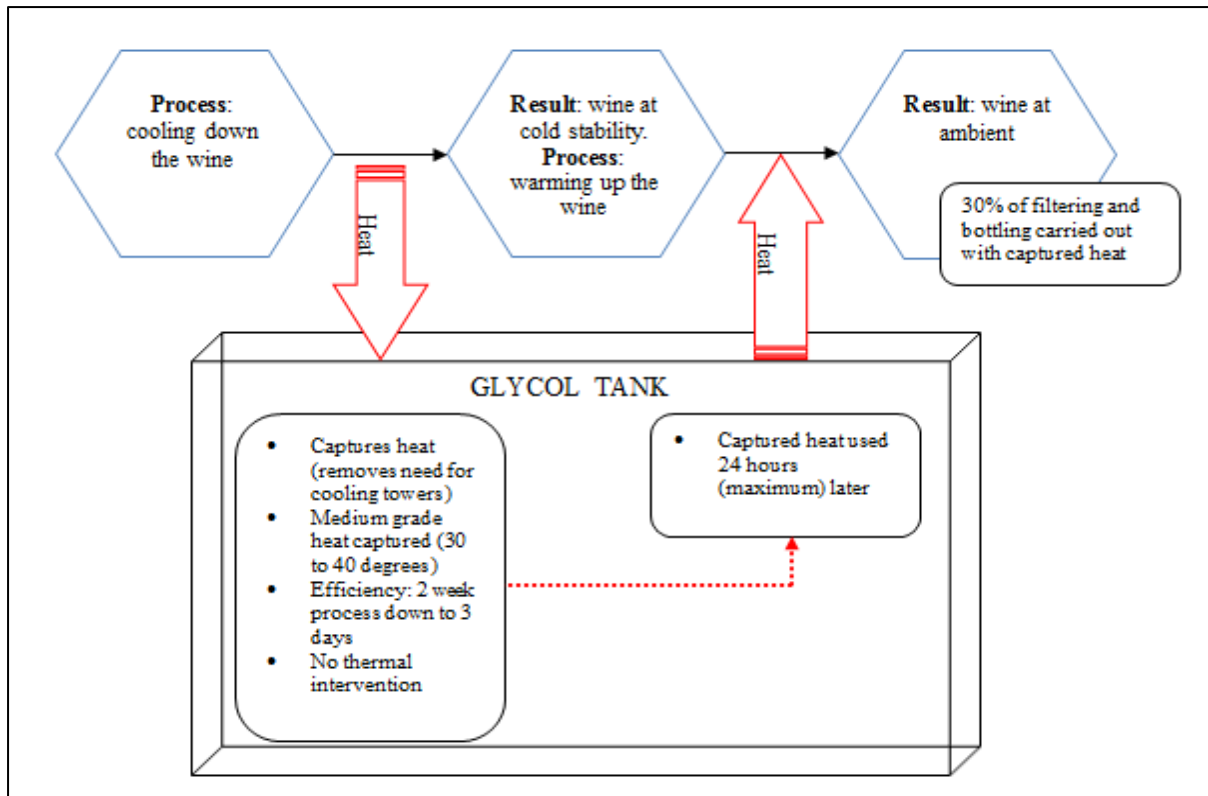


Figure 1: Heat reclaim system used in the refrigeration process

The Schneider system recorded the amount of electricity available from the heat reclaim system and relayed this information, along with data on electricity usage and availability to Cellar Managers. Managers then had the information to determine timing of production and the source of energy to use to deliver the best operational and carbon outcomes. The Cellar Manager explained that each day he reviewed the Schneider information, assessed the production requirements and, in conjunction with the Cellar Supervisors, prepared a production schedule to balance operational and energy efficiency needs. At times, decisions were made to delay some processing activities until the evening to take advantage of off-peak electricity rates or until the next day to ensure peak hour electricity usage remained within the daily limits specified in their provider's contract. While this information promoted energy-conscious decision making, at times operational needs trumped efficiency concerns. For instance, in the harvest season production processes were driven by demand and needed to be completed within set time frames. Energy usage and carbon emissions might be higher than desired during these times. Electricity was monitored each month and large overruns in usage and cost had to be explained to senior management.

CEMARS information provided a useful basis for benchmarking. A new KPI, namely average annual electricity consumption per bottle, provided a 'red line' benchmark for electricity usage between periods. Discussions in weekly cellar team meetings addressed the latest carbon emission reports as well as electricity usage figures. While external benchmarking would indicate a broadening scope of

the PMS, WineCo relied only on internal benchmarking. A possible reason for the internal focus is the challenge of comparing emissions measures between organisations because of methodological inconsistencies (Kolk et al., 2008, Perego and Hartmann, 2009, Hartmann et al., 2013). Internal benchmarking of energy usage provides an alternate way to assess performance beyond the financial perspective.

Each month, managers reviewed the financial, emissions and energy use figures as well as the CEMARS reduction targets. The electricity reduction targets specified in the CEMARS carbon management plan were incorporated into operational budgets, with annual budgeted electricity expenditure decreasing in line with the stated targets. Monthly reviews identified trends in resource consumption and whether operational initiatives were having the desired impact on emissions. Variances in energy use and expenditure were queried by the winery Performance Analyst and discussed by senior winemakers. The Operations Coordinator and Cellar Manager worked closely with the CEMARS data while Accountants and Performance Analysts reviewed the financial performance of business units. Accountants (who monitored expenditures) worked with the Cellar Managers (responsible for the winery budgets and operations) to ensure the carbon emission data aligned with the financial results. As the Cellar Manager said:

“So, they *Performance Analysts*] could say we are 10% up on gas, but we can now say yes, but we are 60% up on production.”

The monthly review process illustrates how the increasingly sophisticated PMS enabled management discussions to expand beyond a purely financial focus and to include non-financial dimensions of performance.

6.2 Measuring transport emissions

In 2009, the carbon impact of transport-related activities was summarised into just two highly aggregated CEMARS measures (see Appendix 1) namely freight by road (local transport of wine and ingredients) and regular petrol (car fleet). In 2010, freight by RoRo⁴ was added as a third transport category. At the time of the study, 80% of the company’s wine making ingredients were transported by rail. The CEMARS measures show that emissions from the RoRo rail carriers were much lower than from trucking but does not indicate the relative volumes being shipped by each transport mode. The impact of WineCo’s initial strategy to reduce emissions by moving grapes and unbottled wine to production facilities by rail would depend on the volumes switched over from road transport. WineCo needed better information to refine its strategy for reducing transportation emissions. The format of

⁴ ships that allow wheeled cargo such as cars, trucks and railroad cars to drive on and off on their own wheels

CEMARS transport measures was organised around type of transport rather than activities, which made it difficult for managers to link emissions to specific operational activities.

After the introduction of Schneider and SoFi, managers were able to analyse transport activities at a more granular level. By 2013, there were seven transport-related carbon emission categories (see Appendix 1) listed under road travel (own fleet/leased): transport of packaging; transport of grapes; transport of juice; transport of finished goods; petrol (premium); and petrol (regular) for vineyard machinery. The measurement categories were now better aligned with specific production activities. The increasing sophistication of the PMS and its re-orientation around transport activities enabled managers to identify carbon reduction initiatives targeting specific production activities.

6.3 Measuring overall impact

Based on information from the publicly available annual CEMARS reports, Appendix 2 summarises the overall change in WineCo's carbon emissions from first certification in 2010 until 2014. This exhibit reveals how CEMARS measures developed over time. Each year CEMARS measured scope 1, 2 and 3 emissions. From 2010 onward, there is also a comparative measure of emissions reflecting the absolute change in tCO₂e emissions against base year (2009) performance. As can be seen from Appendix 2 emissions have risen consistently over the reported period. However, this may simply reflect increasing volumes of production and may not mean rising emissions per bottle. According to the EnviroMark website (owner of CEMARS), WineCo "have reduced their carbon emissions by 25% per bottle of wine". Nonetheless, without knowing production volumes which are not publicly reported it is difficult to interpret the figures.

The basis of the CEMARS measure was changed in 2013, to report changes in scope 1 and 2 emissions (rather than total emissions) against the base year. There is no discussion of why this new indicator was introduced but it may be a response to the seemingly deteriorating results. While total emissions continue to increase in 2013 and 2014, the new indicator reports a reduction in scope 1 and 2 emissions – those the company is most able to influence. In 2014, WineCo added another indicator to report on emission intensity, a ratio linking total emissions to an output measure of total production. Although there is no clear statement of what the output measure is, it appears to be the dollar value of wine produced. In 2014, WineCo reported "A reduction in emissions intensity (for Scope 1, 2 and mandatory Scope 3 emissions) of 6.88 tCO₂e/\$M has occurred; based upon a 3-year rolling average".

In summary, our analysis reveals the mutual influence of on-going developments in the PMS and the carbon reduction strategy. CEMARS measures identified gaps in the PMS information and motivated the development of a more sophisticated PMS. The PMS evolved to routinely record non-financial operational measures, accommodate ad hoc forecasts of future carbon emissions, and provide absolute and relative measures of carbon emissions. The increasingly sophisticated PMS informed refinements

to strategy. As the PMS began to track emissions by additional activity categories, WineCo was able to better focus its carbon management efforts as well as to establish reduction targets.

7. Discussion

Our case provides evidence of the co-evolution of environmental strategy and PMS over time and the influence each has on the development of the other. This study extends our understanding of the relationship between strategy and PMS as described by Perego and Hartmann (2009). These authors considered the uni-directional impact of environmental strategy on the use of PMS and the indirect effect of PMS sophistication on this relationship. The Perego and Hartmann (2009) study was not designed to investigate the interaction between PMS sophistication. This study draws on the management control literature, which acknowledges the two-way interrelationship between strategy and management control systems, (Kober et al., 2007, Kloot, 1997) to ask how WineCo’s carbon strategy and PMS influence their mutual development. The research found that strategy and PMS do co-evolve with developments in one influencing the other. The developments are summarised in Figure 2 below.

		Prior to CEMARS enrolment		Initial stages of CEMARS		Current state
Environmental Strategy		No specific strategy cohering sustainability efforts apart from MD’s belief that sustainability is the right the thing to do Problem: sustainability efforts were ad hoc with no structure to guide decisions on sustainability choices and proposals	→	Sustainability vision focuses on reduction of carbon emissions Problem: CEMARS provided only annual aggregated emission measures. This information was insufficient to guide operational and managerial decision making in real time.	→	Sustainability focuses on key carbon emitting activities and use of emission measures to manage practices and resources to achieve carbon reduction targets
PMS Sophistication	Quantification	Low: Information drawn solely from financial reports e.g. electricity and fuel expenses in the Income Statement	↑ Change: Enrolled into CEMARS ↓	Increasing with inclusion of non-financial information i.e. carbon emission while maintaining the financial reporting	↑ Change: Implementation of new information systems to support CEMARS reporting and strategy implementation ↓	Further increases to include more detailed financial and non-financial information
	Scope	Narrow: information internally focused		Broadening with consideration of non-financial measures from suppliers’ bottle redesign and customer bottle recycling		Further broadening with more detailed financial and non-financial measurements to support both operational and managerial decision making.
	Timeliness	No carbon measure		Annual		Near real-time

Figure 2: Summary of findings

The horizontal arrows reflect the increasing sophistication of the PMS and the refinement of strategy over time. The vertical arrows represent the interactions providing feedback between strategy and the PMS at specific points in time. The diagram conveys that the relationship between strategy and the PMS is more dynamic than reflected in a simple linear progression. In fact, the on-going development in both elements suggests the interactions support an on-going learning process that motivates changes in both

strategy and the PMS. The feedback provided by the interactions between strategy and the PMS influence the on-going evolution of both elements.

Prior to enrolling in CEMARS, WineCo's PMS was based on internally-focused financial measures of resource use including line items for expenditures on electricity, petrol etc. After enrolling in CEMARS the PMS included non-financial emission measures summarising the carbon impact of operational activities. This information was used to identify where strategic initiatives were needed. Thus, the CEMARS measures influenced the development of a carbon reduction strategy even in the initial years when the PMS was relatively unsophisticated. In order to refine and focus the initial strategy, WineCo needed more detailed performance measures. Accordingly, investments were made in SoFi and Schneider to provide regular, real time measures of electricity use within specific operational activities. The PMS thus became more sophisticated to support the existing strategy. Moreover, the increasing sophistication of the PMS provided additional insights on carbon emitting activities that influenced subsequent refinements in the carbon management strategy. The refined strategy necessitating further development of the PMS. This research shows that as organisations undertake their sustainability journey, carbon emission strategies and PMS can actively shape each other. Thus, the role of PMS is not limited to implementing strategy but also helps create it. Furthermore, maintaining alignment between strategy and the PMS depends on an on-going process of mutual adjustments.

WineCo's environmental systems collected, measured and reported on the physical, financial and resource consumption aspects of carbon emitting activities throughout the organisation and supported a range of operational and management decisions. Our evidence supports the findings of Burritt et al. (2011) who reported that companies collect considerable climate change related information beyond cost data from activities and operations throughout the organisation to support different decision making purposes. However, our study challenges their observation that in many companies "the isolated approach to managing ... various issues ... results in inefficiencies that increase the amount of resources spent on carbon management and thus negatively affects the economic performance of the company" (Burritt et al., 2011, p. 83). The integrated operation of WineCo's PMS systems, including SoFi, Schneider and CEMARS, brought together diverse sources of information about carbon emitting activities and initiatives and enabled a coordinated and cost effective carbon management strategy.

WineCo's ability to integrate various types of carbon emission information into decision making processes influenced the implementation of the carbon management strategy. WineCo's financial budgets reflected carbon reduction targets for electricity and managers routinely compared measures of electricity use and electricity cost to evaluate the impact of operational decisions. The consolidation of the various types of information within WineCo's PMS suggests that integration could be a relevant attribute of PMS sophistication. Future studies could consider how to assess the level of information

integration in carbon management processes and the impact of differing levels of integration on strategy implementation.

Additionally, WineCo's managers integrated their use of information generated for internal management and external reporting purposes. Managers simultaneously considered CEMARS measures produced for external reporting purposes alongside the Schneider, SoFi and budget information used for managing internal operations when assessing the impact of production decisions. Thus, WineCo provides an example to counter previous observations that there is rarely a connection between the external and internal uses of carbon information (Zvezdov and Schaltegger, 2015).

The findings of this study have implications for future research. The ongoing process of mutual adjustment between strategy and the PMS is arguably due to WineCo's short history of engagement with external carbon reporting. WineCo's carbon management strategy is still developing. Future studies could consider the relationship between strategy and PMS in organisations with longer involvement with carbon emissions reporting. The relationship may be more stable in these settings. Future studies could benefit from adopting a process based approach to investigate the environmental strategy and PMS relationship. The on-going development of environmental strategy and PMS indicates that in organisations the alignment between the two may vary across time, and be more or less aligned at specific points in time. Cross sectional studies, which assume a static fit between strategy and the PMS, may fail to capture the on-going relations which shape the on-going evolution of both strategy and the PMS and maintain alignment between the two.

From a practical perspective, our study reveals the challenges for organisations hoping to implement carbon management strategies. While PMS systems such as CEMARS provide annual aggregated measures of carbon impact, they may not be sufficiently sophisticated to motivate managers to use the information being provided. In the case of WineCo, additional systems were introduced to supplement and extend the CEMARS information thereby increasing the sophistication of the overall PMS. The extended PMS was designed to make different types (financial and non-financial) and scope of information (internal and external) available to decision makers including emission measures, resource consumption and financial impact. Decision makers were then able to consider all performance dimensions simultaneously. Companies that rely solely on external environmental measurement systems may struggle to provide managers with complete and timely information for decision making.

8. Conclusions

This study investigated the relationship between environmental strategy and the PMS in a case company. It considered how developments in a carbon reduction strategy and in the PMS influenced each other after WineCo enrolled in CEMARS, an external carbon reporting scheme. The two specific questions posed in this paper were 'how does the case organisation's PMS influence the initial and on-

going development of its carbon reduction strategy’ and ‘how does the case organisation’s carbon reduction strategy influence the development of its PMS?’

It was found that WineCo’s PMS measures influenced the development and implementation of its carbon reduction strategy. The company’s initial objective to operate sustainably was not supported by a coherent strategy. Enrolling in CEMARS allowed WineCo to use the annual carbon measures to inform and shape an emission reduction strategy. The emission measures helped identify which operational activities to target for reduction efforts, established a baseline for carbon reduction targets and focused managers’ attention of the carbon impact of operational decisions. Furthermore, increasing the sophistication of the PMS led to refinements of WineCo’s carbon reduction strategy. Enrolment in CEMARS enabled WineCo to develop its PMS beyond historic monthly financial measures to include annual, aggregated, non-financial emission measures and subsequently real time energy consumption and heat reclaim data. The advances in PMS sophistication supported refinements to emission reduction strategy. The initial strategy, focused on bottles, mode of transport, refrigerants and new vehicles, however, had no specific reduction targets. Subsequent refinements identified energy use as a strategic area and established reduction targets for it. The increasing sophistication of the PMS, signalled by physical as well as financial measures, historic and real time data, and more granular reporting motivated refinements to the carbon emissions strategy. The study thus identifies the role of the PMS in the development and refinement of a carbon reduction strategy.

The second question considered how environmental strategy influenced the development and sophistication of the PMS. It was found that the continual refreshing of the carbon reduction strategy in response to annual CEMARS measures resulted in further enhancements of the PMS. The PMS became more sophisticated over time in terms of quantification, scope and timeliness. Managers referred to both carbon emission and budget information to inform decisions and monitored both financial and carbon impacts of decisions taken. As carbon reduction targets were added to the carbon management strategy, performance measures were adjusted by, for example, reducing line item expenditures in operational budgets.

The research reveals the ongoing adjustments required of the PMS and the carbon management strategy to maintain their alignment. This study complements previous work by considering how carbon reduction strategy and PMS co-evolve over time. While the research findings may apply only to the case organisation the study nonetheless provides insights for practitioners and researchers and opens areas for future research.

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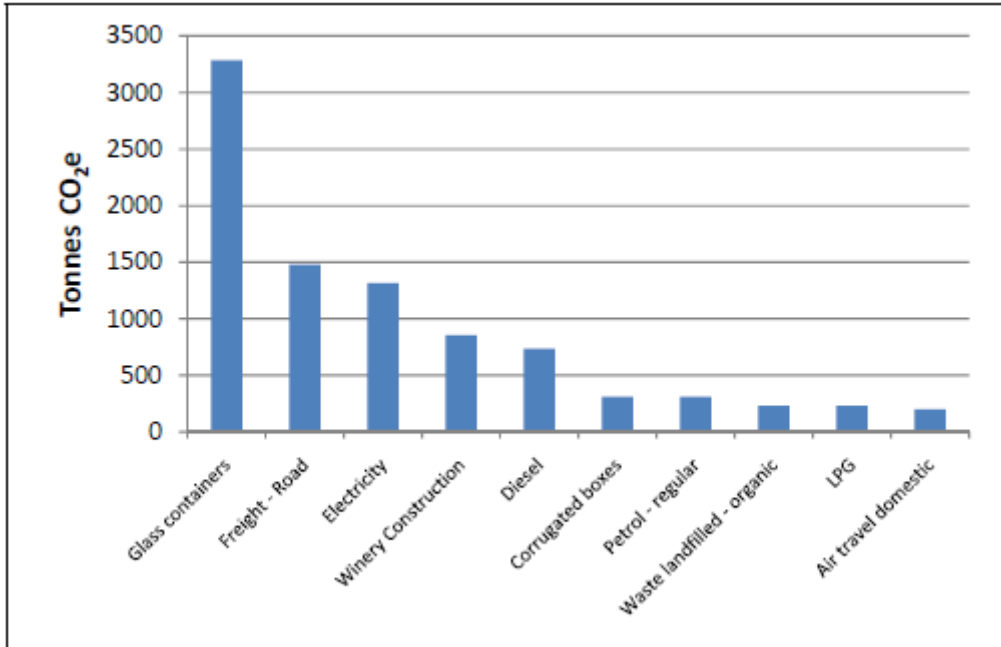
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Appendix 1:

Summary of CEMARS results: WineCo 2009



Summary of CEMARS results: WineCo 2013

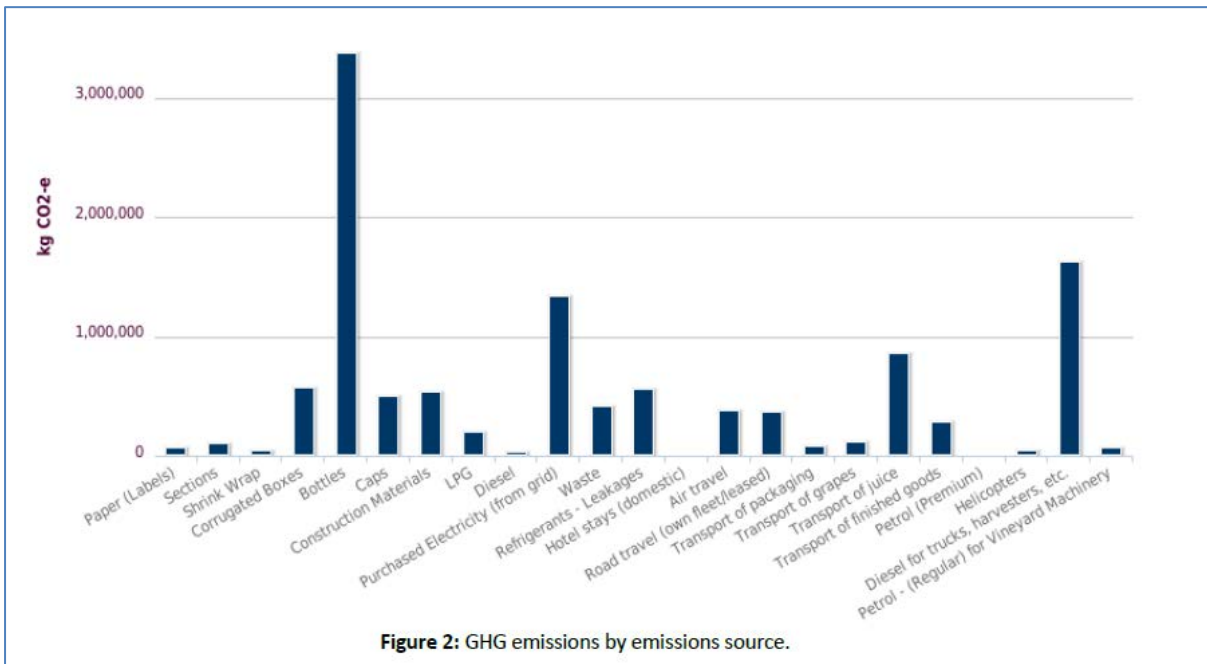


Figure 2: GHG emissions by emissions source.

Appendix 2:

Summary of CEMARS aggregated results: WineCo all years

Total carbon emissions by year and type (rounded)

	2009	2010	2011	2012	2013	2014
Scope 1	897	815	1,258	811	1,490	1,133
Scope 2	1,161	861	794	897	972	891
Scope 3	6,597	7,823	7,925	8,850		
Scope 3 Mandatory	854	381			8,596	9,045
Scope 3 Additional						
Scope 3 One-Off					536	559
Total Emissions	9,509	9,880	9,976	10,559	11,595	11,628
Change from base year		371	467	1,050		
Change in scope 1 & 2* emissions from base year					-143	-34
Change in emission intensity**						6.88 per \$M

Scope 1 direct emissions generated from sources owned or controlled by the organisation

Scope 2 indirect emissions arising from goods or services purchased by the organisation

Scope 3 indirect emissions generated from sources not directly owned by the organisation but relevant to the operation of its business

* The reported change for 2013 is not supported by the figures in this table. They indicate a 405 tCO_{2e} increase

** Emission intensity for Scope 1, 2 and mandatory Scope 3 emissions based upon a 3-year rolling average.