Applying green accounting with the support of ICT

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Master thesis

Economics & ICT

August 16, 2012
Version 1.0

Abstract

Green accounting is interesting nowadays. Organizations claim they are 'green', but how can this be verified? Green accounting can give a framework with the basics of accounting that is also done with money. However, to implement green accounting into an organization, the factors people, processes and technology should be taken into account. There are also many issues in green accounting that need an answer. In this research we discuss these issues to answer how green accounting should be done. In this research, special attention is given to the European Union Emissions Trading Scheme regarding airlines, concluding that international cooperation for green accounting is indispensable. Besides this, emissions from different transport modes are discussed with practical cases about the Opel Ampera and the Dutch railways. This research shows what is needed to apply guidelines and how Information Systems can support green accounting.

Acknowledgements

This thesis is a part of the Economics & ICT program from the Erasmus University Rotterdam. I'm very grateful for all teachers who helped me to gather knowledge during the previous years. This knowledge was very helpful to write the thesis. I would like to thank everybody that helped me with my thesis and with whom I have had conversations. Some of them I would like to thank by name.

First, I would like to thank my wife for her support during the writing of the thesis. Thereby, I want to thank her especially for checking the English grammar and the written text.

Secondly, I would thank my supervisors Prof. Dekker and Dr. Tervonen for their advice and help. Special thanks go to Prof. Dekker with whom I had several interesting brainstorm- and discussing sessions while writing the thesis.

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Chapter 1 – Introduction

1.1 Relevance

Sustainability is a ‘hot item’. More and more companies claim they are ‘green’, ‘sustainable’, and ‘good for the environment’. The purposes of these claims are clear: people like companies who say that they are ‘green’ and many organizations have statements about their Corporate Social Responsibility (CSR). However, is their claim correct? And if it’s correct that a company makes this claim, how could this be measured?

More and more people agree on the fact that a heavy use of the natural resources is bad for our well-being, in early stages or maybe in later stages. The ozone hole is an example about what extreme use of natural resources could do, based on the greenhouse effect. However the chlorofluorocarbon (CFK) that caused the ozone hole problem are reduced and sustainability issues are replaced by the CO_2 problem. The CO_2 emissions are a well-known example of gasses that – indirect – in large amounts can increase the world temperature and thus have an influence on the nature, according to the *Intergovernmental Panel on Climate Change* (IPCC, 2007) in their Fourth Assessment Report.

It’s good when companies intrinsically try to be more sustainable in the sense of ‘less waste of natural resources and less emissions of greenhouse gases’. But how could it be proved that companies are ‘sustainable’, the result that is been wanted? And how far are they sustainable? In many business reports, the term ‘sustainable’ stands for different things. Not only CO_2 emissions are part of the term ‘sustainable’, but also the percentage of man/woman and the participation of disabled people are examples of what is seen as a ‘sustainable organization’. The different explanations of sustainable could be illustrated by the fuel bio-ethanol. Bio-ethanol is called CO_2 neutral. However, using bio-ethanol will require a large amount of land and can have an influence on the well-being of people in third-world countries and the amount of food they have. This example covers different sizes of a sustainable organization. This research will focus on the natural aspects of sustainability regarding emissions: which responsibilities does an organization have on (CO_2) emissions and pollution and how can this be measured?

Measuring the company’s financial statements is done by good accounting. Green accounting promises a good way to give people more insights in the use of natural resources and the emissions an organization produces. Just like organizations use bookkeeping to keep track of their financial transactions, it’s possible to use bookkeeping to keep track of the influences of organizations on the environment. Thereby compensation of emissions in other places can be used in case of emission rights that are divided among organizations. When buying and selling rights, clear agreements between organizations and governments are important. The measurement of greenhouse gasses in form of for instance CO_2 emissions is an important form of measuring the influences on the environment.

However, it's not as easy as simply implementing a green accounting system as implementing a bookkeeping system. Developing a new system is expensive and not practical and changing current systems could also be expensive and in some cases too difficult. Then we also have small and large companies. Large companies have more capacity (knowledge, money and people) where for small companies the paperwork could be too much and the image as 'green company' could be less important. However, when a reliable green accounting system will be used, it's important that both large and small companies work together because large companies outsource work to small companies and the other way around. Calculation throughout the chain is needed to get the most reliable overview. However, the question is whether it's clear which parameters throughout the chain should be taken into account.

The research shows which parameters can be taken into account. If an organization wants to show that it's sustainable and it is using green accounting, which guidelines are the ones that could led the process? If different organizations use different rules and/or guidelines, they could play with numbers but the numbers the customer sees are not reliable then. And then, if some guidelines are clearer, how can we implement them in the existing systems, or do we have to create a new system? How can an organization easily deal with this?

The research will show why good green accounting is needed in order to reduce emissions. Thereby awareness for organizations plays an important role. The research will also support future research into green accounting and implementing this with (Accounting) Information Systems.

1.2 Research question

In this research, we have on main research question. The main research question is split up into several sub-questions which together give an answer to the main research question.

This research is about measuring the emissions of organizations and putting them into meaningful information. Because of the fact that processing data into information nowadays isn't unthinkable without the support of ICT, an important factor of the research will be the support of ICT in the form of Information Systems. This has led to a main research question that focuses on how accounting with emissions data should be done (called 'green accounting') and how Information Systems can support that.

The main research question (how to do green accounting with IT) is split up into three sub-questions which together help to give an answer on the main research question. Because of the fact that standards are very important in accounting, first the current standards in both the financial and green accounting are discussed, resulting into an answer to the sub question: “What are the international standards for accounting and green accounting and which should be applied in order to end up with a good possibility to do IT-audit on green accounting.” The green accounting principles will be discussed. It is important to establish a definition and give an overview about what it is and how it is scoped to end up with guidelines, supporting a clear IT audit. Standards are also an important tool when comparing organizations, making rules and regulations and give a handle to organizations in order to handle transactions in a straight way.

The second sub-question supports the current issues and solutions in green accounting. Green accounting is about the organizations’ own emissions plus the emissions of others that are related to the organizations’ business (indirect emissions). Some examples of issues are: which emissions should be considered? Which levels of emissions should be used? Which calculation method is the best? Also, because of the fact that there is no international accepted standard, what should be done to handle that? The determination of the greenhouse gasses (GHGs) is mainly a chain problem. CO_2 emissions are sold to others in the chain. To handle that, accounting is needed.

In the third sub-question, the link to IT comes forward. Even as bookkeeping is done by IT everywhere, it’s unthinkable that calculations with emissions will not be done with IT. When applying green accounting in a certain way, it could’ve an influence on the working method of people, on processes and on the technology that should be used to measure the data that is needed. These influences should not be undertaken and organizations should consider them well. Summarizing, this leads to the questions below.

Research question: **“How/why should green accounting be done and how could green accounting be supported by Information Systems?”**

1. What are the international standards for accounting and green accounting and which should be applied in order to end up with a good possibility to do IT-audit on green accounting?
2. What are the issues of green accounting and what are possible solutions?
3. What will the influences of green accounting be on people, processes and technology in a company?

This main question and the sub-questions together give support to the thesis topic, research and title ‘Applying green accounting with the support of ICT’. The research will give a handgrip to apply green accounting with (Accounting) Information Systems, based on a case study of the European Union Emissions Trading System in the airline industry and a case about transport modes and what the issues are in choosing a certain transport mode.

1.3 Methodology

The research is mainly based on a literature study, combined with a critical analysis based on a practical situation in the airline industry and issues when comparing emissions of transport modes. During the research, we use some practical information from organizations.

The research is done in a qualitative way, supported by existing literature. This means that the research will not contain many questionnaires results or many numbers and thus focuses on qualitative reasoning.

Outline

After an introduction with the research questions, the thesis starts with a statement about the choices for the main topics in the literature that are related with this research, sometimes based on the learned knowledge during the education Economics & ICT (e.g. Accounting Process Management). These topics are described shortly and are used to search for information in the literature. The topics that we have chosen for this research are: carbon footprint determination, green accounting, emissions trading scheme systems, accounting Information Systems and IT audit. They are important topics in the research, because they are related to the field of green accounting. After this introduction, each of the topics are described, resulting into discussions from different literature sources.

After the literature is discussed, the thesis contains two cases with practical connections to the transport industry. First, the airline industry, that takes part into the European Union Emissions Trading System – from January 2012 –, a system with a trade market of emission rights. Then, different transport modes are discussed, each with their issues. These cases are made to illustrate the issues, some facts and the possibilities of doing green accounting. The thesis will end with the conclusion to the research question and some recommendations for further research.

Chapter 2 – Introduction

2.1 Introduction literature review

We start the research with the literature review. The literature review describes information which is founded in the literature (an overview of the literature can be found in the literature overview). This literature is already available information that gives input for a topic. The information from the literature is linked to five topics. These topics are chosen because of pre research. Measuring sustainability implies that instruments are needed to measure this. Because bookkeeping is used to do accounting with money, measuring can be done with accounting. In the literature, this is called **green accounting**. CO_2 emissions are sold in the chain (by selling products). Therefore, measuring greenhouse gasses is also a chain problem. To handle this accountability of organizations, accounting is needed. Working with green accounting also means that information is needed about accounting: first to know about how accounting should work and secondly how data should be calculated to information. Establishing data to do the bookkeeping is called '**footprint determination**' and is about 'carbon footprints', the footprints to the environment regarding emissions. Determining the right emissions is important to have valuable information.

Green accounting is also needed to exchange the emission rights in trading schemes for emissions that are based on the carbon footprint. These rights are important because systems are built up that allow organizations to trade these emission rights. An example of a trading system is the **European Union Emission Trading System** (ETS) where emission rights are traded between organizations. When an organization emits too many emissions, they need to buy the rights and when they emit less, they could sell their extra rights. The European Commission determines which amounts of emissions are allowed to emit as maximum. Because large organizations with more than 20 Megawatt 'net heat excess'[1] need to take part in this trading system (approximately 10.000 installations[2]), it's a crucial system when talking about green accounting. Working between government and different organizations with emission rights means that accounting is important.

At last both '**Accounting information systems**' and '**IT audit**' are introduced as topics that can support green accounting. Data that will be processed digitally will be processed mostly with an Information System. And because of the fact that in accounting verifiability is very important (to protect fraud), audit can't be left out. The role of emission rights and footprint determination and the possibilities of fraud that can be taken with e.g. trade emissions ask for a good, verifiable system.

[1] http://ec.europa.eu/clima/policies/ets/index_en.htm; accessed at 14-08-2012
[2] http://www.internationalprofs.org/iesc/index.php?option=com_content&view=article&id=118:eu-ets&catid=908:eu-ets&Itemid=88; accessed at 14-08-2012

Synonyms

The subjects that are used to describe the literature that supports answering the research question are below in the table. Besides them, synonyms of these terms are used to search in the literature.

Subject	Synonyms
Determination of carbon footprint	CO_2 emissions determination, CO_2 calculator, ecological footprint
Green accounting	Sustainability accounting, environmental accounting, corporate sustainability
Emission trading systems	EU ETS (European Union Emissions Trading Scheme), emissions trading scheme
Accounting information systems	Information System
IT audit (as support)	Green accounting verification

Figure I – Synonyms of the core subjects of the literature research

2.2 Determination of the carbon footprint

The first subject is about the **determination of the carbon footprint**. The carbon footprint is the amount of greenhouse gas emissions that every individual person, organization, event or product emits to nature. Carbon footprint determination is important while doing green accounting, because it gives possibilities to measure which influences something has on the environment regarding greenhouse gasses. Doing a carbon footprint determination delivers the good numbers for doing green accounting. This topic focuses on determination possibilities and definition issues in the literature, mainly based on two important papers: the much used '*The Greenhouse Gas Protocol*'[3] and '*PAS2050: Specification of the assessment of the life cycle greenhouse gas emissions of goods and services*'[4]. The first is established by the World Resources Institute together with businesses, governments and environmental groups and the second is a specific British standard but is also internationally used[5]. Both are important, used standards where information could be taken from.

One of the main points in these papers is how to determine the emissions of a product and who is responsible for those emissions. One of the issues for example is that only measuring CO_2 could underestimate the impact of other greenhouse gasses like NH_4 (methane). These papers describe how to deal with them using CO_2e, a standardized measurement where other GHGs are transferred into CO_2 emissions. The result is a number of CO_2 emissions that have the same impact as the amount of

[3] http://www.ghgprotocol.org/; accessed at 14-08-2012
[4] http://www.bsigroup.com/en/Standards-and-Publications/How-we-can-help-you/Professional-Standards-Service/PAS-2050/PAS-2050/; accessed at 14-08-2012
[5] http://www.cicsglobal.com/eu/verification/pas-2050/; accessed at 14-08-2012

emissions of the other greenhouse gas. This and much other issues from the topic carbon footprint determination are discussed.

2.3 Green accounting

The second topic is about **green accounting** (sometimes called ‘sustainability accounting’), based on the carbon footprint determination resulting in a reliable overview of emissions. Green accounting and carbon footprint determination seem to be almost the same. The difference is that carbon foot print determination focuses on how to get the data from direct emissions and that accounting also focuses on indirect emissions. Indirect emissions belong to a certain product or service but these emissions are not emitted by the company that uses the product or service. The company itself can’t do a carbon footprint determination then, because the carbon dioxide is emitted somewhere else. Which research is done already in green (or environmental) accounting and what information is available about the processing of measurements of sustainability, are questions in this research topic.

2.4 Emissions trading scheme systems

The third topic describes the **emissions trading scheme systems**. Trading schemes are based on agreements between companies and governments and established by law. Organizations get a certain established amount of emission rights with emissions that they are allowed to emit. The idea behind such a trading system is that if one organization has low emissions it could sell the emission rights it didn’t use (or save) to another organization. The organization that emits more should pay the organization which emits less. Emissions trading scheme systems contribute to issues in green accounting because they are in fact green accounting systems themselves. The largest emissions trading scheme in 2012 is in the European Union. The literature is about the advantages, disadvantages, problems and issues and dealing with trading schemes. There isn’t much literature available about large emissions trading scheme systems, but the literature about the European Union gives a good base about how such a system works and gives input to do a critical analysis.

The fourth and the fifth topic describe the accounting aspects of an Information System and how this system could be taken as reliable.

2.5 Accounting Information Systems

The fourth subject describes what **Accounting Information Systems** (AIS) are and what they do, based on the literature. It’s about the structure of Information Systems with a special focus on Accounting Information Systems. Information Systems play a large role in almost all companies and make work easier and in most cases also cheaper. An Accounting Information System needs to be well designed, so that it’s difficult to fraud with the system. A good design is also needed when trying to process the emission data where rules from green accounting are taken. The book that is used as a basis for this topic is *Accounting Information Systems* by Hall, J.A. (2007).

An example of a company that provides a 'green' component for its Information System is the company SAP (a software solutions company). SAP has a certain extra component to add in their existing Information System. However, developing a new system or use a new component in an existing system means change. This change has an influence on people working in the organization, the processes that should be taken and also the technology changes. It means that a company not only focuses on financial accounting, but also on the impact to nature with green accounting.

2.6 IT audit

Doing financial or green accounting also implies that the data is correct. The last topic 'IT audit' describes information and data from the literature about **IT audit**. It describes what is in the literature about this topic and also specifically in the case of green accounting, because it's important that after determining the carbon footprint into an (green) accounting system, this way of accounting could also be audited. Auditing is important to validate if the data in the system is correct. For financial accounting, there are years of experience. For green accounting, less experience is available. In some cases, it´s possible that a company uses slogans like ´we are green´ without the support of a report that contains information that could be validated if this is true. This means that IT audit should be an important factor when considering measuring impact of emissions and should be taken into account when taking decisions about green accounting.

2.7 Summary

The literature review part is divided into five main topics with five keywords: carbon footprint determination, green accounting, emissions trading scheme systems, (Accounting) Information Systems, and IT audit. In the next chapter, these topics together give a good overview of the literature which is important for this research and support the answering of the research questions.

Chapter 3 - Carbon footprint determination

3.1 Introduction

Carbon footprint is a subset of the term ‘ecological footprint’ and was found by *Wackernagel and Rees (1996)* when the footprint referred to land or sea required for a given human population. In order to reach sustainability, we need to determine the carbon footprint. Before making statements with accounting, determination should be done.

In this chapter, we will discuss the carbon footprint determination. This refers especially to CO_2 emissions. First, we start with a definition. Then we discuss how to deal with other emissions than CO_2. After that, the ‘scopes’ that play an important role in carbon footprint determination, are discussed. The scopes divide the emissions into different categories. Also, standards in common are shortly discussed. The GHGP and the PAS2050 are the standards that are discussed in this chapter.

3.2 Definition

In 1972, a simple formula was developed by *Commoner (1972)* in order to calculate the ‘carbon footprint’ of people on this earth. The idea was that three factors had an influence on the impact of people on earth:

- **I**mpact (on earth) =
    - **A**ffluence (income per capita)
    - **P**opulation (amount of people on earth)
    - **T**echnology (how efficiently natural resources could be used)

The formula is I = A x P x T.

Because of the fact that technology improved severely and because of the fact that people could use more natural resources like coal and oil than 200 years ago, the increase of income per capita and total population hasn’t already been giving a high problem for the available natural resources. However, when using the same amounts of natural resources in future as now are used, they will run out and the formula will then not be valid anymore.

35 years later, in 2007, the IPCC (Intergovernmental Panel on Climate Change) wrote a report about the so called ‘global warming’ and stated that greenhouse gasses (GHGs) are (mainly) responsible for the climate change. According to the IPCC, the different greenhouse gases are the most familiar and highest contributor: CO_2 (58,6%), CH_4 (14,3%) and N_2O (7,9%).

During the years, the consequences of the global warming are also taken into account besides the stock of natural resources. In 2012, for the carbon footprint both the emissions of burning resources and the stock of natural resources are the underlying problems. The carbon footprint is defined by Lynes (2007) as '*a measure of an individual's contribution to global warming in terms of the amount of greenhouse gasses produced by an individual and is measured in units of carbon dioxide equivalent*'.

In this research, the main focus is on CO_2. However, of course other emissions are also important. For this, the so called 'Global Warming Potential' is developed.

3.3 Global Warming Potential

The Greenhouse Gas Protocol (GHGP) and the British specification for life cycle greenhouse gas emissions (PAS 2050) – two important standards – describe the CO_2e measurement. According to these standards, all the different greenhouse gasses can be measured by mass and converted to CO_2e emissions. The base is CO_2, which has a coefficient of one global warming potential (GWP) what results into 1 kg CO_2 = 1 CO_2e kg. The GWP will be measured within a certain time period, because GHGs effects change over time. The effect of the gas methane (in 100 year) is 25 times as high as CO_2 so 1 kg CH_4 (methane) results into 25 CO_2e and has a GWP of 25. The GWP is measured within a certain time schedule, because the amount of the specific GHG could increase and thereafter decrease during its lifetime in the atmosphere. The most used time schedule is the 100 year schedule. This is the standard method for the calculations of the impact of other greenhouse gasses than CO_2 and is used to avoid using other ways of calculation that possibly result into more or less emissions of other gases than CO_2.

Industrial name	Chemical formula	Global Warming Potential (100 year) = CO_2e
Carbon dioxide	CO_2	1
HFC-23	CHF_3	11.700
Methane	CH_4	23-25
Nitrous oxide	N_2O	296-298

Figure II: Table with GWPs of some important greenhouse gases relative to CO_2

Actually, in most cases the factor CO_2 (mostly in tons) is used to determine the footprint. It's possible however that other emissions are also important. An example is cement producing companies: they not only emit CO_2, but also other gasses because of the chemical processes. The GHGP says that it's the best to determine which GHGs are important for the company beside CO_2 and use them into the calculations. It's important to explain – in the reports of an organization – why certain gasses are taken into account and why some aren't. The emissions of other GHGs should then be reported separately. Other emissions than CO_2 are not the main part of this research, but may not be undertaken.

This permissiveness makes it easy for an organization to decide not to take into account data that is difficult to measure. However, it could also be a too simple reason to exclude some emissions. An organization benefits financially from saying they have little emissions, not from telling that they have a large amount of emissions.

3.4 Three scopes

To distinguish between different kinds of emissions, the standards GHGP and PAS2050 describe several scopes. In general, three scopes (or tiers) are important to calculate the carbon footprint:

- Scope I: direct emissions (from the combustion of a car or by making a fire)
- Scope II: emissions through directly bought energy (electricity, heating gas)
- Scope III: indirect emissions caused by the life cycle of a product or service in its whole supply chain

Matthews et al (2008) add another fourth scope that could cover emissions that are related to delivery, use and disposal as a special part of the lifecycle. However, most researches concentrate and include all emissions related to the life cycle in scope III. In this research, three scopes are used. These three scopes are very important in carbon footprint determination. First, we give a short review on them.

Scope I

Scope I contains all direct emissions, emissions that are emitted directly e.g. from cars, planes (combustion), heating, chemical processing etc. Scope I emissions are the most easily measureable emissions because they are emitted onsite and could be controlled by people or organizations themselves. However, Scope I emissions should – according to the GHGP – always be reported, also when the self-generated energy is sold to another party. This fact could be explained into a report as optional information. Because of the fact that the self-generated energy that is sold has to appear as data in the reports, it could create a negative overview of an organization. To compensate this, a record can be made in the document.

Scope II

Scope II emissions are emissions resulting from the direct purchase of electricity, heat, steam etc. Scope II emissions result from processing that result in energy delivery where the emissions take place in another place than where the energy will be used. Due to the published energy mixes, organizations can calculate the emissions which are associated with a certain energy purchase. The organization is only responsible for the delivered electricity (or another product). The producer is accountable for the losses and energy use during transmission and distribution. Together with scope I, about 26% of the total carbon footprint is covered, according to the GHGP.

Scope III

Scope III is the most difficult one and covers the life cycle[6] of products and emissions of activities, including transportation, disposal of products, processes of creating and modifying, machinery, recycling and emissions from the commuter of employees. Scope III emissions are emissions which are not controlled or owned by an organization or person.

Example: Emissions could take place in different scopes. When an employee is driving his own combustion-driven car, the emissions for the employee himself are scope I emissions. When that employee drives an electricity-driven car, they are his scope II emissions. However, when a company tries to estimate the commuter of its employees, those emissions are related to the company's scope III emissions.

Determining the emissions (footprint) of scope I and II seems not very difficult. With the help of detailed ratios about emissions per substance for scope I and facts about the used energy mixes of scope II, the footprint can be determined. However, determining scope III emissions is much more difficult. Both the GHGP and the PAS2050 have extensive descriptions how to possibly deal with these emissions. PAS2050 distinguish between a business-to-consumer (ISO 14044: cradle-to-grave, full life cycle) and a business-to-business assessment (ISO 14040: cradle-to-gate, all emissions between input and output of a product or service within an organization.) How to deal with these scope III emissions according to GHGP and PAS2050 and the accounting issues, is described in the literature study topic 'Green Accounting'.

3.5 Further standards

Some papers give a good overview of available standards like *Pandey* (2010). We found many standards, however none of them can be seen as standard with (international) authority for everybody. The GHGP and PAS2050 are important ones, but also give much freedom in how to use it and even in the choice to use it or not. To calculate the carbon footprint, the international guideline ISO 14067 is under development[7], based on some other ISO's. It will allow companies to compare different products and different companies in their supply chain.

Carbon footprint is commercialized and because of the fact that compensating for emissions deals with money, it's important that the guidelines a company uses have to be clear.

3.6 Chapter conclusion

In a research conducted by *L.E.K. Consulting LLP* (2007), it was found that 44% of consumers prefer to know how large the carbon footprint is while also 43% wants to pay more for products with a lower carbon footprint. This supports the need of sustainability reports and doing emission determination.

[6] http://www.concretethinker.com/solutions/Life-Cycle-Balance.asp; accessed at 14-08-2012
[7] http://www.pcf-world-forum.org/initiatives/international-standards/iso-14067/; accessed at 14-08-2012

However, organizations use different models to estimate or determine their emissions. Besides PAS2050 and the GHGP, there are many footprint models available. A study in Ireland (Kenny, 2009) compared six of them for households (including road transportation and aviation). The results differ from 12,053 to 27,218 kg CO_2 with a standard deviation of 5,106 kg. Furthermore, scope III emissions were excluded, even as CH_4 and N_2O emissions. The conclusion of this research is that data and emissions factors are inconsistent and contradictory and that there are no reliable standards available. It depends on which footprint model is used and the assumptions that are made what the final result will be.

What we further saw in the literature about determination of the carbon footprint is mainly that organizations are non-committal. They have to explain why they make certain choices. However, benchmarking is very difficult because there is no real standard, especially not with scope 3 emissions. Organizations are free to choose which emissions from scope 3 they report and how. The only condition is that they have to explain their choices. This means that based on the current carbon footprint determination models, no good comparison can be made.

The researches done are not clear about which greenhouse gasses have to be taken into account. Also, the difference between direct emissions (from car combustion) or indirect emissions (emissions made for a product you buy) is not clear. It seems that different calculations result into different outcomes, based on different assumptions. In chapter 5 about green accounting, we discuss the relation between carbon footprint determination and green accounting deeper.

Chapter 4 – The EU Emissions Trading Scheme

4.1 Introduction

Emissions trading schemes are an important topic when talking about reduction of emissions and sustainability. Trading schemes are one of the main instruments to meet appointments about reduction of emissions. Because of the fact that trading schemes play an important role, this topic is also an important subject in this research regarding trading emissions between organizations. Besides the EU, there are some other areas also having an emissions trading system, like New Zealand and some States in the United States, but in this research we focus on the EU ETS as largest system with also the largest impact[8].

Emissions trading schemes in the form of cap-and-trade systems try to reduce CO_2 emissions via creating a new market. In this situation, companies have a maximum value of emissions they are allowed to emit, determined by the government. When a company invests in ways to decrease emissions, the company could sell the rights (allowances) of emitting to companies who emit more GHGs. When the maximum of emissions is determined (ceiling) and lowered every year, a company has to invest in reducing its emissions; otherwise it has to pay for it by buying rights from other companies. The idea behind this is that companies feel responsible themselves for their carbon footprint and that they try to reduce it. The result of such an emission trading is that if it's difficult to reduce emissions at one company, the company could 'outsource' reducing emissions to a company who can do it better by buying and selling certain allowances.

4.2 Cap-and-trade

Cap-and-trade is one of the possible trading systems that can be used. Cap-and-trade creates a market where the price for emissions will be determined by the market itself. One of the advantages is that other market influences as inflation will automatically influence the carbon price. The other systems that are possible – emissions fees and command-and-control regulation – are more dependent about governmental decisions. In the case about airlines, a flight tax (kind of fee for emissions) is also discussed. Below we will discuss the cap-and-trade system.

The most well-known cap-and-trade trading scheme is the one from the European Union (EU ETS) and in this scheme, half of the emissions of CO_2 of 30 countries (the EU-27 countries + Iceland, Liechtenstein and Norway) are taken into account, resulting into a market price of € 5-30 per ton CO_2.

[8] http://www.climatechange.gov.au/government/international/global-action-facts-and-fiction/ets-by-country.aspx; accessed at 14-08-2012

This price is dependent of the market and changes over time so there is no clear price available. In 2012, about 40% of the emissions from the EU will be covered by the ETS[9].

The scheme was developed after an international meeting in Kyoto and is derived from the Kyoto Protocol. However, the system operates independently from the Kyoto Protocol. This EU ETS includes the companies with the largest emissions: power stations, combustion plants, oil refineries, iron/steel works and cement, glass and lime factories are required to take part in this trading scheme when they have a net heat excess of more than 20 Megawatt. In the emissions trading scheme (ETS), free allowances are allocated to organizations, based on their historical data. These free allowances – determined by the national governments – are lower than the organizations' actual emissions, so they need to decrease emissions or buy rights to compensate for the extra emissions.

4.3 Banking and borrowing emission rights

The EU ETS consists of three phases and is started in 2005. Organizations that should take part in the trading system get allowances (1 allowance = 1 tCO_2). Within the phase (the trading period) they are allowed to emit until they have reached their maximum. If they exceed their maximum, they should buy allowances from another organization (that produced less than the maximum) or buy rights from the government through auctions. Within the specific phase, organizations are allowed to borrow or bank the allowances. In case of borrowing allowances, organizations use allowances from the next year. In case of banking, they save allowances and use them the next year (or even after some years). Borrowing allowances from the next phase isn't allowed, while banking to use allowances in the next period is allowed after some changes have been made to the regulations of the trading system. We can imagine banking and borrowing emissions rights in order to create some flexibility, but new policy from the government will always be a risk when using banking and borrowing.

The allowances will be reduced in every phase whereby the total amount of emissions in 2020 should be 21% lower than in 2005. In each phase, organizations get a lower cap for emissions and in each phase organizations that should participate will be added.

Phase	Time period	Adding to EU ETS
Phase I	2005-2007	-
Phase II	2008-2012	Airlines (2012)
Phase III	2013-2020	Petrochemicals, ammonia, aluminum industry

Figure III – The different phases with entry years of certain industries in the EU ETS

[9] http://www.internationalprofs.org/iesc/index.php?option=com_content&view=article&id=118:eu-ets&catid=908:eu-ets&Itemid=88; accessed at 14-08-2012

However, the EU ETS is not free of problems. In 2006, a large price dropping took place. The problem and at the same time the difference with a normal trading market, is that the European Commission decides which percentage of emissions should be traded. Furthermore, the industries that were influenced by this ETS came into a bad position related to their (international) competitors.

4.4 Offsetting emissions through CDM

Another way of reaching emission goals (in the ETS) is offsetting emissions. The Clean Development Mechanism (CDM), also derived from the Kyoto protocol, is a mechanism with which organizations can ‘outsource’ emissions to countries and/or organizations which can do that in a cheaper way. An organization can emit the same emissions, but should then invest in programs that offset the emissions of that organization. For example, a German company which invests in windmills in Turkey can compensate a part of its emissions.

However, the CDM isn’t always very effective. We illustrate this with some examples. According to a research from the World Bank[10], the CDM should only play an additional role. One of the examples is a situation in India, where HFC-23 (which has 11.000 more times impact per ton than CO_2) will be destroyed. The furnaces for destroying this HFC-23 are built by Indian companies that get the money from organizations which like compensating their CO_2. This means an incentive for them to produce even more HFC-23 in order to create new furnaces in order to receive new money for compensation. The result for the total amount of CO_2e in the air is even worse than without offsetting[11]. Therefore, from May 2012 the European Commission has forbidden the compensation of CO_2 in this way. Also, offsetting emissions by planting trees or saving trees from being cut is also disallowed under the EU ETS. The reason for this is illustrated by the Dutch documentary program ‘*Keuringsdienst van Waarde*’[12], demonstrating that buying compensation to save trees from cutting down by buying a piece of the Amazon forest, wasn’t correct. The certificate of property was checked and the forest was sold for many times to different organizations. These examples support the need for doing a good green accounting.

4.5 Emission rights accounting

It can be questioned how emission rights should be traded. Emission rights aren’t tangible goods. However, they have a tangible value as far as the value of the certificates containing the rights. These certificates have a value that is related to future production and can thereby be seen as inventory. Because without these certificates, a company isn’t allowed to emit greenhouse gasses by law.

[10] http://www-wds.worldbank.org/external/default/WDSContentServer/IW3P/IB/2011/04/04/000158349_20110404091922/Rendered/PDF/WPS5621.pdf; accessed at 14-08-2012
[11] http://www.trouw.nl/tr/nl/4332/Groen/article/detail/2456734/2011/06/23/CO2-emissiemarkt-trekt-georganiseerde-misdaad-aan.dhtml; accessed at 14-08-2012
[12] http://www.keuringsdienst.nl/page/23457/nl; accessed at 14-08-2012

The certificates can be valued in two ways. The first option is that the rights will be *valued at the price* that is paid for it. This is the simplest way but probably doesn't cover the value it has to the production. When an organization buys certificates, it can also decide to *value the rights related to its production of goods* and its related emissions and the possible future value. This second option will cover future values of the emission rights and organizations should thus anticipate at future values.

4.6 Chapter conclusion

The EU ETS is the largest scheme where other countries in the world can learn from and gives much information about selling and buying emissions rights. However, the risk of only focusing on emissions in the EU is that the ETS damages the economy in the European Union while at the same time emissions are not reduced but are emitted in other countries by outsourcing work to other countries where such a system doesn't exist. This is because of the fact that only direct emissions will be measured and counted as emissions where organizations in the EU are being responsible for.

The EU ETS gives emission reduction flexibility, more than with a standard tax. A standard tax is well-defined, but emission reductions can be expensive in some cases. With a trading system, the government determines the ceiling of emissions and thus the emission reduction goals. Organizations can decide themselves where emission reductions can take place at the lowest cost. This means that reaching emission reduction goals is cheaper. Organizations have to report to their national government but from 2013 there are plans to let organizations report directly to the European Commission.

However organizations get emission rights based on their historic production. So, when an organization had a very inefficient production regarding emissions, they will be rewarded with more free emission rights than organizations which already did savings with their emissions. Thereby, only the large emitters need to take part. Small companies – because of the administration – don't have to take part and get an advantage. Also, not all emissions are included in the system, only CO_2 plays an important factor while also other GHG have an influence on the environment.

Furthermore, it's difficult to value the emission rights economically. When value them at the paid price, the real value (future production) is not included in the price. Taking this value into account is difficult: organizations should estimate the future price of emission rights and this price is uncertain. In chapter 8, emission trading is discussed with a practical case in the airline industry.

Chapter 5 - Green accounting

5.1 Introduction

The term ‘green accounting’ is the base of the research. With accounting, there are standards, rules, regulations etc. In this chapter, the term green accounting is discussed with its issues.

Early scientific work was done by *Repetto* (1989) at the World Resources Institute in order to take green accounting into account. This study – Wasting Assets – showed that the economic growth of Indonesia was simply because of using the natural resources in a fast way. This led to the thought that not only money or the national income are the only factors that have to be taken into account, but also environmental factors. Because if somebody decides to use the natural resources, they could not be used in a next period. This is about the solidarity between parents and their children. Natural resources have a kind of ‘value’. Thereby, according to the IPCC with their report *Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change (2007)*, many natural resources have a role in the global warming and have an influence on the temperature.

The idea of environmental accounting is to go from a (current) well-being system to the future well-being system where natural resources are taken into account at an international level.

First we start with a definition of green accounting. Then we discuss how a report should be created based on the available standards GHGP and PAS2050 and what the possible issues are.

5.2 Definition

The definition of this kind of accounting is a little vague in the literature. Sometimes also the participation of woman is meant by terms like sustainability accounting. There are also different terms used: green accounting, sustainability accounting, environmental accounting, corporate sustainability etc. We especially focus on (CO_2) emissions and their impact and will use the term ‘green accounting’ for that.

When a definition of the carbon footprint is determined, one could take this into account in a company even as money. Instead of doing the bookkeeping with money, the bookkeeping could also be done by CO_2 (or other GHGs). The use of natural resources costs money for the total society, it has a value. Green accounting tries to take this fact into account and could support selling and buying emission rights for instance. In this paper we define green accounting as “*a type of accounting that takes into account the environmental costs of producing and supports the determination of emissions in a whole chain of production*”. The focus is at CO_2 emissions to make it clearer, but this doesn’t mean that other emissions are not important.

In the literature, Schaltegger (2010) states six reasons why sustainability accounting is done. These reasons are not always positive, but give an indication of the reasons that organizations use to explain using green accounting. Some of these reasons show why green accounting is needed.

- **Greenwashing**: when a manager tries to create reports that give better information about the sustainability of the company than the reliability. It's not illegal (yet), but trying to give the company a better reputation than it has;
- **Mimicry**: imitation. When other companies also do it, you want to do it also;
- **Legislative pressure and stakeholder pressure**: when stakeholders or (governmental) organizations ask the company to put a 'cap' on the emissions of GHGs;
- **Self-regulation**: driven by the companies mission itself for different reasons;
- **Corporate responsibility & ethical reasons**: these reasons could be more intrinsic but could also be driven by outside factors;
- **Managing the business case for sustainability**: accounting could make the economic potential of environmental activities clear and supports transparency.

5.3 Report creation

After establishing the reasons why green accounting is done, it's important to know how a report can be created from the determined emissions. The Greenhouse Gas Protocol (GHGP) gives some general steps that can be taken. In this way, the value chain can be described. First, scope I and scope II emissions are clearer than scope III emissions. Scope I and scope II emissions have to be a part of reports. However, the most difficult emissions to deal with are scope III emissions that were described in the literature study 'Carbon footprint'. These scope III emissions cover the whole lifecycle of products and services.

From the value chain – e.g. the lifecycle –, categories that are important should be taken, based on some reasons:

- The emissions of that category are large (or believed to be large), compared to scope I and II emissions of the organization (for example: transportation costs);
- The categories are seen as critical by stakeholders of the organization;
- The specific category contains possibilities for emission reductions;
- Outsourced activities: especially when an activity that is outsourced was done by the organization itself previously.

However, it isn't possible that all data of scope III is measured preciously. The GHGP states that estimates of emissions are acceptable, as long as they are transparent.

Companies, who would like to start with green accounting in order to establish the emissions they emit, should take a base year from where they start the calculations. Data from this base year should be available and verifiable. The base year should be the earliest year as possible but should also be a year from which reliable data is available. This base year should be the starting point for an organization to calculate the current and future (reductions of) emissions. According to the GHGP, it should be well explained why that specific base year is chosen. This freedom will be liked by organizations but doesn't contribute to a well-designed framework to determine emissions based on historical data. It's too non-committal, that can lead to an unequal field.

5.4 Procedures establishing reports

The description of the GHGP to identify and calculate GHG emissions is as follows:

- Identify sources
- Select calculation approach
- Collect data and choose emissions factors
- Apply calculation tools
- Roll-up data to corporate level

Identify sources

The first step is to identify the sources of the emissions and determine what type of emissions the sources have. The GHGP has four categories in which most emissions belong: stationary combustion, mobile combustion, process emissions and fugitive emissions. Available calculation tools are based on these categories. The emissions should also be categorized by the different scopes 1, 2 and 3. Sources that are excluded from GHG emission calculations (PAS2050) are:

- Human energy inputs (e.g. muscles power)
- Transport of consumers to/from retail point
- Transport of employees to/from place of work (commuting)
- Animal transport services

So, commuting and other traffic made by employees and consumers will be counted when determining emissions, according to PAS2050, but not according to the GHGP.

Select a calculation method

Emissions can be measured by monitoring them, but that's not practical. In most cases, the calculation method should be based on specific documented ratios. Emissions from fossil fuels and emissions from biomass should be measured and reported separately. Emissions caused by a short cycle (biomass) have a neutral effect within 100 year. Emissions caused by a long cycle (fossil fuels) have a large effect because the emissions take place much later than they are taken up.

PAS2050 gives an example from the logistics sector where products are distributed within different countries, with different ways of transport and different requirements. In such a situation, they say that the average release of GHGs should be calculated with the average distribution unless better information (precious measurements) is available. For the way of transport itself, the emissions should be divided over the products, based on the mass or volume of the products and the used way of transport. By calculating the emissions the return journeys should also be taken into account: does the vehicle contain goods when it goes back, or is it empty on its return? When a vehicle is empty when returning, probably (almost) two times higher emissions should be counted per product than when a vehicle is full with products at its return journey.

Many assumptions are taken in these cases and choices are made as trade-off between administration work and reliability & accuracy.

Data collection and emission factors choosing

Calculations are based on the kind of scope the emissions belong to. If available, emissions should be based on real emission data. Otherwise they should be based on the specific emissions factors. A company can decide to use the emission factors and say that they don't know the emissions factors while it has benefits for them. In short, data of energy use should be gathered within the different scopes:

Scope 1: purchased fuels
Scope 2: electricity consumption based on emissions factors of the mixes
Scope 3: activity data with the help of emission factors

Calculation tools application

The Greenhouse Gas Protocol Initiative has a website with different cross-sector tools (like electricity and combustion) and sector-specific tools (like cement, aluminum, iron producing etc.) to calculate emissions. The GHGP allows organizations to have their own calculation methods. However, the organizations should prove that they are better than the standard approach from the GHGP. According to PAS2050, functional units should be used to calculate to CO_2e amount or unit sizes when the size is variable. Again, this seems pretty non-committal.

Data roll-up to corporate level

Before rolling up the data to the corporate level, there are – according to the GHGP – two possibilities: centralized calculation (when facilities deliver activity data and 'quantity used' to the corporate level) and decentralized calculation (when facilities do the calculations themselves and after that transmit them to the corporate level). When choosing a decentralized approach, a description about chosen calculation methodologies should be given just like the ratio indicators which are used to calculate emissions at the facility level. When choosing a centralized approach, the facility gives the activity data to the corporate level and they describe what they did.

After an organization performed these steps well, they could set targets to decrease the emissions. They could either choose for *absolute targets* (to reduce the absolute emissions over time) or *intensity targets* (to reduce the emissions relative to a specific business metric over time). The last one also incorporates economic growth. However, this last one doesn't contribute to the (governmental) objectives of total emission reduction.

5.5 Chapter conclusion

Two main standards in green accounting are the GHGP and PAS2050. Yet, they are very non-committal. Organizations can choose themselves if they want to include other emissions than CO_2 and are non-committal when emission data is not completely clear. Another issue that has a great impact is the exclusion of commuting. Sprangers (2011) concluded in the research *Calculating the carbon footprint of universities* that from the Erasmus University in Rotterdam (the Netherlands), two-third of the emissions is caused by commuting of students, teachers and researchers. These emissions are an example of emissions that belong to scope 3 and can be excluded from the emission reports, according to these standards.

We can conclude that standards are available (like PAS2050 and GHGP) but because of the fact that they are very non-committal (especially to scope 3 emissions), they aren't clear enough for green accounting. Besides this, organizations are often allowed to choose their own calculation tools and methods. Thereby, in most cases they don't explain what ratios and factors are behind the reports. To do a good accounting, rules and regulations should be clear and not non-committal. This could be solved by making a certain standard an international accounting standard.
Also, standards seem little detailed. If most emissions are excluded because they are scope 3 emissions, it's an incentive for companies to outsource some production and make it scope 3 emissions instead of scope 1.

It seems important that a clear standard should be made – consisting of the already existing building blocks of the current documents – that is internationally valid.

Chapter 6 - (Accounting) Information Systems

6.1 Introduction

Selling and buying rights and keeping track of (emission) transactions in the production chain belong to accounting. Information Systems can support these transactions and nowadays Information Systems are indispensable.

Accounting Information Systems are systems based on the concept of Information Systems. According to Hall (2008) an Information System is '*the set of formal procedures by which data is collected, processed into information, and distributed to users*'. Accounting systems are systems that – it's in the name – processes the financial transactions, based on financial (for example amounts of money, amounts of products) and non-financial transactions like address changes of a customer.

In this chapter we start with a basic description of an accounting system and the different accounting types and systems that belong to those types. This is also important when talking about different emission reports. After that we'll shortly discuss an accounting framework, followed by a short discussion about the three accounting components people, processes and technology. At the end of the chapter, we discuss IT solutions for green accounting. This chapter supports the research questions by giving an overview how Information Systems can support green accounting.

6.2 Accounting types

Traditional accounting can be divided into three types of accounting: financial accounting (in a transaction processing system, TPS), cost accounting (in a general ledger or financial reporting system, GL/FRS) and management accounting (in a management reporting system, MRS). Financial accounting is the basic information of an organization and is used to create an overview of an organizations' financial position to the stakeholders. The balance sheet is an example of information that belongs to financial accounting. Cost accounting contains information about inventory and specific information from different departments and is linked to management control. With cost accounting, different departments, products etc. could be compared. Management accounting is especially meant for the management in order to make decisions, make plans and control an organization. Unlike the financial accounting and reporting, management accounting is not mandatory according to the law.

Because of the fact that financial accounting is mandatory by law, the system from which the transactions will be calculated should also comply with the law. This system, the financial reporting system (FRS), should e.g. comply with the Sarbanes-Oxley Act legislation and the controls should also be done in a clear way. The information of transactions from the Transaction processing system (TPS) should also be well implemented, if its transaction information flows directly into the FRS.

For green accounting, it means that there can be made a difference between different systems. Single transactions (like in the TPS) are not for external distribution, but the overview (like the FRS), should be based on some (international) agreements. These agreements can be supported by frameworks, like the SAS 78/COSO framework.

6.3 SAS 78/COSO framework

One of the well-known control frameworks is the SAS 78/COSO framework. In this framework, six useful controls play an important role regarding transactions in the TPS:

- **Transaction authorization**: a transaction has to be authorized by a qualified person;
- **Segregation of duties**: the different processes in order to get a transaction from the beginning into the general ledger (GL) should be done by different persons. For example, people who have access to physical assets should not do the record-keeping;
- **Access controls**: there should be well-designed access controls to the GL. Only a few persons should be allowed to get access to the GL;
- **Accounting records**: the records should be done in a clear audit trail. A good audit trail exists of a path with an input, the processing and output phases with a network of journals, documents and ledgers;
- **Independent verification**: a FRS produces two different reports, a GL change report and a journal voucher listing. These two reports could be compared in order to do an independent verification;
- **Supervision**: when there is a lack of personnel, close supervision is needed as a compensating control. This applies mostly at small organizations.

This framework can be well applied when creating an Information System for green accounting or when adding functionalities of green accounting to an existing Information System. It is important that such a system is well organized. Selling emissions rights for example should also be recorded in a good way. It's very important that every organization uses the same framework to make calculations, otherwise some can have disadvantages with clear reports while others benefit by creating unreliable reports.

6.4 Management reporting system

A Management reporting system (MRS) is driven by management interests and is in most cases not meant for external use. Because it isn't mandatory there aren't statutory rules. However, management needs to know that reporting is well executed and in order to establish that, a MRS can be used.

Despite a MRS isn't driven by statutory rules, there are factors that have an influence at the MRS. James A. Hall (2008) names six of them:

- **Management principles**: principles from the management, like the span of control, the responsibilities and the organizations' structure;
- **Management function, level and decision type**: the level of decision (top management or operation management) and e.g. the difference between short term and long term planning;
- **Problem structure**: difference between structured problems and unstructured problems. When problems are structured, they contain the elements data, procedures and objectives. An unstructured problem is more difficult to solve: for unstructured problems there are no procedures to solve it. The more unstructured a problem is, the more a problem has to be solved at a high management level;
- **Types of management reports**: a report could be scheduled (e.g. every month) or on-demand (ad hoc). It depends on the type of report which demands there are;
- **Responsibility accounting**: every economic event should be traced to somebody who is responsible for the event;
- **Behavioral considerations**: it should be well aligned between different managers; their individual objectives should contribute to the organizations' goals.

For green accounting, a MRS can be used to support the management with data and information about emissions so they can explain why certain choices are made. Thereby, future expectations about emissions can be calculated. However, it depends on the kind of organization how such a MRS should be developed and used.

6.5 Accounting components

Accounting systems consist of three components when talking about IT, whereby the third component 'technology' consists of different sub-components:

- People: people who work with the system. They are a part of the system: if they don't understand the system and procedures, the goals are difficult to reach;
- Processes & procedures: this is e.g. about how data should be transferred into information;
- Technology: the system itself with some aspects
    - Software;
    - Data;
    - Infrastructure;
    - Internal controls & security.

All those three components should play an important role in the Information System. People should work together and know how the system works, processes should be well aligned and clear and the technology has to work in a proper way. These three components have to be taken into account when taking decisions about Information Systems.

We now have explained traditional accounting systems and apply them to Accounting Information Systems for carbon footprints.

6.6 IT solutions for GHG monitoring

Schaltegger and Burritt (2010) discuss the question to what type of accounting the environmental accounting belongs to. It's possible to develop an entire new system, or as other option, extend the conventional accounting (financial, cost or management). *Schaltegger and Burritt* argue that it's best to develop a new system because they think it can support the new measurements better. However, they explain sustainability accounting as a broad type of accounting to which also social factors belong like age of employees. Companies that provide Information Systems like SAP already provide some modules to handle environmental accounting.[13] These modules are part of the already existing SAP systems in an organization.

The consultant company PricewaterhouseCoopers has done a research about investigating in IT solutions for GHG emissions monitoring. One of the main findings in this research, executed in 2006, was that many companies use (complex) spreadsheets and that the average time needed for determining and reporting emissions was about 40 man-days per installation per year.

However, spreadsheets have a high-risk, according to this research. They are less secure, the data integrity could be discussed and also the verification and the maintainability are difficult. Thereby, creating reports from the same spreadsheet data is time-consuming. Reports based on this data could be asked by authorities, but are also needed for the company's statements about sustainability. At the same time, most companies use intelligent software like ERP systems to handle the companies' data and to report e.g. about the company's financial statements. Using an IT solution to manage GHG solutions could improve the cost effectiveness, data integration, the reliability and verification time of the reports and creates the possibility of more on-demand reports at different points in time. Although these advantages are large, the implementation of such a system should be done carefully; different data sources that should be linked to each other should be taken into account.

The different solutions provided in that research differ in some functional requirements and non-functional requirements. An organization that is going to use a system should consider its requirements first. Do they want a good helpdesk, provided by the company that provides the system? Do they only want to track CO_2 emissions or also other emissions? Or do they need more advanced emission prediction systems? Does the software provide different languages? Also the importance of the connection between other systems an organization is using should not be forgotten.

[13] http://scn.sap.com/docs/DOC-4798; accessed at 14-08-2012

6.7 Chapter conclusion

Information Systems can support green accounting and nowadays organizations can’t work without them. Because of the fact that products (belonging to services) have not only a monetary value, but also have a valuable impact on the environment, accounting can support statements about the emission data throughout chains. Especially when governments make legislation and organizations are required to keep track of their emission data.

However, we can question the price of doing such an accounting when there are no governmental official requirements. Keeping track of the energy use and determining the emissions needs time and thus (expensive accounting) man hours, money and changing processes. We can imagine that these changes in an organization results into extra work that can also result into (some) emissions.

This means that when determining about doing green accounting, the costs and the emissions of the green accounting processes itself should also be taken into account. However, when legislation demands verifiable statements, accounting systems are indispensible. The best is to develop extensions for monetary accounting systems so the environmental impact can be linked with the costs. Only using one system in an organization is much easier and results into cost savings and a higher reliability.

Chapter 7 - (IT) Audit

7.1 Introduction

Auditing is important to validate if transactions are right and if a system works well. Accounting needs a good verification. When a good verification is not possible, other stakeholders from an organization can't verify if the statements that an organization makes are reliable. There may be no leaks. First we discuss audit in general, after that we head to green accounting.
In this research, audit is seen as a support to accounting. It plays a supporting role.

According to the Encyclopedia Britannica, *audit* could be formulated as: '*examination of the records and reports of an enterprise by specialists other than those responsible for their preparation*'. Audit is the control of systems and procedures by other people than those who performed the actions in systems or those who lead the procedures. In audit, there are two types of audit: internal auditing and external auditing. Internal auditing will be done by people who work in the company itself. They know the systems and procedures and could work faster and could report more detailed about mistakes. They check compliance with rules and regulations and seek for areas where work could be done more efficiently and effectively. At the other side, external auditors are independent from the company and are interested in the effects of the performed activities on the financial statements and if these financial statements are proper.

IT audit is usually done within a broader audit. However, because organizations use more ICT nowadays, the importance of IT audit is more important. The extension of green accounting to the 'normal accounting' adds an extra dimension to this audit. Auditors should check if the organization complies with the governmental regulations in case of the emission rights and rules. Because of the fact that Information Systems automatically create statements, not only the results of the statements should (and could) be verified, but also the way in how these results are created by the Information System. IT audit is different from comparing physical evidence (like receipts) or digital information with data stated in the system. IT audit also looks how data that was put in the system is processed. This data will be processed by programming rules and mathematical calculations. When there is a mistake in the programming, the input data and output information can be 'right'. However, the information is not the information that should be provided. IT audits could also be done at green accounting. This asks for a specific knowledge about how e.g. emission data should be transferred into reports and according to which rules and regulations the reports must satisfy.

7.2 Audit green accounting

With green accounting, just like with normal accounting it's important that information is available and reliable. Only when these factors are good, a good verification is possible. For green accounting, it's important that it's clear how much CO_2 an organization emitted and that their way of determination of total emissions is done in a right way. Thereby, it's important that the calculations to the end reports by IT systems are done well. Auditors should check that used amount of fuel multiplied by the emission factor will lead to the right result.

7.3 Chapter conclusion

We can conclude that audit is important when we want to determine the reliability of a system and the reliability of data. Especially for green accounting, it's important that emissions data is clear and that there are no leaks in the system. A lot of the same issues, as in normal IT audit, are important however the biggest difference is the determination and calculations of emissions which is more difficult than calculating with money.

A good framework is therefore needed in order to establish clear procedures in accounting so we can end up with good verifiable results.

Chapter 8 - Case airlines in trading scheme

8.1 Introduction

In this chapter, a concrete case about the EU Emissions Trading Scheme (EU ETS) for airlines is discussed. Only discussing literature results in general statements that stay without a concrete interpretation. In this case especially airlines are chosen because it is actual, represents a large, international industry that emits many emissions and an industry that should take part in an emissions trading system. Thereby, it makes the literature topics more concrete and it will widen the discussions about emissions and the value of emissions. The discussion about the value of emissions is applied to concrete examples in the airline industry. This concrete case will support answering the research questions by addressing and discussing issues.

Airlines in the EU should take part in the EU ETS, as said in the literature study. The target of the EU is a reduction of 20% of its emissions in 2020 from 1990 levels. About 11.000 installations in the EU are taking part in the EU ETS already and airlines should also take part into this cap-and-trade system from January 2012. This case is used to illustrate one specific group, the airline industry, which should take part into the EU ETS. This group is chosen because it's a new group and has many challenges because of the fact that airlines act internationally, logically. This means that a good accounting is an important factor. In this chapter, problems and challenges are discussed.

8.2 Overview of the case study

In this case study, first the history and the background of the EU ETS will be described and what the role of airlines is in this system. Then facts & figures about the trading system will be described with information how the system works. This basic information supports the rest of the case study: advantages and disadvantages in the system based on literature information and own research and the (financial) impact on airlines and consumers. A comparison between the EU ETS and the (former used) flight tax in the Netherlands and Germany is made and different possible calculations and savings are stated. This chapter ends with an analysis and conclusion of this case.

8.3 History and background of ETS

The EU airlines industry is responsible for about 3% of the CO_2 emissions in the EU from January 1, 2012 according to the European Union[14]. According to them however, the airlines industry is also the fastest growing industry that delivers 87% more CO_2-emissions than the base year 1990. From January 1, 2012, airlines which depart from or arrive in the EU have to take part in the Emissions Trading

[14] http://europa.eu/rapid/pressReleasesAction.do?reference=IP/06/1862; accessed at 14-08-2012

Scheme from the EU. Despite of criticism from the United States and China[15], all airlines should take part for the flights to and from the EU. That means that besides the given 'free rights' for every amount of CO_2 emissions should be paid or compensated when a plane lands in or departs from the EU. If they don't they should pay a penalty of 100 euro per emitted ton of CO_2 and can be banned to land in the EU. To take part, airlines must have a clear overview of their emissions and this data should be verifiable.

The EU ETS is concentrating mainly on the emissions of greenhouse gas CO_2. There are publications about flight emissions that also NO_x, contrails and cirrus clouds (e.g. *Burkhardt and Kärcher,* 2011 and *NASA*, 2004[16]) have at least the same impact on the environment as CO_2, but these don't count in the EU ETS. The EU ETS is only focusing on CO_2. The effect from other greenhouse gasses and the contrails and cirrus clouds are not directly part of this research although there is enough to say about for further research.

8.4 Facts & figures

The base is the average amount of emissions from all the airlines landing in and departing from the EU during the years 2004, 2005 and 2006: 221,4 megaton CO_2. There is a cap of 97% on this average in 2012 and a cap of 95% of these emission amounts in the period 2013-2020. The average emissions of all airlines between 2004 and 2006 determine the total emission rights. This means that in 2012, there should be 3% less CO_2 emissions than that average and in the period after 5%. An airline receives the free emission rights based on the data of two years before the year in which the emission rights will be given. This means that the growth of the total airline industry has got a negative impact on the total CO_2 emissions (they are higher) in 2010. This year will be used to determine the amount of emissions an individual airline gets for free in 2012 and the amount they have to compensate, spare or buy. So indirectly, the cap is higher than the 3% or 5%. The CO_2 cap is a 'hard' cap and independent from grow and loss. As a result, grow of airlines can be reduced.

Period	% of baseline	Free	Auctioned	New entrants & fast growers
2004-2006	100%	-	-	-
2012	97%	85%	15%	0%
2013-2020	95%	82%	15%	3%

Figure IV – Percentage of emissions that airlines will get and should get by auctioning

[15] http://www.luchtvaartnieuws.nl/nl-NL/Article.cms/Airlines/Druk_op_Europees_emissiesysteem_neemt_toe; accessed at 14-08-2012
[16] http://www.nasa.gov/home/hqnews/2004/apr/HQ_04140_clouds_climate.html; accessed at 14-08-2012

Period	% of baseline	Free	Auctioned	New entrants & fast growers
2004-2006	221,4 Mt (100%)	-	-	-
2012	214,8 Mt	182,6 Mt	32,2 Mt	0 Mt
2013-2020	210,3 Mt	172,5 Mt	31,5 Mt	6,3 Mt (each year)

Figure V – Value of emissions that are divided and auctioned

Exceptions

All airlines should take part into the EU ETS scheme, whether they transport passengers or freight. There are a few exceptions. The exceptions that are made are:

- Commercial airlines that make less than two flights to or from the EU a day or emit less than 10.000 tons of CO_2 on flights to or from the EU (this accounts for airlines from about 100 countries in 2012, who do not have to take part into the EU ETS);
- General or small aviation, aviation types with a MTOW (maximum take-off weight) less than 5.700 kg;
- Governmental flights, military flights, emergency and first aid flights, training flights and flights made under the Visual Flight Rules (flights that only fly on visibility conditions).

8.5 From fuel to CO_2 emissions

The current practice in the EU ETS is that the CO_2 emissions are determined by the consumption of fuel. The fuel consumption multiplied by the emission factor results in the amount of CO_2 emissions. The *IPCC* (2006a, pp. 64) created a report with the emission factors of the different fuel types. The most used ‘Jet Kerosene’ emits an average of 71.500 kg CO_2 per TeraJoule energy (with a 95% interval of 67.500-73.000 kg). The calculation is physical and doesn’t fully belong to the research. The exact calculations and explanations are in the tables of the *IPCC* (2006b, pp. 23-26) and in the information of the U.S. Department of Energy[17]. However, it’s important to know the CO_2 emissions of 1 liter of kerosene and this is, according to the calculation in Figure VI, about 2,49 kg CO_2 per liter kerosene.

[17] http://www.fueleconomy.gov/feg/co2.shtml; accessed at 14-08-2012

1 kg kerosene Jet A1	43,15 MJ energy[18]
1 kg kerosene	0,775-0,840 liter kerosene (take 0,8075 as mean[19])[20]
1 liter kerosene	34,84 MJ energy (43,15*0,8075)
1 TeraJoule energy from kerosene	71.500 kg CO_2 [21]
1 MegaJoule energy from kerosene	0,0715 kg CO_2 (/ 1.000.000)
1 liter kerosene (Jet A1)	2,49 kg CO2[22] (34,84 MJ * 0,0715 kg CO2)

Figure VI – Energy values and emissions of kerosene

This means that an airline emits about 2,49 kg CO_2 per liter used fuel. An airline is only allowed to differ from this scientifically determined average if the values for the used energy resource are tested in a scientific lab. So, in the EU ETS the CO_2 emissions are calculated with the amount of used fuel. It's calculated in the following way:

"Fuel in the tank before the flight – fuel in the tank after refueling the plane for the next flight + amount of tanked fuel for that flight" [23]

This means that the extra fuel which is tanked for security reasons is taken into account and does not count.

Now we know the facts and look to the issues of the system.

8.6 Issues

The trading system is not free of problems. In this part, we will list a number of disadvantages and issues.

[18] http://www.bp.com/liveassets/bp_internet/aviation/air_bp/STAGING/local_assets/downloads_pdfs/a/air_bp_products_handbook_04004_1.pdf p. 14; accessed at 14-08-2012

[19] There are different values available to estimate the density of kerosene at 15°C. The BP report says 80,4 and http://www.simetric.co.uk/si_liquids.htm says 81,715; accessed at 14-08-2012. In this research, 0,8075 is taken.

[20] http://www.mepetroleum.com/jet_fuel.htm; accessed at 14-08-2012

[21] IPCC report http://www.ipcc-nggip.iges.or.jp/public/2006gl/pdf/2_Volume2/V2_3_Ch3_Mobile_Combustion.pdf, p. 64; accessed at 14-08-2012

[22] The U.S. Energy Information Administration sets the CO_2 emissions of Jet Fuel at 9,76 kg CO_2 per gallon (= 2,53 kg CO_2 per liter http://www.eia.gov/oiaf/1605/emission_factors.html); accessed at 14-08-2012

[23] http://www.co2-e.nl/luchtvaart.php; accessed at 14-08-2012

Exceptions

We have already described the exceptions of airlines that don't have to take part in the system. One of the possible objections against the exceptions is why airlines which play a role like SLM (Surinam airlines, flying between Amsterdam and Paramaribo)[24], don't have to take part because they only fly on this route between EU and non-EU and that amount of kilometers is below the minimum level from which taking part is mandatory. KLM, also flying on this route, should take part in the EU ETS and has a competition disadvantage. One of the reasons for these exceptions could be keeping the administrative costs at a low level. However, this reason is in contradiction with the reason that every country (also non-EU) should take part to prevent competition disadvantages. One of the possibilities can be that KLM outsources their flights between Amsterdam and Paramaribo to SLM so that the EU ETS could be avoided. When outsourcing, the party who does the operation of the flight is responsible (they tank the fuel and make the kilometers). This will not only result in no effect on emissions but will also disrupt economic competitiveness. SLM can become a monopolist on that route.

Flying other routes

An airline that knows what the costs are of CO_2 emissions can, in case they look to profit particularly, see if they could change their CO_2 emissions not only by decreasing their emissions per kilometer but also by flying other routes. In case that not the whole world takes part in the system (like it's the case with the EU system), it's possible for airlines to change their schedules. For example: to reduce CO_2 costs, flights between Amsterdam and Kuala Lumpur can be interrupted with a stopover in Istanbul (or Dubai). In the system only the distance between Amsterdam and Istanbul counts. Because an airline gets 85% of their emissions for free in 2012, an airline who made direct flights in 2010 could gain rights by making a stopover (they could sell the rights between Istanbul and Kuala Lumpur based on 2010 data or use these rights for other flights). Airlines that already exist have an advantage compared to new airlines that can't do these 'tricks'. Doing this doesn't reduce CO_2 at all, it even increases the CO_2 emissions (making a stopover means more kilometers and taking off and taxiing takes a large amount of the emissions of a flight).

At the other side, the costs of the CO_2 emissions in a system where 82% of the 'costs' are given for free, are not very high (Figure VII). It's a good question if an airline the extra costs that it has to make could save by making an extra stopover. Passengers like flying directly (saves time) and time is also money for cargo flights. Also, the airline should pay the extra costs for landing and handling of the landing and takeoff. Side effects like cheaper kerosene at the airport of the stopover and having less fuel during (and thus weight) a large part of the flight can possibly compensate these extra costs.

However, there is a greater danger: airlines that fly from North-America or South-America to the Middle East or Asia through hubs in Europe. There is a risk that these airlines decide to choose for a

[24] http://www.slm.firm.sr/; accessed at 14-08-2012

new hub in the Middle East (for example Dubai) because they have to pay or get allowances for the whole flight (they arrive in the EU and they depart from the EU). Thereby the same situation appears as with the flight from Amsterdam to Kuala Lumpur: airlines that decide to choose another hub still get emission rights, because they are based on the emission data from the year before the previous year. They can get money for the rights they don't need then. There are no advantages for CO_2 emissions, but windfall profits[25][26] can arise. Windfall profits are unexpected profits, caused by external factors. At the time the EU ETS was introduced, this situation is discussed several times and happened at energy companies who have got too much free rights which they could sell and so they have created an extra profit for themselves. The effect can be that airlines try to sell these rights and that the price of emissions rights in the whole market will decrease because of the large supply. The same situation as in 2007 can happen, when the price of an allowance was only € 0,03 (in August 2012: around € 7,00). For airlines and also for other organizations that take part in the EU ETS, no incentives based on costs are available to decrease CO_2 emissions. The effect will be temporary, because the airline that changes their schedule gets fewer allowances in the new year. Nevertheless, it's an undesirable effect that can happen.

Compensating already exists

Another issue is the fact that there are already programs to compensate the CO_2 emissions from a flight. Passengers can, sometimes via their own airline, sometimes via an external party, compensate their flight emissions. In many cases, this CO_2 will be compensated by projects in third-world countries by planting trees. In the EU ETS, it is not allowed to compensate with 'sinks' like planting trees. The reason can be that planting trees can't be verified in the future (who checks if trees are plant or not?) and because of the fact that trees take CO_2 but emit the CO_2 back to the nature when they die. In some cases there are investments in CDM-projects: projects in third-world countries that should decrease CO_2 emissions. If passengers compensate their CO_2, it can be that passengers get a smaller incentive to do these compensations if airlines let people pay for the CO_2. They have already compensated then. A miscalculation can be made, because 18% should be bought or compensated and 82% of the CO_2 can be emitted 'for free' in the EU ETS. Responsibility can decrease and people can think that they can take a flight without being responsible for the CO_2 emissions: "The airline has already been responsible."

After we have seen some issues, we have a look at the cost impact for passengers and airlines.

[25] http://www.economist.com/economics-a-to-z/w#node-21529318; accessed at 14-08-2012 and http://www.wisegeek.com/what-are-windfall-profits.htm; accessed at 14-08-2012
[26] http://www.ecn.nl/docs/library/report/2008/e08007.pdf; accessed at 14-08-2012

8.7 Impact prices

An airline receives a large part of the allowances for free (85%). An airline can choose to transfer the costs of the not-free emissions to the customers. They can also decide to transfer all the emission rights, both the not-free (15%) and the free (85%) emissions. Two situations can be created. The first one are the so called 'windfall profits' when airlines create an extra profit for themselves. Such a situation is possible at routes where there is only a little competition or not at all. However, an organization should justify itself to their customers and can do this by investments in technology or research to improve for example the production of bio fuel. Another option is investing in more efficient airplanes that use less fuel per distance.
It is thinkable that a complete transfer will not take place in a market where competition is large and a 'green image' is less important than the price.
The second option is that an airline takes the costs of the emission rights of CO_2 themselves. The costs can be processed into the ticket price or in a fuel surcharge. If the airline does nothing with the ticket prices, logically the profit will be less.

Calculation

In the following calculations, a CO_2 calculator from KLM will be used to show prices for both a flight ticket and the costs of the CO_2 emission trading. The KLM calculator[27] says that on a return flight between Amsterdam and Johannesburg (2 x 9.000 km) there is a CO_2 emission of 1.388 kg per passenger. An assumption that is made in this calculation is the market price of one allowance (1.000 kg CO_2): € 12,00. This price is chosen because of an average price based on historical data and a future price assumption[28]. This will result into costs of (1.388/1000)*12 = € 16,66 if 100% of the emissions will be transferred to the passenger and about € 3,33 (20%[29]) of the emissions, if only the part of emissions rights that should be paid, will be transferred. At a distance of 2 x 9.000 kilometers there are little costs compared with the other extra costs and the ticket price. It's about the direct return flights from Schiphol, executed by the KLM and with the prices of November 2011. The costs in the table below are indicative and based on a random flight in the economic class with average prices and are the costs that are given by KLM when booking a flight. In most cases the price will increase when booking a last minute. This is important information because the prices for flights change fast and are dependent of date, time, flight class, height of taxes, demand and supply etc. In the table below, we choose four different destinations, a long, middle-long, shorter and a very short flight, executed by three types of Boeing airplanes: a 777, 747 and a 737.

[27] http://www.klm.com/travel/nl_en/plan_and_book/fly_co2_neutral/calculator/index.htm; accessed at 14-08-2012

[28] The price will increase in the future, but is at the moment of writing (August 2012) only about 7 euro. That means that the prices are even lower than stated in this thesis. The assumed price is to take future increases in prices into account, although it's possible that the price will increase (or decrease) even more.

[29] In 2013 15% and in the period after 20% of the emissions are not free. To take into account some little extra effects like growing of the airline, we round the percentage up to 20%.

From Schiphol to	Johannesburg	New York	Cairo	Paris
Aircraft type	**Boeing 777**	**Boeing 747**	**Boeing 737**	**Boeing 737**
Amount of km	**18.000 km**	**12.188 km**	**6.852 km**	**893 km**
CO_2 emissions	**1.388 kg CO_2**	**1.052 kg CO_2**	**506 kg CO_2**	**70 kg CO_2**
Ticket price	€ 567	€ 345	€ 193	€ 101
Booking fee	€ 10	€ 10	€ 10	€ 10
Fuel surcharge	€ 250	€ 230	€ 170	€ 70
Airport passenger surcharge	€ 26,89	€ 23,84	€ 14,89	€ 16,92
Air Passenger Tax	€ 17,09	-	€ 6,13	€ 12,68
Airport passenger surcharge	€ 14,89	€ 14,89	€ 10,97	€ 14,89
Security surcharge	€ 12,68	€ 12,68	€ 12,68	€ 11,28
Noise surcharge NL	€ 2	€ 2	€ 2	€ 2
Surcharge passenger safety	€ 1,62	€ 1,83	-	-
Various costs	€ 1,80	€ 16	€ 0,74	€ 1
Subtotal	€ 903,97	€ 656,34	€ 420,41	€ 239,77
CO_2 -surcharge 20%	€ 3,33 (+0,37%)	€ 2,52 (+ 0,38%)	€ 1,21 (+ 0,29%)	€ 0,17 (+ 0,07%)
CO_2 –surcharge 100%	€ 16,66 (+1,84%)	€ 12,62 (+ 1,92%)	€ 6,07 (+ 1,44%)	€ 0,84 (+ 0,35%)
Total with surcharge 20%	€ 908,97	€ 658,86	€ 421,62	€ 239,94
Total with surcharge 100%	€ 920,63	€ 668,96	€ 426,48	€ 240,61

Figure VII – KLM flights with the extra costs per ticket when applying EU ETS costs

The results of this analysis can be well compared with the research from *Scheelhaase & Grimme* (2007) who argue that the EU ETS "would produce relatively moderate financial impacts on airlines subject to the ETS". *Scheelhaase & Grimme* argue that, dependent from the kind of airline (network carrier, local airlines, holiday airline or low cost airline), the cost increase will be between 1-3% of the profit of an airline. In this research, the effects are researched dependently of different options when it was not sure how the system actually should work. One of the researched options – whereby all flights that land in or depart from the EU should take part – is almost the same as the current situation. With this option, one allowance has a price of € 30,-, which is substantial high regarding current and historical prices. In the table below the research results from local airline Air Dolomiti, holiday airline Condor, network carrier Lufthansa and low cost airline Ryanair are shown.

	Air Dolomiti	Condor	Lufthansa	Ryanair
Allowances cost in % of revenue	1,01%	1,98%	0,84%	3,02%
Cost of allowances per passenger	€ 1,01	€ 2,97	€ 1,74	€ 1,33
Demand reduction in %	-2,03%	-2,44%	-1,51%	-5,56%

Figure VIII – Elastics of demand when applying an ETS according to Scheelhaase & Grimme

The differences can be explained from the different principles the airlines work with. Ryanair works with the no-frill principle: a ticket has a value for transportation from A to B, but for luggage, meals, priority services etc. should be paid extra. Travelers who travel with a low cost airline are more price-sensitive, according to *Scheelhaase and Grimme* (2007). Lufthansa is more like a service airline: the costs for different services are already transferred into the ticket price. Thereby more business people travel with Lufthansa: they should take a specific flight and are less flexible than a leisure traveler. A leisure traveler can decide to go to another place for holiday or even stay at home. That's why the CO_2 costs per passenger for low cost airlines are larger than for network carriers.

8.8 Comparison EU ETS and flight tax

Like the rest of the large industry in the EU that is taking part in the EU ETS, airlines that take part in the EU ETS need allowances whereby one allowance counts for the right to emit one ton (1.000 kg) of CO_2. The price of allowances is determined by the market and dependent of demand and supply. Another option can be pricing the CO_2 with a tax. The difference with an ETS is that CO_2 savings cannot be traded and so savings cannot take place where this could be done in the most efficient and cheapest way. Therefore, the EU decided to trade the allowances via economic market instruments.

First we look at the Dutch flight tax system. The Dutch flight tax was a simple system. Flights with a shorter route than 2.500 km and/or flights with a destination at an airport in the European Union were taxed with a tax of € 11,25 per passenger per flight. Flights that had as destination an airport outside the EU and had a longer flight route than 2.500 km were taxed with a tax of € 45,00. There is little to discuss about; the boundary (EU and 2.500 km) was clear. However, there were also some negative effects. Based on the data from airports in Belgium and Germany the amount of Dutch passengers travelling via their airports was growing[30], while at the same time the CEO of the Dutch KLM talked about a loss of 900.000 passengers in the Netherlands (mainly the Schiphol airport)[31]. The system of the Dutch flight tax was also discriminating, because passengers that wanted to make a step over

[30] www.nu.nl/economie/1764426/nederlanders-ontwijken-vliegtaks.html; accessed at 14-08-2012
[31] www.nu.nl/economie/1926540/vliegaks-kost-nederland-al-900000-reizigers.html; accessed at 14-08-2012

didn't have to pay taxes. So, there was a possibility to travel from a foreign country to Schiphol and having a step over (without leaving the airport) there to avoid the intercontinental surcharge of 45 euro. In the EU ETS, not only the way of pricing is different but also every plane that lands or departs should take part in the system.

Somewhat later also Germany introduced the flight tax. The system is a bit the same as the Dutch system whereby a tax of 8 euro will be asked for EU destinations, 25 euro for middle distances and 45 euro for long flight distances[32]. Also Germany saw the consequences of the flight tax: airport Weeze, nearby the border with the Netherlands, lost 34,5% of its passengers in the first quarter of 2012, compared to the first quarter of 2011[33].

Comparing to the EU ETS, the cooperation within Europe has a stronger effect than when only a single country is operating on their own. Beside the fact that the flight tax is just a general tax, cooperation with 30 countries is more difficult to circumvent. For passengers, flying from another airport outside the country will be more difficult. For airlines, flying to other airports to circumvent taxes is also more difficult. Airlines and people could use airports outside the EU like Switzerland or Croatia. However, the most important European hubs are London, Paris, Frankfurt and Amsterdam and these airports are inside the EU. Intercontinental flights will go through these airports so taking not part in the EU ETS is difficult. Besides this, Switzerland has its own Trading Scheme and there are some plans to link this system to the EU ETS[34] and Croatia is on its way to enter the EU and should therefore also take part in the EU ETS. Besides these countries, also Morocco, Belarus, Ukraine, Russia, Turkey and some Balkan-countries have an airport just out of the border of the EU-27 (+ the countries Iceland, Liechtenstein and Norway)[35]. It costs a lot of time and money to travel between an EU country and one of these non-EU countries over land or over water. These costs are probably higher than the extra costs of flight tickets. Besides this, for most people it can be a disadvantage to travel to and from the outside EU countries because of the services and probably safety of the planes.

The costs that a passenger has to pay extra because of the EU ETS are much lower than for a flight tax. For example, a flight to Johannesburg from Amsterdam will, in case of an allocation of 20% of the CO_2 emissions, cost € 3,33 extra per passenger with the assumption of an allowances price of 12 euro. Even if the allowances don't cost 12 euro, but for example 36 euro, the extra costs per passenger will be about 10 euro. In the system of the Dutch flight tax, it was 45 euro, even far above the 100% costs of the CO_2 emissions (100% = € 16,66). Only with a non-existent single flight from 50.000 km (45 euro / 16,66 euro * 18.000 from the retour distance Amsterdam – Johannesburg), the 45 euro tax is

32 www.travelvalley.nl/Vliegen/846; accessed at 14-08-2012
33 http://www.nu.nl/economie/2869352/vliegtaks-kost-duitse-luchthaven-weeze-passagiers.html; accessed at 14-08-2012
34 http://www.cembureau.eu/newsroom/article/eu-link-ets-switzerland; accessed at 14-08-2012
35 http://ec.europa.eu/clima/policies/ets/index_en.htm; accessed at 14-08-2012

equal with the costs of the CO_2 emissions with a market price of 12 euro. Even with a much higher market price, the average flight will be not more expensive than this 45 euro flight tax.

In comparison to the flight tax, like executed in the Netherlands between July 2008 and July 2009 and is executed in Germany from January 2011, the EU ETS works very different in valuing CO_2 emissions. With a flight tax a standard amount of money will be asked from every passenger, independent from the efficiency of fuel use per traveler distance and thus largely independent of the CO_2 emissions. The flight tax can be called a 'simple taxation' that has no direct relation with the environmental load. The effect is a higher price per flight, partly independent of kilometers. With the flight tax there is a lower amount of administration (a flight tax is clear and simple), but it misses the efficiency from the EU ETS, that can result into emission savings at the best place. Thereby, the examples of the EU seem that a flight tax can also be much more expensive than the EU ETS, of course dependent from the governmental decisions. There is no green accounting needed when applying flight taxes, because normal accounting can also support this tax.

8.9 Calculations and savings

The EU ETS only covers the scope 1 emissions. To determine these emissions, there are four ways to determine the CO_2 emissions of air traffic to the airlines. The way how determination has to be done has a large impact on the processes in green accounting.

- **Per passenger**: the total CO_2 emissions of an air movement can be allocated to the passengers. It's possible that an overview per type of aircraft of the CO_2 emissions that are made per passenger kilometer will be made. In practice, this means that an airline only has to pay per traveler and not per flight. If not all chairs in an airplane are in use, an airline has less costs than with a full plane. A big disadvantage is that the real CO_2 emissions are not the same as the calculated CO_2 emissions. In this way, airlines have no incentive to fly more efficient (higher average of passenger occupation per airplane). Also, this way of calculations cannot be applied to cargo flights.
- **Per weight:** CO_2 emissions can be allocated dependent of the weight of the plane. A heavier plane will emit more CO_2 emissions than a lightweight (and empty) plane. It's an option to calculate the empty weight (sum of the weight of a plane without passengers, cargo and fuel), the weight of the passengers (assuming an average weight per passenger), the freight and the weight of the fuel. This method can be applied to cargo flights. Ton kilometers can be used: the amount of transported tons multiplied by the total amount of kilometers. However, it's difficult to calculate in this way. A big disadvantage is that it's not always clear what the weight of a plane is. A pilot should know, before leaving the airport, what the weight of its plane is. But checking this by leaving outside the EU would be difficult. Fraud can be applied

easily and the weight of a plane that lands is less than a plane that leaves because of the fuel use.

- **Per amount of fuel:** it's also possible to determine the CO_2 emissions with the used liters of fuel. This is done right know with the EU ETS. The CO_2 emissions per liter of kerosene are known and this method seems the easiest way to determine how many CO_2 is emitted. However, each plane takes away more fuel than exactly needed. A plane can get in situations where landing at its destination is not possible or can get other problems that give trouble. By leaving the EU it's difficult to determine the exact CO_2 emissions based on the fuel, because the remaining fuel should be subtracted from the tanked fuel. The remaining fuel after the landing can be controlled, but at the same time is less reliable with airlines that don't have a hub in the EU. Of course, verification is not complete impossible, because there are available averages of fuel use per aircraft type, weight and distance. However, if a flight is fully booked, it's attractive to specify the fuel use a little bit different from the reality. In the EU ETS the extra fuel is exempted by measuring the amount of fuel in the tank after refueling minus the tanked fuel. In this way, the extra taken fuel doesn't have to be taken into account. The administration of the tanked fuel could be done into two ways. The first is via the airlines themselves and the second is via the fuel company that puts the fuel into the plane. The most easiest one and also best one, mainly because of the fact that the aircrafts land and get fuel on different airports and the fact that airlines are responsible for the CO_2 emissions (the EU ETS keeps the airlines responsible), in this system is to calculate with the data of the airlines.
- **Flight kilometers**: there can be decided what the average CO_2 emissions are per flight kilometer (or in aviation terms: nautical miles). If the place where a plane will enter the EU is known (and with normal flights this is known), the flight kilometers are also known. Kilometers can be calculated by making a straight line between the place of arrival and the place of departure. However, it's more logical to determine the flight path of a plane and use this for determining the total distance. Per kilometer, the CO_2 emissions can be estimated based on the type of aircraft. However, the factor weight should be taken into account. A full occupied plane or almost empty plane (an Airbus A380 can for example transport more than 800 passengers in the maximum configuration but can also have an occupation of only 200 occupied chairs. The same situation applies to cargo flights with the weight of the plane) has a big influence on the fuel use of planes and so for the CO_2 emissions. Another problem is the difference between long and short flights. A plane uses very much fuel by taking off and with a short flight there will be more CO_2 emissions per kilometer – in the same conditions – than with a long flight. This extra fuel is caused by taxiing and ascending until 160 knots (300 km/h) for large passenger planes. The landing mostly takes place with this same speed. The further difference in flight height can be (partly) scratched-out against each other according to the physics.

In the calculation, there should be a kind of a 'start CO_2 emission' for the moment when a plane starts its engines and when the wheels come off the airstrip. There should also be an 'end CO_2 emission' between the moment a plane is taxiing and the moment the engines will be put off and/or the plane has been parked.
It's also not possible to compensate if a plane is flying faster because of a delay. A plane has a certain cruise speed but can fly a little bit faster. However, this means more use of fuel and thus more CO_2 emissions.

We see some different options to calculate the used emissions. In many cases there has to be made a choice between different calculation methods. For every situation, research should be done to determine which method is the best. From these options, determining emissions by fuel use seems the easiest one. This can also be linked easily with accounting. Fuel use is already known and the emission factor is also known. It's also used right now. We conclude that this is the best choice, the easiest one to implement.

8.10 Saving possibilities

Airlines have different possibilities to lower their CO_2 emissions. This thesis will not pay much attention to this fact, but some solutions will be provided to have a clear overview of them and to show that it's possible to reduce emissions:

- Fly on alternative fuels. A flight flying on biofuel will emit CO_2, but these emissions are absorbed before by for example plants in the short term. In the EU ETS, a flight may be seen as CO_2 neutral if a plane is flying fully on biofuel. An issue is the moral question about biofuel: how is the biofuel created? When using large amounts of land in third-world countries and food is used to create biofuel, this could probably create extra food problems there. Biofuel asks for an enormous amount of land, because the energy will be created via the very inefficient photosynthesis. Being aware of this is therefore very important. Flying on electricity isn't an option, because batteries are too heavy for planes and it's impossible to take the needed energy in form of batteries with the plane, because of the large space they need.
- Straight flights or no straight flights. An airline can choose to skip a stopover or making an extra stopover and skipping another flight. This can decrease the total fuel use and thus decrease CO_2 emissions.
- Decreasing the amount of flights. That's a radical step, but sometimes possible. The KLM can for example work together with the organization of hi-speed train Thalys to make travels between Schiphol and Paris more efficient. This also means a reduction of CO_2.
- Better occupation of flights. This can be done by skipping some flights and decreasing the frequency to get a higher percentage of occupied chairs.

- Glider landings. A plane at a great height has much potential energy that can be used in the form of glider landings. While putting the engines (almost) off, a glider landing could be made. There are some safety issues that should be taken into account, because in an emergency situation another plane can need to make an emergency landing and then a go-around should be made. The engines should than be put in full power.
- Decrease amount of used engines. This can be done while landing with a plane with four engines. However, it's also a possibility to use more wide-body planes with two engines instead of four. The less engines, the less fuel is needed.
- Winglets installation. Winglets can improve the efficiency of fuel use by decreasing swirls in the air.
- Replacing planes. Replacing old planes faster with newer planes can decrease the fuel use because most new planes are more fuel efficient. However, creating new planes will increase scope 3 emissions. The advantages will thus only count with very old planes that need replacement in the next years anyway.

8.11 Accounting: scope 1, 2 and 3

When discussing emissions we often divide these emissions into scope 1, 2 and 3 emissions. To have a clear overview which emissions are associated by making flights, we discuss these scopes.

One of the big issues are the limitations regarding scope 3 emissions from a system like the EU ETS. The CO_2 emissions of a flight (kerosene emissions) can be well calculated (being scope 1 emissions according to the GHG protocol), but scope 2 and 3 are not taken into account into the calculations. The scope 1 emissions can be determined pretty easily by doing scientific tests and determining the CO_2 emissions per amount of fuel (like how it works now).

Scope 2 is about the use of electricity. In a plane, all electricity will be created by used kerosene, so scope 1 is playing the role as electricity creator. However, on ground the electricity can come from other sources. A ground power unit (GPU) can work with other fuels. It's also possible that the electricity for the plane when the engines are switched off will be delivered by the airports' electricity network. The create an equal field, this energy should also be taken into account, not only the used kerosene.

Scope 3 is much more difficult. This is about all kinds of CO_2 emissions around the execution of the airline and is about things an airline is outsourcing. Not only the plane itself uses kerosene and will emit CO_2, also with the production, the maintenance and at the end of the life cycle the disposal of a plane, many CO_2 will be emitted. The CO_2 can be calculated with a LCA (Life Cycle Analysis). Besides this, some other things can be thought about:

- Meals in the airplane: low costs airlines ask money for using meals and drinks while service airlines provide this for free (the costs for this are already transferred into the ticket price). We can assume that more food will be taken when this is ‘for free’ and a customer has already paid for it. Thereby, it’s important to take into account the amount of used packaging material and which food will be served. With the production of packaging material and the production of food and drinks, also CO_2 will be emitted. An airline can change its CO_2 emissions also by changing food and drink providing, but the EU ETS doesn’t take this into account.
- The building, maintenance, use and disposal of a terminal and the strokes for landing: with this, also a LCA (Life Cycle Analysis) can give information about the amount of CO_2 emissions of a terminal. A terminal will be built to process passengers that are transported from place to place by a plane. The most CO_2 emissions can thus be attributed to airlines which are using the terminal. Thereby, heating, cooling, electricity, pubs and of course the CO_2 emissions of the building and maintenance should be considered.
- Emissions of CO_2 through personnel. Besides the fact that the transported weight of the stewards and pilots of an airline indirectly will be ‘taxed’ by the EU ETS, an airline will not be asked to take services for personnel into account like using hotels, food, drinks and commuting.
- Emissions of the executing personnel. Examples are air traffic control, mechanics of the planes, service desk employees, telephone operators, restaurants, cleaners etc.
- Pre- and post-transport of the travelers. In most cases, travelers should make a travel before they arrive at the airport and when reaching their destination, they also need transport to go to e.g. their hotel. In most cases this will be done by their own car, a rented car, taxi, metro, bus, tram or train. These ways of transport also emit CO_2. For example in the Netherlands, KLM can choose to make an extra stopover in Eindhoven. This will result in extra kerosene CO_2 emissions but can be a limitation of CO_2 emissions from pre- and post-transport for passengers in the south of the Netherlands. A cooperation between KLM and the Dutch rail operator NS (Nederlandse Spoorwegen) can result in a saving of the worldwide CO_2 emissions, like during a situation in 2009 whereby KLM travelers got a free train ticket for the travel between airport and home[36]. Such actions can’t result in corrections at the total CO_2 emissions that are taken into account by the EU ETS for airlines but can have effects at the worldwide emissions.
- Emissions of marketing. Doing marketing will also result in CO_2 emissions. Examples are the CO_2 emissions through production of billboards, airtime on television and radio and the printing of advertising in newspapers, magazines and leaflets.
- Divers (overhead) work: having a website, administration with computers, sending of invoices, printing of tickets, customs work etc.

[36] http://www.nu.nl/economie/1942695/klm-en-ns-intensiveren-samenwerking.html**;** accessed at 14-08-2012

For scope 3 of airlines we can conclude, comparing to cars and trains, that no roads or railways are needed. The CO_2 emissions of the building, the maintenance and the disposal of the roads result also in many CO_2 emissions. Ships and planes use ‘natural travel paths’ and because of that, their scope 3 emissions can be lower when comparing to the train (which however has less emissions per kilometer when driving, more about this in chapter 9). *The Koninklijke BAM Groep*[37] has done a research to railways and they conclude that a significant part of the CO_2 emissions of train kilometers are taking place during building and maintenance of the railways[38]. According to BAM, every kilometer railway will result into 50 ton CO_2 emissions per year[39]. In chapter 9 of this research more about this, but the scope 3 CO_2 emissions of railways and roads is a good argument to do a good research when comparing for example CO_2 emissions of train and plane. This makes it difficult to determine the exact emissions compared to other transport modes.

It is understandable that the CO_2 emissions of scope 3 are not taken into account. It’s very difficult to calculate these emissions and the responsibility of these emissions can also be somewhere else. Also, according to the GHGP, these emissions don’t have to be taken into account. But to let the system work really well and taking all CO_2 emissions into account when decreasing them, these influences on the global emissions can be taken into account. Landing at airports with a terminal which emits less CO_2 per passenger, stimulating public transport for transport between home and airport and improving efficiency in overhead (for example: paperless working) and also the commuting of the employees[40] have a big influence on scope 3 emissions from the airlines.

8.12 Analysis and chapter conclusion

The EU ETS is a system that needs green accounting in order to work well, so this is a good example of a system that needs green accounting. However, determining the CO_2 emissions of flights is sometimes difficult. The main difficulty is the question what has to be attributed, especially emissions from scope 3. In the EU ETS only the direct CO_2 emissions of fuel will be taken into account, but not the other effects like cirrus clouds and the also important NO_x emissions. Scope 3 effects are not taken into account, emissions that do not belong to an individual flight but can be attributed to that flight. So long as a system for airlines is independent of production, maintenance and disposal, not all real CO_2 emissions are taken into account. It can also be seen as dishonest compared to other ways of transport that also emit CO_2. Not taking into account the CO_2 emissions of for example roads and railways and not taxing the used electricity for e.g. hi-speed trains, delivers a competitive disadvantage to airlines and can be seen as unfair.

[37] An European building company with the Netherlands as administrative center (http://www.bam.nl; accessed at 14-08-2012)
[38] http://www.bamrail.nl/downloadwf/35, p. 2; accessed at 14-08-2012
[39] http://www.bamrail.nl/downloadwf/11, p. 4; accessed at 14-08-2012
[40] Sprangers (2011) did a research to the emissions of the Erasmus University Rotterdam and concluded that two-third of the emissions were caused by commuting of the employees and students.

Another point is that the introduction of an EU ETS system asks for extra administrative handlings. Airlines like the German airline Lufthansa complain about the costs which they have to make for these emissions, but at the same time the ticket prices will only increase with about 1-2%. However, when we count the total costs for an individual airline, there is an impact. For example the German airline Lufthansa calculated that it costs them 100 million per year.[41] We can also conclude that the introduction of the EU ETS was at an unhappy time: during an economic crisis with a high fuel price.

The question is who is helped with such a CO_2 emission trading system. It seems that the EU makes profit, because they earn money with the emission rights that are auctioned. The real purpose – decreasing the contribution from airlines to the global CO_2 emissions – seems small, also because airlines already – without this system – invest in improving the efficiency of their engines and improving the occupation of their planes. Thereby, having only the emission trading in the EU will deliver a large competition disadvantage for the airlines in the EU. According to a Dutch governmental research[42], 200 people could lose their jobs at Schiphol airport because of 150.000 less passengers travelling by plane when a flight ticket tax was introduced in the Netherlands. This should cost Schiphol for about 3,6 million Euros. When applying this in the whole EU, the effects seem smaller because of fewer alternatives at the borders, but this is indicative of competition effects that can happen.

This leads to the question if an EU Emissions Trading System is the best way to reduce emissions as long as not the whole world is taking part. We already saw that airlines can change hubs in the world, mainly in the Middle East. Turkish airlines and the Gulf carriers can avoid Europe. Emissions in the EU are emitted by airlines, but are there no alternatives that are better in reaching both EU and worldwide emission goals?
We already saw that a flight tax had a big impact on single countries and that leaks of passengers to other countries were large. Flight taxes seem to be no real alternative when people first travel to other countries (resulting into even more emissions). Thereby, which tariffs should be determined? When choosing fixed tariffs for the whole EU, some countries will have bigger disadvantages than others.

Maybe, taxes on kerosene can be researched. When applying this, also the world competition has to be taken into account. Taxes on kerosene seem a bit like the same as how the EU ETS works. There is an extra price for every liter burned fuel. The difference is that it is based on the used liters itself, rather than based on the emissions that will be emitted per liter fuel. Thereby, emission rights from the EU ETS can be sold and bought between organizations and thus this system creates flexibility while a tax on kerosene is more a simple tax per liter.

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41 http://investor-relations.lufthansa.com/fileadmin/downloads/en/annual%20meeting/2012/LH-AGM-2012-speech-Christoph-Franz.pdf; accessed at 14-08-2012
42 http://www.nos.nl/artikel/348451-vliegtaks-kost-schiphol-banen.html; accessed at 14-08-2012

The importance of emissions reduction may not be forgotten. If less passengers travel by plane (there is almost no alternative country outside the EU to travel from by plane), the emissions caused by air traffic is also reduced. The advantage is that it's stimulates CO_2 reduction and that the EU can reach its purpose to reduce emissions in 2020 by 20%.

Deciding about emission goals and the instruments that are used to reach them is also a political decision but should be supported by a good analysis of the situation. The system has just started in the airline industry, but there are improvements possible. Extension to more countries is the most important improvement but in order to work better, also prices of emission rights need to increase. While finishing this thesis, the price for emissions is so low that it has almost no effects compared to for instance the high volatile prices of kerosene.

In this system, emissions are based on the fuel use only and thus green accounting implementation is not very difficult. It can be linked with the current fuel use when landing in or departing from the EU and multiplied by the emission factor. However, emissions that are used in the system are limited to scope 1 CO_2 emissions. This means that not all emissions that belong to flights are taken into account.

Chapter 9 - Case transport modes

9.1 Introduction

In chapter 8, we discussed the participation of airlines in the EU ETS. However, this didn't include many of the scope 3 emissions (like e.g. infrastructure emissions of roads) which play a role when determining a certain transport mode. In this chapter we discuss a specific sector, the transport sector. Organizations make claims about emissions of transport modes. The question is how reliable these claims are and what the role of good green accounting is with this data.

In many cases, the calculation of the CO_2 emissions of transport modes is an issue. For a company, this could belong to their scope 1 emissions when they use fuel for their own cars. When using electric cars, the emissions belong to scope 2. For using the train or plane, in many cases an estimate of the emissions is available from the company that transports people. These emissions belong to scope 3. However, what about the scope 3 emissions of the production of cars, the infrastructure and the emissions that will be caused by the 'well-to-pump' distribution? In many cases, these emissions are underestimated. In this case, we give attention to these emissions and the issues when determining them. It supports the research with practical examples and with the extension of the scope 3 emissions of transport modes.

In this transport modes case, we first take an employee who has to travel for a company. Different issues are discussed regarding cars, taxis, public transport with (hi-speed) trains, travelling with a plane and cycling. We exclude walking; this will be seen as having no impact to the amount of emitted emissions. Secondly, some issues of transport of products will be discussed. Transportation can be done in different ways. Each of the ways has its own issues regarding emissions. The purpose of this case is to show the issues in determining emissions and the questions about how to value the emissions for green accounting.

9.2 Cars

Traveling by car results into the burning of fuel and thus into emissions. When travelling by car, these emissions seem very simple. The amount of tanked fuel can be determined exactly. If the employee uses a tank card, the amount of fuel liters is automatically saved into an Information System. If the car is a leased car, the lease company is able to check the kilometers with maintenance of the car. In many cases it's also important to determine emissions per kilometer, in order to make predictions about future use and use of outsourced transport like taxis. Thereby, many leased cars are also used privately and companies should know what the amount of private kilometers is: they are not responsible for those emissions. The formula to determine the amount of kilometers per liter will be simple:

"Amount of driven kilometers / used fuel liters"

The number we get is the average amount of kilometers that can be driven per liter fuel. However, when a car is used both privately and for a company, the owner should keep track of all his kilometers and this will result into more administrative work.

Emissions from fuel can be easily determined. When determining emissions, the amount of CO_2 emissions per liter fuel (emission factor) should be known. Fuel from the pump will result in about the following emissions:

Fuel	Emissions	Power
Gasoline	2,420kg CO_2	9,7 kWh p/liter (35 MJ)
Diesel	2,7kg CO_2	10 kWh p/liter (36 MJ)

Figure IX – Fuel energy values and emissions

These values are estimations because they are based on average temperature values (the mass of liquids is not the same as their volume).

However, the fuel from the pump is not pumped up at the pump. The fuel will be pumped up, transported from oil fields to the refinery. In the refinery it will be distillated to e.g. gasoline and diesel. After that, it will be transported to the pump. *Michael Wang* (2003) from the Center for Transportation Research[43] assumes an efficiency of this process of 80% – and that means for every liter of fuel, 0,25 liter of fuel is needed to transport it from oil field to pump. However, not all sources agree with this data. According to Connekt (2010) it will result into the following emissions, resulting into almost 0,15 liter extra fuel per liter:

Fuel	Emissions well-to-wheel
Gasoline	2,780 kg CO_2
Diesel	3,135 kg CO_2

Figure X – Fuel emissions well-to-wheel

In this process, we see that gasoline and diesel have different emissions. It seems that diesel will emit more CO_2 than gasoline. However, an important factor is also the amount of energy a liter of fuel can generate. 1 liter of diesel can generate more energy than 1 liter gasoline. Besides this, diesel motors are more efficient than gasoline motors. Furthermore, the assumption of the well-to-wheel emissions doesn't apply to every single liter of fuel. It's based on an assumption of the average emissions: how

[43] http://www.transportation.anl.gov/pdfs/TA/273.pdf; accessed at 14-08-2012

further a pump is from the distillation installation, how further the fuel should be transported. And the further the pump is from an oil field, the more emissions should be added per liter when applying well-to-wheel.

When using only the amount of burned fuel from the tank card, information about energy per liter is not needed. The car itself will use the fuel and the energy in the fuel. However, when taking decisions about using cars in an organization, it can be important information. Burning 1 liter diesel emits more CO_2, but will also generate more (efficient) power from fuel to the wheels.

The easiest determination of emissions from one car in a specific year is determining the tanked fuel in that year and multiply the tanked fuel by the emission factor. With the use of an assumption from well-to-pump fuel emissions, the needed emissions can be determined more exactly. Normally car emissions are simply the emissions per car travel. When determining emissions per passenger, the amount of emissions should be distributed between passengers. This is different from the procedure with train or plane travelers that result into the allocation of emissions per person.

However, only taking into account fuel use doesn't give a complete overview of the total emissions that can be incorporated by car kilometers. The production, maintenance and disposal of the car also mean use of energy and materials. Thereby, also the production, maintenance and disposal of infrastructure need energy. These are difficult scope 3 emissions, but should be allocated as emissions to the person or organization that uses the car when taking into account all the emissions that are associated with car driving.

We can have a look at the scope 3 emissions of a car. The research Life-cycle energy consumption and carbon dioxide emissions of world cars by *Kimmo Klemola* (*2006)* concluded that the energy use in the lifetime of a car exists of one-third of the energy use from the production of that car. Two-third exists of the primary energy (fuel) that a car uses. This research clearly shows that burned fuel counts for only two-third of the total emissions. That means that for every kilometer, 50% extra emissions should be added. This is a rough estimate of the scope 3 emissions of the life cycle, but gives an indication about the importance of these emissions. They should not be underestimated.

Overall this means that per liter of fuel 50% extra emissions should be allocated and 25% because of the well-to-wheel emissions. With a calculation of the CO_2 emissions during lifetime, besides the emissions from fuel use, 75% extra emissions should be added for an average car per kilometer.

Beside scope 3 emissions for cars themselves, there are also emissions of using the infrastructure (maintenance and building) like asphalt. It's very difficult to estimate a certain amount of emissions per kilometer of used infrastructure because infrastructure differs and is shared with many other cars and trucks. The best way to handle this is to take an average of emissions belonging to infrastructure per kilometer. However, many assumptions should be made.

Electric cars

Electric cars mostly deal with the same scope 3 issues as fuel-driven cars but differ in emissions relating to energy use. For fuel-driven cars, energy is generated at the car itself, resulting into scope 1 emissions. Electric cars have scope 2 emissions because they use electricity that is generated somewhere else. Besides this, emissions of the batteries can be taken into account as scope 3 emissions.

An important factor when using an electric car is the energy mix of countries or regions. When countries use much 'green' energy like Norway (hydropower) or use nuclear energy like France, they emit less CO_2 as country and that will result in less electric car emissions when using the energy mix assumptions. Thereby the value of nuclear energy should be determined: it's emission free when producing energy (besides the scope 3 emissions of transport and extraction), but can safety also be valued? It's possible to value nuclear energy as emission free, but allocate the nuclear waste in grams to the electricity user.

Opel Ampera

To illustrate the difficulty of determination the emissions with fuel-driven cars but especially with electric cars, we made a case about the electric car Opel Ampera. This car is an electric car but can also be driven by fuel, mainly because the range of driving electric is low (less than 60 kilometers). The emissions belonging to that car consists of fuel emissions when driving on the fuel gasoline. When driving electric, the emissions of scope 1 are zero, but not the emissions of scope 2. Also, the scope 3 emissions are not incorporated. For now, we will exclude scope 3 emissions.

In Figure XII, we show the calculations of scope 1 when this car is driven by fuel and scope 2 emissions when the car is driven by electricity. First, the electricity mix of the Netherlands is needed to determine emissions. This mix (International Energy Agency, 2009[44]) is based on the electricity that is generated in the Netherlands only (excluding imports and exports). The emissions that are associated with the different sources are assumptions made by J. van Staveren (2012[45]).

[44] http://www.iea.org/stats/electricitydata.asp?COUNTRY_CODE=NL; accessed at 14-08-2012
[45] http://www.energiefeiten.nl/; accessed at 14-08-2012

Production from: (2009)	Electricity (GWh)	Percentage	CO_2 emissions kg/kWh	CO_2 emissions well-to-power plant
Coal and peat	26605	23,44%	0,32	0,38
Oil	1487	1,31%	0,27	0,35
Gas	68705	60,53%	0,20	0,25
Biofuels	4538	4,00%	0	0
Waste	3084	2,72%	0	0
Nuclear	4228	3,73%	0	0
Hydro	98	0,09%	0	0
Solar PV	46	0,04%	0	0
Wind	4581	4,04%	0	0
Other sources	130	0,11%	0	0
Total production	113502	100%	-	-
Emission factor average	-	-	0,1996	0,2450

Figure XI – Electricity mix from the Netherlands in 2009

Then we also make some assumptions, also based on the assumptions from J. van Staveren (2012):

- Coal, oil and natural gas emit CO_2, electricity from wind, water, solar energy and nuclear energy will not, just like some other small sources (in fact, these have scope 3 emissions);
- Well-to-plug has an average of 33,33% (33 and 1/3) efficiency. This differs for different kind of energy sources;
- Charging has an efficiency of 85%, the electric motor 95%;
- Electricity from each plug in the Netherlands will be seen as equal: there is no such a thing like ‘green energy’ because no single person has an influence on the public electricity networks. Thereby, most of the ‘green energy’ that is sold by electricity suppliers is based on certificates. These are not always reliable, much of the Dutch ‘green energy’ is based on hydro certificates in Norway that also is sold to Norwegian people as hydro energy[46];
- In the Netherlands, for every liter of gasoline there is a small percentage of biofuel added. This will not be calculated in a special way and is seen as normal gasoline.

[46] http://www.trouw.nl/tr/nl/4332/Groen/article/detail/3298167/2012/08/08/Groene-stroom-is-succes-maar-helaas-niet-groen.dhtml; accessed at 14-08-2012

Opel Ampera electric drive	Opel Ampera fuel-driven (gasoline)
Battery capacity: 16 kWh Useable capacity: 10,4 kWh (35% electric residue for durability of the batteries) Maximum range: 60 kilometer kWh per kilometer: 10,4/60 = 0,1733 Km per kWh: 5,76924186 <u>Primary emissions (well-to-power plant)</u> CO_2 emissions p/km: 0,2450/5,7692 = 0,0425 Emissions primary energy: 42,5 gr/km <u>Plug-to-wheel assumptions</u> Efficiency of the charging (85%) and the car transmission (95%): 10,4 kWh/0,85/0,95 = 13 kWh needed from a plug to charge the batteries for 60 km. <u>Adding well-to-plug assumptions</u> Efficiency = 33 and 1/3 13/(1/3) = 39 kWh needed kWh p/km = 0,65 This means that for every kilometer, 650 watt as primary energy is needed Km per kWh = 1,5385 CO_2 emissions p/km: 0,2450/1,5385 = 0,1592 CO_2 emissions well-to-wheel: **159 gr/km.**	Using 1 liter of gasoline per 16 kilometer (assumption based on some user tests). CO_2 emissions 1 liter gasoline: 2,4 kg CO_2 emissions 1 liter gasoline well-to-pump: 3,1 kg <u>Energy use</u> 1 liter of gasoline: 9,1 kWh Energy use per kilometer: 9,1/16 = 568,8 Wh <u>Primary emissions</u> 3,1/16 = 0,1938 CO_2 emissions well-to-wheel per km: **194 gr/km.**

Figure XII – Emissions comparison between an electric and fuel-driven ride in the Opel Ampera

According to the calculations in the table, the emission factors are:

Electricity 159 gr/km

Gasoline 194 gr/km

This means that driving an Opel Ampera with Dutch electricity results into 18,04% less emissions than driving with fuel. When driving an average of 20.000 km per year, it saves (20.000 x 0,35kg) 700 kg CO_2 per year when driving all kilometers with electricity instead of gasoline. With an emission price of 12 euro (like assumed earlier in the research) per ton CO_2 emissions, it would cost € 8,40 to compensate these emissions, per year. This is very little and worth considering other cars that drive more fuel efficient than 16 kilometer per liter when considering a low-emission car.

For governments, it can be especially interesting because of the subsidies that are given. This data is not only interesting for organizations that try to estimate their emissions, but also for governments who want to determine the best strategies to influence people behavior regarding emissions. In the Netherlands, people who drive an Opel Ampera get subsidies (2012) that can reach thousands of euros because the car will be seen as if it doesn't emit greenhouse gasses. This case shows that there is more than scope 1 emissions and that scope 2 emissions should be taken into account also.

Issues

Some other issues when travelling by car:

- Determination of fuel emissions: difference between different fuel types (energy per liter) and values of volume and mass (scope 1). When determining emissions of fuel, some assumptions have to be made of the temperature and thus density of the liquids.
- Scope 3 emissions of getting the fuel: pumping up oil, distillation and transport of the oil (well-to-pump). How to take them into account: with assumptions or by making calculations for each fuel transport? Assumptions seem needed to keep it easy.
- Other emissions than CO_2 (especially with diesel-driven cars) that can possibly be taken as CO_2e emissions.
- Emissions of the infrastructure of electricity transport, especially regarding capacity of the high power that is needed at charging stations for electric cars.
- Emissions of parking places. When buying new cars for a company, a company needs more land (land use according to GHGP) for parking spaces. This can also apply to parking spaces of the employees at home. According to standards like GHGP, land use can also count in the scope 3 calculations.

9.3 Taxis

Travelling by car can also be done with a taxi. People are transported by a taxi-driver then. Actually, this means that somebody is outsourcing a ride to somebody else and that has consequences for doing green accounting. Taxi driving will result into extra emissions compared with a person who is driving a car himself. After making the ride, a taxi-driver will drive back with an empty car. However, for a company it's very difficult to determine the return ride emissions of a taxi ride.

When analyzing taxi use, we find some issues. Will the taxi driver return to the starting point directly without taking other passengers back? Then the emissions count double. If the driver takes people back in the taxi in the return ride, how should the emissions be allocated? If the driver takes more people than one (taxi sharing), how should the emissions be allocated (especially when different people use the taxi for different destinations)? How does a passenger know what the fuel use and emissions of a taxi are when he/she is in a foreign environment? Can a passenger choose between different taxi cars and pick the one with the lowest emissions? And if so, will this not be only a shift with another passenger that will use the taxi with more emissions?

Taking a taxi is difficult for doing a good green accounting. Assumptions should be made about the return trip and a fuel mix should be chosen. For taking taxis in different countries, organizations should explain why they make certain choices. A possibility can be a standard value per kilometer, but this standard value will thus contain lots of assumptions. This can be extended with a possibility for companies to use their own calculations if they can prove that they are better than the standard emission factors.

9.4 Trains

Taking the train is seen as a sustainable choice. Travelling by train is seen five times by *Milieucentraal*[47] and according to the Dutch railways *NS* four times[48] more sustainable than travelling individually by car. The question is: is this correct? And what is the underlying data? The fact that different organizations claim different reductions compared to driving a car is notable.

In the discussion part about car emissions we already saw that the well-to-wheel calculations result in a more honest calculation of the real emissions. By trains, also the electricity or fuel should be taken into account. This can be done by train distance from the beginning to the end station. The used energy can then be divided among the passengers and allocated to the individual passengers.

However, not all travelers travel from the starting point to the end station. Thereby, the trains are not completely full. For every passenger, the kilometers should be allocated to an individual person for the kilometers he or she has travelled. Thereby, with this calculation, the occupation of the train should also be taken into account. If the train is full, fewer emissions per passenger can be allocated per passenger than when a train has fewer passengers. This is a difficult calculation and will make it difficult for the passengers too. We can say that travelling in rush hour will be more efficient and thus results in fewer emissions. However, this stimulates travelling in rush hour. It results in a need for a higher amount of trains and because of the fact that the amount of trains should increase then, the scope 3 emissions grow (for building new trains). It's better to stimulate people to travel off-peak because the occupation is low and the marginal emissions will then be almost zero.

The best choice is to allocate emissions per kilometer based on the average occupation of trains. In the Netherlands, this is 29%[49]. This means that trains can be about 3 times more efficient in CO_2 than they are now. When increasing efficiency (in particular off-peak trains) in a year, emissions that should be allocated to passengers can also decrease.

According to the NS, the used electricity of NS itself exists of 1.500.000.000 kWh, while 900.000.000 kWh of this is used for the trains themselves[50]. With 16,8 billion traveler kilometers in 2011, this means that for every passenger kilometer 91,46 Wh is needed, including all the electricity use of NS.

[47] http://www.milieucentraal.nl/themas/schoon-en-zuinig-op-weg/auto-ov-of-fiets; accessed at 14-08-2012
[48] http://www.ns.nl/over-ns/ns-en-samenleving/ns-en-samenleving%5B2%5D/met-de-trein-reist-u-groener/een-derde-minder-co2-uitstoot.html; accessed at 14-08-2012
[49] https://zoek.officielebekendmakingen.nl/dossier/31510/kst-22026-313.html; accessed at 14-08-2012
[50] http://www.ns.nl/over-ns/wat-doen-wij/ontdek-ns/wetenswaardigheden/afval-en-energie.html; accessed at 14-08-2012

This includes all the energy NS is using, but to produce this energy there is more primary energy needed because of the efficiency factor of producing electricity. Thereby the distribution of electricity also results into some losses. The efficiency is less than 100% so extra energy is needed to produce the electricity.

However, we may not forget the emissions that are a result of the building of trains and the building and maintenance of the rail infrastructure. Thereby, for the infrastructure and the management of the train many employees are needed. Employees also have their emissions that can be allocated to the rail company. The main example is commuting. As said earlier, averages of 50 ton CO_2 emissions per kilometer railroad per year can be taken[51], according to *BAM*.

There are also some other issues that all should be taken into account when making a framework for train transport:

- 'Stop trains' will stop more times at more stations and will thus emit more emissions per kilometer;
- A traveler has no choice for a train that will bring him from A to B. A newer train can be more efficient. However, a passenger has no choice to choose for a new or older train;
- Season of the year. Travelling in the winter (heating) or summer (air-conditioning) will result in extra emissions, comparing it to spring or autumn;
- Emissions belonging to tickets. In the Netherlands, paper tickets are possible, but also the OV-chip card. Both have their own emissions;
- Emissions of the infrastructure and how to determine them: this means not only rail production and maintenance, but also 'land use'.

Hi-speed train example

Most issues that count for 'normal' trains also count for hi-speed trains. The main difference is that their speed is higher and that means that the energy use per kilometer is higher. Thereby, hi-speed trains make long distances (sometimes through different countries) and have fewer stops. We will give an example of the hi-speed train Thalys to make this more practical.

Thalys is a hi-speed train mainly travelling between Amsterdam (or Cologne) and Paris. The distance from Amsterdam to Paris is about 530 kilometers and will take 3 hours and 19 minutes (2012). The maximum speed is 300 km/h. In their 'koolstofbalans'[52] Thalys says they emit 121.999 tons of CO_2e per year for all train rides, including many scope 3 emissions. In Figure VIII we made an overview of these emissions, based on the 'koolstofbalans':

[51] http://www.bamrail.nl/downloadwf/11; accessed at 14-08-2012
[52] http://www.thalys.com/img/pdf/developpement-durable/bilan-carbone-nl.pdf; accessed at 14-08-2012

Category	Emissions in ton CO_2e	Percentage
Direct electricity	33.765	27,7%
Maintenance and renovation	14.754	12,1%
Services on board	11.274	9,2%
Transport of travelers to and from stations	36.983	30,3%
Infrastructure	23.443	19,2%
Headquarter	1.780	1,4%
Total:	121.999	100%

Figure XIII – Yearly emissions of the hi-speed train Thalys

It's very interesting that Thalys also includes transport to and from the stations and that they conclude that these are large. However, they are not clear about how these emissions are emitted and why. They simply conclude that per travelers' kilometer 15 gram of CO_2 will be emitted when only taking into account direct (electricity) emissions and 26 gram of CO_2 when all factors are taken into account. Examples of other calculations with different trains, hi-speed and 'normal' trains:

Source	Speed	Distance	CO_2 in gram p/km
Milieucentraal[53]	Mixed	Amsterdam – Bordeaux	90 kg in 2300 km = 39,1 gram
Thalys	Mixed	Amsterdam – Paris	26 gram
Duurzame luchtvaart[54]	Hi-speed	>500 km	99 gram
NS in 2010 (Dutch railways)[55]	Low speed	Inland	35,1 gram

Figure XIV – Comparison of different sources regarding emissions per train kilometer

In the table, different emission values are given with a difference up to almost 300%. The source is a very important factor. Organizations that take part in the airline industry say that hi-speed trains emit more than planes. In most cases the assumptions that are made are not clear. Organizations that make the calculations don't specify the emissions and don't explain well how they result into these emissions. This makes a validation very difficult.

[53] http://www.milieucentraal.nl/thema%27s/thema-1/schoon-en-zuinig-op-weg/vakantieverkeer/; accessed at 14-08-2012
[54] http://www.duurzameluchtvaart.nl/upload/actueel_4790_01.pdf; accessed at 14-08-2012
[55] http://www.ns.nl/over-ns/ns-en-samenleving/ns-en-samenleving%5B2%5D/met-de-trein-reist-u-groener/reductie-co2-speerpunt-voor-ns.html; accessed at 14-08-2012

Probably the difficult factor is the energy mix. Thalys can say that their emissions are low because of the high amount of nuclear energy in both France (78%[56]) and Belgium (54%[57]). The energy mix is an important factor for companies to do investments. When the energy mix of a country consists of less fossil fuel, the emissions of used electricity (scope 2) are also less. This means that a hi-speed train in France can be called 'more sustainable' than a hi-speed train in the Netherlands with an electricity mix that consists of more fossil fuel like gas and coal. From this, we can conclude that the energy mix (for electricity production) is a very important factor when determining emissions for electric trains.

9.5 Planes

Traveling by plane is already discussed in the chapter with the case about the EU ETS and airlines. For organizations and choosing their transport mode, one of the important issues is the scope 3 emissions. For planes the building, maintenance and the airports are the important scope 3 emissions. When comparing with travelling by train or car, the scope 3 emissions of the infrastructure can be low because of the fact that there is no (rail)road needed.

9.6 Bikes

Bikes seem a not very used transport mode, but are a very efficient transportation mode. There is less material needed to produce a bike, resulting in low scope 3 emissions. When taking into account the emissions of the employees regarding commuting, companies have an advantage when their employees travel by bike. There can be some questions about eating extra food through people (in fact biofuel), but according to GHGP, man power can be valued as emission free so the scope 1 emissions are zero. When using an electric bike, some scope 2 (electricity) emissions have to be added. These emissions are dependent from the electricity mix.

9.7 Transport

For many companies, another decision that should be made is the decision about the transport modes of goods like for example containers or bulk goods. In last years, production is moved from expensive countries like the countries in the EU to countries with low wages. For Europe, production is done in China and also in Africa. However, these countries are far away from Europe and thus transport is needed to bring products from production facilities to the customer. For long distances, two transport modes are the most used: plane and sea ships. Planes are used for products that need fast transport because they are much more expensive to use for transport than ships. Thereby, when talking about sustainability, planes also emit much more emissions. According to the International Maritime Organization (IMO)[58], container ships emit about 15 gram CO_2 per ton kilometer (1.000 kilograms)

[56] http://www.iaea.org/PRIS/CountryStatistics/CountryDetails.aspx?current=FR; accessed at 14-08-2012
[57] http://www.iaea.org/PRIS/CountryStatistics/CountryDetails.aspx?current=BE; accessed at 14-08-2012
[58] http://vorige.nrc.nl/economie/article1874079.ece/Ze_varen_allemaal_op_stookolie,_vuile_reut; accessed at 14-08-2012

and planes 550 gram CO_2. That's about 36 times more. Because of the fact that both planes and ships use natural transport paths (air and water), the scope 3 emissions of the infrastructure are limited to the terminals and the planes and ships themselves. Transport by plane will thus not only be more expensive but also result into much more emissions.

For the transport from seaport to hinterland, other transport modes can be used. Besides ships and planes, trucks, trains and pipelines can be considered. Each mode has its own advantages and disadvantages.

For the transport, we can distinguish between transport via water, air and land. Scope 3 will be an important issue here: transportation via water and air is about using natural infrastructure, not resulting into emissions for maintenance of the infrastructure (besides the terminals and the maintenance of some rivers). An exception for water transport is when channels are dug, like the Suez channel, the Panama channel and in the Netherlands for instance the 'Amsterdam-Rijnkanaal'. However, most of these channels are dug a long time ago so emissions can't be allocated to the users anymore.

At the other side, pipelines can be used for transport. They have low emissions for the transportation itself (scope 1), but have emissions for maintenance and emissions for building the (long) pipelines. Thereby, an issue is also the land use. When building the pipelines below the ground, there is no land used directly, but this is more expensive in maintenance and building (and also in emissions). When building the pipelines above the ground, it's less safe but cheaper. However, also land is used. Land use can be seen as a non-sustainable choice. This is because at the same place trees can be built for instance and those trees can compensate CO_2.

In between, trucks and trains can be considered. They need an infrastructure on land with maintenance and building emissions, but this infrastructure is shared with other participants (citizens, other companies) and thus these emissions can be shared with others. Trucks use diesel as fuel, trains can also use electricity. This electricity can be generated with sustainable sources but also with coal or gas. For trucks, the scope 1 emissions consist of the emissions of the fuel. For fuel-driven trains the same calculation can be made. However, when a train is driven by electricity, the calculation of scope 1 and 2 is more difficult. When determining, the energy mix of countries or regions is needed. However, when travelling through different countries, determining scope 1 and 2 emissions is more difficult.

The main issue when choosing a transportation mode are the emissions of the infrastructure: for planes it's only the terminal, for ships the same with maybe some maintenance for the rivers. For trains and trucks the (rail)roads should also be taken into account. This is a difficult calculation, because this infrastructure is shared with others.

9.8 Chapter conclusion

In this chapter we discussed different transport modes. We saw that emission determination of some emissions is difficult, especially those of scope 3. After an emission determination, doing green accounting has also many issues as we have seen. Probably the most difficult emissions are emissions from the infrastructure because this infrastructure is shared with many users. With transport modes that use the shared infrastructure, more leaks are possible, because infrastructure has a price when talking about emissions, but the question is whether this is also passed through to organizations. This creates a difference between air and ship transport that uses 'natural travel paths' and transport by roads and railroads that need built paths.

Another very important aspect is the electricity mix. We saw that emissions of electric cars are not zero like sometimes is stated. In the Netherlands they are pretty high because of the bad energy mix regarding emissions. When this electric car uses electricity from Norway for example, it's possible to see it as (almost) emission free because of the high hydro power there. This shows that calculations for energy mixes are precarious.

Furthermore, we saw different assumptions regarding efficiency of turning one kind of energy into another just like the scope 3 emissions of fuels (e.g. well-to-wheel). It's an important question if this can be measured well and if so, if organizations take efficiencies into account when determining their emissions.

Besides air transport, no other transport modes are required to take part into the EU ETS when having an organization in the EU. This makes this chapter different from the previous. When it's not mandatory to keep track of the emissions in an organization, an organization can see this as unwanted, costly and too difficult resulting into less transparency for customers and other stakeholders that want to take decisions based on an environmental statement of organizations that they can trust.

We can also conclude that driving yourself is easier for determining emissions than outsourcing trips to somebody else. The more transport of goods or persons is outsourced, the more difficult it is to know the emissions that belong to a certain transport.

Overall, we see that mainly scope 1 emissions can be calculated relatively easily by set emission values per used liter of fuel. Scope 2 emissions will be more difficult because of the electricity mixes but when knowing the correct data, calculations can be made. The main difficulty besides knowing the correct data is the difference of emissions per kWh in different countries. When operating internationally, this can result into a lot of calculations and thus resulting into much work. For scope 3 emissions, there are many questions about the correctness of the outcomes. In most cases there isn't even enough information to do the calculations. These emissions are very difficult to estimate and to determine. This supports the need to have a good common framework of green accounting and what should be taken into account and what can be left out because it’s too difficult.

Chapter 10 – Conclusion

10.1 Introduction

After doing research, based on the already existing literature, and making analysis in this thesis, we end up with the conclusion to the research question in this chapter. The research question is:

"How/why should green accounting be done and how could green accounting be supported by Information Systems?"

First we start with the main findings, divided into issues from scope 1, 2 and 3. Then we discuss some subtopics like results from the EU ETS and IT issues. After that, we state a short final conclusion, followed by the recommendations for further research.

10.2 Main findings

The main topic in this research is green accounting. All discussions, analyzes and conclusions are input to end up with an answer to the research question. Green accounting is mainly introduced because of the greenhouse gasses that result into worldwide global warming. Green accounting is a way to handle the emission data of different organizations in order to make comparisons possible and to enable legislation to end up with a verifiable reduction of emissions. In this research we defined green accounting as '*a type of accounting that takes into account the environmental costs of producing and supports the determination of emissions in a whole chain of production*'. It can be done in a similar way just like monetary accounting. However, doing and applying green accounting is not very easy. In our research, we saw beside the advantages a lot of limitations, issues and disadvantages. We divide the issues into categories that belong to the emission scopes (1, 2 and 3).

Scope 1 issues

First, to handle emission data, it should be clear what the actual emissions of products or services are. This is about the determination of the carbon footprint. We saw that it is coupled with some issues. Emissions can't be measured easily at every single burning installation; hence they are calculated on basis of fuel consumption. For much kind of fuels there are standardized emission factors per liter or kilogram based on scientific research in labs. We can say that this method is pretty reliable regarding CO_2 emissions, because in most cases determination is about a lot of fuel and then a mean of tests can be taken as reliable value. This method makes it easier for organizations to determine their scope 1 (own burned fuels) emissions: the amount of used fuel multiplied by the emission factor. To create an equal situation around the world, everybody should calculate with the same emission factor for the same fuel. For scope 1, good standards are needed regarding the emission factors and then the emission calculation can be done relatively easily.

Scope 2 issues

For emissions belonging to the use of electricity, we discussed the scope 2 emissions. The main issues here are the electricity mixes of countries. To know the emissions belonging to the use of electricity, we have to know what kind of energy is used to produce this energy. Solar, wind, gas, coal or nuclear energy have their own emissions. We saw that hi-speed train Thalys claimed that they've had less emissions per traveler kilometer than the Dutch railways (NS). This seems weird but it is the result of Thalys using French electricity, largely generated by nuclear power that can be seen as emission free. We saw the same issues with a case about the electric car Opel Ampera and can conclude that a standard for electricity should be clear and that data of the electricity mix of each country or region should be widely available and reliable at every moment. When somebody is using own generated electricity like solar energy, it should be possible to take that into account, but organizations should then prove that their calculations are correct.

Scope 3 issues

Scope 3 emissions are the most difficult emissions to determine. Therefore, the Greenhouse Gas Protocol and the PAS2050 standard excluded them as mandatory emissions and concluded that organizations should explain why they make certain choices about inclusion or not. However, this doesn't create an equal field and these emissions are a large part of the total emissions; according to the GHGP about 74%. Benchmarking is impossible and there are many possibilities to fraud. When an organization is outsourcing, emissions can change from scope 1 or 2 to scope 3 emissions. This creates possibilities for organizations to move their plants to other locations, for instance outside the EU where it will not be covered by the EU Emissions Trading Scheme. Precisely this is one of the main reasons why green accounting is needed. Emissions are 'sold' from one organization to another by selling products and services and this shows that emissions that belong to products or services are part of a chain. A possibility for this is to allocate emissions to a product or service in the same way as is done with VAT.

Though it is important to determine emissions, in many cases emissions from scope 3 are not clear. We saw that assumptions were made about the lifecycle of a car, the emissions belonging to railways and also emissions belonging to fuels before they are burned (transportation, processes etc.). Beside the fact that this information is not clearly available – other parties are also needed for information – the question can also be how to allocate emissions belonging to e.g. infrastructure. There are so many cars and trucks on the road, all driving different distances, different routes, with different impacts (through weight, speed etc.) that dividing seems too difficult. Applying frameworks for roads and railroads means that assumptions have to be made there and probably advantages of emissions belonging to the infrastructure use. Infrastructure can't be simply excluded: we also saw that some train emission calculations claim that trains are (more) sustainable but don't include the emissions belonging to the enormous infrastructure and land use that is needed, compared to planes.

Scope 3 emissions form a large part of emissions that can be allocated to products or services and can thus not simply be excluded. However, when applying a framework, there should be a trade-off between covering emissions and the possibility of measuring certain emissions in a way that competitive parties don't have advantages or disadvantages compared to each other.

Findings airlines in the EU ETS

In this thesis we included a case about the airlines in the EU ETS. This is an example where green accounting is needed already to tax CO_2 emissions. The question if the EU ETS is the right instrument at this moment doesn't belong to this research. However, we saw some improvements in order to create a more equal field between organizations, so the question is what we can learn from the current EU ETS for green accounting.

The EU ETS offers organizations flexibility by trading CO_2 rights, in contrast to a flat flight tax. Clear guidelines have been set-up to do the accounting especially for the airlines, but they only refer to scope 1 emissions of flights starting or ending in the EU. Scope 3 emissions belonging to the terminals or the LCA's (Life Cycle Analysis) are excluded though they are emissions that can be allocated to flights.

This trading system creates flexibility to reduce emissions in the cheapest way but also delivers competition disadvantages when not the whole world is taking part. Because airlines operate very internationally, international competition is an important factor. It's possible that for instance airlines from the Middle East or Turkey profit from the system. However, despite of the losses some airlines claim, the demand effects seem also very low because of the low price of emission allowances (in 2012). Also, the costs of tickets increase with sometimes less than a half percent, thus having only a small influence. The question can be then if the (administration) costs are not too high compared to the benefits. In order to let the EU ETS work, the price of the allowances should increase.

Information Technology

Green accounting should be supported by a reliable Information System that supports keeping track of emissions. Doing everything on paper doesn't work anymore. When a good framework is developed, IT can support the administration so the extra work for organizations is reduced. The choice for a new system or changing current systems should be made by the organization, but it seems most logical to implement a new component in the already existing systems. When emission factors are known, they can be linked to amounts of fuel (scope 1) and electricity (scope 2) automatically and reports can be created. Just like scope 3 emissions are the most difficult in accounting also scope 3 emissions are the most difficult ones to implement in the system. They can't be linked easily to items that already exist in an Information System. For example, infrastructure use is not part of an Information System. Only when emissions become part of a chain, Information Systems can handle them better. Otherwise scope 3 emissions should be calculated by hand with many assumptions.

10.3 Overall conclusion

Green accounting is should be done to give a reliable insight into as much emissions as possible where organizations are responsible for. Thereby it helps them with their choices and the reduction (objectives) of emissions.

An important trade-off should be made between measuring emissions and the (IT) administration work. IT can decrease the administration work by linking it to existing information in the Information Systems, but it can also result into extra emissions because of that extra (IT) work. This factor may not be undertaken.

Overall, we can conclude that determination of emissions results in a lot of work, is sometimes laborious and is above all dependent from a lot of assumptions now. Therefore, it is needed to have better and clearer standards to prevent fraud with statements about emissions. These standards should also include other emissions than CO_2, because they also have their influence. The current standards like GHGP and PAS2050 can be used as base but are not good enough to create an equal international field for organizations. They are too non-committal, especially regarding scope 3 emissions. The best way how green accounting can be developed is to make emissions part of a chain. When a product or service is bought by another organization or person, the emissions belonging to that product will be 'sold' with that product or service. This means that the statements about emissions will depend on fewer assumptions than now. However, it's needed to make international agreements in order to prevent competition disadvantages between countries and to create an equal field.

10.4 Further research

Much more research is possible and is done already. This research supports doing research in the field of green accounting. The most important thing is that an international framework of green accounting will be developed that includes as many emissions as possible.

Further research can be done in different fields: more (unknown) standards that are available can be compared and other emissions than CO_2 can be researched deeper. Also, more issues can be discussed in a research. An example is the transport sector. Different transport modes can be researched more deeply with attention for all aspects. This can result into an overview of the different aspects in e.g. the transport sector so that it can contribute to a standardized framework. Regarding the emissions rights it's interesting how organizations can value them economically and what the best is.

Another interesting aspect can be the appreciation of organizations of green accounting systems. The way they think about doing green accounting the best, especially regarding IT systems, is important to improve the current systems that support green accounting. Interviews are an interesting instrument for that.

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