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Carbon Management Accounting - Practice in Leading German Companies

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Roger L. Burritt, Stefan Schaltegger and Dimitar Zvezdov

Abstract

Corporate activities can only be adjusted and new products and services to fight climate change and other climate impacts of the company be developed successfully if managers have relevant information about carbon dioxide (CO_2) and other greenhouse gases. This paper explores the notion of carbon management accounting - the tools, structures and procedures for managing carbon related information related to corporate activities. To help investigate practice a framework for carbon management accounting is proposed, and the results of interviews with managers in leading German companies about their carbon accounting practices discussed. Forty interviews were conducted in ten listed German companies which have independently received acknowledgement of their good sustainability reporting and sound sustainability performance. With their leading sustainability practices, these companies can also be expected to be leaders in the awareness, collection, measurement, reporting, assurance and use of carbon based information. The results from these exploratory case studies show that even in this selected group of leading German companies, management activities vary considerably in terms of tracking, data keeping and communication as well as volume, location, and organisation of carbon related information flows. The paper draws on the proposed carbon management accounting framework to support both researchers and practitioners in developing information management systems to meet the needs of corporate carbon management.

Keywords: climate change, carbon management accounting, information

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Carbon Management Accounting – Practice in Leading German Companies

1. Increasing economic relevance of carbon related information

Corporate practice with collecting, managing and communicating corporate carbon related information is under researched (see eg Kolk et al., 2008; Hopwood, 2009; Lohmann, 2009) and explored further here. Carbon related information is chosen as the focus of attention for three main reasons: first, the information needed in support of improved carbon management has received increasing attention over the last two decades reinforced by the introduction of emissions trading systems, the Cleaner Development Mechanism and Joint Implementation measures (see for example Ecomac, 1996; Ratnatunga, 2007; 2008; Lohmann, 2009); second, carbon emissions are subject to standardised quantitative measurement and are one of the common environmental aspects appearing in corporate external reports (eg WBCSD/ WRI 2004; Bebbington and Larinaga-González, 2008); and, third, carbon management has recently been gaining attention in public discourse (cf. BDI and McKinsey, 2007; BCG, 2009). As a consequence, information and the management of information about CO_2 releases has become an economically relevant topic for corporate management. *This paper explores carbon management accounting - the tools, structures and procedures for managing carbon related information based on evidence from a set of German companies known for their leadership in sustainability management.* Carbon management accounting is one part of sustainability accounting designed to provide managers with information that will assist companies facing short and long term decisions about carbon emission issues in a world where company activities are strongly implicated in the related ecological crisis (Maunders and Burritt, 1991; IPPC 2007).

At the end of the 1980s stakeholder pressure reached a point which pushed managers to engage with environmental issues (Donaldson and Preston, 1995; Waddock and Groves, 1997; Mitchell *et al*., 1997). At about the same time criticism of company accounting systems which failed to reflect environmental and social dimensions of corporate activities was raised (Gray, 1990; Gray *et al*., 1993; Gray *et al*., 1996). Since then various tools of environmental and sustainability accounting have been developed and applied (Unerman et al., 2007), however, only a limited amount of research has been conducted on the practical implementation and use of sustainability management accounting (Schaltegger *et al*., 2008; Bennett *et al*., 2003; Schaltegger and Burritt 2000) and even less is known about corporate practice on collecting, managing and communicating carbon related information in the company. Although attention directed to carbon issues in companies is on the increase, the amount of actual research conducted on information management practices in regard to carbon issues in companies to date remains limited (CDP, 2009; Okoreke, 2007; Jeswani *et al*., 2007; Hoffman, 2004).

Several main issues remain unexplored, but are of key importance to understanding challenges to managing carbon-related accounting information. On the one hand there has been little evidence obtained about *what* kind of information is actually collected, *how* often the information is collected, and *why* it is collected. Despite these gaps in knowledge, carbon management accounting has been evolving as a tool to support managers in utilising carbon-related information (e.g. WRI, 2009). Yet, companies have struggled with managing carbon related activities, for various interrelated reasons such as: i) deciding what information is relevant to decisions, ii) the need to redesign information management systems to better accommodate current and future short and long term needs, and iii) the actual uses to be made of available information (cf. Burritt *et al*., 2002).

Carbon management accounting systems are being introduced to gather information in response to the growing regulatory, market and informational requirements being set down in a growing number of countries around the world as steps are taken to meet Kyoto Protocol requirements (see e.g. Stern, 2006; Garnaut, 2008), to design sustainability reports in accordance with the Global Reporting Initiative (GRI) and to excel in sustainability ratings conducted for purposes of financial investment analysis (e.g. for the Dow Jones Sustainability Index). The question of how such carbon management accounting systems are actually emerging is relevant and for systematic research a suitable framework is needed. Such a framework is considered in the next section.

Framework for Carbon Management Accounting

With a growing number of businesses starting to look at the environmental aspects of their activities (cf. Schaltegger and Burritt, 2000; Bennett *et al*., 2002) extended research has already been carried out to examine the different aspects and tools of environmental management accounting (EMA).

Carbon Management Accounting (CMA) Framework

		Monetary Carbon Accounting		Physical Carbon Accounting	
		Short term	Long term	Short term	Long term
Past oriented	Routinely generated information	1. Carbon cost accounting (e.g. establishing the revenues and costs from carbon emissions certificates sold and purchased weekly on the market)	2. Carbon capital expenditure accounting (e.g. collection of data about annual capital expenditure on carbon reduction technologies)	3. Carbon flow accounting (e.g. collection of daily carbon emission flow information related to production)	4. Carbon capital impact accounting (e.g. calculation of the carbon footprint reduction of a business over the last ten years)
Past oriented	Ad hoc information	5. Ex post assessment of short term/ relevant carbon costing decisions (e.g. assessing the cost savings each month from changing to the use of long life light bulbs in an office block)	6. Ex post assessment of carbon reducing investments (e.g. assessment of the cost savings from an investment in solar panels for electricity generation at a factory, or checking the life cycle cost savings from investment in production of a new carbon efficient automobile as part of the product mix)	7. Ex post assessment of short term carbon impacts (e.g. collection of information about the reduction in travel miles of an executive as part of a short term carbon reduction programme)	8. Ex post assessment of physical carbon investment appraisal (e.g. review of the carbon reduction achieved by investment in the introduction of a carbon reduction logistics network for distributing products)
Future oriented	Routinely generated information	9. Monetary carbon operational budgeting (e.g. expected monthly monetary savings from carbon reduction related to electricity consumption)	10. Carbon long term financial planning (e.g. forecasting the future financial benefits to be gained from planning to permanently reduce the company´s carbon footprint)	11. Physical carbon budgeting (e.g. expected reduction in CO_2 emitted by a commercial building as staff training in green awareness techniques is introduced)	12. Long term physical carbon planning (e.g. expected reduction in emissions of carbon dioxide from projects generated by the research and development department)
Future oriented	Ad hoc information	13. Relevant carbon costing (e.g. calculating the change in revenues of the next accounting term if CO_2 costs of dirty products are included in the prices charged to customers)	14. Monetary carbon project investment appraisal (e.g. appraisal of expected benefits from investing in a Clean Development Mechanism project to reduce open burning of landfill waste in an overseas country)	15. Carbon impact budgeting (e.g. consideration of CO_2 reduction effect of a project in the next accounting period)	16. Physical environmental investment appraisal (e.g. calculation of total CO_2 reduction effect of clean production investment)

Table 1: Carbon Management Accounting (CMA) framework (based on Schaltegger and Burritt, 2000 and Burritt et al. 2002).

Burritt and Schaltegger (2002) proposed a comprehensive framework for EMA that breaks down management information into: physical and monetary dimensions, the time frame of decision making – past, present and future, length of time frame being short or long run and routineness of the information supplied – regular or ad hoc. In Table 1 this environmental framework is applied to accounting for corporate carbon-related information.

The resulting framework serves as a fundamental guide to the information properties that are most relevant to corporate decision makers and to how these properties are related to the practices and workflows related to collecting and managing carbon information. Such a framework provides the foundation for comparing the scope, range and potential variability of carbon accounting structures and processes in practice.

The first proposal, based on the framework, is that corporate carbon accounting activities will vary in terms of type of data, scope, range and periodicity of the information gathered.

The volume and type of information to be provided by an EMA system is determined by the number and type of managers seeking information for their decisions (Burritt et al., 2002). Managers and their information needs can be linked with the organisational structures within which they work, eg functional (say accounting, production, environmental management, etc.), or decentralised (say, Division A, Division B, etc.). The possibilities for developments in organisational structure that will include carbon related issues include: first, establishment of a new functional department as an add-on to existing systems; second, the development of new integrated management information systems within existing functional departments which include carbon accounting information; and finally, a decentralised carbon accounting system with the best fit to the organisational structure.

The second proposal is that corporate carbon accounting activities will vary depending on the number and type of departments and number of professionals seeking carbon accounting information.

The following section considers evidence about these matters gathered in a range of German companies which are recognised as being leaders in sustainability.

2. Methods for analysing corporate practice in Carbon Accounting

Based on the carbon management accounting framework described in the last section, an exploratory study has been carried out through series of 40 interviews with ten leading German companies listed on the German DAX and MDAX stock exchange (see anonymised version in Appendix 1). The DAX is a stock market index consisting of the 30 main German companies trading on the Frankfurt Stock Exchange, whereas the MDAX is a stock index which includes the next 50 shares from different sectors, excluding technology stocks. The aim was to obtain sufficient information from interviews of managers to derive results using the principle of constant comparison (Boeije, 2002; Richards, 2005; Silverman, 2006; Grbich, 2007). Two levels of comparison are used (a) between companies and (b) between managers. Assessment of interview responses was made directly by the interviewer at the time of the interview with notes being kept and subsequently reviewed until saturation was reached (Guest et al., 2006).

Companies chosen for examination were selected based on the following prerequisites: a) a strong sustainability management commitment and active sustainability programmes, e.g. companies that have recently won sustainability prizes, have achieved a good sustainability report rating by a recognised institution (e.g. the Global Reporting Initiative, or the Institute for Ecological Economy Research in Germany) or have been subject to positive shadow reporting by non-government organisations, b) need to have a complex structure and an accounting system that deals with non-financial information c) willingness to allocate resources to participate actively in the research project (as opposed to mere provision of previously published reports or other related information) and d) variety of industry sectors such as telecommunications, finance, energy, consumer goods, retail, and media, a distribution pattern designed to increase heterogeneity and facilitate analysis of how variations in structures play a role in carbon management accounting. Whereas the first and fourth prerequisites served for pre-selection, the second and the third criteria were applied following the initial negotiation with a set of companies.

In accordance with the ethical agreement related to interviews, the specific identity of participating companies and respondents cannot be disclosed; yet, it can be said that the selected companies are transnational, and quoted on the German stock exchange DAX or MDAX (large and medium-size companies).

To gain an overview of carbon-related information flow management in each company, initial interviews were carried out with the sustainability manager. Subsequently, a senior accountant in charge of carbon-related information was interviewed, as well as further internal users and providers of carbon accounting information identified in the initial interview. The majority of the interviews were carried out on site, with a small number of interviews carried out over the telephone. The average duration of the 40 interviews was 90 minutes.

Although the research was exploratory, a semi-structured questionnaire was developed (see Appendix 2) in order to provide a guideline for the researchers to concentrate on information collection and management practices. Climate change related information collected in the interviews related to the importance of the issue for the company as well as the practices involved in collecting and managing carbon-related information:

characteristics of type of data generated, its purposes, and the functions involved in the process.

The questionnaire contained three sections which led towards the focus on information for carbon management and accounting: (a) carbon policy, practices and evidence; (b) data preparation, collection and flow; and (c) personal attitudes of the managers interviewed. Each is considered briefly below.

(a) Carbon policy, practices and evidence

This most general part of the interview served to establish a starting point by asking broad questions about the company's carbon management as part of the sustainability management policy. The questions sought to determine what is perceived to be happening in the company from different people's perspectives, and the associated processes. The overview of the processes and the people involved with them revealed an outline of the specific topics to be pursued in the rest of the interview as well as with further respondents. This part sought the inter-subjectively testable opinion of the sustainability manager, backed up by evidence.

(b) Data preparation, collection and flow

This section represented an important and necessary part of the research project. It expanded previous insight into the company's sustainability management by looking into the details of data management practices, including carbon management information. The questions were mostly short and explicit, trying to obtain normative information, which could be compared and analysed. The information required was both general - e.g. what type of information is collected, how often, by what means, by whom, etc., and specific - relating to practices and norms. The interviewees were expected to be able to respond to the questions without preparation, such that the questions which were not answered did nonetheless provide useful information as to what was and was not known about the subject. A number of respondents requested that they receive the questionnaire prior to conducting the interview. However, their requests were not accommodated (cf. Richards, 2005 for this methodological decision), since prior preparation was neither required, nor desired as the research was exploring whether respondents were aware of the full amount of sustainability-related carbon information available. Hence, prior preparation by the respondents would have distorted the findings. Essentially the core of the interview this part sought to establish what information is collected by each department involved, how this is achieved and what each professional's motivation is behind the information gathering.

(c) Personal attitude

Separated from the previous section in order to detach personal perspectives from other findings the third part of the interview served to reveal any discrepancies between anticipated and actual sustainability management and practices.

Initial interviews with accounting executives and facilitators of published corporate sustainability reports were followed by interviews with internal users of carbon-related information and administrators of the required data.

The information was collected by means of the questionnaire described earlier. Additional information was collected in the form of field notes which served to reflect initial thoughts that arose during the interviews. These notes were consulted continuously between interviews in order to identify aspects that might have been neglected in the initial phase of the project or that (until this point) appear to be of greater importance than initially expected. Such secondary analysis was qualitatively documented again by means of notes. Despite taping and transcribing interviews being common in qualitative research, these were not carried out in the process of collecting and recording research data, since the focus of the research work was on conceptualising observations rather than on quantitative accuracy.

At a later stage, the results of the research project were summarised in relation to carbon accounting practices, i.e. the answers and observations relating only to carbon accounting were separately analysed, looking for hypothesis supporting evidence as well as expected or unexpected trends that became apparent from the interviews in the sample companies.

The next step in the data analysis was to process data in order to provide the evidence in a comprehensible form reflecting the observations made. In order to produce the evidence in such a form, the qualitative information was quantified in a simple manner (see Table 2). For example, to arrive at the number of objectives of carbon accounting at each company, each of the interview records was consulted to obtain the total number. Other information, such as focus on carbon information (e.g. monetary vs. physical, cf. Table 3) was derived by deduction by analysing the uses of information and then counting the practices that involve the different kinds of information. Also the importance of these practices, as described in the interviews, was considered in analysing the main focus of the information. For example if monetary information is used for senior management purposes decision making, whereas physical information is only used for making employees aware of their carbon footprint, the focus of the information was considered monetary and of high importance.

Importance \ Number of issues	None	A few / unknown	Many
Low	0	1	1
Medium / unclassified	1	2	3
High	1	3	3

Table 2: Interpretation of qualitative data: the above matrix combines the number of carbon-related issues and their importance to derive the true extent to which these issues are tackled

3. Research results

Results are related to the two research proposals based on the carbon management accounting framework previously developed: the first proposal is that corporate carbon accounting activities will vary in terms of type of data, scope, range and periodicity of the information gathered.

3.1 Data, scope, range and periodicity of the information gathered

As specified above the different purposes of corporate carbon accounting define relevant information properties (as discussed by Burritt and Schaltegger, 2002): monetary or physical, length of the time frame, past or future orientation; and routineness of information generation and collection (cf. Schaltegger and Burritt, 2000; Schaltegger *et al.*, 2001).

A number of interviews were carried out at each company in order to reveal as much detail about information management practices as possible in relation to the main purposes specified in the carbon management accounting framework (see results in anonymised Table 3). The respondents were providers and/or users of sustainability-related information as well as those providing support for the sustainability/ carbon management process, typically sustainability/environmental managers, accountants, assurance experts, and software developers.

	Focus on physical / monetary	Focus on short term or long term	Past/future orientated	Routinely generated / ad-hoc	Number of departments actively involved	Main purposes of climate-change-related information
Company A	monetary	short	future	ad-hoc	1	1
Company B	both	both	both	routinely	2	2
Company C	both	long	both	routinely	3	4
Company D	both	both	past	routinely	3	2
Company E	physical	short	past	ad-hoc	1	1
Company F	both	short	both	routinely	1	1
Company G	physical	both	both	routinely	1	3
Company H	physical	short	past	ad-hoc	1	2
Company I	monetary	short	future	routinely	1	3
Company J	physical	short	both	routinely	2	1

Table 3: Collection of carbon related information in the sample companies

As detailed in the following sections information management practices are seen to vary in accordance with industry sector, and focus of climate change efforts, which consider: the measures used – physical or monetary; the main-purpose of climate-related data collection; the length of decision time horizon for which data is collected; the orientation of data gathered – past or future; and the periodicity of data gathering - regular or ad-hoc.

3.1.1 Considerable amounts of monetary and physical carbon accounting related information are collected

Conventional management accounting has a focus on the collection and dissemination of monetary information to decision makers (Horngren and Foster, 1987). From a business perspective the focus on monetary representation of environmental impacts of the company and on the company has grown in importance recently because of the development of emissions trading systems (e.g. Klepper and Peterson, 2004; Kolk and Levy, 2004). In a broader setting, costs of reducing environmental impacts, revenues from emissions trading, capital investment calculations associated with cleaner production and greener products all provide the need for monetary information for decision making. From an environmental management perspective, results show that reduction in and avoidance of carbon dioxide equivalent emissions for compliance purposes provides the main reason for concern over company carbon management practices. Such information is physical in its orientation/ measurement and can be reflected by, for example, company carbon footprints, eco-balances, targets for reduction of carbon emissions expressed in absolute and relative terms, and actual carbon emissions and reductions in comparison with plans, or trends over time. Many carbon accounting issues are related to the need for physical data, but the research provides evidence that monetary quantification plays an equally important role in regard to climate-change information. For instance carbon reduction commitments do require investments (either in technology or in education and training), so that the actual reduction of emissions is normally directly related to the volume of invested resources, whereby these resources are expressed in monetary units. Those companies in the set examined whose activities are directly related to carbon emissions, and thus required by law to provide a detailed emission report, collect information in physical units. These physical units serve not only the regulatory reporting needs but are also fed into a performance measurement system that generates key performance indicators of actual company performance in absolute terms. Such physical information is then converted into monetary units in order to support management decisions related to costing, planning and resource allocation. A summary of the usage of both types of data – physical and monetary – is provided in Table 3.

Table 3, Column 2, reveals the general variety of practices, with two companies collecting only monetary, four only physical, and four collecting both physical and monetary information in their environmental management accounting systems. Evidence from the set of companies shows physical information is more often than not available and kept for bookkeeping purposes and is thus available even if no environmental or carbon management department is officially responsible for the management of such information. For example, detailed physical data relating to energy usage has been collected by the accounting department in all of the sample companies. The data has been used to produce an account of the running costs and has been provided to the facility manager and other managers on a regular basis. Another example of physical carbon-related data being collected is car fleet mileage, which can be conveniently converted into the volume of carbon emissions for a certain period. Such information is typically collected in the company Enterprise Resource Planning system. Hence, carbon accounting is seen as not just being about monetary but also about physical information. The results indicate that a comprehensive understanding of carbon management accounting is needed and that both physical and monetary information are equally relevant, indeed conjoint, for corporate management to support decisions in different situations. One reason for the collection of physical data is the need for the calculation of various costs and potential future costs information about the physical carbon flows (cf. Schaltegger and Burritt, 2000; Jasch, 2008). Another reason is for product design, e.g. as for environmentally benign products, or the requirements of certification and licensing processes.

In a number of situations, monetary information is produced on the basis of physical information. This implies that whatever the focus – being it monetary or physical – the collection of physical information is unavoidable, thus each of the companies focuses at least on physical information, whereas some of the companies are concentrated on both. Yet, this implication must be approached with caution. Collecting physical information with the purpose of producing an account of activities or tracking and managing the performance of products or departments on the one hand must be clearly distinguished from collecting physical information that is intended to be monetarised once it has been collected. Therefore, it is *a priori* decided what information is required and how it will be used. The latter results in various focus of the collected information, despite the fact, that information is initially collected in physical form. These two different approaches towards collecting and utilising physical carbon information are depicted below in Figure 1:

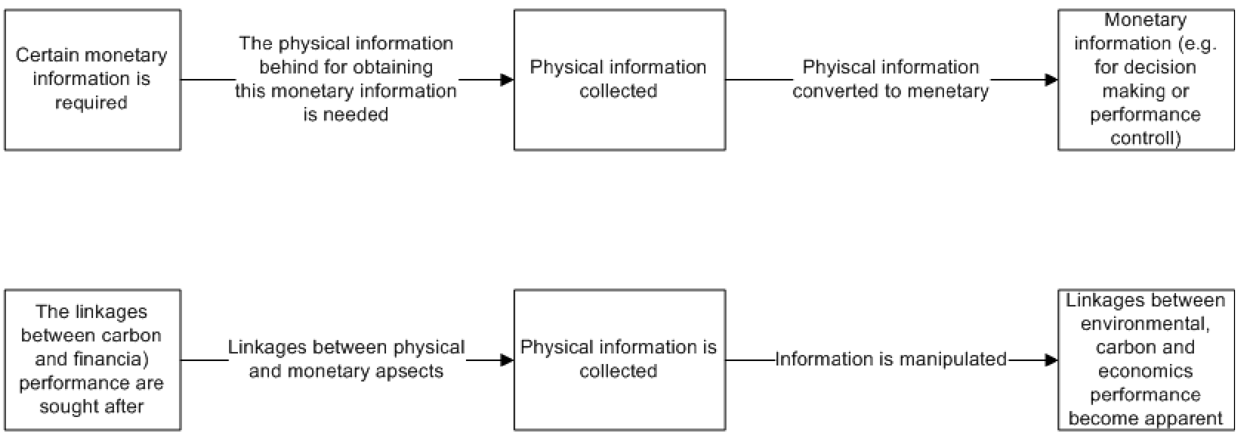

Figure 1: The two different approaches to collecting and utilising physical carbon information. The upper scheme presents a typical monetary-oriented information collection focus, whereas the lower one portrays a focus on physical information and resulting implications

The various interviewees throughout the set of companies reveal that the perception of carbon-related practices varies greatly. Whereas half of the companies see an opportunity in managing their carbon emissions beyond what is legislatively required, for the remaining companies it is seen as an additional burden that needs to be managed and one inflicting additional costs upon the business. Carbon management accounting helps to highlight these differences in perspective such that the over emphasis on win-win situations is somewhat tempered.

3.1.2 Focus on collection of routinely-generated information

The extent to which the total amount of carbon-related information collected was visible to the managers interviewed varied widely among the companies and the respondents as did the overall integration of related information into a single information management system. Distribution of the routineness of the collected information was quite balanced, with seven companies predominantly emphasising routine and three companies ad hoc information. As previously outlined, the extent to which carbon-related information was integrated in an overarching process varied across the sample. Many of the climate change-related activities of the sample companies are carried out on a project basis, which predetermines the ad hoc nature of the supporting information collection (see Table 3, column 5). Project costing requires that a separate data collection system is established where data is input for the specific purpose of the project.

The research confirms that corporate carbon accounting activities vary greatly in terms of type of data gathered, scope, range and amount of effort invested in the process. In the cases where carbon-related information had been collected on a regular basis, information still needed to be converted to carbon equivalent and input into a separate system serving the needs of the particular project. This finding diverges from other sustainability-related information, which is predominantly of an ad-hoc nature, as was expected (cf. Bartolomeo *et a*l., 2000).

3.1.3 Collection of short or long term and past and future carbon related information

In the sample of ten companies, nine of the companies focus on short-term carbon related information, while four companies uses a long time frame. Equally diversified appears the focus of the information regarding its past or future orientation. With eight companies focusing on past-orientated information and seven focusing on future-orientated information, the two are fairly equally represented.

With regard to the diversity of information collection practices, the adaptation of the Environmental Accounting Framework to address carbon accounting appears justified and has been summarised in Table 4. It must be considered that although no evidence was collected that all 16 tools (as outlined in the framework) are deployed by the sample companies, it was observed that all four dimensions of the framework appear to be of relevance to carbon information management: 1) physical and monetary, 2) routinely generated and ad-hoc, 3) past and future orientated as well as 4) short and long-term information. Examples of the actual use of carbon management accounting by the set of companies include: weekly collection of carbon emissions from travelling, monthly collection/calculation of carbon emissions resulting from company operations (such heating, lighting, travelling), monthly aggregation of the expenses on emission reducing measures (e.g. purchasing carbon neutral electricity or emission certificates). Further examples include investment appraisal that considers the future price of carbon emissions and the expected savings resulting from the various alternatives, and long term carbon budgeting (i.e. what measures need to be taken to meet the commitment in 3 years).

The majority of the tools used in the sample companies are concentrated in the first quadrant (i.e. Boxes 3,4, 7 & 8, Table 1) of the framework. This retrospective focus on physical information can be explained through the function of such information in the company. First, it appears that carbon related information is much less of actual financial importance to the company, whereas commitments to decreasing emissions (or failure to address the latter) may have a large financial impact on the company (cf. BCG, 2009). This results in focus being diverted towards the physical dimension of the information.

Schulz and Williamson (2005) state that given the current global conditions, "carbon … is a strategic part of the new competitive game". This may explain the importance of and thus the focus on physical information. Also, it appears that companies tend to decrease their greenhouse gas emissions not solely for the sake of reducing them, but as a side effect of measures of a more pronounced financial importance. However, whether these observations a) hold true and b) are transferable to other companies cannot be verified within the scope of this project.

Also, the purpose of, or decision for, gathering information is specified by four companies to be for compliance with external regulations rather than making internal decisions. It might be thought that all of these listed companies would need to gather information for compliance, but it is not recognised to be the case by the majority of companies.

3.2 The number and variety of departments and type of professionals actively involved in climate change data collection.

The second proposal is that corporate carbon accounting activities will vary depending on the number and type of departments and number of professionals seeking carbon accounting information.

Despite the presumption that the "information age" enables business to collect as much information as needed for decision making, many of the participating companies reveal that the amount of information collected presents a serious challenge to the information management system. Organising such amounts of information is not only a challenge to the management processes of the company, but also limits the realisation of an integrated management system with climate-related accounting embedded. This lack of feasible technical solutions in turn results in greater volumes of ad-hoc collected data, despite the obvious disadvantages such as poor data assurance and process inefficiency.

Among the questions that the respondents were not able to find a solution to was how climate-related information is input, who provides the input, and how to design a central user-friendly interface that can reflect the needs of a wide range of information providers and users. In relation to the design and implementation of such a system, managers at one company stated that at this stage computing power is too cost-intensive for the desired output. On the other hand, this does not appear to be a bottleneck for financial information management systems, which is an indicator of the resource restrictions on the sustainability department and thus of the low strategic importance of carbon-related information in this particular company.

The key message from the interview evidence is that corporate carbon management issues are multifold and have an impact on a wide range of managerial decision situations and decisions. As a consequence different methods of carbon accounting are needed to provide the kind of information which is relevant and valuable for a given decision situation.

Accounting for carbon management can be seen as an approach and a set of new information management and accounting methods that aim at creating and providing high quality information to support a corporation in its movement at least towards carbon neutrality. And since the methodological integration of environmental and social accounting in the existing core business processes is one aspect of the challenges of sustainability management, it is essential that a seamless integration takes place. In practice, however, sustainability accounting is usually established in parallel with conventional management systems, which is likely to lead to inefficient information management (Schaltegger et al., 2003). By following the entire chain of interactions between the actors and functions, the research uncovers pitfalls such as information being collected in an isolated fashion and without sufficient cooperation among the actors. Analysis of reasons for the resulting failure to establish an optimal information flow between professionals and departments raises the issue of whether and how involvement of the accounting function could contribute to addressing these issues.

In modern organisations, data collection and information processing functions of the accountant are shared among several departments and the various actors involved across them (Johnson and Kaplan, 1987). The actor’s task is not to replace the accountant’s function /accounting department but rather to facilitate information management, thereby supporting the tasks which accountants need to perform. Hence, carbon information is not generated in a single department; instead, engineers, plant managers, and other functional managers below the top management have extended their duties and are engaged in the generation and dissemination of information. However, evidence from company managers interviewed reveals that information is not collected in a systematic way, unlike conventional accounting but in an isolated manner, as a result of the diverse functions of the contributors. Attempts to explain this behaviour have been made, e.g. Schaltegger and Burritt (2000) accuses the wide range of addressees as well as the wide range of purposes this data serves as being one reason for the poor information workflow, something that accounting expertise could be deployed to overcome.

As suggested earlier, in functional organisations managers predominantly appear to be interested in information directly related to their own departments and only collect such information unless otherwise required. However, given the absence of uniform information management systems, the various departments tend individually to collect the same information, without taking advantage of information previously gathered, which may better suit their needs. Again, the process of integration of carbon related information poses a serious challenge for existing information management systems and needs to be either updated or completely redesigned, so that carbon-related information is anchored with financial information.

A straightforward example of the resulting inefficiency in the organisation is observed if the same piece of information is collected by the production department in the process of planning production costs, the legal department gathers the information while securing legal compliance, the public relations office obtains the same information while preparing an external report and so on (cf. Schaltegger *et al.*, 2003). As a result, such information is neglected by the single actors because it is perceived as negligible for each department, and is thus not brought to the attention of the management, despite its cumulative importance and spread.

Findings from the interviews reveal that there exists a wide variety of practices related to collection, distribution and usage of carbon information (see Table 3). First, a wide spectrum of practices was observed in relation to the involvement of various departments, the purposes for collecting information and the properties of this information. As shown in Table 3, column 6, the number of departments actively involved in collecting, preparing and using climate change related information varies in the sample. Variability was found to depend closely on the organisational structure of the company regarding carbon-related information management and usage, and organisational structure for carbon information collection was closely related to the various purposes of the information collected. Whereas some of the companies need such information solely for legal compliance, others use it to adjust their operating costs and still others use it for long term planning (e.g. investment appraisal); see Table 4. The results show that in the set of companies examined, only the companies subject to emissions trading system-regulation have made appointments with additional responsibilities to collect and manage such information. The remainder of the companies use existing information systems (typically part of the environmental/sustainability department) to collect and manage such information.

The results reveal that a relation between the number of carbon management accounting applications and the number of departments/functions involved cannot be established. Neither can the interrelationship between carbon accounting information gathered for external regulatory and internal management purposes.

Company	Number of departments involved	What the information is used for		Additional responsibilities created specifically for CO_2-relevant information management
		External	Internal	
A	1		VRC	no
B	2	LC	VRC	yes
C	>3	LC	VRC, CA, RA	yes
D	>3		CA, VRC	no
E	1		VRC	no
F	1	LC	VRC	no
G	1		VRC, CA, RA	yes
H	1		VRC, other decision-making	no
I	1	LC	VRC, CA, RA	yes
J	1		VRC	yes

Legend: LC: legal compliance, VRC: voluntary reduction commitment, CA: cost accounting, RA: resource allocation

Table 4: Use of carbon-related information in the set of companies

3.3 Information collection properties

3.3.1 Number of professionals involved in the information collection system.

Based on the number of professionals/departments involved in the information collection practices in the researched companies, two settings can be differentiated – with few or many departments being involved in collecting information. In the first case, the carbon-related department requests the required information from each department and then collates it to produce a report of use to higher management. Regardless of the size of the carbon-related department, the number of people involved in the collection of carbon-related information is limited to those in this department and, therefore, limits the resources available for collecting such information. By inference a limit is also placed by the carbon related department on understanding about the issues of each and every department, and this is likely to result in the omission/ neglect of relevant information.

In contrast, delegation of the responsibility for collecting carbon related-relevant information to each department results in a very large number of people being involved. This decreases the amount of effort the carbon-related department has to spend on collecting the same amount of data when compared with the previous situation. Decreasing the workload of the carbon-related department by transferring collection responsibilities to individual departments is an advantage of this model, since the information can be input to the system without involving further functions. Furthermore with the decentralised, delegation model greater attention can be drawn to the relevant issues, since the carbon-related team is no longer focused on collecting the data, instead it can spend time looking strategically at information extracted from data fed into the system by others. Finally, resources at the carbon-related department can be concentrated on making and managing linkages between the data produced by different departments.

In summary, evidence gathered from a set of high profile listed German companies indicates the actual richness of carbon related accounting across a range of different decision settings. Managers and companies differ in terms of their own combination of types of carbon related data needed, the time horizon of the decisions the information is to be used for, whether ad hoc or regular information is needed, and if the information is reporting on past or future carbon-related matters. Results also reveal great variety in the organisational structures used to communicate environmental-related data. From the perspective of practice the carbon management accounting framework provides a useful broad mapping for managers which will help them divert attention from fixating on a single carbon related issue such as emissions trading which is the present vogue.

3.3.2 Interactive chains of information management.

The explorative character of the project conducted aimed to reveal what practices are carried out by companies as well as who is involved or in charge of these practices. As Table 4 reveals, a number of the researched companies have delegated the process of carbon management to a single person or department, in order to improve coordination and process efficiency. An example of such an interactive chain is presented in Figure 2.

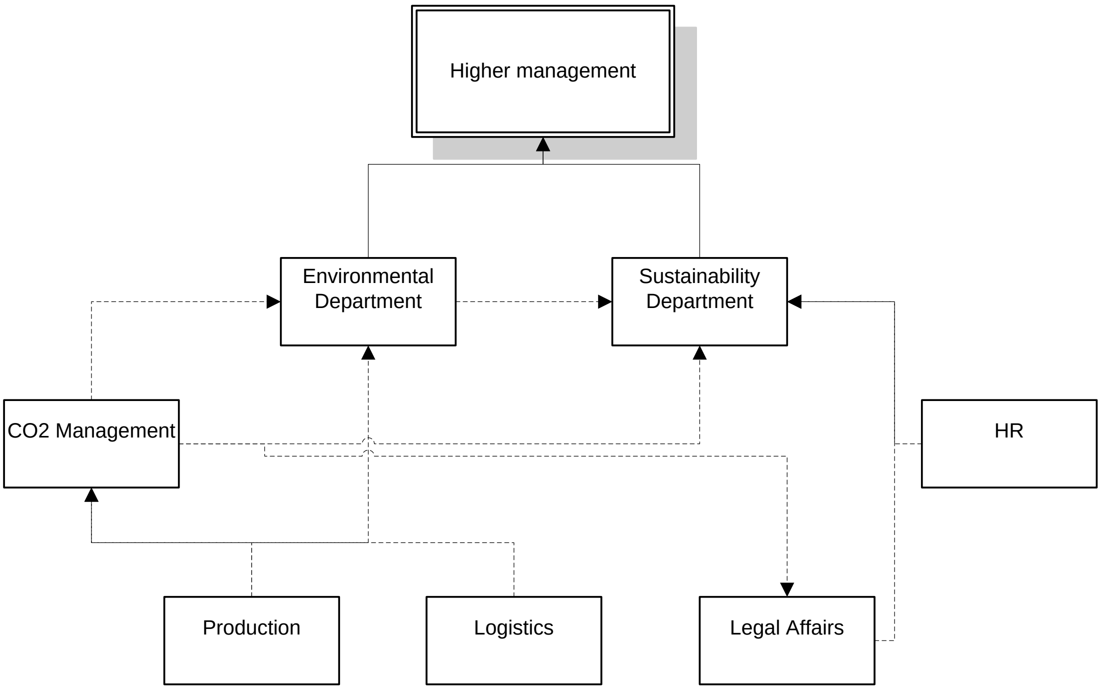

Figure 2: An example of an interactive chain of carbon (information) management.

The above figure draws a simplified depiction of the responsibilities and departments involved in managing CO_2 issues and related information. Although the carbon management responsibility is separated from the environmental department, a close cooperation between the two exists, although in the above case the flow of information appears one-directional, i.e. information is reported to the environmental department. Although a clear distinction between the environmental and separate carbon departments was observed in a few companies, the reasons behind this separation appear somewhat illogical or at least unclear.

4. Conclusion and implications for further research

Climate change has become a major societal issue enticing politicians to introduce regulations, activating customers to ask for carbon footprint information on products, and investors to require the assessment of carbon emission induced financial effects on corporate value. In short, for companies the management of carbon related issues is becoming economically important. As a consequence, carbon related information has to be collected, analysed, managed and communicated internally to support and communicate management decisions. With the increasing introduction of markets in CO_2 emissions and related incentive structures to deal with carbon issues, ever more departments and management levels are addressing CO_2 issues. Climate change related information is thus not just departmental information for sustainability service units but rather economically important information for many different departments and managers in a company. This development needs a framework to structure the different carbon information management methods evident today, as proposed with the carbon management accounting framework developed in this paper.

		Carbon Management Accounting (CMA) Framework			
		Monetary Carbon Accounting		Physical Carbon Accounting	
		Short term	Long term	Short term	Long term
Past orientated	Routinely generated information	C F	D	B C D F G I	B C D G
	Ad hoc information	A J	J	E F H J	B E F H J
Future orientated	Routinely generated information	C F I	D I	B C D G	B D F G I
	Ad hoc information		G	A	

Table 5: Mapping of the findings from interviews of 40 managers in 10 listed German companies (the darker the background = the greater the use of tools)

The framework is used as a basis to investigate corporate practice in carbon accounting. The main findings summarised from a set of 40 in-depth interviews in ten large German companies (see Table 5) are that, firstly, considerably more climate change related information is collected than just cost information about CO_2 and its equivalent. Indeed, physical information seems to dominate in the companies examined. Carbon management accounting, therefore, has to include physical as well as monetary information and information management methods. Secondly, CO_2-related information is collected in various places in organisations for very different decision situations and purposes. Climate change issues may influence operational costs as well as investments, have short as well as long term relevance, and be collected in ad hoc and regular ways. The need is for companies to consider more sophisticated organisation and design of carbon management accounting. The carbon management accounting framework therefore proposes to distinguish carbon accounting methods between past and future orientation, routine and ad hoc, and short and long term according to decision situations.

Carbon management is a means toward the sustainable development of a company. Without creating a business case corporate climate change measures remain philanthropic and luxury. This often conflicts with the primary goals of managers, who are urged to obtain immediate or short-term performance improvement. Short term economic performance is therefore considered a major hurdle on the road to sustainability (Rappaport, 2005; Rappaport, 1999). Carbon management accounting is thus challenged to support identification of links and opportunities to create business cases for corporate climate change management (Schulz and Williamson, 2005) in all of the situations identified in the framework.

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Appendix 1: Interviews

<table>
<tr><th>ID</th><th>Interviews with the following positions</th><th>Interview status</th><th>Type of carbon information collected / used
Information on:</th><th>Who needs carbon-related information</th></tr>
<tr><td rowspan="4">D</td><td>Corporate Sustainability Manager</td><td>conducted (December 2008)</td><td rowspan="4">• physical carbon emissions resulting from production and transport,
• the cost of past and future measures to reduce or mitigate emissions</td><td rowspan="4">• accounting (for aggregation and assurance)
• environmental management (for performance measurement and external reporting)
• senior management for decision making</td></tr>
<tr><td>Environmental Manager</td><td>conducted (June 2009)</td></tr>
<tr><td>Chief Accountant</td><td>conducted (July 2009)</td></tr>
<tr><td>Corporate Responsibility</td><td>conducted (June 2009)</td></tr>
<tr><td rowspan="4">G</td><td>Sustainability Communication collection</td><td>conducted (February 2009)</td><td rowspan="4">• relative and absolute amounts of emissions from production and transportation
• emissions from office buildings and mobility
• emissions saved by carbon-reducing projects</td><td rowspan="4">• carbon department (monetary aspects)
• environmental department (physical aspects)
• communication (reporting)</td></tr>
<tr><td>Assistant SC- social aspects</td><td>conducted (February 2009)</td></tr>
<tr><td>Corporate Sustainability Manager (Brussels)</td><td>conducted (April 2009)</td></tr>
<tr><td>Environmental Manager</td><td>conducted (April 2009)</td></tr>
<tr><td rowspan="5">A</td><td>Sustainability Manager</td><td>conducted (May 2009)</td><td rowspan="5">• the emissions resulting from direct activities at the company (e.g. travelling, office heating, etc) and their monetary expressions
• costs and savings of the above measures</td><td rowspan="5">• sustainability department (commitment fulfilment and reporting)</td></tr>
<tr><td>Coordinator Sustainability Activities worldwide</td><td>conducted (February 2009)</td></tr>
<tr><td>Environmental Manager</td><td>conducted (April 2009)</td></tr>
<tr><td>Assistant (environmental accounting)</td><td>conducted (April 2009)</td></tr>
<tr><td>Setup of an Sustainability Software</td><td>conducted (April 2009)</td></tr>
</table>

<table>
<tr><td rowspan="4">H</td><td>Sustainability Manager</td><td>conducted (February 2009)</td><td rowspan="4">• physical carbon performance of investment projects</td><td rowspan="4">• sustainability management (evaluate project performance and investment attractiveness)
• equity research
• investor relations</td></tr>
<tr><td>Board Office Sustainability Management</td><td>conducted (February 2009)</td></tr>
<tr><td>Renewable Energy finance</td><td>conducted (October 2009)</td></tr>
<tr><td>Investor Relations</td><td>conducted (October 2009)</td></tr>
<tr><td rowspan="2">F</td><td>Sustainability Manager</td><td>conducted (February 2009)</td><td rowspan="2">• own and suppliers' physical carbon performance
• expenses on securing the target performance
• financial benefits of achieving the targets</td><td rowspan="2">• environmental department (measure & reduce emissions over the whole supply chain)</td></tr>
<tr><td>Social & Environmental Affairs</td><td>conducted (October 2009)</td></tr>
<tr><td rowspan="3">C</td><td>Sustainability Manager

Sustainability Manager</td><td>conducted (February 2009)

conducted (October 2009)</td><td rowspan="3">• physical amount of emissions from electricity generation and related operations
• expenditures on carbon emission allowances
• (monetary and physical) savings from emission reduction projects
• amount of carbon emissions avoided
• historical level of emissions (both absolute and per employee and kwh electrical energy produced)</td><td rowspan="3">• carbon department (regulatory matters)
• sustainability department (physical analysis and relation between physical and monetary aspects)</td></tr>
<tr><td>Management Accountant</td><td>scheduled for June 2009, rescheduled for September 2009 re-rescheduled for November, no date fixed yet</td></tr>
<tr><td>CO2</td><td>scheduled for June 2009, rescheduled for September 2009 re-rescheduled for November, no date fixed yet</td></tr>
</table>

B	Corporate Responsibility	conducted (March 2009)	• physical information on regulatory issues • carbon-related expenditures (e.g. investment in more efficient machines)	• carbon department (regulatory) • environmental department (physical information such as project results, savings, etc)
E	CSR Coordination	conducted (February 2009)	• physical amount of emissions from each completed project • expected amount of emission from future projects • cost on building more CO_2 efficient buildings • CO_2 saving from building in such a manner	• Sustainability department (information on physical performance so that projects can be compared; also information costs related to these physical improvements) • Project managers are required to provide such information in sufficient detail
	Project Manager	Scheduled for May 2009, has not taken place yet due to resource limitation, expected to take place by the end of January 2010 at the latest		
I	Head of environmental affairs	conducted (September 2009)	• physical information for regulatory purposes • physical and monetary information for voluntary	• sustainability manager (coordinating and decision making) • project managers (decision making)
	Accounting	scheduled to take place by mid December		
	Project manager	scheduled to take place in December		

	CO2 Manager	scheduled to take place in December	reporting • long-term emission trends • process efficiency (physical information)	• operation managers (provide information) • carbon department (one-man department, regulatory issues)
J	Common reporting system	October 2009	• all physical aspects of product transportation • total amount of emissions • amount of emissions reduced/avoided • monetary information on the resources spent on such projects	• common reporting system (internal reporting) • carbon-footprint accounting (data verification) • product manager (costing)
	Carbon footprint accounting	scheduled to take place by mid-December		
	Product manager	scheduled to take place by mid-December		

Appendix 2: Interview agenda

Interview agenda

Project 5-429:

ACCOUNTING INFORMATION AND THE ACCOUNTING FUNCTION IN SUSTAINABILITY MANAGEMENT

Comments

The following semi-structured questionnaire is an abridged version of the full questionnaire administered to each interviewee. The questions left are those that directly investigate or are related to carbon accounting practices. The questions were developed for an interview and the answers include an additional qualitative answer or an explanation of the answer given, *e.g. question 8:*

8. How far does your current accounting system deal with the integration of (physical) carbon aspects?	1 2 3 4

The respondents were required to provide a short verbal description of the state of integration of the information: e.g. there is one particular accounting professional, who works very closely with the sustainability department to implement changes in the accounting system that reflect the needs of the sustainability department adequately.

The interviews were scheduled to take about one hour (depending on the company, interviewed person, etc). Yet, the majority of the interviews took about 90 minutes to complete.

Unless otherwise indicated, a larger number means "more".

I. Sustainability policy, practices and evidence

1. Why do you collect carbon related information?

required for decision making	1	2	3	4
required / useful for controlling purposes	1	2	3	4
required by higher management	1	2	3	4
we have some spare resources	1	2	3	4
useful for own work	1	2	3	4
required by another person or department	1	2	3	4
externally required	1	2	3	4
I do not know	1	2	3	4
Other: ________________	1	2	3	4

2. How is carbon related information useful for your own work in particular?

3. What is the actual contribution of (using) carbon related information in your work?

improved economics aspects	1	2	3	4
improved environmental performance	1	2	3	4
improved social performance	1	2	3	4
improved reputation	1	2	3	4
improved management accounting	1	2	3	4
improved decision-making	1	2	3	4
improved reporting	1	2	3	4
other: ________________	1	2	3	4

4. How does the top level commitment address challenges related to sustainability management? (e.g. by means of policies, orders, instructions)	supporting primary 1 2 3 4

5. Is the monetarisation of carbon performance seen as practicable? How and for whom?	hardly <-> completely 1 2 3 4

6. How long have you been collecting/using carbon-related information?

7. Was the collection of carbon related information triggered by a certain event?

8. How far does your current accounting system deal with the integration of (physical) carbon aspects?	1 2 3 4

9. How far has the accounting/information management system with respect to carbon accounting evolved in the past:

1 year	1	2	3	4
5 years	1	2	3	4
10 years	1	2	3	4
15 years	1	2	3	4

In terms of what?

10. To what extent, in your opinion, is your carbon accounting approach the result of your company's

context	1	2	3	4
country	1	2	3	4
pattern of evolution	1	2	3	4
accident	1	2	3	4
law	1	2	3	4
accounting standards	1	2	3	4
customs	1	2	3	4
other	1	2	3	4

11. Is environmental information collected/used throughout the value chain	no 1	2	throughout 3	4

12. How important are the following environmental impacts related to your company's activities:				
Environmentally related impacts on the economic situation of your company	1	2	3	4
Company-related impacts on environmental systems	1	2	3	4

13. How is your financial performance influenced by your carbon management activities?

14. Which of your department's (company's) activities affect climate change?

II. Data preparation, collection and flow

15. What carbon data is collected and how is this done?

How is information relevant to you collected?				
ad hoc	1	2	3	4
integratively	1	2	3	4
Is it collected upon request or systematically?				
upon request	1	2	3	4
continuously	1	2	3	4
Time frame				
past-oriented	1	2	3	4
future-future oriented	1	2	3	4
Time frame length				
short term	1	2	3	4
long term	1	2	3	4
Nature of the information				
qualitative	1	2	3	4
quantitative	1	2	3	4
Format				
physical	1	2	3	4
monetary	1	2	3	4

16. Collection, management and reporting of carbon-related information

Who collects carbon-related information	Who manages the process	Who is this information reported to	By what means is data/information collected, managed and reported (e.g. ERP, reports, etc)

17. How has carbon-related information been integrated in your accounting system?	
slowly quickly _________ (years/months)	1 2 3 4
gradually stepwise	1 2 3 4

18. How much room for improvement does your current accounting system offer with respect to carbon related information?	restricted advanced 1 2 3 4

19. Absolute information (kg, tonnes) or relative (kg/employee, gram/km)

20. How does reporting influence carbon-related information collection?

o distorts o supports o competes o completes

21. What emissions are monitored (e.g. CO_2 emissions, methane, etc.)

22. Is the CO_2 footprint of your products or services known? In what detail?