Targeting Energy Management

Targeting Energy Management - Analysing targets, outcomes and impacts of corporate energy and greenhouse gas management programmes

Martijn Rietbergen
Utrecht University, Faculty of Geosciences, Copernicus Institute of Sustainable Development, Group Energy and Resources
HU University of Applied Science Utrecht, Research Centre Technology & Innovation

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Analysing targets, outcomes and impacts of corporate energy and greenhouse gas management programmes

Energiebeheer gericht aanpakken

Het analyseren van doelstellingen, resultaten en impacts van energie- en broeikasgasbeheersprogramma's in bedrijven

(met een samenvatting in het Nederlands)

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List of Abbreviations and Units

BaU:	Business-as-usual
CA:	Certification Agency
CMM:	Capability Maturity Model
CO_2PL:	CO_2 Performance Ladder
CR:	Certification Requirement
CSR:	Corporate Social Responsibility
EEI:	Energy Efficiency Index
EMAT:	Economically Most Advantageous Tender
ETS:	Emission Trading Scheme
EU:	European Union
FTE:	Full Time Equivalent
GHG:	Greenhouse Gas
GPP:	Green Public Procurement
kt:	Kilotonne
Mt:	Megatonne
PBP:	Payback period
PDCA:	Plan-Do-Check-Act
PJ:	Petajoule
SEC:	Specific Energy Consumption
SKAO:	Independent Foundation for Climate Friendly Procurement and Business
t:	Metric tonne
yr:	Year

Chapter 1

Introduction

1.1 Context

Global climate change is a major threat to sustainable development. This was internationally recognized in 1992 during the United Nations Conference on Environment and Development, also known as the 'Rio Conference'. This conference, amongst others, resulted in the United Nations Framework Convention on Climate Change (UNFCCC) - an intergovernmental treaty that aims at "stabilizing greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system" (UN, 1992). Later in 2010, parties to the UNFCCC agreed to commit to a maximum temperature rise of 2°C above pre-industrial levels in order to prevent the most severe impacts of climate change (UNFCCC, 2011). Therefore, the concentration of greenhouse gases in the atmosphere should stabilize to around 450 parts per million of CO_2-equivalent (IPCC, 2007).

The following strategies for curbing energy-related greenhouse gas emissions are often suggested: energy efficiency improvement, renewable energy, nuclear energy, and carbon capture and storage. Energy efficiency improvement will be the main strategy for reducing energy-related greenhouse gas emissions until at least 2030. It is projected that almost half of the necessary greenhouse gas emission reductions will be achieved by energy efficiency improvement (IEA, 2015).

Although there is a huge potential for energy efficiency improvement, a large part is not utilized yet (UNEP, 2011). This is caused by various investments barriers that prevent the implementation of energy efficiency measures, see e.g. Blok (2009): actors may not be aware of energy efficiency options (knowledge barrier), energy efficiency measures may not be economically attractive (economic barrier), there may be a lack of interest in energy efficiency, energy efficiency measures options may not be available yet (technical barrier), there is not a well-defined structure to decide upon and carry out energy efficiency investments (organizational barriers) or the actor carrying out energy saving investments may not be the actor who has the financial benefits (landlord-tenant barrier).

1.2 Stimulating the uptake of energy and greenhouse gas management

1.2.1 Energy and greenhouse gas management

Within companies energy management is frequently considered as a means to overcome several of these kinds of energy efficiency barriers (see, e.g. Ates & Durakbasa, 2012; Worrell, 2011; OECD, 2015). *Energy management* is defined as 'effectuating organizational, technical and behavioural actions in a structural and economically sound manner in order to minimize consumption of energy' (SenterNovem, 2004). It includes a wide range of *energy management practices*, such as: management responsibility (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) and reviewing (management review). The embedding of these energy management practices in company-wide management structures can be facilitated by using *Energy Management Systems.* The implementation of an energy management system must ultimately lead to the continuous improvement of energy efficiency (see, e.g. EPA, 2014; ISO, 2011). The exact requirements of an energy management system are specified by so-called *energy management standards*. The internationally acknowledged ISO-50001 (ISO, 2011) is probably the most well-known standard for energy management. Apart from the (inter)national standardization bodies other parties can formulate non-standardized specifications for energy management systems (Reinaud et al., 2012). Companies can seek certification of their energy management system through accredited agencies to ensure compliance with such energy management standards. Since energy use is often the main cause of CO_2 and greenhouse gas emissions for many companies, energy management is also considered the principle element of greenhouse gas management (Carbon Trust, 2010). Greenhouse gas management aims at minimizing greenhouse gas emission in a similar way as energy management.

1.2.2 Programmes for energy and greenhouse gas management

The uptake of energy management in firms can either be stimulated by government policies, NGO or private sector-led initiatives (IIP, 2013). In all cases energy and greenhouse gas management becomes part of a wider *programme for energy efficiency or greenhouse gas management*. These programmes are often a combination of several elements, e.g. energy management obligations; (ambitious) energy or greenhouse gas reduction target; the availability of incentive, support and compliance schemes, and 3) other obligations like public reporting, certification and verification (IEA/IIP, 2012). Due the complexity of such schemes, energy management programmes can come in many different forms, see e.g. overviews by Kahlenborn et al. (2010), Price et al. (2005), IEA/IIP (2012), IIP (2013). However, roughly such programmes can be divided in *mandatory* energy management programmes, *incentive-based* energy management programmes and *market-driven* certification programmes for energy management (Dahlgren, 2014). Mandatory energy management programmes, like the energy conservation law in Japan, enforce the adoption of energy management using a regulatory approach including measures for noncompliance (Kimura & Noda, 2014). Incentive-based energy management programmes, like the Swedish programme for improving energy efficiency in energy-intensive industries, promote the adoption of energy management by offering certain incentives, such as the exemption from regulatory policies or taxes, ease of access to information, and financial support (Stenqvist & Nilsson, 2012). Market-driven certification programmes for energy management, like the U.S. Superior Energy Performance programme, stimulate the adoption of energy management by promoting third-party certification of corporate energy management.

1.3 Setting targets for energy efficiency and greenhouse gas emission reduction

Setting targets for energy efficiency and greenhouse gas emission reduction is a key element in many programmes for energy and greenhouse gas management[1]. ISO (2011) defines energy targets as 'detailed and quantifiable energy performance requirements, applicable to the organization or parts thereof'. Meeting these targets will contribute to achieving the wider company's environmental quality objectives. Within energy or greenhouse gas management programmes targets are predominantly set for individual companies, but some programmes set targets for groups of companies (sector level) as well.

In general, when setting targets the following step-by-step approach is suggested: deciding about the organizational boundary (process, facility, business unit, entire company, group of companies, sector level); choosing the target type (absolute, relative, other); choosing the base year (rolling or fixed); defining the completion date (one year or multi-year commitment period); deciding upon the length of commitment period (long, medium or short); deciding about the use of offsets; and deciding about the target level (WBCSD/WRI, 2004; CDP, 2013; Carbon Trust, 2008).

One of the key issues in target-setting is choosing the target type. Many different target types for energy efficiency improvement or greenhouse emission reduction exist, that each have their pros and cons. In general, a broad distinction is made between absolute and relative targets. Absolute targets prescribe that a firm must limit its total energy demand or greenhouse gas emissions within the organisational boundary to a certain pre-defined level at a fixed point in the future. Relative targets aim at reducing the ratio between energy use or greenhouse gas emissions within the organisational boundary and a relevant performance metric (i.e. ton of product, number of employees or amount of turnover) to a certain pre-defined level over time (WBCSD/WRI, 2004).

Another important issue in the target-setting process is establishing the stringency of the target, i.e. the target level for energy efficiency or greenhouse gas emission reduction. This is especially important if targets are prescribed (fixed) by the programme initiator, or if targets are negotiated between firms and the programme initiator or a third-party, and to a lesser extent in the case where targets are self-imposed by the participating firm. In general, approaches for setting target levels may range from unilateral decisions by policy makers; collaborative approaches using feedback from the target group, consumers/third parties or experts; and a wide variety of modelling approaches (e.g. theoretical limits, past performance analysis, business-as-usual projections, benchmarking, cost-benefit and economic analysis), see e.g. Tonkonogy (2007), NCHRP (2010). In the end, a combination of these approaches is often used to establish target levels in energy and greenhouse gas management programmes.

1.4 Evaluating targets, outcomes and impact of energy and greenhouse gas management programmes

In contrast with the large amount of research on the relationship between environmental performance and implementing environmental management systems

[1] Target-setting for energy efficiency and greenhouse gas emission reduction has also been debated in various other energy, climate and environmental policy schemes, such as environmental management schemes (Honkasalo, 1998; Zobel, 2008), industrial energy or emission permits; and in internal and external cap and trade systems (Groenenberg & Blok, 2002; Victor & House, 2006).

(see e.g. the overviews by Heras-Saizarbitoria & Boiral, 2013; Nawrocka & Parker, 2009), the amount of empirical research evaluating the benefits, performance and impacts of introducing energy management systems, like ISO50001, is less extensive, amongst others due to its recent implementation (Bunse et al., 2011). However, there is a rich amount of literature on programmes for energy efficiency improvement and greenhouse gas emission reduction, like the numerous voluntary agreement schemes that also promote the uptake of energy management practices.

There are various *benefits* for firms to adopt energy management (programmes). The major benefits may include: reduced costs, increased environmental performance, public recognition, deferred legislation or other more stringent policies, and increased eligibility for using financial incentives or other competitive advantages, see e.g. Okereke (2007), Sullivan (2011), Rezessy & Bertoldi (2011). A smooth implementation of energy management practices is however not self-evident. Several *barriers* may inhibit the adoption of such energy management practices. These are for example the lack of commitment of top management; lack of priority given to energy issues; lack of financial resources; lack of organizational support; lack of information, lack of organizational culture of continuous improvement (see e.g. Reinaud et al., 2012; McKane et al., 2010; Rohdin & Thollander, 2006; Brown & Key, 2003). The importance of these barriers is confirmed by several studies examining the practice of energy management in particularly industrial sectors. In general, energy management practices have not been widely adopted, even not among energy-intensive firms. Though, especially well-organized, large and energy-intensive firms have been more successful, active and motivated in adopting energy management practices compared to other firms (Ates & Durakbasa, 2012; Thollander & Ottoson, 2010; Lee, 2012a; Backlund et al., 2012; Brunke et al., 2014; Christoffersen et al., 2006; Martin et al., 2012).

The uptake of energy management in firms can be stimulated by introducing programmes for energy efficiency and greenhouse gas emission reduction that include energy management obligations as well. On the one hand, several studies focusing on industrial sectors confirm the positive *impacts* of introducing such energy management programmes, on adopting new energy and greenhouse gas management practices (Backlund et al., 2012; Helby, 2002; Stenqvist et al., 2011; Krarup & Ramesohl, 2002; Price, 2005). These studies suggest that such programmes improve various energy management practices such as monitoring and reporting procedures, introducing energy efficiency procurement rules, raising awareness, increasing motivation etc. On the other hand, evaluations of voluntary agreements, as an important example of energy management programmes, also show that lenient targets, insufficient specific obligations, and deficiencies in reporting, monitoring and verification are often important threats of such programmes for delivering meaningful energy savings or greenhouse gas emission reductions (Rezessy & Bertoldi, 2011). It is often being suggested that these weaknesses can be addressed by involving independent third parties for verification and compliance assessments (Rezessy & Bertoldi, 2011). However, experience with conducting independent audits in the broader context of environmental management certification, shows that such audits are far from independent, rigorous and objective; that audits focus more on procedural conformity rather than on internalization of good environmental practices; and that a clear process for evaluating the continuous environmental performance improvement is lacking (see, Ammenberg et al., 2001, Boiral, 2007; Boiral & Gendron, 2011; Heras-Saizarbitoria et al., 2013)

At the time of research primarily studies were available investigating the outcomes of energy management programmes, see e.g. Farla & Blok (2002). Evaluations assessing the ex-post *impacts* of introducing energy management programmes on energy conservation in industrial sectors were almost non-existing. More recently, several studies have been carried out evaluating the impact of energy and greenhouse has management programmes. On the one hand some studies confirm the positive impact of such programmes on reducing energy use, see e.g. Cahill & Gallachóir (2012), Stenqvist & Nilsson (2012). On other hand, various studies claim that there is no consistent evidence about the (direct) relationship between implementing energy management (systems) and the firms' carbon performance, see Böttcher & Müller (2014), Lee (2012a) and Martin et al. (2012).

Market-driven (certification) programmes for energy and greenhouse gas management can play an important role in greening the supply chain. Buyers can encourage their suppliers to implement (certification) programmes for energy and greenhouse gas management, thereby contributing to energy efficiency and greenhouse gas emission reduction in the supply chain. In the broader context of green supply chain management a wide range of studies has been published that discuss the use of environmental criteria, tools and indicators in green supply management (e.g. Kovács, 2008; Lee, 2012b; Gonzáles et al., 2008; Nawrocka et al., 2009), that track progress towards green public procurement goals (e.g. Bouwer et al., 2006; PWC et al., 2009 and AEA, 2010); and that evaluate the enforcement of environmental requirements in green procurement contracts (Faith-Ell et al., 2006). Studies assessing the quantitative environmental impacts of such green supply chain initiatives are however rare, except for Ecofys (2012) and DHV (2009), that show the enormous potential for reducing energy use and greenhouse gas emission in the supply chain.

1.5 Why this thesis?

1.5.1 Scientific needs

This thesis fills several gaps in the scientific literature on energy and greenhouse gas management programmes. First, there is only limited scientific insight into the impact of introducing such programmes on improving internal energy management practices particularly in non-industrial sectors. Second, scientific studies about the quantitative impacts of implementing these programmes on energy conservation or greenhouse gas emissions within companies and their supply chain are rare. Third, limited empirical insight exists into the process of setting corporate energy or greenhouse gas emission reduction targets in programmes for energy and greenhouse gas management.

1.5.2 Societal needs for the thesis

There is also a clear public interest in this research. Participation in energy and greenhouse gas management programmes may provide participating firms certain financial benefits, serve as proof of compliance to governmental policies or provide public recognition. Therefore, it is in the public interest to investigate whether the eligibility for such competitive advantages is also based on genuine energy management practices. Furthermore, the design, implementation and monitoring of such programmes may require a lot of effort (in terms of time and money), from various societal stakeholders. Society therefore deserves to understand whether all these efforts put in mitigating climate change also do have an impact.

1.5.3 Relevance for practitioners

Also from a practitioner's point of view, this thesis will provide relevant insights. Practitioners, managing, implementing or accrediting energy efficiency or greenhouse gas emission reduction programmes need to understand how such programmes work in practice, need to have insight in the potential outcomes and impacts of these programmes, and need to understand how effectiveness of such programmes can be improved. More specifically, this thesis provides relevant insights for practitioners in the different types corporate targets for energy and greenhouse gas emission reduction, the pros and cons of using these different types, and how target for energy efficiency and greenhouse gas emission reduction can be established.

1.6 Introducing the energy and greenhouse gas management programmes observed in this study

Two rather distinctive programmes for energy and greenhouse gas management implemented in the Netherlands are being studied, i.e. the Long-term Agreements on Energy Efficiency and the CO_2 Performance Ladder.

1.6.1 The first generation Long-Term Agreements on Energy Efficiency

The Long-Term Agreements on Energy Efficiency were introduced in the Netherlands in 1992. The scheme has dictated energy conservation policies in the Netherlands for a long time, therefore making it an urgent object of research. These government-initiated incentive-based agreements are tailor-made negotiated agreements between the Ministry of Economic Affairs and industrial sectors. The voluntary, but binding agreements aimed at energy savings in the production process of primarily energy-intensive companies. The first generation of Long-Term Agreements did not follow a standardized approach for the continuous improvement of energy management. However, the agreements specified several energy management practices that companies needed to adopt, like regularly drawing up energy conservation plans, setting targets for energy efficiency improvement, implementation of economically feasible energy conservation measures, and annual monitoring and reporting of energy use. A wide range of supporting policy measures was available such as information and consultancy, investment subsidies, and energy audits. Energy efficiency improvement targets were negotiated at sector level, without a formal burden sharing approach among individual firms. In return for commitment to the agreements, the government promised not to impose supplementary national policy governing CO_2 reduction or energy conservation on these sectors. In 1998, the first generation of the Long-Term Agreements on Energy Efficiency were superseded by new covenants. The less energy-intensive companies continued their participation in the second (1999-2008) and third (2009-2020) generation of the Long-term Agreements on Energy Efficiency[2]. The more energy-intensive companies joined the Benchmarking Covenant on Energy Efficiency (1999-2009) that later continued into the Long-Term Agreement on Energy Efficiency (2009-2020) for companies participating in the European Union Emission Trading Scheme, see RVO (2014).

[2] The second and third generation of Long-Term Agreements on energy efficiency added energy savings throughout the entire product chain and renewable energy.

1.6.2 The CO_2 Performance Ladder

The CO_2 Performance Ladder is a more recent example of a programme for energy and greenhouse gas management, affecting companies in non-industrial sectors. Since these sectors have not been subject to specific energy and climate policies before, it is important to investigate whether such programmes can bring about impacts effectively. The NGO / private sector led programme was developed in 2009 by ProRail, the state-owned company responsible for the management of the Dutch railway network. Since 2011, the Independent Foundation for Climate Friendly Business and Procurement is the NGO responsible for the management of programme. The CO_2 Performance Ladder is characterized as a market-driven certification programme for energy and greenhouse gas management. Participation can give companies certain competitive benefits in the awarding of procurement contracts. Companies therefore need to get their energy and greenhouse gas management certified by an independent third party organization. The programme has its own energy management specifications, which are strongly linked to standardized approaches such ISO-50001 standard for energy management. Amongst a wide range of energy management specifications, such as commitment of the management board, drawing up energy conservation plans, monitoring of greenhouse gas emissions, annual publication of results, companies must individually establish greenhouse gas emission reduction targets (SKAO, 2014).

1.7 Evaluating impacts, outcome and implementation process

This study is rooted in the field of evaluation research. ‘Evaluation’ is defined as the systematic and objective assessment of an on-going or completed project, programme or policy particularly aimed to determining the needs, design, implementation process, outcome, impact, and efficiency (Rossi et al., 2004). This study focusses on the implementation process, outcomes and impacts of energy and greenhouse gas management programmes. Process evaluations assess how well a program is being operated, implemented and adopted. Outcome evaluations assess the extent to which a program achieves its intended objectives. Impact evaluations aim at determining what changes in the programme outcomes can be attributed to programme intervention, see EREE (2006). Programme impact is also known as programme effect, effectiveness, or actual outcome.

1.8 Research objective, questions and thesis outline

The wider objective of this thesis is to contribute to improving the effectiveness of programmes for energy efficiency improvement and greenhouse gas emission reduction in companies by evaluating the target-setting process, the outcomes and impacts of such programmes. The main research question of this thesis is formulated as follows:

“What is the impact of energy and greenhouse gas management programmes on improving corporate energy management practices, accelerating energy efficiency and CO_2 *emission reduction?”*

This research question will be studied by means of two different cases of energy and greenhouse gas management programmes, i.e. the Long-Term Agreements on Energy Efficiency and the CO_2 Performance Ladder. The main research question is broken down in the following sub questions:

1. *How can ambitious targets for energy efficiency improvement and greenhouse gas emission reduction in programmes for energy and greenhouse gas management be established?*

This question will be addressed in chapters 2 and 3. *Chapter 2* will present a taxonomy for distinguishing various types of targets for limiting energy use and greenhouse gas emissions. A comprehensive overview is presented of past, current and proposed future policies worldwide using such targets for limiting industrial energy use or greenhouse gas emission reductions at sector or firm level. This overview includes approximately 50 different emission permit systems, voluntary or negotiated agreement schemes and emission trading systems. The various target types are compared with respect to the certainty of the environmental outcome and compliance costs, the targets' relevance for the public and for industry and their environmental integrity, as well as their complexity and potential for comparison. *Chapter 3* investigates the target-setting process in the CO_2 Performance Ladder. It is an example of an energy and carbon management programme that explicitly requires firms to set ambitious targets for greenhouse gas emission reduction. In this chapter we will investigate whether the current target-setting procedures in the CO_2 Performance Ladder does guarantee the establishing of such ambitious greenhouse gas emission reduction targets. The CO_2 Performance Ladder introduces a wide range of specific requirements for setting ambitious targets that will be introduced in this chapter. The interpretation of these requirements by various involved actors (scheme owner, firms, third party certification authorities, consultants) will be investigated. Next, the way companies establish ambitious greenhouse gas emission reduction targets will be studied. This will be followed by an evaluation of the ambition level of the greenhouse gas emission reduction targets. Finally the auditing practice of third party certification agencies responsible for assessing target levels will be analysed.

2. *What is the impact of energy and greenhouse gas management programmes on improving energy and greenhouse gas management in practice?*

This second research question will be addressed in *chapter 5*. Also in this chapter the CO_2 Performance Ladder is the object of research. In this chapter the following energy management practices are being studied: 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 and target-setting for CO_2 emission reduction. Improved practices must lead to additional energy conservation and CO_2 emission reduction measures and ultimately CO_2 emission reduction. Therefore, this chapter investigates the impact of the CO_2 Performance Ladder on taking additional energy conservation and CO_2 emission reduction measures, analyses the CO_2 emission reductions since the introduction of the CO_2 Performance Ladder, and provides a preliminary assessment of the impact of the programme on CO_2 emission reduction. As the CO_2 Performance Ladder is 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 is studied as well.

3. *What is the impact of energy and greenhouse gas management programmes on energy efficiency improvement and greenhouse gas emissions reduction?*

This third research question will be addressed in both chapters 4, 5 and 6. *Chapter 4* evaluates the potential impact (ex-ante) of the CO_2 Performance Ladder on the reduction of CO_2 emissions in the Netherlands. An inventory is made of firms participating in the programme, their CO_2 footprints and CO_2 emission reduction targets. Business-as-usual scenarios are constructed forecasting CO_2 emissions, turnover and employment in the involved sectors. On the basis of these business-as-usual trends, CO_2 footprints and target levels for CO_2 emission reduction, the potential outcome of the programme is estimated. *Chapter 5* evaluates (ex-post) the achieved CO_2 emission reduction of companies participating in the CO_2 Performance Ladder. Moreover, it provides a preliminary assessment of the impact of the programme on CO_2 emission reduction. *Chapter 6* investigates the outcome and impact (ex-post) of the Long-Term Agreements on Energy Efficiency in the Netherlands. Two distinctive methods are explored to isolate the impact of these agreements on energy savings. The first method calculates the impact of the Long-Term Agreements on Energy Efficiency by estimating the additional investments (and related energy savings) made by the involved industries. The second method assesses the impact of the Long-Term Agreements on Energy Efficiency by comparing the monitored energy efficiency improvement with modelled energy efficiency improvements in the business-as-usual case. By applying these methods the energy savings that can be attributed to the Long-Term Agreements on Energy Efficiency will be calculated.

Chapter 7 will summarize the research objectives, the main research findings and conclusions of this thesis.

Chapter 2

Setting SMART targets for industrial energy use and industrial energy efficiency

Martijn G. Rietbergen, Kornelis Blok

Energy Policy (2010) 38, p. 4339-4354

Abstract
Industrial energy policies often require the setting of quantitative targets to reduce energy use and/or greenhouse gas emissions. In this paper a taxonomy has been developed for categorizing SMART industrial energy use or greenhouse gas emission reduction targets. The taxonomy includes volume reduction targets, physical efficiency improvement targets, economic intensity improvement targets and economic targets. This paper also provides a comprehensive overview of targets for industrial energy use or greenhouse gas emission reductions at sector or firm level in past, current, and proposed future policies worldwide. This overview includes approximately 50 different emission permit systems, voluntary or negotiated agreement schemes and emission trading systems. Finally, the paper includes an assessment of the various types of targets. The target types are compared with respect to the certainty of the environmental outcome and compliance costs, the targets' relevance for the public and for industry, and their environmental integrity, as well as their complexity and potential for comparison.

2.1 Introduction

Policies directed at improving industrial energy efficiency or limiting emissions related to industrial energy use have existed in many countries since the 1970s. Most often, these policies had a permissive character, i.e. they only intended to stimulate changes in industrial energy use without trying to achieve specific quantitative targets (Keijzers, 2000).

Currently, policies directed at limiting industrial energy use are often embedded in national climate policies. Many countries have set national quantitative greenhouse gas (GHG) emission reduction targets mainly in the framework of the Kyoto Protocol. These quantitative targets for industrial energy use and associated emissions can be set in various ways, at various scales and by different actors. Therefore, target-setting for industrial energy use is not connected to a specific policy instrument. Target-setting is not only an important element in industrial energy or emission permits, but also an important element for voluntary or negotiated agreements. Furthermore, in the case of most emission trading systems, some type of target-setting is important in order to set the level from the purchase and sale of emission rights.

It is critical for policy makers to understand the different possibilities for setting quantitative targets for industrial energy use and the process of formulating and setting these targets. This is important for of a number of reasons. First, in order to design effective energy and climate policies, policy makers should be able to establish proper targets and review the goal achievement of these targets. Second, in current energy policies it is becoming increasingly important to relate the results of industrial energy policies to the efforts, expressed in financial and administrative terms, that are required from the target group. Policy makers should therefore be aware of the economic, social and environmental implications of setting targets on industrial energy use. Third, regulating and motivational properties of different types of targets can be different. A solid understanding of these characteristics is essential when setting new energy targets. Finally, one should have a firm grasp of the extent to which the industrial energy policies contribute to reaching national targets. This is especially important since energy policies are increasingly becoming embedded in national climate policies.

There exists extensive research on the different types of targets that reduce industrial energy use or GHG emissions and an assessment of the associated strengths and weaknesses of said targets. Some papers give insight into the *taxonomy* (Arroyo, 2006) and characteristics of GHG emission reduction targets (WBCSD/WRI, 2004). For example, Arroyo (2006) presents a variety of target types for GHG emission reduction and shows that targets can be set by different actors and at various geographical scales (examples refer mainly to the U.S). The Greenhouse Gas Protocol (WBCSD/WRI, 2004), a corporate accounting and reporting standard, provides guidance on the process of setting corporate GHG targets, amongst others decision making on the target type and other important target characteristics. Many papers *evaluate* volume GHG targets (also known as absolute or fixed targets) in the context of developing alternative climate change commitments at country level such as GHG intensity targets (GHG per unit GDP), command and control measures, carbon taxes and energy technology strategies, see e.g. Philibert & Pershing (2001), Lisowski (2002) and Aldy et al., (2003). A few papers evaluate volume GHG targets and GHG intensity targets in more detail and compare these targets with respect to e.g. certainty of compliance costs, efficiency of GHG reductions, environmental effectiveness, incentives for technological progress and application for international negotiations on climate change, see Dudek & Golub (2003), Kolstad (2005), Pizer (2005) and Herzog et al. (2006). Despite all of this research, none of the papers in recent literature provide a comprehensive *overview* of the current use of different target types in industrial energy efficiency policies or climate policies around the world[3].

This literature review shows that in previous analyses the use of targets is largely limited to taxonomies, and pros and cons of GHG volume and intensity targets. Other types of targets (e.g. physical efficiency and economic) and energy use targets are typically not taken into account. Furthermore, the different target types are often only discussed as alternatives for national climate commitments. Targets for energy use or GHG emission reduction in the industrial sector and in industrial companies often receive less attention.

These considerations bring us to the research objectives of this paper. The first aim of this paper is to develop a taxonomy of various targets for industrial energy use. We will present an overview of the different approaches for setting targets for industrial energy use and associated GHG emissions. The scope of this paper is limited to so-called SMART targets for industrial energy use and its associated emissions. SMART targets are specific, measurable, appropriate, realistic and timed (see section 2.2.3 for further elaborations on the concept of SMART targets). Second, the paper gives a comprehensive overview of the current use of SMART targets limiting industrial energy use and CO_2/GHG emission reduction. We will study the application of the various types of targets in energy and climate policy instruments. The inventory of the different

[3] Herzog et al. (2006) do evaluate the use of GHG intensity targets of the most prominent policies around the world, but neglect policies with other types of targets.

types of targets and their application is based on the experience with target-setting in many voluntary agreements and energy regulations in many countries, e.g. see IEA/OECD energy efficiency policy and measures database (IEA, 2008a), the IEA/OECD climate change policy and measure database (IEA, 2008b) and the MURE measure database (FISIR, 2009). Third, the analysis will include an assessment of the various approaches for target-setting. A wide range of criteria for assessment of target types was used in related papers, see for example Bramley (2007), Herzog et al. (2006), Kolstad (2005), Dudek & Golub (2003), Hoehne (2006), Edvardsson, (2005) and Philibert & Pershing (2001). We will select and elaborate the criteria that are the most relevant for assessing different types of targets for industrial energy conservation. We will not deal with the various approaches to set the level or the stringency of the targets.

The outline of this paper is as follows. Section 2.2 describes the purpose of setting policy targets, the rationale behind SMART targets and a further demarcation of the type of targets included in the paper. Section 2.3 describes different types of industrial targets. Section 2.4 provides a comprehensive overview of policies for industrial energy use and energy efficiency with SMART targets. Section 2.5 discusses the different types of targets in more detail. Section 2.6 evaluates the target types on the basis of several criteria. In section 2.7 we will draw the conclusions.

2.2 Targets: definition, functions and SMART conditions

This section defines what a target is and shows how targets relate to policy objectives, strategies and measures (2.2.1). Furthermore, this section describes the various functions of setting targets (2.2.2) and the conditions that SMART targets should meet (2.2.3). We also further demarcate the type of targets included in the paper (2.2.4).

2.2.1 The role of targets

In this paragraph we focus on the supporting role of targets in a policy design process. A policy design process ideally consists of the following steps. First, the fundamental principles of policies must be determined. Fundamental principles are the societal key values that underlie the policy. Second, the quality objectives of policies must be specified. A quality objective is defined as ‘a succinct statement of the key goal(s) being pursued over the medium to long-term’ (Marsden & Bonsall, 2006). Third, policy makers should decide upon the concrete policy strategies. Policy strategies are the main patterns of activities to achieve the quality objectives. Finally, policies and measures must be developed (Edvardsson, 2005). Policies and measures are the instruments or tools needed in order to implement the strategies. Targets will specify the level of performance that an entity (organization, firm or (sub)sector) intends to achieve for a particular activity by the implementation of these policies and measures (Marsden & Bonsall, 2006). Quality objectives and policy strategies are often also supported with quantitative targets on a relatively high aggregated level, e.g. national level[4].

As an example, we will present the role of targets in the Dutch ‘Long-Term Agreements on Energy Efficiency’ in the 1990s. The fundamental principles (1) of Dutch energy policy in the 1990s are based on the concept of ‘sustainable development’. The quality objectives (2) of energy policy at that time were reliable, affordable and clean energy supplies. These quality objectives were worked out

[4] In this paper we limit ourselves to targets for firms and (sub)sectors, see also section 2.2.4.

through several strategies (3), including energy conservation and promotion of renewable energy. A national target was set to improve energy efficiency by 1.7% on an annual basis and to reduce CO_2 emissions by 3% in the period 1989-2000. The strategies included policies and measures (4) stimulating energy conservation. The 'Long-Term Agreements on Energy Efficiency' were selected as the most important policy instrument for energy conservation. An industry wide target of 20% energy efficiency improvement in the period 1990-2000 and separate sector targets were formulated (EZ/VROM, 1992).

2.2.2 What are the functions of setting targets?

Setting targets can have various functions in the different phases of the policy cycle. Van Herten & Gunning-Schepers (2000) identify those functions of setting targets for health policy[5]. It is expected that those functions are in many cases also valid and similar for energy policy making. We can distinguish the following functions of target-setting: to explore, to guide, to motivate and to regulate.

In the policy formulation stage targets can stimulate the debate about GHG emission reductions, give insight into energy use patterns, provide support for priority setting in energy policies, and describe the desired end-state or quality to be reached by energy and climate policies. These processes should be thought of as an exploratory function of setting targets. This exploratory function of setting targets can, for example, be observed in the negotiation phase on the reduction targets in the European burden sharing agreement and the Kyoto Protocol.

In the implementation stage of energy policies targets should stimulate the target group to put efforts in achieving policy targets. A target can either be action guiding or action motivating; Edvardsson & Hansson (2005) make an explicit distinction between the two. A target is action-guiding 'when it directs and co-ordinates action, over time and between agents, towards the desired end-state'. A target is action-motivating when it motivates the target group to take action. In other words, an action-motivating target stimulates a certain type of behaviour of the target group. By doing so, targets improve the commitment of the target group to the policy. Targets can for instance, improve energy management of the target group, by identifying realistic strategies, and specifying timetables and the allocation of resources. This mechanism has for example been observed in the Long-Term Agreements on Energy Efficiency where drawing up energy conservation plans and monitoring of in-company energy use is an important element of learning processes in firms (Blok & Rietbergen, 2004).

In the policy evaluation stage monitoring provides relevant information about the goal achievement for the target group and information for the policy makers about the level of compliance. By doing so, in the final stage of the policy cycle targets have a regulating function by measuring the actual behavior against the desired behaviour. There are a couple of examples of policy programmes and instruments that have extensive monitoring and reporting procedures, such as the Dutch 'Long-Term

[5] Marsden & Bonsall (2006) have a slightly different approach by analysing the motivations for the use of targets instead of the functions of using targets. The five principal motivations of using targets are better management, legal and contractual obligations, resources constraints, consumer orientation and political aspirations. WBCSD/WRI (2004) identify similar drivers for companies to adopt GHG targets: minimizing GHG risk, achieving costs savings and stimulating innovation, preparing for future regulation, demonstrate leadership and corporate responsibility and participating in voluntary programmes (and thus public recognition).

Agreements on Energy Efficiency' (Novem, 1999) and the European GHG emission trading scheme (VROM, 2004).

2.2.3 SMART targets

The concept of SMART goals and targets originates from the idea of 'management by objectives' introduced by Drucker (1954). SMART targets or goals should meet the following conditions: targets must be Specific, Measurable, Appropriate, Realistic and Timed[6] (van Herten & Gunning-Schepers, 2000; Edvardsson & Hansson, 2005). The level to which these conditions are met determines the ability of the target to guide, motivate or regulate the target group.

Specific: the target must clearly specify what is to be achieved. The purpose of specific targets is to guide the target group in a preferred direction. It must be clear to the target group what that direction is and to what degree the goal must be achieved. The more specific the target, the more motivated the target group is to achieve the goal and the better the target group can be regulated. However, the drawback is that very specific targets might neglect some opportunities for reduction of energy use and GHG emissions. Another drawback is that very specific targets might be less relevant for overall policy strategy. Furthermore, the focus is only on achieving the specific target and consequently a genuine motivation for an efficient use of energy might be neglected.

Measurable: over the duration of the compliance period the target must allow for regular evaluation of the goal achievement and effectiveness. The purpose of a measurable target is to motivate and regulate the target group, by giving feedback on the goal achievement or checking the compliance.

Appropriate: targets must be appropriate for the policy maker and the target group. Targets that are relevant for the policy maker are linked to the overall objectives and aims of the authorities' strategy. Thus, targets should contribute to national commitments in international climate change policies. Relevant targets should motivate the target group to be cooperative with overall policy.

Realistic: the target is achievable within the duration of the compliance period. There are two aspects of target realism: the associated costs and the relative distance. The cost applies to both the size of investment relative to the resources available and/or the profitability of the investment. Relative distance to the target applies to the effort required for the firm or industry to attain the stated goal. Targets should stimulate the companies to go beyond their business-as-usual trajectory and should therefore be sufficiently ambitious. However, if targets are too ambitious, companies may have little hope of reaching them and therefore, may put in little or no effort (Edvardsson & Hansson, 2005).

Timed: targets must specifically delineate the time period in which the set goals need to be achieved. Targets should be set for the short to medium term. However, this can lead companies to focus only on meeting the target with little incentive to go beyond it. On the other hand, if targets are not timed, there is little motivation for the target group to put effort in achieving the target. Therefore, targets should be sufficiently ambitious in time.

[6] Sometimes other keywords behind the letters in the acronym are used such as 'significant', 'motivational', 'attainable', 'relevant' and 'trackable'.

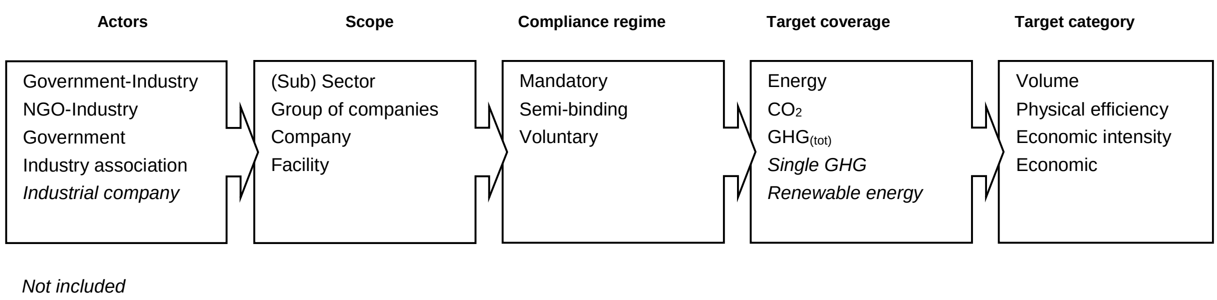
2.2.4 Not all targets are SMART

These SMART criteria leave out several types of targets. First, qualitative approaches, such as targets prescribing the use of a certain type of technology, like ‘Best Available Techniques’, ‘As Low As Reasonable Achievable’, ‘Best Practical Means’ or ‘Best Technical Means’ are not taken into consideration. Those targets are not precise and not easily evaluable since it is not clear to what extent the target has to be achieved and it is difficult to measure the degree of attainment. In practice, the application of these standards often requires further interpretation and additional requirements in quantitative terms, e.g. payback period. Second, this paper focuses only on specific targets for limiting energy use or the associated CO_2 emissions of industrial processes in the manufacturing industry. The reason for solely focusing on manufacturing industry is that this industry is one of the largest energy-consuming sectors and most energy policies are directed towards this specific sector. By limiting the research to energy use targets for industrial processes, the paper excludes energy efficiency targets and standards for appliances. Third, we also exclude renewable energy targets and targets that are set to limit specific GHGs other than CO_2. Fourth, we focus only on targets for individual firms or targets that are set at the sectoral level. National, regional and multi-sectoral targets are not taken into account, since targets at these levels do not specify obligations for individual firms or (sub)sectors and are therefore, not an effective means to stimulate energy efficiency improvement or emissions reduction in firms. Fifth, we exclude aspirational or visionary targets, like for example the target set by the United Kingdom to reduce national CO_2 emission by 60% from 2000 levels by 2050 (DTI, 2003) and the position of the European Union that developed countries should reduce their emissions by 60% to 80% by 2050 compared to 1990 (CEU, 2007). These kinds of targets are not SMART since they have long-term objectives. To our knowledge aspirational or visionary targets for policies aimed at industrial energy efficiency improvement do not exist. Finally, result-based targets, like the EU objective to limit average global temperature increase to no more than 2 degrees Celsius over pre-industrial levels included (EC, 2005) are also excluded. This type of target-setting is not appropriate since there is a weak link between the strategy of energy conservation or CO_2 emission reductions and achieving the 2 degree target. Further, the contribution of the manufacturing industry to those targets is not easily to measure and evaluate.

2.3 Types of SMART industrial energy targets

Targets can be set by different actors in different geographical levels (scope), and under different compliance regimes, see Figure 2.1. A variety of actors can set targets for industrial energy efficiency, e.g. by governments unilaterally or bilaterally with industry, by NGOs-industry partnerships, by industrial associations and even by private entities solely.

Figure 2.1: Different characteristics of targets



Furthermore, industrial energy targets can be set at different aggregated levels: e.g. facility level, company level, for a group of companies, (sub)sector level (nationally, regionally or globally). Targets can be further categorized by the degree to which they are truly binding or not (compliance regime). We distinguish mandatory targets, completely voluntary targets and semi-binding targets analogous to Price (2005). Mandatory targets are legally binding targets and non-compliance of these mandatory targets will result in a penalty fee. Voluntary targets are not legally binding and no penalties exist if these targets are not met. Semi-binding targets use the threat of future regulations or energy/GHG emission tax policy as a motivation for compliance. Next, targets can cover energy consumption, CO_2 emissions or (all) GHG emissions. The following categories of quantitative targets can be distinguished: volume targets, physical efficiency targets, economic intensity targets and economic targets. Target categories can be further broken down into target types. A detailed taxonomy of industrial energy use targets is given in Table 2.1 including some examples. Similar targets can obviously be set for limiting CO_2 and GHG emissions.

Table 2.1: A taxonomy of targets for industrial energy use

Category	Type of target	Example
Volume targets	Energy use target	“Limit total energy use to 100 PJ by 2020”
	Energy use reduction target	“Reduce total energy use 10% in 2020 compared to the level in 1990”
		“Reduce energy use 5 PJ in 2020 compared to the level in 1990”
Physical efficiency targets	Energy efficiency target	“The specific energy use should reach a level of 30 GJ/tonne of product in 2020”
	Energy efficiency target for new installations	“New facilities must operate using the best economic and technical technologies available, being a maximum of 4 GJ/tonne product”
	Energy efficiency benchmark target	“The company should belong to the 10% most energy efficient in the world”
	Energy efficiency improvement target	“The specific energy use of a plant should be reduced by 20% by 2020 compared to the level in 1990” (eq. “Reduce total energy use by 20% in 2020 compared to the frozen efficiency energy use in 1990”)
		“Reduce specific energy consumption by 10% by 2020 compared to the BAU” (eq. to “Reduce total energy use by 10% by 2020 compared to the BAU”)
		“The specific energy use of a plant should be reduced by 1% per year”
		“The energy efficiency index of the company must be reduced by 10% in the period 2008-2020”
Economic intensity targets	Energy intensity target	“The energy intensity should reach a level of 1000 kWh/$ sales by the year 2020”
	Energy intensity improvement target	“The energy intensity in terms of GJ/$ value added should be reduced with 10% within 5 years”
Economic targets	Socio-economic target	“All measures with costs less than 20$ per GJ energy saved should be taken”
	Profitability target	“All measures with a payback period of less than five years should be taken”
	Ability-to-pay target	“All measures should be taken unless the net costs of the measures exceeds 1% of total costs of the company”

There are other distinguishing elements in setting targets that are worth mentioning briefly. First, there are questions related to the product’s life cycle. For example, where in the life cycle should the target be applied, and how should system boundaries, like geographical coverage, be drawn to define energy consumption and emissions, see Phylipsen et al. (1998). Second, the length of the commitment period is a distinguishing element. For example, targets may be achieved in one specific year, e.g. limit energy use to 100 PJ in 2020, or within a multi-year period, e.g. limit energy use to 100 PJ in the period 2018-2022. The multi-year commitment period is advantageous because it reduces the risk that unforeseen events negatively influence target achievement. Third, the choice of target base year is also critical. This can either be fixed, e.g. specific energy use of a plant should be reduced 20% in 2020 compared to the level in 1990, or rolling, e.g. specific energy use must be reduced 1% per year (WBCSD/WRI, 2004)[7]. It is also possible to use a multi-year average as fixed base value.

2.4 Policies for industrial energy use and energy efficiency with SMART targets

Targets are used in various types of policy programmes and instruments such as emission trading schemes, environmental permits and voluntary or negotiated agreements. Table 2.2 provides an overview of the policy programmes and instruments that are included in the analysis.

There are various emission trading schemes worldwide: the national allocation plans in the framework of the European emission trading scheme (EC, 2003) and the linked Norwegian emission trading scheme, the New Zealand emission trading scheme (MFE, 2009) and the 'Carbon Pollution Reduction Scheme' in Australia (DOCC, 2008)[8]. All of these emission trading schemes set quantitative mandatory targets. In a few countries voluntary pilot projects on domestic GHG emission trading were set up, e.g. in the United Kingdom (Defra, 2006), Japan (Ninomiya, 2006) and the U.S. (CCX, 2008). In the U.S. the 'Western Climate Initiative' (WCI, 2009), the 'AB32 - the California Global Warming Solutions Act' (CARB, 2009) and the 'American Clean Energy and Security Act' (Larsen et al., 2009), also propose emission trading schemes. One of the compliance mechanisms in the 'Canadian Regulatory Framework for Air Emissions' is also the trading of CO_2 emission allowances (EC, 2007).

There are a few environmental permitting schemes that set SMART targets, such as the environmental permitting system in the Netherlands (VROM, 1999), Belgium (EMIS, 2008) and the United Kingdom (EA, 2002). Permitting schemes in many other countries rely on energy audits and require the implementation of selected energy efficiency measures; those permit schemes are often lacking uniform SMART targets.

Finally there are many voluntary or negotiated agreements that set SMART targets. These agreements can have voluntary, semi-binding or mandatory targets[9]. There is a wide range of agreements with *voluntary targets*. First there are unilateral commitments made by polluters such as the 'WBCSD - Cement Sustainability Initiative' (WBCSD, 2007), the 'Aluminium for Future Generations Initiative' (IAI, 2007) and the 'CEFIC Voluntary Energy Efficiency Programme for the Chemical Industry' (CEFIC, 2005). In these agreements industry unilaterally declares to make quantified commitments to energy reduction use or GHG emission reduction. Second there are agreements (strategic partnerships) between companies and environmental NGO's that set targets on CO_2, GHG or energy use reduction. Examples are the 'Partnerships for Climate Action' by Environmental Defense (Petsonk, 2002), the 'PEW Business Environmental Leadership Council' (PEW, 2007) and the 'WWF Climate Savers Programme' (WWF, 2006). Third, there are agreements between industry and public authorities.

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[7] See WBCSD/WRI (2004) for a comparison of targets with rolling and fixed base years.

[8] Schemes especially designed for emission trading among electricity producers and large electricity consumers are not included.

[9] We have tried to include all target-based agreements with negotiated targets at company or sub-sector level and performance based agreements with quantitative performance goals at company or sub-sector level, see Storey et al. (1997). Excluded are performance-based agreements with quantitative targets at multi-sector industrial level and performance-based agreements requiring an energy auditing procedure without clear target-setting for the implementation of energy efficiency measures.

Table 2.2: Policy programmes with SMART targets

Country	Policy programme	Start	Stop	Compliance regime	$E/CO_2/GHG$ cap	$E/CO_2/GHG$ emission reduction	SEC/SCE (absolute)	SEC/SCE improvement (relative)	EEI/CO_2EI	$E/CO_2/GHG$ efficiency benchmarking	Minimum energy/ CO_2 efficiency	Energy/CO_2/GHG intensity (absolute)	Energy/CO_2/GHG intensity improvement (relative)	Economic	Reference
Environmental permit															
Belgium	Environmental permit	2004	-	R										PBP	EMIS, 2008
Netherlands	Environmental permit	1994	-	R										PBP	VROM, 1999
UK	Environmental permit	2002	-	R										Cspec	EA, 2002
Emission trading															
Australia	Carbon pollution reduction scheme	2010	-	R										Cspec	DOCC, 2008
EU+EEA	European emission trading scheme	2005	2008	R	C										EC, 2003
Japan	Voluntary emission trading scheme	2005	2007	V		C									Ninomiya, 2006
New Zealand	Emission trading scheme	2010	-	R	C										MFE, 2009
United Kingdom	UK emissions trading scheme (pilot)	2002	2006	V		C									Defra, 2006
USA	Chicago climate exchange	2003	2010	R		C									CCX, 2008
USA	American clean energy and security act (proposed)	2012	2050	R	C										Larsen et al., 2009
USA	AB32 - California global warming solutions act (proposed)	2012	2020	R	C										CARB, 2009
USA	Western climate initiative (proposed)	2012	-	R	C										WCI, 2009
Voluntary Agreements - unilateral industry agreement															
EU	Voluntary energy efficiency programme chemical industries (CEFIC)	1992	2005	V				E							Cefic , 2005
Global	Cement sustainability initiative (WBCSD)	2002	-	V			C	C							WBCSD, 2007
Global	Aluminum for future generations (IAI)	2003	-	V				E							IAI, 2007
Voluntary Agreements - between industry and public authority															
Belgium	Benchmarking covenant (Flanders)	2004	2012	Th						E				IRR	CB, 2007
Belgium	Voluntary agreements (Wallonia)	2000	2012	Th					C/E					PBP	CGW, 2007
Belgium	Audit covenant	2005	2013	Th										IRR	VAV, 2007
Canada	Regulatory framework for air emissions	2006	2010	R				C						Cspec	EC, 2007
Canada	Industry program for energy conservation	1975	-	V				E					E		NRCAN/OEE, 2007
Canada	Quebec voluntary agreement with Aluminum Industry	2002	2012	V	C						C				MSDEP, 2006
China	Top 1000 industrial energy efficiency programme	2005	2010	V			E	E							Price, 2010
China	Shandong pilot project voluntary agreement with 2 steel companies	2003	2005	V				E							Hu, 2007
Denmark	Agreements on industrial energy efficiency	1993	-	R										PBP	Krarup, 2000
Finland	Energy efficiency agreements	2008	2016	V				E				E			Motiva, 2009
France	Voluntary agreements on CO_2 reductions	1996	2002	V		C	C								Chidiak, 2002
France	AERES negotiated agreements	2002	2007	Th	C		C								AERES, 2003

Table continued

Country	Policy programme	Start	Stop	Compliance regime	$E/CO_2/GHG$ cap	$E/CO_2/GHG$ emission reduction	SEC/SCE (absolute)	SEC/SCE improvement (relative)	EEI/CO_2EI	$E/CO_2/GHG$ efficiency benchmarking	Minimum energy/ CO_2 efficiency	$Energy/CO_2/GHG$ intensity (absolute)	$Energy/CO_2/GHG$ intensity improvement (relative)	Economic	Reference
Germany	Joint declaration on global warming prevention	1995	2000	Th		C/E	E	C/E					C		Ramesohl, 2000
Germany	Agreement on climate protection	2000	2012	Th		C		C/E					C		RWI, 2005
Ireland	The self audit scheme/large industry energy network	1994	-	V				E	E						SEI, 2007
Japan	Keidanren voluntary action plan on the environment	1997	2010	Th	C/E	C/E		C/E							Keidanren, 2006
Korea	VA system for energy conservation & reduction of GHG emissions	1998	-	V		C		C/E					C/E		Kemco, 2007
Netherlands	Long term agreements 1	1992	2000	Th					E				E		EZ, 1998
Netherlands	Long term agreements 2	2000	2012	Th					E					PBP	EZ, 2003
Netherlands	Long term agreements 3	2008	2020	Th					E					PBP	EZ, 2008
Netherlands	Benchmarking covenant	2001	2012	Th						E					EZ, 1999a
New Zealand	Voluntary agreements to limit CO_2 emissions	1995	2000	Th				C							Jamieson, 1996
New Zealand	Negotiated greenhouse agreements	2003	2005	R						C					MFE, 2005
Norway	Voluntary agreement with aluminum industry	1997	2005	V				C							IEA, 2008b
Sweden	Programme for energy efficiency in energy intensive industry	2005	2010	R										PBP	SEA, 2007
Switzerland	CO_2 target agreements - voluntary agreement	2001	-	Th					E						SAEFL, 2001
Switzerland	CO_2 target agreements - formal commitment	2001	-	R	C				C						SAEFL, 2001
United Kingdom	Negotiated agreement with chemical industry	1990	2005	V				E							CIA, 1999
United Kingdom	Climate change agreements	2001	2013	R		C/E	E	C/E	C/E			E			ETSU, 2001
USA	Climate VISION	2003	-	V		C/E		C/E							US-DOE, 2007
USA	Environmental performance track	2000	2009	V	C/E										EPA, 2006b
USA	EPA climate leaders	2002	-	V		C		C					C		EPA, 2006a
Voluntary Agreements - between polluters and pollutes															
Global	Climate savers (WWF)	1999	-	V		C		C							WWF, 2006
Global	Partnerships for climate action (Environmental defense)	2000	-	V	C	C									Petsonk, 2002
Global	Business environmental leadership council (PEW)	1998	-	V	C	C/E		C/E				C			PEW, 2007

V = voluntary target, R = binding target, Th = non-compliance threatened by regulatory measures, C = CO_2/GHG target, E = Energy target, PBP = Payback period, IRR = Internal rate of return, Cspec = specific CO_2 mitigation costs

Examples of agreements between government and industry with completely *voluntary* targets are the ‘Climate VISION Program’ (US-DOE, 2007), ‘EPA Climate Leaders’ (EPA, 2006a) and ‘Environmental Performance Track’ (EPA, 2006b) in the U.S, the ‘Canadian Industry Program for Energy Conservation’ (NRCAN/OEE, 2007), the ‘Quebec Voluntary Agreement with Aluminium Industry’ (MSDEP, 2006), the voluntary agreements in Korea (Kemco, 2007), the ‘Energy Efficiency Agreements’ in Finland (Motiva, 2009), the French ‘Voluntary Agreements on CO_2 Reduction’ (Chidiak, 2002), the ‘Self Audit Scheme/Large Industry Energy Network’ in Ireland (SEI, 2007), the voluntary agreement on energy between government and aluminium industry in Norway (IEA, 2008b), the voluntary agreement with two steel companies in China (Price et al., 2004), and the negotiated agreement with chemical industries in the United Kingdom (CIA, 1999).

The voluntary or negotiated agreements with *semi-binding targets* are the French ‘AERES Negotiated Agreements’ (AERES, 2008), the ‘Joint Declaration on Global Warming Prevention’ in Germany (Ramesohl & Kristof, 2000) followed by the ‘Agreement on Climate Protection’ (RWI, 2005), the first generation of ‘Long-term Agreements on Energy Efficiency’ in the Netherlands (EZ, 1998), followed by the second and third generation of ‘Long-Term Agreements on Energy Efficiency’ and the ‘Benchmarking Covenant on Energy Efficiency’ (EZ, 1999a), the ‘Audit Covenant’ and the ‘Benchmarking Covenant on Energy Efficiency’ in Flanders – Belgium (VAV, 2007 and CB, 2007), the voluntary agreements on energy efficiency in Wallonia – Belgium (MRW, 2002), the ‘Keidanren Voluntary Action Plan on the Environment’ in Japan (Keidanren, 2006) and the voluntary agreements to limit CO_2 emissions in New Zealand (Jamieson, 1996).

The government-industry agreements with *mandatory targets* are the negotiated greenhouse agreements in New Zealand (MFE, 2005), the Danish ‘Agreements on Industrial Energy Efficiency’ (Krarup & Ramesohl, 2000), the Canadian ‘Regulatory Framework for Air Emissions’ (EC, 2007), voluntary measures under the CO_2 law in Switzerland (IEA, 2008b), the United Kingdom ‘Climate Change Agreements’ (Ekins & Etheridge, 2006), the ‘Programme for Energy Efficiency’ in energy intensive industry in Sweden (SEA, 2007) and the ‘Top 1000 Industrial Energy Efficiency Programme’ in China (Price et al., 2010).

2.5 Unfolding SMART energy and CO_2/GHG targets

2.5.1 Volume targets

Although volume targets have been fairly common in areas of environmental policy, in the area of energy use and GHG emissions they have been scarce until the 21st century. Volume targets prescribe that a company or a sector is not allowed to use more than a certain amount of energy or emit more than a certain amount of CO_2/GHG emissions at a fixed point in the future (energy use or CO_2 emission target in absolute terms). Alternatively, volume targets can also require that a certain percentage of the energy use or CO_2/GHG emissions must be reduced relative to a base year at some fixed point in the future (energy or CO_2 emission reduction targets in relative terms). In both cases volume targets must ultimately limit or reduce energy use or CO_2/GHG emissions to a certain absolute level.

Energy use targets

Energy use targets are predominantly used in bilateral government-industry agreement schemes or partnerships and NGO-industry partnerships, but are less common than other types of targets, see Table 2.2. Energy use targets are more commonly expressed in relative terms, e.g. “the total energy use must be reduced with 10% in 2020 compared to the level in 1990”, than in absolute terms, e.g. “the total energy used must be limited to 100 PJ in 2020”.

An early European example of an agreement scheme with an energy use reduction target in relative terms is the declaration of the German textile industry on energy saving and CO_2 emission reduction. The textile industry committed itself to reduce energy use by 20% in the period 1987-2005. A more recent example that also has the least permissive character is the sector target set by the British steel industry in the framework of the ‘Climate Change Agreements’ in the United Kingdom. The steel industry is one of the few sectors that had agreed upon an energy use reduction target. The target is to reduce energy use by 11.5% in 2010 compared to the level in 1997 (ETSU, 2001). In the Japanese ‘Keidanren Voluntary Action Plan on the Environment’ (Keidanren, 2006) launched in 1997, a minority of the industrial sectors have defined energy use reduction targets. For example, the Japanese iron and steel industries have set a target to reduce energy consumption in 2010 by 10% compared with energy consumption in 1990.

CO_2/GHG emission volume targets

Currently, volume targets for CO_2 or GHG emissions are emerging rapidly. These types of targets are used in various types of policy programmes, such as emission trading schemes and voluntary agreement schemes. Both CO_2/GHG emission caps, e.g. limit total CO_2/GHG emissions to 1000 kton CO_2eq in 2020, and CO_2/GHG emission reduction targets, e.g. reduce total CO_2 emissions 10% in 2020 compared with the level in 1990, are frequently used.

The Kyoto Protocol and the distribution of national climate commitments is obviously the most important example of global energy and climate policies that set CO_2/GHG emission volume targets. The European Community is committed to achieving an 8% reduction of GHG emissions by the year 2008-2012 compared to 1990 levels. The member states of the European Union have agreed to fulfil their commitments jointly. In 2005 a scheme for the trading of greenhouse gas emission allowances in the European Union came into effect. Each member state had to draw up a national allocation plan stating the total quantity of allowances that it intended to allocate and how the allowances would be distributed among the participants in the ETS. There are three distinctive methods to allocating CO_2 emission allowances: *grandfathering, benchmarking* and *auctioning*.

Grandfathering provides emission allowances free of charge to the participants. The allocation is based on historic emissions of the participant and can be modified by including other factors such as sector-specific growth rates, capacity utilization rates and energy efficiency benchmarks. Grandfathering has been the main approach used to allocate emission allowances in the first and second phase of the EU ETS.

Like grandfathering, *benchmarking* also provides emission allowances for free, but benchmarking allocates emissions on the basis of a GHG or energy efficiency benchmark, e.g. tons CO_2/ton of product, and the production level (Groenenberg & Blok, 2002). Up till now, benchmarking has only been used as a method to allocate emissions for new entrants in energy-intensive industries.

In some EU member states, a small share of the emission allowances has been auctioned. In the case of *auctioning*, emission allowances are sold to the highest bidder. Setting targets at firm level is therefore unnecessary. Full auctioning will be used in the ‘Carbon Pollution Reduction Scheme’ in Australia (DOCC, 2008). This scheme only sets limits to all emission sources covered and not to individual firms or facilities.

Next to emission trading schemes, there are also a wide range of voluntary or negotiated agreements with CO_2/GHG emission volume targets. The Swiss CO_2 target agreement is an example of a voluntary agreement between industry and public authority with CO_2/GHG emission targets expressed in absolute terms. In this agreement, firms adopt binding CO_2 caps, which exempts them from a CO_2 tax. A second example is the EPA 'Climate Leaders Program' in the U.S.. Several companies committed themselves to CO_2 or GHG emission volume reduction targets expressed in relative terms, e.g. Eastman Kodak committed itself to a 10% reduction of GHGs in 2008 compared to the level in 2004. The potash industry is the only sector under the German voluntary agreements that adopted CO_2 emission volume reduction targets (78% CO_2 emission volume reduction in 1990-2005).

CO_2/GHG emission volume targets are also commonly used in bilateral NGO-industry partnerships, such as the 'WWF Climate Savers Programme'. By 2006, 11 international partners had set a corporate-wide GHG volume reduction goal and created inventories of their emissions in order to measure progress (WWF, 2006). One company, Johnson and Johnson, set a 7% GHG emission reduction target by 2010 compared to the 1990 level.

2.5.2 Physical efficiency targets

Physical efficiency targets are quite common in energy and climate policies. These targets can either aim at a certain energy efficiency or CO_2 efficiency level at a fixed point in the future (physical efficiency targets in absolute terms) or aim at a certain improvement of energy or CO_2 efficiency compared to a business-as-usual case or a base year (physical efficiency improvement targets in relative terms).

Energy efficiency targets: Specific energy consumption and EEI

Energy efficiency is defined as output per unit energy input. For industrial processes in general, the inverse of energy efficiency, i.e. the specific energy consumption (or specific energy use, unit energy use or physical energy use) is used:

Equation 2.1:

$$SEC = \frac{E}{P}$$

SEC = Specific energy consumption
E = Energy input to the process
P = Output of production process

Energy efficiency targets are used in multiple types of voluntary agreements schemes, see Table 2.2. Energy efficiency improvement targets, like "the SEC of a plant should be reduced by 20% in 10 years" (relative reduction of SEC) are very frequently used, whereas energy efficiency targets, like "the SEC should reach a level of 30 GJ/tonne ammonia" (absolute target value for SEC) are not.

The few examples of agreements with efficiency targets expressed in terms of an absolute target value for the SEC can be found in the British 'Climate Change Agreements', where e.g. the brewing industry has set a goal to achieve a primary SEC of 56.94 kWh/hectolitre by 2010, and in the German 'Declaration on Global Warming Prevention', where the sugar industry is aiming at the limitation of energy use per tonne of sugar beet to 29 kWh/ton in the period 1990-2005. Energy efficiency benchmarking agreements are another example of policy instruments using efficiency targets expressed in terms of an absolute target value for the SEC. In fact, benchmarking is an approach to setting the level of a target. A benchmark target is an energy efficiency target that is dependent on the performance of the other firms in a more or less homogeneous group. A benchmark procedure typically works as follows: the SEC is determined for a group of homogeneous firms, e.g. all ammonia producers in the world. Subsequently, the firms are ordered according to increasing SEC and a benchmark target for a specific company could then require the company to implement improvements so that it shifts into a lower percentile of the population. Such a benchmarking target is used in the Dutch 'Benchmarking Covenant on Energy Efficiency', concluded in 1999 between the Dutch government and energy-intensive industries (energy consumption > 0.5 PJ per unit per year). According to the covenant, energy-intensive industries are obliged to be among the leaders in energy efficiency for processing installations by 2012. The Belgium government subsequently concluded a similar benchmarking covenant with energy intensive industries.

Many sector agreements in the German 'Declaration on Global Warming Prevention', the German 'Agreement on Climate Protection', the Japanese 'Keidanren Programme' and the British 'Climate Change Agreements' have set energy efficiency improvement targets expressed in terms of a relative reduction of the SEC: e.g. the German cement industry aimed at a 20% reduction in the specific fuel consumption kJ fuel/kg cement produced (1987-2005) and the British textile industry aimed at a 9% reduction of primary SEC from 1999-2010.

China introduced the 'Top-1000 Energy-consuming Enterprise Programme'. Firms participating in this programme must adopt 'energy-saving' targets. The energy saving target is an absolute energy saving value that each enterprise is expected to save in 2010 against a growth baseline (Price et al., 2010). The target achievement depends on the production volume and the reduction of SEC[10].

For individual processes or sectors that are dominated by one individual process, the SEC is a useful measure of energy efficiency. However, most industries and sectors produce a mix of products. In that case the SEC should be replaced by an energy efficiency index (EEI). The EEI is a weighted average of the values of the SEC for a range of products[11]:

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[10] Energy savings in year i compared to the previous year i - 1 are calculated with the following formula (Price et al., 2010):

$$E_{savings,i} = P_i * (SEC_{i-1} - SEC_i)$$

[11] If specific energy use of products is unknown project monitoring can be used to calculate the EEI. EEI is then calculated by:

$$EEI = \frac{E}{E + \Delta E_{realised\ savings}}$$

This methodology is for example applied in the Swiss voluntary CO_2 target agreements and in some sectors/companies participating in the first generation of the long-term agreements in the Netherlands.

Equation 2.2:

$$EEI = \frac{\sum_{x=1}^{n} SEC_x * P_x}{\sum_{x=1}^{n} SEC_{ref,x} * P_x} = \frac{E_{actual}}{E_{frozen\ efficiency}}$$

EEI	=	Energy Efficiency Index of an industrial sector
E_{actual}	=	Total energy use of an industrial sector in a specific year
P_x	=	Production volume for product x in a specific year
SEC_x	=	Specific energy use for product x in a specific year
$SEC_{ref,x}$	=	Reference specific energy use for product x

The problems associated with constructing an EEI are discussed in Phylipsen et al. (1998). One of the crucial aspects is the choice of a set of reference values for the specific energy consumption ($SEC_{ref,x}$). Various options are available, e.g. historic levels of the SEC of the various products, best practice levels or best-plant levels of the various product SECs.

A target for the reduction of the EEI was used in the first generation of 'Long-term Agreements on Energy Efficiency' for the Netherlands. The target was to decrease the EEI over the period 1989 - 2000 with a certain percentage, generally about 20%. This can be indicated as an energy efficiency improvement target in relative terms: the weighted energy consumption per unit product should be decreased by 20%. The EEI is also used as a target in the voluntary agreements between industry and the Wallonia government in Belgium, the 'Climate Change Agreement' with chemical industry in the United Kingdom and the voluntary CO_2 target agreement in Switzerland.

CO_2/GHG efficiency targets: specific CO_2/GHG emissions and CO_2EI

CO_2/GHG efficiency targets can be set analogous to Equation 2.1 and Equation 2.2. Such targets are used in various types of policy instruments (see Table 2.2). CO_2/GHG efficiency improvement targets, like "the specific CO_2 emissions (SCE) of a plant should be reduced by 20% in 10 years" (relative reduction of SCE) are very frequently used, whereas CO_2/GHG efficiency targets, like "the SCE should reach a level of 1000 kg/tonne of product" (absolute target value for SCE) are not.

The 'AERES Negotiated Agreements' with French industry are the only known examples of policy instruments with CO_2/GHG efficiency targets expressed in terms of an absolute target value for SCE. Under these agreements, for example, the French glass industry agreed that firm-level SCE must reduce emissions to 692 kg CO_2 per ton of glass produced in 2007. Approximately half of the 33 agreements under the AERES programme set this type of target.

Efficiency targets in absolute terms are often used to limit energy use and emissions in buildings, appliances and equipment. Absolute target values for the SCE applied as a minimum CO_2 efficiency level for new process installations are however scarce. One distinctive example of such targets was found in a sector agreement between the government of the Canadian Quebec region and the aluminium industry. In this agreement they utilise the concept of 'Best Available Technology Economically Achievable'. As part of the agreement, the sector 'ensures' that new facilities will operate using the best economic and technical technologies available, being a maximum of 2 tonnes of CO_2eq per tonne of aluminium produced (MSDEP, 2006).

CO_2/GHG efficiency improvement targets expressed in terms of relative reduction of the SCE can be found in many sector agreements in the German 'Declaration on

Global Warming Prevention'. The overall target of the German 'Declaration on Global Warming Prevention' is to reduce the SCE by 20% in 2005 from the level of 1990. The target of the follow-up agreement ('German Agreement on Climate Protection') is a reduction of SCE by 28% in the period 1990 – 2005 and reduce its specific emissions by 35% in 2012 compared to the 1990 level. The target for 2012 includes CO_2 as well as the five other GHGs controlled under the Kyoto Protocol. The industrial sectors contribute to the overall target with different sector targets. Many industrial sectors, such as the potash[12], ceramic and paper industries have set sector targets in terms of relative reduction of SCE per tonne of product. In Canada the 'Regulatory Framework for Industrial Air Emissions' requires that each sector reduces the SCE from combustion and non-fixed process emissions by 6% annually in the period 2007-2010 and thereafter by 2% annually (EC, 2007). The target must primarily be achieved through emission abatement actions[13].

There exist two examples of agreements that include a CO_2 efficiency index (CO_2 EI), analogous to Equation 2.2. The CO_2EI is used in the Wallonia voluntary agreements on energy (MRW, 2002) and in the 'Climate Change Agreement' with aluminium industries in the United Kingdom.

2.5.3 Economic intensity targets

Economic intensity targets aim at decoupling the energy use or emissions from economic output. These targets can set limits to the ratio of energy use (or CO_2/GHG emissions) and the economic activity (economic energy or CO_2/GHG intensity target in absolute terms) or aim to improve this ratio (economic energy or CO_2/GHG intensity improvement target in relative terms). The economic activity can be expressed in terms of the value of production, value added, revenue or sales.

Equation 2.3:

$$\varepsilon = \frac{E}{A}$$

ε	=	Economic energy intensity
E	=	Energy input to the process
A	=	Economic activity

Economic intensity targets are sometimes proposed as alternative approaches for binding Kyoto commitments at the national level. The U.S. and Argentina for example, use national level economic intensity targets; however, economic energy or CO_2 intensity targets are rarely used in industries. The companies or sectors that do set energy intensity targets are generally not the most energy intensive industries.

There are some examples of companies or sectors that have set their own economic energy or CO_2/GHG intensity improvement targets in relative terms. In the 'EPA Climate Leaders Program' the pharmaceutical company Pfizer intends to reduce global GHG emissions by 35% per dollar of revenue between 2000 and 2007 (EPA, 2006a). Electrotechnical industries in Germany have set economic energy intensity improvement targets in the 'Joint Declaration on Global Warming Prevention' as well

[12] The potash industries have also formulated a CO_2 volume reduction target.

[13] There are also limited possibilities to comply with these targets through other mechanisms: 1) firms could meet their compliance obligations through contributions to a technology fund, see section 'socio-economic targets'; 2) emissions trading; 3) credits from the Kyoto Protocol's Clean Development Mechanism and 4) recognition of early action.

as in the following ‘Agreement on Climate Protection’. The target set in the ‘Agreement on Climate Protection’ is a 40% reduction in the CO_2 emission per € production value in the period 1990-2012 (RWI, 2005). In the first generation of the ‘Long-Term Agreements on Energy Efficiency’ in the Netherlands, Philips Electronics set a 25% target to improve economic energy intensity, defined as energy use divided by the total value of production, in the period 1989-2000.

In the framework of the ‘Climate Change Agreements’ in the United Kingdom, the sector craft bakeries and supermarkets are the only sectors that have set an absolute target value for the economic energy intensity; the target is to achieve a 1160 kWh/£k added value in 2010 (ETSU, 2001).

2.5.4 Hybrid targets

The energy efficiency targets of the German chemical industries, in the framework of the ‘Agreement on Climate Protection’ and the ‘Joint Declaration on Global Warming Prevention’, are measured by dividing the energy index in the sector by a production index as in Equation 2.4:

Equation 2.4:

$$SEC = \frac{\text{energy index}}{\text{production index}} = \frac{E / E_0}{\sum_{k=1}^{n} b_k * I_k}$$

and

$$I_k = \sum_{x=1}^{n} g_j * V_j$$

SEC	=	Specific energy consumption of an industrial sector
I_k	=	Production index of the sub sector k
b_k	=	Share of the sub sector in the value added of the total sector at factor costs in the base year
E	=	Total energy consumption of sector in a specific year
E_0	=	Total energy consumption of sector in the base year
g_j	=	Share of production value in the gross production value in the sub sector in the base year
V_j	=	Production volume index

The production volume can be based on physical output in case very homogenous products are produced such as in the sector of basic chemicals or on the basis of the production value, corrected for inflation, in sub sectors with heterogeneous products or products with significant quality differences. Apart from the sub sector of basic chemicals all other sub sectors in the chemical industries report production volume on the basis of the production value. The advantage of using the ratio of the energy index and production index above the EEI is that reference values of the SEC of the various products are not needed, while it still takes into account structural changes in the sector. This type of target makes it possible to construct a hybrid production index, where physical production values and economic values of production are combined.

2.5.5 Economic targets

Economic targets have not been used very frequently in energy policies. However, the level of many other types of targets, such as volume and physical efficiency targets are based on a techno-economic assessment. Economic targets take into account costs and or revenues of energy saving investments, which help to define the financial burden for individual firms. We distinguish profitability targets, socio-economic targets, and ability-to-pay targets.

Profitability targets

Profitability targets require that all energy saving measures implemented be economically attractive from a private perspective. A specific cut-off maximum payback period (PBP), e.g. 5 years or a positive net present value (NPV) at a certain discount rate (e.g. 15%) can be used to assess the profitability of energy saving measures.

Since the beginning of this decade, profitability targets have been used more frequently in energy policy instruments. However, these types of targets are only used in unilateral government decisions and bilateral industry-government agreements. The Danish ‘Agreement Scheme on Industrial Energy Efficiency’ (Krarup & Rahmesohl, 1999) is one of the earliest examples of policy instruments to set profitability targets. They require companies to implement all energy conservation projects with a PBP of less than 4 years. As part of the agreement, that can either be individual or collective, companies receive a CO_2-tax rebate. The Swedish ‘Programme for Energy Efficiency’ in energy-intensive industries, introduced in 2005, has a similar scheme. Participating companies must implement an energy management system and carry out an energy audit in the first two years. During the remaining three years the companies must implement energy efficiency measures that have a PBP less than 3 years (SEA, 2007).

Profitability targets are also used in the Dutch environmental permit system and the second and third generation of ‘Long-Term Agreements on Energy Efficiency’ in the Netherlands. Firms are required to implement all energy saving measures *that could reasonably be asked*. Under this scheme, the measures ‘that could reasonably be asked’ is defined as measures with a positive NPV at a discount rate of 15% (VROM, 1999; EZ, 2003; EZ, 2008). This corresponds to a PBP of approximately 5 years. Similar energy requirements can be found in the environmental permitting system and in the ‘Audit Covenant’ in Belgium. According to this ‘Audit Covenant’, medium-sized energy intensive firms (0.1 – 0.5 PJ/year) must carry out energy audits and all the measures with an IRR of 15% or more must be implemented in the first phase. In the second phase less attractive measures with an IRR of 13.5% or more must be taken (VAV, 2007).

Socio-economic targets

Socio-economic targets require that all measures meeting a certain cost-effectiveness criteria must be implemented. The cost-effectiveness of energy efficiency measures from a social perspective can be expressed in terms of specific costs. These are the costs per unit of effect obtained. Examples are the specific cost of saved energy ($/GJ) and the specific CO_2 mitigation costs ($/t$CO_2$).

A number of policy instruments that set requirements to specific costs as a target for industrial conservation propose this type of target-setting. The ‘Regulatory Framework on Air Emission’ in Canada sets binding targets for specific CO_2 emission reductions. To a limited extent these regulatory obligations can be met by contributing to a so-called climate change technology fund at a rate of 15CAN$ (around 10€) per tonne of carbon dioxide equivalent from 2010 to 2012 and 20CAN$ (around 13€) per tonne in 2013. Thereafter, the rate is pegged to the growth rate of nominal GDP. The fund will be used to invest in new technologies that are shown to yield CO_2 emission reductions (EC, 2007). These limits to specific costs are also known as price caps and the safety valve. In the Australian ‘Carbon Pollution Reduction Scheme’ emission allowances are auctioned but the government has decided to set a price cap for five years of 40AUS$ (around 25€) per tonne CO_2, rising at 5% per annum (DOCC, 2008). A third example of a socio-economic target are the energy efficiency requirements in the IPPC guidelines in the United Kingdom. Operators that do not participate in the 'Climate Change Agreements or operators that fail to meet these obligations, must draw an energy efficiency plan and rank all energy efficiency measures on the basis of specific costs. Each measure that results in net costs savings should be considered for implementation (EA, 2002). The discount rate should be selected by the operator, but typically varies from between 6-12% in the United Kingdom. According to EA (2002), the Environment Agency is also considering requiring the implementation of techniques that have positive specific costs. To date, no progress has been made on developing stricter targets.

Ability-to-pay target

A type of target that is not being used in practice is the ability-to-pay target. Similar to the profitability target, the ability-to-pay target also takes into account the reasonability of the energy saving investments from a private perspective. The implementation of energy saving measures should not substantially affect the competitiveness of the firms. The ability-to-pay target does take into account the total investment costs of energy saving; whereas the profitability target and the social-economic target do not do that. There are different possibilities to design such ability-to-pay targets, e.g. firms should take all energy saving investment unless the net costs of the measures exceeds x% of the total production costs, x% of the total turnover or x% of the total profits. Blok & Rietbergen (2004) have analysed the impact of a standard that requires firms to take all energy saving investment unless the net costs of these measures exceed 0.2% of the total costs of the company. It appears that such an ability-to-pay target leads to similar energy savings as in a regime that uses profitability criteria of no more than 5 years.

2.6 Assessment of the different target options

One objective of this paper is to assess various approaches used in setting targets. A wide range of criteria for assessment of target types has been used in related papers. For example, Bramley (2007) uses the criteria of environmental fairness, economic feasibility (profitability, ability-to-pay, cost-effectiveness), environmental integrity, cost (un)certainty, urgent action, geographical balance. Herzog et al. (2006) evaluate environmental effectiveness, complexity and public understanding, data verification and compliance, and interaction with emission trading. Additional criteria found in other papers are e.g. potential for (international) comparison, encouragement of early action (Hoehne, 2006), relevance for the target group (Edvardsson, 2005), contribution to economic growth (Philibert & Pershing, 2001), incentives for technological progress and relevance for international climate policies (Dudek & Golub, 2003).

In this paper we assess the target types on the basis of the following criteria. First, we discuss the (un)certainty of environmental outcome. Some target types will not lead to a particular environmental outcome while others do. Second, we look at the environmental integrity of targets; a target type must guarantee that the environmental outcome and achievement of the targets is the result of real abatement (no loopholes). Third, an issue that is often debated is the (un)certainty of compliance costs. Some target types do not give sufficient insight in the total costs involved to compliance with the target level. Fourth, we evaluate the public relevance. We question whether the target is linked to current climate change policies or not. Fifth, we discuss the relevance of the target for the industry. Targets that are relevant for industry are most likely to be better accepted and subsequently, more easily adopted. Some target types align better with certain business strategies or decision-making processes than other types of targets. Sixth, we discuss whether the targets allow for a good international or national comparison. Finally, we will look at the complexity of the target. Table 2.3 summarizes the assessment of the target options.

Table 2.3: Assessment summary of the target options

Assessment criteria	low		high
Certainty of environmental Outcome	physical efficiency target economic intensity target economic target		volume target
Environmental integrity	economic intensity target volume target		physical efficiency target economic target
Certainty of compliance costs	volume target	physical efficiency target economic intensity target	economic target
Public relevance	economic target	physical efficiency target economic intensity target	volume target
Relevance for industry	volume target	economic intensity target	physical efficiency target economic target
Potential for comparison	volume target	economic intensity target economic target	physical efficiency target
Complexity	volume target	physical efficiency target	economic intensity target economic target

1. (Un)certainty of the environmental outcome. Volume targets may look very appealing to governments since the impact on the environment in terms of energy use reduction or CO_2/GHG emission reduction is clearly stated in the case of full compliance. In contrast, physical efficiency targets do not control the total energy use and its related emissions of a firm or a sector; these targets allow industries to grow their energy use and emissions. In order to limit uncertainties in the environmental outcome of these targets good insight into the business-as-usual scenario is required. Alternatively, a feedback loop can be used to regularly adjust the efficiency targets in order to achieve the preferred environmental outcome. However, this will lead to 'uncertainty of effort' among the regulated firms (ESST, 2008).

In the special case of a benchmarking target, companies do not have to perform better than the peer group. Consequently, these targets do not lead to the best environmental outcome possible. Another problem with benchmarking is that setting the level of the target may be difficult: it is difficult to assess the energy efficiency of the world top because of the strategic value of this type of information[14]. Similar to physical efficiency targets, the environmental outcome of economic intensity targets is uncertain. Economic intensity targets permit the unlimited growth of energy use or emissions as long as it is compensated by a growth in the economic output of a sector or firm (Lisowski, 2002). The stringency of the target can be hard to evaluate depending on the indicator measuring the economic activity. Economic targets also do not control

[14] There are several restricted methods for benchmarking the energy efficiency. In the so-called full benchmark all comparable installations in the world are involved, and the best standard is defined as the best decile (the 10% best industries); in the region benchmark, the best regions are involved and the average of the best region is defined as best standard; in the best practice method, only the very best in the world is looked at, defining the best standard as a 10% higher specific energy consumption; if previous methods are not feasible, auditing principles will be applied to estimate the potential energy efficiency improvements.

the absolute emissions. The stringency of the target determines whether the environmental outcome goes beyond the business-as-usual effects.

2. Environmental integrity. Although the environmental outcome of policies and measures with volume targets is certain in the case of full compliance, it does not mean that the quality of the outcome is satisfactory (Herzog et al., 2006). The total energy use and emissions can also be reduced e.g. 1) if industrial facilities change owners, 2) by outsourcing industrial activities or 3) closing down plants, reducing domestic activities and increasing it overseas and 4) structural changes in the production (Elliot, 2003). In those cases, energy use and GHG emissions are not reduced by the implementation of GHG abatement technologies. A regular adjustment of volume targets may be necessary in order to assure the environmental integrity of the target achievement. The environmental integrity of physical efficiency targets is much more certain, since the commitment level for companies remains the same if output fluctuates. Furthermore, there is a direct relationship between the target and energy efficiency technology since the effect of energy saving measures is expressed in terms of physical efficiency improvement (Phylipsen et al., 1998). Moreover, physical energy efficiency targets can take into account both the increase in the production volume and in particular cases, structural changes in the product mix. The environmental integrity of economic targets is also assured while these target types are met by implementing energy efficiency measures on a project basis. Meeting the economic intensity target does not necessarily mean that it has been achieved by the implementation of abatement technologies: economic intensity targets can be achieved by increasing the economic output, reducing energy use / GHG emissions or a combination of both.

3. (Un)certainty of compliance costs. One of the major disadvantages of volume targets is the high uncertainty of the costs related to achieving the target. The (un)certainty of the costs for complying with the volume targets depends on the (un)certainty in the output level at the end of the commitment period and the uncertainty in the emission abatement costs at a certain output level (Kolstad, 2005). Since total energy use or emissions are capped, unexpected high economic growth and economic output can put a considerable financial burden on the target group, especially if the cost-supply curve of abatement technologies is steep. On the other hand, higher economic growth can provide financial means for investments in emission reduction technologies. These financial implications of the volume targets can only be negotiated in the target-setting process in case there is negotiation involved. According to Herzog et al. (2006), this may lead to weaker targets, in order to reduce the uncertainty of total compliance costs for the target group. It must also be mentioned that the (un)certainty of compliance costs also depends on the type of policy instrument that sets the target. For example, emission trading schemes make compliance to the target level more flexible and in effect, reduce the cost uncertainty. Combining volume targets with a so-called safety valve or price cap that sets a limits to the compliance costs in terms of $/$CO_2$, also reduces uncertainty. However, a price cap may compromise the environmental outcome of the policy.

In contrast, both physical efficiency and economic intensity targets reduce uncertainty in compliance costs, compared to volume targets in case of unexpected high growth of activity (Pizer, 2005; Ellerman and Wing, 2003; Kolstad, 2005). Physical efficiency and economic intensity do not limit the total compliance costs in the case of unexpected growth, but due to the nature of the target (total allowable energy use or emissions are conditional on the activity), compliance costs do not increase as fast as is the case with volume targets, thereby reducing the uncertainty. The reduced uncertainty of costs associated with intensity targets may lead to the adoption of more stringent targets (van Vuuren et al., 2002). Physical efficiency targets and economic intensity targets are less flexible in combination with emission trading and are therefore more costly (Dudek & Golub, 2003).

The major advantage of economic targets is that they take cost aspects into account which provides target groups with a better sense of total compliance costs and the associated risks. The ability-to-pay targets set limits to total compliance costs and uncertainty is fully reduced. Profitability targets guarantee that firms only have to implement measures that are economically attractive from a private perspective. Profitability targets do however not control the total compliance costs. The total compliance costs or at least the total initial investment may increase drastically at high energy prices. An important advantage of socio-economic targets is that theoretically it leads to the lowest total costs for the society as a whole. However, for individual companies the burden may be substantial if a large part of the energy savings or emission reduction potential is present within these companies. This is even a bigger issue in a situation where standards are not applied internationally.

4. Public relevance. Volume targets expressed as energy use and CO_2/GHG emission targets in absolute terms have the advantage that they can be easily aggregated across sectors and borders, traded and used in offset schemes. These targets therefore provide insight in the contributions of individual firms or sectors to achieve national or international climate change commitments. All other types of targets do not have the advantage of being in accordance with current international climate commitments under the Kyoto Protocol. Though, physical efficiency targets are proposed for post-Kyoto commitments in global sector agreements. Economic targets (specific costs) in combination with binding caps are sometimes proposed as alternative international climate commitments. Economic intensity targets on the country level are also propagated as new climate change commitments, especially for developing countries. An important advantage of economic intensity targets is that they fit well with the public interest in decoupling environmental pressure from economic output (Herzog, 2006).

5. Relevance for industry. Both physical efficiency targets and profitability targets are extremely important to industry, making them more acceptable compared to other target types. Profitability targets fit well with industry practice of cost-benefit analysis. The payback period, net present value and internal rate of return are often used to decide upon important investments. The positive characteristic of physical efficiency targets is that they fit well with industry practice where costs (i.e. energy) are tracked per unit (Elliot, 2003). Physical efficiency targets are however not suitable for sectors with a large variety of products or for sectors that do not produce physical products but services (Phylipsen et al., 1998). A good denominator to measure the output of a firm must be available. That is straightforward for manufacturing firms, but more difficult in diversified corporations producing a large variety of goods, e.g. electronic industries like Philips. An advantage of physical efficiency and economic intensity targets is that they do not emphasize a decline in the total emissions such as volume targets do, making them acceptable among firms. Physical efficiency and economic intensity targets can also be described as performance targets, which not only avoid the suggestion of limiting growth but even have a positive motivational effect (Pizer, 2005). Economic intensity targets also fit with industries nature to minimize costs (energy input) against economic output.

6. Potential for comparison. An important drawback of volume targets, expressed in an absolute target value for energy use or CO_2/GHG emissions is that they do not allow for a comparison of the stringency of the target and the energy performance among companies in the same sector nationally or internationally. Physical efficiency targets in absolute terms as used in benchmarking policies, facilitate the comparison of the performance and the stringency of the target among similar companies in a sector, nationally and internationally. Physical efficiency improvement targets in relative terms can compare the (annual) progress that firms have yet to make. This most likely explains the preference for using efficiency improvement targets in relative terms above absolute target values for efficiency, which are only suitable to compare the performance of similar companies. However, a true comparison is only possible if all the conditions like historic improvements, production volume and structure, base year etc. are equal. Economic intensity targets are difficult to compare across countries since they lack the ability to reflect structural differences (Phylipsen et al., 1998). Economic targets allow for a comparison of the financial efforts that companies are making in order to limit energy use, however, regional differences in energy prices must also be taken into account.

7. Complexity. The nature of volume targets is very straightforward: these targets prescribe that a company or a sector is not allowed to use more than a certain amount of energy or emit more than a certain amount of CO_2/GHG at a fixed point in the future. Volume targets can easily be used for any type of firm. However, setting the target level or the allocation of emission allowances can be a much more complex procedure requiring many other parameters. Other types of targets are more complex and their complexity increases the uncertainty to the environmental outcome, raises the costs for monitoring and verification and eventually could lead to the adoption of less stringent targets. The evaluation of the physical energy efficiency targets requires more data collection than volume targets, especially in the case of more complex targets such as the EEI. There are also several problems associated with economic intensity targets. One problem is that the economic activity must be adjusted for changes in the product price and inflation in order to make economic intensity comparable over time. Second, there are many options in measuring economic activity, see Farla (2000). Value added is strongly influence by changes in product prices, feedstock prices etc. The influence is smaller for the value of shipments (Phylipsen et al., 1998). Economic targets are relatively complex targets. Many different input parameters like the energy price, life time of the investment, discount rate determine the profitability of the investments, the specific mitigation costs or the ability-to-pay and in the end the environmental outcome.

2.7 Conclusions

The primary goal of this paper was to develop a taxonomy for SMART targets for limiting industrial energy use and associated GHG emissions. The developed taxonomy distinguishes volume reduction targets, physical efficiency improvement targets, economic intensity improvement targets and economic targets, including socio-economic targets, profitability targets or ability-to-pay targets. We have shown that targets can be established by different actors, with various scopes, under different compliance regimes and with different target coverage.

The second aim of this paper was to analyse the current use of SMART targets in industrial energy and climate policies. Targets are used in various policy instruments and measures such as limited number environmental permits, a wide range of voluntary or negotiated agreements and a substantial number of emission trading schemes. The number of policy instruments and measures that use economic targets continues to increase.

The third aim of the paper was to evaluate the various types of targets. Volume targets guarantee a relatively certain environmental outcome, have high public relevance and are not as complex as other types of targets. Physical efficiency targets lead to environmental improvements with a high level of integrity, allow for (international) comparison of the environmental performance among firms or sectors and have high relevance for industry. Economic targets combine various advantages such as a high level of environmental integrity, high certainty of compliance costs and high relevance for industry. Economic intensity targets do not have clear advantages compared to other type of targets.

Energy or climate policies that allow industries to comply with the targets through various mechanisms, e.g. CO_2 cap and trade systems or the Canadian 'Regulatory Framework for Air Emissions', can reduce risks and uncertainties regarding the environmental outcome, environmental integrity and compliance costs, but may result in more complex compliance procedures.

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Chapter 3

The target-setting process in the CO_2 Performance Ladder: Does it lead to ambitious goals for carbon dioxide emission reduction?

Martijn G. Rietbergen, Arjan van Rheede, Kornelis Blok

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Abstract
Energy management and carbon accounting schemes are increasingly being adopted as a corporate response to climate change. These schemes often demand the setting of ambitious targets for the reduction of corporate greenhouse gas emissions. However, only limited empirical insight is available regarding the companies' target-setting process and the auditing practice of certification agencies that evaluate ambition levels of greenhouse gas reduction targets. We studied the target-setting process of firms participating in the CO_2 Performance Ladder. The CO_2 Performance Ladder is a new certifiable scheme for energy management and carbon accounting that is used as a tool for green public procurement in the Netherlands. This study aimed at answering the question 'To what extent does the current target-setting process in the CO_2 Performance Ladder lead to ambitious CO_2 emission reduction goals?'. An exploratory research design was used as the main research approach for this study. Data were collected through interviews with relevant stakeholders (companies, consultants, auditors and scheme owner), document reviews of the certification scheme, and monitoring reports. The research findings indicated that several certification requirements for setting CO_2 emission reduction targets were interpreted differently by the various actors. Conformity checks by the auditors did not always include a full assessment of all certification requirements because of the lack of well-defined assessment criteria. The research results also indicated that corporate CO_2 emission reduction targets were not ambitious. The analysis of the target-setting process revealed that there was a semi-structured bottom-up auditing practice for evaluating the corporate CO_2 emission reduction targets, but the final assessments of whether target levels were sufficiently ambitious were not very well defined. The main conclusion is that the current target-setting process in the CO_2 Performance Ladder did not necessarily lead to the establishment of the most ambitious goals for CO_2 emission reduction. Other approaches for setting target levels, such as minimum performance levels, must be considered to maintain the CO_2 Performance Ladder as a valid tool for green public procurement.

3.1 Introduction

Energy management and carbon accounting schemes have been increasingly adopted by firms as a response to climate change (Stechemesser & Guenther, 2012; Schaltegger & Csutora, 2012; Ascui & Lovell, 2012). In many energy management and carbon accounting schemes, setting corporate targets for energy or greenhouse gas (GHG) emission reduction is a key obligatory element. The aim of this exploratory research is to improve the understanding of the target-setting process in energy management and carbon accounting schemes. As an example, we will study the process of establishing GHG emission reduction targets in the CO_2 Performance Ladder (CO_2PL). The CO_2PL is a certifiable scheme for energy management and GHG reporting, that is used as a tool for green procurement by several Dutch public authorities, particularly for awarding contracts in the construction and civil engineering sector. Companies in these sectors are generally not subject to other specific energy or climate policies and programmes (e.g. European Union (EU) Emission Trading Scheme or Long-Term Agreements on Energy Efficiency). The adoption of the CO_2PL is therefore considered a major stimulant for energy efficiency improvement and CO_2 emission reduction in these firms. Up till now, the CO_2PL has only been implemented in the Netherlands, however, the scheme is drawing international attention as a tool for green procurement (Goldberg et al., 2012; ESAM, 2013).

Among other requirements, the CO_2PL explicitly requires participating firms to set ambitious GHG emission reduction targets. During an external audit, certification agencies (CAs) must assess whether these target levels are sufficiently ambitious. Currently, however, it is unknown whether the target-setting process guarantees the establishment of ambitious GHG emission reduction targets. The main research question to be answered in this paper is therefore *'To what extent does the current target-setting process in the* CO_2 *Performance Ladder lead to ambitious corporate GHG emission reduction goals?'* First, the interpretation of the scheme's certification requirements (CRs) for setting GHG emission reduction targets by various involved actors (scheme owner[15], firms, CAs, consultants) will be investigated. Second, the current target-setting process will be studied from a corporate perspective. Third, the auditing practice of assessing target levels for GHG emission reduction will be analysed. Finally, the ambition level of corporate GHG emission reductions targets will be evaluated. This study builds on earlier research by Rietbergen & Blok (2013) on the CO_2PL. They investigated, among others, the scheme coverage in terms of CO_2 emissions, the different types of GHG emission reduction targets set by participating companies, and the potential impact of the CO_2PL on reducing CO_2 emissions.

This paper is organised as follows. Section 3.2 presents a literature review on setting corporate GHG emission reduction targets. Section 3.3 addresses the research methods and data collection. Section 3.4 briefly introduces the CO_2PL as a certifiable scheme for energy management and carbon accounting and describes the CRs for setting corporate GHG emission reduction targets. Section 3.5 presents the findings of our study, including the interpretation of various CRs, a review of the corporate target-setting process and the auditing practices by CAs. The results of this study are discussed in section 3.6, and in section 3.7, we will draw the conclusions.

3.2 Setting corporate greenhouse gas emission reduction targets: a literature review

Many organisations are adopting energy management and carbon accounting schemes today. Energy management schemes enable organisations to follow a systematic approach in achieving continuous improvement of their energy performance, whereas carbon accounting schemes are concerned with measuring of GHG emissions at various levels (organisational, corporate, project, plant) for various purposes such as reporting, compliance, disclosure, and auditing (Ascui & Lovell, 2011). Energy management schemes are often developed in accordance with standardised approaches for management systems, such as the ISO-50001 standard for energy management (ISO, 2011). Corporate carbon accounting schemes are often based on standards such as the ISO-14064-1 standard (ISO, 2006) or the GHG Protocol (WBCSD/WRI, 2004) for reporting GHG emissions. Energy management and carbon accounting schemes can be part of either government-initiated policies and

[15] The CO_2PL is currently managed by the Independent Foundation for Climate-Friendly Business and Procurement (SKAO).

measures, voluntary corporate initiatives for GHG emission reduction or NGO-led partnerships for climate mitigation (IEA/IIP, 2012).

The drivers for implementing energy management and carbon accounting schemes have been extensively researched (e.g. Okereke, 2007; Kolk & Pinkse, 2004; Sullivan, 2011). Companies mainly adopt these schemes to reduce costs and environmental emissions, prepare for or comply with governmental regulations, contribute to the design of GHG policies and programmes, enhance corporate reputation via environmental leadership, and increase eligibility for using financial incentives or other competitive advantages.

Setting corporate energy or GHG emission reduction targets is a key element in energy management and carbon accounting schemes. Corporate energy or GHG emission reduction targets are defined as detailed and quantifiable requirements for improving the energy or GHG performance of (parts of) the company. These targets should arise from the company’s overall energy or GHG objectives. These objectives are the broader goals that the company sets itself to meet the organisation's energy or carbon reduction policy (ISO, 2011). Corporate energy and GHG target-setting has been debated in various other energy, climate and environmental policy schemes, such as voluntary agreements on energy (Krarup & Ramesohl, 2002), environmental management schemes, like ISO-14001 and EMAS (Honkasalo, 1998; Zobel, 2008), and in internal and external cap and trade systems as part of the discussion on allocation methods for distributing emission allowances (Groenenberg & Blok, 2002; Victor & House, 2006). Target-setting in general also plays a crucial role in the performance assessment in many other policy fields such as, health, transport and safety (e.g. van Herten & Gunning-Schepers, 2000; Edvardsson, 2005; NCHRP, 2010).

Target levels for energy efficiency improvement or GHG emission reduction in energy management and carbon accounting schemes can either be completely voluntary, minimum (fixed) performance requirements or negotiated. Some schemes allow firms to set completely voluntary targets for reducing GHG emissions, e.g. the Business Environmental Leadership Council (BELC, 2013). Other schemes may require minimum levels for energy performance improvement, e.g. the Superior Energy Performance Programme (Scheihing et al., 2013). Finally, there are also schemes that require the negotiating of ambitious GHG emission reduction target levels, such as the CO_2 Performance Ladder. In the latter case, specific rules and guidelines for setting ambitious targets are often set by the scheme.

Various papers have investigated the different options for formulating corporate GHG emission reduction or energy efficiency improvement targets (e.g. Margolick & Russell, 2001; Rosenberg et al., 2012; Rietbergen & Blok, 2010). The main target types distinguished are absolute or volume targets, economic intensity targets, physical efficiency targets, and economic targets for GHG emission reduction. Diverse studies have evaluated these different target types for developing energy and climate policies on the basis of a wide variety of assessment criteria (e.g. Rosenberg et al., 2012; Randers, 2012; Herzog et al., 2006). Many papers and reports have surveyed the use of energy efficiency and GHG emission reduction targets in specific examples of corporate responses to climate change (e.g. Sullivan, 2011; Gouldson & Sullivan, 2013; Zobel, 2008). These studies investigated, among other factors, the type, scope, commitment period and ambition level of the energy efficiency and GHG emission reduction targets. Only a few studies aimed at estimating the quantitative impacts of GHG emission reduction initiatives that require the setting of corporate GHG emission reduction targets (Rietbergen & Blok, 2013; Ecofys, 2012; CDP, 2012; Hörisch, 2013).

Several guidance documents were drawn up to provide a step-by step approach for setting GHG emission reduction targets in various GHG reporting schemes or standards (WBCSD/WRI, 2004; CDP, 2013; Carbon Trust, 2008). In general, these approaches include the following procedural steps: obtaining senior management commitment, choosing the target type, decision on the organisational boundary, choosing the base year, developing baselines, defining the completion date, deciding upon the length of commitment period, deciding about the use of offsets or credits and deciding about the target level (WBCSD/WRI, 2004). In these guidance documents and also in the academic literature little attention has however been paid to the methodologies for setting the target levels for corporate GHG emission reduction. In general, approaches for setting target levels may range from unilateral decisions by policy makers, collaborative approaches using consumer feedback or experts opinions, benchmarking and a wide variety of modelling approaches (e.g. theoretical limits, past performance analysis, business-as-usual projections, cost-benefit and economic analysis), see e.g. Tonkonogy (2007), NCHRP (2010). In sectors such as the manufacturing and construction industry, target costing may also be used when designing new products or buildings (Russell-Smith, 2014). Target costing is a cost management technique for reducing the life cycle costs of a product, and thus include energy costs as well.

The academic literature provides limited empirical insight into the process of setting GHG emission reduction targets in schemes for energy management and carbon accounting. Margolick & Russell (2001) looked into the process of setting voluntary targets for energy efficiency or GHG emission reduction of companies under the Business Environmental Leadership Council. The main conclusions were that the target-setting process followed more or less the step-by-step approach as suggested by the WBCSD/WRI (2004), energy management systems were considered as a valuable tool for target-setting, and companies used both top-down and bottom-up approaches within the company's target-setting process. In a top-down target-setting process, the target levels are derived for the entire company at once, whereas in a bottom-up target-setting process, target levels are based on the potential CO_2 emission reduction of various saving measures.

The CO_2PL is an energy management and carbon accounting scheme that explicitly requires firms to set ambitious GHG emission reduction targets. During an external audit, an independent organisation must assess whether these targets are sufficiently ambitious. To our knowledge, no specific research has been published about the independent assessment of energy or GHG emission reduction target levels in the context of energy management system certification, though Dusek & Fukuda (2012) provided insight into the practice of evaluating corporate targets, target levels and target performance by sustainability rating agencies and Socially Responsible Investment in Japan. These sustainability rating agencies and Socially Responsible Investment funds are responsible for measuring the sustainability performance of Japanese firms. Among others, this study indicated that among the rating agencies, a clear process for evaluating corporate environmental targets and performance improvement was lacking. A few other studies provide more empirical insight into conducting independent audits for certification of corporate environmental management systems in accordance with the ISO-14001 standards. This ISO standard also requires firms to set environmental targets, but it does not specify target levels (ISO, 2004). Ammenberg et al. (2001) investigated how external auditors interpreted and applied central requirements of the ISO-14001 standard and how that influenced the environmental efforts of certified organisations. They concluded: that many important requirements were interpreted differently by the auditors, that ISO-14001's requirement concerning the continual environmental improvement was often limited to the performance improvement of a few environmental aspects, and that there was an inconsistency in determining the significant environmental aspects. Other papers provide more general empirical insight into conducting these audits for ISO-140001 certification (e.g. Boiral, 2007; Boiral & Gendron, 2011; Heras-Saizarbitoria et al., 2013). These papers concluded that these audits for ISO-14001 certification appeared far from independent, rigorous and objective, that the audits focused more on procedural conformity rather than on internalisation of good environmental practices, and that external audits were often conducted from a consultancy rather than a conformance perspective.

This literature review reveals that studying the target-setting process is relevant from a scientific point of view. There is only limited empirical insight into the companies' internal processes of setting corporate targets and establishing ambitious target levels, the auditing practices of CAs and the role of various stakeholders in the target-setting process. Studying the practice of target-setting in certifiable energy management and accounting schemes is legitimate as well from a societal point of view, as certification may provide firms certain financial benefits, serve as proof of compliance to governmental policies and provide public recognition.

3.3 Research methods and data collection

An *exploratory research design* was chosen as the main research approach for this study. This type of research is often conducted when there are very few earlier studies, and the aim is to obtain insight in a specific subject area (Collis & Hussey, 2013). Insight into the target-setting process was obtained by reviewing various versions of the CO_2PL handbook (ProRail, 2009a; ProRail, 2010a; ProRail, 2010b; SKAO, 2011; SKAO, 2012) and by conducting thirty-three in-depth interviews with companies participating in the CO_2PL, the (former) scheme owner, CAs and consultancies.

Seventeen interviews with corporate representatives responsible for coordinating the CO_2PL were conducted. The total number of companies participating in the scheme was approximately 280, in January 2013. Table 3.1 shows the NACE section[16], size[17], certificate level, CO_2PL certificate version and CA of the interviewed companies. A stratified random sampling method was used to ensure that specific sub-groups were properly represented in the sample. Firm size and certificate level were chosen as the relevant stratification variables. Companies holding a certificate at level 1 or 2 were excluded because they did not have to formulate quantitative CO_2 emission reduction targets. The sample fractions for each (sub)group were based on the sub-group's relative share in the total CO_2 emissions covered by the CO_2PL. Only companies located within a limited geographical perimeter were chosen because of practical reasons.

[16] NACE is the statistical classification system of economic activities in the EU (EC, 2008).

[17] Firm size depends on the corporate CO_2 footprint and the company's main type of activity. As an example, small firms in the construction industry sector emit less than 2000 tCO_2/y, middle-sized firms emit between 2000 and 10000 tCO_2/y and large firms emit more than 10000 tCO_2/y on their construction or production sites.

Table 3.1: Company profiles

NACE section[1]	N	Firm Size	N	Certificate Level	N	Version CO_2PL	N	CA	N
C	5	Large	11	1	-	2.1	3	KEVS	1
F	10	Middle	4	2	-	2.0	6	BV	1
G	1	Small	2	3	10	1.2	4	DNV	5
J	1			4	2	1.1	4	KIWA	6
				5	5	1.0	0	INTRON	1
								LR	3

[1] Section C is 'Manufacturing', section F is 'Construction', section G is 'Whole sale and retail trade' and section J is Information and communication'.

A convenience sample of five consultancies that advised companies on the implementation of the CO_2PL was selected for our study. These consultancies assisted approximately 80 different companies in obtaining a CO_2PL certificate. The consultancy work includes, among other aspects, the process management, carbon footprint analysis, target-setting, and chain analyses.

Nine experienced auditors from various CAs were interviewed. These auditors represented the CAs in meetings with SKAO in which interpretations of the scheme are being discussed. The interviewees were involved in more than 160 different certifications as an auditor and also acted as internal reviewers (second assessors) of more than 75 audits. The CAs involved in this research covered more than 95% of the market for CO_2PL certification and included Det Norske Veritas (DNV), KEMA Verification Services (KEVS)[18], KIWA, SGS, Intron, Bureau Veritas (BV), TÜV-Nord and Lloyds Register (LR). Three CAs, Eerland (EER), DEKRA and Aboma, were excluded because they just recently started auditing companies. Approximately 50 accredited auditors may conduct CO_2PL audits.

The semi-structured interviews with the stakeholders included both standardised open-ended interview questions and fixed-response interview questions. The key interview topics were the interpretation of the CRs, the auditing practice, the corporate target-setting process, and, specifically, the assessment of the ambition level of the GHG emission reduction targets. Full anonymity was promised to the interviewees. Reports of the interviews were written and submitted to the interviewees for review and approval. The interviews were conducted in the period December 2012 until March 2013.

Methods for programme evaluation, i.e., measuring programme outcome (Rossi et al., 2004), were applied to assess the extent in which GHG emission reduction targets of the interviewed companies were reached. This evaluation provided us information about the ambition level of the targets. The level of target achievement was based on data in progress reports from the participating companies.

A *descriptive research design* was chosen to investigate the ambition level of the targets among the CAs and per certificate level. A dataset earlier compiled by Rietbergen & Blok (2013) was updated and used for statistical analysis. The dataset included amongst others the CA, certificate level, CO_2 emission reduction target type, and target level of 255 different companies, see Table 3.2.

[18] In February 2012, DNV and KEMA merged into DNV KEMA Energy & Sustainability.

Table 3.2: Summary of the dataset

CA	N	%	Certificate level	N	%	Target type	N	%	Mean target level (%/y)	SD
KIWA	78	30.6	Level 3	156	61.1	CO_2	128	50.2	0.029	0.025
DNV	59	23.1	Level 4	29	11.4	CO_2/FTE	66	25.9	0.032	0.029
KEVS	38	14.9	Level 5	67	26.3	CO_2/€	61	23.9	0.031	0.030
LR	17	6.7	Missing	3	1.2					
BV	15	5.9								
SGS	12	4.7								
INTRON	10	3.9								
TÜV	20	7.8								
EER	4	1.6								
DEKRA	1	0.4								
Missing	1	0.4								

3.4 The CO_2 Performance Ladder and corporate CO_2 emission reduction targets

This section introduces the CO_2PL as a certifiable energy management and carbon accounting scheme (3.4.1) and highlights the specific requirements for setting corporate CO_2 emission reduction targets (3.4.2).

3.4.1 The certification scheme

In 2009, the CO_2PL was introduced as a certifiable scheme for energy management and carbon accounting. The CO_2PL is strongly linked to existing international standards for reporting GHG emissions (ISO-14064-1) and energy management (ISO-50001). The underlying certification scheme discriminates among five ‘certificate levels’ that indicate the maturity of the company’s energy and GHG management (Ngai et al., 2013). The certificate levels relate to four key process areas that a company should focus on to improve its GHG management. These four key process areas 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.

Each key process area contains an audit checklist with the CRs a company should meet for each certificate level. Table 3.3 shows the general CRs for each key process at each certification level. If all of the criteria at a certain level are met, the company is awarded a ‘CO_2PL certificate’ indicating the achieved certificate level. A certificate is valid for three years, but compliance assessment must be performed every year. After three years re-certification is required. For more information about the certification process, the use of CO_2PL in public procurement procedures and the competitive advantage in awarding contracts, the reader is referred to Rietbergen & Blok (2013).

Table 3.3: General certification requirements for key process (A-D) for different certificate levels (1-5)

Level	1	2	3	4	5
A Insight	The company has partial insight into its energy consumption.	The company has an insight into its energy consumption.	The company has converted its energy consumption into CO_2 emissions.	The company reports its carbon footprint in accordance with ISO14064-1 for Scope 1, 2 & 3.	The company requires that its A-suppliers have a Scope 1 & 2 emissions calculation in accordance with ISO14064-1.
B Reduction	The company investigates opportunities for reducing energy consumption.	The company has an energy reduction target, described in qualitative terms.	The company has quantitative CO_2 reduction objectives for its own organisation.	The company has quantitative CO_2 reduction objectives for Scope 1, 2 & 3 CO_2 emissions.	The company reports on a structural and quantitative basis the results of the CO_2 reduction objectives for Scope 1, 2 & 3.
C Transparency	The company communicates its energy reduction policy on an ad hoc basis.	The company communicates its energy policy internally (to a minimal degree) and possibly externally.	The company communicates about its carbon footprint and reduction objectives both internally and externally.	The company maintains dialogue with government bodies and NGOs about its CO_2 reduction objectives and strategy.	The company is publicly committed to a government or NGO CO_2 emission reduction programme.
D Participation	The company is aware of sector and/or supply chain initiatives.	The company is a passive participant in initiatives aimed at reducing CO_2 emissions in or outside the sector.	The company is an active participant in initiatives aimed at reducing CO_2 emissions in or outside the sector.	The company initiates development projects that facilitate reductions in CO_2 emissions in the sector.	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.

Source: SKAO (2011).

3.4.2 Certification requirements for setting corporate CO_2 emission reduction targets

The general CRs listed in Table 3.3 are broken down into more detailed CRs. At certificate level 3, companies should among others fulfil CR 3.B.1, which refers to the setting of CO_2 emission reduction targets for scope 1 & 2 emissions (Table 3.4). Scope 1 emissions are direct emissions from sources either owned or controlled by the company. Scope 2 emissions are the indirect emissions from the generation of electricity purchased and consumed by the company. Companies that want to obtain a certificate at level 4 must also meet CR 4.B.1, that involves the setting of CO_2 emission reduction targets for scope 3 emissions (Table 3.4). Scope 3 emissions are other indirect emissions that result from the company's activities but that are emitted from sources that are not owned or controlled by the company itself.

Table 3.4: Certification requirement (CR) 3.B.1 and 4.B.1

3.B.1	CR	The company has drawn up a quantitative reduction objective for scope 1 & 2 emissions by the company and its projects[1], expressed in absolute values or percentages in relation to a reference year and within a fixed period of time and has drawn up a related action plan, including the measures to be taken on the projects.
4.B.1	CR	The company has formulated CO_2 reduction objectives for scope 3, based on two analyses from 4.A.1[2], or on two material GHG-generating activities, or chains of activities. A related action plan has been drawn up, including the measures to be taken. Objectives are expressed in absolute values or percentages in relation to a reference year and within a fixed period of time.

[1] A project can be a construction project at a building site, a maintenance contract, an advisory and design assignment, or a delivery of goods and services.
[2] CR 4.A.1 states that the company has a demonstrable insight into the most material emissions from scope 3, and can present at least two analyses of these scope 3 emissions of GHG-generating activities, or chains of activities.
Source: SKAO (2012).

The CRs are accompanied by further specifications and assessment guidelines for CAs. The most relevant specifications and assessment guidelines are listed in Table 3.5. The version number of the CO_2PL handbook that introduced the specification or assessment guideline was put within parentheses. A clear distinction between assessment guidelines and specifications appears to be lacking. Some assessment guidelines for CR 3.B.1 are similar to specifications for CR 4.B.1 and vice versa.

Table 3.5: Selected specifications (S) and assessment guidelines (G) for 3.B.1 and 4.B.1 (SKAO, 2012)

3.B.1	S	The 'quantitative emission reduction target is set at the company level for scope 1 and 2 emissions separately' (2.0).
	S	The CO_2 emission reduction target 'must relate to the projects' (2.0).
	S	The CO_2 emission reduction target 'must be significant and comparable to that of peers in the sector' (2.0).
	S	The CO_2 emission reduction target 'must be chosen for the most dominant emissions' (2.0).
	G	'The scale of the target, in the light of the starting point situation, is so meaningful that this can reasonably be described as a serious challenge' (2.0).
	G	'The target is followed up regularly on an annual basis and adapted on the basis of new energy conservation opportunities' (2.0).
4.B.1	S	The ambition level of the CO_2 emission reduction target 'must be significant and comparable to that of peers in the sector' (1.1).
	S	'The scale of the target, in the light of the starting point situation, is so meaningful that this can reasonably be described as a serious challenge' (2.0).
	S	The company must also provide a written statement 'demonstrating the extent to which it is a front runner, average performer or laggard in terms of the emissions in scope 3' (2.0).
	S	The 'ambition level of the CO_2 emission reduction targets must be based on its position as purchaser within the sector' (2.0).
	S	'More effort is expected from laggards than of front runners' (1.1).
	G	'The company must submit a written substantiated statement about its position as purchaser within the sector' (2.0).
	G	CO_2 emission reduction targets can be differentiated among frontrunners, average performers and laggards (1.1).

3.5 Research findings

In this section, the main research findings will be presented. Section 3.5.1 discusses how key criteria in the CRs, specifications and assessment guidelines are interpreted and used in target-setting procedures. Section 3.5.2 analyses the target-setting process from a corporate perspective, whereas section 3.5.3 reviews the auditing practice of CAs.

3.5.1 Interpretation and application of key criteria in target-setting procedures

This section discusses how key criteria in the CRs, specifications and assessment guidelines are interpreted and used in target-setting procedures.

Type of CO_2 emission reduction targets

The scheme does not provide clear insight into the type of CO_2 emission reduction targets that are actually allowed. On the one hand, the CR 3.B.1 may suggest that only volume targets for CO_2 emission reduction are permitted, either expressed in an absolute value (e.g., 100 tons of CO_2 emission reduction in 2015 compared to the level in 2011) or as a percentage (2% CO_2 emission reduction in 2015 compared to the level in 2011). On the other hand, CR 3.B.1 may suggest that relative targets for CO_2 emission reduction, measuring CO_2 emissions against an activity indicator are allowed as well (e.g. 10% CO_2 emission reduction measured against the company's turnover in the period 2011 to 2015).

Among the interviewed auditors, there was no fully harmonised idea about the type of CO_2 emission reduction target allowed by the scheme. The majority of the auditors allowed firms to set any type of target as long as it is useful for steering the company's GHG management. One auditor strictly demanded firms to set volume targets because the auditor thought this was explicitly required by the CO_2PL. The majority of the interviewed auditors agreed that only volume targets would be allowed if CR 3.B.1 was interpreted very strictly. One auditor only permitted firms to formulate relative targets because only these targets allow for a good comparison of the GHG performance over time. The lack of harmonisation is remarkable because the fact that CO_2PL does not prescribe a specific type of CO_2 emission reduction target was discussed during harmonisation meetings in 2011.

A minority of the companies chose volume targets, because they either believed this was explicitly required by the CO_2PL, they were unfamiliar with setting relative CO_2 emission reduction targets, or they wanted to obtain the CO_2PL certificate in very short period of time. The majority of the companies favoured relative targets because these types of targets still allow firms to increase their total CO_2 emissions. Several types of activity indicators were used such as the number of number of Full-Time Equivalents (FTE), the company's turnover or the amount of products produced. Some companies also developed a CO_2 efficiency index, which is a weighted average of CO_2 efficiencies of different corporate activities. Some companies deliberately formulated their CO_2 emission reduction targets in an ambiguous way, added clauses such as 'under similar business conditions' or formulated both relative and volume targets. Many firms considered the formulation of CO_2 emission reduction targets as a difficult but an important learning process. The different learning experiences included, among others, understanding the pros and cons of various target types, the continuous search for better performance indicators and the use of correction factors, e.g. degree days or inflation.

Targets must be set for scope 1 and 2 emissions separately

The CO_2PL requires that CO_2 emission reduction targets must be set for scope 1 and 2 emissions separately. Previous research by Rietbergen & Blok (2013) already indicated that firms did not strictly follow this criterion. Companies formulated CO_2 emission reduction targets for either the entire organisational boundary, for scope 1 and 2 emissions separately, or for specific emission sources. Only five auditors involved in this research strictly enforced the criterion that targets must be set for scope 1 and 2 emissions separately. Some auditors claimed that it was more important to formulate Key Performance Indicators (KPIs) for specific emission sources to measure progress of CO_2 emission reduction rather than setting targets for scope 1 and 2 emissions separately.

Targets must be significant

The scheme requires that the CO_2 emission reduction targets are 'significant'. Reviewing earlier versions of the CO_2PL handbook (ProRail, 2009b) learns that "significant, in this case, refers to the company's own situation. The scale of the objective, in the light of the starting point situation, is so significant that this can reasonably be described as a serious challenge.". In other words, the ambition level of the CO_2 emission reduction targets should be a serious challenge as far as that can reasonably be asked from the company. However, due to subsequent editing, rewriting and publishing new versions of the CO_2PL handbook, the criterion that targets must be significant was fully disconnected from its interpretation that the (ambition level of the) CO_2 emission reduction target must be a serious challenge. This probably explains why the various stakeholders in the CO_2PL, including CAs, consultancies and (former) scheme owners, do not have a common understanding about the meaning of the phrase that 'targets must be significant.' Interviewees suggested that it could mean that targets must be 'ambitious', 'SMART', 'comparable', 'measurable', 'relevant', 'go beyond the error margin', 'have a noticeable effect', 'account for the most dominant emissions', or 'account for emissions offering considerable reduction potential'.

Targets must be comparable among peers

The CO_2PL requires that CO_2 emission reduction targets are comparable to that of peers in the sector. The scheme does not unequivocally state 'what' should be comparable. The question is open about whether the target level or the target type should be comparable. Though, the majority of the interviewees assumed that the comparability criterion refers to target level. Most of the interviewed firms compared their target levels to that of other companies in the sector, but the comparison did not really affect the ambition level of the targets. Companies often criticised the usefulness to make a comparison because there is a lack of good peers: the types of activities, the emission reduction potentials, the CO_2 footprints and the target types can vary considerably among peers in the sector. The majority of the auditors also made critical comments about the comparability criterion. They argued that information to compare the ambition level of the targets is lacking, that the scheme already calls for the setting of ambitious targets, and that this criterion may even negatively influence the ambition level of the targets, as the least ambitious CO_2 emission reduction target accepted by CAs may become the reference value for other companies. Half of the auditors indicated that they never checked if the ambition level of the targets of the audited companies were comparable to that of their peers.

Assigning points to the certification requirements

Auditors must assign a number of points to each detailed CR that reflect the extent to which the company fulfils the rules. CAs did not apply a scoring guideline to assign specific points for each criterion mentioned in the detailed CRs. Mostly, companies received the full amount of points for both CR 3.B.1 and 4.B.1. Only in a few cases were points deducted if firms did not fully comply with the CRs and the underlying criteria, e.g. not specifying CO_2 emission reduction targets for scope 1 and 2 emissions separately, limited substantiation of the target levels, and the lack of quantified impacts of the energy saving measures. Weak target levels were very rarely a reason to deduct points, according to the auditors.

3.5.2 The corporate practice of setting CO_2 emission reduction target levels

This section describes the process of establishing target levels for CO_2 emission reduction from a corporate perspective and evaluates whether current target levels are ambitious.

The corporate target-setting process

Companies used both top-down and bottom-up approaches for establishing CO_2 emission reduction targets. In a top-down target-setting process, the target level is derived for the entire company at once without a detailed analysis of its reduction potential (Margolick & Russell, 2001). Among the interviewed companies, approximately 60% followed a top-down target-setting process. These companies are predominantly large in size. Various reference values were used to set the target levels. Companies based their target levels on CO_2 emission reduction targets in national climate policies, energy efficiency improvement targets in Long-Term Agreements, benchmarks with other companies, targets of the holding company, credible minimum values (proposed by consultants) that would be approved by CAs, standard values for 'ambitious targets' proposed by consultants and arbitrary values. Top-down target-setting processes were often combined with a bottom-up processes to test the feasibility of the target. Since companies started renewing their CO_2 emission reduction targets, bottom-up target-setting processes have become more dominant.

A bottom-up target-setting process is based on the potential CO_2 emission reduction of various measures that could be implemented in the company (Margolick & Russell, 2001). Among the interviewed companies, approximately 40% followed a bottom-up target-setting process. In general, the bottom-up target-setting process involves the following elements. First, a CO_2 emission inventory and energy audit were drawn up. Second, the most dominant CO_2 emission sources were identified. Third, an inventory was made of the possible reduction measures, including the CO_2 emission reduction potential. Fourth, a selection was made of measures to be implemented. Fifth, the target level was established by calculating the impact of the selected measures on the CO_2 emission reduction of the entire organisational boundary. If necessary, additional measures were selected to establish higher target levels. Six, the base year and length of the commitment period were chosen. Seventh, targets were approved by the higher management.

Some notable observations of the bottom-up target-setting process were as follows. First, the estimated CO_2 reduction potential of most saving measures appeared to be rather indicative. Therefore, aggregate target levels were not very accurate. Second, in general, explicit financial criteria were not taken into account when setting the target level, though, particularly larger companies carefully looked at the business case before deciding to take the measures. Third, as mentioned earlier, firms compared their target levels with their peers, but this approach was heavily criticised. Other target-setting approaches, such as target costing or projecting baseline emissions under a business-as-usual scenario to evaluate the ambition level of the target were never used. Fourth, decisions about the target levels for the reduction of scope 2 emission were often arbitrary, as these targets could be achieved very easily by switching from grey to green electricity. Firms also deliberately spread reduction efforts over time. Fifth, in general, companies said that they set modest, realistic and feasible targets. However, sometimes target levels were weakened if the higher management considered the targets too ambitious. The perceived corporate risks of underachievement especially forced large companies to weaken their targets.

Are the CO_2 emission reduction targets ambitious?

A widely accepted definition of ambitious corporate GHG targets does not exist. However, 'ambitious' generally implies that corporate GHG targets should substantially go beyond business-as-usual projections, must be aligned with science based climate targets, must be based on the adoption of best available techniques, must require considerable effort in economic or financial terms and target achievement is not necessarily certain (WRI, 2013; Edvardsson-Björnberg, 2013).

Previous research by Rietbergen & Blok (2013) showed that the current level of volume targets for CO_2 emission reduction and CO_2 emission reduction targets measured against FTE do go beyond BAU, while CO_2 emission reduction targets measured against turnover are likely to be met anyhow, even without the CO_2PL. Rietbergen & Blok (2013) also concluded that Dutch climate goals of the non-ETS sectors in 2020 will be achieved if current target levels are being prolonged. The previous section already showed that targets seem to be aligned with policy objectives rather than science based climate targets. During the interviews, the use of best available techniques did not appear to be a guiding principle in setting ambitious targets. The corporate targets also did not seem to require considerable efforts since most of the energy saving measure often did not require any investments. Approximately 40% of the interviewed companies in this study even acknowledged that their CO_2 emission reduction targets were rather weak compared with their reduction potentials. The majority of the consultancies also considered the CO_2 emission reduction targets as weak because companies only implement those measures that are considered as ‘low-hanging fruit’. In contrast, almost all auditors considered the CO_2 emission reduction targets of the firms as reasonably ambitious, as at least some serious effort is required to reduce CO_2 emissions (Table 3.6). These judgments were based on the actors’ own interpretation of the term ‘ambitious’.

Table 3.6: To what extent do you consider CO_2 emission reduction targets as ambitious?

Actor	N	Not ambitious at all	Weak	Reasonably ambitious	Very ambitious
CAs	9		17%	83%	
Companies	17	6%	35%	53%	6%
Consultants	6	17%	58%	25%	

A high percentage of the involved companies (80%) expected to achieve their targets easily within the agreed time period. This was confirmed by an analysis of the achievement of targets for the reduction of scope 1 and 2 emissions. The analysis was based on the data in the progress reports published by the companies. Table 3.7 shows, for fifteen companies the target type, the level of the reduction target and the achieved reductions on an annual basis. All companies that set relative targets (1 - 9) achieved their targets or performed much better than planned. Targets were achieved relatively easily because of smaller project portfolios (in cases of absolute targets), more efficiency with increased business (in cases of relative targets), inflation (in cases of targets expressed against turnover), more realised CO_2 emission reductions than expected beforehand and strong contribution of supporting governmental policies (e.g. attractive fiscal policies for leasing energy efficient cars). A couple of companies even knew beforehand that they could easily achieve their targets because the targets were set for a very short time frame and the energy savings measures would be implemented anyway. Three companies that set volume targets for CO_2 emission reduction are lagging far behind on schedule. They had difficulties with achieving their targets, due to the need for extra investments, the increased number of projects and delayed implementation of energy saving measures.

Table 3.7: Achievement of targets for the reduction of scope 1 and 2 emissions

Company No.	Target type	Reduction target on annual basis	Target period	Achieved reduction on annual basis	Measured period
1	CO_2/EURO	-1.7%	2009-2015	-4.2%	2009-2012
2	CO_2/EURO	-2.6%	2009-2013	-7.6%	2009-2012
3	CO_2/EURO	-2.3%	2010-2016	-12.9%	2010-2011
4	CO_2/FTE	-3.0%	2009-2014	-6.7%	2009-2012
5	CO_2/FTE	-2.5%	2009-2019	-3.5%	2009-2012
6	CO_2/FTE	-10.0%	2011-2012	-16.8%	2011-2012
7	CO_2 efficiency index	-1.0%	p/year	-3.2%	2010-2012
8	CO_2 efficiency index	-1.2%	2009-2014	-2.8%	2009-2012
9	CO_2/ton product	-5.1%	2009-2011	-5.8%	2009-2011
10	CO_2	-2.0%	2010-2011	+4.4%	2010-2011
11	CO_2	-2.0%	2010-2011	-4.0%	2010-2011
12	CO_2	-1.3%	2009-2013	+11.2%	2009-2012
13	CO_2	-2.0%	p/year	+4.8%	2009-2012
14	CO_2	-0.8%	2008-2012	-3.0%	2008-2012
15	CO_2	-2.7%	2009-2012	-12.7%	2009-2012

Ambition levels of CO_2 emission reduction targets by certificate level

In accordance with CR 5.B.2, companies certified at level 5 are obliged to reach their CO_2 emission reduction targets, otherwise they risk losing their certificate. This obligation might suggest that firms holding a certificate at level 5 set more conservative CO_2 emission reduction targets than firms holding a certificate at a lower level. An independent-samples t-test using SPSS was conducted to compare the target levels of companies holding a level 3 or 4 certificate and companies holding a level 5 certificate. The dataset earlier compiled by Rietbergen & Blok (2013) containing target levels, target types and CAs of 255 companies was updated and used for this analysis (Table 3.2). The test results did not indicate a significant difference (using a significance level of 0.05) in the ambition level of volume targets for CO_2 emission reduction at certificate level 3 or 4 ($M = 0.029$, $SD = 0.025$) and certificate level 5 ($M = 0.027$, $SD = 0.024$), $t(125) = 0.393$, $p = 0.695$. Also CO_2 emission reduction targets measured against FTE at certificate level 3 or 4 ($M = 0.033$, $SD = 0.032$) and level 5 ($M = 0.030$, $SD = 0.016$) did not show a significant difference in ambition level, $t(64) = 0.316$, $p = 0.753$. A significant difference between the ambition levels of CO_2 emission reduction targets measured against turnover at certificate level 3 or 4 ($M = 0.033$, $SD = 0.035$) and level 5 ($M = 0.028$, $SD = 0.014$) could not be observed either, $t(59) = 0.675$, $p = 0.502$. These results suggest that, based on our sample, the certificate level does not have a significant effect on the target level. This idea was supported by various respondents saying that a significant difference in the CO_2 emission reduction target level cannot easily be justified if a company increases its certificate level. As a result, companies kept target levels at certificate level 3 or 4 deliberately modest, to limit the future risks of non-compliance if a certificate level 5 was obtained.

3.5.3 The auditing practice of assessing target levels

This section analyses how CAs assess target levels for the reduction of corporate CO_2 emissions.

Assessing target levels for scope 1 and 2 emission reduction

Auditors put forward that energy and GHG management have not been a priority in many companies under the CO_2PL until recently. Despite companies still taking relatively easy energy conservation measures, much more corporate effort was put into reducing CO_2 emissions than before, according to the auditors. A majority of the auditors therefore considered the targets as reasonably ambitious (Table 3.6). In the relatively early stage of adopting the CO_2PL, auditors considered the setting of ambitious CO_2 emission reduction targets as less important than increasing the consciousness of corporate energy and GHG management. Auditors also argued that companies have a relatively strong position in claiming that target levels are sufficiently ambitious, since a real mechanism for enforcing ambitious targets is lacking in the CO_2PL. As a result, the majority of auditors never disapproved the ambition level of the CO_2 emission reduction target, except for very evident cases, such as CO_2 emission reductions through the switching from grey to green electricity. This practice was confirmed by the interviewed consultants who said that CAs always agree upon the ambition level of the CO_2 emission reduction targets. The companies said that the target level itself was never criticised, whereas the motivation of the target level was often a point of discussion.

Auditors used both bottom-up and top-down approaches to assess whether CO_2 emission reduction targets were a serious challenge to the companies. The semi-structured bottom-up process to assess the ambition level of the targets involved the following steps. First of all, auditors checked if there was a list available with energy saving measures, including an indication of the saving potential. This list of saving measures provided a preliminary assessment of the company's effort in CO_2 emission reduction. Auditors said they gained sufficient experience to judge what type of general measures could be taken by the companies. Second, the majority of the auditors also checked if the saving potential was supported by references or calculations. According to approximately half of the auditors, the substantiation of the target level with a set of measures with indicative energy savings was sometimes insufficient. Third, the majority of the auditors also evaluated whether saving potentials are realistic and feasible on the basis of their gut feeling and experience. However, none of the auditors recalculated these energy savings or CO_2 emission reductions. Auditors rarely evaluated the economic feasibility of the reduction measures. As many measures had not yet required a large amount of investment, auditors did not consequently check whether financial budgets were sufficient for the proposed measures. Auditors rarely took into account inflation figures to assess the ambition level of CO_2 emission reduction targets measured against turnover.

In the top-down approach, auditors used some guidelines or rules of thumb to assess whether the target is ambitious. Four auditors put forward that ambitious CO_2 emission reduction targets should go beyond 2% per year. It is remarkable that auditors did not distinguish between ambition levels for relative and absolute reduction targets, as the impact of relative and absolute targets can differ considerably. Auditors also had difficulties with explaining the origin of this value. One auditor thought 'it is a guideline from the handbook.' One auditor referred to the study from Primum (2012) that provided average values for the different CO_2 emission reduction target types, and others referred to reduction targets of other energy and climate policies. References for the latter targets were the energy efficiency target for Long-Term Agreements in the Netherlands, i.e., 2% energy efficiency improvement per year; the CO_2 emission reduction target for companies involved in the EU Emission Trading Scheme, i.e., 21% CO_2 emission reduction in the period 2005 to 2020 and the EU climate target, i.e., a 20% reduction in EU GHG emissions from 1990 levels in 2020. One auditor considered CO_2 emission reduction targets as ambitious if 50% of the maximum reduction potential is achieved within a three-year period.

Assessing target levels for scope 3 emissions

The scheme requires that firms set targets for the reduction of scope 3 emissions and that the ambition level of these targets are substantiated. On the one hand, the explanatory notes suggest that CO_2 emission reduction targets for scope 3 emissions 'can be differentiated among frontrunners, average performers and laggards', meaning that 'more effort is expected from laggards than of front runners.' Therefore, companies must 'demonstrate the extent to which it is a front runner, average performer or laggard in terms of the emissions in scope 3, by providing a written substantiated statement.' On the other hand, the explanatory notes also state that 'the ambition level of the GHG emission reduction targets must be based on its position as purchaser within the sector.' Therefore, CAs must verify if 'the company has submitted a written substantiated statement about its position as purchaser within the sector.' An explanation of 'position as purchaser within the sector' is lacking in the CO_2PL handbook. According to ProRail, the firm's 'position as purchaser within the sector' corresponds to the company's rank as a front runner, average performer or laggard. These above-mentioned statements are therefore equivalent. In contrast, SKAO suggested that these statements are actually different. Companies should, on the one hand, clarify their rank as a front runner, average performer or laggard, and, on the other hand, companies must substantiate their position as purchaser within the sector referring to the company's influence on reducing emissions in the supply chain.

The auditing practice of assessing target levels for scope 3 emissions showed some interesting observations. First of all, auditors generally accepted targets for scope 3 emission reduction more easily than targets for scope 1 and 2 emissions, as the impacts of energy savings measures in the supply chain are rather difficult to assess, the company's influence on reducing emission in the supply chain can be limited, and energy saving projects can be very different among the involved companies. Therefore, the assessment of CR 4.B.1 was, on the one hand, based on checking whether targets for the reduction scope 3 emission were set and, on the other hand, based on the type, number and diversity of reduction measures taken. Second, none of the auditors were able to explain the difference between the two different statements for substantiating the target levels for scope 3 emission reduction as mentioned above. Moreover, they complained that criteria to evaluate the underpinning of these statements were lacking. As a result, the majority of the auditors never checked whether companies handed in the above mentioned statements. Only, a small minority of auditors always required firms to provide a reasoned explanation on whether the company was a front runner, average performer or laggard in terms of scope 3 emissions. The criteria used for evaluation were the ambition level of targets, the type and number of emission reduction measures, and the level of active participation in the supply chain.

Ambition levels of CO_2 emission reduction targets by CAs

CAs have potentially a strong influence on establishing the ambition level of the CO_2 emission reduction target. A Kruskal-Wallis test was therefore performed to evaluate whether ambition levels of the three major target types were significantly different among the CAs. The dataset earlier compiled by Rietbergen & Blok (2013) was updated and used for this analysis (Table 3.2). Groups with sample size less than 5 were excluded. The test results indicated that only in the case of CO_2 emission reduction targets measured against turnover, the Kruskal-Wallis test showed a statistically significant difference in the score between the different CAs, $\chi^2(3, N = 50) = 18.311$, $p = 0.000$, with a mean rank score of 43.25 for KEVS, 27.89 for DNV, 23.20 for KIWA and 8.25 for TÜV. A follow-up test (Mann-Whitney) conducted to evaluate pairwise differences among the CAs indicated that there was a significant difference among all groups, except for DNV and KIWA, see appendix 3A with detailed results of the Mann-Whitney test.

3.6 Discussion, limitations and recommendations

In this section, we will interpret the results of our study (3.6.1), compare our results with earlier research (3.6.2), discuss the limitations of the research (3.6.3) and provide further recommendations for improving the target-setting process of the CO_2PL (3.6.4).

3.6.1 Interpretation of the research results

The research results indicate that certain important criteria for setting corporate GHG emission reduction targets were not very well-defined. As a result, there was no fully harmonised interpretation among the stakeholders of the scheme's obligations. In addition, conformity checks by CAs did not always include a full assessment of key criteria explicitly mentioned in the specifications of the CRs and its assessment guidelines. This may at least suggest that a level playing field for firms is currently lacking if it comes to setting GHG emission reduction targets. The lack of well-defined criteria and incomplete conformity checks did not contribute to a rigorous process of establishing GHG emission reduction targets and evaluating target levels.

There were various reasons for not checking conformity. Auditors did not consider some criteria as useful, did not understand certain criteria precisely, or did not have the right information or guidelines for evaluation. Any ambiguities in the schemes and difficulties with conformity assessments must, however, be discussed with the SKAO or during harmonisation meetings with CAs. Prior to this research project, setting GHG emission reduction targets was not an important topic for harmonisation among CAs. This might suggest that auditors did not take their full responsibility as a guardian, evaluator or innovator of the scheme.

The research results indicated that the targets were not very ambitious given the majority of the criteria for ambitious GHG emission reduction targets in section 3.5.2. First, until now the achievement of the CO_2 emission reduction targets did not require considerable efforts; companies took only relatively easy energy savings measures at low costs. Second, firms tend to avoid risks of underachievement, e.g. by limiting ambition levels of GHG emission reduction targets, ambiguous target-setting, setting short term commitments and deliberately spreading efforts over time, and thereby making target achievement more certain. Third, the concept of best available technologies was not used as a guiding principle in the process of setting ambitious targets. Fourth, ambition levels are often based on policy objectives rather than science based climate targets that will be more demanding. Fifth, CO_2 emission reduction targets measured against turnover are likely going to be met anyway, even without the CO_2PL. On the basis of these arguments, we may conclude that current target levels cannot be qualified as ambitious goals yet, despite earlier conclusions by Rietbergen & Blok that the projected impact of the CO_2PL scheme on CO_2 emission reduction goes beyond BAU projections.

The analysis of the auditing practice of CAs revealed that there is a semi-structured bottom-up auditing practice for evaluating the corporate GHG emission reduction targets. This bottom-up approach follows more or less the main criteria for setting GHG emission reduction targets in the CO_2PL. The final assessments of auditors on whether target levels are sufficiently ambitious are not very well-defined. The latter part of the conclusion is supported with several findings. First, the interviews revealed that judging the target level and its substantiation was often based on gut feelings rather than sound analysis. Second, auditors often considered the increased consciousness of CO_2 management more important than the target level itself, especially during the initial certification period. Third, target levels were almost never rejected by the CAs, suggesting that auditors agreed relatively easily with the proposed target levels after debates with the companies. Fourth, CAs admitted that they could not put much pressure on the firms to adopt ambitious targets because of a lack of coercive measures in the scheme.

The results of the Kruskal-Wallis test (section 3.5.3) revealed that in the cases of volume targets for CO_2 emission reduction and CO_2 emission reduction targets measured against FTE no significant difference in the ambition level could be observed among the involved CAs. This could suggest that CAs had a harmonised idea about the ambitious target levels. However, the Kruskal-Wallis test also showed that in the case of CO_2 emission reduction targets measured against turnover significant differences existed between CAs. These latter findings are supported by our findings that the auditors' judgements about target levels were not very well-defined. Therefore, it is more likely that similar target levels were the results of a peer review process among firms.

Although this research was of an exploratory and mainly qualitative nature, it is reasonable to think that the observations may also apply to the CO_2PL as a whole, since many of the observations point in the same direction. Moreover, after carrying out the interviews we experienced that no new insights were gained and theoretical saturation was achieved. In addition, the interviewed auditors were involved in the majority of the certifications, and the interviewed firms were randomly selected. Although the interviewed consultants were not randomly selected, we still believe that the conclusions are valid, since the consultants played a less important role in this research. Besides, the consultants assisted a fairly high share of firms in the scheme (80 companies) with obtaining a CO_2PL certificate.

3.6.2 Comparison with earlier research results

Our research findings confirm the results of earlier studies that concluded that certification audits are not very rigorous and uniform (Boiral & Gendron, 2011; Heras-Saizarbitoria et al., 2013; Dusek & Fukuda, 2012). The results of our study are also consistent with the study by Ammenberg et al. (2001) that concluded that specific CRs were interpreted differently by the auditors. The conclusion of earlier research by Boiral (2004), Boiral & Gendron (2011) and Heras-Saizarbitoria et al. (2013) that environmental certification focused more on a procedural conformity rather than on internalization of good environmental practices are hard to compare with the results of our study. In our study, we focused on just one specific element of the CO_2PL rather than the entire management system. Though, on the one hand we have seen that among firms target-setting (as part of energy management systems) is a learning process that led to more useful, specific, measurable and sometimes more ambitious targets. On the other hand, some firms also tended to search for ways to pass the audit with minimal effort. Thus, internalisation of good practices of target-setting was observed, but some firms focused strongly on procedural conformity as well.

3.6.3 Limitations of this research

First, the CO_2PL is a relatively new certification scheme that is still developing. As a consequence, the research results only characterise the auditing practice and the target-setting process at a given moment in time. More specifically, at the time of the research, there was not much experience yet with the process of re-certification required after a period of three years. As a result, the corporate target-setting process and its external assessment during re-certification have not been accounted for yet. It is, however, expected that improvements will be implemented in upcoming (re-) certifications and new issues of the CO_2PL handbook. Longitudinal research could study the improvements in the target-setting process over time.

Second, auditor independence is a topic that did not receive full attention during this research. However, there were some indications that CAs probably did not fully exert their influence on the target-setting process because of their auditor-client dependent relationship. Further research should be conducted to investigate the impact of the auditor-client relationship on the target-setting process.

Third, our conclusions about the ambition level of the GHG emission reduction targets were mainly based on judgments of the involved actors and the degree in which targets were achieved. A more complete understanding of the ambition level of GHG emission reduction targets could be obtained by a more detailed investigation of the additionality of the CO_2PL, e.g. by including an analysis of the extent to which companies put more effort and resources into implementing energy conservation measures than they usually did.

3.6.4 Recommendations for target-setting procedures in CO_2PL

This study indicates that the current target-setting process leaves a lot of room for improvement. There are some possible options for rapidly implementable improvements. First, the interpretations of the CRs, specifications and assessment guidelines can be harmonised without much effort by rewriting the explanatory notes of the CO_2PL handbook. Second, the introduction of guidance documents for setting GHG emission reduction targets such as CDP (2013) might be considered to improve the quality of the target-setting by firms. It is a waste of time to re-invent the wheel for setting corporate targets again and again by firms that start their certification process for the first time. Third, the use of certain criteria in the specifications of the CRs and the assessment guidelines should be reconsidered as the added value is questionable. Fourth, alternative approaches for setting target levels should be considered, such as benchmarking of energy saving measures, minimum performance levels (e.g. Scheihing et al., 2013), or obligations that require the implementation of measures with maximum payback periods (e.g. Agentschapnl, 2013).

3.7 Conclusions

Energy management and carbon accounting schemes have rapidly emerged as a corporate response to climate change. These schemes often demand the setting of ambitious targets for the reduction of corporate GHG emissions. As an example, we studied the target-setting process of the CO_2 Performance Ladder (CO_2PL). The CO_2PL is a certifiable scheme for energy and greenhouse gas (GHG) management that is used in green procurement processes in the Netherlands. This study aimed to answer the question ‘to what extent does the current target-setting process in the CO_2 Performance Ladder lead to ambitious corporate GHG emission reduction goals?’

The main conclusions that can be drawn from our research are as follows. First, the current target-setting practice is not a rigorous and uniform process mainly due to the lack of well-defined criteria and incomplete conformity checks. Second, the current target levels for corporate GHG emission reduction cannot yet be qualified as ambitious. Last, there is a semi-structured procedure for evaluating GHG emission reduction targets, but the final assessment whether target levels are sufficiently ambitious are not well-defined. Overall, we can conclude that the current target-setting process in the CO_2PL does not necessarily lead to ambitious corporate GHG emission reduction goals as yet.

In the specific case of the CO_2PL, target-setting procedures must be improved to maintain the CO_2PL as a valid tool for green procurement. Rapidly implementable improvements, such as rewriting the scheme's explanatory notes, can easily be implemented to streamline the target-setting process in the CO_2PL. The findings of our research also advocate that alternative approaches for setting target levels, such as minimum performance levels, must be considered in the scheme. In general, this study confirms that qualitative approaches for establishing target levels as used in the CO_2PL must be avoided in energy management or carbon accounting schemes, especially if certification provides participating firms certain financial benefits, serves as a proof of compliance or enhances corporate reputations (e.g. Krarup & Rahmesohl, 2002).

This study contributes to the literature on energy management schemes (e.g. Kolk & Pinkse, 2004), carbon accounting (e.g. Ascui & Lovell, 2011; Stechemesser & Guenther, 2012) and environmental auditing (e.g. Ammenberg et al., 2001; Heras-Saizarbitoria et al., 2013) by providing better insight in the corporate target-setting process and the auditing practice of certification agencies in a specific example of an energy management and carbon accounting scheme. However, more research must be performed to define best practices for setting ambitious corporate GHG emission reduction goals, to study the impact of auditor client relationships on the target-setting process and to investigate the additional impact of the CO_2PL on CO_2 emission reduction.

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Appendix 3A

Table 3A.1: Results of the Mann-Whitney test KIWA - DNV

Ranks

	CA	N	Mean Rank	Sum of Ranks
Target Level	KIWA	20	17.7	354
	DNV	18	21.5	387
	Total	38		

Test Statistics[a]

	Target Level
Mann-Whitney U	144
Wilcoxon W	354
Z	-1.054
Asymp. Sig. (2-tailed)	0.292
Exact Sig. [2*(1-tailed Sig.)]	.303[b]

[a]. Grouping Variable: CA
[b]. Not corrected for ties.

Table 3A.2: Results of the Mann-Whitney test KIWA - KEVS

Ranks

	CA	N	Mean Rank	Sum of Ranks
Target Level	KIWA	20	10.9	218
	KEVS	6	22.17	133
	Total	26		

Test Statistics[a]

	Target Level
Mann-Whitney U	8
Wilcoxon W	218
Z	-3.171
Asymp. Sig. (2-tailed)	0.002
Exact Sig. [2*(1-tailed Sig.)]	.001[b]

[a]. Grouping Variable: CA
[b]. Not corrected for ties.

Table 3A.3: Results of the Mann-Whitney test KIWA - TüV

Ranks

	CA	N	Mean Rank	Sum of Ranks
Target Level	KIWA	20	15.6	312
	TüV	6	6.5	39
	Total	26		

Test Statistics[a]

	Target Level
Mann-Whitney U	18
Wilcoxon W	39
Z	-2.563
Asymp. Sig. (2-tailed)	0.01
Exact Sig. [2*(1-tailed Sig.)]	.009[b]

[a]. Grouping Variable: CA
[b]. Not corrected for ties.

Table 3A.4: Results of the Mann-Whitney test DNV - KEVS

Ranks

	CA	N	Mean Rank	Sum of Ranks
Target Level	DNV	18	10.47	188,5
	KEVS	6	18.58	111,5
	Total	24		

Test Statistics[a]

	Target Level
Mann-Whitney U	17.5
Wilcoxon W	188.5
Z	-2.439
Asymp. Sig. (2-tailed)	0.015
Exact Sig. [2*(1-tailed Sig.)]	.012[b]

[a]. Grouping Variable: CA
[b]. Not corrected for ties.

Table 3A.5: Results of the Mann-Whitney test DNV - TüV

Ranks

	CA	N	Mean Rank	Sum of Ranks
Target Level	DNV	18	14.92	268,5
	TüV	6	5.25	31,5
	Total	24		

Test Statistics[a]

	Target Level
Mann-Whitney U	10.5
Wilcoxon W	31.5
Z	-2.906
Asymp. Sig. (2-tailed)	0.004
Exact Sig. [2*(1-tailed Sig.)]	.002[b]

[a]. Grouping Variable: CA
[b]. Not corrected for ties.

Table 3A.6: Results of the Mann-Whitney test KEVS - TüV

Ranks

	CA	N	Mean Rank	Sum of Ranks
Target Level	KEVS	6	9.5	57
	TüV	6	3.5	21
	Total	12		

Test Statistics[a]

	Target Level
Mann-Whitney U	0
Wilcoxon W	21
Z	-2.882
Asymp. Sig. (2-tailed)	0.004
Exact Sig. [2*(1-tailed Sig.)]	.002[b]

[a]. Grouping Variable: CA
[b]. Not corrected for ties.

Chapter 4

Assessing the potential impact of the CO_2 Performance Ladder on the reduction of carbon dioxide emissions in the Netherlands

Martijn G. Rietbergen, Kornelis Blok

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Abstract
Green public procurement is often promoted as a tool to reduce energy use and CO_2 emissions in the supply chains of public entities. However, only a limited number of studies have quantitatively assessed the environmental impacts of green public procurement schemes. The aim of this paper was to assess the potential impact of the CO_2 Performance Ladder on the reduction of carbon dioxide emissions in the Netherlands. The CO_2 Performance Ladder is a new green procurement scheme that is currently used by several Dutch public authorities. It is a staged certification scheme for energy and CO_2 management. Achieving certification gives companies a competitive advantage in the contract awarding process. Currently, more than 190 companies participate in the scheme. The scheme accounts for 1.7 Mt of aggregate CO_2 emissions, corresponding to nearly 1% of national greenhouse gas emissions in the Netherlands. Since the introduction of the scheme, total CO_2 emissions have decreased substantially. Nevertheless, these emission reductions should be interpreted with caution because the emission reductions are largely due to reductions by a few companies, and the level of emissions is affected to a large extent by economic activity. The companies participating in the scheme have set different types of CO_2 reduction targets with varying levels of ambition. The projected impact of reaching these targets on CO_2 emissions is a total CO_2 emission reduction in the range of a 0.8%/yr to 1.5%/yr, with a most likely value of 1.3%/yr. The CO_2 Performance Ladder could therefore contribute significantly to achieving the annual reduction rate necessary to remain below the 2020 Dutch emission ceiling for sectors not included in the European Union Emission Trading Scheme.

4.1 Introduction

Global greenhouse gas (GHG) emissions must be reduced drastically to limit global increases in temperature to the relatively safe level of maximum 2 degrees Celsius (IPCC, 2007; UNFCCC, 2009). The European Union agreed to reduce EU GHG emissions to at least 20% below 1990 levels by 2020 (COM, 2007). A wide variety of national policies, measures and tools are available to reduce greenhouse gas emissions (e.g. IEA, 2012; IPCC, 2007). Green public procurement (GPP) is often promoted as a tool to reduce energy use and CO_2 emissions in the supply chain of public entities (COM, 2008a; Nash, 2009).

4.1.1 Green public procurement

GPP is ‘a process whereby public authorities seek to procure goods, services and works with a reduced environmental impact throughout their life cycle when compared to goods, services and works with the same primary function that would otherwise be procured' (COM, 2008b)[19]. GPP can have multiple benefits, such as reducing the environmental impact of products, works and services; stimulating technological innovation among companies; accelerating market penetration of sustainable products; raising awareness for sustainability issues and reducing risk and costs for public authorities (e.g. COM, 2008b; Michelsen & de Boer, 2009; UNDP, 2008).

Sustainable production and consumption in the supply chain can be fostered by using environmental criteria at various stages of the procurement process. EC (2011), UNDP (2008) and ICLEI (2007) provide a detailed description of how environmental criteria can be used in procurement procedures. First, environmental criteria can be used in the design of technical specifications for the product, service or work to be procured. These technical specifications may include compulsory environmental demands that must be met by the procured product, service or work. Second, environmental criteria can be introduced as selection criteria for candidate contractors. These selection criteria can only be applied if specific environmental experience and competence are needed to fulfil the contract. Third, environmental criteria can be included as 'contract award criteria' if the contract is awarded in accordance with the principles of the 'economically most advantageous tender.' The economically most advantageous tender (EMAT) approach includes other criteria for awarding contracts in addition to price. Finally, environmental criteria can also be introduced as contract performance clauses that specify how the work or service will be performed.

4.1.2 Introduction to the CO_2 Performance Ladder

In 2009, a new GPP scheme called the 'CO_2 Performance Ladder 1.0' (CO_2PL) was developed by ProRail (2009a)[20]. ProRail is a state-owned company in the Netherlands that is responsible for network infrastructure management, rail capacity allocation and traffic control on the Dutch railway network. The CO_2PL was introduced to encourage climate-friendly and energy-efficient performance by the companies in ProRail's supply chain. The CO_2PL is a staged certification scheme for energy and CO_2 management that is used in ProRail's procurement processes. Achieving a desirable certification level gives companies a competitive advantage in obtaining contracts that are awarded in accordance with the principles of the 'economically most advantageous tender.' The CO_2PL is not used as a contract performance clause, as criteria for selecting candidates for service and work contracts or as a compulsory environmental requirement for the service or work contract.

The potential environmental impacts of this GPP scheme are expected to be considerable because the purchasing power of ProRail is substantial. Their annual budget for contracted goods, works and services is approximately €1.9 billion, of which a large portion is awarded through calls for tenders (van Dalen, 2012). The CO_2PL was received positively by ProRail's suppliers. In March 2011, a total of 88 companies were already participating in the CO_2PL scheme (Dorée et al., 2012). Due to the increasing number of participating companies and the potentially wider adoption of the scheme among other contractors, the 'Independent Foundation for Climate Friendly Procurement and Business' (SKAO) was established to take over the management of the CO_2PL scheme from ProRail in March 2011. SKAO published an update to the CO_2PL (2.0) in March 2011 (SKAO, 2011), making the CO_2PL more suitable for other

[19] GPP is different from 'Sustainable Public Procurement' (SPP). SPP includes both environmental and social criteria in the purchasing decisions.

[20] ProRail has since then published two more updates of the CO_2PL: CO_2PL 1.1 (September 2010) and CO_2PL 1.2 (December 2010).

commissioning parties. Recently, Rijkswaterstaat (the executive arm of the Dutch Ministry of Infrastructure and the Environment) and a number of municipalities have also adopted the CO_2PL in their tendering procedures.

The fast growing number of certified companies and the adoption of the scheme by other commissioning parties shows that the CO_2PL is becoming a well-developed and widely accepted instrument for GPP. Given the success of the scheme thus far, SKAO is striving to ensure that the CO_2PL scheme becomes the standard instrument for GPP in the Netherlands in fields such as civil and hydraulic engineering, in which GPP concerns the reduction of CO_2 emissions from energy and material use. However, for the various stakeholders in the scheme, including the scheme owner, the commissioning parties and the participating companies, a wider adoption of the scheme is only legitimate if the adoption of CO_2PL contributes significantly to the CO_2 emission reductions of the participating companies and their supply chains.

4.1.3 Environmental impacts of green supply chain management

Assessing the CO_2PL scheme's potential environmental impacts is also relevant from a scientific point of view. There is only a limited number of studies on the environmental impacts of green supply chain management, the impacts of GPP on CO_2 emission reduction and the CO_2PL in general.

There is a large amount of published literature about green supply chain management (see the reviews by Srivastava, 2007; Seuring & Müller, 2008; Ilgin & Gupta, 2010 and Sarkis et al., 2011). A large number of studies focus on the role of sustainability tools such as ISO certification, environmental management systems, corporate social responsibility (CSR) schemes, carbon accounting and sustainability indicators (e.g. Kovács, 2008; Lee, 2012b; Gonzáles et al., 2008; Nawrocka et al., 2009 and Darnall et al., 2008) in green supply chain management. To our knowledge, however, scientific studies assessing the environmental impacts of the use of these sustainability tools in green supply chain management are rare. Ecofys (2012) is the only study to date that has investigated the (potential) environmental impacts of a CO_2 emission reduction initiative (WWF's Climate Savers Programme) aimed at reducing CO_2 emissions in company supply chains.

A substantial amount of literature has been published about the application of GPP. Several studies have examined the use of environmental criteria (type, quality, occurrence, etc.) in GPP schemes, identified the range of product groups covered by GPP schemes, and analysed the volume of green purchased goods in various Member States of the European Union (e.g. Bouwer et al., 2006; PWC et al., 2009 and AEA, 2010). Several studies monitoring levels of GPP have also been carried out in the Netherlands (see KPMG, 2011; PWC, 2009; BECO, 2008 and Significant, 2007). Other studies have focused specifically on the environmental aspects of construction contracts (Varnäs et al., 2009), studied the progress of GPP (Nissinen et al., 2009) and evaluated the enforcement of environmental requirements in GPP contracts (Faith-Ell et al., 2006). Relatively few studies have analysed the potential environmental impacts of GPP schemes. The consulting firm DHV (2009) estimated the environmental impacts if all public procurement contracts in the Netherlands would include environmental requirements as technical specifications. PWC (2009) evaluated the impact of green procurement schemes on CO_2 emissions for 10 different product categories in various European Union countries in 2006-2007.

Thus far, only a limited number of published studies focus on the CO_2PL. Dorée et al. (2011) described the rapid diffusion of the CO_2PL, addressed its use in bidding procedures and analysed its critical success factors. Veneberg (2010) provided insight into the effect of the CO_2PL on contractor strategies, organisation and work progress. Primum (2012) evaluated how well the CO_2PL was implemented by certified companies. Goldberg (2012) compared the design features of the CO_2PL with other industrial supply chain initiatives. Finally, Wilbrink (2012) provided preliminary insights into the impacts of CO_2PL on business operation, CO_2 emission reductions and the costs of the scheme for a few participating companies. A review of the literature published on the CO_2PL showed that there is still no evidence as to whether the scheme as a whole will lead to a significant reductions in CO_2 emissions, which is the overall objective of the scheme.

4.1.4 Research objectives, definitions and project scope

The primary research objective in this study was to perform an ex-ante evaluation assessing the potential impact of the CO_2PL on the reduction of CO_2 emissions in the Netherlands. The potential impact of the CO_2PL was estimated as the net annual change in CO_2 emissions (expressed in %/year) (based on emission levels for the base year of 2010) that would be achieved if the companies currently certified fully complied with the scheme. The levels of CO_2 emissions quoted in this paper also include CO_2 equivalent emissions from other GHGs, unless stated otherwise. The scope of this study was strictly limited to assessing the potential impact of the scheme on CO_2 emissions by the certified companies. We did not evaluate the design of the CO_2PL, assess the implementation process, evaluate the efficiency of the scheme or assess other impacts aside from reductions in CO_2 emissions[21].

4.1.5 Research methods

In this study we used the methodologies for ex-ante impact assessments of energy and climate policies discussed by IEA (2005) and Blok (2009). We used the following methodological steps. First, companies participating in the scheme were identified and characterised. Second, data about the CO_2-footprints and CO_2 reduction targets of the companies were collected. Third, baseline projections were developed to assess the potential impact of full compliance to the different types of CO_2 reduction targets. Fourth, we analysed the net annual change in CO_2 emissions (expressed in %/yr) (based on emission levels from the base year, 2010) that could be achieved by full compliance with the CO_2PL scheme. In addition, we evaluated the policy implications of the scheme by comparing the potential impact of the scheme with the CO_2 reduction targets required by the European Union and national policies.

4.1.6 Data collection

A current overview of all companies certified by the scheme was obtained from the SKAO website[22]. Information about the companies was gathered through CO_2PL certificates, including company size, certification level and industry type. The CO_2 footprints from the participating companies were downloaded from their corporate websites (e.g. KWS, 2010; Van Oord, 2011; DHV, 2011). Information about the CO_2 reduction targets was collected from the companies' energy management plans, which are required to be made public on company websites (e.g. Movares, 2010;

[21] See Rossi et al. (2004) for an overview of the various types of evaluation questions and methods.

[22] www.skao.nl. The website lists all certificate holders including company size, certificate level and place of business.

Oranjewoud, 2011; Strukton, 2012). In a few cases, we contacted companies and requested them to provide additional information about the type of target-setting used and about their CO_2 footprint. Additional information about the rationale of the CO_2PL was mainly retrieved from documents published by ProRail (2009a; 2010a) and SKAO (2011).

4.1.7 Organization of the paper

Section 4.2 describes the rationale of the CO_2PL. Section 4.3 presents a descriptive analysis of companies currently participating in the CO_2PL. Section 4.4 describes the aggregate CO_2 emissions affected by the CO_2PL and provides an estimation of the total realised reduction in CO_2 emissions. Section 4.5 discusses the CO_2 reduction targets, the ambition levels of the targets and the potential impact of the scheme in greater detail. The results of the study are discussed in Section 4.6, and in Section 4.7 we draw conclusions.

4.2 Rationale of the CO_2PL

The CO_2PL is a staged certification scheme for energy and CO_2 management that is used in public procurement procedures. This section describes the concept behind the scheme, provides a short overview of the certification process and illustrates how the CO_2PL is applied as a tool for GPP.

4.2.1 The concept behind the CO_2PL

The CO_2PL staged certification scheme is based on the concept of Capability Maturity Models (CMMs). CMMs distinguish between a number of different maturity levels that 'indicate the capability of an organisation to perform important processes to deliver a certain product or a process' (Paulk et al., 1993). CMMs often include five maturity levels: initial, repeatable, defined, managed and optimised. The certification scheme in the CO_2PL discriminates among five so-called 'certificate levels' that indicate the evolutionary stage of a company as it moves towards achieving optimal CO_2 management. The certificate levels pertain to key process areas that an organisation should focus on to improve CO_2 management. There are four key process areas identified in the CO_2PL: (A) drawing up CO_2 emission inventories, (B) setting and achieving CO_2 reduction targets, (C) transparency and communication of the company's CO_2 footprint and energy policy and (D) participation in (supply chain) initiatives. Each key process area contains an audit checklist with the specific requirements a company should meet for each certificate level. The audit checklists are published in the CO_2PL handbook (SKAO, 2011). Table 4.1 shows the general audit requirements for each key process at each certification level[23]. These requirements must be met at the company level. However, companies must also provide specific evidence that a project for which a CO_2-related award advantage has been obtained meets selected audit requirements.

[23] The general audit requirements are broken down into more detailed sub-requirements.

Table 4.1: General audit requirements for key process (A-D) for the different certificate levels (1-5)

Level	1	2	3	4	5
A Insight	The company has partial insight into its energy consumption.	The company has an insight into its energy consumption.	The company has converted its energy consumption into CO_2 emissions.	The company reports its carbon footprint in accordance with ISO14064-1 for Scope 1, 2 & 3.	The company requires that its A-suppliers have a Scope 1 & 2 emissions calculation in accordance with ISO14064-1.
B Reduction	The company investigates opportunities for reducing energy consumption.	The company has an energy reduction target, described in qualitative terms.	The company has quantitative CO_2 reduction objectives for its own organisation.	The company has quantitative CO_2 reduction objectives for Scope 1, 2 & 3 CO_2 emissions.	The company reports on a structural and quantitative basis the results of the CO_2 reduction objectives for Scope 1, 2 & 3.
C Transparency	The company communicates its energy reduction policy on an ad hoc basis.	The company communicates its energy policy internally (to a minimal degree) and possibly externally.	The company communicates about its carbon footprint and reduction objectives both internally and externally.	The company maintains dialogue with government bodies and NGOs about its CO_2 reduction objectives and strategy.	The company is publicly committed to a government or NGO CO_2 emission reduction programme.
D Participation	The company is aware of sector and/or supply chain initiatives.	The company is a passive participant in initiatives aimed at reducing CO_2 emissions in or outside the sector.	The company is an active participant in initiatives aimed at reducing CO_2 emissions in or outside the sector.	The company initiates development projects that facilitate reductions in CO_2 emissions in the sector.	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.

Source: SKAO (2011).

4.2.2 Certification process

The certification process for assessing the maturity level of a company's CO_2 management works as follows. First, the company must determine the organisational boundary in accordance with the methodologies described in the CO_2PL handbook (SKAO, 2011). The company then decides which certification level (1-5) it wishes to obtain. The company prepares a self-assessment report to ensure that the company's energy and CO_2 management complies with the requirements set out in the CO_2PL scheme (see Table 4.1). A portfolio of several audit documents, such as policy documents, technical reports, annual reports, communication procedures, etc., is prepared for the external audit. During the external audit, each of the specific requirements the company must meet to obtain the aspired certificate level are evaluated by an external party, the certification agency. This agency awards points for each item on the audit checklist. A calculation procedure is then used to determine whether the minimum requirements for the aspired certificate level have been fulfilled. More detailed information about the calculation procedures used for this step of the certification process can be found in SKAO (2011). The final result of the certification process is a 'CO_2PL certificate' indicating the achieved certificate level. While the CO_2PL certificate is valid for three years, compliance assessments are still carried out every year.

4.2.3 The CO_2PL and green procurement

The premise of the CO_2PL is that a company's CO_2 performance gives the company a competitive advantage in contracts awarded in accordance with the principles of the economically most advantageous tender. Therefore, the CO_2PL also includes a set of EMAT criteria corresponding to each CO_2 certification level. To a large extent, the EMAT criteria are equivalent to the CO_2PL audit requirements for the five certificate levels. Companies tendering for a contract issued by Rijkswaterstaat or a municipal authority must specify the CO_2 ambition level for the project. If the contract is awarded, the EMAT criteria (linked to the specified CO_2 ambition level) become binding contractual requirements. Within one year after the contract has been awarded, the contractor must demonstrate that he has complied with these EMAT criteria at the project level. A CO_2PL certificate at the equivalent ambition level counts as sufficient evidence that the company has met the EMAT requirements for the project. Obtaining a CO_2PL certificate is advantageous because once the certificate has been obtained, it can be used for additional future tendered projects. This reduces the administrative burden on companies that frequently participate in public tenders. The CO_2PL is applied differently by ProRail in its procurement procedures. ProRail does not include EMAT requirements as additional criteria for awarding procurement contracts; rather, it simply gives a competitive advantage to companies with a CO_2PL certificate (SKAO, 2011).

4.2.4 Competitive advantage in obtaining contracts

The CO_2PL certificate level of an individual company or the CO_2 ambition level stated in the EMAT procedure gives the company a certain advantage during the contract awarding procedure. How does it work? Let us suppose that a contract is awarded on the basis of the lowest bid (see Table 4.2). Three companies (A, B and C) tender for the contract and each make a bid. Company A, B and C bid €100K, €103K and €101K, respectively for the contract. Normally, Company A would be selected for the contract because its bid was the lowest. However, the CO_2PL certificate level of each individual company gives a particular advantage to that company in the contract awarding procedure. For example, the CO_2PL certificate levels 1, 2, 3, 4 and 5 correspond to a 1, 3, 4, 7 and 10% fictitious discount, respectively, on the original bid. In our example, Companies A, B and C had obtained a certificate level of 3, 4 and 2, respectively. Thus, the Level 4 certificate held by Company B granted that company a 7% fictitious discount on the company's original bid of €103K. The 7% discount resulted in Company B having the lowest fictitious bid (€95.79K), and Company B was awarded a €103K contract (ProRail, 2010b).

Table 4.2: CO_2PL and company advantage in obtaining contracts

Company	Bid	Certificate level	Fictitious discount	Fictitious bid	Contract award
A	€100K	3	4%	€96.00K	NO
B	€103K	4	7%	€95.79K	€103K
C	€101K	2	3%	€97.97K	NO

Often a consortium of companies tenders for a contract. In this case, the company with the lowest level of certification determines the fictitious discount on the original bid. The commissioning party decides on the fictitious discount level corresponding to the various certificate levels.

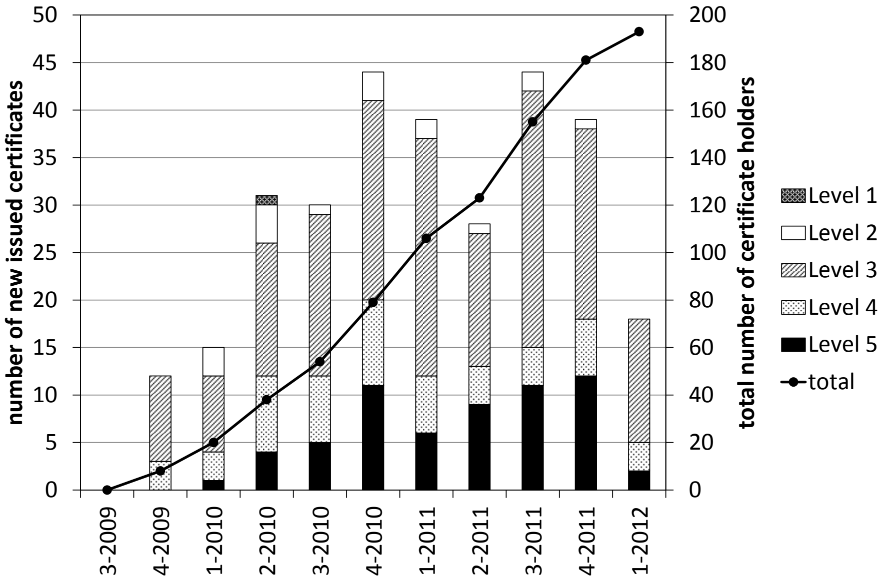
4.3 Characterisation of companies participating in the CO_2PL

Since the introduction of CO_2PL, a large number of companies have received a CO_2PL certificate. This section provides insight into the adoption rate of the scheme, the number of certificate holders, the number of firms by certificate level and company size and the type of industrial sectors that are currently involved in the CO_2PL.

4.3.1 Total number of certificates

The adoption rate of the scheme is very high; approximately 20 new companies received a certificate every quarter (see Figure 4.1). The total number of certificate holders is greater than 190 (date: February 2012). A certificate can cover several companies or joint ventures subsidiaries, etc. that belong to a parent company. More than 300 certificates have been issued since the start of the CO_2PL in the fourth quarter of 2009. Many certificates were withdrawn because they were superseded by higher-level certificates or by new certificates from parent companies. The majority of the companies (approximately 80%) enter the CO_2PL scheme at Level 3. On average, it takes approximately 5 months to increase in certification level from 3 to 4 and approximately 7 months to increase in certification level from 4 to 5. The CO_2PL certificates are issued by certification agencies. Currently, eight authorised agencies may issue these certificates[24]. KIWA, Det Norske Veritas Certification and KEMA Emissions Verification Service have served more than 80% of the market to date. Recently, new authorised agencies like TÜV and Bureau Veritas have started offering certification services.

Figure 4.1: Certificates issued per quarter and total number of certificate holders



4.3.2 Company size and certification level

According to the SKAO CO_2PL handbook 2.0 (SKAO, 2011), companies must state their size on their CO_2PL certificates. SKAO distinguishes among three size categories for companies: small, medium and large. The definition of company size is based on the company's CO_2 emissions. However, the categorisation of size also depends on the company's main type of activity. SKAO makes a distinction between (1) companies

[24] See www.skao.nl for an up-to-date list of certification agencies.

that provide specific services and (2) companies that supply products or deliver building and civil engineering works[25]. See Table 4.3 for specific details. Company size also determines whether specific certification scheme obligations are valid or not.

Table 4.3: Company size categories

Company size category	Service sector	Building and civil engineering sector and other sectors supplying products
Small	Total CO_2 emissions < 500 t/year	Total CO_2 emissions from office space and business accommodations < 500 t/year and total CO_2 emissions from building and production sites < 2000 t/year
Medium	Total CO_2 emissions < 2500 t/year	Total CO_2 emissions from office space and business accommodations < 2500 t/year and total CO_2 emissions from building and production sites < 10000 t/year
Large	Total CO_2 emissions > 2500 t/year	Total CO_2 emissions from office space and business accommodations > 2500 t/year and total CO_2 emissions from building and production sites > 10000 t/year

Source: SKAO (2011).

Table 4.4 shows the number of participating companies by certificate level and company size category. The companies are almost equally distributed among the three company size categories. The majority of the companies (57%) have a Level 3 certificate.

Table 4.4: Number of companies by certificate level and company size

Level	1	2	3	4	5	Total	%
Unknown	0	0	20	2	1	*23*	12%
Small	0	2	28	2	22	*54*	28%
Medium	0	2	34	10	14	*60*	31%
Large	0	0	30	7	22	*59*	30%
Total	*0*	*4*	*112*	*21*	*59*	*196*	100%
%	0%	2%	57%	11%	30%	100%	

4.3.3 Types of industry

Table 4.5 shows the number and percentage of companies by industry that reported a specific SBI'08/NACE branch code on their CO_2PL certificate[26]. A large number of the companies participating in the CO_2PL operate in the construction industry because the CO_2PL was originally designed to promote CO_2 emission reductions and energy efficiency among ProRail contractors. Sixty percent of the companies that reported NACE codes were in the construction industry (F). The construction industry includes branches 41 (construction of buildings), 42 (civil engineering) and 43 (specialised construction activities). The 10 largest Dutch construction companies in terms of turnover all participate in the scheme (Cobouw, 2011)[27]. These are often parent companies or holdings that may have several CO_2PL certificates. Companies in the construction industry supply chain, such as manufacturers of concrete structures (SBI 23) or structural metal products (SBI 25) also participate in the CO_2PL. A relatively high

[25] Based on EC Directive 2004/17/EC on coordinating the procurement procedures of entities operating in the water, energy, transport and postal services sectors (EC, 2004).

[26] SBI is the Dutch industry standard classification system and comparable to the NACE European classification system. Note that firms can be active in several branches and may therefore cite multiple SBI'08/NACE codes. Unfortunately, more than one third of the firms failed to report their SBI'08/NACE code. A substantial number of companies reported old SBI'93 codes instead of the new SBI'08 codes. SBI'93 codes have been converted to SBI'08 based on CBS (2008).

[27] According to CBS (2012), the total number of construction companies in the Netherlands with more than 100 employees is approximately 400.

percentage of participating companies (13%) are consulting firms (SBI 71) that provide technical services to commissioning parties. However, the CO_2PL scheme also includes companies that are not directly related to construction activities, i.e., companies providing other services such as ICT, catering services and rental and leasing activities. Remarkably, there are also companies participating in the CO_2PL that have not done business with ProRail (Wilbrink, 2012; Dorée et al., 2011). There is also a small number of participating foreign companies.

Table 4.5: SBI/NACE codes of participating companies

SBI	Branch	N	share
8	Other mining and quarrying	2	1%
23	Manufacture of other non-metallic mineral products	4	2%
25	Manufacture of fabricated metal products, except machinery and equipment	9	5%
26	Manufacture of computer, electronic and optical products	2	1%
27	Manufacture of electrical equipment	4	2%
28	Manufacture of machinery and equipment n.e.c.	4	2%
33	Repair and installation of machinery and equipment	7	4%
39	Remediation activities and other waste management services	9	5%
41	Construction of buildings	26	13%
42	Civil engineering	55	28%
43	Specialised construction activities	37	19%
46	Wholesale trade, with the exception of motor vehicles and motorcycles	5	3%
49	Land transport and transport via pipelines	3	2%
50	Water transport	2	1%
62	Computer programming, consultancy and related activities	4	2%
70	Activities of head offices; management consultancy activities	3	2%
71	Architectural and engineering activities; technical testing and analysis	26	13%
74	Other professional, scientific and technical activities	2	1%
77	Rental and leasing activities	4	2%
81	Services to buildings and landscape activities	2	1%
	Other branches	12	7%
	SBI code not reported	71	36%

Note: Only codes occurring more than once are shown.

The CO_2PL certificates provided information about several company characteristics, such as company size, certificate level and industry type. However, a substantial number of certificates were not published on corporate websites or did not contain information about company size or industry type, even though this information is required by the scheme.

4.4 CO_2 emissions from companies in the CO_2PL

Building an improved understanding of corporate CO_2 emissions is one of the key elements of the CO_2PL. This section describes the standards and requirements for reporting a CO_2 footprint, determines the aggregate CO_2 emissions of the participating companies and discusses the CO_2 emission reductions achieved to date.

4.4.1 Emission scope reporting in the CO_2PL

CO_2 emission reporting in the CO_2PL is based on the ISO 14064-1 and CO_2 emission factors published in the SKAO CO_2PL handbook (SKAO, 2011). ISO 14064-1 specifies a number of guidelines and requirements at the organisational level for the quantification and reporting of greenhouse gas (GHG) emissions. The CO_2 emission inventory (or CO_2 footprint) of certified companies consists of three types of GHG emissions: direct emissions (Scope 1), indirect emissions (Scope 2) and other indirect emissions (Scope 3). Scope 1 emissions are direct emissions from sources either owned or controlled by the company, such as emissions from burning fuels in boilers, CHP plants and furnaces; emissions from business travel by car and emissions from the use of refrigerants. Scope 2 emissions are indirect emissions from the generation of electricity purchased and consumed by the company. In the CO_2PL scheme, companies must also report emissions from business air travel and from private cars used for business travel as Scope 2 emissions. In contrast, in the widely used GHG emission protocol, these types of emissions are reported as Scope 3 (WBCSD/WRI, 2004). Scope 3 emissions are other indirect emissions that result from the company's activities but are emitted from sources that are not owned or controlled by the company itself. For example, Scope 3 emissions include emissions from business trips by public transport and the use of taxis and emissions from the production and extraction of purchased materials and waste disposal. Companies can reduce their CO_2 emissions by implementing energy efficiency measures, through technological innovation or by changing the type of energy sources. Companies cannot reduce their emissions through carbon offsetting.

Table 4.6: Emission scopes as defined in the CO_2PL

Scope 1	Scope 2	Scope 3
Fuel used (e.g. heating, generators) Business car travel Air conditioning refrigerants	Purchased electricity, steam Private cars used for business travel Business air travel	Business travel by public transport Commuter travel Waste disposal Paper used Electricity used at client sites Suppliers/outsourced emissions Other consumables …

4.4.2 Reporting obligations

Key Process A of the CO_2PL ('insight into CO_2 emissions') requires the identification, reporting and verification of the company's CO_2 footprint and CO_2 emissions in the company's supply chain. The exact reporting obligations depend on the certification level. Scope 1 and Scope 2 emissions must be reported and verified for companies that wish to obtain a Level 3 certification. For a Level 4 certification, companies must also provide insight into the most important Scope 3 emissions. Level 5 certification requires the annual reporting and verification of Scope 1 and 2 emissions in conformity with ISO 14064-1 for at least 50% of the company's principal suppliers[28].

4.4.3 Reported CO_2 emissions

We were able to collect CO_2 emission inventories from 170 companies for the year 2010. Total CO_2 emissions reported in 2010 by these companies amounted to 1.71 Mt CO_2, including Scope 1 emissions (71%), Scope 2 emissions (15%) and Scope 3 emissions (14%). Approximately 20% of the certificate holders were responsible for nearly 80% of total emissions reported. Internal suppliers within the organisational boundary of Van Oord dominated the Scope 1 emissions. These internal suppliers emitted 177 kt of CO_2 from fuel combustion due to dredging activities. The remaining activities of Van Oord accounted for 10 kt of CO_2 .The company Fri-Jado accounted for 80% of Scope 3 emissions because it reported the global warming potential of refrigerants for its sold products (cooling plants). In total, 53 companies reported Scope 3 emissions in 2010[29]. We also collected CO_2 emission inventories from 122 companies for the year 2009. These 122 companies reported 1.54 emitted Mt CO_2 in 2009.

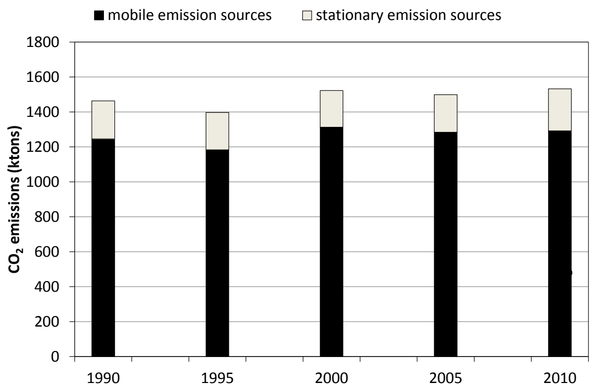
[28] This requirement does not apply to small businesses.

[29] The average share of scope 3 emissions in the total emissions reported is around 28% in the companies that reported this type of emission.

4.4.4 Comparison with national emissions

Figure 4.2 shows the CO_2 emissions in the construction sector according to the Dutch Pollutant Release and Transfer Register (PRTR, 2011). A distinction was made here between emissions from stationary sources and emissions from mobile sources on site. CO_2 emissions in the construction sector in 2010 amounted to 1.53 Mt. Total domestic GHG emissions in the Netherlands in 2010 was 210 Mt (CBS et al., 2012). Estimated Scope 1 and 2 CO_2 emissions from construction companies participating in the CO_2PL was more than 970 kt in 2009[30]. These figures indicate that a substantial portion of the CO_2 emissions from the construction industry has not yet been accounted for by the CO_2PL. Approximately 30 of the top 50 largest construction companies (measured in terms of turnover) do not yet participate in the CO_2PL. These 30 companies are responsible for 15% of the total turnover among the top 50 companies. It must be stressed that the PRTR data and the CO_2PL data are not totally comparable because of differences in the processes of collecting, reporting and preparing data, and the organisational boundaries of the individual companies may also be disparate between the two data sources. Further studies are needed to more precisely determine the differences between the PRTR data and the CO_2PL data.

Figure 4.2: CO_2 emissions in SBI41-42-43 according to Pollutant Release and Transfer Register



4.4.5 CO_2 emission reductions

Table 4.7 shows the Scope 1, 2 and 3 CO_2 emissions from the 110 companies that reported emissions in 2009 and 2010. Total emissions decreased by 7.8%[31]. Total Scope 1 emissions decreased from 984 to 949 kt (-3.5%). Scope 1 emissions (excluding Van Oord emissions) increased from 756 to 762 kt (+0.8%). Scope 2 emissions decreased from 238 to 208 kt (-12.6%). These emission reductions were mainly achieved by switching from grey to green electricity. The rules for calculating CO_2 emissions from green electricity were less strict prior to 2011, and therefore CO_2 emission reductions could be achieved more easily. Scope 3 emissions decreased by 18.6%, mainly due to emission reductions by Fri-Jado. However, these results should be interpreted with caution. First, there are some limitations to data quality in the CO_2 emission inventories (see the following section). Second, it must be stressed that the calculated emission reductions were based only on data from 2009 and 2010 and not

[30] Including emissions from those companies in construction industries that reported their NACE codes and also the emissions from other major construction companies that did *not* report their NACE code.

[31] If we exclude the two dominant companies in terms of Scope 1 and Scope 3 CO_2 emissions (Van Oord and Fri-jado, respectively), total CO_2 emissions decreased by 2.8%.

on long-term data. Third, it must be pointed out that the construction industry experienced an economic decline in 2009 and 2010. Further research is needed to explain the decreases in Scope 1 and 2. Additional factors requiring examination include changes in economic activity, fuel switching and energy efficiency improvement.

Table 4.7: CO_2 emissions from companies that reported emissions for 2009 and 2010

Emission scope	2009 (kt)	2010 (kt)	Change (%)
Scope 1	984	949	-3.5%
- Van Oord	*228*	*187*	*-18.0%*
- Remaining companies	*756*	*762*	*+0.8%*
Scope 2	238	208	-12.6%
Scope 3	280	228	-18.6%
- Fri-Jado	*225*	*180*	*-20.2%*
- Remaining companies	*54*	*48*	*-11.8%*
Total	1501	1384	-7.8%

4.4.6 Quality of the CO_2 emission inventories

As explained in the previous section, there are some limitations to data quality for the reported CO_2 emissions data. Within the scope of this research, we were unfortunately not able to investigate the magnitude of the limitations on the emissions data. In this section we will however discuss the quality of the CO_2 emission inventories on the basis of the GHG accounting and reporting principles prescribed by WBCSD/WRI (2004). These GHG accounting and reporting principles include: relevance, completeness, consistency, transparency and accuracy.

One important aspect of the relevance of CO_2 emission inventories is the selection of the organisational boundary. The organisational boundaries of the companies in this study may have changed between 2009 and 2010, e.g. through changes in the financial or operational control of companies. In the construction industry in particular, new subsidiaries are often set up for specific projects. The CO_2PL requires that a company's CO_2 footprint must be recalculated if the organisational boundaries have changed. In this respect, it is not yet clear to what extent the CO_2 footprints in 2009 are comparable to the footprints in 2010.

A CO_2 emission inventory should account for and report on *all* GHG emission sources and activities within the selected organisational boundary. It is likely that administration, data collection and monitoring of CO_2 emissions improved between 2009 and 2010, giving companies more complete and accurate insights into their CO_2 emissions in 2010. It could therefore be argued that the CO_2 footprints for 2009 are not as complete as the CO_2 footprints for 2010. With respect to Scope 3 emissions, the CO_2PL only requires companies at Level 4 or 5 to deliver at least two analyses of the most important CO_2 emission sources in their supply chain. The Scope 3 emissions inventory was therefore far from complete. However, a substantial number of companies with Level 3 certificates did report Scope 3 emissions even though it is not required by the scheme. The scheme includes several guidelines for improving and extending the Scope 3 emissions inventory over time. Errors in Scope 3 emissions may occur because emissions in the supply chain can be counted more than once, i.e., Scope 3 emissions are counted as Scope 1 or Scope 2 emissions by other companies. It is likely that the double-counting of Scope 3 emissions had only moderate impacts on the emission estimates in this study because the reported Scope 3 emissions were relatively small.

A consistent methodology should be used for CO_2 emission reporting to allow for meaningful comparisons between emissions over time. CO_2 emission inventories required by the CO_2PL are primarily based on ISO 14064-1 and the CO_2 emission factors published in the SKAO CO_2PL handbook. Nevertheless, in some cases, CO_2 emissions were reported on the basis of other standards that had different emission scopes and sets of CO_2 emission factors (e.g. ENCORD, 2012[32]). Furthermore, since the introduction of the CO_2PL, some of the CO_2 emission factors have been updated. Recalculation of the CO_2 footprint is required if the CO_2 emission factors have been updated for the dominant emission sources. As of yet, we know little about the effects of using other reporting standards and updated CO_2 emission factors on aggregate CO_2 emissions, the distribution of CO_2 emissions and calculated emission reductions.

In general, the transparency of CO_2 emission reporting can be ensured by an independent external verification. Companies in the CO_2PL that want to comply with Level 3 certification can opt for an emission verification statement based on ISO 14064-3 that is drawn up by an independent institution. However, this requirement is not obligatory at Level 3 and therefore a lack of transparency may have had an impact on the quality of the CO_2 emission inventories.

Finally, there are other concerns regarding the accuracy of the CO_2 emission inventories. According to ProRail (2010c), there may be several uncertainties in emission reporting, such as the choice of emission factors, uncertainty in the emission factors themselves, uncertainty in the collected data and uncertainty in the extrapolation of emissions data.

4.5 CO_2 reduction targets, target ambition levels and potential impact

The CO_2PL requires that firms set ambitious targets for the reduction of CO_2 emissions. This section discusses the various types of CO_2 reduction targets that companies have set, analyses the ambition level of the CO_2 reduction targets and assesses the potential impact of the scheme on CO_2 emission reductions in the Netherlands.

4.5.1 Obligations regarding the formulation of reduction targets

Setting CO_2 reduction targets is part of Key Process B (‘reduction’) in the CO_2PL. The exact requirements depend on the certification level. At certification Level 2, companies must formulate qualitative objectives for energy efficiency improvement and renewable energy that are approved by the management. Quantitative reduction targets must be formulated separately for Scope 1 and 2 CO_2 emissions for companies that wish to be certified at Level 3. The CO_2 reduction targets must be reasonably ambitious and comparable with targets of other companies in the sector. At Level 4, companies must also set quantitative reduction targets for emissions in the supply chain. There are no additional obligations regarding the setting of reduction targets at Level 5. Obligations regarding progress reports, efforts to maintain continuous improvement and the realisation of CO_2 reduction targets are other important aspects of Key Process B.

4.5.2 Analysis of CO_2 reduction targets

The CO_2PL requires that certified firms set SMART CO_2 reduction targets, meaning that targets must be Specific, Measurable, Appropriate, Realistic and Timed (Rietbergen & Blok, 2010). The following analysis shows that the CO_2 reduction targets of companies in the CO_2PL do not meet these SMART conditions in every case.

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[32] ENCORD (2012) is based on the GHG Protocol ‘A corporate accounting and reporting standard’ (WBCSD/WRI, 2004). See ERM (2010) for an overview of company GHG reporting methodologies.

'Specific' refers to the condition that the description of the targets must clearly specify what is to be achieved. Our analysis of the CO_2 reduction targets revealed that more than half of the companies reported aggregated CO_2 reduction targets covering emissions within the entire company's boundary. Approximately 15% of the companies reported specific CO_2 reduction targets for emission Scopes 1 and 2 as required by the scheme. Some companies set separate targets for specific emission sources, such as the electricity they purchase. A few companies did not report any targets at all.

'Measurable' refers to the condition that the targets must allow for regular evaluation of progress towards the emission reduction goal. Almost every company participating in the CO_2PL scheme has set quantitative targets for CO_2 reductions or energy efficiency that can be used for evaluation purposes.

'Appropriate' means that the targets must be relevant for policy makers and the target group. All of these targets may be relevant for the companies to steer their corporate sustainability strategy. However, the only type of CO_2 emission reduction target that is appropriate for policy makers or SKAO is a volume target.

'Realistic' means that the target is achievable over the duration of the target period. In the following sections we will discuss the ambition level of the various types of CO_2 reduction targets.

'Timed' means that the target includes a time period within which the target should be achieved. The majority of companies appear to have set short-term targets. On average, the targets must be achieved within a period of five years. Around 15% of the companies have set targets that extend beyond a 10-year time frame. Most of the companies have chosen 2009 or 2010 as the reference year against which the target achievement will be measured. The remaining companies either have used other years as a reference, do not report a reference year, or use a rolling base year.

4.5.3 Ambition level of CO_2 reduction targets

The CO_2PL requires that the CO_2 reduction target level is reasonably ambitious and comparable among companies in the sector. Figure 4.3, Figure 4.4 and Figure 4.5 show frequency histograms of the three major types of reduction targets for Scope 1 and Scope 2 emissions[33]. For example, 20 of the companies that had formulated a volume target for CO_2 emission reductions report a reduction target in the range of 2.0%/yr - 2.5%/yr.

Table 4.8 shows the average volume-weighted ambition level for the various target types. Equation 4.1 in the appendix was used for calculating the average volume-weighted ambition level of the various target types. The average ambition level of the volume targets for CO_2 emission reductions in Scope 1 and 2 was 2.1%/yr. Volume targets for the reduction of emissions from specific sources, such as the combustion of fossil fuels to generate electricity, can be much more aggressive, i.e., up to 36%/yr. Some companies have formulated their ambition level to achieve climate neutrality in the longer term by including measures for CO_2 compensation. The average ambition level of CO_2 emission reduction targets measured against full time equivalents or hours (worked) was 2.8%/yr. Companies that have formulated CO_2 emission reduction targets measured against turnover aim to reduce their CO_2 emissions by 2.0%/yr per € turnover on average. None of the companies that have set

[33] Targets for Scope 3 emissions were not taken into account in this research. Targets for Scope 3 emissions often aimed at reducing CO_2 emissions from specific sources such as paper, waste or other purchased materials. The variety of emission sources also makes it difficult to assess the potential impact of these targets on CO_2 emission reductions.

CO_2 emission reductions targets measured against turnover reported that the turnover figures will be adjusted for inflation. The ambition level of the various target types in comparison to business-as-usual projections is discussed in the next section.

The histograms show that there was considerable variation in the ambition level of the CO_2 reduction targets of the participating companies. However, firm conclusions about the magnitude of the variation in ambition level cannot yet be drawn because the ambition level data are not broken down by sector. Further research is necessary to fully understand the process of setting CO_2 reduction targets and ambition levels.

Figure 4.3: Histogram of volume targets for CO_2 emission reductions

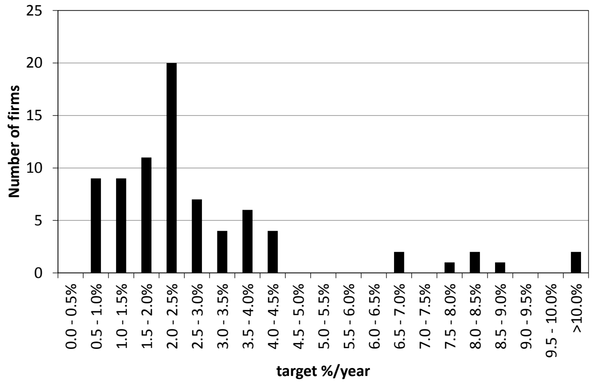


Figure 4.4: Histogram of CO_2 emission reductions targets measured against FTE

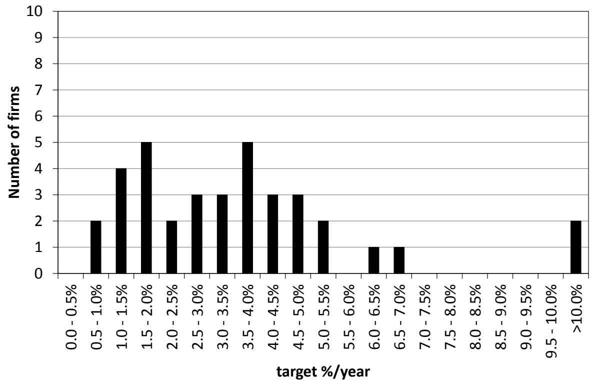
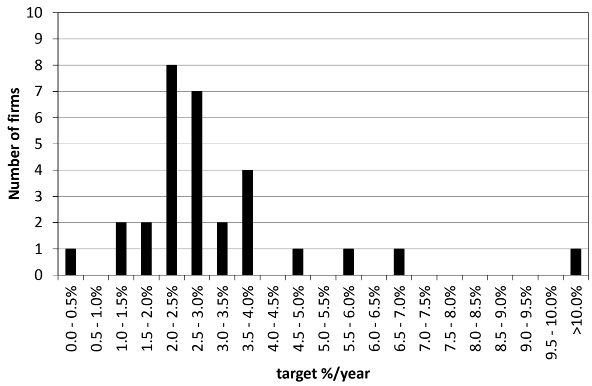


Figure 4.5: Histogram of CO_2 emission reductions targets measured against turnover



4.5.4 Assessing the potential impact of CO_2 reduction targets on CO_2 emissions

Table 4.8 shows the average weighted ambition levels for three different target types and the projected impact of these targets on Scope 1 and Scope 2 CO_2 emissions. The impact of volume targets on CO_2 emission reductions in the case of full compliance depended solely on the ambition level for the target (see Equation 4.2 in the appendix). Therefore, the projected reduction in CO_2 emissions was 2.1%/yr.

The impact of CO_2 emission reduction targets measured against FTE or hours (worked) was dependent on the ambition level of the target and the projected number of FTEs working in the construction industry (see Equation 4.3 in the appendix). Table 4.9 shows several baseline projections for future number of FTEs in the construction industry. The impact of CO_2 emission reduction targets on CO_2 emissions (measured against FTE) was estimated at -2.0%/yr to -2.4%/yr for the average growth scenarios of CBS, EIB and TNO. In the event of high employment growth, the impact on CO_2 emissions was estimated to be -1.5%/yr. A limited increase in the number of FTEs would result in a 2.5%/yr reduction in CO_2 emissions.

The impact of CO_2 emission reduction targets measured against turnover in current prices depended on the ambition level of the target and the projected figures for turnover in current prices (see Equation 4.4 in the appendix). Table 4.9 shows several baseline projections used to estimate the annual growth of turnover in the construction industry. It was estimated that CO_2 emissions would increase by 0.4%/yr to 1.5%/yr in the average growth scenarios for CBS, EIB and TNO. In scenarios of high and low economic growth, the use of these targets would result in an increase in CO_2 emissions of 2.2%/yr and 0.3%/yr, respectively.

The total potential impact of the CO_2PL was calculated as the weighted average of the projected impacts of the various CO_2 reduction targets (see Equation 4.5 in the appendix). The weighting was based on total CO_2 emissions for the companies by type of target. The total potential impact that could be achieved by full compliance with the CO_2 reduction targets, estimated as the *net annual change in* CO_2 *emissions compared to emission levels in the base year 2010,* was estimated to be between -0.8%/yr and -1.5%/yr, with a most likely value of -1.3%/yr[34]. The projected impact of the CO_2PL would range from -1.3%/yr to -2.0%/yr if the CO_2 emission reduction targets measured against turnover were based on constant prices.

Table 4.8: Average weighted ambition level and projected net annual change in CO_2 emissions compared to emissions in the base year 2010 for the various target types

Target type	Average weighted ambition level	Projected net annual change in CO_2 emissions				
		CBS average	CBS high	CBS low	EIB	TNO
CO_2	-2.1%			-2.1%		
CO_2/FTE	-2.8%	-2.2%	-1.5%	-2.5%	-2.0%	-2.4%
CO_2/€ turnover[1]	-2.0%	1.0%	2.2%	0.3%	1.5%	0.4%
Total		-1.3%	-0.8%	-1.5%	-1.1%	-1.4%

[1] Turnover in current prices.

[34] 0.8-1.5%/yr of the CO_2 emissions corresponding to the CO_2PL in 2010 amounted to 14 - 26 kt. Total CO_2 emissions by ProRail, the initiator of the scheme, was 77 kt in 2010.

Table 4.9: Baseline projections for annual growth in turnover and FTEs

Projections	CBS average[1]	CBS high[2]	CBS low[3]	EIB[4]	TNO[5]
FTE projections	0.7%	1.4%	0.4%	0.8%	0.4%
Turnover projections (constant prices)	1.3%	2.6%	0.7%	2.1%	1.0%
Turnover projections (current prices)	3.0%	4.3%	2.4%	3.6%	2.5%

[1] Baseline projections for FTE and turnover at current prices are based on trend analyses of CBS data for the construction industry during the period from 1995-2010 (CBS, 2012). Projections for turnover at constant prices exclude the average annual inflation rate in the period 2004-2011 (1.7%/yr) (CBS, 2012).
[2] Baseline projections for FTE and turnover at constant prices are based on doubled CBS average figures. Projections for turnover at current prices include the average annual inflation rate for the period from 2004-2011 (1.7%/yr) (CBS, 2012).
[3] Baseline projections for FTE and turnover at constant prices are based on CBS average figures divided by two. Projections for turnover at current prices include the average annual inflation rate for the period from 2004-2011 (1.7%/yr) (CBS, 2012).
[4] Baseline projections for FTE and turnover at constant prices are based on the EIB forecasts for the period of 2010-2016 (EIB, 2010). Projections for turnover at current prices include the projected inflation rate of 1.5%/yr for the period from 2011-2015 (CPB, 2011).
[5] Baseline projections for FTE and turnover at constant prices are based on the TNO forecasts for the period of 2010-2015 (2010). Projections for turnover at current prices include the projected inflation rate of 1.5%/yr for the period from 2011-2015 (CPB, 2011).

A trend analysis of CO_2 emissions in the construction industry (see Figure 4.2) indicated that CO_2 emissions increased by 0.4%/yr in the period from 1990-2010. Consequently, the potential impact of the CO_2PL on CO_2 *emission reductions compared to a business-as-usual scenario* was estimated to be between -0.7%/yr and -2.4%/yr, taking into account the 0.5% uncertainty range in the trend analysis of the CO_2 emissions. A comparison of business-as-usual projections of CO_2 emissions with the projected impact of the various target types showed that the volume targets for CO_2 emission reductions were ambitious. The CO_2 emission reduction targets also seemed ambitious when measured against FTE due to the modest projected growth in FTE. A considerable portion of the CO_2 emission reduction targets measured against turnover was likely to be achieved anyhow because the turnover was not adjusted for inflation.

4.5.5 Implications for CO_2 reduction policies

In 2007, the European Union agreed on a target of reducing EU GHG emissions by at least 20% below 1990 levels by 2020 (COM, 2007). The European Emission Trading Scheme (ETS) was adopted (EC, 2003) in order to reduce GHG emissions from large installations or plants in the energy and industrial sectors. ETS sectors aimed for a 21% GHG emission reduction in 2020 compared to 2005 emissions. The EU Effort Sharing Decision (EC, 2009) established annual binding GHG emission targets for non-ETS sectors, including the construction industry, in the EU Member States for the period from 2013–2020. The Netherlands is required to reduce its GHG emissions in non-ETS sectors by at least 16% in 2020 compared to 2005 emission levels[35]. Based on GHG emission data from CBS et al. (2012), CO_2 emissions must be reduced by at least 1.4%/yr from 2010 onwards to reach the CO_2 emission ceiling for non-ETS sectors in 2020[36]. The most likely projected impact of the CO_2PL, i.e. a 1.3%/yr reduction in CO_2 emissions, is slightly lower than the average required emission reduction rate of 1.4%/yr. However, it must be emphasised that the non-ETS sectors involved do not have separate CO_2 emission reduction targets. Therefore, the sectors do not necessarily have to contribute equally to achieve the overall target.

[35] This excludes CO_2 emissions from the generation of purchased electricity. Such emissions are allocated to the electricity producers that are part of the ETS scheme. Emission reductions can also be achieved to a certain extent through carbon offsets.

[36] CO_2 emissions from non-ETS sectors in 2010 amounted to 126.0 Mtons (CBS et al., 2012). The CO_2 emission cap for non-ETS sectors in 2020 was estimated to be 109.7 Mtons (16% lower than reported CO_2 emissions for 2005).

4.6 Discussion of the results

In this section we discuss the results and compare them with the results of other studies. First, the validity of these results depends in large part on the quality of the baseline projections and business-as-usual estimates used in the research. Baseline projections from various sources have been used in this study to demonstrate the sensitivity of the results to changes in the growth rates of FTE and turnover. However, companies that have set volume targets for CO_2 emission reductions are dominant in this analysis, and the differences in the projected net annual change in CO_2 emissions for the different scenarios are therefore rather small. The projected net annual change in CO_2 emissions based on high growth rates for turnover at current prices showed slightly different results from the other scenarios. We acknowledge that business-as-usual projections of CO_2 emissions in the construction industry is another important topic of discussion. However, to avoid additional uncertainties in the results due to using these business-as-usual projections, we deliberately focused on analysing the net change in CO_2 emissions compared to emission levels in the base year (2010).

The projected impacts of the CO_2PL on CO_2 emission reductions are based on forecasts of turnover and FTE in the construction sector only, but companies operating in other sectors also participate in the scheme. Nevertheless, many of the companies from other sectors are in the construction business supply chain. Growth rates of turnover and FTE in other sectors are within the range of the projected baselines (CBS, 2012). Hence, the research results were not significantly influenced by using just forecasts of FTE and turnover in the construction industries.

Furthermore, we must stress that the calculations for the potential impact of the CO_2PL on CO_2 emission reductions were based only on data from companies that set targets within the target types presented in Table 4.8. However, the CO_2 emissions accounted for in this analysis represented more than 80% of Scope 1 and Scope 2 emissions. We therefore expect that the exclusion of companies that have set other types of CO_2 reduction targets or targets for specific emission sources did not significantly influence the results.

Another important assumption of this study was that the companies would fully comply with the CO_2 reduction targets. On the one hand, it can be argued that the companies will not fully comply with the CO_2 reduction targets. This may be the case particularly for firms certified at Levels 3 and 4 because they are not necessarily required to achieve their selected targets. On the other hand, we can expect targets to be reached because the targets contribute to larger corporate sustainability strategies. Furthermore, companies certified at Level 5 are obliged to reach their CO_2 reduction targets or else risk losing their certification.

Our results are based on the current ambition levels of the CO_2 reductions targets of certified companies. During the course of this study, we have observed that some companies, for whatever reason, have already changed the type and ambition level of their CO_2 reduction targets. Target types and ambition levels may change in the future, especially once the initial commitment periods have ended.

Thus far, we have not addressed the question of how much of the calculated potential impact on CO_2 emission reductions can be attributed to the CO_2PL. On the one hand, no sector-wide policies or measures for CO_2 emission reduction or energy efficiency improvement have been implemented as yet in the construction industry. Only a very small number of companies participate in Long-Term Agreements on Energy Efficiency. The contribution of other policies and measures to CO_2 emission reductions is therefore expected to be modest. On the other hand, Wilbrink (2012) suggests that the CO_2PL is often considered an enhancement of existing policies for

CSR. Therefore, it can be argued that the potential impact on CO_2 emission reductions estimated in this study may not be fully attributed to the CO_2PL. Further research is necessary to more precisely separate the impact of the CO_2PL from the impacts of other energy and climate policies and CSR.

The average ambition level for the various types of CO_2 reduction targets observed in this study was lower than that estimated by Primum (2012). This difference might be explained by the larger sample size used in our study. In our study we identified 145 companies with relevant CO_2 reduction targets, whereas Primum (2012) examined only 106 different companies.

According to DHV (2009), CO_2 emissions could be reduced by 2.5 Mt from 2010–2020 if technical specifications were used as environmental criteria in *all public procurement contracts* in the Netherlands. A 1.7 Mt CO_2 emission reduction could be achieved by requiring the purchase of green electricity and a 0.8 Mt reduction could be achieved by implementing obligatory energy efficiency measures. The projected impact of the CO_2PL on CO_2 emissions for the *companies currently involved* was a reduction of 1.3%/yr, corresponding to a total reduction of approximately 0.2 Mt CO_2 in from 2010– 2020. Therefore, in absolute terms, the contribution of the CO_2PL to bridging the emission gap for non-ETS sectors is not yet significant. However, it is difficult to extrapolate the results of our study to other sectors and relate our figures to the projected impacts calculated by DHV (2009). Further research is needed to understand the potential impact of the scheme on CO_2 emissions if the CO_2PL were expanded to other sectors of the Dutch economy.

In the previous section we compared the estimated impact of the CO_2PL to the CO_2 emission reduction requirement for the year 2020. It could be argued that the estimated impact was not fully comparable with the emission reduction requirement. On the one hand, the CO_2 emission ceiling for non-ETS sectors for 2020 did not include CO_2 emissions from the generation of purchased electricity, and CO_2 emission reductions could also be achieved to a certain extent by carbon offsetting. On the other hand, the estimated impact of the CO_2PL *does* include the reduction of CO_2 emissions from purchased electricity, and carbon offsetting is excluded from the CO_2PL. Nevertheless, we argue that the comparison of the potential impact of the CO_2PL and the CO_2 emission reduction requirement for 2020 was reasonable because CO_2 emissions from purchased electricity in the construction sector were much smaller than CO_2 emissions from fuel use, and the amount of allowed carbon offsets was small.

4.7 Conclusions

Global greenhouse gas (GHG) emissions must be reduced drastically to limit global temperature increase to a relatively safe level of 2 degrees Celsius. The European Union (EU) agreed to reduce its GHG emissions by at least 20% below 1990 levels by 2020. The EU Effort Sharing Decision established annual binding GHG targets for non-ETS sectors in the EU Member States for the period from 2013–2020. The Netherlands needs to reduce its GHG emissions in these non-ETS sectors by at least 16% from 2005–2020.

Green public procurement (GPP) is often recognized as an effective instrument for reducing energy use and CO_2 emissions in the supply chain of commissioning parties. In 2009, a new GPP scheme called the CO_2 Performance Ladder (CO_2PL) was introduced in the Netherlands. Participating companies can certify their energy and CO_2 management according to specific requirements laid down in the scheme. These requirements include the reporting of CO_2 emissions and the setting of ambitious CO_2

emission reduction targets, among others. The question is whether this type of GPP scheme can contribute significantly to CO_2 emission reductions in the Netherlands.

The main conclusion that emerged from this study was that the total potential impact of the CO_2PL on the CO_2 emissions of the participating companies was estimated at -0.8%/yr to -1.5%/yr, with a most likely value of -1.3%/yr. This result suggests that the CO_2PL could contribute significantly to achieving the annual rate of CO_2 emission reduction that is necessary to remain below the Dutch emission ceiling for non-ETS sectors in 2020 (-1.4%/yr). In absolute terms, the contribution of the CO_2PL to bridging the emission gap for non-ETS sectors is not yet significant because currently only a small portion of CO_2 emissions from non-ETS sectors is covered by the scheme.

On the one hand, the rapid growth in the number of certified companies across various non-ETS sectors offers favourable prospects for further absolute CO_2 emission reductions in the Netherlands. On the other hand, the future success of the scheme will mainly depend on the broader application of the scheme as a tool for GPP among other commissioning parties. The CO_2PL scheme's main objective, which is to achieve strong cuts in CO_2 emissions, may also be jeopardized by weak enforcement strategies, ambiguities in the target-setting process and other loopholes in the scheme.

This study contributes substantially to our understanding of the scheme coverage, the CO_2 emission reduction ambitions of the participating companies, and the potential impact of the CO_2PL on emission reductions. However, considerably more research must be conducted to critically evaluate the design of the scheme and the certification process in more detail, to assess the additional impacts of the CO_2PL on corporate energy management practices and innovation, and to review the process of establishing ambitious targets for corporate CO_2 emission reductions.

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Appendix 4A

The average weighted ambition level of the various CO_2 reduction target types presented in Table 4.8 has been calculated by using the following formula:

Equation 4.1

$$AWAL = \sum_{i=1}^{n}\left[\left(10^{\log(1+target_i)/L_i} - 1\right) * CO_{2\,i,\,base\,year}\right] / \sum_{i=1}^{n}\left[CO_{2\,i,\,base\,year}\right]$$

Where,

AWAL	=	Average volume-weighted ambition level of the CO_2 reduction target type (%/yr)
$target_i$	=	Ambition level of CO_2 reduction target of company i (% reduction over the total commitment period)
L_i	=	Duration of the commitment period of company i
$CO_{2\,i,\,base\,year}$	=	CO_2 footprint (scope 1 and 2 emissions) of company i in the base year

The projected net annual change in CO_2 emissions of the various target types and the total potential impact of the scheme as presented in Table 4.8 has been calculated by using the following formulas:

Equation 4.2

$$NAC_{CO_2} = AWAL_{CO_2}$$

Equation 4.3

$$NAC_{CO_2/FTE} = 1 - (1 + AWAL_{CO_2/FTE}) * (1 + AG_{FTE})$$

Equation 4.4

$$NAC_{CO_2/turnover} = 1 - (1 + AWAL_{CO_2/turnover}) * (1 + AG_{turnover})$$

Equation 4.5

$$NAC_{TOT} = \left(A * NAC_{CO_2} + B * NAC_{CO_2/turnover} + C * NAC_{CO_2/FTE}\right) / \left(A + B + C\right)$$

Where,

NAC_{CO2}	=	Projected net annual change in CO_2 emissions of volume targets for CO_2 emission reduction (%/yr)
$NAC_{CO2/turnover}$	=	Projected net annual change in CO_2 emissions of CO_2 reduction targets measured against turnover (%/yr)
$NAC_{CO2/FTE}$	=	Projected net annual change in CO_2 emissions of CO_2 reduction targets measured against FTE (%/yr)
NAC_{TOT}	=	Total projected net annual change in CO_2 emissions of all CO_2 reduction target types (%/yr)
$AWAL_{CO2}$	=	Average weighted ambition level of volume targets for CO_2 emission reduction (%/yr)
$AWAL_{CO2/turnover}$	=	Average weighted ambition level of CO_2 reduction targets measured against turnover (%/yr)
$AWAL_{CO2/FTE}$	=	Average weighted ambition level of CO_2 reduction targets measured against FTE (%/yr)
AG_{FTE}	=	Baseline projection for annual growth of FTE (%/yr)
$AG_{turnover}$	=	Baseline projection for annual growth of turnover in current prices (%/yr)
A	=	Sum of scope 1 and 2 CO_2 emissions from companies with volume targets for CO_2 emission reduction in 2010
B	=	Sum of scope 1 and 2 CO_2 emissions from companies with CO_2 reduction targets measured against turnover in 2010
C	=	Sum of scope 1 and 2 CO_2 emissions from companies CO_2 reduction targets measured against FTE in 2010

Chapter 5

Improving energy and carbon management in construction and civil engineering companies through green procurement – Evaluating the impacts of the CO_2 Performance Ladder

Martijn G. Rietbergen, Ivo J. Opstelten, Kornelis Blok

Abstract

Energy and carbon management programmes are being implemented to facilitate continuous energy efficiency and carbon performance improvement in various economic sectors. In the Netherlands, the CO_2 Performance Ladder has been introduced as a market-driven certification programme for energy and carbon management. Among the 500 participating companies, mainly from the construction and civil engineering sector, the CO_2 Performance Ladder is often considered as the major stimulant for energy efficiency improvement and CO_2 emission reduction. This research addressed the question: *'What is the impact of the* CO_2 *Performance Ladder on improving energy and carbon management in construction and civil engineering firms'*. The research was primarily 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 indicated that the CO_2 Performance Ladder has improved various energy management practices at administrative level, while implementation of energy management practices at lower levels in the organization has just gradually started. Companies mainly have implemented measures affecting the supporting business processes instead of the companies' core processes. The CO_2 Performance Ladder has particularly stimulated green electricity purchasing and the adoption of various behavioural energy efficiency and CO_2 emission reduction measures. Since the introduction of the CO_2 Performance Ladder CO_2 emissions have decreased by 5.1%/yr, of which a large part can be attributed to activity reductions. Nevertheless, the CO_2 Performance Ladder seems to have enhanced CO_2 emission reductions among the participating companies. Overall, we conclude that, driven by the potential competitive advantage in contract awarding, the CO_2 Performance Ladder has been responsible for a strong shift towards more mature energy management among construction and civil engineering firms, that would not have been achieved otherwise.

5.1 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., 2010). 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 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 section 5.2.

This paper is organized as follows. Section 5.2 briefly reviews the literature on energy management systems. Section 5.3 shortly introduces the CO_2PL. Section 5.4 addresses the research methods and data collection. Section 5.5 presents the main research findings of our study. The results are discussed in section 5.6. In section 5.7 we will draw the conclusions.

5.2 Energy management systems

5.2.1 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. de Groot et al., 2001; Fleiter et al., 2012; Sorrel, 2004; SPRU, 2000). 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), see e.g. Palm & Thollander, 2010. Energy management is frequently considered as a means to overcome many of these kinds of barriers (Ates & Durakbasa, 2012; Worrell, 2011; Backlund, 2012).

Unfortunately, a generally accepted definition of 'energy management' seems to be lacking, see Capehart et al. (1997), Carbon Trust (2010), VDI (2007), IEA/IIP (2012), DSA (2001) for various definitions of energy management. 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, 2010). 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 organisation's wider management processes to be fully effective (Carbon Trust, 2010; Capehart et al., 1997). The integration of energy management in the organisation's overall management structure can be facilitated by using *Energy Management Systems* (Thollander & Ottoson, 2010). Various comparable definitions of energy management systems exist in the academic and practitioner literature, see Reinaud et al. (2012), ISO (2011), Kahlenborn et al. (2012), and DSA (2001) for various definitions. 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, see e.g. DSA (2001), NSAI (2005), ANSI (2005) and 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. (2010) 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 responsibility (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), and 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 & Nilsson, 2012). Both governments, NGOs and industries are therefore developing various approaches to promote the uptake of energy management systems (Dahlgren, 2014). These approaches may include for example mandatory energy management programmes, like in Japan (Kimura & Noda, 2014), incentive based energy management programmes, like in Sweden (Stenqvist & Nilsson, 2012) and market-driven certification programmes for energy management like in the United States (Scheihing et al., 2013).

5.2.2 Evaluating the performance of energy management programmes

In contrast with the large amount of research on the relationship between environmental performance and environmental management systems (see overviews by Heras-Saizarbitoria & Boiral, 2013; Nawrocka & 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 & Pinkse (2004), Sullivan (2011). 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 lack of 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, 2013; Heindrichs & Busch, 2012; Reinaud et al., 2012; McKane et al., 2010; Rohdin & Thollander, 2006; SPRU, 2000; Blass et al., 2014; Rohdin et al., 2007; Brown & 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 & Durakbasa, 2012; Thollander & Ottoson, 2010; Lee, 2012a; 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 & Noda, 2014; Backlund et al., 2012; Helby, 2002; Stenqvist et al., 2011; Krarup & 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, see Böttcher & Müller (2014), Lee (2012a) and Martin et al. (2012). A few studies assessed quantitative impacts of introducing energy management programmes on energy conservation in industrial sectors, see e.g. Rietbergen et al. (2002), Cahill & Gallachóir (2012), Stenqvist & Nilsson (2012).

Most of the studies cited above evaluated the outcomes, rather than impacts, of introducing energy management programmes on improving energy management practices. Moreover, most studies focussed on energy management systems, practices and programmes in primarily industrial sectors. As a result, up till 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 the CO_2PL as an example of an energy management programme introduced in a non-industrial sector, i.e. the construction and civil engineering sector.

5.3 The CO_2 Performance Ladder

5.3.1 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 (see e.g. Ngai et al., 2013; Antunes et al., 2014; Introna et al., 2014) and discriminates five 'certificate 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 their 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 5.1 shows the general requirements for each key topic at each certification level. The programme's requirements 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 (Primum, 2014). The CO_2PL specifies requirements that go beyond the ISO-50001 standard, particularly in key topics C and D.

Table 5.1: General certification requirements of the CO_2PL

Level	1	2	3	4	5
A Insight	The company has partial insight into its energy consumption.	The company has an insight into its energy consumption.	The company has converted its energy consumption into CO_2 emissions.	The company reports its carbon footprint in accordance with ISO-14064-1 for Scope 1, 2 & 3.	The company requires that its A-suppliers have a Scope 1 & 2 emissions calculation in accordance with ISO-14064-1.
B Reduction	The company investigates opportunities for reducing energy consumption.	The company has an energy reduction target, described in qualitative terms.	The company has quantitative CO_2 reduction objectives for its own organisation.	The company has quantitative CO_2 reduction objectives for Scope 1, 2 & 3 CO_2 emissions.	The company reports on a structural and quantitative basis the results of the CO_2 reduction objectives for Scope 1, 2 & 3.
C Transparency	The company communicates its energy reduction policy on an ad hoc basis.	The company communicates its energy policy internally (to a minimal degree) and possibly externally.	The company communicates about its carbon footprint and reduction objectives both internally and externally.	The company maintains dialogue with government bodies and NGOs about its CO_2 reduction objectives and strategy.	The company is publicly committed to a government or NGO CO_2 emission reduction programme.
D Participation	The company is aware of sector and/or supply chain initiatives.	The company is a passive participant in initiatives aimed at reducing CO_2 emissions in or outside the sector.	The company is an active participant in initiatives aimed at reducing CO_2 emissions in or outside the sector.	The company initiates development projects that facilitate reductions in CO_2 emissions in the sector.	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.

Source: SKAO (2014).

A third party organization conducts an independent certification audit to verify whether the requirements, linked to the certificate level aspired by the company, are met. The company is awarded a 'CO_2PL certificate' indicating the achieved certificate 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).

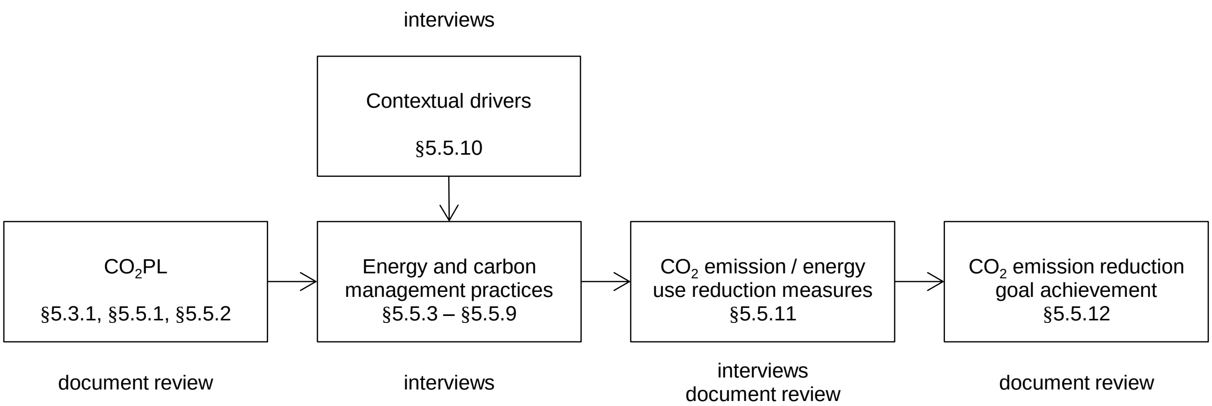
5.3.2 Literature review on the CO_2PL

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 & Blok (2013) claimed that CO_2 emissions of participating companies could potentially be reduced by 0.8-1.5%/yr in absolute terms, which would be sufficient to keep up the pace 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, see Addo-Nkansah et al. (2012), Boersen (2012), Oost (2012), Oudejans (2012), Wilbrink (2012), Primum (2012). The latter two 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.

5.4 Research questions, methods and data collection

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 in construction and civil engineering firms’. First, we investigate whether the CO_2PL is having significant effects on adopting new energy and carbon management practices in certified firms. The 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 and target-setting for CO_2 emission reduction. Second, we study whether additional energy conservation and CO_2 emission reduction measures have been taken by certified firms, due to the CO_2PL. Third, we evaluate the CO_2 emission reductions since the introduction of the CO_2PL. As the CO_2PL is 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 is studied as well, see Figure 5.1. This research specifically focusses on the impact of the CO_2PL on improving internal energy and carbon management practices. The impact of the CO_2PL on managing supply chain CO_2 emissions are not focal points of our research.

Figure 5.1: Research framework and data collection



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 a management system for energy and CO_2 emission reduction. Furthermore, only companies with a CO_2 footprint larger than 5 ktons of CO_2 emissions in scope 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 & Blok, 2013). Finally, companies must still be an active participant in the CO_2PL.

Table 5.2: Profiles of interviewed companies

	Company name	n[1]	CO_2PL level	Certified since Q/yr	NACE[2]	CO_2 emission reduction target: type[3]	start-end	target (%/yr)	achieved (%/yr)	last year reported	CO_2 emissions: 2013 (tons)	reduction (%/yr)[4]	Other policies, standards and certifications: ISO14001	LTA3	CSRPL
1	ARCADIS	2	5	Q1/2010	71	CO_2/FTE	2008-2015	-1.2%	-6.2%	2013	6718	-8.3%	yes	no	no
2	Baas BV	1	3	Q4/2010	42, 43	CO_2/FTE	2009-2015	-2.7%	-4.3%	2013	3930	-9.6%	no	no	no
3	Ballast Nedam	1	5	Q4/2009	41, 42	CO_2/M€	2008-2020	-2.9%	-3.8%	2013	50000	-8.9%	yes	yes	no
4	BAM Civiel BV	2	5	Q4/2010	41, 42	CO_2/M€	2009-2015	-2.7%	#N/A	#N/A	5523	-11.0%	yes	no	no
5	BAM Infratechniek	1	5	Q2/2010	41-43, 71	CO_2/M€	2009-2015	-2.7%	#N/A	#N/A	15670 [5]	#N/A	yes	no	no
6	BAM Rail	2	5	Q2/2010	42	CO_2	2009-2012	-5.3%	-8.8%	2013	6272	-8.9%	yes	no	no
7	Beelen Recycling	2	5	Q1/2012	38, 43	CO_2/M€	2010-2013	-2.7%	1.7%	2013	14814	18.9%	yes	no	yes
8	Besix	2	5	Q4/2010	41, 42	CO_2/M€	2009-2015	-1.7%	-5.4%	2013	5729	-3.1%	yes	no	no
9	Boskalis	2	5	Q2/2011	42	CO_2/M€	2009-2020	-0.5%	-13.3%	2013	61710	-17.8%	yes	no	no
10	Den Ouden Groep	1	3	Q3/2011	38, 42, 43	CO_2/M€	2009-2014	-1.7%	3.4%	2013	6914	-3.7%	yes	no	no
11	Gebr. van 't Hek	1	3	Q1/2011	42	CO_2	2010- …..[6]	-2.0%	0.3%	2013	7202	0.0%	no	no	no
12	GMB	1	5	Q1/2011	41, 42, 43	CO_2/M€	2009-2015	-4.1%	-7.6%	2013	14490	1.3%	yes	no	no
13	GP Groot Infra	1	3	Q3/2011	38, 42	CO_2/FTE	2011-2020	-2.0%	2.8%	2013	14800	8.4%	yes	no	no
14	Heijmans	1	5	Q4/2010	41, 42, 43	CO_2/M€	2009-2016	-2.5%	-7.9%	2012	45964	-6.7%	yes	yes	no
15	Imtech	1	5	Q1/2010	42, 43	CO_2	2008-2013	-2.1%	-3.0%	2013	8549	-1.8%	yes	no	no
16	Mourik	2	5	Q1/2011	41-43	CO_2/M€	2009-2020	-2.0%	-4.8%	2013	11230	-2.6%	yes	no	yes
17	Ooms civiel	1	5	Q1/2011	41-43	CO_2/M€	2009-2014	-2.1%	0.5%	2013	11080	-4.0%	yes	yes	no
18	Ordina	2	4	Q3/2011	62	CO_2/FTE	2010-2020	-2.2%	0.2%	2013	15281	-3.0%	yes	yes	no
19	Strukton Groep	1	5	Q4/2009	41-43, 71	CO_2/M€	2009-2020	-1.5%	-3.8%	2013	36708	-6.2%	yes	yes	no
20	Strukton Rail	1	5	Q4/2009	42	CO_2/M€	2008-2020	-1.3%	-3.1%	2013	15902	-0.3%	yes	no	no
21	TKF	1	3	Q2/2011	27, 35	CO_2/M€	2009-2015	-4.7%	-4.3%	2013	9761	-2.1%	yes	no	no
22	Van Gelder Groep	1	5	Q3/2011	42, 43, 71	CO_2/FTE	2010-2015	-1.7%	-11.4%	2013	8100	-5.3%	yes	yes	no
23	VHB	1	5	Q4/2010	41, 42	CO_2	2009-2015	-1.0%	2.3%	2013	4466	1.0%	yes	no	no
24	Van Wijnen	2	5	Q1/2011	41	CO_2	2009-2015	-2.1%	-4.2%	2013	8196	-3.4%	yes	no	no
25	Wolter en Dros	1	4	Q1/2010	43	CO_2/M€	2011-2013	-0.1%	-3.8%	2013	5273	-8.5%	yes	no	no
											394282	-6.8%[7]			

Table continued

#	Company name	n[1]	CO_2PL level	Certified since Q/yr	NACE[2]	CO_2 emission reduction target					CO_2 emissions		Other policies, standards and certifications		
						type[3]	start-end	target (%/yr)	achieved (%/yr)	last year reported	2013 (tons)	reduction (%/yr)[4]	ISO14001	LTA3	CSRPL
26	De Nijs	1		Not certified	41	no					1268		yes	no	yes
27	De Vries & Verburg	1		Not certified	41	no					1000		yes	no	yes
28	Giesbers bouw	1		Not certified	41	CO_2/M€	2011-2017	-4.7%	#N/A	#N/A	731		yes	no	no
29	Hurks	1		Not certified	41	no					no		yes	no	no
30	Nijhuis	1		Not certified	41	no					#N/A		no	no	yes
31	Plegt Vos Infra	1		Not certified	41, 42	CO_2/FTE	2009-2020	-3.0%	#N/A	#N/A	#N/A		yes	no	no
32	Ten Brinke	1		Not certified	41	no					No		no	no	no

[1] Number of interviewees.
[2] NACE codes: 27 = manufacture of electrical equipment, 35 = electricity, gas, steam and air conditioning supply, 38 = waste collection, treatment and disposal activities; materials recovery, 41 = construction of buildings, 42 = civil engineering, 43 = specialized construction activities, 62 = computer programming, consultancy and related activities 71 = architectural and engineering activities; technical testing and analysis (EC, 2008).
[3] CO_2 = volume target for CO_2 emission reduction, CO_2/FTE = CO_2 emission reduction target measured against Full Time Equivalents, man hours or productive hours, CO_2/M€ = CO_2 emission reduction targets measured against turnover or production value.
[4] Annual emission reductions in the period 2009-2013.
[5] 2010.
[6] Rolling base year.
[7] Weighted average emission reductions using the CO_2 footprint in 2012 as a weight.

The target population consisted of 57 firms, out of more than 500 certified companies (date: February 2014). Thirty-three companies, which were randomly selected from the target population, were contacted to participate in the research. Finally, a sample of twenty-five firms was selected; six firms were rejected because a new CO_2PL coordinator was recently appointed and two firms were not willing to participate. Table 5.2, shows the company profiles of the sample. Most companies had construction and civil engineering as their main activity[37]. All companies were classified as large companies since they generally exceed the criteria for small and medium-sized enterprises according to CEC (2003)[38].

A mixed methods approach (Saunders et al., 2009) was used to investigate whether the CO_2PL has significant effects on the energy and carbon management in the involved companies. Some part of the data, such as the energy saving and CO_2 emission reduction measures, CO_2 emission reduction targets, and CO_2 footprints were collected by reviewing relevant company documents, such as corporate energy management plans, annual reports and CO_2PL progress reports. 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. The interviewees held varying positions such as Sustainability, Health, Environment and Quality (SHEQ) manager, sustainability officer, environmental coordinator, director, energy consultant etc. In total twenty-seven interviews with thirty-four representatives of twenty-five certified companies were conducted in the period from March 2014 until July 2014. Most of these interviews were conducted by alternating couples of interviewers. In December 2014, seven additional interviews were conducted with non-certified companies, see Table 5.2. 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). The semi-structured interviews, that typically took 100 to 120 minutes, 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 section 5.2). The transcripts were coded, cross checked and categorized for further textual analysis by using QSR NVIVO 10 software package (QSR, 2012). In section 5.5, 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', '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 5.2 to maintain participant anonymity.

[37] The turnover of the top 50 construction and civil engineering companies was 32 billion euros in 2012 (Cobouw, 2013). The construction industry emitted 1.4 Mtons of CO_2 from stationary and mobile sources in 2013, excluding CO_2 emissions from the generation of purchased electricity and supply chain CO_2 emissions. This corresponded to about 0.7% of the national emissions from the Netherlands (CBS, 2014).

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

5.5 Research findings

5.5.1 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 and especially the continuous improvement and reducing your emissions.'* {D}, *'Before we did not have any kind energy management system, so this is a giant step forward.'* {P}, *'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}.

5.5.2 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_2*PL because you cannot bid on ProRail works without a* CO_2*PL certificate and you will lose a lot of revenue.'* {D}, '*You'll have to take part in 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, cost reduction, 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[39]. 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 till 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.

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

5.5.3 Changes in energy management practices

We asked certified companies to evaluate the extent to which several management practices were part of the business operation, thereby distinguishing between the current practices and the practice 1-2 years prior to the introduction of the CO_2PL. The questionnaire was inspired on the method developed by EPA (2014), but we aggregated several energy management practices in the questionnaire. Interviewees could choose whether the energy management practices were fully implemented, implemented on an average level, partly implemented or non-existent. Figure 5.2 shows the results of the before – after comparison of the energy management practices.

Figure 5.2: Participant group self-reported changes in energy management practices (n = 25).

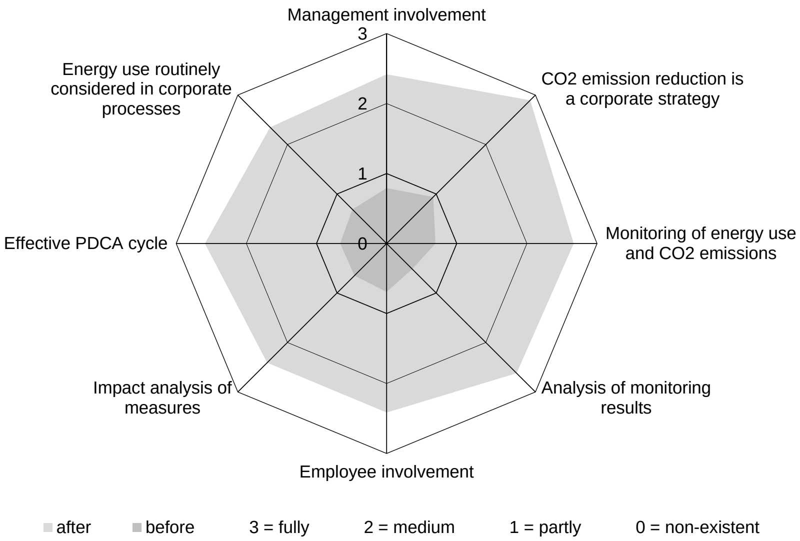


Figure 5.2 reveals that on average almost none of the energy management practices were even partly implemented in the daily business operations prior to the introduction of the CO_2PL. Since the introduction of the CO_2PL this has changed remarkably. In the following paragraphs the changes in energy management practices are discussed in more detail.

5.5.4 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, see Figure 5.2. 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 solely a CO_2 emission reduction strategy.

5.5.5 Appointed energy managers

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. 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.

5.5.6 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 has changed substantially since the implementation of the CO_2PL (see Figure 5.2). 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. 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 reorganisations, 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 paragraph 5.5.8). 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, 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 footprints seemed to be limited among the non-certified companies.

5.5.7 Plan-Do-Check-Act (PDCA) cycle

Certified companies generally agreed that the CO_2PL facilitated the introduction of a 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 Figure 5.2. 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 few 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[40], if available.

Quotes from certified companies that support the importance of developing a 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 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*

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

and then … Act, but there 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}, *'We plan, we implement and we check more and more, but acting … that is something that can certainly be improved. That does not only relate to energy/CO_2, but also to quality and safety.'* {M}. 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}, *'The continuous improvement cycle for energy management has been effective in the past years, but there are certain limits to the continuous improvement since the general measures for CO_2 emission reduction have been implemented.'* {C}.

5.5.8 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 section 5.5.7). 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 5.2 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).

5.5.9 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}, and '*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. Companies generally 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: *'Creating awareness by the* CO_2*PL 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}, *'Employees are talking about it, conscious decisions are being made, it is being taken into consideration.'* {T}, '*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 level, 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}, *'We will certainly reprimand someone if a generator is running without any purpose, since it only costs money.'* {Y}, *'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. That's smart until winter times, when the engine cools down rapidly and the guy cut through the wires of the start-stop system.'* {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.

5.5.10 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 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 comprise 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* (VROM, 1993). 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[41]. 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_2*PL is just the specification of the '*CO_2 *paragraph' in the ISO-14001.'* {G}, *'The* CO_2*PL 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_2*PL 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 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.

5.5.11 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 5.3 shows the categorized measures for energy efficiency improvement and CO_2 emission reduction that were implemented by certified firms. The list of measures was taken from companies' websites, energy management plans and CO_2PL progress reports. 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 tire 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.

[41] 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 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 only affect supporting business processes.

Table 5.3. CO_2 emission reduction measures adopted by certified firms

Measure category - *Subcategory*	Measures implemented			Extent to which the CO_2PL stimulated the adoption
	#	% of total	% of the firms (n = 25)	%
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. We found that, on average, the CO_2PL has stimulated the adoption of CO_2 emission reduction measures to a reasonable extent (50%), see Table 5.3. The adoption of energy efficiency measures was primarily accelerated because of the enhanced insight in energy conservation options and not because of more relaxed investment criteria for energy efficiency or increased technological innovation. Green electricity was particularly stimulated by the CO_2PL, not because the CO_2PL requires companies to have targets for renewable energy, but mainly because green electricity 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.

5.5.12 CO_2 emissions, reductions and goal achievement

The aggregated CO_2 emissions of the 57 companies amounted to 1.6 Mtons in 2012. The CO_2 emissions of these companies decreased by 5.1%/yr on average in the period 2009-2013, of which 90% was achieved in scope 1. This value was estimated by calculating the weighted average of the annual emission reduction rates of the individual companies. The coefficient of the exponential regression line for the available corporate CO_2 emission data was used as the best estimate for the annual emission reduction rate of individual firms. The CO_2 footprint in 2012 was used as the weight. An analysis of goal achievement among 46 companies learned that 72% of these companies complied with the annual reduction rate required to reach the agreed target level. A significant difference of the compliance rates between firms certified at level 3, 4 or 5 could not be observed. The CO_2 emissions of the 25 interviewed companies, their annual CO_2 emission reductions and goal achievement can be found in Table 5.2. Forty-five companies published data to construct CO_2 emission trends (-5.8%/yr) and inflation-adjusted turnover trends (-4.5%/yr) in the past 4-5 years. The difference between these average annual trends (1.3%/yr) can be interpreted as the annual CO_2 emission reduction rate due to energy efficiency improvement and fuel switching.

5.6 Discussion

5.6.1 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 & Rahmesohl (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 top management commitment, increased priority for energy issues, enhanced co-ordinated actions, 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 & Thollander, 2006; Blass et al., 2014; McKane et al., 2010. 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 & Noda, 2014). Our study also confirmed conclusions from Krarup & Rahmesohl (2002) and Backlund et al. (2012) that energy management programmes tend to have little impact on investment criteria of energy efficiency measures.

Despite the various new energy management practices introduced in the certified firms, the impact of the CO_2PL on improving energy management could also be criticized. First, the studied 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 regards to requirements in key topics C and D (see Table 5.1). The above mentioned criticism is in line with Kimura & 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 in a study by Kimura & 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 emphasize of the CO_2PL on continuous improvement of energy management.

We concluded that the CO_2PL stimulated the adoption of energy efficiency and CO_2 emission reduction measures to a reasonable extent (50%), which is similar to the results obtained by Wilbrink (2012) (43%). Research on the CO_2PL by Primum (2012) also concluded that most of the proposed energy efficiency and CO_2 emission reduction measures affected the supporting business processes instead of the companies' core processes.

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. (2012) 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 calculated annual rate of CO_2 emission reduction (5.1%/yr) over the past 4-5 years was way beyond the projected impact of the CO_2PL on CO_2 emission reduction (0.8-1.5%/yr) according to Rietbergen & Blok (2013). The difference was attributed to favourable long-term economic forecast used in Rietbergen & Blok (2013) compared to the actual economic downturn in the past years. The calculated annual CO_2 emission reduction rate due to energy efficiency improvement and fuel switching amounted to 1.3%/yr. A first comparison of these figures with generally accepted values for autonomous energy efficiency improvement of 0.5-1%/yr (EEW, 2013), suggested a net positive impact of the CO_2PL on CO_2 emission reduction. However, firm conclusions cannot be drawn yet due to the lack of sector specific baselines, unknown intra-sectoral structural changes and the debatable use of turnover as a proxy for firms' output.

5.6.2 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 & 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 quantitative research, i.e. evaluating goals achievement mainly relied on the self-reported CO_2 performance data in the base year and in the year 2013. Since CO_2 performance data in the base year must be updated in the case of changes in the organizational boundary, we might expect that conclusions about goal achievement were reliable. The calculated CO_2 emission reductions were based on time series analysis of reported CO_2 emissions in the past 4-5 years, instead of just comparing CO_2 footprints in the base year and the year 2013. We think that the used approach was stronger because the larger amount of data outweighed the errors that might occur due to the varying organizational boundaries of a few firms in the intermediate years.

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. Such a control was not available since all major companies in the construction and civil engineering sector already participated in the CO_2PL. 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 Figure 5.2 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, but nevertheless provided insight in the changes in general energy management practices since the implementation of the CO_2PL. Furthermore, interviewees had difficulties with judging the significance of the CO_2PL on adopting CO_2 emission reduction measures. Obviously, the figures in the last column in Table 5.3 could not be considered as the exact impact of the CO_2PL. However, if translated in qualitative terms, it is considered as a good approximation of the importance of the CO_2PL in taking new energy efficiency and CO_2 emission reduction measures. Although the results of these questionnaires with closed questions may not be very precise in quantitative terms, they certainly supported the research results obtained from the open-end questions and analysis of achieved CO_2 emission reductions.

5.6.3 Programme recommendations

This study illustrated that the CO_2PL has been an important asset for energy and carbon management. However, we have the following recommendations for the scheme owner to maintain the CO_2PL as an effective tool for energy and carbon management. First, the CO_2PL should 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 rather than checking administrative procedures. Third, we recommend to critically evaluating the use of 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.

5.6.4 Recommendations for further research

A qualitative assessment on its own cannot evaluate the impact of a programme (Worldbank, 2010). Because of the strong qualitative approach used in our study, we therefore recommend to conduct an ex-post impact assessment analysing the net quantitative impacts of the CO_2PL on CO_2 emission reduction. Changing energy management practices is often considered as a long-term process. Since the CO_2PL has been in place since just 5 years, we suggest carrying out a longitudinal study evaluating the impacts of the CO_2PL on improving energy management in the longer term. 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. We therefore recommend studying the impact of the

CO_2PL on managing supply chain CO_2 emissions, which up till now has been an unexplored topic.

5.7 Conclusions

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 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 improvements in energy management practices were still administrative in nature, further implementation of energy management practices at lower levels in the organization has gradually started. Second, companies have mainly implemented energy efficiency and CO_2 emission reduction measures that affected supporting business processes instead of companies' core processes. 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, since the introduction of the CO_2PL CO_2 emissions have decreased by 5.1%/yr of which a large part can be attributed to a loss of turnover. Nevertheless, the CO_2PL seems to have enhanced CO_2 emission reductions among the involved firms. 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 among construction and civil engineering firms that would not have achieved by other contextual drivers solely. However, maintaining the CO_2PL as an effective tool for energy and carbon management requires more focus on genuine energy management practices, stronger PDCA cycles, and more effective procurement procedures.

Acknowledgements

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Chapter 6

Do agreements enhance energy efficiency improvement? - Analysing the actual outcome of Long-Term Agreements on industrial energy efficiency improvement in the Netherlands

Martijn G. Rietbergen, Jacco C.M. Farla, Kornelis Blok

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Abstract
Since 1992 Long-Term Agreements on Energy Efficiency have become the main policy instrument for energy conservation in the Netherlands. This article investigates whether these agreements bring about improvements in energy efficiency additional to those that would occur anyway, were there no such agreements. The major part of the article explores two possible methods to isolate the impact of the agreements on energy conservation. The first method, which is based on a bottom-up approach, assesses the actual outcome by analysing the effects that changes in the firms' investment behaviour have on industrial energy conservation. The second method, which is based on a top-down approach, assesses the actual outcome by comparing the monitored energy efficiency improvements with modelled, estimated efficiency improvements in the 'business-as-usual case'. The main conclusion is that between a quarter and a half of the energy savings in the Dutch manufacturing industry can be attributed to the agreements.

6.1 Introduction

Since 1992 government and the industry in the Netherlands have been concluding Long-Term Agreements (LTAs) on energy efficiency improvement. Such agreements between government and business are voluntary and are commonly perceived as a promising and (cost)-effective alternative to traditional regulation (CEC, 1996; IEA/OECD, 1997). However, it is not yet known with certainty that voluntary agreements really enhance energy efficiency improvement.

Several evaluations of the agreements' impact on energy efficiency improvement in the Netherlands have been carried out, see e.g. Farla & Blok (2002), Korevaar et al. (1997), EZ (annual). These evaluations were concerned mainly with the question of whether the agreements achieved their targets. However, so far few attempts have been made to assess whether the agreements lead to improvements in energy efficiency additional to those that would have come about anyway. Literature shows that up till now quantitative evidence for additional effects of the agreements is limited due to the following reasons. First of all, there appears to be a general lack of baselines against which to assess agreements. Case study results from a research project on the effectiveness of six environmental agreements by EEA (1997) show that in the majority of cases there were no quantitative data available from which to determine the baseline. In only one case there was (limited) quantitative evidence pointing to the agreement's effectiveness. Another difficulty is how to disentangle the effect of the different instruments in the policy mix aimed at energy conservation (Korevaar et al., 1997). For example, energy price policy, taxes and subsidies and environmental policy instruments can distort the impact assessment of the agreement. Furthermore, it is often difficult to distinguish energy efficiency improvement from structural changes in the economy, like de-materialisation and intersectoral and intrasectoral shifts (Farla & Blok, 2000; Eichhammer & Jochem, 1998).

This article explores two possible methods to isolate the actual outcome of the agreements[42]. The first method, based on a three-step *bottom-up approach,* analyses the actual outcome of the voluntary agreement by investigating the additional investments (and related energy savings) made by the manufacturing industry. It thereby tackles the problems relating to the disentanglement of the policy mix. In this study, the LTA is considered as a complex of policies in which the energy covenant is the main element. The supporting measures like subsidies and fiscal incentives are assumed to be an integral part of the LTA policy mix, whereas complementary effects of combined heat and power generation and environmental policies are not attributed to the LTAs. The second method, based on a *top-down approach*, attempts to assess the actual outcome of the agreements by comparing the monitored energy efficiency improvement with modelled, estimated efficiency improvements in the business-as-usual case. The business-as-usual case reflects the energy efficiency improvement arising from technological or operational changes in the absence of agreements and other environmental policy instruments.

The outline of the paper is as follows. Section 6.2 describes the Long-Term Agreements on energy efficiency in the context of the industrial energy conservation policy and explains how the LTAs relate to supporting measures and complementary policies. In section 6.3 the three-step bottom-up approach is developed to analyse how changes in investment behaviour affect energy conservation. Section 6.4 derives estimations of the energy efficiency improvement in the business-as-usual case from a model that simulates investment of firms in energy saving technologies. Section 6.5 summarises the main conclusions and gives suggestions how further research can improve the analysis of the actual outcome of voluntary agreements.

6.2 Long-Term Agreements on Energy Efficiency

As a result of increasing environmental awareness in the late eighties the Dutch government decided to give stronger and new policy impulses to energy conservation and the application of renewable energy resources. This decision was embodied in new measures, including Long-Term Agreements, announced in the National Environmental Policy Plan (VROM, 1989) and the First Memorandum on Energy Conservation (EZ, 1990). The goal set by the government was to stabilise national CO_2 emission in 1994-1995 at the 1990 level and reduce CO_2 emissions by 3-5% by the year 2000 relative to 1989/1990. In order to achieve these environmental objectives, the manufacturing industry had to make a substantial contribution towards reducing energy consumption. In the First Memorandum on Energy Conservation the target formulated for the manufacturing industry was a 20% energy efficiency improvement[43] by the year 2000 relative to 1989. On the basis of new economic growth forecasts this target was lowered to 19% in the Second Memorandum on Energy Conservation (EZ, 1993). The objective for industrial energy efficiency improvement could be achieved by means of the measures in the following energy

[42] This paper and the paper by Farla & Blok (2002) are both to a large extent based on the results of an evaluation study commissioned by the Ministry of Economic Affairs (Glasbergen et al., 1997). This paper evaluates the agreements' ability to induce supplementary effects, whereas the paper by Farla & Blok (2002) assesses the monitoring methodologies and the quantitative results of the agreements.

[43] Excluding feedstocks.

conservation programme (EZ, 1993). However, an absolute precondition for those improvements was the availability of an effective set of supporting instruments.

6.2.1 Energy conservation programme for the manufacturing industry

Since the introduction of the Second Memorandum on Energy Conservation the LTAs have become the crux of the national energy policy. The LTAs are considered as one of the three tracks leading to energy conservation in the manufacturing industry. The LTAs are concluded with energy intensive industrial sectors (sectoral energy consumption >1 PJ). The agreements cover branches responsible for about 90% of the total energy consumption in the manufacturing industry[44]. Most of the LTAs with manufacturing industry aim at an energy efficiency improvement of 20% in the year 2000 relative to the level in 1989. The second track consists of the 'light manufacturing strategy', designed to achieve energy savings by small enterprises that are responsible for about 10% of the energy consumption in the manufacturing industry. The LTA approach was considered to be unsuitable for small enterprises. The 'light manufacturing strategy' is supported by the business licensing procedure based on the Environmental Management Act. The contribution of the 'light manufacturing industry strategy' to energy conservation in the manufacturing industry (in terms of saved energy) is however assumed to be limited compared to the impact of the LTAs. The third track is concerned with consolidating the technological base, detailed in technology programmes and in specific schemes to encourage new technologies. This track aims at ensuring the availability of practical conservation options in the longer term. The effects of this track on energy efficiency improvement up till 2000 can also be regarded as limited.

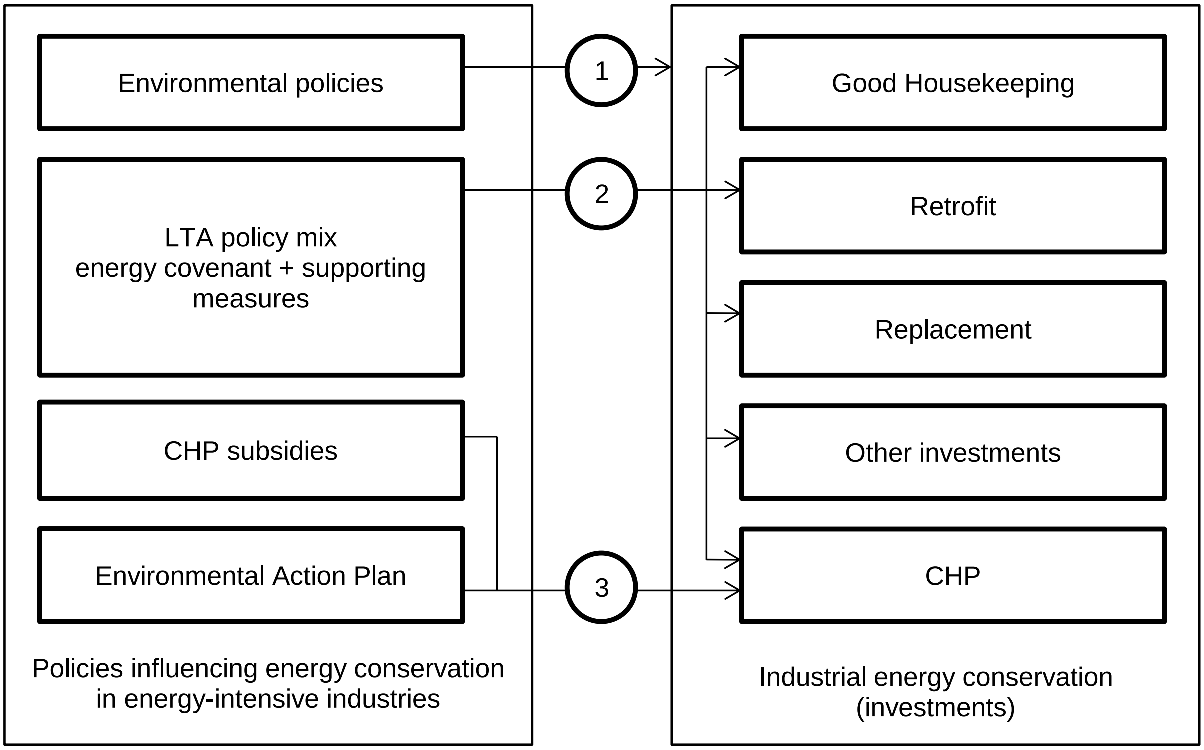
6.2.2 Supporting measures and complementary policies

Besides the LTA (energy covenant) there are several complementary policies and supporting measures that influence energy conservation investments in energy-intensive industries, see Figure 6.1. First of all, there is a set of policy measures which support the implementation of the energy covenant. The supporting measures are particularly relevant but not exclusively available to firms in the LTA scheme. The Second Memorandum on Energy Conservation (EZ, 1993) distinguishes the following set of instruments: 1) Energy management: energy audits and monitoring systems designed to support the firms' energy management. 2) Investment subsidies and fiscal incentives: several subsidy schemes and fiscal incentives introduced to encourage investment in energy saving projects (especially in technologies less familiar to industry), like for example energy recovery and heat pumps; 3) Demonstration: special support schemes drawn up to promote technological innovation; 4) Novem sector programmes: funds made available for the support of energy conservation studies, research & development projects and the support of monitoring and communication. 5) Information and consultancy: various subsidy schemes introduced to encourage firms to use external consultants providing screening, information and consultancy services, including the advisory activities of the energy production and distribution sectors within the framework of the Environmental Action Plan (MAP) and the Environmental Plan for Industry respectively. In this research this set of supporting

[44] A critical assessment of the official monitoring figures and comparison with data from the CBS (annual) by Farla & Blok (2002) suggest that only 72-75% of the industrial energy consumption is covered by the LTAs.

measures is considered to be an integral part of the LTA policy mix which influences the investment behaviour of firms (cf. 2 in Figure 6.1)

Figure 6.1: Policies influencing energy conservation investment in energy-intensive industries



Note: In this study, the LTA is considered as a mix of policies of which the energy covenant is the main element. The energy covenant is supported by accompanying measures like subsidies and fiscal incentives which are assumed to be an integral part of the LTA policy mix. The complementary effects of other energy and environmental policies on energy conservation are not attributed to the LTAs.

Another particular and even more relevant initiative of the MAP is to encourage co-operation between industry and energy distribution companies in the field of industrial combined generation of heat and power (CHP). According to Blok & Farla (1996), these complementary activities of the energy distribution sector and special investment subsidies for CHP (cf. 3 in Figure 6.1) made the most significant contribution to the growth of the CHP capacity in the early nineties. However, LTAs did little to encourage investment in CHP (cf. 2 in Figure 6.1).

Furthermore, industry has to comply with other regulatory policy instruments within the framework of the national environmental policy. These instruments, which closely resemble those used in the industrial energy conservation policy, include environmental covenants, corporate environmental care systems and environmental permits. The environmental permit is considered as a ‘fall-back’ instrument if firms refuse to comply with the LTA. The complementary effects of these environmental policy instruments on energy conservation (cf. 1 in Figure 6.1) are however considered to be limited, since recently these regulatory instruments have paid only little attention to energy issues Glasbergen et al. (1997).

6.2.3 Progress with the industrial LTAs

Up till 1 December 1998 30 LTAs have been concluded with industry[45]. Currently more than 1250 firms are participating in the industrial LTAs. The total primary energy use, excluding feedstocks, covered by the industrial agreements amounted to 556 PJ in 1998. In the period 1989-1998 the total amount of saved energy compared to a frozen efficiency energy consumption was about 117 PJ (EZ, 1999b)[46]. In 1998 the average energy efficiency improvement in 29 industrial sectors[47] amounted to 17.4% compared to the 1989 level, corresponding to an annual average energy efficiency improvement of 2.1%. The results for different clusters of industry, however, vary considerably. The chemical industry, accounting for more than 60% of the energy consumption of the Dutch manufacturing industry, is performing better than average, whereas clusters like light industry and building materials are far behind schedule. If the average results up to the year 1998 are extrapolated, the projected energy efficiency improvement in the year 2000, when most of the LTAs came to an end, will amount to 20.8%. Thus, on the basis of these results the average target of 20% energy efficiency improvement is expected to be within reach.

6.3 Analysis of the effects of changes in investment behaviour on industrial energy conservation

One way to isolate the actual outcome of the LTAs is to investigate the additional investment and the related energy savings made by industry. The following three-step bottom-up method has been developed to estimate the effect that changes in investment behaviour have on industrial energy conservation. In this analysis only the impact of the LTA-policy mix (cf. 2 in Figure 6.1) is taken into account .

6.3.1 Method

First, an inventory is made of all the energy-saving measures taken at sector level. The energy- saving measures are attributed to different investment categories, which have been derived from the classification used in the Dutch annual LTA progress reports, see e.g. VNP (1998), Novem (1996a), Novem (1996b). The LTA progress reports generally distinguish between the following investment categories:

- *Good housekeeping/energy management*. This category concerns energy-saving measures that have a relatively short payback period and do not require large investment.
- *Replacement investments*. These investments are aimed at the replacement, maintenance or extension of industrial equipment. Replacement investments are made primarily for strategic reasons. The profitability of these investments does in general not depend on the energy conservation potential. Energy

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[45] Excluding refineries. See table 1 in the paper by Farla & Blok (2002) for an overview of the long-term agreements on energy efficiency that were contracted up till mid-1998. The LTA with cocoa industry is not included in the table.

[46] The frozen efficiency energy consumption is the amount of energy that would have been used if the energy intensity of (production) processes and activities had not changed. The frozen efficiency energy consumption takes into account structural changes and activity growth within the sectors and firms.

[47] The cocoa industry has recently concluded an LTA. The monitoring results are not available yet and therefore not included in these figures.

conservation, related to these investments, often has a process-integrated character.

- *Energy-saving investments (retrofit)*. Energy-saving investments concern measures aimed primarily at the improvement of energy efficiency. Hence, the profitability of these investments depends largely on the conservation potential of the energy-saving measure. Examples of such investments are insulation, adjustable speed drives and heat recovery.
- *Combined heat and power generation (CHP)*. Investments in co-generation are considered as a separate conservation category, since CHP can lead to a considerable saving of fuel.
- *Other measures*. Finally, some activities come under the heading of ‘other measures’; these include the closing down of firms and NO_x emission reduction measures, which can also improve energy efficiency.

In the second step it is judged whether and to what extent firms’ investments are encouraged by the agreements. The firms’ investment behaviour is assessed from the perspectives of both *experts (a)* and *firm actors (b)*.

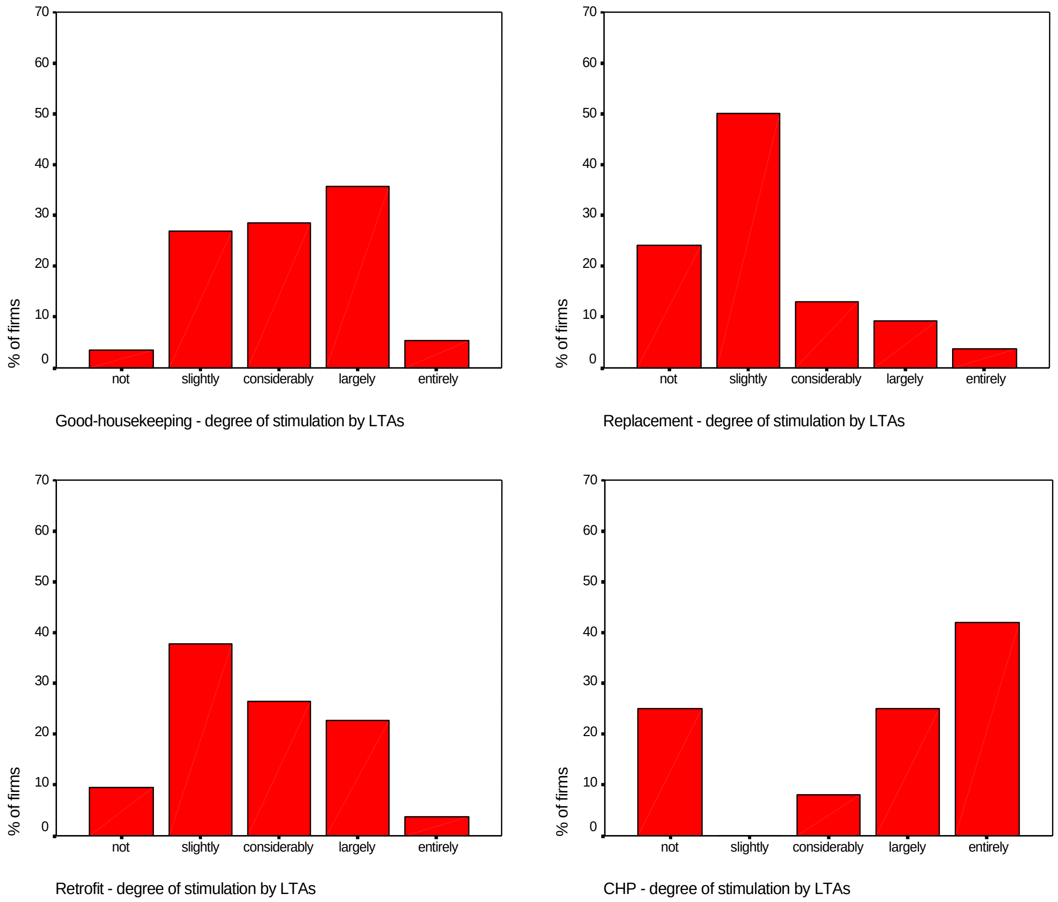
In this study the *expert opinions* about the investment behaviour of firms are judgements made by the research team about the investment behaviour of firms as well as the judgement made by the steering committee of the project ‘Evaluatie Meerjarenafspraken over energie-efficiency’ set up by Glasbergen et al. (1997). In general, the following guidelines for the assessment procedure are observed:

- Investments in energy-saving measures in the category *good housekeeping/energy management* are assumed to be stimulated almost entirely by the agreements, since the measures do not invoke excessive costs; the measures could have been taken anyway.
- Since *replacement projects* are not primarily implemented for the purpose of energy efficiency improvement, these investments are considered to be stimulated only slightly by LTAs.
- According to the experts the investments in *CHP* are promoted to a slight extent (cf. 2 in Figure 6.1), since CHP investment is already considerably encouraged by the MAP drawn up by energy distribution companies as well as by the special subsidies for the promotion of CHP investment (cf. 3 in Figure 6.1).
- Since measures in the category *retrofit investments* are aimed at the improvement of energy efficiency and require considerable investment, the experts assume that these measures are largely stimulated by agreements.
- Investments in the category ‘*other activities*’ are assumed not to be stimulated by the agreements.

In particular cases energy-saving measures can also be ‘considerably stimulated’ by an LTA. For more details on the assessment procedure followed the reader is referred to Glasbergen et al. (1997).

In a survey conducted by de Groot et al. (2001), *firm actors* were asked to assess to what degree agreements have promoted investment in ‘good-housekeeping measures’, ‘replacement projects’, retrofit measures’ and ‘CHP-installations’. The survey yielded a data set for about 60 Dutch firms with an LTA on energy efficiency. The data set includes firms in nine different industrial sectors. Figure 6.2 shows the survey response.

Figure 6.2: Survey response



More than 90% of the respondents point out that energy-saving measures in the category ‘good-housekeeping’ are slightly to largely stimulated by the LTAs. This judgement contrasts sharply with the opinion of the experts, who assume that good-housekeeping measures are stimulated almost entirely by LTAs. According to 50% of the firms replacement investments are stimulated slightly by the LTAs. This result corresponds very closely to the opinion of the experts. The firms are of the opinion that the retrofit investments are slightly to largely stimulated by the LTAs. This differs from the opinion of the experts who assume that the investments are largely stimulated by the LTAs. More than 65% of the firms with a CHP plant indicate that the CHP investments are largely to almost entirely promoted by the LTAs. The survey response contrasts with the opinion of the experts. The high response in the category ‘not’ stimulated can probably be attributed to the fact that a large number of firms had invested in CHP installations before LTAs were concluded.

In the third step the qualitative judgements are translated into a weighting scheme in order to calculate the actual outcome of the LTAs in terms of saved energy. The sensitivity of the weighting scheme is tested by considering a low and a high variant. Table 6.1 shows the three weighting schemes:

Table 6.1: Weighting schemes used in the sensitivity analysis

Degree of stimulation	High	Average	Low
Not stimulated	10%	0%	0%
Stimulated to a slight extent	30%	20%	10%
Considerably stimulated	60%	50%	40%
Largely stimulated	90%	80%	70%
Entirely stimulated	100%	100%	90%

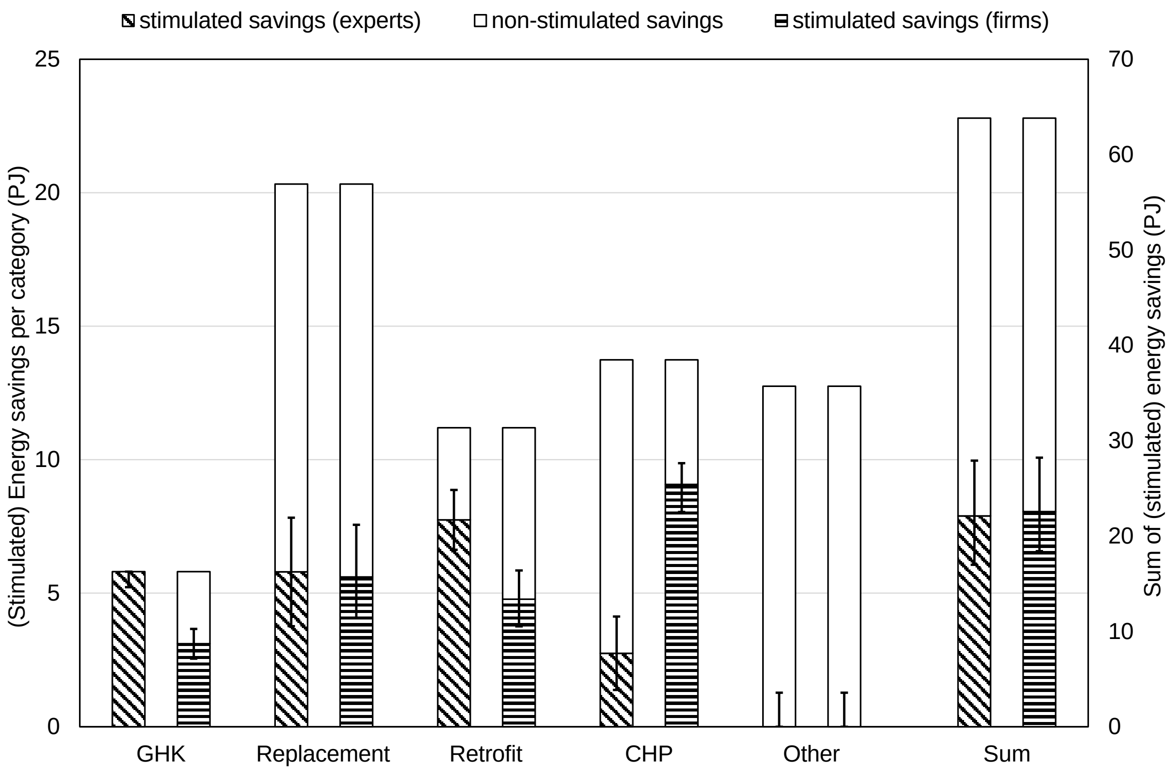
Note: Table 6.1 must be read as follows. The average weighting scheme assumes that 80% of the saved energy is the actual effect of the agreement in the case where investments are 'largely stimulated'. If investments are stimulated to a slight extent, only 20% of the saved energy is encouraged by the agreement, etcetera. The actual effect of all the investments on energy conservation is calculated in this way and aggregated on a sector level.

6.3.2 Results

The method outlined in the previous section was applied to the following five industrial LTAs: chemical industries; paper & board industries; glass industries; iron & steel industries and margarine, fats & oils. In 1996 the share of the five sectors in the energy consumption covered by the 29 industrial LTAs was nearly 80%. The analysis of the effects of changes in investment behaviour on industrial energy conservation covers the period 1989-1996.

The total energy saved in the five evaluated industrial sectors amounted to 64 PJ in the period 1989-1996. The average energy efficiency improvement in the five sectors amounted to about 13.1% in 1996 compared to the level in 1989. This is slightly better than the average result (12.5%) as reported by the Ministry of Economic Affairs (EZ, 1997).

Figure 6.3: (Stimulated) energy savings per conservation category

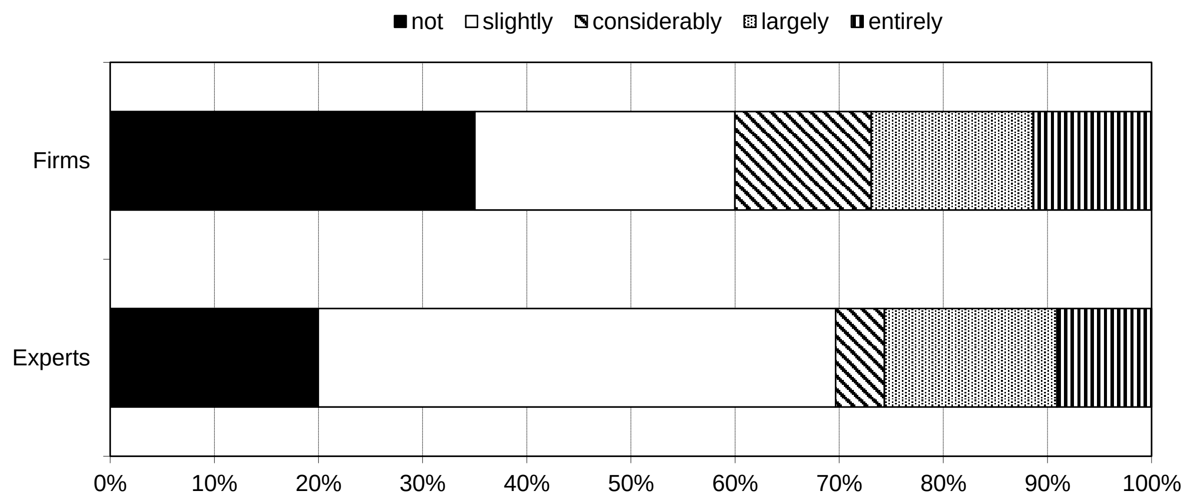


Note: Sum of the energy savings plotted against secondary axis. Error bars indicate the stimulated energy savings when the low and high weighting schemes are used.

Figure 6.3 shows the estimated contribution that energy savings in the five investment categories made to the total savings of the five evaluated industrial sectors in the period 1989-1996. The energy-saving data per investment category were derived from the annual LTA progress reports of the individual sectors (Novem, 1996a; Novem, 1996b; Novem, 1994a; Novem, 1994b; Novem, 1995a; Novem, 1995b; Novem, 1996c; Novem, 1996d; Novem, 1997a; Novem, 1997b; Novem, 1997c; Novem, 1997d; VNP, 1997). Investment in the replacement of existing equipment contributes the most to the overall energy savings (32%). The investment categories ‘retrofit’ (18%), ‘CHP investments’ (22%) and the category ‘other activities’ (22%) contribute almost equally to the overall energy savings. The remaining 9% of the energy savings can be identified as good housekeeping measures.

The investments made in the evaluated industrial sectors were assessed according to the procedure outlined in the previous section. Figure 6.4 shows the aggregated results of the qualitative judgements from the perspective of the firm actors as well as the experts. On the basis of the firms’ and the experts’ judgement, it can be concluded that about 30-40% of the energy savings are considerably to almost entirely stimulated by the LTAs, whereas 60-70% of the total energy savings are slightly or not stimulated by the LTAs. The firms indicated that more than one third of their energy savings are not stimulated at all by the LTAs. The experts are of the opinion that about 50% of the energy savings are slightly encouraged by the LTAs. The stimulated energy savings per investment category are depicted in Figure 6.3. The error bars indicate the stimulated energy savings when the other weighting schemes were used. Large differences between the stimulated savings from the perspective of the firms and the experts can be observed in the investment categories ‘good housekeeping’, ‘retrofit’ and ‘CHP’. The total stimulated savings from both perspectives however do not differ very much. The estimations based on the expert opinions indicate that about *27-44%* (17-28 PJ) of the energy savings can be attributed to the implementation of the LTAs. When the assessment is based on the firms’ survey response, the percentage of energy savings promoted by the LTAs is about *29-44%* (18-28 PJ).

Figure 6.4: Qualitative assessment results (aggregated)



Note: the figure indicates which part of the energy savings is not stimulated or is stimulated slightly, considerably, largely and entirely.

6.3.3 Discussion

The design of the method requires clarification. First, it should be emphasised that, although the overall assessment results do not differ very much, large differences were observed between the firms’ and experts’ judgement regarding industrial investment behaviour. In this respect it is regrettable that the bias in firms’ survey response and possible misinterpretation of survey questions could not be analysed in more detail on the basis of the survey data. Secondly, due to a lack of detailed energy-saving data and information on the purpose of investments the energy-saving measures were classified into only five different categories. A more detailed classification of energy-saving measures (for example distinguishing own CHP and joint venture CHP's) and thus an appropriate assessment would probably have led to more accurate results.

With regard to the quality of the results, it should be mentioned that the results depend for a large part on the energy-saving investments made in the chemical industry. The chemical industry is responsible for more than 70% of the total energy savings in the five evaluated sectors[48]. If the chemical industry is not taken into account the effectiveness of the LTAs ranges from 41-59% (expert opinion) and 35-52% (firms' judgement). Secondly, it should be pointed out that the results are slightly overestimated, since the energy efficiency improvement (1989-1996) in the evaluated sectors is higher (13.1%) than average (12.5%). On the basis of these figures the actual outcome in terms of additional energy savings is assumed to be overestimated by about 5%.

6.3.4 Recommendations

Further analysis of the effects of changes in investment behaviour is in our opinion a promising route for further research. This type of analysis can be further enhanced in the following ways. First of all, we recommend that the definition of investment categories should be improved and the level of detail be increased. As suggested in the previous section this could improve the quality of the results. Secondly, we believe that more systematic surveys should be conducted among firms. Although one has to deal with problems like the stated behaviour of firms, we propose to study in more detail the effects of LTAs on energy efficiency investment behaviour. It would be advisable to take into account the impact analysis of specific supporting measures and complementary policies as well as other incentives for and barriers to further energy efficiency improvement in the survey. Furthermore, we suggest there should be an 'on line' evaluation of the energy conservation projects, since an annual survey would reflect more accurately the dynamic effects of the agreements, such as energy management, technological diffusion and innovation.

6.4 Model-based energy efficiency improvement in the BaU case

An alternative way of isolating the actual outcome of the LTAs is to compare the overall monitored energy efficiency improvement with the energy efficiency improvement in the business-as-usual (BaU) case. The BaU scenario reflects the energy efficiency improvement arising from technological or operational changes that would have taken place anyway, even without the influence of the LTA policy mix. In short, the energy efficiency improvement in the BaU case is estimated by simulating the impact that energy investment behaviour of industrial firms had on energy efficiency improvement in the absence of the LTAs.

[48] In this respect it is regrettable that in this particular sector there are substantial discrepancies between the energy consumption data of LTA monitoring reports and national statistics, see Farla & Blok (2002). This means that the overall results must be regarded as only preliminary.

6.4.1 Method and results

The behaviour of firms with regard to investment in energy-saving measures depends largely on the payback period (PBP) of these investments (Koot et al., 1984). A simple PBP is calculated by dividing the total investment by the annual revenues.

Equation 6.1:

$$PBP = \frac{\text{Total investment}}{\text{Net annual revenues}} = \frac{I}{SEPC - OM}$$

I = Investment costs (Dfl/yr)
SEPC = Annual saved energy purchase costs (Dfl/yr)
OM = Annual operation and maintenance costs (Dfl/yr)

All these costs are compared to the costs in the situation without the energy-saving measure.

Farla & Blok (1995) and de Beer et al. (1995) have derived implementation models to describe the investment behaviour of firms, see Table 6.2. Both models are different interpretations of basic survey data collected by Gruber & Brand (1991) and Koot et al. (1984). The models indicate the percentage of firms that are willing to adopt an energy conservation technology with a cut-off payback period (PBP). For example, de Beer et al. (1995) assume that all firms adopt investments with a PBP of less than 2 years, whereas only 15% of the firms accept investments with a PBP of more than 5 years.

Table 6.2: Implementation models

Model I – Adoption (%)	Payback period (year)	Model II – Adoption (%)
95	<1	100
80	<2	100
55	<3	86
30	<4	56
10	<5	39
0	>5	15

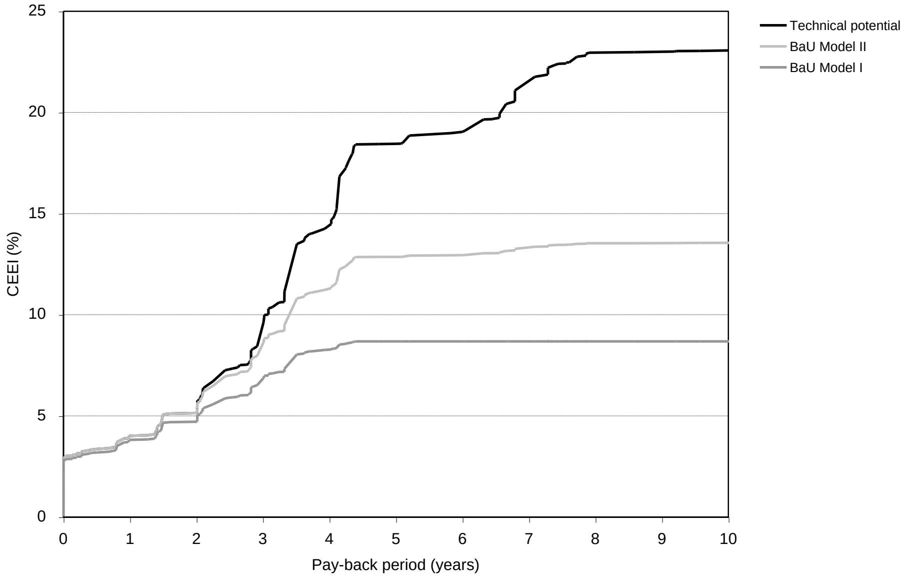
Note: The adoption percentage indicates the fraction of firms willing to invest when the payback criterion is met.
Source: Farla & Blok (1995) for Model I and De Beer et al. (1995) for Model II.

Next, the implementation models are applied to the ICARUS-3 technology database developed by de Beer et al. (1994). ICARUS is an acronym for 'Information system on Conservation and Application of Resources Using a Sector approach'. ICARUS is a database containing information on the saving potential and costs of a large number of both demand-side and supply-side technologies for improving energy efficiency in all sectors of the Dutch economy. The ICARUS database allows us to calculate the industrial potential for energy conservation according to the payback period (PBP) of investments. The European Renaissance scenario and a low energy price scenario were selected for the calculations de Beer et al. (1994)[49]. Power plants were assumed to have an average efficiency of 40% in the year 2000. In Figure 6.5 the cumulative energy efficiency improvement (CEEI) resulting from all the conservation measures

[49] The European Renaissance (ER) scenario is one of the several scenarios composed by the Central Planning Bureau that reflect the expected economic and societal developments (CPB, 1993). The ER scenario assumes an average GDP growth of 2.7% in the period 1990-2000. Due to the uncertainties in the development of the energy prices the Central Planning Bureau distinguishes a low and a high energy price scenario. We have selected the ER scenario and the low energy prices scenario since these scenarios correspond with the trends in the mid-nineties very well.

that can be implemented (technical potential) in the period 1990-2000 is plotted against the PBP.

Figure 6.5: Cumulative industrial energy efficiency improvement (CEEI) versus the payback period



The technical potential for industrial energy conservation in the period 1990-2000 is estimated to be 30% of the projected frozen-efficiency primary energy demand in the year 2000. The energy efficiency improvement achieved by CHP (6.5%) is included in these figures.

The figures in Table 6.2 are used to weigh the energy efficiency improvement of the various techniques available in the database; the efficiency improvements resulting from the investments with a specific PBP are multiplied by the corresponding adoption percentages. The outcome of these calculations corresponds to the energy efficiency improvement in the BaU case. Figure 6.5 shows that the BaU energy efficiency improvement in the period 1990-2000 was estimated to be 9-15% depending on the implementation model used[50]. Subsequently, the annual average improvement can be estimated at 0.9-1.6%. These figures correspond very well to the findings by Grubb et al. (1993). According to Grubb et al. (1993) the average value of the energy efficiency improvement in the BaU case for all the regions in the world amounts to about 1.0%. However, Grubb et al. (1993) mentions that several studies report more optimistic values, amounting to 1.5%.

Comparison of the annual average energy efficiency improvement in the BaU case (0.9-1.6% a year) with the official monitoring figures (1.9% a year) shows that in the period 1989-1996 the effectiveness or in other words the agreements' contribution to the overall energy efficiency improvement was estimated to be *18-53%* (12-33 PJ).

6.4.2 Discussion and recommendations

In this section we discuss the method and the results presented in previous section. First of all, we point to a number of uncertainties concerning the implementation models used in this study. It should be clear that the profitability barrier that is modelled is not the only barrier to investment; other barriers include lack of knowledge and lack of interest in energy efficiency investments. Here, it should be noted that Korevaar et

[50] The BaU energy efficiency improvement according to model II increases from 14% to 15% if investments with a PBP higher than 10 years are also taken into account.

al. (1997) and Glasbergen et al. (1997) suggest that these barriers are precisely the ones tackled by the agreements. Therefore, the BaU energy efficiency improvement is probably overestimated and the environmental effectiveness of the agreements underestimated.

We therefore suggest the use of more complex implementation models that simulate energy efficiency investment behaviour. Currently the PITA-model[51] is being developed by the National Institute of Public Health and the Environment (RIVM, 2000) and it will be accompanied by a new ICARUS-4 version (Alsema, 2000). The aim of the PITA-model is to analyse the effectiveness of policy instruments for energy conservation. The PITA-model takes into account not only the costs and profitability of energy-saving technologies but also the complexity of technologies, knowledge barriers, market demands and attitude of firms regarding environmental issues. In this model it is particularly the investment barriers tackled by the LTA that are taken into account in the analysis of the actual outcome. The first results of this route to improve analysis of the agreements' actual outcome will become available in 2001.

It should also be mentioned that there are uncertainties in the technology database ICARUS. These uncertainties in the database and their effects on the actual outcome of the agreements could however not be assessed within the scope of this study. The reader who needs detailed background information about the technology database ICARUS is referred to de Beer et al. (1994).

6.4.3 Alternative BaU scenarios

As suggested by Korevaar et al. (1997) and EEA (1997) alternative BaU scenarios can be obtained from the trend analysis of the energy efficiency improvements that occurred prior to the LTA. However, in this type of analysis one encounters the same kind of 'disentanglement' problems as already indicated. Moreover, structural changes in the economy, like de-materialisation as well as inter- and intra-sectoral shifts, can also have a significant effect on energy efficiency, especially in the long term (Farla & Blok, 2000). A possible way of tackling these problems is to perform a decomposition analysis, see for example Ang (1995), which can divide energy efficiency developments into various (long-term) trends. Decomposition analysis is however only applicable in the case of long-term analysis and can only be promising if the energy efficiency improvement is sufficiently large. Preliminary results by Rietbergen & Blok (1999) show however that, due to the multitude of parameters and the complexity of the interdependencies, past trajectories cannot simply be extrapolated into the future, unless a thorough impact analysis is made of energy prices and subsidies for energy conservation.

6.5 Conclusions and recommendations

In this article we have investigated whether the Dutch LTAs are able to make additional contributions to energy efficiency. We did this by making different estimates of the agreements' actual outcome. The main conclusion of this research is that, although the actual outcome has still not been estimated accurately, the agreements on energy efficiency in the Netherlands certainly have had a stimulating effect. The two estimates which are based on the impact analysis of changes in investment behaviour indicate that from the perspective of experts and firms 27-44% and 29-44% of the total energy savings can be attributed to the LTAs. The simulation of investment behaviour shows

[51] PITA stands for Policy Instruments for Technology Adoption.

that about 18-53% of the total energy savings was promoted by the LTAs. As discussed, the lower limit of 18% is considered to be an underestimate.
Thus, both methods lead us to conclude that on average between a *quarter and a half* of the energy savings in the Dutch manufacturing industry can be attributed to the policy mix of Long-Term Agreements and supporting measures. In other words the rate of energy efficiency improvement has increased by 33-100% compared to a situation in which there are no agreements. Apparently, then the agreements are valuable policy instruments for energy efficiency improvement if accompanied by ambitious target-setting, effective supporting measures and reliable monitoring procedures.

In our opinion there are three ways of improving the analysis of the actual outcome of the agreements. First of all we recommend a further analysis of the effect of investment behaviour on energy conservation, since this approach circumvents problems arising from the various instruments in the policy mix. To improve our understanding of the firms' energy investment behaviour, we suggest that more systematic surveys should be carried out among firms and an 'on line' evaluation should be made of energy conservation projects. Secondly, we recommend the development and use of more complex implementation models to simulate investment behaviour. These models should also take into account investment barriers - other than the profitability barrier - which are especially relevant for the LTAs. A promising alternative, not taken into account in this study, might be a micro-panel data analysis. The preliminary results of such a type of analysis performed by Bjørner & Togeby (1999) indicate that it should soon be possible to make more accurate evaluations of the actual outcome of various policy instruments like voluntary agreements.

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Chapter 7

Summary and conclusions

7.1 Introduction

Global greenhouse gas emissions must be reduced drastically to limit global increases in temperature to the relatively safe level of maximum 2 degrees Celsius. In the coming decades, energy efficiency improvement will be the main strategy for reducing energy-related greenhouse gas emissions. Although there is a huge potential for energy efficiency improvement, a large part is not utilized yet. This is caused by various investments barriers that prevent the implementation of energy efficiency measures. The introduction of energy management is frequently considered as a means to overcome several of these kinds of energy efficiency barriers.

The uptake of energy management in firms can be stimulated by introducing wider programmes for corporate energy and greenhouse gas management. These programmes are often a combination of several elements, e.g. energy management obligations; (ambitious) energy or greenhouse gas emission reduction targets; the availability of incentive, support and compliance schemes; and other obligations like public reporting, certification and verification. Up till now there is however limited insight in the process of setting ambitious energy efficiency or greenhouse gas emission reduction goals within these programmes, in the impact of introducing such programmes on improving energy management practices, and in the impact of these programmes on energy conservation or greenhouse gas emission reduction. The main research question of this thesis is formulated as follows:

“What is the impact of energy and greenhouse gas management programmes on improving corporate energy management practices, accelerating energy efficiency improvement and CO_2 emission reduction?”.

In this thesis the first generation of Long-term Agreements on Energy Efficiency in the Netherlands and the CO_2 Performance Ladder are studied as two different cases of energy and greenhouse gas management programmes. The Long-Term Agreements on Energy Efficiency are tailor-made negotiated agreements between the Ministry of Economic Affairs and industrial sectors, aiming at energy savings in the production process of energy-intensive companies. The CO_2 Performance Ladder is a certification programme for energy and carbon management in the Netherlands, mainly adopted by non-industrial firms. Participation can give companies certain competitive benefits in the awarding of procurement contracts.

The remaining parts of this chapter summarize the thesis chapters one by one. The final section draws the general conclusions.

7.2 Setting SMART targets for industrial energy use and industrial energy efficiency

Target-setting is often a key element in industrial energy policies, including various energy and greenhouse gas management programmes. There is a range of characteristics that distinguishes targets from each other, such as the actors involved in the target-setting process, the binding character of the target (binding, semi-binding, voluntary), the target boundary (scope and coverage), the length of the commitment period, the type of base year (fixed or rolling), the target category and type, etc.

The primary goal of Chapter 2 was to develop a taxonomy for categorizing various types of SMART industrial energy use or greenhouse gas emission reduction targets. The taxonomy includes: volume targets (also known as absolute targets); physical efficiency and economic intensity targets (both known as relative targets); and economic targets. Volume targets prescribe that a company or a sector must either limit its total energy use or greenhouse gas emissions to a certain prescribed level or reduce energy use or greenhouse gas emissions by a certain percentage relative to a base year. Physical energy or CO_2 efficiency targets prescribe that firms must either limit the amount of energy use (or greenhouse gas emissions) per unit physical output to a certain level or reduce the amount of energy use (or greenhouse gas emissions) per unit physical output with a certain percentage compared to a business-as-usual case or a base year. Economic energy or CO_2 intensity targets prescribe that firms must either limit the amount of energy use (or greenhouse gas emissions) per unit economic activity or reduce the amount of energy use (or greenhouse gas emissions) per unit economic activity with a certain percentage compared to a business-as-usual case or a base year. The economic activity can be expressed in terms of production value, value added, revenue or sales. Economic targets take into account costs and or revenues of energy saving investments, which help to define the financial burden for individual firms. We distinguish socio-economic targets, profitability targets and ability-to-pay targets.

Chapter 2 also provides a comprehensive overview of the use of targets for industrial energy use or greenhouse gas emission reductions at sector or firm level in past, current, and proposed future policies world-wide. This overview includes approximately 50 different emission permit systems, emission trading systems and voluntary or negotiated agreement schemes.

Finally, Chapter 2 includes an assessment of the various types of targets. The target types are compared with respect to the certainty of the environmental outcome and compliance costs, the targets' relevance for the public and for industry, and their environmental integrity, as well as their complexity and potential for comparison. Volume targets guarantee a (relatively) certain environmental outcome, have high public relevance and are not as complex as other types of targets. Physical efficiency targets lead to environmental improvements with a high level of integrity, allow for (international) comparison of the environmental performance among firms or sectors and have high relevance for industry. Economic targets combine various advantages such as a high level of environmental integrity, high certainty of compliance costs and high relevance for industry. Economic intensity targets do not have clear advantages compared to other type of targets.

7.3 The target-setting process in the CO_2 Performance Ladder

Energy and carbon management programmes, like the CO_2 Performance Ladder, have been increasingly adopted by firms as a response to climate change. These schemes often demand the setting of ambitious targets for the reduction of corporate greenhouse gas emissions. However, only limited empirical insight is available in the way ambitious target levels for corporate greenhouse gas emission reduction are being established. Chapter 3 therefore aims at answering the question 'To what extent does the current target-setting process in the CO_2 Performance Ladder lead to ambitious CO_2 emission reduction goals?'. An exploratory research design was used as the main research approach for this study. Data were collected through interviews with relevant stakeholders, document reviews of the certification scheme, and monitoring reports.

First, the research findings indicated that several certification requirements for setting CO_2 emission reduction targets were not very well defined. As a result, there was no fully harmonised interpretation among the stakeholders (companies, third-party certification agencies, scheme owner, consultants) of the exact scheme's obligations. Second, the research results indicated that the targets were not very ambitious yet, e.g. because CO_2 emission reductions did not require considerable efforts from firms up till now, firms tend to avoid risks of underachievement, the concept of best available technologies was not used as a guiding principle in the process of setting ambitious targets, and some targets are likely going to be met anyway, even without the CO_2 Performance Ladder. Third, the research provided insight in the way independent certifying agencies evaluate the target levels for corporate greenhouse gas emission reduction. There appeared to be a semi-structured procedure among certifying agencies for evaluating the target-setting of greenhouse gas emission reduction goals, but the final assessment whether target levels are sufficiently ambitious was not well-defined. Thereby, external assessments were not always based on the full set of criteria explicitly mentioned in the scheme's requirements.

Overall, we can therefore conclude that the current target-setting process in the CO_2 Performance Ladder does not necessarily lead to the most ambitious corporate greenhouse gas emission reduction goals as yet. Other approaches for setting target levels, such as minimum performance levels, must be considered, to maintain the CO_2 Performance Ladder as a legitimate tool for green public procurement.

7.4 Assessing the potential impact of the CO_2 Performance Ladder on the reduction of carbon dioxide emissions in the Netherlands

The CO_2 Performance Ladder is a certifiable energy and carbon management programme that can also be used as a tool for green public procurement. Green public procurement is often recognized as an effective instrument for reducing energy use and CO_2 emissions in the supply chain of commissioning parties. The question is whether this type of green procurement scheme can contribute significantly to CO_2 emission reductions in the Netherlands. The research question addressed in chapter 4 is 'What is the potential impact of the CO_2 Performance Ladder on the reduction of carbon dioxide emissions in the Netherlands?'. The research was based on several methodologies for ex-ante impact assessments of energy and climate policies. Data were collected from document reviews, such as CO_2 footprints, energy management plans, progress reports and environmental statistics.

At the time of research, more than 190 companies participated in the scheme (halfway 2015 the number is over 650). The majority of these firms belonged to the construction or civil engineering industry. The scheme accounted for at least 1.7 Mt of aggregate CO_2 emissions, corresponding to nearly 1% of national greenhouse gas emissions in the Netherlands. The aggregate CO_2 emissions include direct CO_2 emissions, indirect CO_2 emissions of purchased electricity, heat and steam and indirect CO_2 emissions from private cars used for business travel. Companies participating in the scheme have set different types of CO_2 reduction targets with varying levels of ambition. The three major types of targets for CO_2 emission reduction used are volume targets for CO_2 emission reductions, economic intensity targets, measuring CO_2 emission reductions against turnover and relative targets measuring CO_2 emission reductions against full time equivalents (FTE), worked hours, or productive hours. Very few companies have set physical CO_2 efficiency targets. Table 7.1 shows the average volume-weighted ambition levels for three major target types. Various business-as-usual scenarios were constructed forecasting the turnover and employment in the construction and civil engineering industry. On the basis of these projections, the net annual change in CO_2 emission was estimated under the assumption that companies would fully comply with the targets, see Table 7.1.

Table 7.1: Average weighted ambition level and projected net annual change in CO_2 emissions compared to emissions in the base year 2010 for three target types

Target type	Average weighted ambition level	Projected net annual change in CO_2 emissions		
		Average	High	Low
CO_2	-2.1%		-2.1%	
CO_2/FTE	-2.8%	-2.2%	-1.5%	-2.5%
CO_2/€ turnover	-2.0%	1.0%	2.2%	0.3%
Total		-1.3%	-0.8%	-1.5%

Overall, we conclude that the potential impact of the CO_2 Performance Ladder on reducing CO_2 emissions is in the range of 0.8%/yr to 1.5%/yr, with a most likely value of 1.3%/yr. The CO_2 Performance Ladder could therefore contribute significantly to achieving the annual CO_2 emission reduction rate necessary to remain below the Dutch emission ceiling for sectors not belonging to the European Union Emission Trading Scheme from 2010 until 2020 (-1.4%/yr). In absolute terms, the contribution of the CO_2 Performance Ladder to bridging the emission gap for sectors not belonging to the European Union Emission Trading Scheme is not yet significant because currently only a small portion of CO_2 emissions from these sectors is covered by the scheme.

7.5 The impact of the CO_2 Performance Ladder on improving energy and carbon management in construction and civil engineering firms

Energy and carbon management programmes, like the CO_2 Performance Ladder, are being implemented to facilitate continuous energy efficiency and carbon performance improvement in participating firms. Among the 500 participating companies (halfway 2015 the number is over 650), mainly from the construction and civil engineering sector, the CO_2 Performance Ladder is often considered as the major stimulant for energy efficiency improvement and CO_2 emission reduction. Chapter 5 addressed the question: ‘What is the impact of the CO_2 Performance Ladder on improving energy and carbon management in construction and civil engineering firms’. The research was primarily based on interviews, descriptive analysis of energy efficiency and CO_2 emission reduction measures and quantitative analysis of CO_2 emission reductions.

Our study revealed that the CO_2 Performance Ladder stimulated a wide range of energy management practices such as stronger top management commitment; increased priority for energy issues’; improved Plan-Do-Check-Act cycles for energy management; improved insight in CO_2 emissions, performance and reduction options; and increased employee awareness. A wide range of potential energy efficiency barriers has therefore been tackled. Though, the CO_2 Performance Ladder has mainly improved energy management practices at administrative level, while implementation of energy management practices down-stream in the organization has just gradually started. Companies have implemented various CO_2 emission reduction measures that can be categorized as green mobility measures, green electricity, efficient (use of) machinery, more efficient production of materials, energy saving in buildings, renewables, and other measures. Companies have mainly adopted measures that affect the supporting business processes instead of the companies’ core processes.

The CO_2 Performance Ladder has particularly stimulated green electricity purchasing and the adoption of various behavioural energy efficiency and CO_2 emission reduction measures. Over the past 4-5 years CO_2 emissions have decreased by 5.1%/yr, which is way beyond the projected impact of the CO_2 Performance Ladder on CO_2 emission reduction (0.8-1.5%/yr) calculated in chapter 3. The large difference was attributed to favourable long-term economic forecast used in Chapter 3 compared to the actual economic downturn in the past years. However, the CO_2 Performance Ladder still seems to have enhanced CO_2 emission reductions among the participating companies in addition to the steep CO_2 emission reductions due to the activity losses in the past years.

Overall, we conclude that, driven by the potential competitive advantage in contract awarding, the CO_2 Performance Ladder has been responsible for a strong shift towards more mature energy management among construction and civil engineering firms that otherwise would not have occurred.

7.6 Do agreements enhance energy efficiency improvement?

Negotiated energy agreement are commonly perceived as a promising and (cost)-effective alternative to traditional regulation. However, it is not yet known whether such agreements really enhance energy efficiency improvement. In Chapter 6 we therefore study the Long-Term Agreements on Energy Efficiency, that have been an important policy instrument for industrial energy conservation in the Netherlands for already several decades. We will address the question: ‘What is the impact of the Long-term Agreements on accelerating energy efficiency improvement in the Netherlands?’. In this chapter, we specifically focus on the first generation of Long-Term Agreements in the period 1992-2000. These agreements were one of the first examples of energy covenants between government and industry in the world, making it an interesting topic of research. Other type of agreements on energy efficiency would prolong the first generation of Long-Term Agreements at a later stage. The research was based on several methodologies for impact assessment of energy and climate policies. Data were mainly collected from monitoring reports and interviews.

This chapter describes two approaches (bottom-up and top-down) developed to isolate the impact of the Long-Term Agreements on Energy Efficiency. The first bottom-up method isolates the impact of the Long-Term Agreements by making an estimate of the additional energy conservation investments and the associated energy savings. The energy conservation measures (and related savings) are first assigned to one of the following categories (in brackets the share in the total amount of energy saved): good housekeeping measures (9%), replacement investments (32%), energy efficiency and retrofit measures (18%), combined heat and power (22%) and other measures (22%). Subsequently, both experts and companies assessed to what extent different energy conservation investments categories have been encouraged by the Long-Term Agreements. For example, the Long-Term Agreements have ‘strongly’ encouraged retrofit measures, while replacement investments have been encouraged only ‘slightly’. By assigning weights to the different ‘degrees of stimulation’, we could finally calculate the amount of stimulated energy savings for each category and hence the overall impact of the Long-Term Agreement on improving energy efficiency. The alternative top-down method isolates the impact of Long-Term Agreements by comparing the achieved energy efficiency improvement (-2.1%/yr in the period 1989-1998) with estimates of the energy efficiency improvement in the business-as-usual scenario (0.9%/yr - 1.6% /yr). The estimates of energy efficiency improvement in the business-as-usual scenario were based on model simulations.

The main conclusion is that between a quarter and a half of the energy savings in the Dutch manufacturing industry can be attributed to the agreements. In other words, the rate of energy efficiency improvement has increased by 33-100% compared to a situation in which there were no agreements.

7.7 Overall conclusions

The overall conclusions related to the three research questions in this thesis are the following:

1. *How can ambitious targets for energy efficiency improvement and greenhouse gas emission reduction in programmes for energy and greenhouse gas management be established?*

Establishing ambitious targets for improving corporate energy efficiency or reducing greenhouse gas emissions requires clearly specified guidelines. Target-setting approaches that lack well-defined concepts, requirements and clear assessment procedures for evaluating target levels, do not lead to the most ambitious corporate targets and must therefore be avoided. The target-setting process in the CO_2 Performance Ladder is in this respect a clear example of what not to do when aiming for ambitious target levels.

Energy and greenhouse gas management programmes must therefore use approaches for establishing target levels that are better aligned with suggested criteria for ambitious goals: targets should substantially go beyond business-as-usual projections, must be aligned with climate targets, must be based on the adoption of best available techniques, and must require considerable effort in economic or financial terms (WRI, 2013; Edvardsson-Björnberg, 2013). This implies that target levels should include obligations that for example require minimum performance levels (Scheihing et al., 2013), follow science based target-setting approaches (Krabbe et al., 2015), are based on benchmarking of energy efficiency measures (SKAO, 2015), or require the implementation of profitable energy saving measures (Agentschapnl, 2013). Though it must be acknowledged that also these approaches may have their drawbacks, e.g. with respect the enforceability, see e.g. CE et al. (2011).

A wide variety of quantitative targets for energy efficiency improvement and greenhouse gas emission reduction can be established, including absolute targets, relative targets and economic oriented targets. It is often suggested that in the case of relative targets uncertainties with respect to compliance costs of companies are reduced in comparison with absolute targets, which may lead to more ambitious targets (van Vuuren et al., 2002). In this study we found that this is true for CO_2 emission reduction targets measured against labour input. Contrary, CO_2 emission reduction targets measured against turnover, which is a more commonly used indicator for measuring activity, appeared to be less ambitious (i.e. have lower impacts) than volume targets.

2. *What is the impact of energy and greenhouse gas management programmes on improving energy and greenhouse gas management in practice?*

Programmes for energy and greenhouse gas management can considerably enhance energy management practices, such as top management commitment, increased priority for energy issues, enhanced co-ordinated actions, improved insight in CO_2 emissions, performance and reduction options, and target-setting. These programmes are an extra impetus for energy and greenhouse gas management compared to existing energy and climate policy instruments, certification schemes and societal trends for sustainability.

In general our conclusions are in line with the existing literature on the impact of energy and greenhouse gas management programs, see e.g. Backlund et al. (2012), Krarup & Rahmesohl (2002), Stenqvist et al. (2011), Kimura & Noda (2014), Harrington et al. (2014). All these studies have addressed positive impacts to the introduction of such energy and greenhouse gas management programmes on improving energy management practices in primarily industrial sectors. Our study thus adds that such programmes can also for non-industrial firms have a serious impact on improving energy management.

However, a strong incentive, like the potential competitive advantage in contract awarding, is necessary as a driving force for continuously improving corporate energy management. These latter findings strongly confirm earlier observations from e.g. Krarup & Rahmesohl (2002), Rezessy & Bertoldi (2011) and Reinaud et al. (2012) on the need to embed energy management systems in wider governmental or sectoral energy management programmes (including voluntary agreement schemes) to be effective.

Furthermore, we have found that energy and greenhouse gas management programmes can stimulate the adoption of additional energy conservation measures in at least the short to medium long term. The magnitude of the additionality which is in the range of 25-50%, is confirmed by other studies, see e.g. Ericsson (2006), Cahill & Gallachóir (2012), Stenqvist & Nilsson (2012), Ecorys (2013). Particularly green electricity purchasing and the adoption of various behavioural energy efficiency and CO_2 emission reduction measures have been stimulated in the studied companies. Though, in general most of the implemented measures are relatively easy and low-cost energy savings measures that affect supporting business processes rather than more challenging energy saving measures in the core process. These results are difficult to compare with other studies, that did not use such a detailed breakdown of energy saving measures or covered other type of sectors.

In the longer term, it remains to be seen if energy management programmes can also further internalize energy management in the companies' organization that goes beyond the administrative level or whether the focus is mainly on procedural conformity as is often suggested in the context of environmental auditing, see e.g. Boiral (2007), Heras-Saizarbitoria et al. (2013). More intensive third party compliance audits are therefore needed that guarantee the implementation of genuine energy management practices. The alternative is that programme owners or regulatory authorities steer stronger on achieving energy efficiency improvement or CO_2 emission reduction targets.

3. *What is the impact of energy and greenhouse gas management programmes on energy efficiency improvement and greenhouse gas emissions reduction?*

Programmes for energy and greenhouse gas management can have an impact on improving energy efficiency and reducing greenhouse gas emissions. In the energy and greenhouse gas management programmes considered in this study we found that both energy efficiency and relative CO_2 emission reductions were enhanced within a range of 0.3%/yr - 1.0%/yr beyond autonomous improvements. Such programmes for energy and greenhouse gas management can therefore make an important contribution to achieving national energy and climate objectives. However, the values for enhanced energy efficiency improvement are not sufficient to double the rate of energy efficiency improvement, which is necessary to limit global temperature rise to no more than 2 degrees (Rogelj et al., 2013). The estimated relative CO_2 emission reduction rate (1.3%/yr) is also far from sufficient to meet sector specific CO_2 intensity pathways for stabilizing greenhouse gas emissions in the atmosphere to around 450 ppm in 2050. The sector specific CO_2 intensity pathway for the category ‘other industrial sectors’, that also includes the construction and civil engineering sector, requires more than 5%/yr CO_2 intensity reduction from 2015 until 2050 (Krabbe et al., 2015). Therefore the impact of these programmes must be further reinforced, e.g. by aligning corporate greenhouse gas emission reduction targets with climate goals (Krabbe et al., 2015), by engaging the supply chain companies in reducing CO_2 emissions (Reinaud et al., 2012), and stronger regulatory threats in the case of non-compliance (Price, 2005; Rezessy & Bertoldi, 2011).

Overall, it can be concluded that programmes for energy and greenhouse gas management can be an effective tool for improving energy management practices, stimulating adoption of additional energy conservation measures, and accelerating energy efficiency improvement or reducing greenhouse gas emission beyond business-as-usual in at least the short-to-medium long term. To guarantee higher impacts of such programmes in the longer term, it is necessary that these programmes are accompanied by clear procedures for setting ambitious targets for energy efficiency improvement or reducing greenhouse gas emissions; that strong incentive and supporting schemes are available; and that clear and effective compliance procedures for genuine energy management practices are in place.

7.8 Closing remarks

- From a methodological point of view this thesis contributed to the literature by developing a bottom-up methodology for assessing the impact of energy and greenhouse gas management programmes. Estimates of the programme impact are based on the rated additionality of individual energy conservation measures and their savings. Although such methodologies can also be debated, e.g. because the self-rated additionality may be biased, they are an important addition to existing assessment methodologies that use top-down approaches.
- In this study we evaluated the results and impacts of the first generation of Long-Term Agreements on Energy Efficiency in the Netherlands in the period 1992-1998. More recent progress reports from the newer Long-Term Agreements show that the rate of energy efficiency improvement in the production process in the same sectors investigated in this study remained at a similar level of 1.8%/yr in the period 1998-2007, but declined to 1.3%/yr in the period 2009-2013 (RVO, 2014, SenterNovem, 2008). More recently also the second and third generation of thesis Long-term agreements have been evaluated (Ecorys, 2013; Arentsen, 2004). According to Ecorys (2013) participants attributed 60% of the energy savings to the Long-Term Agreements. However, Ecorys (2013) also claims that this value is likely overestimated and that the impact is rather limited, amongst others because participants also agree that 60-80% of the investments would have been taken anyway also without the Long-Term Agreements. Arentsen (2004) concludes that the industrial Long-Term Agreements have had an additional impact of 1.4%/yr energy-efficiency improved compared to average domestic energy efficiency improvements in the period 1989-2002.

7.9 Recommendations for further research

Based on the research presented in this thesis we suggest the following routes for further research to improve the understanding of energy and greenhouse gas management programmes:

- The comparison of energy and greenhouse gas management programmes remains difficult due to differences in the design, target types and reporting requirements, see for example Rezessy & Bertoldi (2011) for an overview of results and impacts of several voluntary agreement programmes. Furthermore, research on the impact of energy and greenhouse gas management programmes did not always appear to be comparable, since different assessment methods, tools and indicators were used, ranging from simple questionnaires, in depth interviews (both used in our study), to more extended energy maturity matrixes and even questionnaires with over 100 questions (e.g. Backlund et al., 2012; Carbon Trust, 2011; Harrington et al., 2014). In this respect, very long questionnaires to measure impact are not very suitable for large-scale research requiring a high response rate. We could further learn from a cross-programme comparison, by using a more harmonized approach for assessing impacts of energy management programmes. We therefore recommend to develop such a standardized methodology and carry out comparative research on the impact of various energy management programmes on improving energy management practices, the successes and failures of such programmes and the cost-effectiveness.
- In this study we only considered the impacts of energy and greenhouse gas management programmes on improving internal energy and greenhouse gas management practices, energy efficiency and CO_2 emission reduction. However, the potential for energy efficiency improvement and CO_2 emission reduction in the supply chain is probably much larger. Up till now this has been a rather unexplored topic, except for studies like Ecofys (2012) and DHV (2009). We therefore recommend studying the use of energy management (systems) in reducing supply chain CO_2 emissions, thereby mainly focusing on the impacts in terms of CO_2 emission reductions versus the design features of such supply chain initiatives (see IIP/Ecofys (2012) for various supply chain initiatives promoting energy savings and greenhouse gas mitigation). The CO_2 Performance Ladder could serve here as a case study since it also explicitly sets requirements to managing supply chain CO_2 emissions.
- A question that also needs more attention in future research is how the impact of energy and greenhouse gas management can be sustained within companies. Therefor we suggest to further study the relationship between energy management and the barriers for energy efficiency improvement in more detail. Such a study might provide fruitful proposals for designing more effective energy management programmes.
- In relation to the previous point we also suggest to focus future research on the question how good energy management practices can be further internalized within the companies' organization. Most research up till now focused on analysing the rather administrative, organizational and technical aspects of energy management practices. However, energy management also includes behavioural actions necessary for the continuous improvement of energy performance. Future research should focus on the question how various levels of staff can effectively be engaged in energy management (systems) to reach

tangible impacts in the long term. It is suggested that in-depth case studies are carried out in companies, involving a wide range of different staff.

Hoofdstuk 7

Samenvatting en conclusies

7.1 Inleiding

De wereldwijde uitstoot van broeikasgassen moet drastisch worden teruggebracht om de mondiale stijging van de temperatuur tot het relatief veilige niveau van maximaal 2 graden Celsius te beperken. In de komende decennia zal de verbetering van de energie-efficiëntie de belangrijkste strategie zijn voor het verminderen van de energie-gerelateerde uitstoot van broeikasgassen. Hoewel er een enorm potentieel is voor verbetering van de energie-efficiëntie, wordt een groot deel daarvan nog niet benut. Dit wordt veroorzaakt door diverse investeringsbarrières die de invoering van maatregelen voor energie-efficiëntie verbetering verhinderen. De invoering van energiemanagement wordt vaak beschouwd als een manier om dergelijke barrières voor energiebesparing te overwinnen.

De invoering van energiemanagement in bedrijven kan worden gestimuleerd door de introductie van programma's voor energie-efficiëntie verbetering en vermindering van de uitstoot van broeikasgassen. Deze programma's zijn vaak een combinatie van verschillende elementen zoals verplichtingen voor energiemanagement; (ambitieuze) doelstellingen voor energiebesparing of beperking van de uitstoot van broeikasgassen; de beschikbaarheid van regelingen voor stimulering, ondersteuning en naleving; en andere verplichtingen, zoals openbare rapportages, certificering en verificatie. Tot nu toe is er echter beperkt inzicht in het proces van het formuleren van ambitieuze doelstellingen voor energie-efficiëntie verbetering of het terugdringen van de uitstoot van broeikasgassen binnen deze programma's, in de gevolgen van de invoering van dergelijke programma's op de verbetering van het energiemanagement, en in de impact van deze programma's op energiebesparing of de vermindering van de uitstoot van broeikasgassen. De centrale onderzoeksvraag van dit proefschrift is als volgt geformuleerd:

"Wat is de impact van energie- en broeikasgasmanagement programma’s op het verbeteren van het energiemanagement in de praktijk, het versnellen van de energie-efficiëntie verbetering en het beperken van de uitstoot van broeikasgassen in bedrijven?".

In dit proefschrift worden de eerste generatie van de Meerjarenafspraken voor energie-efficiëntie verbetering in Nederland en de CO_2 Prestatieladder bestudeerd als twee verschillende casussen van programma’s voor energie- en broeikasgasmanagement. De Meerjarenafspraken voor energie-efficiëntie verbetering zijn op maat gemaakte convenanten tussen het Ministerie van Economische Zaken en industriële sectoren, gericht op energiebesparing in het productieproces van energie-intensieve bedrijven. De CO_2 Prestatieladder is een certificeringsprogramma voor energie- en broeikasgasmanagement in Nederland, waar vooral niet-industriële bedrijven aan deelnemen. Deelname kan bedrijven bepaalde competitieve voordelen geven bij de aanbesteding van opdrachten.

De resterende delen van dit hoofdstuk vatten de hoofdstukken in dit proefschrift één voor één samen. In de laatste paragraaf worden de algemene conclusies getrokken.

7.2 SMART geformuleerde doelstellingen voor industrieel energiegebruik en industriële energie-efficiëntie

Het vastleggen van doelstellingen is vaak een belangrijk element in het industriële energiebeleid, met inbegrip van programma's voor energie- en broeikasgasmanagement. Een scala van kenmerken onderscheidt deze doelstellingen van elkaar, zoals de actoren die betrokken zijn bij het bepalen van de doelstelling, het bindende karakter van de doelstelling (bindend, semi-bindend, vrijwillig), de organisatorische grens (scope en dekking), de lengte van de verbintenisperiode, het type basisjaar (vast of rollend), de categorie en het type doelstelling, etc.

Het primaire doel van hoofdstuk 2 was het ontwikkelen van een taxonomie voor het categoriseren van verschillende soorten SMART geformuleerde doelstellingen voor het beperken van het industriële energiegebruik of de broeikasgasemissies. De taxonomie omvat: volume doelstellingen (ook bekend als absolute doelstellingen); doelstellingen voor de fysieke energie-efficiëntie en economische energie intensiteit (beide bekend als relatieve doelstellingen); en economische doelstellingen. Volume doelstellingen schrijven voor dat een bedrijf of een sector het totale energieverbruik of de uitstoot van broeikasgassen beperkt tot een vooraf bepaald niveau of dat het energiegebruik of de uitstoot van broeikasgassen wordt verminderd met een bepaald percentage ten opzichte van een basisjaar. Doelstellingen voor de fysieke energie- of broeikasgasefficiëntie schrijven voor dat bedrijven het energiegebruik (of de uitstoot van broeikasgassen) per eenheid fysieke productie beperken tot een vooraf bepaalde waarde of dat het energiegebruik (of de uitstoot van broeikasgassen) per eenheid fysieke productie met een bepaald percentage wordt verbeterd ten opzichte van business-as-usual of een basisjaar. Doelstellingen voor de economische energie- of broeikasgasintensiteit schrijven voor dat bedrijven het energiegebruik (of de uitstoot van broeikasgassen) per eenheid economische activiteit beperken tot vooraf bepaalde waarde of dat het energiegebruik (of de uitstoot van broeikasgassen) per eenheid economische activiteit met een bepaald percentage wordt verbeterd ten opzichte van business-as-usual of een basisjaar. De economische activiteit kan worden uitgedrukt in termen van de waarde van de productie, toegevoegde waarde, de omzet of de verkoop. Economische doelstellingen houden rekening met de kosten en baten van energiebesparende investeringen, en helpen daarmee de financiële lasten voor de bedrijven en de maatschappij te definiëren. We onderscheiden doelstellingen die rekening houden met de winstgevendheid van de investeringen, de specifieke kosten van de investering en de totale omvang van de investering.

Hoofdstuk 2 biedt ook een uitgebreid overzicht van het gebruik van doelstellingen voor industrieel energiebesparing of broeikasgasemissiereductie op sector- of bedrijfsniveau in voormalig, huidig, en toekomstig beleid. Dit overzicht bevat ongeveer 50 verschillende systemen voor milieuvergunningen, systemen voor emissiehandel, en programma's voor de beperking van het energieverbruik en of broeikasgasuitstoot (inclusief vrijwillige afspraken of convenanten).

Tenslotte bevat hoofdstuk 2 een evaluatie van de verschillende soorten doelstellingen. De doelstellingen worden daarbij vergeleken met betrekking tot de zekerheid van het milieuresultaat en de nalevingskosten, de relevantie van de doelstelling voor de maatschappij en voor de industrie, de milieu-integriteit, evenals de complexiteit en het potentieel voor onderlinge vergelijking. Volume doelstellingen staan garant voor een (relatief) zeker milieuresultaat, hebben hoge maatschappelijke relevantie en zijn niet zo complex als andere soorten doelstellingen. Doelstellingen voor fysieke energie-efficiëntie leiden tot verbetering van de milieu kwaliteit met een hoge mate van integriteit, maken (internationale) vergelijking van de milieuprestaties tussen bedrijven of sectoren mogelijk en hebben een hoge relevantie voor de industrie. Economische doelstellingen combineren verschillende voordelen zoals een hoge mate van milieu-integriteit, een hoge zekerheid van de nalevingskosten en een hoge relevantie voor de industrie. Doelstellingen voor de economische energie intensiteit hebben geen duidelijke voordelen ten opzichte van andere type doelstellingen.

7.3 Het formuleren van CO_2 reductiedoelstellingen in de CO_2 Prestatieladder

Energie- en broeikasgasmanagement programma's, zoals de CO_2 Prestatieladder, worden in toenemende mate door de bedrijven geïmplementeerd als een antwoord op klimaatverandering. Deze programma's vragen vaak van bedrijven dat ambitieuze doelstellingen voor de vermindering van de uitstoot van broeikasgassen worden geformuleerd. Echter, er is slechts beperkt empirisch inzicht in de wijze waarop dit precies gebeurt. Hoofdstuk 3 beantwoordt daarom de vraag 'In hoeverre leidt de huidige manier waarop doelstellingen worden geformuleerd in de CO_2 Prestatieladder ook daadwerkelijk tot ambitieuze CO_2 emissiereductie doelstellingen?'. Een exploratief onderzoeksontwerp werd gebruikt als de belangrijkste aanpak voor deze studie. De gegevens zijn verzameld middels interviews met relevante belanghebbenden, documentonderzoek van het certificeringsschema en de monitoringrapporten voor broeikasgasemissies.

Als eerste laat het onderzoek zien dat een aantal certificatie-eisen voor het formuleren van CO_2 emissiereductiedoelstellingen niet erg goed zijn gedefinieerd. Als gevolg daarvan is er onder de diverse belanghebbenden (bedrijven, certificerende instanties, programma-eigenaar, en externe adviseurs) geen volledig geharmoniseerde interpretatie van de exacte verplichtingen in het programma. Vervolgens laat het onderzoek zien dat de doelstellingen voor CO_2 emissiereductie nog niet erg ambitieus zijn, bijvoorbeeld omdat de vermindering van de CO_2 uitstoot nog geen aanzienlijke inspanningen hebben gevraagd van bedrijven; omdat bedrijven de neiging hebben om risico's van onderpresteren te vermijden; omdat het concept van beste beschikbare technieken niet gebruikt wordt als leidraad voor het bepalen van ambitieuze doelstellingen; en omdat een aantal doelstellingen waarschijnlijk toch gehaald gaan worden, zelfs zonder de CO_2 Prestatieladder. Tenslotte geeft het onderzoek inzicht in de manier waarop doelstellingen voor CO_2 emissiereductie worden beoordeeld door onafhankelijk certificerende instanties. Er blijkt een semigestructureerde procedure te bestaan onder de certificerende instanties voor het evalueren van doelstellingen voor de beperking van de uitstoot van broeikasgassen. Echter, de uiteindelijke beoordeling of de doelstellingen voldoende ambitieus zijn, is niet goed gedefinieerd. De externe beoordeling van de doelstellingen bleek bovendien niet altijd gebaseerd op de volledige set van criteria die expliciet vermeld staan in de eisen van het programma.

Algemeen kunnen we daarom concluderen dat de huidige manier waarop doelstellingen in de CO_2 Prestatieladder worden geformuleerd en vastgesteld niet noodzakelijkerwijs leidt tot de meest ambitieuze doelen voor het terugdringen van broeikasgassen. Andere methoden voor het vaststellen van doelstellingen, zoals minimale prestatieniveaus, moet worden overwogen, om de CO_2 Prestatieladder te handhaven als een deugdelijk instrument voor duurzame aanbesteding.

7.4 Het beoordelen van de potentiële impact van de CO_2 Prestatieladder op de vermindering van de kooldioxide-uitstoot in Nederland

De CO_2 Prestatieladder is een certificeerbare norm voor energie- en broeikasgasmanagement die ook kan worden gebruikt als instrument voor duurzaam aanbesteden. Duurzame aanbesteding van projecten wordt vaak gezien als een effectief instrument voor het verminderen van het energiegebruik en de CO_2 uitstoot in de keten van de opdrachtgevers. De vraag is of dit soort instrumenten voor duurzame aanbesteding ook daadwerkelijk bij kunnen dragen aan de vermindering van CO_2 uitstoot in Nederland. De onderzoeksvraag in hoofdstuk 4 is daarom: 'Wat is de potentiële impact van de CO_2 Prestatieladder op de vermindering van de CO_2 uitstoot in Nederland?'. Het onderzoek gebruikt verschillende methoden en technieken voor de ex-ante effectbeoordeling van energie- en klimaatbeleid. De gegevens zijn afkomstig van documenten, zoals CO_2 voetafdrukken, energiemanagementplannen, voortgangsrapportages en milieu-statistieken.

Op het moment van het onderzoek namen meer dan 190 bedrijven deel aan de CO_2 Prestatieladder (halverwege 2015 zijn dat er meer dan 650). Het merendeel van deze bedrijven behoorden tot de bedrijfstak bouwnijverheid. De CO_2 uitstoot van deze bedrijven is tenminste 1,7 miljoen ton, wat overeenkomt met bijna 1% van de nationale emissies van broeikasgassen in Nederland. De CO_2 uitstoot omvat de directe CO_2 uitstoot, de indirecte CO_2 uitstoot van ingekochte elektriciteit, warmte en stoom en de indirecte CO_2 uitstoot van personenauto's gebruikt voor zakelijke reizen. Bedrijven die meedoen aan de CO_2 Prestatieladder hebben verschillende type CO_2 reductiedoelstellingen geformuleerd met uiteenlopende ambitieniveaus. De drie belangrijkste type doelstellingen voor vermindering van de CO_2 uitstoot zijn volume doelstellingen voor de reductie van CO_2 uitstoot, doelstellingen voor de economische energie intensiteit die CO_2 emissie afzetten tegen de omzet, en relatieve doelstellingen die CO_2 uitstoot afzetten tegen het aantal voltijd medewerkers (FTE), gewerkte uren of productieve uren. Doelstellingen voor de fysieke energie-efficiëntie worden door zeer weinig bedrijven gebruikt. Tabel 7.1 toont het gemiddeld gewogen ambitieniveau van de drie meest voorkomende type doelstellingen. Vervolgens zijn diverse business-as-usual scenario's ontwikkeld die de omzet en de werkgelegenheid in de bouwnijverheid prognosticeren. Op basis van deze prognoses is een raming gemaakt van de netto jaarlijkse verandering van de CO_2 uitstoot in de veronderstelling dat bedrijven volledig voldoen aan de CO_2 reductiedoelstellingen, zie tabel 7.1.

Tabel 7.1: Gemiddeld gewogen ambitieniveau en geraamde netto jaarlijkse verandering in de CO_2 uitstoot in vergelijking met het basisjaar 2010 voor drie type doelstellingen

Type doelstelling	Gemiddeld gewogen ambitieniveau	Geraamde netto jaarlijkse verandering van de CO_2 uitstoot		
		Gemiddeld	Hoog	Laag
CO_2	-2,1%		-2,1%	
CO_2/FTE	-2,8%	-2,2%	-1,5%	-2,5%
CO_2/€ omzet	-2,0%	1,0%	2,2%	0,3%
Totaal		-1,3%	-0,8%	-1,5%

Het potentiële effect van de CO_2 Prestatieladder op het verminderen van de CO_2 uitstoot wordt geraamd tussen 0,8%/jaar en 1,5%/jaar, met een meest waarschijnlijke waarde van 1,3%/jaar. De CO_2 Prestatieladder kan daarom een belangrijke bijdrage leveren aan de jaarlijkse CO_2 emissiereductie (-1,4%/jaar in de periode 2010-2020) die nodig is om onder het Nederlands emissieplafond te blijven voor de sectoren die niet deel uit maken van het Europese CO_2 emissiehandelssysteem. In absolute termen is de potentiele bijdrage van de CO_2 Prestatieladder aan het behalen van de klimaatdoelstelling voor bedrijven die niet deel uit maken van het Europese CO_2

emissiehandelssysteem nog niet erg groot, omdat op dit moment slechts een klein deel van de CO_2 emissies van deze sectoren onder de CO_2 Prestatieladder valt.

7.5 De impact van de CO_2 Prestatieladder op verbetering van energie- en broeikasgasmanagement in bouwnijverheidsbedrijven

Energie- en broeikasgasmanagement programma's, zoals de CO_2 Prestatieladder, worden geïmplementeerd om de continue verbetering van energie-efficiëntie en broeikasgasprestatie in de bedrijven te faciliteren. Onder de 500 deelnemende bedrijven (halverwege 2015 zijn dat er meer dan 650), voornamelijk afkomstig uit de bouwnijverheid, wordt de CO_2 Prestatieladder vaak beschouwd als de belangrijkste stimulans voor verbetering van de energie-efficiëntie en CO_2 emissiereductie. Hoofdstuk 5 gaat in op de vraag: 'Wat is de impact van de CO_2 Prestatieladder op verbetering van energie- en broeikasgas management in bouwnijverheidsbedrijven'. Het onderzoek is voornamelijk gebaseerd op interviews, analyses van de energiebesparings- en CO_2 emissiereductie-maatregelen en kwantitatieve analyse van de vermindering van de CO_2 uitstoot.

Deze studie toont aan dat de CO_2 Prestatieladder het energiemanagement op een groot aantal vlakken heeft gestimuleerd, zoals een sterker commitment van het topmanagement, een verhoogde prioriteit voor energievraagstukken, een verbeterde Plan-Do-Check-Act cyclus voor energiebeheer, een verbeterd inzicht in de CO_2 uitstoot, prestaties en reductieopties, en een toegenomen energiebewustzijn onder de medewerkers. Diverse barrières voor energiebesparing zijn hiermee overwonnen. De CO_2 Prestatieladder heeft vooral het energiemanagement op administratief vlak verbeterd, terwijl de uitvoering van energiemanagement op lagere niveaus in de organisatie maar pas is begonnen. Bedrijven hebben verschillende CO_2 emissiereductiemaatregelen genomen die kunnen worden gecategoriseerd in maatregelen voor groene mobiliteit, groene stroom, energie-efficiënt (gebruik van) materieel, efficiëntere productie van materialen, energiebesparing in gebouwen, hernieuwbare energiebronnen en andere maatregelen. Bedrijven hebben vooral maatregelen genomen die de ondersteunende bedrijfsprocessen beïnvloeden in plaats van de kernprocessen van het bedrijf. De CO_2 Prestatieladder heeft vooral de inkoop van groene elektriciteit gestimuleerd en de invoering van verschillende gedragsmaatregelen voor energiebesparing en CO_2 emissiereductie. In de afgelopen 4-5 jaar is de CO_2 uitstoot gedaald met 5,1%/jaar. Dat is veel meer dan de verwachte impact van de CO_2 Prestatieladder op CO_2 emissiereductie (0,8-1,5%/jaar) berekend in hoofdstuk 3. Het grote verschil is toe te schrijven aan de gunstige economische vooruitzichten die zijn gebruikt in hoofdstuk 3 ten opzichte van de werkelijke economische teruggang in de afgelopen jaren. Echter, indien rekening wordt gehouden met CO_2 emissiereducties als gevolg van de economische teruggang in de afgelopen jaren, lijkt de CO_2 Prestatieladder nog steeds de CO_2 emissiereductie onder de deelnemende bedrijven te hebben versterkt.

Algemeen kunnen we concluderen dat, gedreven door de mogelijke voordelen in aanbestedingsprocedures, de CO_2 Prestatieladder verantwoordelijk is voor een sterke verschuiving naar een meer volwassen vorm van energiemanagement onder de bedrijven in de bouwnijverheid, die anders niet zou hebben plaatsgevonden.

7.6 Versnellen Meerjarenafspraken energie-efficiëntie verbetering?

Energieconvenanten tussen overheid en industrie worden vaak gezien als een veelbelovend en (kosten)-effectief alternatief voor traditionele regelgeving. Het is echter nog niet bekend of dergelijke convenanten ook daadwerkelijk de energie-efficiëntie verbeteren. In hoofdstuk 6 bestuderen we daarom de Meerjarenafspraken over energie-efficiëntie, die al decennialang een belangrijk beleidsinstrument voor energiebesparing in Nederland zijn. We gaan in op de vraag: 'Wat is de impact van de Meerjarenafspraken op de energie-efficiëntie verbetering in Nederland'. In dit hoofdstuk richten we ons specifiek op de eerste generatie van de Meerjarenafspraken over energie-efficiëntie in Nederland uit de periode 1992-2000. Deze Meerjarenafspraken waren een van de eerste voorbeelden van energieconvenanten tussen overheid en industrie in de wereld. De eerste generatie Meerjarenafspraken zou later nog worden gevolgd door nieuwe meerjarenafspraken over energiebesparing. Het onderzoek is gebaseerd op verschillende methodieken voor effectbeoordeling van energie- en klimaatbeleid. De gegevens werden voornamelijk verzameld uit de monitoringrapportages en interviews.

In dit hoofdstuk worden twee methoden (bottom-up en top-down) ontwikkeld om de impact van de Meerjarenafspraken over energie-efficiëntie te isoleren. De eerste bottom-up methode isoleert de impact van de Meerjarenafspraken door een inschatting te maken van de additionele energiebesparingsinvesteringen en de daarbij behorende energiebesparing. De energiebesparingsmaatregelen (en bijbehorende besparingen) worden daartoe eerst ingedeeld in één van de volgende categorieën (met tussen haakjes het aandeel in de totale energiebesparing): good housekeeping maatregelen (9%), vervangingsinvesteringen (32%), energie-efficiëntie of retrofit maatregelen (18%), warmtekrachtkoppeling (22%) en andere maatregelen (22%). Vervolgens is zowel door deskundigen als bedrijven beoordeeld in hoeverre verschillende categorieën energiebesparingsinvesteringen zijn gestimuleerd door de Meerjarenafspraken. Er is bijvoorbeeld beoordeeld dat retrofit maatregelen in ‘sterke mate’ zijn gestimuleerd door Meerjarenafspraken, terwijl vervangingsinvesteringen maar in ‘beperkte mate’ zijn aangemoedigd door de Meerjarenafspraken. Door weegfactoren toe te kennen aan de verschillende ‘mate van stimulering’ kon tenslotte de gestimuleerde energiebesparing per categorie worden berekend en daarmee de totale impact van de Meerjarenafspraken op de verbetering van de energie-efficiëntie. De alternatieve top-down methode isoleert de impact van de meerjarenafspraken door de bereikte energie-efficiëntie verbetering (-2,1%/yr in de periode 1989-1998) te vergelijken met de energie-efficiëntie verbetering in het business-as-usual scenario (0,9%/jaar – 1,6%/jaar). De energie-efficiëntie verbetering van in business-as-usual scenario is vastgesteld op basis van modelsimulaties.

De belangrijkste conclusie is dat tussen een kwart en de helft van de energiebesparing in de Nederlandse industrie kan worden toegeschreven aan de Meerjarenafspraken. Met andere woorden, de mate van verbetering van de energie-efficiëntie is toegenomen met 33-100% in vergelijking met een situatie waarin er geen Meerjarenafspraken zouden zijn geweest.

7.7 Algemene conclusies

De algemene conclusies met betrekking tot de drie onderzoeksvragen in dit proefschrift zijn de volgende:

1. *Hoe kunnen ambitieuze doelstellingen voor verbetering van de energie-efficiëntie en de beperking van de uitstoot van broeikasgassen in programma's voor energie- en broeikasgasmanagement worden vastgesteld?*

Het bepalen van uitdagende doelen voor het verbeteren van de energie-efficiëntie of het verminderen van de uitstoot van broeikasgassen vereist duidelijk omschreven richtlijnen. Procedures voor het formuleren van doelstellingen waarbij goed gedefinieerde concepten, eisen en duidelijke beoordelingskaders voor het evalueren van het ambitieniveau ontbreken, leiden niet tot de meest ambitieuze doelstellingen en moeten daarom worden vermeden. De wijze waarop CO_2 reductiedoelstellingen in het kader van de CO_2 Prestatieladder worden vastgesteld is in dit opzicht een duidelijk voorbeeld van wat juist niet zou moeten worden gedaan als wordt gestreefd naar ambitieuze doelstellingen.

Energie- en broeikasgasmanagement programma’s moeten daarom gebruik maken van methoden voor het vaststellen van doelstellingen die beter aansluiten bij de voorgestelde criteria voor ‘ambitieuze doelstellingen’: doelstellingen moeten aanzienlijk verder gaan dan business-as-usual projecties; moeten worden afgestemd op klimaatdoelstellingen; moeten gebaseerd zijn op het gebruik van de best beschikbare technieken; en moeten een aanzienlijke inspanning in economisch of financieel opzicht eisen (WRI, 2013; Edvardsson-Björnberg, 2013). Dit houdt in dat de doelstellingen bijvoorbeeld minimale prestatieniveaus zouden moeten bevatten (Scheihing et al., 2013), dat ze volgen uit een ‘science-based’ aanpak voor reductiedoelstellingen (Krabbe et al., 2015), of dat ze zijn gebaseerd op de benchmarking van energiebesparingsmaatregelen (SKAO, 2015), of dat de uitvoering van rendabele energiebesparende maatregelen wordt geëist (Agentschapnl, 2013). Echter, dit soort typen doelstellingen hebben natuurlijk ook nadelen, zoals bijvoorbeeld de handhaafbaarheid, zie CE et al. (2011).

Er is een grote verscheidenheid aan kwantitatieve doelstellingen voor de verbetering van de energie-efficiëntie en het terugdringen van de uitstoot van broeikasgassen, waaronder absolute doelstellingen, relatieve doelstellingen en economisch gerelateerde doelstellingen. Vaak wordt gesuggereerd dat bij relatieve doelstellingen de onzekerheid in de nalevingskosten voor de bedrijven wordt gereduceerd in vergelijking met absolute doelstellingen, wat weer kan leiden tot meer ambitieuze doelstellingen (van Vuuren et al., 2002). In deze studie vonden we dat dit geldt voor CO_2 emissiereductiedoelstellingen gerelateerd aan de input van arbeid. CO_2 emissiereductiedoelstellingen gerelateerd aan de omzet (die een meer algemeen gebruikte indicator is voor het meten van de bedrijfsactiviteit), blijken daarentegen minder ambitieus te zijn (dat wil zeggen: hebben een lagere impact) dan absolute doelstellingen.

2. *Wat is de impact van energie- en broeikasgasmanagement programma's op het verbeteren van energie- en broeikasgasmanagement in de praktijk?*

Programma's voor energie- en broeikasgasmanagement kunnen het energiemanagement in de praktijk aanzienlijk verbeteren, zoals sterker commitment van het top management, een verhoogde prioriteit voor energievraagstukken, verbeterde gecoördineerde acties, beter inzicht in de CO_2 uitstoot, prestaties en besparingsmogelijkheden, en het vaststellen van energie-efficiëntie en CO_2 emissiereductiedoelstellingen. Deze programma’s zijn dus zeker een extra impuls voor energie-efficiëntie verbetering en broeikasgasemissiereductie ten opzichte van bestaande beleidsinstrumenten, milieucertificeringen of maatschappelijke aandacht voor energie en klimaat.

In het algemeen zijn de conclusies in overeenstemming met de bestaande literatuur over de effecten van energie- en broeikasgasmanagement programma's, zie bijvoorbeeld Backlund et al. (2012), Krarup en Rahmesohl (2002), Stenqvist et al. (2011), Kimura & Noda (2014), Harrington et al. (2014). Al deze studies rapporteren positieve effecten van de invoering van dergelijke energie- en broeikasgasmanagement programma's op de verbetering van het energiemanagement in de praktijk in voornamelijk industriële sectoren. Onze studie voegt dus toe dat dergelijke programma's ook voor niet-industriële bedrijven een serieus effect kunnen hebben op de verbetering van het energiemanagement.

Echter, een sterke prikkel, zoals het potentiële voordeel bij aanbestedingen, is noodzakelijk als drijvende kracht voor een blijvende aandacht voor energiemanagement. Deze laatste bevindingen bevestigen eerdere observaties van bijvoorbeeld Krarup & Rahmesohl (2002), Rezessy & Bertoldi (2011) en Reinaud et al. (2012) over de noodzaak om energiemanagementsystemen in te bedden in bredere energiemanagement programma's (waaronder vrijwillige energieconvenanten) om effectief te zijn.

Verder hebben we gevonden dat energie- en broeikasgasmanagement programma's de invoering van aanvullende energiebesparende maatregelen op tenminste de korte tot middellange termijn kunnen stimuleren. De additionaliteit die wordt geschat op 25-50%, wordt bevestigd door andere studies, zie bijvoorbeeld Ericsson (2006), Cahill & Gallachóir (2012), Stenqvist & Nilsson (2012), Ecorys (2013). Met name de inkoop van groene elektriciteit en de invoering van verschillende gedragsmaatregelen voor energie-efficiëntie en CO_2 emissiereductie zijn gestimuleerd in de onderzochte bedrijven. In onze studie vonden we dat het merendeel van de uitgevoerde maatregelen relatief eenvoudige en goedkope energiebesparende maatregelen zijn die betrekking hebben op de ondersteunende bedrijfsprocessen in plaats van de meer uitdagende energiebesparende maatregelen in de kernprocessen van de bedrijven. Deze resultaten zijn moeilijk te vergelijken met andere studies, die niet zo'n gedetailleerde uitsplitsing van energiebesparende maatregelen hebben gebruikt of die betrekking hebben op andere sectoren.

Op de langere termijn, valt echter nog te bezien of energiemanagement programma's ook het energiemanagement dieper in de organisatie kan verinnerlijken, waarbij energiemanagement dus verder gaat dan het bestuurlijk niveau of dat de focus vooral ligt op procedurele conformiteit zoals vaak wordt gesuggereerd in het kader van de milieuaudits, zie bijvoorbeeld Boiral (2007), Heras-Saizarbitoria et al. (2013). Gerichte onafhankelijk controle audits zijn nodig om te garanderen dat het ingevoerde energiemanagement ook verder gaat dan het bestuurlijke en administratieve niveau van het bedrijf. Het alternatief is dat programma-eigenaren of regelgevende instantie sterker sturen op het bereiken van doelstellingen voor de verbetering van de energie-efficiëntie en CO_2 emissiereductie.

3. *Wat is de impact van energie- en broeikasgasmanagement programma's op de verbetering van de energie-efficiëntie en de vermindering van de uitstoot van broeikasgassen?*

Programma's voor energie- en broeikasgasmanagement kunnen een impact hebben op de verbetering van de energie-efficiëntie en het terugdringen van broeikasgassen. In de energie- en broeikasgasmanagement programma's die in deze studie zijn onderzocht vonden we dat zowel de energie-efficiëntie verbetering als de relatieve vermindering van de CO_2 uitstoot worden versneld met 0,3%/jaar - 1,0%/jaar bovenop autonome verbeteringen. Dergelijke programma's voor energie- en broeikasgasmanagement kunnen daarmee een belangrijke bijdrage leveren aan het bereiken van nationale energie- en klimaatdoelstellingen. Echter, deze waarden voor de verbetering van de energie-efficiëntie zijn niet voldoende om de energieefficiëntieverbetering te verdubbelen. Dat wordt namelijk nodig geacht om de wereldwijde temperatuurstijging te beperken tot niet meer dan 2 graden (Rogelj et al., 2013). De geschatte relatieve CO_2 emissiereductie (1,3%/jaar) is ook verre van voldoende om sectorspecifieke trajecten voor de beperking van de CO_2 intensiteit te volgen die nodig zijn voor het stabiliseren van de uitstoot van broeikasgassen in de atmosfeer tot ongeveer 450 ppm in 2050. Het sectorspecifiek CO_2 intensiteit traject voor de categorie 'andere industriële sectoren', dat ook de bouw en civiele sector bevat, vereist meer dan 5%/jaar vermindering van de CO_2 intensiteit in de periode 2015 tot 2050 (Krabbe et al., 2015). De impact van deze programma's zal daarom verder moeten worden versterkt, bijvoorbeeld door aanpassing van de CO_2 emissiereductiedoelstellingen aan wereldwijde klimaatdoelstellingen (Krabbe et al., 2015), door het betrekken van de bedrijven in de keten in het verminderen van de CO_2 uitstoot (Reinaud et al., 2012), en een sterkere regulerende dreiging wanneer doelstellingen niet worden nageleefd (Price, 2005; Rezessy & Bertoldi, 2011).

Over het geheel genomen kan worden geconcludeerd dat op de korte tot middellange termijn programma's voor energie- en broeikasgasmanagement een effectief instrument kunnen zijn voor de verbetering van energiemanagement in de praktijk, het stimuleren van het nemen van extra besparingsmaatregelen, en het versnellen van energie-efficiëntie verbetering en het terugdringen van de uitstoot van broeikasgassen. Om een grotere impact van dit soort programma's op langere termijn te kunnen garanderen is het noodzakelijk dat deze programma's vergezeld gaan met duidelijke procedures voor het bepalen van ambitieuze doelstellingen voor de verbetering van de energie-efficiëntie of de vermindering van de uitstoot van broeikasgassen; dat uitdagende prikkels en ondersteunende maatregelen aanwezig zijn; en dat controle procedures voor de naleving van energiemanagement helder en effectief zijn.

7.8 Slotopmerkingen

- Vanuit methodisch oogpunt heeft dit proefschrift bijgedragen aan de literatuur door de ontwikkeling van een bottom-up methode voor de evaluatie van de impact van energie- en broeikasgasmanagement programma's. Beoordelingen van het programma effect zijn gebaseerd op de geschatte additionaliteit van individuele energiebesparingsmaatregelen en hun energiebesparing. Hoewel dergelijke methoden ook kunnen worden bediscussieerd, bijvoorbeeld omdat de ingeschatte additionaliteit bevooroordeeld kan zijn, zijn deze methoden toch een belangrijke aanvulling op de bestaande top-down evaluatie methoden.
- In deze studie zijn de resultaten en effecten van de eerste generatie van de Meerjarenafspraken over energie-efficiëntie in Nederland in de periode 1992-1998 geëvalueerd. Meer recente voortgangsrapportage van de nieuwere Meerjarenafspraken laten zien dat de verbetering van de energie-efficiëntie in het productieproces in dezelfde sectoren als onderzocht in deze studie op een vergelijkbaar niveau bleef van 1,8%/jaar in de periode 1998-2007, maar daalde tot 1,3%/jaar in de periode 2009-2013 (RVO, 2014, SenterNovem, 2008). Meer recent zijn ook de tweede en derde generatie van de Meerjarenafspraken over energie-efficiëntie geëvalueerd (Ecorys, 2013; Arentsen, 2004). Volgens Ecorys (2013) schrijven deelnemers aan de Meerjarenafspraken 60% van de energiebesparing toe aan het convenant. Echter, volgens Ecorys (2013) is deze bijdrage overschat omdat volgens de deelnemers 60-80% van de maatregelen ook zouden zijn genomen zonder de Meerjarenafspraken. Arentsen (2004)

concludeert dat de Meerjarenafspraken een additionele effect hebben van 1.4%/jaar aan energiebesparing wanneer energie-efficientie verbetering van de deelnemende sectoren wordt vergeleken met de binnenlandse energie-efficientie verbetering in de periode 1989-2002.

7.9 Aanbevelingen voor verder onderzoek

Op basis van de resultaten in dit proefschrift bevelen we de volgende routes aan voor verder onderzoek om het begrip van energie- en broeikasgasmanagement programma’s nog verder te verbeteren:

- De vergelijking van energie- en broeikasgasmanagement programma's blijft lastig vanwege verschillen in het ontwerp, verschillende type doelstellingen en rapportage-eisen, zie bijvoorbeeld Rezessy & Bertoldi (2011) voor een overzicht van de resultaten en effecten van verschillende vrijwillige energiebesparingsconvenanten. Onderzoek naar de impact van energie- en broeikasgasmanagement programma’s blijkt ook niet altijd vergelijkbaar te zijn omdat verschillende evaluatiemethoden, instrumenten en indicatoren werden gebruikt, variërend van eenvoudige vragenlijsten, diepte-interviews (beiden gebruikt in onze studie), tot meer uitgebreide ‘energy maturity’ matrices en zelfs vragenlijsten met meer dan 100 items (zie bijvoorbeeld Backlund et al., 2012; Carbon Trust, 2011; Harrington et al., 2014). Zeer lange vragenlijsten om de impact te meten zijn in dit opzicht niet erg geschikt voor grootschalig onderzoek die een hoge respons eisen. We kunnen verder leren van een onderlinge vergelijking van programma’s, met behulp van een meer geharmoniseerde onderzoeksaanpak voor het evalueren van de effecten van energiemanagement programma's. Wij adviseren daarom een dergelijk gestandaardiseerde methode te ontwikkelen en een vergelijkend onderzoek uit te voeren naar de impact van verschillende energiemanagement programma's op de verbetering van het energiemanagement in de praktijk, de succes- en faalfactoren van dergelijke programma's en de kosteneffectiviteit.
- In deze studie hebben we alleen gekeken naar de effecten van energie- en broeikasgasmanagement programma's op het verbeteren van het interne energiemanagement, de energie-efficiëntie en CO_2 emissiereductie. Echter, het potentieel voor verbetering van de energie-efficiëntie en CO_2 emissiereductie in de keten is waarschijnlijk veel groter. Tot nu toe dit is een vrij onontgonnen onderwerp, met uitzondering van studies zoals Ecofys (2012) en DHV (2009). Wij adviseren daarom het gebruik van energiemanagement (systemen) om de CO_2 uitstoot in de keten te verminderen verder te bestuderen, waarbij vooral de nadruk zou moeten liggen op het effect in termen van CO_2 emissiereductie ten opzichte van het ontwerp van deze keteninitiatieven (zie IIP/Ecofys (2012) voor diverse keteninitiatieven ter bevordering van energiebesparing en broeikasgasemissiereductie). De CO_2 Prestatieladder zou hier kunnen dienen als een case study, omdat de CO_2 Prestatieladder ook expliciet eisen stelt aan ketensamenwerking.
- Een vraag die ook meer aandacht behoeft in toekomstig onderzoek is hoe de impact van energie- en broeikasgasmanagement binnen bedrijven kan worden gecontinueerd. Daarom stellen wij voor om de relatie tussen energiemanagement en de barrières voor verbetering van de energie-efficiëntie in meer detail te bestuderen. Een dergelijke studie zou met vruchtbare

voorstellen kunnen komen om meer effectieve energiemanagement programma's te ontwerpen.

- In relatie tot de vorige aanbeveling stellen we ook voor om toekomstig onderzoek te richten op de vraag hoe goed energiemanagement verder kan worden geinternaliseerd binnen de bedrijfsorganisatie. Het meeste onderzoek was tot nu toe gericht op het analyseren van vooral administratieve, organisatorische en technische aspecten van energiemanagement. Echter, energiemanagement betreft ook gedragsverandering die nodig is voor de continue verbetering van de energieprestaties van het bedrijf. Toekomstig onderzoek moet zich richten op de vraag hoe medewerkers op verschillende niveaus in het bedrijf effectief kunnen worden betrokken bij energiemanagement (systemen) om tastbare resultaten op de lange termijn te bereiken. Diepgaande case studies zouden bijvoorbeeld kunnen worden uitgevoerd bij bedrijven, waarbij een breed scala van verschillende actoren wordt betrokken.

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Curriculum Vitae

Martijn Rietbergen was born in Nijmegen (1972), the Netherlands. In 1996 he obtained a MSc. Degree in Environmental Science at the Radboud University Nijmegen. He started his academic career as a junior researcher at the department of Science, Technology and Society, Utrecht University. Until 2001 he worked amongst other on the EU funded VAIE project (Voluntary Agreements – Implementation and Efficiency) and the NOP project on Policy Instrument for Energy Efficiency Improvement of which the results are included in this thesis. In the period 2001-2004 he worked at the Leiden University as the co-ordinator for the European Postgraduate Course in Environmental Management. In 2003 he returned to the Utrecht University to work as the programme manager for the MSc. Energy Science at the Copernicus Institute for Sustainable Development and Innovation. Since 2008 Martijn has been employed at the University of Applied Science Utrecht, where he held several positions such as lecturer in sustainable energy systems in various BEng. Programmes, as project leader for the Institute Engineering & Design and as researcher at the Research Centre Technology & Innovation. In 2012 he was awarded a research voucher from the University of Applied Science Utrecht to continue his PhD research. He received his PhD degree from the Utrecht University in 2015.

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