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ORIGINAL ARTICLE

Improving energy and carbon management in construction and civil engineering companies—evaluating the impacts of the CO_2 Performance Ladder

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Abstract In the Netherlands, the CO_2 Performance Ladder has been introduced as an energy management programme to facilitate continuous energy efficiency and carbon performance improvement in non-industrial sectors. This paper addresses the question: 'What is the impact of the CO_2 Performance Ladder on improving energy and carbon management and reducing CO_2 emissions in construction and civil engineering firms'. The research was based on interviews, descriptive analysis of energy efficiency and CO_2 emission reduction measures and quantitative analysis of CO_2 emission reductions. The research results indicate that the CO_2 Performance Ladder has improved various energy management practices at administrative level, while internalization of energy management practices at lower levels in the organization has just gradually started. Companies have implemented a wide range of new energy efficiency and CO_2 emission reduction measures. However, most measures only affected supporting business processes instead of companies' core processes. About 30–50 % of these measures have been identified as additional. Green electricity purchasing and the adoption of behavioural measures were particularly stimulated. The annual CO_2 emission reduction rate due to energy efficiency improvement and fuel switching amounted to 3.2 %/year (2010–2013). First estimates suggest that about 1.0–1.6 %/year of these CO_2 emission reductions can be attributed to the CO_2 Performance Ladder. However, these figures should be handled with caution because of various uncertainties. Overall, we conclude that, driven by the potential competitive advantage in contract awarding, the CO_2 Performance Ladder has been responsible for improving energy management and enhancing CO_2 emission reduction among construction and civil engineering firms, which most likely would not have been achieved otherwise.

Keywords Energy and carbon management · Construction industry · Programme evaluation · CO_2 Performance Ladder

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Introduction

In many countries energy and carbon management programmes have been implemented in various economic sectors to stimulate continuous energy efficiency improvement and CO_2 emission reduction (Reinaud et al. 2012; McKane et al. 2009). In the Netherlands, the CO_2 Performance Ladder (CO_2PL) has been introduced as a market-driven certification programme for energy and carbon management in the construction and civil engineering sector. The CO_2PL is often seen as a major stimulant for energy efficiency improvement and CO_2 emission reduction among firms in this sector since they are generally not subject to other specific energy or climate policies and programmes.

The aim of this research is to evaluate the impacts of the CO_2PL on improving energy and carbon management and CO_2 emission reduction in construction and civil engineering companies. This research thereby responds to the interest of various stakeholders to get better insight in the performance of the CO_2PL. This research contributes to scientific literature by further extending empirical insights into the impact of energy management programmes on improving energy management practices in non-industrial sectors, which is a topic that has not been widely studied before. For more details, see the section 'Energy management systems'.

This paper is organized as follows. The second section briefly reviews the literature on energy management systems. The third section shortly introduces the CO_2PL. The fourth section addresses the research methods and data collection. The fifth section presents the main research findings of our study. The results are discussed in the sixth section. Finally, we will draw the conclusions.

Energy management systems

Energy management systems, standards, practices and programmes

It has been acknowledged that there is sufficient potential to increase energy efficiency and reduce CO_2 emissions to meet future energy and climate targets (UNEP 2011). However, a wide range of barriers impede the tapping of this potential (see, e.g. SPRU 2000; de Groot et al. 2001; Sorrell 2003; Palm and Thollander 2010; Fleiter et al. 2012). These barriers are often classified in economic (e.g. hidden costs, risks, split incentive), organizational (e.g. company culture) and behavioural barriers (e.g. bounded rationality, inertia). Energy management is frequently considered as a means to overcome many of these kinds of barriers (Ates and Durakbasa 2012; Worrell 2011; Backlund et al. 2012).

Unfortunately, a generally accepted definition of '*energy management*' seems to be lacking (see e.g. Capehart et al. 2003; Carbon Trust 2011; VDI 2007; IEA/IIP 2012; DSA 2001). We will consider energy management as 'effectuating organizational, technical and behavioural actions in a structural and economically sound manner in order to minimize consumption of energy' (Senternovem 2004). Since energy use is often the main cause of CO_2 emissions for many companies, energy management is also considered the principle element of carbon management (Carbon Trust 2011). Therefore, in the remainder of this paper, no explicit distinction has been made between energy and carbon management.

Energy management needs to be an integral part of organization's wider management processes to be fully effective (Carbon Trust 2011; Capehart et al. 2003). The integration of energy management in the organization's overall management structure can be facilitated by using *energy management systems* (Thollander and Ottoson 2010). Various comparable definitions of energy management systems exist in academic and practitioner literature (Reinaud et al. 2012; ISO 2011; Kahlenborn et al. 2012; DSA 2001). We define an energy management system as 'a set of interacting procedures, processes and practices ensuring the systematic planning, implementation, monitoring and reviewing of activities for the continuous improvement of corporate energy or carbon performance'. The systematic approach in achieving continuous improvement is based on the Deming cycle or plan-do-check-act continual improvement framework (ISO 2011).

An *energy management standard* specifies the requirements of an energy management system. Several official energy management standards have been developed over the past years by (inter)national standardization bodies (DSA 2001; NSAI 2005; ANSI 2005; CEN 2009). The internationally acknowledged ISO-50001 (ISO 2011) is probably the most well-known standard for energy management. Companies can seek certification of their energy management system through accredited agencies to ensure complete compliance with such energy management standards. Apart from the (inter)national standardization bodies other parties, in most cases governments, can formulate non-standardized specifications or guidelines for energy management systems (Reinaud et al. 2012). Kahlenborn et al. (2010) and McKane et al. (2009) provide overviews of various energy management standards, specifications or guidelines developed over the past years.

A wide range of *energy management practices* is highlighted in energy management standards, specifications or guidelines (see e.g. EPA 2014; ISO 2011; Carbon Trust 2011). In general, the key practices include:

- Management involvement (making commitment to continuous improvement, providing organizational support and resources)
- Energy policy (setting targets, adopting procurement rules)
- Energy planning (drawing up action plans, assess opportunities)
- Implementation (taking measures, monitoring emissions, training of employees, communicating results)
- Checking (analysing and evaluating energy performance and progress)
- Reviewing (management review)

For a wide-spread adoption among target groups, energy management systems must be embedded in wider *energy management programmes* and be accompanied with other obligations, incentives or measures (Reinaud et al. 2012; Stenqvist and Nilsson 2012). Governments, NGOs and industries are therefore developing various approaches to promote the uptake of energy management systems (Dahlgren et al. 2014). These approaches may include for example mandatory energy management programmes, like in Japan (Kimura and Noda 2014); incentive-based energy management programmes, like in Sweden (Stenqvist and Nilsson 2012) and market-driven certification programmes for energy management like in the USA (Scheihing et al. 2013).

Evaluating performance of energy management programmes

In contrast with the large amount of research on the relationship between environmental performance and environmental management systems, see e.g. Heras-Saizarbitoria and Boiral (2013) and Nawrocka and Parker (2009), the amount of empirical research evaluating the benefits, performance and impacts of introducing energy management programmes is less extensive (Bunse et al. 2011). Below, we will briefly summarize the existing research.

The *motivations* for adopting energy management programmes have been researched by e.g. Okereke (2007), Kolk and Pinkse (2004). Companies mainly adopt these programmes to reduce costs and environmental emissions, prepare for or comply with governmental regulations, contribute to the design of climate policies and programmes, enhance corporate reputation, and increase eligibility for using financial incentives or other competitive advantages.

Various researchers studied the *barriers* (drivers) that inhibit (stimulate) the adoption of energy management systems. These include, in random order: the commitment of top management; appointed (ambitious) energy manager; employee awareness, involvement and motivation; priority given to energy management and energy issues; financial resources and organizational support; incentives or support programmes; organizational culture of continuous improvement and availability of information (based on Rudberg et al. 2013; Heindrichs and Busch 2012; Reinaud et al. 2012; McKane et al. 2009; Rohdin and Thollander 2006; SPRU 2000; Blass et al. 2014; Rohdin et al. 2007; Brown and Key 2003).

Several studies examined the *adoption* of energy management practices by firms in particularly industrial sectors in the context of different energy management programmes. In general, energy management practices were not widely adopted, even not among energy-intensive firms. Though, several studies suggested that especially well-organized, large and energy-intensive firms were more successful, active and motivated in adopting energy management practices compared to other firms (Ates and Durakbasa 2012; Thollander and Ottoson 2010; Lee 2012; Backlund et al. 2012; Brunke et al. 2014; Harrington et al. 2014; Christoffersen et al. 2006; Martin et al. 2012).

Only a few studies touch upon the *impact* of introducing energy management programmes on adopting new energy and carbon management practices. These studies, mainly using qualitative approaches, confirmed the positive *impacts* of introducing various types of energy management programmes, on adopting new energy and carbon management practices (Kimura and Noda 2014; Backlund et al. 2012; Helby 2002; Stenqvist et al. 2011; Krarup and Ramesohl 2002). Other studies, using more quantitative approaches, did not provide consistent evidence about the (direct) relationship between implementing energy management (systems) and firms' carbon and financial performance (Böttcher and Müller 2014; Lee 2012; Martin et al.

2012). A few studies assessed quantitative impacts of introducing energy management programmes on energy conservation in industrial sectors (Rietbergen et al. 2002; Cahill and Gallachóir 2012; Stenqvist and Nilsson 2012).

Most of the studies cited above focussed on evaluating the outcomes, rather than impacts, of introducing energy management programmes on improving energy management practices. Moreover, most studies focussed on evaluating energy management systems, practices and programmes in primarily industrial sectors. As a result, up until now, there is limited scientific insight into the impact of introducing energy management programmes on improving energy management practices in non-industrial sectors. In this research, we will therefore study the impact of CO_2PL as an example of an energy management programme introduced in a non-industrial sector, i.e. the construction and civil engineering sector.

The CO_2 Performance Ladder

The CO_2 Performance Ladder and energy management

The CO_2PL is a market-driven certification programme for energy and carbon management that can be used as a tool to reward climate-friendly behaviour when awarding contracts. It is based on the concept of energy maturity models (Ngai et al. 2013; Antunes et al. 2014; Introna et al. 2014) and discriminates five 'certification levels'. These certification levels indicate the maturity of the company's energy and carbon management. Hereby, companies should focus on four key topics to improve its energy and carbon management. These key topics are (A) drawing up CO_2 emission inventories, (B) setting and achieving CO_2 emission reduction targets, (C) transparency and communication of the company's CO_2 footprint and energy policy and (D) participation in (supply chain) initiatives. Table 1 shows the general requirements for each key topic that a company should meet for each maturity level. These general requirements are broken down into subrequirements that can be found in the CO_2PL handbook (SKAO 2014). Table 1 also shows some important subrequirements. These subrequirements are strongly linked to existing international standards for reporting greenhouse gas emissions (ISO-14064-1) and energy management (ISO-50001). A gap analysis of the ISO-50001 and CO_2PL learns that most of the ISO-50001 requirements for energy management systems have been covered by requirements for key topics A and B of the CO_2PL at level 3, which includes management involvement, energy policy and planning, implementation, checking and reviewing. Some detailed subrequirements in ISO-50001 being part of the paragraphs on 'energy review', 'energy objectives, energy targets and energy management action plans' and 'monitoring, measurement and analysis' have not been explicitly covered in the CO_2PL. The requirements for internal auditing are more concise in the CO_2PL than in ISO-50001. The CO_2PL specifies requirements that go beyond the ISO-50001 standard, particularly in key topics C and D. See Primum (2014) for the full gap analysis.

The company decides about the aspired certification level (1–5). It prepares a self-assessment report to ensure that the company's energy and CO_2 management complies with the CO_2PL requirements. A portfolio of several audit documents, such as policy documents, technical reports, annual reports, communication procedures, is prepared for an external audit. A third party organization conducts an independent certification audit to verify whether the subrequirements for all key topics, linked to the aspired certification level and the preceding levels, are met. The company is awarded a 'CO_2PL certificate' indicating the achieved level. Companies qualify for a competitive advantage in the awarding of procurement contracts, depending on the achieved certification level. For more information about the certification process, the use of the CO_2PL in public procurement procedures and the competitive advantage in awarding contracts, the reader is referred to SKAO (2014).

Literature review on the CO_2PL

The number of peer-reviewed academic papers on the CO_2PL is still limited. Dorée et al. (2011) analysed the critical success factors of the scheme, being the certification combined with incentive mechanisms, the institutional embedding and the attention given to the support structure. Rietbergen and Blok (2013) claimed that CO_2 emissions of participating companies could potentially be reduced by 0.8–1.5 %/year in absolute terms, which would be sufficient to keep up the pace

Table 1 General requirements and some important subrequirements of the CO_2PL

Level	A: insight	B: reduction	C: transparency	D: participation
1	The company has partial insight into its energy consumption.	The company investigates opportunities for reducing energy consumption.	The company communicates its energy reduction policy on an ad hoc basis.	The company is aware of sector and/or supply chain initiatives.
2	The company has an insight into its energy consumption.	The company has an energy reduction target, described in qualitative terms.	The company communicates its energy policy internally (to a minimal degree) and possibly externally.	The company is a passive participant in initiatives aimed at reducing CO_2 emissions in or outside the sector.
	—The company has an up-to-date energy audit report.	*—The reduction objective has been endorsed by higher-tier management.*	*—The company has an effective steering cycle with designating responsibilities.*	
3	The company has converted its energy consumption into CO_2 emissions	The company has quantitative CO_2 reduction objectives for its own organization.	The company communicates about its carbon footprint and reduction objectives both internally and externally.	The company is an active participant in initiatives aimed at reducing CO_2 emissions in or outside the sector.
	—The company has a detailed and up-to-date emissions inventory for the actual scope 1 & 2 emissions in accordance with ISO 14064–1. *— The emissions inventory is verified by a certifying organization to at least a limited degree of certainty.*	*—The company has drawn up an energy management programme (in accordance with EN50001 or equivalent), which has been endorsed by higher-tier management, communicated internally and externally, and implemented within the company.*	*—The company has a documented internal and external communication plan with designated tasks, responsibilities and methods of communication*	
4	The company reports its carbon footprint in accordance with ISO-14064-1 for scopes 1, 2 and 3.	The company has quantitative CO_2 reduction objectives for scopes 1, 2 and 3 CO_2 emissions.	The company maintains dialogue with government bodies and NGOs about its CO_2 reduction objectives and strategy.	The company initiates development projects that facilitate reductions in CO_2 emissions in the sector.
5	The company requires that its A-suppliers have a scopes 1 and 2 emissions calculation in accordance with ISO-14064-1.	The company reports on a structural and quantitative basis the results of the CO_2 reduction objectives for scopes 1, 2 and 3.	The company is publicly committed to a government or NGO CO_2 emission reduction programme.	The company takes an active part in setting up a sector-wide CO_2 emission reduction programme in collaboration with the government or an NGO.
		—The company succeeds in meeting its reduction objectives		

Source: SKAO (2014)

with the annual reduction rate necessary to remain below the 2020 Dutch emission ceiling for sectors not participating in the European Union emission trading scheme (EU-ETS). Rietbergen et al. (2014) concluded that the target-setting process in the CO_2PL did not necessarily lead to the establishment of the most ambitious goals for CO_2 emission reduction. These aforementioned papers did not address the impact of the CO_2PL on improving energy management. A range of other non-peer-reviewed papers, theses and reports on different aspects of the CO_2PL has been published (Addo-Nkansah et al. 2012; Boersen 2013; Oost 2012; Oudejans 2012; Wilbrink 2012; Primum 2012). The latter two references are the most relevant for this research. Wilbrink (2012) studied the impacts of the CO_2PL on business operation, CO_2 emission reductions and the costs of the scheme in the very early stage of the CO_2PL. Primum (2012) primarily evaluated how well the CO_2PL was implemented by certified companies.

Research questions, methods and data collection

Research questions, topics and methods

The main research question addressed in this study is 'What is the impact of the CO_2 Performance Ladder on improving energy and carbon management and CO_2 emission reduction in construction and civil engineering firms'. A mixed methods approach, combining both qualitative and quantitative data collection techniques and analysis procedures (Saunders et al. 2009), was used to investigate the impact of the CO_2PL on improving energy and carbon management in the involved companies. The research has been broken down into five topics.

- First, we investigated the main characteristics of the CO_2PL, the participants' opinion about the CO_2PL and the main reasons for participating in the scheme.
- Second, we investigated whether the CO_2PL has had significant effects on adopting new energy and carbon management practices in certified firms. Personal interviews with corporate representatives responsible for coordinating the implementation of the CO_2PL were conducted to identify the impact of the CO_2PL on improving corporate energy management practices, see the appendix for the questionnaire. The main interview topics included are the organizational changes, the monitoring and analysis of energy use and CO_2 emission reduction, the functioning of the plan-do-check-act cycle, the management involvement, target setting for CO_2 emission reduction and employee involvement. A fully comparable control group was not available since all major companies in the construction and civil engineering sector already participated in the CO_2PL. However, some smaller non-certified companies in the same sector were used as a control group.
- Third, we studied whether additional energy conservation and CO_2 emission reduction measures have been taken by certified firms, due to the CO_2PL. The various measures were taken from companies' energy management plans and websites. The impact of the CO_2PL on taking these measures is rated by the interviewees conforming to the method by Rietbergen et al. (2002).
- Fourth, we investigated the achieved CO_2 emission reductions due to energy efficiency improvements and fuel switching (thus excluding reductions from changes in production output), the additional impacts of the scheme on CO_2 emission reduction and the goal achievement of CO_2 reduction targets. The necessary data were taken from corporate energy management plans, annual company CO_2PL progress reports and databases with company information on turnover.
- Fifth, as the CO_2PL was probably not the only driver for changing energy management practices, the influence of other contextual drivers, such as corporate strategies, other governmental policies and market-based standards, was also discussed during the interviews.

This research specifically focusses on the impact of the CO_2PL on improving internal energy and carbon management practices and CO_2 emission reductions. The impact of the CO_2PL on managing supply chain CO_2 emissions is not a focal point of our research.

Research population

The target population to which we want to generalize the research findings was limited to firms that met the following conditions. Companies must have obtained a CO_2PL certificate at least before the second quarter of 2012 because companies must have had sufficient time to implement the CO_2PL as an energy or carbon management system. Furthermore, only companies with a CO_2 footprint larger than 5 ktons of CO_2 emissions in scopes 1 and 2 were included since these companies were roughly responsible for about 80 % of the total emissions covered by the CO_2PL scheme (Rietbergen and Blok 2013). Finally, companies must still be an active participant in the CO_2PL. The target population consisted of 57 firms out of more than 500 certified companies (date: February 2014), covering about 1.48 Mtons of aggregated CO_2 emissions in 2013. Table 2 shows the company profiles of the research population. Most companies had construction and civil engineering as their main activity. All companies were classified as large companies since they generally exceed the criteria for small- and medium-sized enterprises according to CEC (2003).[1]

Interview sample

Thirty-three companies, which were randomly selected from the target population, were contacted to participate in the research. Finally, a sample of 25 firms was selected (companies 1–25 in Table 2); six firms were rejected because a new CO_2PL coordinator was recently appointed; and two firms were not willing to participate. The interviewees held varying positions such as sustainability, health, environment and quality (SHEQ) manager; sustainability officer; environmental coordinator;

[1] The number of large construction companies in the Netherlands, each employing more than 100 people, was 320 in the year 2014 (CBS 2014).

director; energy consultant etc. In total, 27 interviews with 34 representatives of 25 certified companies were conducted in the period from March 2014 until July 2014. In December 2014, seven additional interviews were conducted with non-certified companies (companies 58–64 in Table 2). These latter companies were shortlisted on the Cobouw 50, a list with the 50 largest companies in the construction and civil and engineering sector in the Netherlands (Cobouw 2013).

Interview procedure and data analysis

The semi-structured interviews were mostly conducted by alternating couples of interviewers. The interviews, that typically took 100 to 120 min, were tape recorded, fully transcribed and sent back to the interviewees for review and approval. The interview guide, that contained open-end questions and short questionnaires with closed questions, was based on a literature review of the CO_2PL, energy and environmental management systems (see 'Energy management systems' and 'The CO_2 Performance Ladder'). The transcripts were coded, cross checked and categorized for further textual analysis by using QSR NVIVO 10 software package (QSR 2012). In 'Research findings', the similarity in the responses was reported as follows: 0–25 % agreement was categorized as 'low' or a 'few'; 25–50 % was categorized as 'several'; 50–75 % was categorized as 'considerable', 'substantial' and 'the majority'; and 75–100 % was categorized as 'high' or 'most'. Some quotes of interviewees were translated from Dutch to English and cited in the research findings. The capital letters in curly brackets refer to certified companies but cannot be directly linked to the companies in Table 2 to maintain participant anonymity.

Research findings

This section presents the following topics: the general opinion about the CO_2PL ('General opinion about the CO2 Performance Ladder'), the motivations to adopt the CO_2PL ('Motivation for adopting the CO2 Performance Ladder'), the impacts on improving energy management practices ('The impact on improving energy management practices'), the contextual drivers for energy and carbon management ('Contextual drivers for energy and carbon management'), the implemented measures for energy efficiency and CO_2 emission reduction ('Implemented measures for energy efficiency and CO2 emission reduction') and the quantitative impacts of the scheme on CO_2 emission reduction ('CO2 emissions reductions, additionality and goal achievement').

General opinion about the CO_2 Performance Ladder

Participating firms generally had a positive attitude towards the concept of energy and carbon management introduced by the CO_2PL: 'I think it is a good instrument to create awareness about your emissions, to continuously improve your energy management and to reduce your emissions.' {D}, 'Energy was considered as a necessary evil. You need energy to do construction work. We did not think about energy efficiency in our work, and that has certainly changed due the introduction of energy and carbon management.' {I}. Though, there was a wide range of critical remarks among almost all firms that could not easily be ignored. Companies were critical about the application of the CO_2PL in procurement procedures, such as: 'There is limited capacity to distinguish yourself in contract procurement because all the competitors are at the same level.' {J}, 'It has become a commercial rat race.' {E}, 'It is just a checkbox that must be ticked in contract awarding procedures.' {S}; about the format of the scheme, such as: 'There is limited continuity in the scheme's requirements.' {D}, 'The requirements are multi-interpretable.' {D}, 'SKAO created their own standards instead of building close upon existing ISO standards.' {T}, and other issues such as: 'It is so simple to obtain a level 5 certificate … you don't have to put effort in it.' {B}, 'It's just paper work.' {S}, 'It's more a checklist rather than a management system.' {Q}, 'The scheme narrows the focus to CO_2 while other CSR topics are also important.' {E}.

Motivation for adopting the CO_2 Performance Ladder

Almost all companies primarily adopted the CO_2PL because of the (expected) competitive advantage in contract awarding. The CO_2PL can give companies competitive benefits, either as a pre-qualification criterion (preceding the tendering) or as a contract award criterion. Relevant quotes of interviewees include: 'We have adopted the CO_2PL because you cannot bid on ProRail works without a CO_2PL certificate and you will lose a lot of revenue.' {D}, 'You'll have to take part in

Table 2 Profiles of (interviewed) companies

Company name	n[a]	CO_2PL Level	Certified since (Q/year)	NACE[b]	CO_2 emission reduction target				CO_2 emissions reduction			Other policies, standards and certifications		
					Type[c]	Start–end	Target (%/year)	Achieved (%/year)	2013 (tons)	Reduction (%/year)	Period	ISO14001	CSRPL	LTA3
1 ARCADIS	2	5	1/2010	71	CO_2/FTE	2008–2015	−1.2	−3.3	6686	−5.0	2008–2013	Yes	No	No
2 Baas	1	3	4/2010	42, 43	CO_2/FTE	2009–2015	−2.7	−4.3	3930	−9.6	2009–2013	No	No	No
3 Ballast Nedam	1	5	4/2009	41, 42	CO_2/M€	2008–2020	−2.9	−3.8	50,000	−8.9	2008–2013	Yes	No	Yes
4 BAM Civiel	2	5	4/2010	41, 42	CO_2/M€	2009–2015	−2.7	#N/A	5523	−11.0	2009–2013	Yes	No	No
5 BAM Infratechniek	1	5	2/2010	41–43, 71	CO_2/M€	2009–2015	−2.7	#N/A	15,670[d]		2009–2010	Yes	No	No
6 BAM Rail	2	5	2/2010	42	CO_2	2009–2012	−5.3	−8.8	6272	−8.9	2009–2013	Yes	No	No
7 Beelen Recycling	2	5	1/2012	38, 43	CO_2/M€	2010–2013	−2.7	1.7	14,814	18.9	2010–2013	Yes	Yes	No
8 Besix	2	5	4/2010	41, 42	CO_2/M€	2009–2015	−1.7	−5.4	5729	−3.1	2009–2013	Yes	No	No
9 Boskalis	2	5	2/2011	42	CO_2/M€	2009–2020	−0.5	−13.3	61,710	−17.8	2009–2013	Yes	No	No
10 Den Ouden Groep	1	3	3/2011	38, 42, 43	CO_2/M€	2010–2014	−2.1	1.1	6914	−3.7	2010–2013	Yes	No	No
11 Gebroeders van't Hek	1	3	1/2011	42	CO_2	2010–…..[e]	−2.0	−2.6	6606	1.3	2009–2013	No	No	No
12 GMB	1	5	1/2011	41–43	CO_2/M€	2009–2015	−4.1	−7.6	14,490	1.3	2009–2013	Yes	No	No
13 GP Groot Infra	1	4	3/2011	38, 42	CO_2/FTE	2011–2020	−2.0	2.8	14,800	8.4	2011–2013	Yes	No	No
14 Heijmans	1	5	4/2010	41–43	CO_2/M€	2012–2016	−1.5	−0.2	45,234	−6.3	2009–2013	Yes	No	Yes
15 Imtech	1	5	1/2010	42, 43	CO_2	2008–2013	−2.1	−3.0	8549	−1.8	2008–2013	Yes	No	No
16 Mourik	2	5	1/2011	41–43	CO_2/M€	2009–2020	−2.0	−4.8	11,230	−2.6	2009–2013	Yes	Yes	No
17 Ooms Civiel	1	5	1/2011	41–43	CO_2/M€	2009–2014	−2.1	0.5	11,080	−4.0	2009–2013	Yes	No	Yes
18 Ordina	2	3	3/2011	62	CO_2/FTE	2010–2020	−2.2	0.2	15,281	−3.0	2010–2013	Yes	No	Yes
19 Strukton Groep	1	5	4/2009	41–43, 71	CO_2/M€	2009–2020	−1.5	−3.8	36,708	−6.2	2008–2013	Yes	No	Yes
20 Strukton Rail	1	5	4/2009	42	CO_2/M€	2008–2020	−1.3	−3.1	15,902	−0.3	2008–2013	Yes	No	No
21 TKF	1	3	2/2011	27, 35	CO_2/M€	2009–2015	−4.7	−4.3	9761	−2.1	2009–2013	Yes	No	No
22 Van Gelder Groep	1	5	3/2011	42, 43, 71	CO_2/FTE	2010–2015	−1.%	−11.4	8100	−5.3	2010–2013	Yes	No	Yes
23 VHB	1	5	4/2010	41, 42	CO_2	2009–2015	−1.0	2.3	4466	1.0	2009–2013	Yes	No	No
24 Van Wijnen	2	5	1/2011	41	CO_2	2009–2015	−2.1	−4.2	8196	−3.4	2009–2013	Yes	No	No
25 Wolter en Dros	1	4	1/2010	43	CO_2/M€	2011–2013	−0.1	−3.8	5273	−8.5	2008–2013	Yes	No	No
26 A. Hakpark	–	3	3/2011	41, 42	CO_2	2011–2012	−2.0	12.0	24,798	2.7	2010–2013			
27 A. Jansen	–	3	3/2011	43	CO_2	2010–2014	−0.5	−9.4	11,617	−11.8	2010–2013			
28 J.P. van Eesteren	–	4	4/2010	41	CO_2/M€	2012–2015	−7.2	2.8	2357	−32.0	2011–2013			
29 Geluk	–	3	1/2012	42	CO_2 eff.	2009–2015	−10.0	#N/A	5697	−1.1	2009–2013			
30 ABB Benelux	–	3	2/2011	71, 33	CO_2/FTE	2009–2019	−2.5	−16.6	5706	−19.8	2009–2013			
31 Baggerbedrijf de Boer	–	3	1/2012	42	CO_2	2010–2015	−0.9	2.2	27,737	1.4	2010–2013			
32 BAM Wegen	–	5	4/2009	41–43	CO_2	2011–2015	−0.5	−0.1	47,293	−3.4	2008–2013			
33 Capgemini	–	4	1/2011	66	CO_2	2011–2016	−6.9	−5.5	33,636	−9.0	2009–2013			
34 Croon Elektrotechniek	–	4	2/2010	27	CO_2/h	2011–2015	−2.9	−0.2	8476	3.5	2008–2013			
35 Dura Vermeer	–	5	4/2009	41–43	CO_2/FTE	2010–2014	−1.3	−4.7	29,281	−7.0	2009–2013			
36 Fri-Jado	–	4	3/2010	28	CO_2/FTE	2009–2012	−9.1	−9.2	3684	−9.3	2009–2013			
37 Gebr. Van der Lee	–	3	3/2011	42, 43	CO_2/M€	2010–2013	−1.0	#N/A	23,705	−0.4	2010–2013			
38 De Vries & Van De Wiel	–	4	2/2010	43	CO_2	2011–2020	−1.0	−5.5	12,259	−3.5	2010–2013			

Table 2 (continued)

Company name	n[a]	CO_2PL Level	Certified since (Q/year)	NACE[b]	CO_2 emission reduction target				CO_2 emissions reduction			Other policies, standards and certifications		
					Type[c]	Start–end	Target (%/year)	Achieved (%/year)	2013 (tons)	Reduction (%/year)	Period	ISO14001	CSRPL	LTA3
39 Grontmij Nederland	–	5	2/2011	74	CO_2/FTE	2009–2015	−4.8	−1.2	7526	−9.3	2009–2013			
40 Hollandia	–	5	3/2011	25	CO_2/h	2013–2020	−3.1	#N/A	6542	−7.8	2010–2013			
41 Antea	–	5	4/2010	71	CO_2/FTE	2009–2015	−4.7	−6.7	4222	−10.1	2009–2013			
42 Joulz	–	5	4/2011	35	CO_2/FTE	2007–2020	−2.2	−9.4	11,953	2.1	2010–2013			
43 KWS Infrabouw	–	5	2/2010	42	CO_2 eff.	Multiple	#N/A	#N/A	92,357	0.0	2009–2013			
44 Martens en Van Oord	–	3	4/2010	42, 43	CO_2 eff.	2009–2020	−1.0	−0.9	19,778	4.0	2009–2013			
45 ProRail	–	4	1/2010	49, 71	CO_2	2010–2020	−13.5	−34.3	18,500	−37.4	2008–2013			
46 Rexel Nederland	–	3	2/2011	46	CO_2/FTE	2010–2015	−8.8	−17.0	2516	−22.2	2010–2013			
47 RoyalhaskoningDHV	–	5	1/2010	71	CO_2/FTE	2012–2017	−4.4	−8.3	12,071	−17.8	2012–2013			
48 Shanks	–	3	1/2012	37, 38	CO_2/M€	2010–2020	−1.0	−3.5	391,686	−2.0	2010–2013			
49 Theo Pouw	–	3	1/2012	38	#N/A	#N/A	#N/A	#N/A	62,260	5.3	2010–2013			
50 van den Herik Sliedrecht	–	4	4/2011	41–43	CO_2/M€	2010–2013	−1.7	−12.6	6225	0.0	2009–2013			
51 Van Gansewinkel Groep	–	3	3/2010	38	CO_2 eff.	2010–2014	#N/A	#N/A	112,410	4.8	2010–2013			
52 Van Oord Nederland	–	5	4/2010	41–43	CO_2 eff.	2010–2015	−1.0	−4.8	42,119	−44.4	2009–2013			
53 Vialis	–	4	4/2010	71	CO_2	2009–2013	−6.3	−10.3	3683	−12.6	2009–2013			
54 Victor Buyck	–	4	3/2011	25	CO_2/h	2009–2014	−2.1	−10.8	4961	−7.1	2009–2013			
55 Visser & Smit Hanab	–	3	3/2011	42–43	CO_2/M€	2013–2016	−1.7	#N/A	21,024	−5.4	2010–2013			
56 Volker Rail Nederland	–	5	4/2009	25, 42, 71	CO_2 eff.	2009–2015	−2.7	#N/A	10,642	−0.4	2008–2013			
57 VWBVGO	–	4	2/2012	41	CO_2/M€	2011–2014	−1.7	−2.9	22,147	−9.1	2010–2013			
									1,483,805	−7.4	2010–2013			
58 De Nijs	1	Not certified		41	No				1268			Yes	No	Yes
59 De Vries & Verburg	1	Not certified		41	No				1000			Yes	No	Yes
60 Giesbers bouw	1	Not certified		41	CO_2/M€	2011–2017	−4.7		731			Yes	No	No
61 Hurks	1	Not certified		41	No				No			Yes	No	No
62 Nijhuis	1	Not certified		41	No							No	No	Yes
63 Plegt Vos Infra	1	Not certified		41, 42	CO_2/FTE	2009–2020	−3.0					Yes	No	No
64 Ten Brinke	1	Not certified		41	No				No			No	No	No

[a] Number of interviewees

[b] NACE codes: 25 = Manufacture of structural metal products; 27 = manufacture of electrical equipment; 33 = repair and installation of machinery and equipment; 35 = electricity, gas, steam and air conditioning supply; 38 = waste collection, treatment and disposal activities and material recovery; 41 = construction of buildings; 42 = civil engineering; 43 = specialized construction activities; 46 = wholesale trade, except of motor vehicles and motorcycles; 49 = land transport and transport via pipelines; 62 = computer programming, consultancy and related activities; 66 = activities auxiliary to financial services and insurance activities; 71 = architectural and engineering activities and technical testing and analysis (EC 2008)

[c] CO_2 = volume target for CO_2 emission reduction, CO_2/FTE = CO_2 emission reduction target measured against full time equivalents, CO_2/h = CO_2 emission reduction target measured against man hours or productive hours, CO_2/M€ = CO_2 emission reduction targets measured against turnover or production value, CO_2 eff. = other CO_2 efficiency targets

[d] CO_2 footprint 2010

[e] Rolling base year

the CO_2PL for a 10 % competitive advantage, since margins are very low. We should be glad if we can get 2–3 % margin.' {E}, 'The reason to adopt the CO_2PL is purely commercial. You cannot afford to miss 5 or 10 % compared to your competitors.' {J}. Secondary reasons for adopting the CO_2PL were improving public image; seeking confirmation of previous efforts on energy efficiency improvement or CO_2 emission reduction; broadening of existing CSR policies and strategies; reducing CO_2 emissions; reducing cost and complying with requirements of the holding company, clients or customers. Several firms (not included in our sample) did not continue their certification (see www.skao.nl) after the expiring date since the CO_2PL did not give them additional competitive benefits compared to other existing CSR policies and certifications.[2] Among the companies not holding a CO_2PL certificate, the lack of competitive benefits, the narrow focus of the scheme and the lack of priority for CO_2 emission reduction were the main reasons for not participating in the scheme up until now. However, three of these non-certified firms claimed that a CO_2PL certificate could be obtained easily since they fulfil the (most important) CO_2PL requirements.

The impact on improving energy management practices

We asked interviewees to rate on a 0–3 point scale the state of various energy management practices at present and 1–2 years prior to the introduction of the CO_2PL. Interviewees could choose whether these energy management practices were fully implemented, implemented on an average level, partly implemented or non-existent in the daily business operation. No specific indicators were given to distinguish between the various levels. See appendix for the questionnaire.

Figure 1 reveals that on average, almost none of the energy management practices were even partly implemented in the daily business operation prior to the introduction of the CO_2PL. Since the introduction of the CO_2PL, all these energy management practices have improved significantly. In the following paragraphs, the results presented in Fig. 1 are discussed in more detail by linking them to the responses on the open-end interview questions.

Management involvement

A positive shift in the boards of directors' attitude towards energy management was observed among almost all companies since the introduction of the CO_2PL. Prior to the introduction of the CO_2PL, the majority of the boards of directors were not actively involved in energy and CO_2 management, did not explicitly hold responsibilities for energy and CO_2 management and did not show any leadership on this topic. Since the introduction of the CO_2PL, the boards of directors have, in general, become much more responsible, concerned and involved in their companies' energy and CO_2 management. For example, interviewees stated that 'CO_2 and energy management have become a recurring topic on management meetings.' {L}, 'CO_2 has even become part of the remuneration package.' {P}, and 'The board of directors decides upon CO_2 emission reduction measures, even before we propose them.' {G}. Not surprisingly, this attitude shift was mainly driven by the commercial benefits of holding a CO_2PL certificate, the multiple benefits of CO_2 emission reduction and sustainable business strategies, the obligations of the CO_2PL scheme and in some cases the intrinsic motivation of individual board members. The interviews also revealed more critical quotes that highlighted the boards of directors' very pragmatic attitude towards the CO_2PL like 'The CO_2PL is not a matter of choice, but a need.' {B}, 'The only thing the board of directors wants from us is that we reduce energy, implement nice projects and keep the CO_2PL certificate on the wall.' {X}, 'There are also managers that say: 'please deliver me this certificate once a year, and I don't want to see your face for another year'.' {J}. Despite these critical remarks about the management involvement, the majority of the interviewees said that there was sufficient management support to implement the basic elements of the CO_2PL properly. Among non-certified companies, management is more dedicated towards implementing a broader CSR strategy in their corporate business rather than a specific CO_2 emission reduction strategy.

Organizational changes

Prior to the introduction of the CO_2PL, people from various departments, such as the purchasing manager, administrators/accountants, building and facility managers and equipment support managers, already held responsibilities for the companies' energy management.

[2] Based on a telephone survey among these companies.

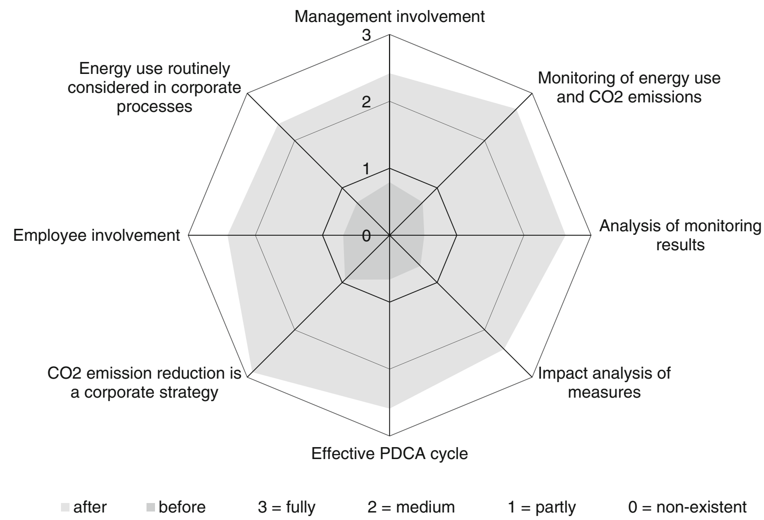

Fig. 1 Participant group self-reported comparison of energy management practices, before and after the implementation of the CO_2PL ($n = 25$)

Energy management was however often not a coordinated effort yet in the majority of the companies. In most companies, a small CO_2PL project team was formed to initiate the (further) development of the company's energy and carbon management, to implement the CO_2PL in the organization and to obtain the CO_2PL certification. After having implemented the CO_2PL, one specific staff member became responsible for coordinating the continuous improvement of the energy and CO_2 management, being the linking pin between the management, the rest of the company and a CO_2PL team. The size of the CO_2PL team (2–6 persons) and its character (multidisciplinary group on CO_2PL, part of CSR group, duo of management—CO_2PL coordinator), the frequency of the meetings (4–20 times per year), the amount of extra appointed staff for the CO_2PL (extra staff or tasks assigned to existing staff), the responsible departments (e.g. SHEQ, CSR), and type of management (project management vs line management) differed widely among the certified firms. However, the majority of the interviewees agreed that there was sufficient organizational support for implementing the CO_2PL.

Monitoring and analysing energy use and CO_2 emissions

The practice of monitoring energy use and CO_2 emissions, the analysis of energy use and CO_2 emissions and the impact analysis of measures have changed substantially since the implementation of the CO_2PL. In most of the companies, information about energy consumption was already available prior to the introduction of the CO_2PL, mainly through energy bill payments. However, real 'insight' in the energy flows and CO_2 footprint was lacking. Almost all companies agreed that, due to the CO_2PL, better insight was gained in the CO_2 emissions and energy use, e.g. by (sub)metering of energy use, gathering more (detailed) data, frequently drawing up monitoring reports, and internal discussions about energy use and CO_2 emissions (see Fig. 2). Relevant quotes include for example: 'The CO_2PL provided us with insight in our energy use and CO_2 emissions. Prior, we did not know whether we emitted 100 kg of CO_2 or 1 million tons of CO_2.' {W}, 'Prior to the CO_2PL, half of CO_2 footprint was based on guesswork, simply because we did not have the data.' {G}, 'It turned out that we have been paying the energy bills of office space that did not belong to us anymore. There was simply no one who was checking these kinds of things.' {I}. Apart from the CO_2PL, company reorganizations, strengthened internal cooperation and centralized procurement of energy also considerably enhanced the insight in the companies' energy use and CO_2 emissions. Almost all companies introduced certain performance metrics to further analyse these energy use and CO_2 emission data on company level (see also section 'Setting CO2 emission reduction targets'). The level of detail of the more in-depth analysis of energy efficiency and CO_2 emission performance varied widely among the certified firms (e.g. at the level of buildings,

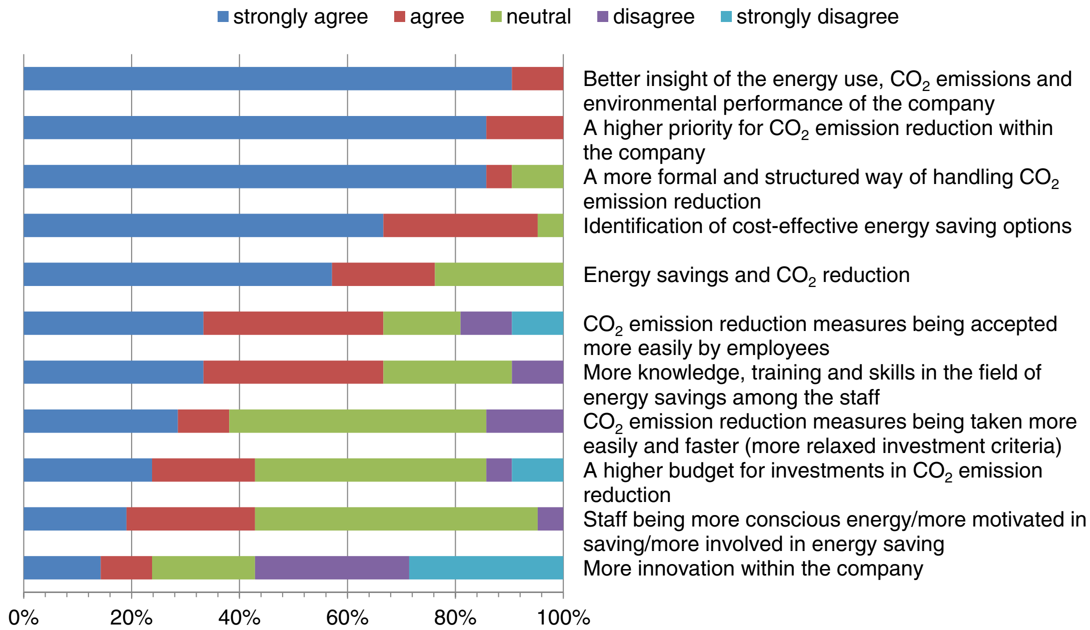

Fig. 2 Responses to the question "The CO_2PL contributed to …"

projects, machinery, individual cars). Companies stressed the difficulty of developing meaningful performance metrics, e.g. due to the project-based type of work, varying types of construction and civil engineering activities and the wide use of subcontractors. Although companies claimed to have enhanced their insight in the impact of CO_2 emission reduction measures, this is limited to easily measurable CO_2 emission reductions of purchasing green electricity and driving more efficient lease cars. The majority of the non-certified companies also started to make CO_2 footprints on an annual basis since around 2012, however, with varying consistency, accuracy and completeness. Further analysis of these data seemed to be limited among the non-certified companies.

Plan-do-check-act cycle

Certified companies generally agreed that the CO_2PL facilitated the introduction of a plan-do-check-act (PDCA) cycle for energy management in their business operation, resulting in a more formal, structured and planned approach for energy savings and CO_2 emission reduction (see Fig. 2). Prior to the introduction of the CO_2PL, a PDCA cycle for energy and CO_2 management was almost non-existent in many companies, except for the very energy-intensive, large or ISO-14001-certified firms. Even these firms that already implemented some kind of PDCA cycle for energy management prior to the CO_2PL agreed that CO_2PL improved their steering cycle, e.g. by more specific attention to CO_2, more regular audits and communication requirements. Non-certified companies just recently integrated energy efficiency and CO_2 emission reduction as one of the topics in PDCA cycles for ISO-14001 or CSR Performance Ladder,[3] if available.

Quotes from certified companies that underline the importance the PDCA cycle for energy and CO_2 management include: 'In the beginning, many measures were introduced, but there was no steering cycle, nobody was responsible, and therefore many measures failed.' {H}, 'The PDCA steering cycle works … you will have to face the facts regularly, it should not be something that you do only once, otherwise the continuous improvement cycle does not work properly.' {K}, 'Iterating the PDCA cycle, making it a recurring topic on the agenda and then it will be properly embedded in the business operation. In some cases this means that the paperwork shows that nothing has been done for a long

[3] The CSR Performance Ladder is a management system for corporate social responsibility (FSR 2014). Companies that have adopted the CSR Performance Ladder may also competitive benefits in contract awarding procedures.

time, which is important signal for the companies' management.' {S}. Thus, at least at administrative level, the CO_2PL has ensured that CO_2 is more routinely considered in the corporate processes. Key elements in the PDCA cycle, like the annual external audits, the internal audits and bi-annual reporting requirements and management reviews, were generally considered as useful triggers for putting regular attention to the companies' energy and CO_2 management. Despite these positive impacts, several signals showed that the PDCA cycle did not always work properly. Several companies said that the lack of 'acting' impeded the continuous improvement cycle: 'The steering cycle exits: Plan, Do, Check and then … Act, but there the steering cycle is failing due to the limited priority given to energy and CO_2 emission reduction within the company.' {U}, 'The problem is that after three quarters of the steering cycle you sometimes fail to 'Act', to give the finishing touch, to evaluate and to decide whether energy saving or CO_2 emission measures will become a standard part of the business operation.' {F}. The lack of financial resources/cost-effective CO_2 emission reduction opportunities was also considered as a barrier for the continuous improvement of energy management among a few firms: 'We are losing interest in the CO_2PL since the low-hanging fruits have been picked.' {S}, 'The PDCA cycle is still in place; however it is being cut off somewhere, since there are no financial resources to invest.' {T}.

Setting CO_2 emission reduction targets

Since the introduction of the CO_2PL, CO_2 emission reduction has become a corporate strategy for all firms, amongst others due to explicit requirement of setting companywide CO_2 emission reduction targets. Prior to the introduction of the CO_2PL, almost none of the certified companies established such targets, except the few energy-intensive companies in our research (see also 'Plan-do-check-act cycle' section). Among non-certified companies, the number of firms that have established CO_2 emission reduction target was still low. The CO_2PL allows that companies can set different type of CO_2 emission reduction targets. The main target types were volume targets for CO_2 emission reduction, targets for CO_2 emission reduction measured against FTE and targets for CO_2 emission reduction measured against turnover or production value. Table 2 provides an overview of the target types and levels for each company. For further insights in the process of setting CO_2 emission reduction targets, see an earlier study by Rietbergen et al. (2014).

Employee involvement, awareness and training

Several certified companies think that stigmas about energy use in the construction and civil engineering sector, like 'The more fuel you burn, the harder you work.' {H}, 'We have all been raised by the idea that the chimney must exhaust smoke to earn money.' {M}, 'On a construction site a generator must run 24/7. That is sustainable, otherwise you are going bankrupt.' {J}, are gradually being tackled, also due to the CO_2PL. These companies agreed that the CO_2PL helped creating awareness among the employees about energy use and CO_2 emissions, started motivating people to contribute to energy conservation and CO_2 emission reduction and involved them in energy and carbon management (see Fig. 2): 'Creating awareness by the CO_2PL is very important … that is what makes people change their behaviour.' {A}, 'You need to report your footprint, draw up plans, implement measures and review … thus automatically people will become more aware than in the past.' {R}, 'You feel that CO_2 is becoming an issue also among project leaders, just like the topic of safety performance introduced 10 years ago.' {M}. Companies are also modestly positive about increased training opportunities, knowledge and skills about energy and CO_2 among employees, such as eco-driving instruction, toolbox meetings (short talks delivered at the workplace) about energy use and training for the efficient use of machinery. Though, the majority of the companies agreed that adoption of energy management practices, that go beyond management and staff levels, are difficult, slow and not effective yet. The main reason is that energy conservation and CO_2 emission reduction still do not have very high priority yet among construction companies. 'For the guys that are paving the roads with asphalt during the night, safety is their main concern and not CO_2 emission reduction. For sure that they use strong construction site illumination.' {J}. Energy conservation and CO_2 emission reduction is in most cases still considered as a by-product of measures that reduce costs, save time or increase safety performance: 'For example, employees propose a different construction method that saves time … so you need less energy for your construction site hut

… in that order.' {F}, 'The e-driver training programme is first of all a measure to reduce costs and improve safety performance … and as a result it also reduces CO_2 emission.' {U}. Other barriers for implementing energy conservation and CO_2 emission reduction measures in projects were experienced discomfort of energy-saving measures: 'We have installed start-stop switches in our mobile equipment, a smart idea, … till someone cut through the wires of the start-stop system during winter times, when engines cool down rapidly.' {S}; inertia: 'People are aware of the impact of their driving style on emissions. Changing driving style is something that we are working on, but that is not something you change today or tomorrow.' {W}; and lack of communication: 'Most employees at the buildings sites do not have an e-mail address, so it is very difficult to reach them.' {A}. Thus, CO_2PL has not ensured yet that CO_2 is routinely considered in the corporate processes at lower levels in the organization. Therefore, companies have introduced strategies, such as constantly repeating the CO_2 message, implementing measures one by one instead of all measures at once, trying to eliminate the human factor, and more frequent checks, to overcome these aforementioned barriers.

Contextual drivers for energy and carbon management

In the previous section, we have seen that various new energy and carbon management practices have been adopted since the introduction of the CO_2PL. The question is however whether the adoption of these energy and carbon management practices can be fully attributed to the CO_2PL or whether other contextual drivers, such as corporate strategies for cost reduction and sustainability, governmental policies and market-based standards/certifications have been dominant as well.

Cost reduction and *sustainability* were generally considered as the most important drivers for implementing energy conservation measures. Cost efficiency has already been a priority issue in energy-intensive firms such as dredging companies, where energy cost comprises more than 50 % of the contract price. In other construction firms, where the share of energy costs in total contract prices of construction projects is generally in the range of a few percent, cost reduction has become very important in the past 5 years, due to the economic decline, the small margins and fierce competition. The societal trend towards developing sustainable business operations and CSR was also mentioned as an important trigger for companies for intensified energy and carbon management.

All companies were subject to the Dutch *Environmental Management Act*. Though, none of the companies ranked the environmental management act among the important drivers for energy efficiency and CO_2 emission reduction in their daily business operations. A few certified companies participated in the third generation of *Long-term agreements on energy efficiency*, LTA3 (RVO 2014), mainly by having shares in asphalt plants.[4] Due to its specific focus on energy efficiency improvement of asphalt plants, the LTA3 did not strongly influence the internal energy management of these construction and civil engineering companies.

Almost none of the certified firms had implemented the *ISO-50001 standard* for energy management (ISO 2011). In contrast, almost all companies adopted the *ISO-14001 standard* for environmental management (ISO 2004) in various parts of their companies. The majority of these companies received their ISO-14001 certificate shortly before or after the CO_2PL was adopted by the company. The CO_2PL was generally considered as a more important driver for energy conservation than the ISO-14001 standard: 'The CO_2PL is just the specification of the 'CO_2 paragraph' in the ISO-14001.' {G}, 'The CO_2PL has a much more compelling effect on the energy management (than ISO-14001) … there is no room anymore for a noncommittal approach.' {O}, 'In the CO_2PL there is commercial pressure to maintain energy management at a high level.' {J}. The few very large companies that obtained the ISO-14001 certificate already several years prior to the start of the CO_2PL scheme acknowledged the ISO-14001 standard as an important starting point for environmental management and the CO_2PL as a fruitful follow-up for energy and carbon management. Among the non-certified companies, ISO-14001 was more frequently considered as the cornerstone of CO_2 management. The *CSR Performance Ladder* also seemed to be a driving force for energy and CO_2 management among non-certified companies. Among certified companies, the CSR Performance Ladder has not been widely adopted. Several certified

[4] Since 2013, asphalt industries have been regulated under the EU-ETS. As a result, the asphalt industries switched from the LTA3 to the LEE covenant (Long-term agreement on energy efficiency for EU-ETS companies).

companies, often belonging to larger multinationals, participated in the *Carbon Disclosure Project* (CDP 2013). Although considered as important at high strategic corporate level by several firms, the CDP did not seem to have practical implications on internal energy and carbon management in the Netherlands. *BREEAM certifications* of projects were not relevant for most of the certified companies. Non-certified companies were dealing more frequently with BREEAM, but there was generally a stronger focus on the energy efficiency of the object to be built rather than the construction process itself.

Implemented measures for energy efficiency and CO_2 emission reduction

According to the rules of the CO_2PL, companies can reduce their CO_2 emissions by implementing energy efficiency measures, through technological innovation or by changing the type of energy sources. It is not allowed to reduce CO_2 emissions through carbon offsetting. Table 3 shows the categorized measures for energy efficiency improvement and CO_2 emission reduction that were implemented by certified firms. The total number of measures taken by the 25 firms was around 400. Most measures can be categorized as 'green mobility', including measures such as capping CO_2 emissions of lease cars, requiring maximum allowable fuel economy labels of lease cars, eco-driving instructions and training, checking tyre pressure and the use of electric cars. Nearly all firms also started purchasing green instead of grey electricity to reduce their CO_2 emissions on projects or in office buildings. The category 'machinery' includes measures such as the more efficient use of machinery, buying more efficient machinery and energy metering of machinery. Companies producing (raw) materials such as asphalt or concrete implemented various measures to reduce energy use in their production facilities. Energy efficiency measures in office buildings were also often taken, such as energy-efficient lighting, insulation, and energy-efficient equipment, for heating and cooling. Several companies installed renewable energy equipment, like solar panels on the rooftops of their office buildings. Finally, there is a wide range of measures classified under the category 'other', including for example behavioural measures on production sites, energy-efficient office equipment/green IT, more efficient project management, alternative workplace strategies, reducing paper use etc. Companies ranked the CO_2 capping of cars/fuel-efficient cars, general energy-saving measures in office buildings and green electricity among the measures that contributed the most to CO_2 emission reduction. These types of measures often do not require any behavioural change, can be implemented without a lot of effort and can only affect supporting business processes.

Table 3 CO_2 emission reduction measures adopted by certified firms

Measure category	Measures implemented			Extent to which the CO_2PL stimulated the adoption
—Subcategory	No.	Percentage of total	By percentage of the firms ($n = 25$)	Percentage ($n = 353$)
Green mobility	147	37	100	53
—CO_2 capping, fuel-efficient cars	*21*	*6*	*84*	*51*
—Eco-driving	*24*	*6*	*76*	*70*
Green electricity	24	6	92	74
Machinery	41	10	80	59
—Efficient use of machinery	*23*	*6*	*60*	*65*
Production of materials	17	4	36	35
Building	67	17	100	38
—General energy-saving measures	*45*	*11*	*100*	*65*
Renewables	9	2	36	42
Other	88	22	100	37
Total	*393*	*100*		*50*

We asked interviewees to rate the extent to which the CO_2PL has stimulated the adoption of each CO_2 emission reduction measure (cf. Rietbergen et al. 2002). A rating scale with the following verbal qualifiers (and numerical percentage) was used: none (0 %), to a small extent (25 %), to a reasonable extent (50 %), to a large extent (75 %) or to a full extent (100 %). The percentages assigned to the verbal qualifiers were used to calculate the aggregated impact. On average, the CO_2PL has stimulated the adoption of CO_2 emission reduction measures to a reasonable extent (50 %). We also asked companies to judge whether the measures would also have been taken in the hypothetical absence of the CO_2PL. Companies stated that 30 % of the measures would not have been taken without the CO_2PL.

The adoption of energy efficiency measures was primarily accelerated because of the enhanced insight in cost-effective energy conservation options and not because of more relaxed investment criteria for energy efficiency, increased technological innovation or increased investment budgets (see Fig. 2). Although the CO_2PL requires companies to set targets for renewable energy, purchasing of green electricity was particularly stimulated by the CO_2PL because it can quickly reduce CO_2 emissions at reasonable costs without compromising any working procedures. Various behavioural measures in the category 'green mobility' (such as eco-driving programmes), 'machinery' and 'other' have also been stimulated by the CO_2PL to a reasonable or large extent. The high impact of the CO_2PL on these types of measures was confirmed by the significantly higher share of certified firms that switched to green electricity and introduced eco-driving campaigns compared to non-certified firms. The impact of the CO_2PL on introducing more fuel-efficient cars might be overrated since all non-certified firms also introduced more fuel-efficient cars in the past years. Moreover, it is very likely that favourable national fiscal policies for greening Dutch car fleet played a decisive role.

CO_2 emissions reductions, additionality and goal achievement

Fifty-four companies published data to construct aggregated CO_2 emission trends in the period 2010–2013. CO_2 emissions of these companies decreased by 7.4 %/year[5] in that period of which 85 % related to direct scope 1 CO_2 emissions and the remaining part to indirect scope 2 CO_2 emissions.

The CO_2 emission reductions originating from energy efficiency improvement and fuel switching were separated from the CO_2 emission reductions due to changes in the production output by comparing the frozen efficiency CO_2 emissions with the actual emissions. The frozen efficiency CO_2 emissions are the estimated CO_2 emissions if no energy efficiency or fuel switching would have occurred (Phylipsen et al. 1998). The frozen efficiency CO_2 emissions in year j were calculated as follows:

Frozen efficiency CO_2 emissions:

$$\text{Frozen efficiency } CO_2 \text{ emissions}_j = \sum_{i=1}^{50} CO_2 \text{ intensity}_{i,2010} * \text{deflated turnover}_{i,j} \quad \text{(Eq.1)}$$

where

CO_2 intensity$_{i,2010}$	= CO_2 emissions per € deflated turnover of firm i in 2010
deflated turnover$_{i,j}$	= deflated turnover of firm i in year j

The deflated turnover was used as a proxy for the firm's production output due to the lack of physical measures of output which are a preferred indicator to measure production output (CIEEDAC 2015).

Figure 3 shows the frozen efficiency CO_2 emissions and the actual CO_2 emissions of 50 companies in the period 2010–2013. The total CO_2 emissions of these 50 companies decreased by 7.9 %/year.[6] The annual CO_2 emission reduction rate due to energy efficiency improvement and fuel switching (reflected by the CO_2 intensity trend) amounted to 3.2 %/year. The remaining 4.7 %/year was attributed to a drop in the production output (reflected by deflated turnover trends).

Using values for the rated additionality of 30–50 % as found in the previous section implies that 1.0–1.6 %

[5] The CO_2 emissions have not been corrected for weather conditions since only a minor share of the CO_2 emissions relate to the energy use for heating office buildings.

[6] The actual CO_2 emission reductions are much higher than the figures earlier reported by Rietbergen (2015) due to the availability of more recent data from more companies over longer time periods.

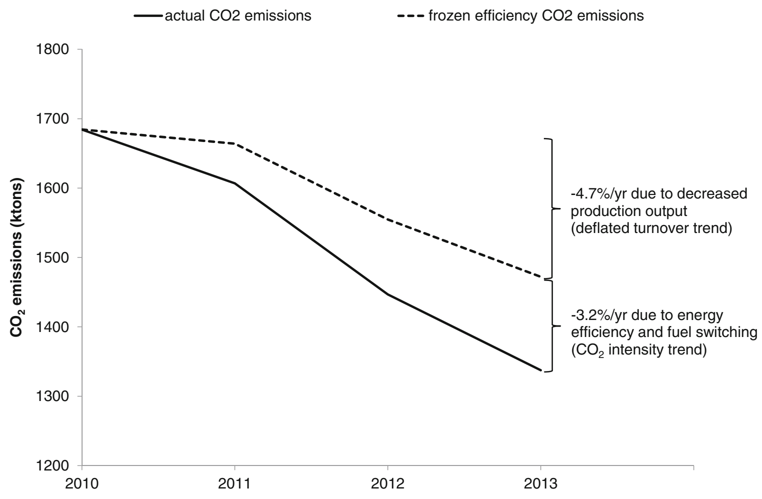

Fig. 3 Actual and frozen efficiency CO_2 emissions in the period 2010–2013 ($n = 50$)

of the annual CO_2 emission reductions can roughly be attributed to the CO_2PL. This corresponds to 97–167 ktons of cumulative avoided CO_2 emissions in the period 2010–2013 extrapolated for the entire target group of 57 companies.

Forty-six companies published data to evaluate goal achievement of the CO_2 emission reduction targets, see Table 2. Sixty-seven percent of these companies complied with the annual reduction rate required to reach the agreed target level. Firms at certification level 5 must succeed in meeting their targets in contrast with firms at lower certification levels. The percentage of firms that is on track did, however, not significantly differ by certification level.

Discussion

Interpretation and comparison of the research results

In the case of the CO_2PL, the potential competitive advantage in procurement contracts was the primary driving force for companies to improve their energy and carbon management practices. This strongly confirmed conclusions by e.g. Dorée et al. (2011), Krarup and Ramesohl (2002) and Reinaud et al. (2012) that energy management systems must be embedded in a broader energy management programme and be accompanied with other obligations, incentives or measures to be effective. This strong incentive of the competitive advantage may however also be a potential threat for the successful continuation of CO_2PL as a tool for improving energy and carbon management if the scheme will not be adopted more widely among commissioning parties. Another threat for improving energy management via the CO_2PL in the long term is the limited ability to really distinguish between leaders and laggards in terms of energy management since most large companies hold a level 5 certificate.

Our study confirmed the earlier conclusion by Wilbrink (2012) that the CO_2PL was considered as a real asset for improving energy management among the majority of the certified companies. More specifically, our study revealed that the CO_2PL stimulated management involvement; increased priority for energy issues; improved PDCA cycles; improved insight in CO_2 emissions, performance and reduction options; and increased employee awareness, thereby tackling a wide range of potential barriers inhibiting the effective implementation of energy management as suggested by e.g. Rohdin and Thollander 2006; Blass et al. 2014; McKane et al. 2009. These results confirmed the positive impacts of introducing energy management programmes on improving energy management practices found in other studies (Stenqvist et al. 2011; Helby 2002; Backlund et al. 2012; Kimura and Noda 2014). Our study also confirmed conclusions from Krarup and Ramesohl (2002) and Backlund et al. (2012) that energy management programmes tend to have little impact on investment criteria and the planning of energy efficiency measures.

Despite the various new energy management practices introduced in the certified firms, the impact of the CO_2PL as an energy management system could also be criticized. First, the implemented energy management practices were rather administrative in nature. Second, in relation to the previous point, adoption of energy management practices beyond staff level, at lower levels in the organization, was still in its early stage. Third, interviews with several companies suggested that the impact of the CO_2PL has already reached its limits, like PDCA cycles starting to fail, lack of quick win opportunities, cynical views on certifiable management schemes, pragmatic attitudes of top management and narrow focus on just CO_2 emission reduction. Fourth, several interviewees argued that the CO_2PL was often just used as an administrative checklist rather than a real management system, especially with regard to requirements in key topics C and D. The above-mentioned criticism is in line with Kimura and Noda (2014) claiming that energy management systems were not always effective in inducing tangible energy conservation measures. Based on these above-mentioned observations, it is however too early to conclude that the CO_2PL also tends to lead to a ceremonial behaviour rather than genuine improvements of energy management as was suggested by Boiral (2007) in the case of ISO-14001, especially because improving energy management is considered a long-term effort.

Our study suggested that impacts of the CO_2PL on improving energy management practices were more substantial in less energy-intensive (75 %) than more energy-intensive (25 %) firms, confirming findings by Kimura and Noda (2014). However, we also found evidence that, although larger and more energy-intensive firms already introduced some energy management practices before the introduction of the CO_2PL, the CO_2PL contributed to further improvement of energy management practices in these companies. These latter findings seemed to contrast Wilbrink's study on the CO_2PL claiming that the CO_2PL did not have a substantial impact on improving energy management among specifically larger companies. The contradicting findings might be explained by the time lag between our study and Wilbrink's study and the strong emphasis of the CO_2PL on continuous improvement of energy management.

We found that 30 % of the energy efficiency and CO_2 emission reduction measures would not have been taken without the CO_2PL and that the CO_2PL stimulated the adoption of these measures to a reasonable extent (50 %). A rated additionality of 30–50 % is in line with results from several other studies that roughly attributed 40–60 % of the energy savings or CO_2 emission reductions to adopting energy or greenhouse gas management programmes (Ericsson 2006; Cahill and Gallachóir 2012; Stenqvist and Nilsson 2012; Ecorys 2013; Wilbrink 2012).

In our study, we found clear signs that the CO_2PL was the major contributor to improving energy management practices. In contrast, Helby (2002) could not clearly separate the effects of introducing an energy management programme from the effects of ISO 14001 because both were strongly interwoven. The slightly more modest impacts of the CO_2PL on energy management in the few firms that obtained a ISO-14001 certificate several years before the introduction of the CO_2PL confirmed earlier observations by McKane et al. (2009) that ISO-14001 played a catalytic role in drawing up energy policies, setting targets and assigning responsibilities, while at the implementation level (performance measurement, energy audits, management reviews), the role of ISO-14001 was weaker. Also based on the findings in non-certified firms, we therefore expect that in the absence of the CO_2PL energy management practices also would have been improved since other incentives such as ISO-14001 would have filled the gap of the CO_2PL. However, we expect that energy and carbon management would not have been improved as advanced, fast and dedicated as it has been in the case of the CO_2PL due the strong incentive of green procurement, the specific focus of the CO_2PL on energy and carbon management and third-party certification.

The average annual CO_2 emission reduction rate (7.4 %/year) among 53 companies in the target population in the period 2010–2013 was way beyond the projected CO_2 emission reductions (0.8–1.5 %/year) if companies would comply with their CO_2 emission reduction targets (Rietbergen and Blok 2013). The difference was attributed to favourable long-term economic forecast used in Rietbergen and Blok (2013) compared to the actual economic downturn in the past years.

A first estimate of the additionality of the CO_2PL shows that CO_2 emission reductions have been enhanced by 1.0–1.6 %/year in the period 2010–2013. A comparison of the CO_2 intensity trend among the investigated firms (−3.2 %/year) with generally accepted values for autonomous energy efficiency improvement of 0.5–1 %/year (EEW 2013) also suggests a net positive impact of the CO_2PL and other contextual drivers on CO_2 emission reduction. Based on the findings in 'Contextual drivers for energy and carbon management', it is expected that the impact of other contextual drivers is rather limited and most impacts can be attributed to the CO_2PL. However, firm conclusions on the quantitative impacts of the CO_2PL cannot be drawn yet due to several uncertainties like the lack of sector specific baselines, the lack of a control group, unknown intra-sectoral structural changes and the debatable use of turnover as a proxy for firms' production output (CIEEDAC 2015). Despite these uncertainties, it is still very likely that the CO_2PL has enhanced CO_2 emission reductions among the involved firms because of the magnitude of the annual CO_2 intensity reduction rate, the adoption of additional energy conservation measures and the improved energy management practices.

In the longer term, it remains to be seen if the achieved CO_2 emission reduction rates due to energy efficiency improvement and fuel switching can be maintained. Up until now, most energy conservation and CO_2 emission reduction measures did not require large investments, whereas future CO_2 emission reductions will likely be more expensive.

Validity and reliability of the research

The quality of the research approach can be judged by testing the reliability, external and internal validity and construct validity (Golafshani 2013). *Reliability* refers to the consistency of the obtained results. We are aware that moderator, respondent and question bias may play an important role in the reliability of the qualitative research (Nawrocka and Parker 2009). However, we limited the threats of these biases by interview testing, using a standardized interview, carrying out interviews in alternating couples of interviewers, by promising full anonymity to the respondents, by posing both open and closed questions on similar topics during the interview and by cross checking the coding of the transcripts. The reliability of the quantitative research mainly depended on the random errors in the self-reported CO_2 performance data. Since random errors are cancelled out when calculating aggregated values, the uncertainties in the calculated CO_2 emission (intensity) trends are expected to be very limited. Conclusions about goal achievement were also considered very reliable because especially CO_2 performance data in the base year must be updated annually in the case of changes in the organizational boundary.

External validity refers to the generalizability of the research results. The qualitative research results can at least be generalized to our target population; since our interview sample was randomly chosen, the rate of participation was high (93 %) and the sample covered 44 % of the target population. It is expected that the main research results can also be generalized to other certified medium-sized enterprises, with sufficient organizational capacity in the construction and civil engineering sector.

Internal validity refers to the confidence of the causal conclusions of the research. In this study, a non-experimental self-report research design was chosen as the main approach to compare the impact of the CO_2PL on improving energy and carbon management. The results of the 'before–after' comparison should be handled carefully as 'changes' and not directly as 'impacts' of the CO_2PL. However, the majority of the firms attributed the improved energy management practices strongly to the CO_2PL instead of other contextual drivers. Quasi-experimental research designs are generally a stronger approach for counterfactual analysis. However, such research designs need a fully comparable control group with non-participants, which was not available. Nevertheless, the internal validity of the results was further strengthened by using a group of companies involved in the construction of residential and non-residential buildings as a comparison.

Construct validity refers to identifying correct operational measures for the concepts being studied. The inadequate operationalization, as a major threat to construct validity, was expected to be limited in the open-end questions during the interviews; most of the definitions, understandings and concepts related to energy management were based on the CO_2PL handbook of which all interviewees were familiar with. The energy management practices in the questionnaire with closed question like in Fig. 1 could have been operationalized more specifically, e.g. by using methods suggested by EPA (2014). Summarizing several constructs in closed questions did not allow for a proper measurement of the maturity of specific management practices. Nevertheless, these closed questions provided insight in the changes in general energy management practices since the implementation of the CO_2PL that confirmed the responses obtained from the open-end questions.

Programme recommendations

This study illustrated that the CO_2PL has been an important asset for improving energy and carbon management and CO_2 emission reduction. However, we have the following recommendations for the scheme owner to maintain the CO_2PL as an effective tool for energy and carbon management in the longer term. First, the CO_2PL should more strongly emphasize the continuous improvement as prescribed by PDCA cycles. Second, annual compliance assessments should shift more towards stimulating genuine energy management practices in core processes and projects rather than checking administrative procedures. The alternative could be that the CO_2PL steers stronger on achieving energy efficiency improvement or CO_2 emission reduction targets. Third, we recommend to critically evaluating the use of the CO_2PL in procurement procedures to stimulate CO_2 emission reduction on project level more effectively, e.g. by introducing benchmark values for energy use or CO_2 emissions per unit of activity or product.

Recommendations for further research

First of all, we suggest carrying out a longitudinal study evaluating the impacts of the CO_2PL on improving energy management in the longer term, while changing energy management practices is often considered as a long-term process. Second, we recommend to evaluate to what extent energy management practices also have been internalized in different layers of the organization, e.g. by in-depth company case studies. Third, we recommend studying the impact of the CO_2PL on managing supply chain CO_2 emissions. In this study, we only considered the impacts of CO_2PL on improving internal energy management, while the potential for CO_2 emission reduction in the supply chain is probably much larger. Finally, we also recommend to further investigate the net quantitative impacts of the CO_2PL on CO_2 emission reduction, e.g. by constructing sector specific baselines, analysing intra-sectoral structural changes and measuring physical production output.

Conclusion

The CO_2 Performance Ladder (CO_2PL) is a market-driven certification programme for energy and carbon management that primarily attracts construction and civil engineering firms. In this study, we addressed the question: 'What is the impact of the CO_2 Performance Ladder on improving energy and carbon management and CO_2 emission reduction in construction and civil engineering firms'. The main conclusions emerging from this study are the following.

First, the CO_2PL has been responsible for improving various energy management practices in certified firms. Although these improvements were still rather administrative in nature, the internalization of energy management practices beyond staff level has gradually started. Second, companies have implemented a wide range of new energy efficiency and CO_2 emission reduction measures. However, most measures only affected the supporting business processes instead of companies' core processes. About 30–50 % of these measures have been identified as additional. The CO_2PL has particularly stimulated green electricity purchasing and the adoption of various behavioural measures for energy efficiency and reducing CO_2 emission reductions. Third, the annual CO_2 emission reduction rate due to energy efficiency improvement and fuel switching amounted to 3.2 %/year (2010–2013). First estimates suggest that about 1.0–1.6 %/year of these CO_2 emission reductions can be attributed to the CO_2 Performance Ladder. However, these figures should be used with caution because of various uncertainties, like unknown intra-sectoral structural changes, the lack of a comparable control group and the debatable use of turnover as a proxy for firms' production output. Nevertheless, it is still very likely that the CO_2PL has enhanced CO_2 emission reductions beyond business-as-usual.

Overall, we conclude that, driven by the potential competitive advantage of the CO_2PL in contract awarding, the CO_2PL has been responsible for a strong shift towards more mature energy management and enhancing CO_2 emission reduction among construction and civil engineering firms that most likely would not have been achieved by other contextual drivers solely. However, maintaining the CO_2PL as an effective tool for energy and carbon management and CO_2 emission reduction requires more focus on genuine energy management practices, stronger PDCA cycles, and more effective procurement procedures.

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Appendix

Questionnaire

1. General questions

  – Company name
  – Interviewee
  – Date
  – Interviewers
  – CO_2PL level
  – What is your position within the company and your affiliation with the CO_2PL?
  – What were the most important reasons for the company to obtain a CO_2PL certificate?
  – How important is the CO_2PL for the company to win bids?
  – What is your general opinion about the CO_2PL as a tool for improving energy management?

2. Contextual drivers

  – Does the company hold an ISO14001 certificate, CSR Performance Ladder certificate, or any other type of certified environmental management system? If so, since when? Which management system has the most important impact on energy management?
  – What are the most important triggers for energy efficiency improvement and CO_2 emission reduction in your company? Please prioritize, explain and differentiate between: general corporate strategies (e.g. cost reduction, sustainability), governmental policies (e.g. Long-term agreements, environmental permits, EU-ETS), other certifications (e.g. CO_2PL, CSR Performance Ladder, ISO14001, BREEAM).

3. Impact of the CO_2PL

  – In what way has energy management changed since the introduction of the CO_2PL?
  – To what extent has the CO_2PL been truly embedded in the company and adopted by the employees?
  – Please indicate on a 4 point scale to what extent the following energy management practices were already implemented in the business operation prior to the introduction of the CO_2PL. 1 = non-existent, 2 = partly implemented, 3 = average, 4 = fully implemented, 0 = I don't know. Please clarify your answer.

  • The company's management shows visible leadership with respect to energy management (e.g. actively involved, board member has specific responsibilities for energy management).
  • Energy conservation and CO_2 emission reduction is an objective of the company and is part of the company's strategy.
  • Energy and CO_2 emission are being monitored in such a way that they can be managed.
  • Energy and CO_2 emissions are being analysed, e.g. by relating the figures to turnover/FTE/km/production, corrected if necessary, and broken down in significant emission streams).
  • Employees are in involved in energy conservation issues and stimulated to do so.
  • The impact of energy conservation and CO_2 emission reduction measures are being monitored in such a way these measures can be evaluated.
  • An effective PDCA cycle is in place for the continuous improvement of energy management (setting targets, energy planning, implementation, review).
  • Energy conservation and CO_2 emission reduction are routinely considered in the business operation (e.g. in procurement procedures, as part of management reports, operational planning and execution).

  – Please indicate on a 4 point scale to what extent the energy management practices mentioned above have been implemented in the business operation since the introduction of the CO_2PL. 1 = non-existent, 2 = partly implemented, 3 = average, 4 = fully implemented, 0 = I don't know.

4. Energy saving and CO_2 emission reduction measures

  – The following list of energy saving and CO_2 emission reduction measures has been compiled retrieved from progress reports and companies'websites. Please indicate for each measures when the measure was implemented.

- Please rate the extent to which the CO_2PL has stimulated the adoption of each CO_2 emission reduction measure. Choose between: none (0 %), to a small extent (25 %), to a reasonable extent (50 %), to a large extent (75 %) or to a full extent (100 %).
- Please judge whether the measure would have been taken anyway, also without the CO_2PL.
- Which measures have contributed the most to CO_2 emission reduction?

5. CO_2 footprint, targets, activity indicators

- What is the annual company's CO_2 footprint in the 2009, 2010, 2011, 2012, 2013. Please differentiate between scope 1 and scope 2 emissions?
- What is the annual company's turnover in 2009, 2010, 2011, 2012, 2013?
- What is the company's CO_2 emission reduction target?
- Since when does the company establish CO_2 emission reduction targets?

6. Organisation

- To what extent is top management committed to energy and carbon management? Please explain.
- How has the organization of energy management changed since the introduction of the CO_2PL? Did the company already have an appointed energy manager or coordinator prior to the CO_2PL? Is the CO_2PL a team effort or solely a task of the coordinator?
- Are the certain barriers for the effective implementation of the CO_2PL in your company?
- Do you annually perform internal audits? What do they deliver?

7. Potential benefits of the CO_2PL

- Please indicate to what extent you agree with the following statements (choose between: strongly agree, agree, neutral, disagree, strongly disagree). The CO_2PL contributed to:

• More innovation within the company.
• Staff being more conscious energy/more motivated in saving/more involved in energy saving.
• A higher budget for investments in CO_2 emission reduction.
• CO_2 emission reduction measures being taken more easily and faster.
• CO_2 emission reduction measures being accepted more easily by employees.
• More knowledge, training and skills in the field of energy savings among the staff.
• Energy savings and CO_2 reduction.
• Identification of cost-effective energy saving options.
• A higher priority for CO_2 emission reduction within the company.
• A more formal and structured way of handling CO_2 emission reduction.
• Better insight of the energy use, CO_2 emissions and environmental performance of the company.

- Please elaborate on the above mentioned statements.

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